Master thesis

Sustainable structural timber floors

The influence of vibrational performance on the sustainability of structural timber floors

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by

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Preface

This thesis was written to finalise the Master Degree of Civil Engineering for the Track Building Engineering, with specialisation Structural Design at the TU Delft. I want to thank everybody for their involvement, time and dedication in the process of writing, reviewing and assessment of this thesis. A special thanks for my graduation committee for their support and guidance during the thesis process.

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Abstract

The recent developments in the building industry to build more sustainable should result in the use of light constructions with a low environmental impact. Timber is a suitable material for this purpose. To reduce the environmental impact of a building, an improvement in an often used structural element can have a significant impact on the sustainability. Floors are a large part of the material consumption of building. A challenge with lightweight timber floors is the vibrational performance of the floor due to walking humans. Conventional concrete floors are less sensitive to vibrations due to their large weight. The vibrations of the floor have influence on the comfort of the humans residing on the floor. Furthermore, concrete is generally seen as a less environmentally friendly material than timber. This raised the main research question of this thesis: How do vibrational performance levels influence the sustainability of several timber floor systems, considering multiple design configurations, compared to conventional concrete floor systems?

The floors used in this research are a CLT floor, LVL box floor, TCC floor, concrete cast in situ floor and concrete hollow core floor. For the research on the vibrational performance and sustainability of floors some methods for assessment are used. For the vibrational performance the assessment method from the renewed Eurocode 5: Timber structures is used. This assesses the resonant and transient vibration response of the floor and checks them with predetermined vibrational comfort criteria. For the assessment of the sustainability the environmental cost indication is used. This method assesses several environmental impact categories and weighs their impact onto the environment, separately the global warming potential is also assessed by the CO2eq emissions of a material.

The result gathered from the research show that timber floors are more sensitive to vibrational performance than concrete floors. Floors with a high vibrational performance need a significantly higher floor height than low performance floors. The influence of damping and floor configurations is important for the vibrational performance. The environmental impact of timber floors have an advantage when biogenic carbon is taken into account. Concrete floors can reach longer floor spans and for high performance floors have a lower increase of environmental impact than timber floors. For the environmental impact of a floor, reuse or recycling is important for the end-of-life scenario.

To draw a conclusion to the main research question; Vibrational performance of floors do effect the environmental impact of the floors. High performance floors have a significantly higher environmental impact than low performance floors. The environmental impact of concrete floors increases less for higher floor performances than timber floors. Timber floors are more sustainable within their technical feasibility. The floor configurations can mitigate vibrations and can thus reduce the environmental impact of the floors.

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Part I

Introduction

1. Introduction

1.1 Relevance of research

The world's climate is changing rapidly (IPCC 2022) and so is the perception of the human contribution to this increasingly challenging environment. The building industry is becoming more conscious of the challenges for the future. The building industry currently contributes largely in the worldwide emissions of CO2 In order to improve this, one of the challenges is to create a sustainable building environment, by decreasing fossil dependencies and to build carbon neutral in 2050 (Ministerie van Infrastructuur en Waterstaat, 2023). This can be achieved by building with new and innovative building methods as well as using different building material.

A leap forward in sustainability can be managed by tackling the building element with the largest use of building materials first. One of the most common elements in the building industry are floors. Around 50% of the material use in buildings are for floors (Van Haalen, 2018). A small improvement in sustainability for floors can potentially have a large impact on the total environmental impact of the building industry.

Concrete and steel are currently the main material used to construct buildings and floors. Timber is historically one of the oldest materials used for construction of buildings and floors. The use of timber diminished the last centuries (Van der Lugt, 2020) due to the technological improvements of materials such as concrete and steel. Technological advancements of engineered timber products such as cross laminated timber (CLT) and laminated veneer lumber (LVL) created competitive alternatives for these materials.

Due to the low density of timber, it facilitates lightweight structures. This results in more sustainability benefits, such as lightweight foundations, less heavy machinery needed to produce and install the building, less transportation movements to and from the building site. While on the contrary, lightweight structures are susceptible to human induced vibrations, where heavy structures are less sensitive to these vibrations. Since in general mass dampens vibrations and lowers the amplitude (Labonnote, 2012).

The effect of lightweight structures was experienced on the *"De Karel Doorman"* project in Rotterdam. This project was halted due to excessive dynamic behaviour of the lightweight structure. The results of the investigation performed by TNO resulted in the insight that strength nor deflection seemed the governing criteria, but the vibrational performance (Oonk, 2020). Vibrational performance regulations were already available, but have been expended since this incident. The Hivoss guideline was developed on behalf of the Research Fund for Coal and Steel and was specified for steel structures (Research Fund for Coal & Steel, 2007).

Due to the upcoming use of timber in floors, the renewed Eurocode 5 has included a method to analyse and validate the vibrational performance of timber floors. Both are based on decades of research into vibrations (Smith et al., 2009).

The vibration of floors have influence on the assessed comfort of the users (Labonnote, 2012). Since comfort is a subjective requirement several levels can be defined ranging in comfortability. In order to comply with certain comfort requirements the floor structure should be adjusted and this might result in addition of materials (Smith et al., 2009). This addition of materials has influence on the environmental impact of the floor structure. In a Malaysian study by Balasbaneh et al.(2022) on four different heavy floor types a timber-concrete based floor had the lowest environmental impact, but only one situation was analysed and due to the heavy floors, vibrations where not taken into account.

Since lightweight floors could need more material to comply with vibrational requirements and heavy floors are less prone to be governed by vibrational performance, the question arises what the influence of the vibrational performance is on the environmental impact of the floors. Especially when using different floor types and materials. This is a deficiency in the knowledge about the relation of vibrational performance of lightweight structures and their environmental impact.

1.2 Problem statement

Timber floors have a high potential to make the building industry more sustainable. Timber has a lot of advantages over conventional materials such as concrete and steel. It has a lower environmental impact and has the potential to build lighter floors. A downside of these lightweight floors is their susceptibility to vibration, which can be a governing design criteria.

To reduce the vibrations in a floor, material needs to be added. This reduces the sustainability of the floor and thus a reduction in sustainability potential. Since vibrations influence the comfort of people in the building, it is possible to define levels of vibrational comfort for a floor. The severeness of these levels can contribute to using less or more material for the floors and thus influences the environmental impact of the floor.

Conventional heavyweight concrete floors are less sensitive for vibrations and its environmental impact is based on governing criteria like strength and deflection. The measures taken to comply lightweight floors to the vibrational requirements might reduce their sustainability, while heavyweight floors comply without measures taken.

Further research is required to give insights whether lightweight timber floors are always more sustainable than heavyweight concrete floors given multiple vibrational requirements in several design configurations.

1.3 Research question and objective

The following main research question will be the basis to solve the problem mentioned in the problem statement.

How do vibrational performance levels influence the sustainability of several timber floor systems, considering multiple design configurations, compared to conventional concrete floor systems?

The main objective of this research is to find for different design configurations the influence of vibrational performance levels on the environmental impact of different timber floor systems and compare this to the performance of conventional concrete floors. This research should enable engineers to make more sustainable design decisions for floors which are exposed to human induced vibrations.

1.4 Methodology and thesis structure

This thesis was performed in the timeframe April 2022 until August 2023. This thesis consists of four parts, where part I introduces the problem, state of art, research questions and method. To be able to resolve the main research question several sub questions are defined, which are answered in the chapters in part II & III. In part II a literature research is executed into available structural floors, the theory behind floor vibrational performance and the theory behind quantification of sustainability. In part III a modelling study is performed onto the vibrational performance of the different floor types and a data comparison study is executed for the sustainability of different floor types. This information is combined and a comparison between floors, vibrational performance and sustainability is stated. In part IV the research is compressed into the discussion, conclusions and recommendations.

Part I: Introduction

Chapter 1: Introduction

Chapter 1 gives a general introduction into the thesis subject. It introduces the problem arisen from previous research and literature and the relevance of this research. The problem itself is then stated and the research question, objective and methodology is described.

Part II : Research on floors, vibrations and sustainability

Chapter 2: Timber & conventional floor systems

In chapter 2 the available timber floors and conventional concrete floors are described. These floors will further be used for the analysis in part III. The data used for the available structural floors, are provided by several manufacturers, dependent on the material. The following sub questions are used to clarify and support the main research question.

a. What kind of timber products are available?
b. What floors are used conventionally?

Chapter 3: Theory and quantification of floor vibrations

In chapter 3 the background of the vibrational performance of floors is introduced. For the analysis of the vibrational performance of the floors, the method from the draft Eurocode 5 (NEN-EN 1995-1-1:2022, section 9.3) is used and a comparison is made with the HIVOSS method. Data is gathered from manufacturers and literature. The following sub questions are used to clarify and support the main research question.

a. What are vibrations?
b. Which factors are influential in floor vibration?
c. What are the testing criteria for vibrational performance?
d. Which levels of vibrational comfort could be stated?
e. Does adding mass have a positive influence on the vibrational performance?
f. How do known methods for analysing vibrational performance work?
g. What is the best way to analyse vibrations in timber floors?
h. Is this method also applicable to concrete floors?

Chapter 4: Theory and quantification of sustainability

In chapter 4 the definition of sustainability of materials is explained and a method to quantify the sustainability is introduced. The Environmental Cost Indication (ECI) is the used method, its strengths and weaknesses will be explained and scenarios will be drafted in order to be able to compare different materials with each other. The following sub questions are used to clarify and support the main research question.

a. What is sustainability of construction materials?
b. How can sustainability be quantified?
c. Which factors are influential for environmental impact of floor systems?
d. What is the role of circularity in the environmental impact?
e. How can circularity be quantified?

Part III: Vibrational performance and sustainability of floors

Chapter 5: Vibrational performance of floors

In chapter 5 the vibrational analysis of multiple floor is performed. This analysis is executed according to several scenarios to sketch the influence of several parameters and to make comparison of different floors possible. The structural calculations are performed using the appropriate Eurocodes and the vibrational performance is verified according to the draft EN 1995-1-1 method. The following sub questions are used to clarify and support the main research question.

a. What is the minimum floor considering structural safety?
b. What should be added to comply with different vibration levels?
c. What are useful parameters to optimize the vibrational performance of the floor?

Chapter 6: Environmental impact of floors

In chapter 6 the environmental impact of different floors are tested using different sustainability scenarios. These scenarios are based on short and long term environmental effects. The ECI of these scenarios are compared for several floors. The following sub questions are used to clarify and support the main research question.

a. What is the environmental impact of the floors?
b. What is the effect of including or excluding environmental impact modules?
c. Which environmental impact modules should be tested for a fair comparison?

Chapter 7: Relation between vibrational performance and sustainability of floors

In chapter 7 the vibrational performance of the floors and the environmental impact of the used materials are combined. The effect of vibrational performance on the sustainability of a floor is shown. Some parameters which can improve the environmental impact and/or vibrational performance will be discussed. The following sub questions are used to clarify and support the main research question.

a. What is the relation between environmental impact and vibration levels?
b. What is the difference in environmental impact between different floors based on the vibrational performance?
c. In what way do design choices influence the environmental impact based on vibrational performance?

Part IV: Discussion, conclusions and recommendations

The discussion in chapter 8 will summarize and discuss the main findings of this research. Chapter 9 will give the conclusions from this research and recommendations for future research.

Part II

Research on floors, vibrations and sustainability

2. Timber and conventional floor systems

This chapter introduces the structural storey floor in buildings along with possible types of floors. The main subject will be floors based on timber, but for the comparison, conventional floors from concrete will also be introduced. The fabrication method and some properties of each floor type will also be introduced. The types of floor introduced in this chapter will be used for the analyses in the upcoming chapters.

2.1 Use of floors in buildings

This thesis analyses the behaviour of one of the most common element types in the building industry; the structural floor. The floor carries the loads of the spaces above and divides spaces above and below the floor. It acts as a barrier and a load carrier. This thesis specifically looks into the structural storey floor in utility buildings such as offices.

Historically, decennia ago, floors were usually built from wooden beams with planks on top. Buildings were often built with timber as it was readily available and strong enough for its purpose (Powell, 2011). In the last decennium, materials such as steel and concrete became more popular to build with. One of the reasons was the higher strength and less prone to fire. Concrete floors became the new standard in the building industry. Recently, timber gained interest and popularity again for structural use in buildings. Due to the low environmental impact of the timber and innovations in engineered timber, such as CLT and LVL.

Concrete floors are still the most commonly used floors in the building industry. Different types of floors are in use. Next to conventional solid concrete floors, also hollow core floors are commonly used as a structural storey floor. Usually the bare structural floor will be finish ed with a floor on top, this is common with all floor types and is usually dependent on building physical requirements. The upcoming paragraphs will go into each floor type, its production process, strengths, weaknesses and which data is used for each type of floor.

2.2 Timber floor types

Timber is not a new material for the construction of floors, but due to recent innovations in engineered timber products, it regained interest. The new types of timber floors are Cross Laminated Timber (CLT) floors, Laminated Veneer Lumber (LVL) box floors and Timber Concrete Composite (TCC) floors. These floors will be used in this thesis and are explained in the following paragraphs. Each floor will have a standardised floor build-up consisting of an insulation layer, screed and a floor finish. This build up can be seen in figure 2.1. This floor build up will be on top of each structural floor, independent of the material, in the figure a basis structural floor of CLT is taken. It shows a typical build-up of a floor. Depending on the function of the room above the floor, building physical requirements such as sound insulation and heat insulation the build up can change, so this wont be taken into account in this research, except the weight of a typical floor build up including the weight of installations are taken into account in the structural calculations.

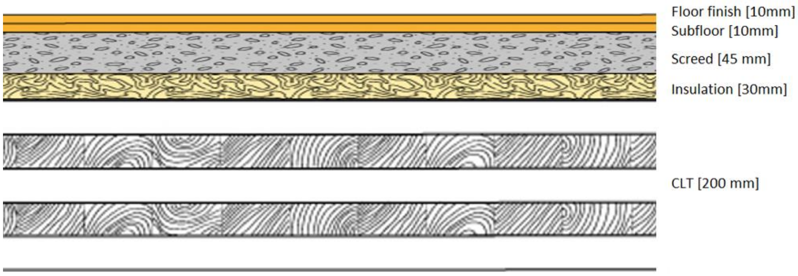


Figure 2.1: Example of floor construction build-up on a CLT basis

Cross Laminated Timber (CLT)

Cross Laminated Timber is a relatively new construction material, it is a panel made from solid timber glued together in cross direction, hence the name Cross Laminated Timber. The panel is built from spruce and pine softwood and is fabricated in a factory and can be processed into readily avaible wall, floor or roof panels. The panels can consist of 3, 5, 7 or 8 layers depending on the structural requirements of the panel. The panels are glued together with approximately 1 volume percent of glue and 99% solid timber (Stora Enso). The servicelife of the timber product can reach 100 years in indoor environments.

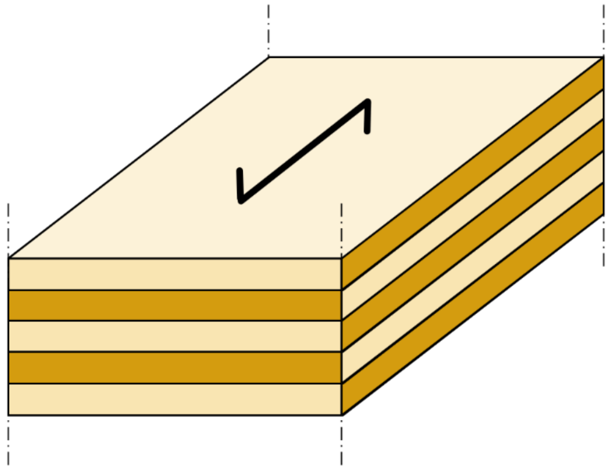


Figure 2.2: Graphic interpretation of a CLT panel

The production process of CLT is as follows: Trees are cut down and sawn into squared timber, this timber is then kill dried to approximately 12% moisture content, the timber is then strength graded, trimmed and fingerjointed into long boards, it is then planed, edgebonded and surfacebonded. It is then put into position lengthwise and then crosswise, the panel is then pressed together and cured. The CLT panel is then ready for post processing into building elements. The CLT panels are available in a maximum width of 4 meters and a maximum length of 16 meters. The structural strength of the panel is dependent on the main loadbearing direction, this is the direction of the toplayer and bottomlayer of the panel. To increase the strength in a certain direction, the top and bottom 2 boards can be layed into the loadbearing direction to increase the stiffness in this main direction. The strength of the toplayers of timber are usually C24 grade. Floors are available from 80mm (3 layers) to 320mm (8layers) thickness. The floors considered in this thesis can be found in a*ppendix A*.

Figure 2.3: Example of a CLT building with CLT floors

Laminated Veneer Lumber (LVL) Box floor

Laminated Veneer Lumber is a timber based panel product, it consists of tightly glued veneers in a main direction. Veneers are the product of peeling a tree, such that thin sheets arise. The timber used is spruce softwood. The LVL is available as beams and panels, to create a floor, the beams are connected to panels such that a box floor is built. See figure 2.3. This box shape is an important factor to be able to use LVL as a flooring material. This geometry used less material than solid floors and it enables comparable spans with lighter floors.

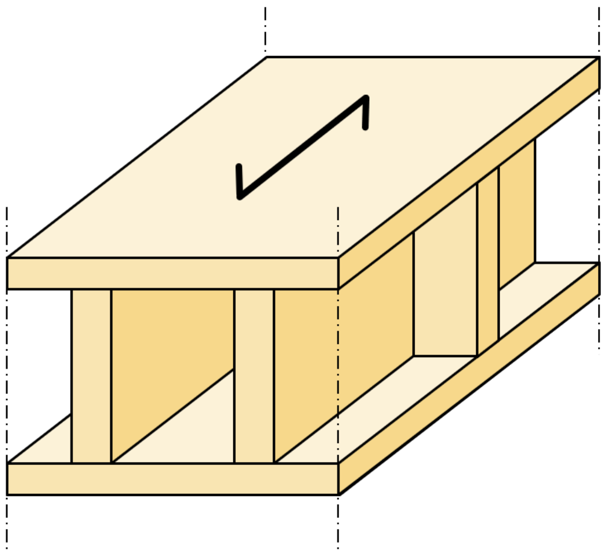


Figure 2.4: Graphic interpretation of a LVL panel

The production of LVL is as follows: Trees are cut down, the tree is soaked in water to soften the wood, it is then peeled into veneers, dried to 9% moisture content and graded. Next, the veneer goes to the layup line where the veneer is stacked and glued together, then the stack of glued veneers is pressed and sawn to the right dimensions. The layup can have the veneers in the same direction or some in the cross direction, this depends on the structural requirements of the LVL type. The amount of glue used in the LVL panels is approximately 6,5% of the volume and 93,5% of timber veneers (Stora Enso). The servicelife of the LVL product can reach 100 years in indoor environments. LVL panels are avaiable in width upto 2,5m and a maximum length of 24m. The strength grade of LVL is upto C44 class. The panels are available upto 75mm thickness. The floors considered including the calculations can be found in *appendix A*.

Figure 2.5: Example of a LVL floors (open box)

Timber Concrete Composite (TCC)

Timber Concrete Composite is a combination of a timber based panel and concrete on top of the timber panel. For this thesis, the basis for the timber-concrete composite considered is a CLT panel with concrete structurally bonded to the top of the CLT panel. In theory this results in a floor which combines the advantages of a CLT floor and a concrete floor.

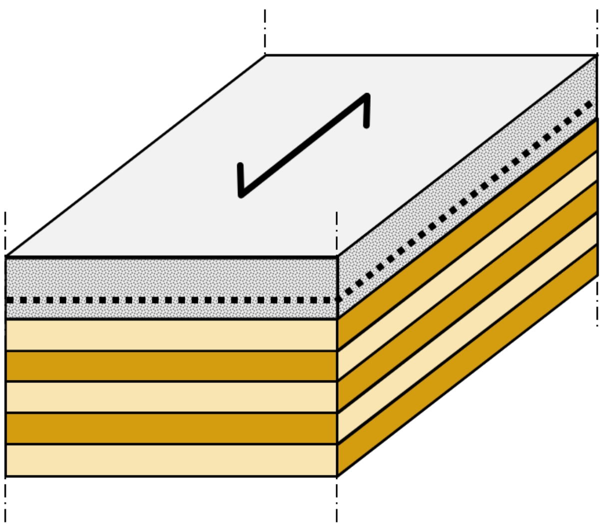


Figure 2.6: Graphic interpretation of a TCC panel

The production process starts with the CLT panel, which is brought to the construction site. The CLT panel can already be prepared for the structural concrete layer by the use of prefabricated grooves in the CLT or on site fasteners will be added to the panel. The panel itself already functions are formwork for the concrete. On site some reinforcement is added and the concrete is poured on top. This results in a solid connection between the CLT panels and the concrete. Figure 2.6 shows a TCC floor. The final floor will be a solid floor with all possible dimensions with a limit to the length of the CLT elements. The floors considered including the calculations can be found in *appendix A*.

Figure 2.7: Example of a TCC floor in a building

2.3 Conventional floor types

For this research the timber floor types are measured against the conventional floors types currently often used in buildings. The conventional floors made are from concrete. For this research, 2 conventional type floors are considered. The solid reinforced concrete cast in situ floor and a prefab concrete hollow core floor. These floors will be explained in the paragraphs below. To be able to make a fair comparison, the build-up of the concrete floors is the same as for the timber floors, this can be seen in figure 2.1.

Concrete cast in situ

Concrete cast in situ is a conventional way to build. A steel reinforcement is created within the formworks and concrete is cast in between. The concrete can withstand high compression but can handle limited tension. In order to cope with the tension the steel reinforcement is put in place. This results in a heavy floor due to the solid concrete slab. See figure 2.8. Due to the pouring of the concrete the material has a large freedom to get the shape needed. A downside is that a formwork needs to be put in place to support the drying concrete until it can bear is own load. Due to this design freedom, the dimensions are not limited to fabrication sizes.

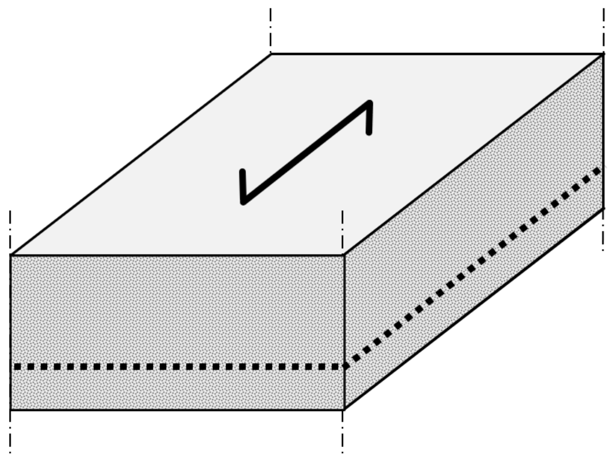


Figure 2.8: Graphic interpretation of a concrete cast insitu panel

The construction can withstand high forces and due to the high stiffness and strength. Concrete is versatile due to the specifiable concrete mixture, which enables concrete to have different strength grades. In this research the strength grade of C30/37 will be used.

Figure 2.9: Example of a concrete cast insitu building

Concrete hollow core

Concrete hollow core floors are another conventional material to build with. The concrete plate has hollow cores which makes the floor lighter but still strong. The steel rebar in the floors are pretensioned during the fabrication process. A graphical representation can be seen in figure 2.10. The floor is prefabricated and has typically a strength grade of C45/55 (VBI).

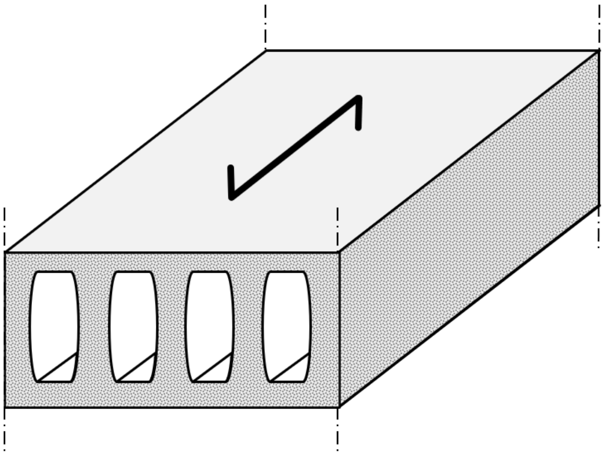


Figure 2.10: Graphic interpretation of a concrete hollow core panel

The floors are prefabricated in slabs of 1,2m width, fitting plates with specific widths can be fabricated to order. The plates are cut to length up to 16m, which is also the approximated maximum span. The floors can also be prefabricated with slots for plate coupling or installations.

Figure 2.11: Example of concrete hollow core floors in building

3. Theory and quantification of floor vibrations

This chapter discusses the theory of vibrations in floors. It explains the way vibrations work in a floor what the vibrational source is, what the important parameters are and which influence they have. It also be explains which methods can be used to analyse vibrational behaviour of a floor. The corresponding criteria on which a floor should comply and which vibration levels are known. Finally, a method will be deducted which will be used in the model and data analysis in part III of this thesis.

3.1 Theoretic background of vibrations

In order to understand vibrational behaviour of floors, a basic knowledge about what floor vibrations are, which factors are important and how to analyse these vibrations. This chapter will go into the background knowledge of vibrations.

3.1.1 Basis of vibrations

Vibrations can be stated as a harmonic displacement of a structure in a certain time caused by an external force. The structure in this case is a floor. The dynamic behaviour is caused by a dynamic load which excites a dynamic force on the structure. A simple model to determine displacements, velocities and accelerations of this structure is a single-degree-of-freedom (SDOF) system. This model consists of 3 components: mass, stiffness and damping. Figure 3.1 shows this simple SDOF system (Blaauwendraad, 2016).

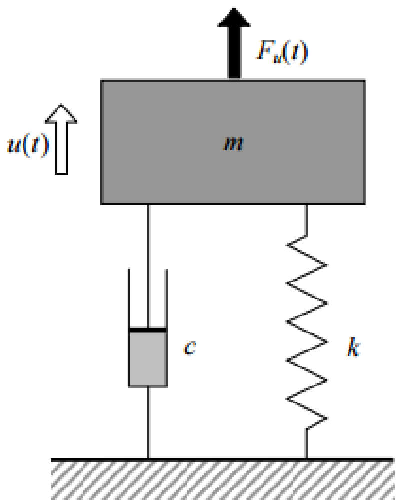


Figure 3.1: SDOF system

The SDOF system is a dampened mass-spring system with one degree of freedom. The mass is concentrated at a point and the damping and stiffness are idealized at that point. This point can be displaced by the external force. The mass [m] is the modal mass of the floor, the damping [c] is the assigned damping of the floor and the stiffness [k] is the stiffness of the floor.

Eigen frequency & mode shapes

Each system has a its own eigen frequency, this is a rate of which the system will naturally vibrate. This is measured in Hz (cycles per second). A system, in case of this thesis a floor, will oscillate in accordance with a few properties of the floor, namely the stiffness, mass and span. The eigen frequency of a simply supported floor can be calculated according to formula (3.1), where EI is the stiffness of the floor, m the mass per unit area (kg/m2) of the floor and L the span of the floor.

$$f_1 = \frac{\pi}{2}\sqrt{\frac{EI}{mL^4}} \qquad (3.1)$$

A system has unlimited eigen frequencies, these are called the harmonic frequencies. The first harmonic frequency corresponds to the first mode shape of a system, the second harmonic for the second mode shape and so on. See figure 3.2 for the first 3 mode shapes of a simply supported beam. These mode shapes correspond to a natural wave position which fits the system, hence the natural frequency. The first mode shape requires the least amount of energy to get into motion. Considering a certain constant dynamic load, the first mode will thus cause the largest deflection and motion. Higher mode shapes require more energy to get into motion and will thus have a lower deflection and motion. The first(fundamental) frequency always corresponds to the first mode shape (Smith et al., 2009).

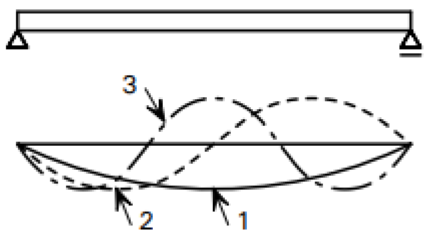


Figure 3.2: First 3 mode shapes of a simply supported beam

Modal mass

The modal mass of a floor is important for the vibrational performance of the floor. The modal mass is the total amount mass of the floor which is being activated by a vibration. Thus the kinetic energy within the system (Jarnerö, 2014). The modal mass depends on the mode shape and thus the floor configuration, but can be approximated for a simply supported floor by formula (3.2). The modal mass is used to calculate the resulting reaction and dynamic behaviour of the floor.

$$M^* = \frac{mBL}{2} \qquad (3.2)$$

Damping

The damping of a system reduces the oscillating deflection caused by dynamic loading. Damping dissipates the energy introduced by the dynamic load. This dissipation can be transferred internally and externally. Internally via friction and externally to adjacent structural components, objects on the floor or even with active dampening. The system dampens the dynamic load over time until the structure in equilibrium again. Dampening is hard to predict due to the complexity of elements involved and to what level each element adds to the damping of the system. The level of damping is often determined from measurements on a situation in practice (Cobelens, 2018) (Labonnote, 2012).

The level of damping is expressed as a damping ratio which is a percentage of the critical damping. Critical damping is the amount of damping in which the excited system directly returns to its equilibrium position without oscillating (Blaauwendraad, 2016). The figure below shows the degree of damping.

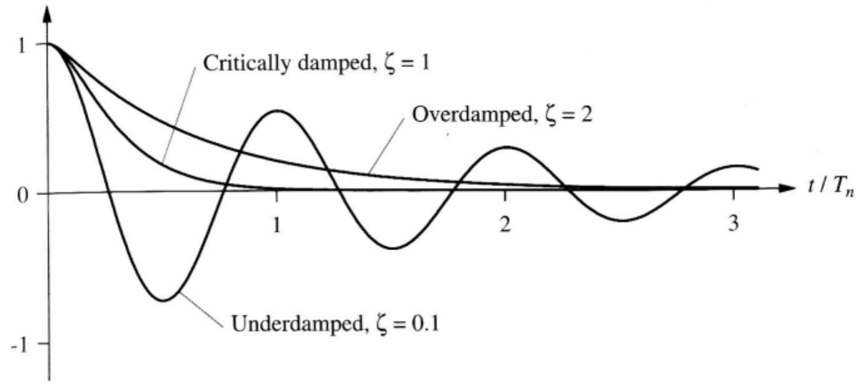


Figure 3.3: Degree of damping (P. Johansson,2009)

Response

The vibrations initiated by an excited force on the floors will give a response on the floor itself. The response is dependent on the abovementioned stiffness, modal mass and damping ratio of the floor. The floor will start vibrating in different mode shapes, depending on the frequencies of the excited force. The floor will start vibrating with a certain acceleration. The magnitude of acceleration is also dependent on the mode shape, usually the first mode shape has the highest acceleration (Willford & Young, 2006). There are 2 types of vibrations which will occur; resonant response and transient response. These responses are shown in figure 3.4.

Resonant response is the vibrational behaviour of the floor in which the whole floor starts vibrating in a steady state. The resonance will be initiated by a multiplication of the base frequency of the excited dynamic force. When this frequency coincides with the eigenfrequency of the floor, resonance will occur (Galanti et al., 2009).

The transient response is a dampened local behaviour. The response will react to a local dynamic force excitation on the floor. The floor is locally vibrating, but is quickly dampened. Both responses can cause discomfort for the occupants of the floor and thus both should be assessed (Galanti et al., 2009).

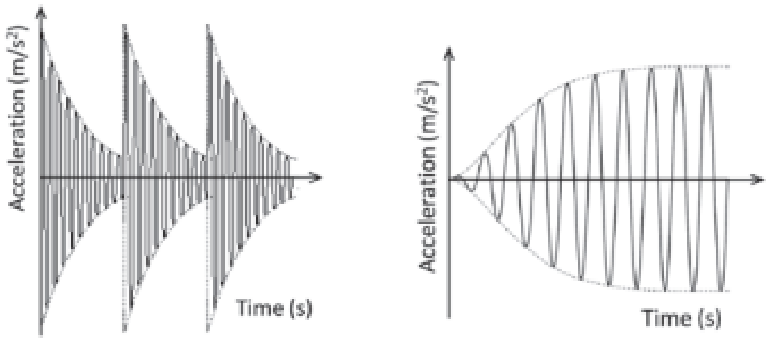


Figure 3.4: Transient response(left) and resonant response (right)

3.1.2 Effect of floor design configuration

The parameters mass, stiffness and damping have a direct effect on the dynamic behaviour of the system. These parameters can be directly taken from a certain situation such as a floor. Changing these parameters can change the vibrational performance of the floor. Next to these parameters, the configuration of the floor can also influence the parameters and thus the dynamic behaviour. The possible changes in floor configurations can be adjusting the width of the floor or floor element, change structural constraints, change the span of the floor or increase the damping. These changes have effect on the eigenfrequencies, modal mass and damping of the floor and thus have impact on the vibrational performance.

When vibrational performance is a possible governing criteria for designing a floor, not only the basic parameters could be changed but the configuration can also change to mitigate the dynamic response of the floor. Changing the floor configuration can change the boundary conditions of the floor and improve the vibrational performance without changing the cross sectional properties of the floor.

3.2 Human induced vibration and perception

Human induced vibrations

Vibrations in a structure originate in a source which induces a dynamic load onto the structure. In case of a floor the vibration can originate from the walking motion of humans. This force has a certain pattern which creates a frequency profile for the walking motion. Figure 3.5 shows the movement of a single step of a person. While the person walks, the step load changes on the contact between the foot and ground. As shown, the walking movement creates a slight elevation of the body. When the heel is dropped on the floor, this creates a force impulse.

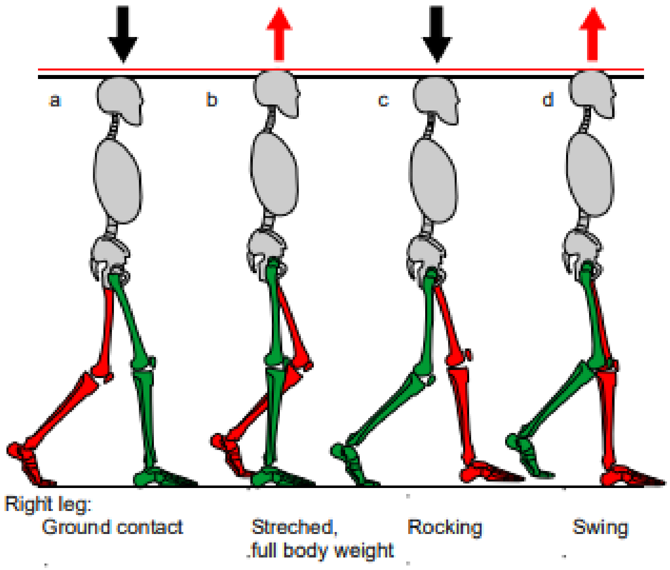


Figure 3.5: Walking motion (Galanti et al., 2011)

The walking movement causes the floor to vibrate. Figure 3.6 shows a typical velocity time history response of a point on the floor to a dynamic walking load. It shows a certain increasing and decreasing repetition as the person walks past the measurement point. The walking motion itself creates a continuous frequency profile, this profile can be analysed with a Fourier Transformation which converts the total frequency signal into the sum of its frequencies. This then shows the main frequencies of which the motion is built up. See figure 3.7. A typical frequency profile of walking motion can be found in figure 3.8.

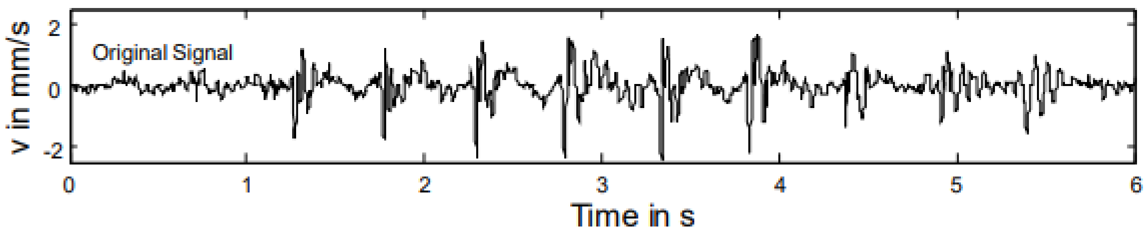


Figure 3.6: Typical floor velocity response of walking motion (Galanti et al., 2009)

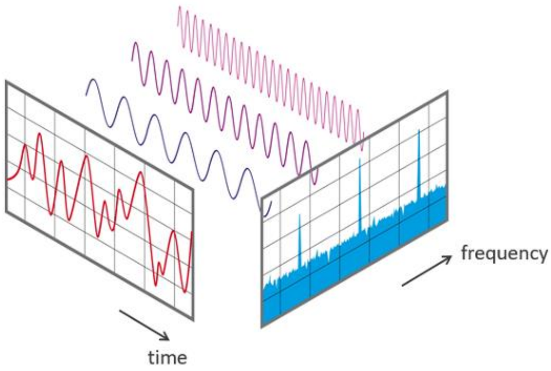


Figure 3.7: Graphical example of interpretation of Fourier transformation (NTI, 2020)

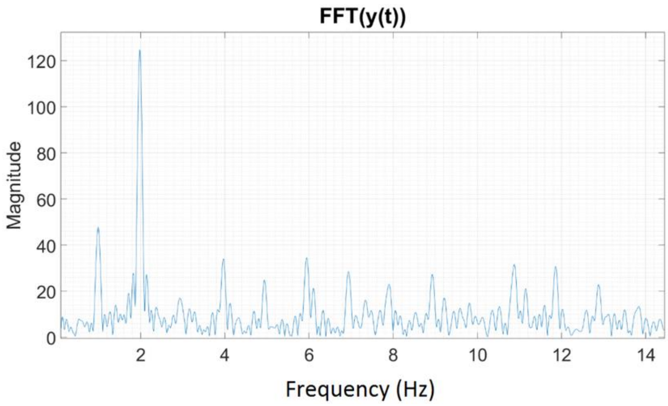


Figure 3.8: Typical frequency profile of walking motion (Martinelli et al.,2015)

While looking at the behaviour of a group of people, it can be noticed that everybody has a different walking speed. This difference in walking velocity causes a difference in step frequency. The step frequency has influence on the force impulse on the floor (Galanti et al., 2011). Figure 3.9 shows the time history of contact force for two different step frequencies.

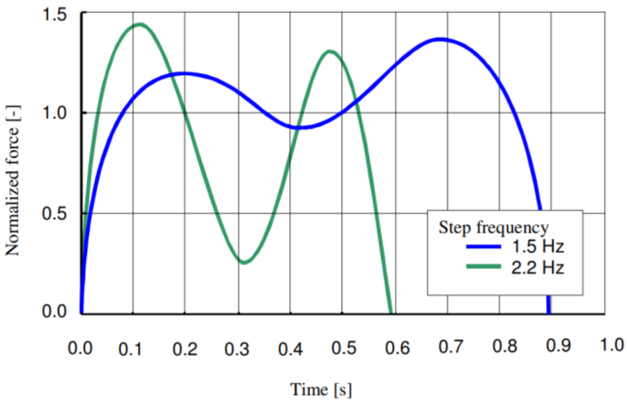


Figure 3.9: Time history of contact force for different step frequencies (Galanti et al., 2011)

In order to be able to design a floor, it is necessary to find the behaviour of a bigger group. A research was performed by Galanti et al. (2011) which measured the step frequencies at an office building in Delft. The research had measured the body mass and step frequency of 700 persons. It was found that step frequency had no correlation with body mass. The results of the research are shown in figure 3.10. The figure shows the distribution of step frequency and body mass. What can be found is that for this group, the mean step frequency is 2 Hz and that the average body weight was 80kg. Compared to ISO10137 table A.3, which states that the step frequency of the first harmonic has a range between 1,2 Hz and 2,4 Hz, this is in accordance with the research from Galanti et al. (2011).

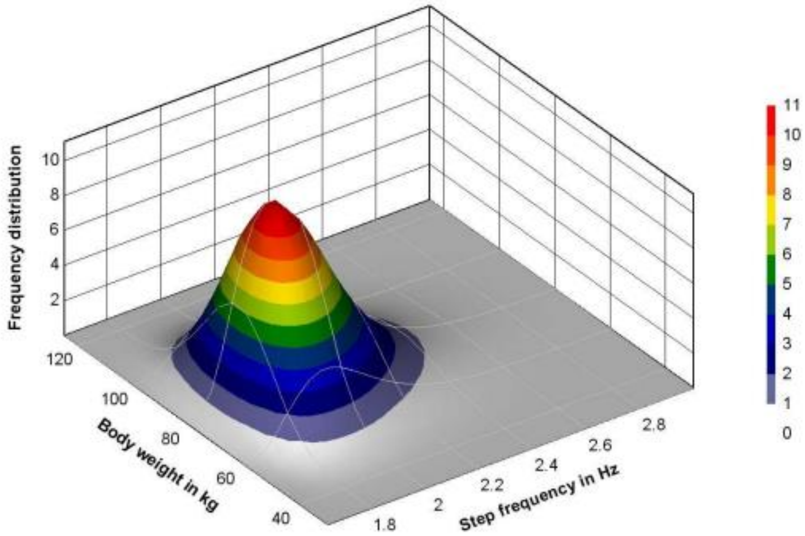


Figure 3.10: Frequency distribution of body mass and step frequency (Galanti et al., 2011)

The vibrations of a floor induced by walking will have a forcing frequency equal to the step frequency of the walking motion. This step frequency will be the first harmonic frequency, twice the step frequency will be the second harmonic frequency, three times the step frequency will be the third harmonic frequency and so forth. These harmonics coincide with the mode shapes. A higher harmonic needs more energy to get into that mode shape, a higher harmonic thus creates less vibrations, since there is less energy left. Higher harmonics thus result in less dynamic force onto the floor. This can be seen in figure 3.11.

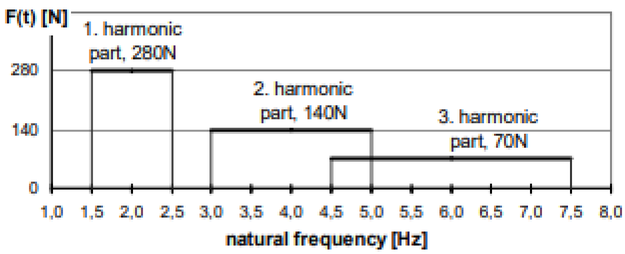


Figure 3.11: Harmonics and according force (Hamm et al., 2010)

Perception of vibrations

The walking motion of humans induce the vibrations of the floor, this influences the comfort perception of occupants of the floor. The human perception is the primary concern of a vibrating floor when sensitive equipment is not present on the floor. The perception of the vibration on humans can be expressed with two methods, both methods are based on a single person walking. The first method is the Vibration Dose Value (VDV), the second method uses a Response factor (Willford & Young, 2006). These methods are explained below.

The vibrational performance is measured in root mean square acceleration of the floor. The human perception of vibrations is stated in Annex C of the ISO10137 standard. This is shown in figure 3.12, the line in the figure shows the baseline of a barely perceptible vibration for the average human. This perception is dependent on the frequency range of the vibration. Humans are most susceptible to vibrations in the 4 Hz to 8 Hz range. In this range the baseline rms acceleration is 0,005 m/s^2.

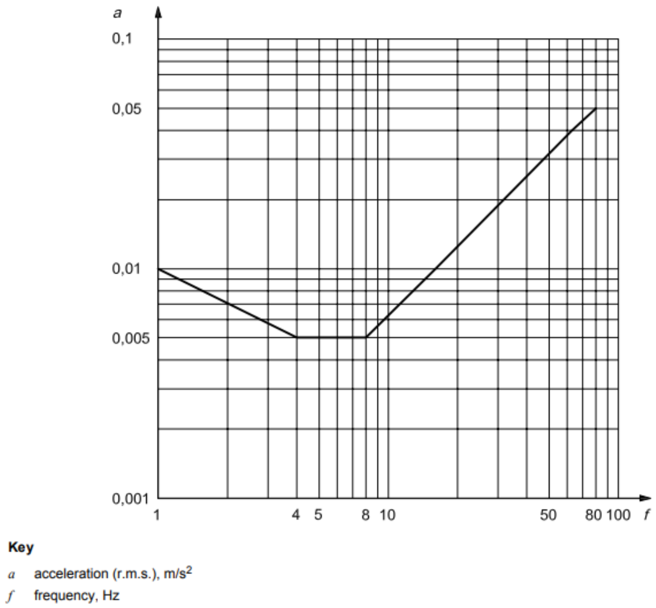


Figure 3.12: ISO10137, figure C1: Baseline curve for vibrational sensitivity

The Vibrational Dose Value is based on intermittent vibrations, this means that there are no continuous walking actions. Thus acceleration peaks are allowed over the duration of the day where the floor is occupied. These peaks can be higher than what vibration levels allow under continuous walking, but the occurrence has to be rare. The Vibration Dose Value can be stated as the sum of all walking induced vibrations over a certain period of time (Smith et al., 2009). Formula 3.3 shows the calculation of the VDV, it shows the acceleration is weighted to the power of 4, this means that a high peak in acceleration has a more significant influence on the VDV than the duration of an acceleration.

$$VDV = \left(\int_0^T a^4(t)\, dt \right)^{0,25} \qquad (3.3)$$

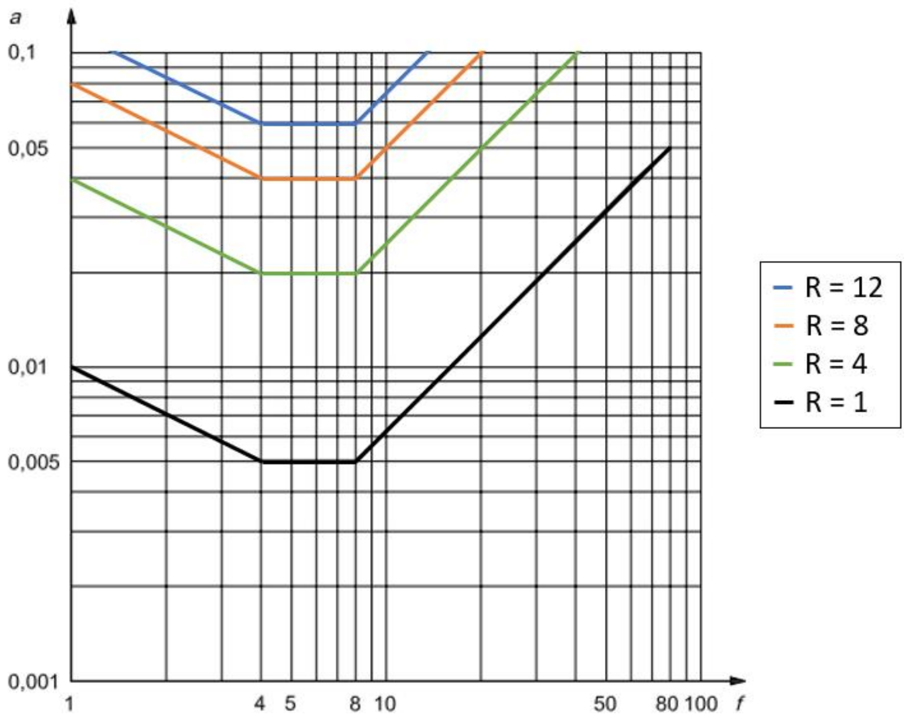
In the design phase an assessment needs to be made how often a particular vibration level occurs and the duration of it. This increases the difficulty of in the design phase to predict the level of comfort on the floor (Willford & Young, 2006). The method of VDV also makes a distinction between the night and daytime occupation of the floor. So two different VDV's need to be predicted for daytime and night time use. The VDV limits for vibrations of floors for building are specified by *BS 6472: Guide to evaluation of human exposure* and can be found in table 3.1. This shows the VDV limits for three different vibration levels where the level of probable discomfort is taken as criteria.

Table 3.1: Vibration Dose Value limits in $m/s^{1,75}$ for walking vibration

Place	Low probability of adverse comment	Adverse comment possible	Adverse comment probable
buildings 16 h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
buildings 8 h night	0.13	0.26	0.51

The second method to quantify the perception of vibration on humans is by calculating the Response factor of the floor. The response factor is based on the multiplication of the baseline of the vibrational perception of an average human. This is the baseline from figure 3.12. The Response factor is based on a multiplication of the baseline acceleration of 0,005 m/s^2, this results in R=1. This is used for frequencies of the 4 Hz to 8 Hz range. On frequencies of 8Hz and higher the line in figure 3.12 has a slope. The flat value of acceleration cannot be used, for this range, the derivative of the acceleration is used. The derivative is the velocity of the floor, which has according to the slope of the line a value of 0,0001 m/s. The frequency domain of 4 Hz to 8 Hz can be seen as the resonant response and the range of 8 Hz and higher can be seen as the transient response (Willford & Young, 2006) (Draft prEN 1995-1-1).

The vibrational performance levels can be stated with a certain Response value. These values have the multiplication of the barely perceptible vibration of R=1. The range of acceptable R values can differ per occupation function of a building, but can also be used for bridges or stadiums. Bridges and stadiums have a higher allowable Response value than functions within buildings. Chapter 3.3 will go further into different floor vibration levels and their according Response value. Figure 3.13 shows the graphical interpretation of the Response values as a multiplication of the ISO10137 C1 baseline vibrations.



Key

a acceleration (r.m.s.), m/s^2

f frequency, Hz

Figure 3.13: ISO10137, figure C1: Baseline with Response value examples

3.3 Vibrational assessment methods

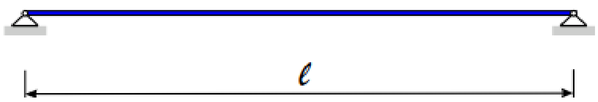
To be able to analyse the dynamic behaviour of a floor, a method should be used to be able to quantify the vibrational performance and refer to a proportion of the vibrational perception in vibrational performance levels. Two methods will be considered for analysis of the dynamic behaviour of the floor. The first one is the commonly used method for vibrational analysis of floors, called Hivoss (Human Induced Vibrations Of Steel Structures) (Research Fund for Coal & Steel, 2007). This method originates as a tool to analyse vibrations in steel floors. This method is explained in *3.3.1 Hivoss method*. The second method is the vibrational analysis part of the renewed Eurocode 5: Timber structures (Draft prEN 1995-1-1). This method is used to calculate the vibrational performance of timber structures. This method is explained in *3.3.2 Renewed Eurocode 5 method*. The background of this method is based on mechanics and vibrational analysis literature.

3.3.1 Hivoss method

The Hivoss method originates in the steel industry, where human induced vibrations needed to be anslysed, which indicates the name: Human Induced Vibrations Of Steel Structures, Hivoss. The Hivoss is based on the RMS90 acceleration of the floor. This parameter is the 90th percentile of the RMS of the floor acceleration. This percentile is taken to include deviation of the weight of people walking on the floor. The assessment is based on 3 main parameters namely the damping percentage, first eigen frequency of the floor and the modal mass of the floor.

Calculation of vibrations

The vibration calculation according to Hivoss is performed, firstly the stiffness EI is calculated, then the distributed mass is determined by addition of the permanent load, self-weight and 10%-20% of the variable weight. Then the eigenfrequency of the floor and the module mass is calculated according to the formulas given in the Hivoss method for a simply supported beam. These can be found in figure 3.14.



$$f = \frac{2}{\pi}\sqrt{\frac{3EI}{0.49\,\mu l^4}} \qquad M_{mod} = 0{,}5\,\mu\,l$$

E Youngs-Modulus [N/m²]
I Moment of inertia [m^4]
μ distributed mass [kg/m]
ℓ length of beam

Figure 3.14: Formula for eigenfrequency and modal mass from hivoss (Research Fund for Coal & Steel, 2007)

The frequency and modal mass are the parameters on which the vibrational performance is measured. The Hivoss divides the vibrational performances into 5 classes, A to F. For office functions, the vibrational performance will be critical in class E, and preferably in class D or higher. See table 3.2 for the vibrational classes and functions.

Table 3.2: Vibration classes and preferable levels from hivoss (Research Fund for Coal & Steel, 2007)

Class	OS-RMS$_{90}$ Lower Limit	OS-RMS$_{90}$ Upper Limit	Critical Workspace	Health	Education	Residential	Office	Meeting	Retail	Hotel	Prison	Industrial	Sport		
A	0.0	0.1	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended		
B	0.1	0.2	Critical	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended		
C	0.2	0.8	Not recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended		
D	0.8	3.2	Not recommended	Critical	Critical	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended	Recommended		
E	3.2	12.8	Not recommended	Not recommended	Not recommended	Critical	Critical	Critical	Critical	Critical	Critical	Recommended	Recommended		
F	12.8	51.2	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Not recommended	Critical	Critical		

Recommended
Critical
Not recommended

When the class is selected, damping percentage, eigenfrequency and modal mass are calculated, the vibrational performance can be seen in the diagram shown in figure 3.15, this shows the diagram for damping percentage 7%. The classes are shown in the diagram, each class is according to a specific ES-RMS threshold represented in table 4.6. This is a root-mean-square acceleration.

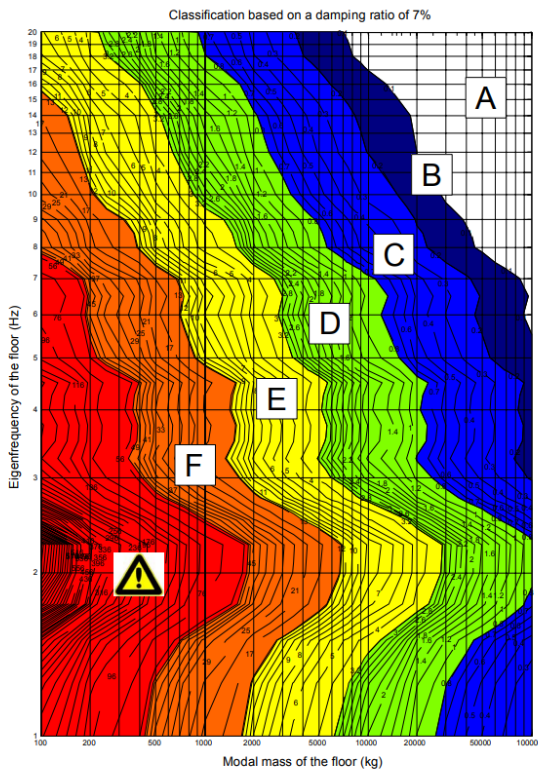


Figure 3.15: Hivoss ES-RMS diagram for 7% damping (Research Fund for Coal & Steel, 2007)

The design process is shown in figure 3.16. The process is relatively straightforward and doesn't give much insight information and specific behaviour of parameters. The acceleration is estimated from the graph and the actual calculation is not clearly visible. The parameter estimates such as damping are relatively high compared to other results, so this might be only useful for this hivoss method.

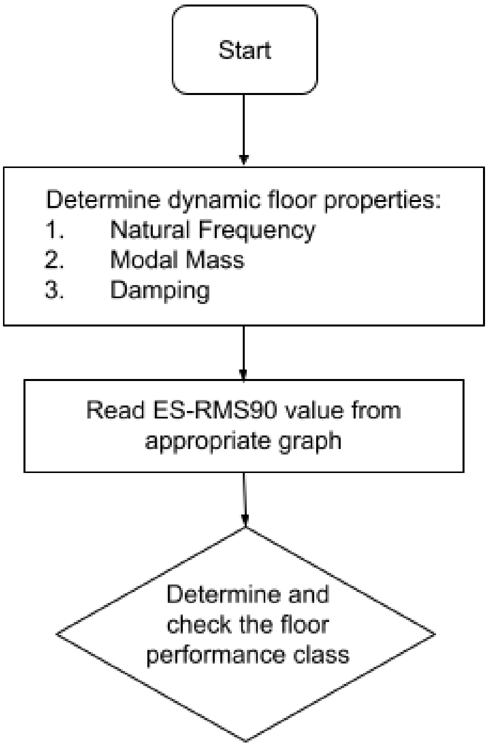


Figure 3.16: Design process of Hivoss

An interesting behaviour within the Hivoss method can be seen in figure 3.17. It shows the effect of changing different parameters in the calculations. What can be found from the vibrational analysis with the Hivoss guideline, is that increasing the stiffness of the cross section will improve the vibrational performance of the floor. According to the hivoss, addition of mass will not have much effect on the vibrational performance since the eigen frequency also decreases, staying within the same vibrational class range. The effect of widening the floor element has a clear effect on the vibrational class. Using a wider floor, the vibrations will be mitigated and thus a higher performance class can be achieved.

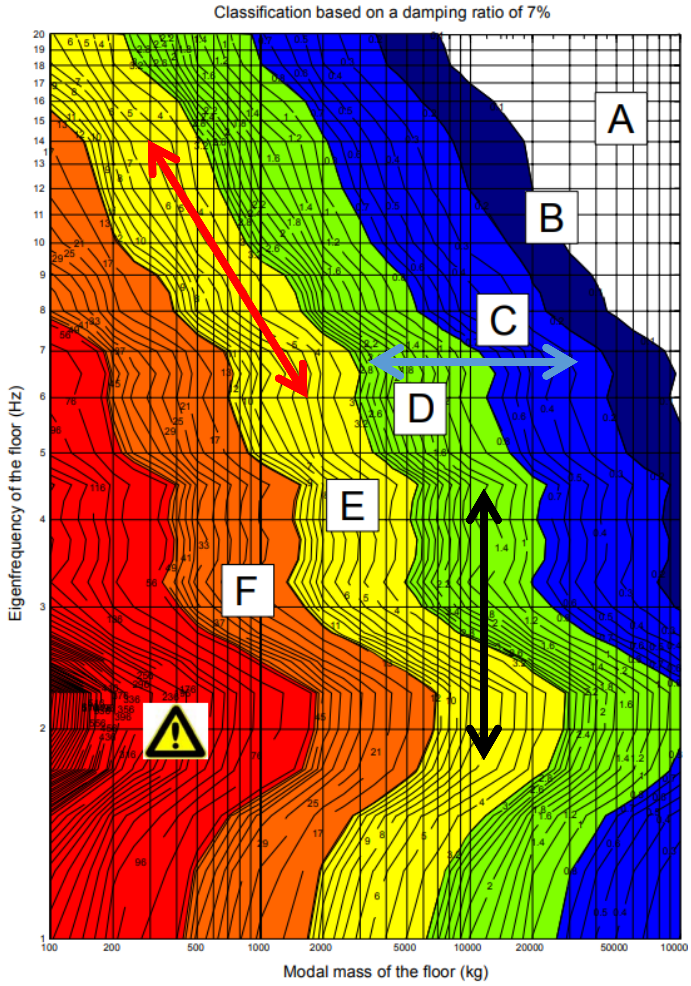


Figure 3.17: Stiffness influence: black, Mass influence: red, Width influence: blue

3.3.2 Draft EN 1995-1-1 Eurocode 5 method

The second method of vibration analysis of floors, the method used in draft NEN-EN 1995-1-1(2021) is analysed. This method is based on extensive literature originated from the steel and concrete industry and based in structural mechanics. This method uses fundamental frequency, dampening, stiffness, acceleration and velocity as parameters to calculate vibrations and testing criteria are set according to these parameters. This method is different from the Hivoss method, where as it takes more parameters into account and tests on different criteria during different types of vibration. This might give a different result than other methods.

Calculation of vibration

The criteria on which the Eurocode 5 vibration analysis is based, are the fundamental frequency, stiffness, acceleration (resonant response) and velocity (transient response) of the floor system. Based on these criteria floor performance levels are created. These floor vibration levels are based on the a minimal acceleration and velocity and multiples of that baseline. These baselines are denoted by the Response factor. The response factors and according criteria for the vibrations can be found in table 3.3. The calculation for the vibrational performance are shown below. First the eigenfrequency of the floor is calculated. Secondly the deflection of the floor under a 1kN load is calculated. Then the resonant response and transient response are calculated.

Eigenfrequency of floor (beam)

$$f_1 = k_{e,1}\, k_{e,2}\, \frac{\pi}{2L^2}\sqrt{\frac{(EI)_L}{m}} \qquad k_{e,2} = \sqrt{1 + \frac{\left(\frac{L}{B}\right)^4 (EI)_T}{(EI)_L}}$$

Deflection of floor under a 1kN load

$$w_{1kN} = \frac{F\,L^3}{48\,(EI)_L\,B_{ef}}$$

$$B_{ef} = \min\left\{0{,}95\,L\,\left(\frac{(EI)_T}{(EI)_L}\right)^{0,25};\, B\right\}$$

Resonant response

$$a_{rms} = \frac{k_{res}\,\mu\,F_h}{\sqrt{2}\,2\,\zeta\,M^*}$$

$$k_{res} = \max\left\{0{,}192\left(\frac{B}{L}\right)\left(\frac{(EI)_L}{(EI)_T}\right)^{0,25};\, 1{,}0\right\}$$

$$\boldsymbol{M^* = \frac{m * L * B}{2}}$$

Transient response

$$I_m = \frac{42\, f_w^{1,43}}{f_1^{1,3}}$$

$$v_{1,peak} = k_{red} \frac{I_M}{(M^* + 70\text{ kg})}$$

$$k_{imp} = \max\left\{0{,}48 \left(\frac{B}{L}\right)\left[\frac{(EI)_L}{(EI)_T}\right]^{0,25}; 1{,}0\right\}$$

$$v_{tot,peak} = k_{imp}\, v_{1,peak}$$

$$v_{rms} = v_{tot,peak}\,(0{,}65 - 0{,}01\, f_1)(1{,}22 - 11{,}0\,\zeta)\,\eta$$

$$\eta = \begin{cases} 1{,}35 - 0{,}4\, k_{imp} & \text{when } 1{,}0 \le k_{imp} \le 1{,}9 \text{ else } \eta = 0{,}59 \text{ (for joisted floors)} \\ 1{,}35 - 0{,}4\, k_{imp} & \text{when } 1{,}0 \le k_{imp} \le 1{,}7 \text{ else } \eta = 0{,}67 \text{ (for all other floors)} \end{cases}$$

After the calculations have been done, an eigenfrequency, deflection response, acceleration response and velocity response are known. These are tested to the criteria found in table 3.3. Each factor gives its own resulting floor performance level. The highest level out of the criteria will be the decisive floor performance class. The responses which need to be taken into account are bounded by the eigen frequency. Resonant response and transient response should be tested when the eigen frequency if between 4,5 Hz and 8 Hz. When the eigenfrequency is above 8 Hz, the change of unbearable resonance are small, thus only transient response has to be fulfilled. The full design process can be found in figure 3.18.

Table 3.3: Floor vibration performance levels from draft prEN1995 (Draft prEN 1995-1-1: 2021)

	Floor performance levels					
Criteria	**I**	**II**	**III**	**IV**	**V**	**VI**
Response factor R	4	8	12	24	36	48
Upper defelction limit $w_{lim,max}$ mm	0,25		0,5	1,0	1,5	2,0
Stiffness criteria for all floors w_{1kN} mm ≤	w_{lim} calculated with Formula 9.30					
Frequency criteria for all floors f_1 Hz ≥	4,5					
Acceleration criteria for resonant vibration ($f_1 < f_{1,lim}$) design situations a_{rms} m/s² ≤	0,005 R					
Velocity criteria for all floors v_{rms} m/s ≤	0,0001 R					

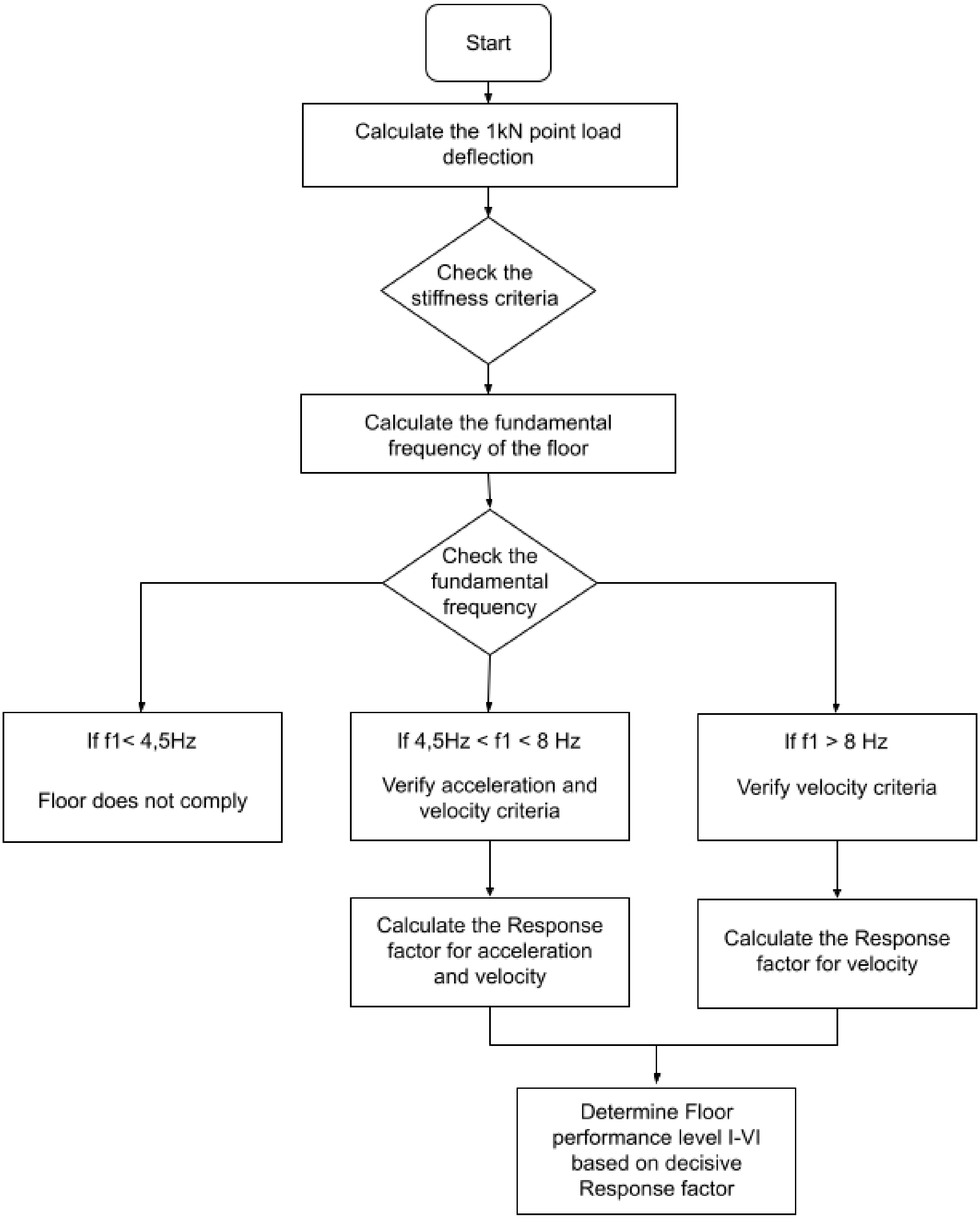


Figure 3.18: Design process of vibrational performance according to draft prEN1995

3.4 Influential factors in vibrational assessment

The assessment of vibrational performance includes multiple factors. The factors are independent of the method used, but for the method of the draft EN 1995-1-1 some factors are important to consider in more detail. These factors are the effective width of an element, the damping ratio of the specific floor types, the effect of additional mass on the floor, the background of the acceleration response calculation within the draft EN 1995-1-1 , the definition of a high and low performance floor for an office and the applicability of methods for different materials. These will be discussed in the paragraphs below.

Effective width of an element

When taking longitudinal and transverse stiffness of a floor into account, there are limits to where extra width will increase the stiffness of an element. Increased transverse stiffness will increase the cooperative width of a floor. The same accounts for short floor spans, this will decrease the effective width of the floor. The effective floor width is the width which cooperates in the vibrational resistance. The effective width of a floor is calculated using formula 1. Where EI_T/EI_L is the relative transverse stiffness. The effective stiffness is the smaller of the effective floor stiffness or the width of an element. In figure 3.19, the relative transverse stiffness is shown against the panel length and panel width (Wallner-Novak et al., 2018).

$$B_{ef} = \min\left\{0{,}95\,L\,\left(\frac{(EI)_T}{(EI)_L}\right)^{0{,}25};B\right\} \qquad \text{(formula 1)}$$

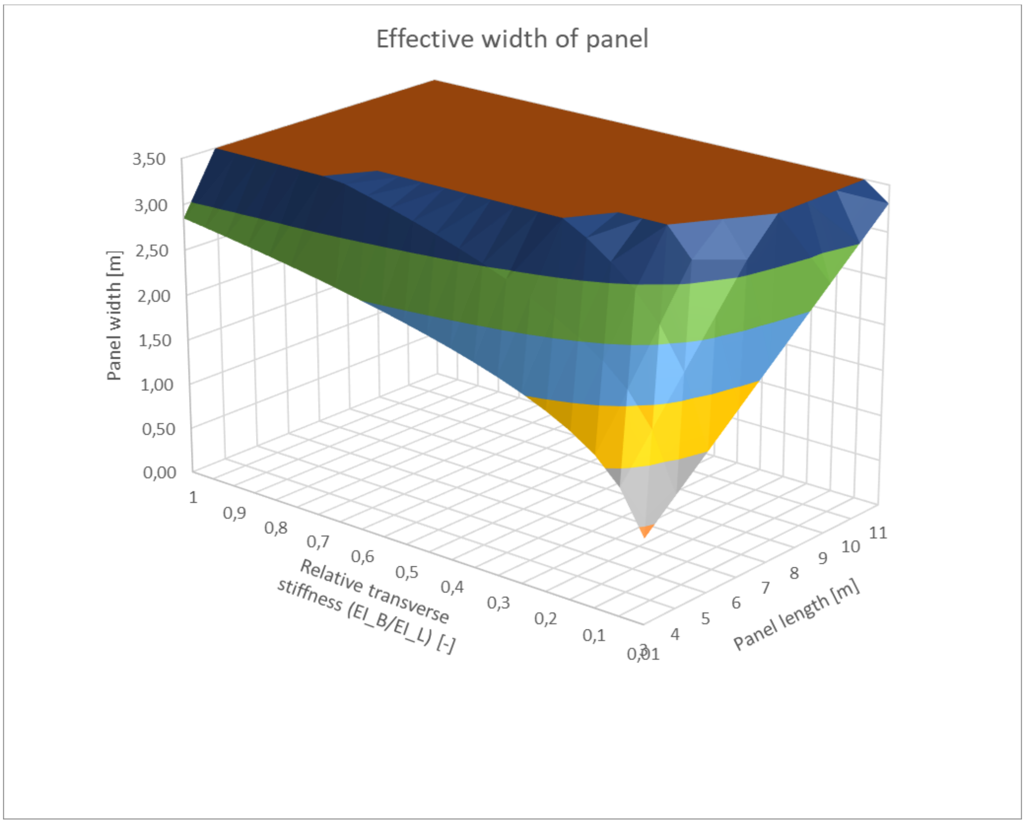


Figure 3.19: Effective width of a panel (Wallner-Novak et al., 2018)

What can be seen is the for low relative transverse stiffness (So the transverse stiffness is a lot smaller than the longitudinal stiffness) and low spans, the effective width becomes less. The graph gives an overview for panel widths of 1m to 3,5m. For lower panel widths, the panel width itself will in most cases be decisive. If the panel becomes wider, the effective width of the panel will more often be less than the panel width itself. The effective width will be used in the calculations of the vibrational performance of the floor systems. This means the effective width will be maximised by the panel width of a single panel. The width is important for different parameters and vibrational performance of the floors.

Damping ratio

Damping is an important parameter for the dynamic behaviour of the floors. The damping of a floor will control the speed at which energy, introduced by walking is dissipated by the system, in this case the floor.

The damping value itself is hard to calculate and very dependent on constraints such as the use of a screed, and materials used. Most damping ratios are acquired by testing of floors in practice, which results in data to determine a damping ratio. This can then be used for vibrational calculations for future use. To give an insight in typical damping values for different floor types, several sources have been found. These sources show different damping ratios depending on the empirical data used on different materials with and without certain floor constraints. Table 3.4 shows typical damping ratios according to ISO10137 with a certain range for several floor types, especially concrete and steel floors. It also shows a value to use for preliminary design of bare floors.

Table 3.4: Typical damping ratios. Jarnero, (2014) from ISO10137

Type of floor	**Range of spans for damping ratios given** (m)	**Damping ratio ζ** (% of critical)		
		Typical range	Extreme range	Values for preliminary design of bare floors
Steel joist/concrete slab simply supported	9 – 15	0.8 – 3.0	0.6 – 7.4	1.3
Steel joist/concrete continuous slab construction across walls	4 – 8	1.0 – 5.0	0.8 – 8.6	1.5
Fully composite steel beams with shear connectors to concrete slab	6 – 20	1.5 – 5.0	0.5 – 8.0	1.8
Prestressed concrete, precast	2 – 15	0.8 – 3.0	0.5 – 6.5	1.3
Reinforced concrete, monolithic	5 – 15	1.0 – 3.0	0.6 – 5.0	1.5
Wood joist floors	2 – 9	1.5 – 4.0	1.0 – 5.5	2.0
NOTE Damping ratios depend on the type of construction, material, presence of non-structural elements, age, quality of construction and amplitude and frequency of vibration. For concrete structures the presence or absence of cracks is also significant. For any form of construction, the type of joint and the type of bearing employed play an important role in damping. For floors, the presence of some floor and ceiling finishes and partitions can increase the damping ratio considerably.				

For timber floors table 3.4 shows a damping ratio of 2%. This can be compared to damping ratios from other sources. The damping values stated by Abeysekera, Hamm and Toratti (2018) in figure 3.20, give more insight in timber based floors. Floors with higher mass or higher stiffness have an increased damping ratio. The increase of damping ratio with higher stiffness is also stated by Weckendorf et al. (2015).

ζ = 0,02 for joisted floors

ζ = 0,025 for timber-concrete and mass timber floors

ζ = 0,03 for joisted floors with a floating layer

ζ = 0,035 for timber-concrete composite and mass timber floors with a floating layer

ζ = 0,04 for all floors with a floating layer and supported on 4 sides

ς = 0,06 for all floors with a floating layer, supported on 4 sides by timber walls via flexible bearings.

Figure 3.20: Typical damping ratios for timber (Abeysekera et al., 2018)

Table 3.5 shows the typical damping ratios according to Hamm et al. (2010) where the damping ratio is between 1% and 3%. The current EN1995-1-1 (2011) also indicates in paragraph 7.3.1(3) a damping ratio of 1% as a standard for timber floors.

Table 3.5: typical damping ratios for timber floors (Hamm et al., 2010)

Type of floor	Damping D [ ]
timber floors without any floor finish	0,01
plain glued laminated timber floors with floating screed	0,02
girder floors and nail laminated timber floors with floating screed	0,03

The damping values stated by Abeysekera et al.(2018), ISO10137 and Hamm et al.(2010) also suggest that floors with higher stiffness and/or mass result in a higher damping ratio and thus a better vibrational performance. In addition to this information the effect of constraints and floor build-up on the damping ratio of a floor is further researched. The research from Hamm, Richter and Winter (2010) gives an insight in results from different results from test on vibrational performance. In their research 14 floors are tested with different configurations. Table 3.6 shows the results. It shows that insulation from the vibration source is advantageous for the damping ratio, but also the constraints of the floor, use of screeds or use of springs or bearings for the support of the floor. Different constraints can have different impacts on the damping ratio, heavy floors can result in higher damping ratios but the floor finish, use of screeds, specific bearings or partition walls can also increase the damping ratio.

Table 3.6: Test results of frequency and damping ratio of timber floors (Hamm et al., 2010)

VA		mass [kg/m²]	f_1 [Hz]	D_1 [%]
1	no floor finish, elastomer bearing	41	14,85	4,52
4	no floor finish, timber bearing	41	15,00	3,59
5	only 60 mm grit	122	10,40	-
6	light floor, bearings on 2 sides	140	10,30	2,99
7	light floor, bearings on 4 sides	140	10,15	3,47
8	like VA 6, add. lower deck	151	9,75	3,16
9	like VA 8, lower deck on springs	151	10,35	2,15
10	like VA 9 with carpet	154	10,30	2,39
11	heavy floor add. lower deck	278	9,75	2,85
12	heavy floor (no lower deck)	267	9,55	2,91
13	like VA 12 with carpet	270	9,62	3,16
14	heavy floor bearings on 4 sides	267	10,35	4,57

From the given data from literature a conservative damping ratio is noted for the different floor types. The damping ratios are still an uncertain prediction, but the use conservative values of the bare floors ensures that the resulting floor has at least a better performance (Hamm et al.,2010). These can be found in the table 3.7. The damping ratios are based on the bare floor design without the use of (floating)screeds, bearings or partition walls. The damping ratios for CLT and the LVL box floor are based on the combination of damping ratios found by Hamm et al. (2010) and Abeysekera (2018) and ISO10137. The damping ratio of Timber Concrete Composite is based on the same sources with the additional information that heavier floor have a higher damping ratio (Hamm et al. 2010) and thus has a slightly higher damping ratio. The concrete floors are based on the ISO10137 base and the values from Johansson(2009), see *"effect of additional mass"* paragraph. The bare concrete floor have a lower damping ratio, but the effect of mass increases the damping ratio. This results in the damping ratios in table 3.7

Table 3.7: damping ratio per floor type

Floor type	**Damping ratio**
CLT	2,0%
LVL boxfloor	2,0%
TCC	2,5%
Concrete insitu	1,0%
Concrete Hollow Core	0,5%

Effect of additional mass

A research done by Johansson (2009) on concrete hollow core floors shows the results of a vibrational experiment on a hollow core concrete floor and a second test on which the same floor is loaded with an additional layer of concrete. Within the experiment, the damping ratios of the first three vibration modes were determined as an average of the calculated damping ratios of several vibrational input signals of accelerometers. The result of this experiment is that the damping ratio of the floor increases and the acceleration decreases, see table 3.8. This concludes that the vibrational performance of the concrete hollow core floor increases due to the additional mass in the layer of concrete. This effect is also endorsed by the research of Hamm et al (2010).

Table 3.8: Damping ratio of experiment with concrete hollow core floor, before and after the addition of a concrete topping (Johansson, 2009)

	Mode 1: ζ	Mode 2: ζ	Mode 3: ζ
Before	0.0064	0.0027	0.0024
After	0.0115	0.0040	0.0035

Literature such as Cobelens (2018) and the hivoss (Research Fund for Coal & Steel, 2007) already described the effect of additional mass on the vibrational performance. The increase of mass causes a decrease in the eigen frequency of the floor. This cancels the direct effect of mass on the vibrational performance of the floor. Another effect noted by Cobelens (2018) as well as Johansson (2009) is the increase of the damping ratio. This will have influence in the reduction of the floor vibrations.

Background of acceleration calculation

The draft EN1995:1-1 gives a formula(1) to calculate the rms acceleration of a floor. This formula is simplified for the practical use. But the question might be asked whether this simplification still represents the real world. To investigate on this, a research into the background is performed. This begins at the mechanics, formula 2 gives the place of a floor vibration, formula 3 is the second derivative of the place function, which is the acceleration of the floor (Smith et al., 2009).

$$a_{\mathrm{rms}} = \frac{k_{\mathrm{res}}\, \mu\, F_{\mathrm{h}}}{\sqrt{2}\, 2\, \zeta\, M^*} \tag{1}$$

$$w_n(x,t) = \sum_{n=1}^{\infty} u_n \sin(2\pi f t + \phi_n) \sin\left(\frac{n\pi x}{L}\right) \tag{2}$$

$$a(x,t) = \sum_{n=1}^{\infty} -4\pi^2 f_n^{\,2} u_n \sin(2\pi f_n t + \phi_n) \sin\left(\frac{n\pi x}{L}\right) \tag{3}$$

For these formulae, the frequency is important, in this case the forcing frequency. Which is the frequency in which the source excited a force. Important to notice here, the acceleration formula gives a continuous motion, so in practice this can only be the case when the floor will resonate, and thus the forcing frequency will be equal to the eigenfrequency of the floor. For transient behaviour, the vibration will be dampened and will thus behave differently than formula 3. Converting formula 2 into a rms function with practical input parameters, formula 4 will come out (Smith et al., 2009).

$$a_{\mathrm{w,rms,e,r,n,h}} = \mu_{\mathrm{e,n}}\, \mu_{\mathrm{r,n}} \frac{F_{\mathrm{h}}}{M_{\mathrm{n}} \sqrt{2}} D_{\mathrm{n,h}} W_{\mathrm{h}} \tag{4}$$

This formula 4 looks more like the formula used in draft EN1995:1-1 . Important parameters here are the mu values and the Fh: excitation force in h^{th} harmonic. Fh is a forcing frequency, which is calculated using formula 5 and the according table 3.1, which uses fourier coefficients of the frequency in an h^{th} harmonic. Table 3.2 gives an insight in the range of Fh values used. Considering a minimal eigenfrequency of a floor, only the 3rd and 4th harmonic could occur, since this only considers the resonant behaviour of the floor.

$$F_h = \alpha_h Q \tag{5}$$

Where:

- α_h is the Fourier coefficient of the h^{th} harmonic (table 3.8)
- Q is the static force exerted by an ‘average person’ (taken as 76 kg / 746N)

Table 3.8: Design Fourier coefficients for walking activities (Smith et al., 2009)

Harmonic h	Excitation frequency range hf_p (Hz)	Design value of coefficient α_h	Phase angle ϕ_h
1	1.8 to 2.2	$0.436(hf_p - 0.95)$	0
2	3.6 to 4.4	$0.006(hf_p + 12.3)$	$-\pi/2$
3	5.4 to 6.6	$0.007(hf_p + 5.2)$	π
4	7.2 to 8.8	$0.007(hf_p + 2.0)$	$\pi/2$

Table 3.9: Excitation force range for first 4 harmonic frequencies according to Smith et al. (2009)

Harmonic number	Harmonic frequency range		Excitation Force	
	hfp - low [Hz]	hfp - high [Hz]	Fh - low [N]	Fh - high [N]
1	1,8	2,2	276,5	406,6
2	3,6	4,4	71,2	74,7
3	5,4	6,6	55,4	61,6
4	7,2	8,8	48,0	56,4

A different calculation is performed by Wilford& Young (2006), they base the acceleration on the Dynamic load factor: Dynamic load as a fraction of a person's weight. Looking at figure 8, is can be seen that in the first harmonic, the frequency is important for the magnitude of the DLF. For the second, third and fourth harmonic this is less the case. So a higher harmonic is less dependent on the forcing frequency and has a lower DLF. These graphs are produced using data from several experiments performed by 6 previous researches. The values and formula's in table 3.3 are derived from this research. The data in table 3.10 shows the mean value of the DLF and a design value of the DLF(Design value has a higher value). Table 3.11 and 3.12 give the dynamic force range in h^{th} harmonic for the forcing frequency. This dynamic force is the DLF multiplied by an average persons weight of 76kg.

Table 3.10: DLF data from 4th harmonic research (Wilford & Young, 2006)

Harmonic number, h	Harmonic forcing frequency (Hz)	Mean value (DLF)	Coefficient of variation	Design value (DLF)
1	1–2.8	$0.37(f - 0.95)$, $\not> 0.5$	0.17	$0.41(f - 0.95)$, $\not> 0.56$
2	2–5.6	$0.054+0.0044f$	0.40	$0.069+0.0056f$
3	3-8.4	$0.026+0.0050f$	0.40	$0.033+0.0064f$
4	4–11.2	$0.010+0.0051f$	0.40	$0.013+0.0065f$
h>4	>11.2	0		0

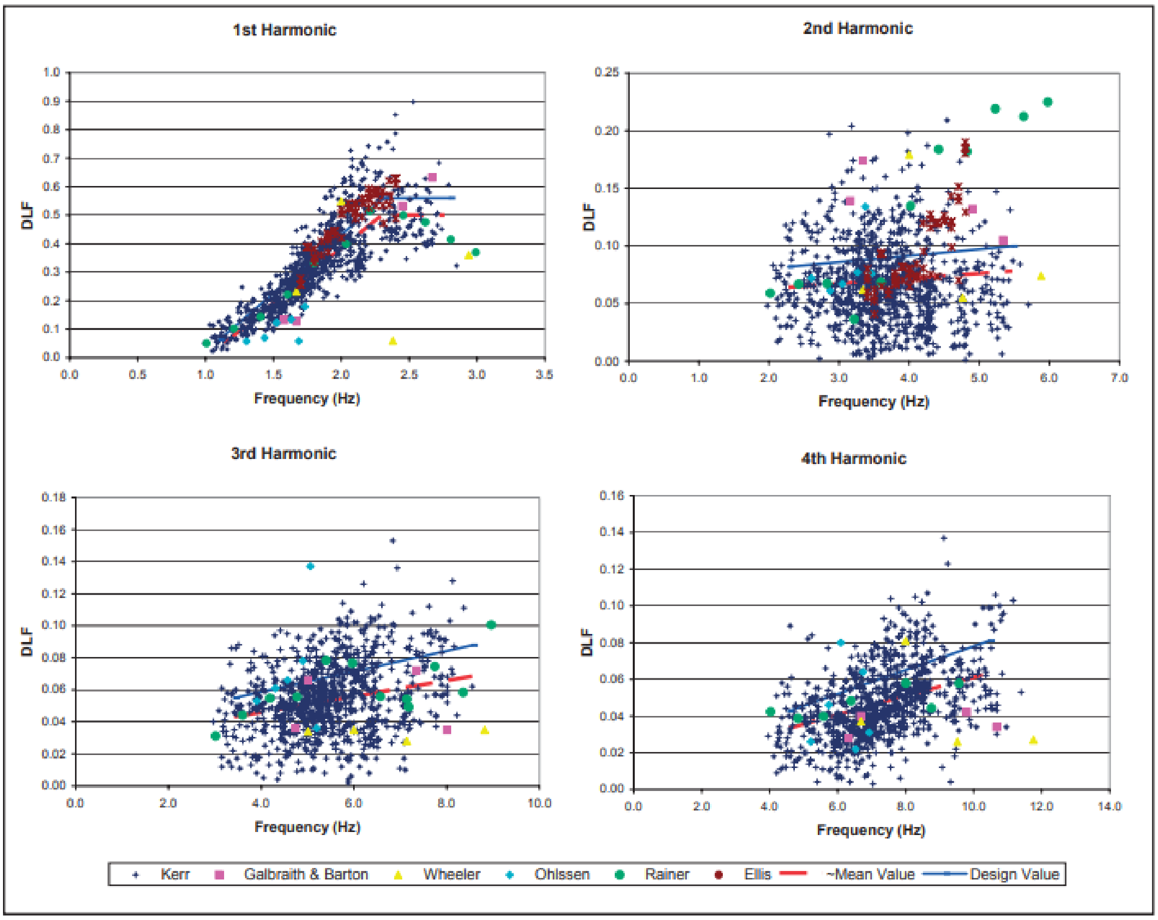


Figure 3.21: DLF for first 4 harmonic frequencies: (Wilford& Young, 2006)

Table 3.11: Design values according to Wilford& Young (2006)

Harmonic number	**Harmonic frequency range**		**Excitation Force**	
	low [Hz]	high [Hz]	DLF - low [N]	DLF - high [N]
1	1	2,8	15,3	417,8
2	2	5,6	59,8	74,9
3	3	8,4	38,9	64,7
4	4	11,2	29,1	64,0

Table 3.12: Mean values according to Wilford& Young (2006)

Harmonic number	**Harmonic frequency range**		**Excitation Force**	
	low [Hz]	high [Hz]	DLF - low [N]	DLF - high [N]
1	1	2,8	13,8	373,0
2	2	5,6	46,8	58,7
3	3	8,4	30,6	50,7
4	4	11,2	22,7	50,1

The draft EN 1995-1-1 eurocode 5 prescribes a vertical force Fh, assumed force by a walking person as F=50N. When considering the values from Wilford& Young and Smith, the vertical force of 50N is a high mean value for the third and fourth harmonic. The eigenfrequency of a floor cannot be lower than 4,5 Hz, considering an average walking frequency of 2 Hz, the first and second harmonic cannot result in resonance. The third and fourth harmonic can result in resonance, but the vertical load will be conservatively taken at around 50N.

Another important parameter is the mu values. These values take care of the resonance build-up. This means that if a floor has a large span and a large walking path length, the chances of resonance increase, because the walking frequency has a higher change to match with the eigenfrequency of the floor. Figure 3.22 shows the Resonance build-up factor according to some damping ratios and the walking path length for a walking induced frequency of 2 Hz. The draft EN 1995-1-1 considers a walking path length of around 5 meters for a damping ratio of 2% (standard for timber floors) this results in a build-up factor of 0,4. The longer the walking path length and damping, the higher the build-up factor. This factor is based on

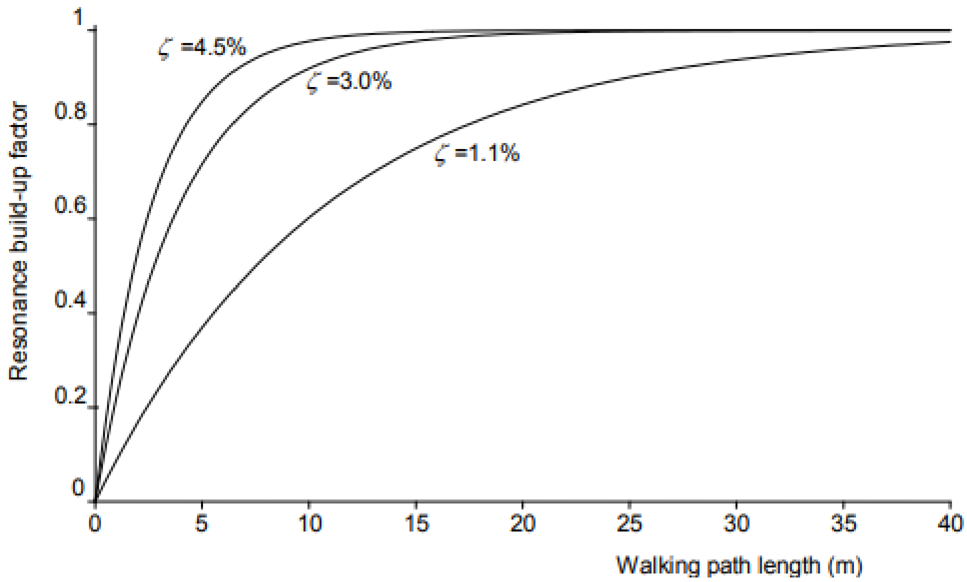


Figure 3.22: Resonance build-up factor for walking path length (Smith et al., 2009)

Relevant floor performance class for office floors.
In order to qualitatively validate the vibrational performance of a specific floor function, some criteria need to be drafted. The function considering in an office floor. The basis of floor performance classes are the acceleration or velocity of a floor. Tests in practice have shown the human sensitivity for floor vibrations and their subjective judgement about this. The research into these tests have given insight in the maximum and minimum allowable criteria for vibrational comfort. Torattti & Talja (2006) summarized experimental vibrational acceptance data from several researches and proposed a vibration classification system. This classification system is based on 5 levels, A to E. See figure 3.23.

A	Special class for vibrations inside one apartment. Normal class for vibrations transferred from another apartment. The vibration is usually imperceptible.
B	Higher class for vibrations inside one apartment. Lower class for vibrations transferred from another apartment. The vibration may be perceptible but usually it is not annoying (inside one apartment).
C, base class	Normal class for vibrations inside one apartment. The vibration is often perceptible and some people may feel it annoying (inside one apartment).
D	Lower class for vibrations inside one apartment. For example attics and holiday cottages. The vibration is perceptible and most people feel it annoying (inside one apartment).
E	Class without restrictions.

Figure 3.23: Proposal vibrational classes description according to Torattti & Talja (2006)

Toratti & Talja streched that the perception of vibrations is an individual feature, which means that each person has a different threshold of vibrational annoyance and thus the vibrational class used should always be agreed upton with the client. The vibrational levels are based on parameters such as the deflection of the floor, acceleration and velocity of the floor, depending on the eigenfrequency of the floor. Table 3.13 shows the criteria limits for each class proposed by Toratti & Talja (2006).

The vibrational perception is a subjective measure and differs from country to country and building functions. The perception from Toratti & Talja (2006) is based on European researches, Wilford& Young (2006) also presented some limit criteria values for different floor occupations based on American standards. For premium quality open-plan offices with busy corridors, a response factor of R=8 is advised. When sensitive equipment is used on the floor, different vibrational levels are advised. These levels are shown in table 3.14 (Wilford& Young, 2006) shows the floor function and according maximum velocity of the floor. This is according to the American ASHRAE organisation. The maximum allowable velocity is 400 um/s, which is similar to a R=4, class 1 vibration according to the draft EN 1995-1-1.

Table 3.13: Acceptance limits vibration classes according to Torattti & Talja (2006)

	Dynamic vibration values				Static deflection values	
	$f_0 < 10$ Hz		$f_0 > 10$ Hz		$f_0 > 10$ Hz	Floor plate or superstructure
	$a_{w,rms}$ [m/s²]	v_{max} [mm/s]	v_{rms} [mm/s]	$\|u_{max}\|$ [mm]	Global deflection [a] δ_0[mm/kN]	Local deflection [b] δ_l[mm/kN]
A	≤ 0.03	≤ 4	≤ 0.3	≤ 0.05	≤ 0.12	≤ 0.12
B	≤ 0.05	≤ 6	≤ 0.6	≤ 0.1	≤ 0.25	≤ 0.25
C	≤ 0.075	≤ 8	≤ 1.0	≤ 0.2	≤ 0.5	≤ 0.5
D	≤ 0.12	≤ 10	≤ 1.5	≤ 0.4	≤ 1.0	≤ 1.0
E	> 0.12	> 10	> 1.5	> 0.4	> 1.0	> 1.0

[a] Deflection of main beams

[b] Deformation caused by floor tops (measured at a distance of 600 mm, Figure 1) which are deformations of top plate, floating floor or raised floor.

Table 3.14: Vibration criteria for sensitive equipment (Wilford & Young, 2006)

Criterion curve	Max. velocity level* µm/sec (RMS)	Detail size** microns	Description of use
Workshop (ISO2631 and BS6472) *R* = 8, ASHRAE J	800	N/A	Distinctly perciptible vibration. Appropriate to workshops and non-sensitive areas.
Office (ISO2631 and BS6472) *R* = 4, ASHRAE I	400	N/A	Perceptible vibration. Appropriate to offices and non-sensitive areas.
Residential day (ISO2631 and BS6472) *R* = 2, ASHRAE H	200	75	Barely perceptible vibration. Appropriate to sleep areas in most instances. Probably adequate for computer equipment, probe test equipment and low-power (to 20X) microscopes.
Operating theatre (ISO2631 and BS6472) *R* = 1, ASHRAE F	100	25	Threshold of perception. Suitable for sensitive sleep areas. Suitable in most instances for microscopes to 100X and for other equipment of low sensitivity.

Looking at a research from Abeysekera et al. (2018), other values are shown, these values are based on European researches and continue on the first proposal of Toratti & Talja (2006). And come up with a high performance of class 2 and a low performance of class 4. The renewed Eurocode 5 (draft prEN1995-1-1, 2021) stretched the proposed vibrational performance classes into 6 classes based on a quality, base and economic choice. The according classes can be found in table 3.15, the limit criteria can be found in table 3.3. A note with the classification is that the assigned floor performance levels can be stated in the National annex depending on the country. This gives room to cater to the different vibrational perception of occupant in different countries. Abeysekera et al. (2018) and Hamm et al.(2010) also suggested this. The Talja & Toratti (2006) research was based in Finland and Finnish vibrational perception is more sensitive than in other countries in Europe (Abeysekera et al.(2018), which results in too strict limiting criteria for use in a general EU standard.

Table 3.15: Recommended selection of floor performance levels (Draft prEN 1995-1-1, 2021)

Use category	Quality choice	Base choice	Economy choice
A (residential) – multi-family block – single family house	levels I, II, III levels I, II, III, IV	level IV level V	level V level VI
B (office)	levels I, II, III	level IV	level V

The renewed Eurocode 5 distinguishes offices and residential building functions. What can be seen is that for vibrational performance of a floor, an office has a higher criterium than residential floors. This might be because of the amount of exceeding vibrational events in a residential building compared to an office. In offices, longer paths can be walked, which build up more likeliness for vibrations and more walking movements are made than in a residential building. (See VDV: Vibration Dose Value)

Important here is to notice that the vibrational performance is confined by the lower frequencies in a floor these range from 0 Hz to 100 Hz. This is not to be confused with the acoustic performance of a floor, which considers higher frequencies up to 20.000 Hz.

For the research in this thesis a low and high performance level for offices should be decided upon. For the low performance floor, the economic choice of level 5 from the draft EN 1995-1-1 Eurocode 5 method is chosen. For the high performance floor a quality choice is chosen at level 2. This is in line with a quality office choice from Wilford & Young (2006) and Abeysekera et al. (2018).

Applicability to other materials

The methods explained in chapter 3.3 can be seen as assessment of floor vibrations independent of the material used. The Hivoss has a background in the steel and concrete industry and the method from EC5 is specifically made for the timber industry. The use of the EC5 method is however based on literature and experimental data originating in mechanics and dynamics. These background where originally based on concrete and steel structures. The new Eurocode 5 for timber structures took this knowledge and used it as method in this Eurocode 5. The background is amongst others based on Wilford &Young (2006), Smith et al. (2009), Abeysekera et al.(2019) & Hamm et al. (2010) on which the hivoss is also based. The draft EN 1995-1-1 method will be the most accurate calculation and will give the best insight in the actual behaviour of the floors. For timber as well as for concrete.

4. Theory and quantification of sustainability

This chapter discusses the theory of sustainability of construction materials and specifically floors. It presents a way to quantify the sustainability of materials and which components of the methods should be considered in a sustainability analysis. Furthermore, not only the material will be taken into account, but also the circularity of the floor element, since this is an important factor for future reuse. Finally a method will be deducted on which the environmental impact of a floor can be calculated.

4.1 Definition of sustainability

To be able to compare the sustainability of different materials, it needs to be defined what sustainability means. What is a sustainable product or a sustainable development and what factors are involved in sustainability? In 1987 the Brundtland commission, assigned by the United Nations, defined sustainable development as: *"Sustainable development is development that meets the needs of the present generation without compromising the ability of future generations to meet their needs".* This suggest that today's activities should not negatively impact future generation. To specify this definition for the building industry, the "needs" are mainly resources such as raw materials and energy. The production and use of these materials and energy should not negatively impact the life of future generations. The idea is to keep and improve a clean environment and healthy living conditions (Jonkers, 2020).

A common misconception is that sustainability means solely a low carbon dioxide emission. This is misleading, because a product or material could emit a lot of different chemical composition or deplete natural resources which also have impact on the environment. These factors which influence the environment are qualitatively stated as environmental impact categories. Each category treats a specific environmental impact based on an equivalent of the main chemical composition. A Life Cycle Assessment (LCA) tool is used to quantify these environmental impacts for a specific product or material (Jonkers, 2020).

4.2 Quantification of sustainability

To be able to make a comparison of the sustainability of different materials and products, a method needs to be found to quantify the sustainability. In chapter 4.1 a LCA is stated as a tool to quantify the environmental impact of a material. This tool is used to as a background for an Environmental Product Declaration (EPD) which quantifies the environmental impact in various phases of the lifetime of a material or product. The results of this EPD can then be used to attach a certain fictious environmental cost, which is the fictious cost to compensate for the environmental harm done by the product or material. This so called shadow cost is a way to weigh the environmental damage of each environmental impact category. This results in an Environmental Cost Indication (ECI). These will be further explained in the next paragraphs.

4.2.1 Environmental impact categories

To quantify the sustainability according to the environmental impact, the categories should be explained. These categories will be used in the LCA assessments. In the current guidelines for the Netherlands, 11 impact categories are used. This is stated in the "Nationale Milieu Database"(NMD). However a new standard is introduced in 2021 where 19 impact categories are taken into account. The extension from 11 to 19 impact categories consists of addition of several sub-indications and some new indications. The standard with 11 impact categories is called *'Set 1'* and is based on EN15804+A1. The standard with 19 impact categories is called *'set 2'* and is based on EN15804+A2. With new environmental data for products, both of these sets are mandatory to supply (Stichting Nationale Milieudatabase, 2020).

Although set 2 contains the most actual data, data from set 1 should be tested and approved according to the new standard. This is a comprehensive task for suppliers of the data and is thus still in progress. Another technical delay is caused by the conversion of data for which the information basis did not comply with the new determination method. This is the case for materials such as concrete and timber. Another reason for the use of set 1 is the conversion from environmental data to an ECI. The weigh factors for set 2 are not yet available and thus the weigh factors and data from set 1 should be used currently to find an ECI.

The 11 impact categories which are going to be used for the materials in this thesis are found below. Each impact category is shortly explained using Jonkers (2020). Table 4.1 gives an overview of the impact categories and its corresponding standardized equivalent unit.

1. **Abiotic Depletion Potential Non-Fuel (ADP non-fuel)**
2. **Abiotic Depletion Potential Fuel (ADP fuel)**

The abiotic depletion is split in two parts, firstly the non-fuel and secondly fuel. Abiotic depletion is the measure for scarcity of non-living resources. The non-fuel part is the depletion of raw materials, minerals and metals. The fuel part is regarding the depletion of energy resources. Both have a referred unit of kg Sb (antimony) equivalent. ADP-fuel could also be measured in MJ energy need.

3. **Global Warming Potential (GWP)**

The global warming potential quantifies the effects of greenhouse gas emissions due to human activity, so called anthropogenic. The 5 main greenhouse gases include carbon dioxide (CO_2), methane (CH_4), chloro-fluor-carbons (CFC's), Ozone (O_3) and nitrous oxide(N_2O). The total emissions of these compounds combined is expressed in the unit kg CO_2-equivalent. These emissions have effect on the greenhouse effect, the disruption of the worldwide climate, temperature raise and accessory effects.

4. **Ozone layer Depletion Potential (ODP)**

The effect of ozone (O_3) on the environment has two sides. In the lower atmosphere it is a greenhouse gas with a negative impact, but in the higher atmosphere it is useful as it protects the earth from penetrating UV radiation. Halogenated compounds such as CFC's are powerful greenhouse gasses which decompose the ozone layer in the higher atmosphere. The reference unit for ozone layer depletion is kg CFC-11 equivalent.

5. **Photochemical Oxidation Potential (POCP)**

Photochemical Oxidation is the reaction of emitted airborne pollutants with sunlight. Which results in the formation of chemically reactive compounds. These can be harmful for both human health and the natural environment. An example of harmful compounds are Volatile Organic compounds (VOC's), Carbon monoxide (CO) and nitrogen oxides (NO_x). These are especially emitted in the combustion of diesel fuels. The reference unit for Photochemical oxidation is kg ethylene (C_2H_4) equivalent.

6. **Acidification Potential (AP)**

The acidification potential is the effect of emissions that are acidic or produce acid when reacting with water. Compounds which cause acidification are sulphur oxides (SO_x) and nitrogen oxides (NO_x). The acidification can have short and long term degradational effects on the natural environment as well as the built environment. The reference unit for Acidification is kg SO_2 equivalent.

7. **Eutrophication Potential (EP)**

Eutrophication is the load of excessive nutrient in the environment, for example from fertilizing agricultural soils. Nitrogen (N) and phosphorous (P) are common compounds used as fertilizer. The excess of nutrients create a sudden imbalance in the nature, which can result in loss of biodiversity. The reference unit for eutrophication is kg PO_4 equivalent.

8. **Human Toxicity Potential (HTP)**

Human Toxicity refers to the compounds which have a negative effect on the human health. The emitted compounds can end up in air, water or soil. The toxicity of the compound itself and the emitted dose determine the contribution to the impact category. The reference unit for human toxicity is kg 1,4 dichlorobenzene (DB) equivalent.

9. Freshwater Aquatic Eco-Toxicity Potential (FAETP)

Freshwater aquatic eco-toxicity has a similar effect as human toxicity where the compounds released in the environment harm the organisms living in freshwater aquatic ecosystem. Possible components are wastewater, heavy metals and oil or mining residues. The reference unit for freshwater aquatic eco-toxicity is kg 1,4 dichlorobenzene (DB) equivalent.

10. Marine Aquatic Eco-Toxicity Potential (MAETP)

Marine aquatic eco-toxicity has a similar effect as freshwater aquatic eco-toxicity where the compounds released in the environment harm the organisms living in marine aquatic ecosystem. A specific compound causing problems is Persistent Organic Pollutants (POP's). These compounds don't or slowly degrade, which causes it to accumulate in the food chain until it reaches toxic levels, especially in organisms higher up in the food chain. The reference unit for marine aquatic eco-toxicity is kg 1,4 dichlorobenzene (DB) equivalent.

11. Terrestrial Eco-Toxicity Potential (TETP)

Terrestrial eco-toxicity has a similar effect as marine aquatic eco-toxicity but specifically for the terrestrial (land) environment. Compounds like pesticides and insecticides used in agriculture can reach toxicity levels influencing terrestrial plants and animals which can eventually accumulate in the food chain, causing more extensive problems. The reference unit for marine aquatic eco-toxicity is kg 1,4 dichlorobenzene (DB) equivalent.

4.2.2 Life Cycle Assessment (LCA)

A life Cycle Assessment is a tool to quantify the environmental impact of a product or material based on the environmental impact categories explained in 4.2.1. The background and rules of the tool can be found in its standards: EN 159978, ISO14025 and EN15804. An important part of the LCA is the life cycles through which the product or material goes. The life cycle stages can be found in figure 4.2. The life cycles an LCA considers are the production stage, construction stage, use stage and end-of-life stage. These stages will be explained in further paragraphs. The LCA identifies the environmental impact contribution of each life stage. This can be used to show the overall impact and impact per life cycle stage.

To make a Life Cycle Assessment a framework is used, this creates the base for a fair comparison between materials or products. See figure 4.1 Within this LCA the environmental impact of raw materials and all occurring transport and processing is summed. As mentioned before, the LCA is executed for several phases, each phase has its relevant environmental impact stated in the LCA. This way, the phases can be compared separately. The environmental impact can be graphically presented in environmental profiles of the impact categories per life cycle stage (Jonkers, 2020).

The first step of an LCA is defining the Goal & Scope of the material or product assessed, this includes a functional unit. This functional unit is the unit amount which is assessed, e.g. 1 M3 of material or a 200mm high floor. The goal of the study comprises of 3 elements: Description of application, the reason why the LCA is performed and the target audience. The intended application of the LCA can be for comparison of products or indication of high environmental impacts within the product. The reason for assessment of the LCA could be for obtaining an EPD or for optimisation of the environmental impact of the production process. The target audience could be an end user, government or stakeholders withing the supply chain. The scope of the LCA considers the functional unit, the system boundaries and which data will be used (Jonkers, 2020).

The second step of an LCA is making a Life Cycle Inventory(LCI) Analysis, this is an inventory of all relevant materials and processes linked to the life cycle phases of the assessed product. A distinction is made between each life cycle, so all processes and materials can be linked accordingly. The third step is the Life cycle impact assessment(LCIA), in this phase all the LCI data is combined and weighed according to the quantity and environmental impact related to each step in the products life cycle stage. Finally an environmental profile can be made for the product for the functional unit chosen. In the final step, the results of the LCIA are interpretated and discussed where the results are applicable and limitations are stated.

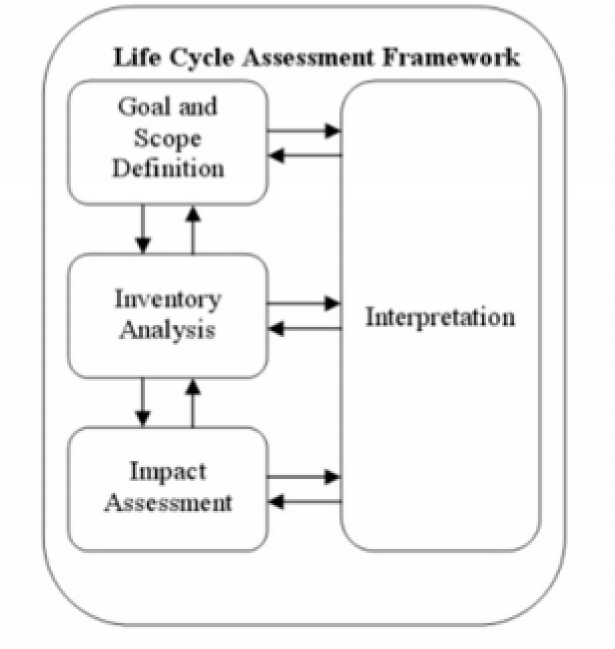


Figure 4.1: LCA Framework

4.2.3 Life cycle modules A-D

An LCA consists of several modules, each of them quantifies the environmental impact of a certain part in the lifetime of a product or functional unit of the product. The life cycle phases range from A to D, where A1-A3 is the production phase, A4-A5 the Construction phase, B the Use phase, C the end of life phase and D the Loads & Benefits which contains the value at the end of the functional life of a product. An explanation of the modules used in LCA's can be found underneath.

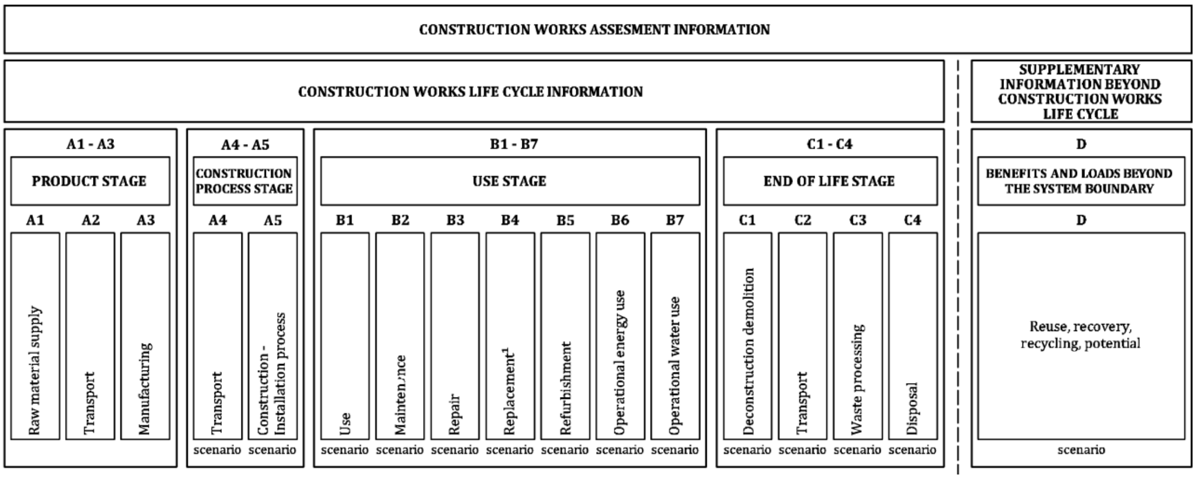


Figure 4.2: Life cycle modules A to D. (NEN-EN 15804:2012+A2:2019)

Module A1-A3: Production phase

This module represents the environmental impact of the production phase. This phase consists of 3 parts; A1: Raw material supply, A2: Transport and A3: Manufacturing. These parts have their own contribution to the total environmental impact of the specific phase.

Module A4-A5: Construction phase

This module represents the environmental impact of the construction phase. This phase consists of 2 parts; A4: Transportation and A5: Construction installation process. These parts have their own contribution to the total environmental impact of the specific phase. This phase is scenario dependant, because of the possible variations in construction location and the production process used by the contractor.

Module B: Use phase

This module represents the environmental impact of the use phase. This phase consists of 7 parts; B1: Use, B2: Maintenance, B3: Repair, B4: Replacement, B5: Refurbishment, B6: Operational energy use and B7: Operational water use. These parts have their own contribution to the total environmental impact of the specific phase.

Module C: End of life phase

This module represents the environmental impact of the end-of-life phase. This phase consists of 4 parts; C1: Demolition process, C2: Transport, C3: Waste processing, C4: Disposal. These parts have their own contribution to the total environmental impact of the specific phase.

Module D: Loads & Benefits

This module represents the environmental impact of the potentially savings by re-uses, recovery or recycling potential of the material.

4.2.4 Environmental product declaration (EPD)

The environmental impact of materials is given in an Environmental Product Declaration (EPD). These EPD's are manufacturer dependent, since the process to produce a product differs per manufacturer. The EPD's are drafted by independent third party companies based on EN 15804:2012. These EPD's are the result of an LCA of the specific products. These EPD's consist of the environmental profile including the numerical data per life cycle module as seen in figure 4.2. EPD's differ from each other by included impact categories and included modules. So not all EPD's can be directly compared to each other.

4.2.5 Environmental Cost Indication

The environmental cost indication (ECI) is a method which enables the incorporation of the environmental impact categories into one weighted value. This value can then be used to compare different materials and different design concepts. The weighted value of each environmental impact category is determined by the dutch Nationale Milieudatabase (NMD), based on the EN 15804 standard. See table 4.1 for the weigh factor per impact category.

The environmental data received from an LCA is available in a product specific EPD. Within this EPD, the values of the kg equivalent unit is stated. To get environmental cost indication, the amount of substance is weighed with the weigh factors from table 4.1. This results in a total environmental cost of the product. The cost is depicted in euro, which relates to the shadow costs of the product. This shadow costs are the costs which should be made to compensate the negative effect of product on the environment. These costs are a unit and is not directly related to the practical and technical exploitation and feasibility of environmental compensation. The weighing factor gives an indication of the severeness of the environmental impact of a certain impact category.

Table 4.1: Impact categories, its equivalent unit and weigh factor

Environment Impact category	Equivalent unit	Weighfactor [EU/kg eq.]
Abiotic Depletion Potential Non-Fuel -ADP-non-fuel	kg Sb eq	€ 0,16
Abiotic Depletion Potential Fuel - ADP	kg Sb eq	€ 0,16
Global Warming Potential - GWP	kg CO2 eq	€ 0,05
Ozone layer Depletion Potential – ODP	kg CFK-11 eq	€ 30
Photochemical Oxidation Potential – POCP	kg C2H4 eq	€ 2
Acidification Potential – AP	kg SO2 eq	€ 4
Eutrophication Potential – EP	kg PO4 eq	€ 9
Human Toxicity Potential – HTP	kg 1,4-DCB eq	€ 0,09
Freshwater Aquatic Eco-Toxicity Potential – FAETP	kg 1,4-DCB eq	€ 0,03
Marine Aquatic Eco-Toxicity Potential - MAETP	kg 1,4-DCB eq	€ 0,00
Terrestrial Eco-Toxicity Potential – TETP	kg 1,4-DCB eq	€ 0,06

4.2.6 Biogenic carbon content and embodied carbon content

Biogenic carbon content, this shows the CO2 saved within a material. This is specifically for biobased materials such as timber, in which CO2 is captured during the growth of the tree. The biogenic carbon content for concrete is zero, since it is non-biogenic. Biogenic carbon content differs from the embodied carbon content, according to carbon leadership forum: “the embodied carbon content refers to the greenhouse gas emissions arising from the manufacturing, transportation, installation, maintenance, and disposal of building materials.” So the carbon emissions and capturing during the total lifecycle of a material. The following formula is used to calculate the biogenic carbon content (NEN EN 16449-2014).

$$P_{CO_2} = \frac{44}{12} \times cf \times \frac{\rho_\omega \times V_\omega}{1 + \frac{\omega}{100}}$$

The formula above calculates the captured carbon content within biomass in kg/m3. The [cf] factor is the carbon fraction of woody biomass, which is 0,5 as default. The density[ρ_ω] is specified per timber species at the specific moisture content [ω]. [V_ω] is the volume of timber used in the product. This calculation can be used for different types of timber.

The biogenic carbon content is the carbon captured by biomass. Due to the short cycle of capturing carbon within a building material, timber is an attractive material to build with. The carbon is relatively recent taken from the environment and stored in the timber. The use of timber enables the capture of carbon within buildings. When the timber is sourced using sustainable forestry, new trees will grow and capture more carbon from the atmosphere. The newer trees will take more carbon from the environment than older trees do (Blass & Sandhaas, 2017). Thus by using timber as a building material, carbon is being captured and stored in a useful way.

By incorporating the biogenic carbon in the environmental impact calculations, the short term (module A) Global Warming Potential will result in a negative value, thus a decrease of CO2eq. In the end-of-life phase (C), when a scenario of incineration or natural degradation would be chosen, the biogenic carbon will be returned back to nature. Which will make it in the worst scenario a net zero Co2 emission. Materials such as concrete will always have a CO2 emission in the short term (module A), but no capturing, thus a CO2eq emission will always be present.

4.2.7 Magnitude and proportion of environmental impact

The environmental impact of the floors can differ from floor type and material. The environmental impact is divided into several impact categories. In figure 4.3 the kg equivalent of each impact category for several materials can be seen as wel as the ECI value. Two impact categories clearly outweigh the rest namely Marine Aquatic toxicity and Global warming potential. These impact categories have large emissions. But if the ECI is taken from the same products, other impact categories also weigh into the total ECI value. Figure 4.3 shows that the global warming potential has the largest impact on the ECI value, and the second most influential impact category is the human toxicity, which has a lower emission in kg equivalent. So sometimes small emissions have a large environmental impact as well as large emissions might have low impact. The impacts shown in the graphs is for 200mm floors for each material, CLT, LVL box floor, concrete in situ floor and a concrete hollow core. The data is taken from the NMD and used as illustration of the proportions between emissions and Environmental Cost indication.

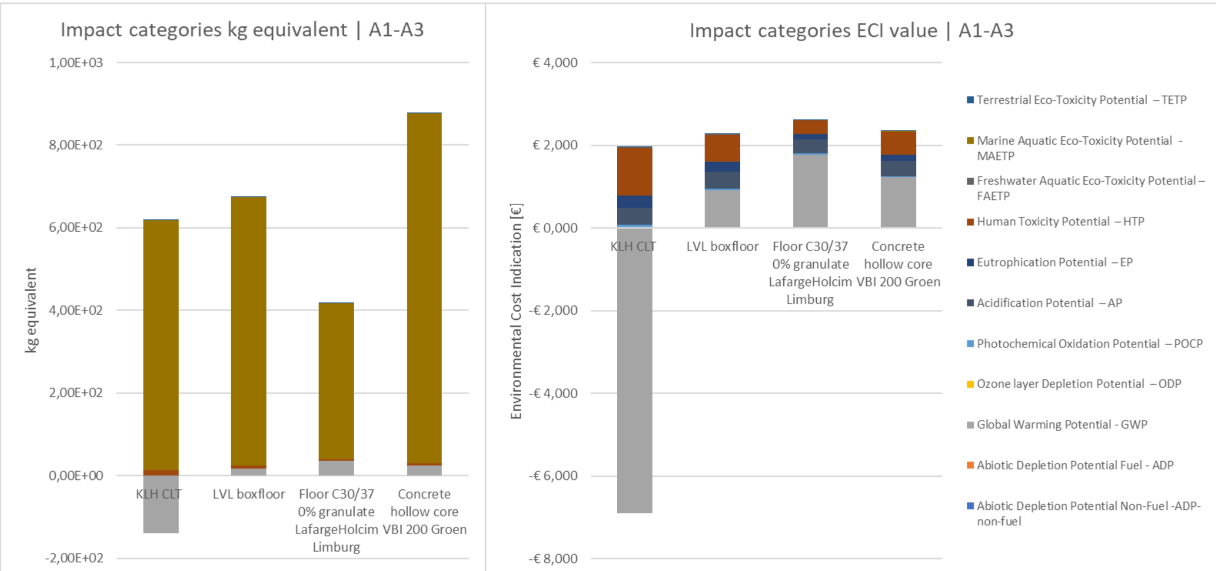


Figure 4.3: Impact categories kg equivalent and according ECI

4.2.8 Scenarios within EPD's

The life cycle modules previously introduced give the environmental impact of each life cycle stage. The environmental data is gathered using the LCA for the product. This data from the LCA is often presented in an EPD. The actions within a products life are not always known upfront. This means that several scenarios can be introduced with each its own environmental impact. As can be seen in figure 4.2, the environmental impact of the production phase(A1-A3) of a product can be measured, but the products environmental impact in the future are harder to measure or decide. The building phase(A4-A5) is dependent on the way the building is built as well as the location where it s built. For the Use phase (B), often it is unknown whether a damage will occur or how the product will behave in a certain environment. The end-of-life phase(C) is even more difficult to predict, there are several possibilities on what will happen with a product once it reaches the end of its service life. For timber product it could be reused, recycled, incinerated or it could end up in a landfill. Concrete products can be reused, recycled or end up as landfill as well. Each of these have a different environmental impact. Simply assuming the best possibility will happen might lead to non-realistic choices for the environmental impact.

4.3 Circularity

The life cycle assessment(LCA) is a tool to calculate the environmental impact of a structural element. This tool is useful to compare several types of floor systems. This system indicates several emissions for a unit of material. These factors give a monetary compensation value for each kind of emission. Adding these costs, will give the total environmental cost given in euros. This is an Environmental Cost Indication (ECI). This system calculates the environmental costs for different stages of the structure. But does not include the factor of time. It is a measurement tool meant to compare the environmental impact of a material or structural part based on a functional unit.

In the long run, the longer a material or element is in use, the better it is for the environment. Even if the structure is at the end of its functional lifetime, the materials or element could be reused in other buildings. This prevents the emissions and environmental damage caused by new materials. Another factor to consider is the scarcity of primary materials, reusing the materials which are already available decreases the pressure on natural primary resources. So circular potential of an element is also important to consider. Also taking into account the Dutch governments goals to have a fully circular economy in 2050 (Ministerie van Infrastructuur en Waterstaat, 2023).

In theory a lot of elements and materials could be reused at the end of their lifetime. But in practice, especially in economic sense, the element or material should be easy to taken out of a structure in order to be able to easily reuse it in a new construction. For the circular potential of a building, the ease of detachable elements is a good way to measure its potential. A way to quantify the circular potential of an element is by using the “losmaakbaarheidsindex” (Alba concepts et al. (2021). This index gives points for several aspects of detachability and the ease of detachability. This counts up to a score, with which the different floor elements can be compared.

4.4 Data availability and sources

To be able to make a comparison between the environmental impact of materials, qualitative data is needed. The data available for environmental impact of materials and products can differ from product, supplier, certifier and age of the environmental product declaration(EPD). An EPD consists of several modules corresponding to the life cycle phase of the product. From the production phase in module A to the reusability in module D. Depending on the EPD, some modules are included and some not.

Furthermore, the EPD consists of environmental impact categories to be able to quantify the environmental impact accordingly. In the newest EPD's, 19 impact categories are used, but older epd's include 11 or 17 impact categories. This gives a tangled set of data. To be able to unravel this data and make it useable for comparison, the data needs to be generalised for the dutch market. The 'Nederlandse Milieu Database' (NMD) provides this service for the dutch market. A software tool is used to get the data out of the NMD. For this research 'GPR aterial' software is used, which uses the NMD 4.3 dataset.

Within this data from the NMD, a selected range of materials and products is available, this data is available in 3 categories. According to the 'Bepalingsmethode Milieuprestatie Bouwwerken, 2020' these 3 categories are the following:
Category 1: Supplier specific data, independently tested according to NMD standards
Category 2: Unbranded data from several suppliers, independently tested according to NMD standards
Category 3: Unbranded data, not tested according to NMD standards

The accuracy of the data is best for category 1 data and worst for category 3 data. Currently in the NMD database, most of the data for floors is either category 1 or category 3. The difficulty of this data is the lack of variety, in the category 1 data, only a few or sometimes only 1 supplier EPD is available or only a less accurate category 3 EPD is available.

Data sources

GPR Material – NMD

There are several data sources for environmental product data. The most commonly used source in the Netherlands is the NMD. Using a software tool GPR, the most appropriate EPD's for the dutch market are analysed, the EPD's contain environmental data based on 11 impact categories and mostly contain data for modules A to D. The available data is dependent based on 3 categories data as stated in the paragraphs above.

OneClickLCA – worldwide EPD's

Another data source for worldwide EPD's is OneCLickLCA, this has more EPD's available which will be less coordinated and can differ more than the unified NMD data. Although this data is more widely spread, an average of the EPD's can be made to give an insight in the range and validity of chosen EPD values. The environmental data from OneClickLCA is based on 6 impact categories and thus less extensive than the NMD data. The data can be put in the 3 categories as well. The first category is manufacturer data which is verified, the second category is data which is put together by an organisation and verified. The third category is data which is generalised by OneClickLCA itself or manufacturer data which is not verified externally.

The OneClickLCA and GPR material database will be used to analyse data from both sources, this analysis can be found in chapter 6. A list of EPD's, its source and additional information can be found in *Annex C: Sustainability – overview of resources*.

4.5 Sustainability scenarios

To make a fair comparison on the sustainability of floors, the environmental impact of different floor types and materials is compared. This is done according to the method described above using the environmental cost indication, which gives a fictive value to the environmental impact category. For the comparison 4 situations are tested in 4 according scenarios. For the scenarios the period are taken into account and important environmental impacts.

The A1-A3 modules are analysed for the short term environmental impact of the production phase. The long term environmental impact is analysed is analysed by using modules A1-A3 and C, where the production phase and end-of-life phase is taken into account. Since a material or product has a certain end-of-life, this module can be taken as a certainty. Although it is unknown when the end of life of a product is, the environmental impact will in the end happen. The Environmental Cost Indication is taken into account as the total environmental impact of the material taken the different periods. The Global Warming Potential is taken into account to analyse the materials for the potential to reduce the global warming. See the scenarios below. Biogenic carbon content is considered separately and not taken into account in the environmental data analysis.

Sustainability scenarios

<u>Scenario 1: ECI A1-A3</u>

Environmental cost indication of the production phase A1-A3.

<u>Scenario 2: ECI A1-A3 + C</u>

Environmental cost indication of the production phase A1-A3 and end-of-life phase C.

<u>Scenario 3: GWP A1-A3</u>

Global Warming Potential of the production phase A1-A3.

<u>Scenario 3: GWP A1-A3+C</u>

Global Warming Potential of the production phase A1-A3 and the end-of-life phase C.

Part III

Vibrational performance and sustainability of floors

5. Vibrational performance of floors

This chapter discusses the vibrational performance of timber and conventional floors. An excel model is created to calculate the vibrational performance according to the renewed EC5 method. This method will be applied for all floor materials. The calculations will be performed for several scenario's which will be defined in this chapter. Each scenario for a vibrational performance levels has to meet at least the structural safety minimums. The results of the vibrational performances will be compared and shown in this chapter.

5.1 Introduction and method

In chapter 3, the theory behind floor vibrations, its source and quantification methods are analysed. This analysis lead to the draft EN 1995-1-1 method which can be used to check the vibrational performance of the different floor types introduced in chapter 2. Chapter 5 will combine knowledge by implementing the theory from chapter 3 on the floors from chapter 2. These floors are analysed for different scenarios in a standardised situation and this result is further interpreted.

5.2 Standardised situation & scenarios

To be able to make a comparison between the different floors, a standardised situation is created as input for all calculations. This scenario is based on a reasonable situation for an office floor. A situation sketch can be found in figure 5.1. The floor will have a varying span L and a width W. This width can be composed out of several floor elements with a width Wp. This is relevant for prefab elements such as CLT, LVL, TCC and concrete hollow core. For the vibrational performance, a conservative limit is taken at the structural element width, this limits the effective width of the floor, thus vibrating floor area. This is conservative, since vibrations can activate adjacent floor elements (Wallner Novak, 2018). But for this research, this is not taken into account.

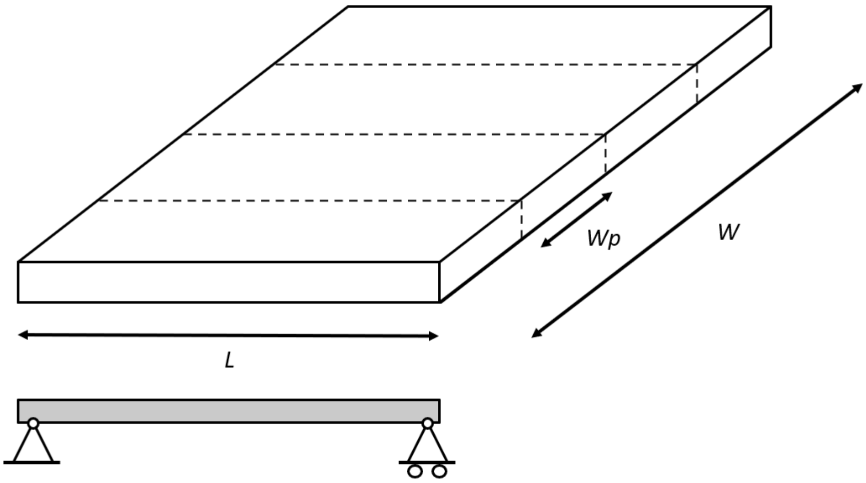


Figure 5.1: Standardised situation for vibrational analysis

The floor performance of each floor is tested in the standardised situation according to a few scenarios. These scenarios deal with a variation in conditions which influence the vibrational performance of the floor. All scenarios have the standardised situation as basis and each floor has its specific damping ratio and floor stiffness characteristics. The five floor types introduced in chapter 2 are verified in each scenario. The scenarios are expressed in minimal floor height necessary to comply with the requirements of the scenario. The basis of all scenarios is a structurally safe floor. This will be further expressed in chapter 5.3. The following scenarios are stated.

Vibrational scenarios

Scenario 1: Low performance & narrow

This scenario involves a basic floor with a low vibrational performance and a narrow element width. The floor has an element width of 1m and needs to fulfil a vibrational performance class 5 to comply.

Scenario 2: Low performance & wide

This scenario involves a basic floor with a low vibrational performance and a wide element width. The floor has an element width of 3m and needs to fulfil a vibrational performance class 5 to comply.

Scenario 3: High performance & narrow

This scenario involves a basic floor with a high vibrational performance and a narrow element width. The floor has an element width of 1m and needs to fulfil a vibrational performance class 2 to comply.

Scenario 4: High performance & wide

This scenario involves a basic floor with a high vibrational performance and a wide element width. The floor has an element width of 3m and needs to fulfil a vibrational performance class 2 to comply.

The variation of the 4 scenarios is chosen to indicate the effect of the vibrational floor performance level and the effect of a change in floor geometry. The floor performance classes chosen to accommodate a high and low performance are chosen from the literature. The relevant floor performance classes 2 and 5 are according to the draft prEN1995:1-1 (2021), Abeysekera et al.(2019), Hamm et al.(2010) and Toratti(2006), see chapter 3. For the effect of geometry, it is chosen to change the width of the floor, this is done because it has the most direct effect on the floor performance and is a design choice which can be easily adjusted. Other parameters such as damping and mass could be chosen, but damping is relatively hard to use as a design parameter since it yields lower differences and is dependent on the floor configuration itself. The mass could be changed by adding mass on top of the floor, but this lowers the eigenfrequency of the floor. This effect compensates the effect of mass addition and thus overall has a lower effect on the vibrational performance of the floor.

5.3 Structural calculations

In order to show the effect of vibrational performance on the type and height of a floor, firstly the minimum floor needs to be calculated. The minimum floor is the minimum floor height needed to have a structurally safe floor. In this paragraph the structural calculations needed to verify the structural safety of the floors considered in this thesis will be shown. This research considers several types of materials and floors, these are shown in chapter 2. The first calculations are performed using criteria such as moment capacity, shear resistance and deflection of the floor, regarded as a simply supported beam. Classic beam theory is used, due to the elemental components of the floors, this seems realistic. The floors are subjected to a standardised load according to the Eurocode 1991. The structural calculations are based on an office floor with a permanent load of 1,5 kN/m2, consisting of 1kN/m2 for floor finish and 0,5 kN/m2 for installations and the self-weight of floor. A variable load of 3 kN/m2 is also taken into account in the calculations.

The method and formulas used to calculate the minimum structural safe floor can be found in *appendix A: Structural calculations*. This annex shows the calculation of the considered loads on the floor, the cross sectional properties of the different floor types and the verification calculations of the floors. The results of the structural calculations can be found below. The minimum structural floor height for the 5 different floor types can be found in figure 5.1. What can be seen is that timber based floors are higher than concrete based floors on comparable floor spans. Although, the floor height is within a reasonable range. The steps in the lines are caused by the discrete floor height steps of practically available floors.

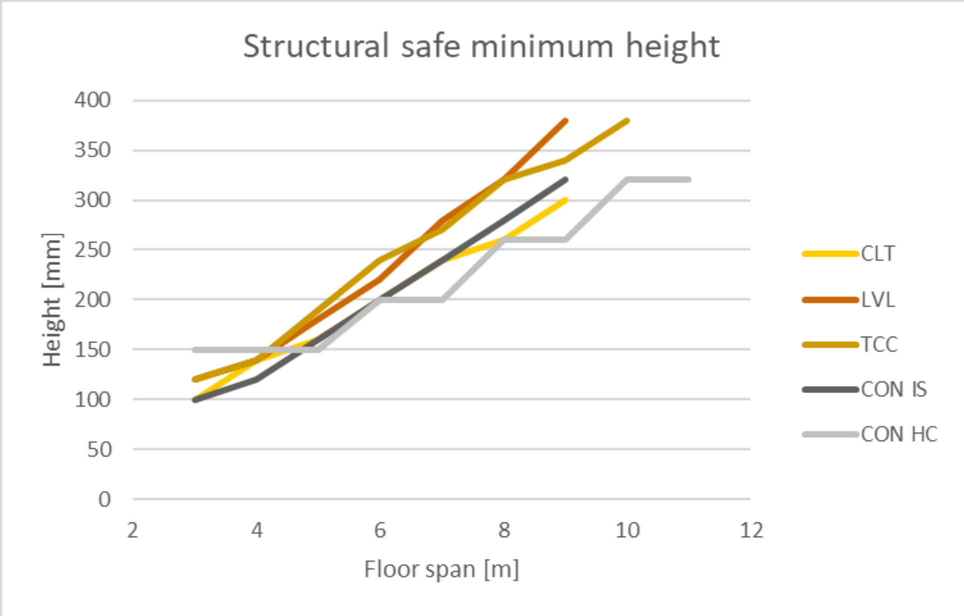


Figure 5.2: Structural minimum heights of floor

For each floor type the enveloping lines are calculated, these lines show the minimal floor height necessary to fulfil a structural safety requirement such as moment capacity, shear capacity or deflection including creep. In figure 5.2 the enveloping lines for the structural safety are shown per material. For CLT, LVL, TCC and concrete in situ (CON IS) the total deflection of the floor including creep is decisive. For concrete hollow core (CON HC) the moment capacity is decisive. For most floors the shear capacity is the least decisive and the smallest floor height is for most floor spans safe, considering the shear capacity. For the LVL box floor, the shear capacity is more decisive than the moment capacity, but the deflection still determines the decisive floor height considering structural safety. All structural calculations are performed using a calculation per unit width, so the calculations are for a simply supported beam of 1m width. Table 5.1 shows the minimum structural height per floor span in meters and the corresponding height in millimetres.

Table 5.1: Minimum structural height in millimetres

Span [m]	CLT [mm]	LVL [mm]	TCC [mm]	CON IS [mm]	CON HC [mm]
3	100	120	120	100	150
4	140	140	140	120	150
5	160	180	190	160	150
6	200	220	240	200	200
7	240	280	270	240	200
8	260	320	320	280	260
9	300	380	340	320	260
10			380		320
11					320

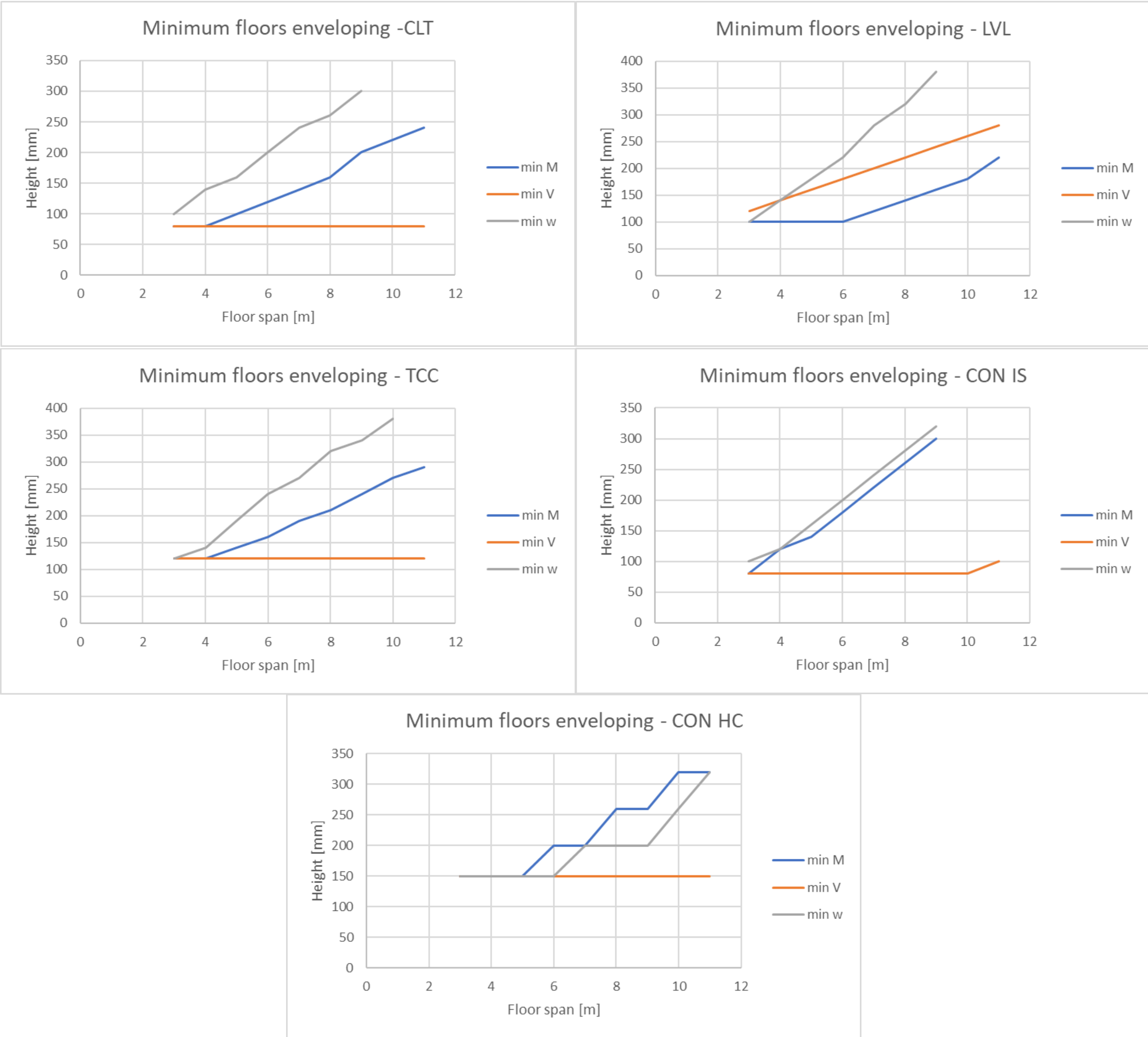


Figure 5.3: Enveloping lines for structural requirements

The graphs shown in figure 5.3 show the enveloping line of the structural safety floor height minimums for the moment capacity, shear capacity and final deflection including creep. The moment capacity and shear capacity are based on the ultimate limit strength (ULS) and the deflection including creep is based on the serviceable limit strength (SLS). The lines within the graphs show the structural floor height necessary to cope with the occurring moment, shear or deflection at a certain span. The shear capacity has in most cases, except for LVL, a horizontal line. This means that for most floors, the minimum floor height is able to cope with the occurring shear from the load case. Due to the box floor geometry of the LVL, the shear capacity of the floor has to increase over a larger span.

The minimum structural safe floor height of most floors types are governed by the deflection including creep of the floor. The larger the span, the larger the minimum floor height has to be. For mass timber floors such as CLT and TCC, this deflection is the governing criteria. In the minimum floor for deflection and moment a slight squiggle can be seen, this is due to the difference in properties for specific CLT floors. CLT floor can be executed with a double top layer in the same direction, this increases the stiffness and thus reduces the deflection, keeping the minimal structural floor height the same. For TCC the concrete layer on top of the CLT adds to this height disruption due to the slight increase of concrete top thickness as the panels get thicker.

For the LVL box floor the governing criteria is the deflection including creep, this is due to the geometry of the floor, relatively much material of the floor is at the top and bottom of the cross section with some webs to support the top and bottom plate. The deflection of the box floor can be reduced by using thicker top and bottom plates. The stiffness of the floor is the result of the relatively high floor height. The combination of a large height and high strength LVL material causes the floor to have a high moment capacity. This can be seen as the moment capacity is the least governing criteria. Due to the small webs of the floor, the shear capacity of the floor is less and thus needs more floor height to cope with the occurring shear.

For concrete based floors, the deflection and moment capacity of the floor are near each other. For concrete insitu floors, the governing criteria of moment capacity and deflection are close. Depending on the inclusion of creep and the creep factor taken into account (See appendix A) the minimum floor height due to deflection might be lowered. For concrete hollow core floors, the moment capacity is the governing criteria and the deflection requires the same or a less high floor.

In the upcoming chapters the structural minimum floor is regarded in several results. This minimum structural floor consist of the floor height of the governing criteria for each floor type, based on figure 5.3, which for most cases thus is the deflection including creep. Figure 5.2 already shows the governing line for each floor type. This is regarded as the structural minimum floor height.

5.4 Vibrational performance calculations

The vibrational performances of each floor type is considered below. The scenarios mentioned previously in this chapter are considered per material. The vibrational performance is calculated according to the renewed EC5 method explained in chapter 3. This calculation can be found in *appendix B*. Some important parameters should be discussed before the results, these parameters influence the results or show limitations of the method used. These topics will be discussed in the paragraphs below. In the results, two topics will have the main focus, firstly the difference between a high and low vibrational performance and secondly the mitigation of vibrational response by the use of different floor configurations. This is represented by a narrow (1m) or wide (3m) floor.

Damping values

The damping values differ per floor type. As seen in chapter 3 where the vibrational assessment method was introduced, the damping values can differ per floor type and boundary conditions. Calculating the specific damping value of a floor is complicated and depending on a lot of parameters, so an estimate is used to be able to make calculations of the floor. This estimate is based on literature on experimental results of floor vibration tests. So the damping values can be seen as empirical. The damping values per material can be found in table 5.2. The background of each damping value can be found in chapter 3.

Table 5.2: damping ratio per floor type

Floor type	Damping ratio
CLT	2,0%
LVL boxfloor	2,0%
TCC	2,5%
Concrete insitu	1,0%
Concrete Hollow Core	0,5%

Floor performance levels calculations

The procedure to get a certain floor performance level is as follows, due to the use of practically available floor sizes the available floor are limited. The calculation is as shown in appendix B and chapter 3. Each floor has certain parameters which are then used to discretely calculate the eigen frequency, deflection, resonant response and transient response. So each floor height results in a governing floor performance level based on the previously mentioned criteria. Since this results in a discrete set of floor performance levels, it is possible that not each performance level is possible within a certain floor material and span. If a continuous calculation of floor heights would have been calculated, a certain floor performance level would have been possible. Since practical available sizes are used in this research, the step in floor height results in a jump in floor performance level. In this research a low and high performance vibration, indicating a level 5 or level 2. This indicates that a high performance can include level 5, 4 and 3, a high performance could include level 2 and 1. Especially when the difference in floor height between a high and low performance level is small, the floor might include higher performance levels. In practice this might result in difficulty to design for a specific floor performance level.

Model parameters assumptions
The calculation of the vibrational performance of the floors are based on certain assumptions, these will be explained in this paragraph. The damping value assumptions and procedure on which the vibrational performance levels have already been discussed. The assumptions for parameters such as effective width, transverse stiffness inclusion, frequency calculation and modal mass calculation are discussed in this paragraph. The formulas used and calculations can be found in *appendix B.*

For the width of the floor, it is assumed that the floor exists of elements with a certain size. Depending on the dimensions of the floor, the amount of width which is effectively used differs, this is called the effective width. This is dependent on the ratio transverse stiffness and longitudinal stiffness, which is explained in chapter 3. For the vibrational calculations the effective width of the floor is used, but is limited to the individual elements width. For structural calculations the actual width of the floor is used per running meter.

The transverse stiffness is included in several parts of the vibrational calculations of the floor. It is used in the determination of the effective width of the floor and it is used in the calculation of resonant response and transient response. These vibrational responses behave differently in floors for different stiffness ratio. A higher transverse stiffness will reduce the response, since more material dampens the movement of the floor.

The eigen frequency of the floor is based on a simply supported beam on two supports. This means that the main eigenfrequency is calculated for the longitudinal direction in which the highest dynamic load can occur. And that the effect of adjacent floor elements is not taken into account, which is a conservative assumption. Taking adjacent elements into account will complicate the calculations, but might increase the eigen frequency and might reduce the vibrational response.

The modal mass of the floor is based on a single supported floor , this means that only 2 sides are supported. In this case half of the mass of the floor is taken into account, this is 100% of the permanent load and 10% of the variable load. The mass is calculated for the full width of the element, since the whole mass of the element is being put into motion. Adjacent elements are not taken into account, when it would be accounted for, the panel would have 4 supported sides or partly supported sides, which make the calculations more complex. This also results in a lower modal mass, since only a quarter of the elements mass is taken into account when the panel is fully supported on 4 sides.

Enveloping line
The verification of the floors is done using the criteria and according floor performance levels of the renewed EC5 method. The main response which are tested are the root-mean-square acceleration and the root-mean-square velocity of the floors. Respectively corresponding to the resonant floor response and the transient floor response. The velocity and acceleration criteria react differently to parameter changes. One of these responses can be governing in

the design criteria, this can result in counterintuitive results. Figure 5.4 shows the enveloping lines of a concrete in situ floor for a 3m wide floor and a low floor performance level (Level 5) It shows the minimum structural height regarding the transient response (V_rms), the minimum structural height regarding the resonant response (A_rms), the structural height regarding the structural safety (Struct. Min) and the overall governing line. It shows that for this scenario the concrete in situ floor's governing criteria is the structural minimum, except for the floor at a span of 8 meter. So the concrete floor is less sensitive to vibration.

For other floors or by a change in boundary parameters, it might happen that the vibrational criteria (resonant or transient) will be governing, this might result in a counterintuitive result where a less tall floor height might fulfil the floor performance level. This is shown in figure 5.4 when the structural minimum is not taken into account. At 8m and 9m the acceleration criterium is governing, but at 10m the velocity criterium becomes governing. This results in a "dip" in the overall governing line. This is a counterintuitive result, which can be explained by the boundaries set up by the method. The specific boundary where this comes from is the frequency domain which boundaries are from 4,5 Hz to 8 Hz. And are not directly from the acceleration response of the floor. For larger floor spans, the vibrational criterium might change from a transient response to a resonant response, due to a lower eigenfrequency. The resonant response might be the governing criteria. Since the modal mass of a large span increases and the driving force stays the same, the acceleration decreases for longer spans. The resonant response has to be tested for when the eigen frequency of the floor is smaller than 8 Hz. Most governing vibrational calculations are based on the transient response.

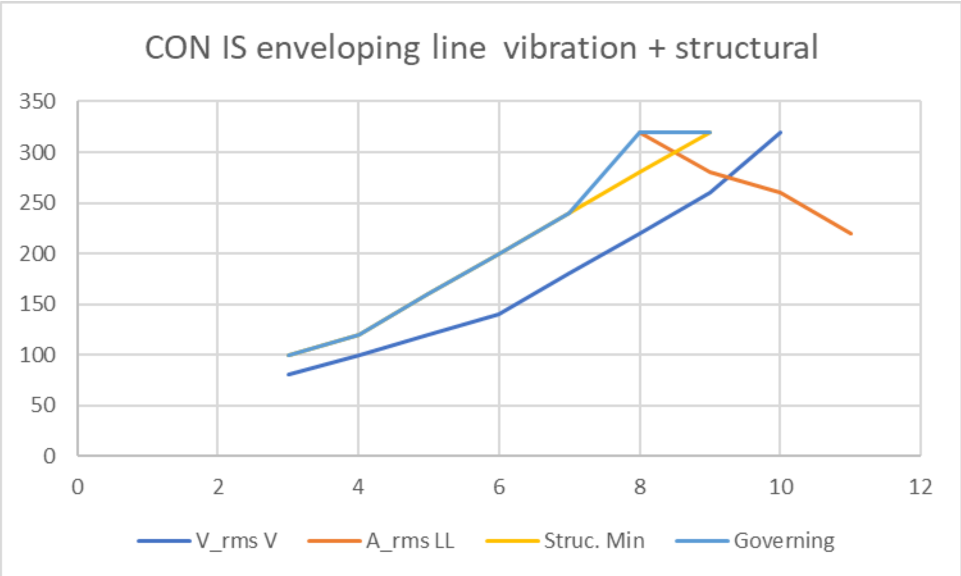


Figure 5.4: Enveloping lines of Concrete in situ, scenario 2

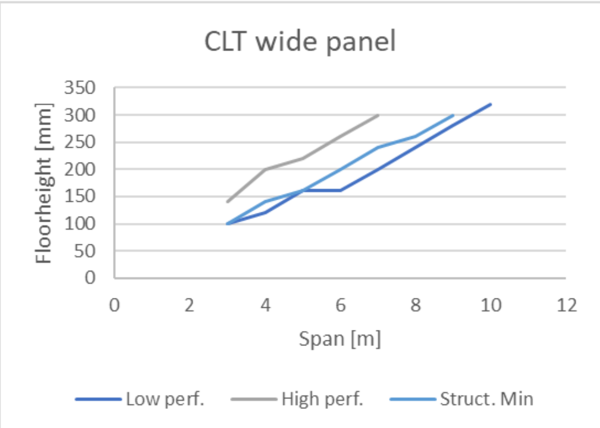
Results per material type

In the following paragraphs the results of the vibrational performance per material type will be shown. For each material the vibrational scenarios will be analysed. The scenarios will show the effect of a floor with a low and high vibrational performance and will show the effect of changes in geometry to mitigate vibrational problems. This is done using a narrow (1m) or wide(3m) floor. Scenario 1 and 3 will give the difference in low and high performance floors with a narrow width floor. Scenario 2 and 4 will show the difference in low and high performance floors given a wide width. The difference between the floor height with a high or low performance level and the minimum structural height is also put against each other.

What commonly can be noticed is that there is a difference between the high and low performance floor height, the effect of a wider floor shows that the geometry is important to take into account and it can mitigate the vibrational over a larger floor. Resulting in a similar floor height with a higher vibrational performance.

CLT

Figure 5.5 shows the vibrational performance of a narrow floor with the floor height necessary for a high performance floor, low performance floor and the minimal structural height floor. The figure shows that for a wide panel the difference between a high and low performance floor are smaller than for a narrow floor. This is the effect of the difference in geometry. The wide floor also has on a comparable span a lower floor height. Another difference is that for the wide panel, the structural minimum has already a low performance level. What can be seen in the same figure is the possible solution for a high performance floor with a narrow panel are limited to very small spans.



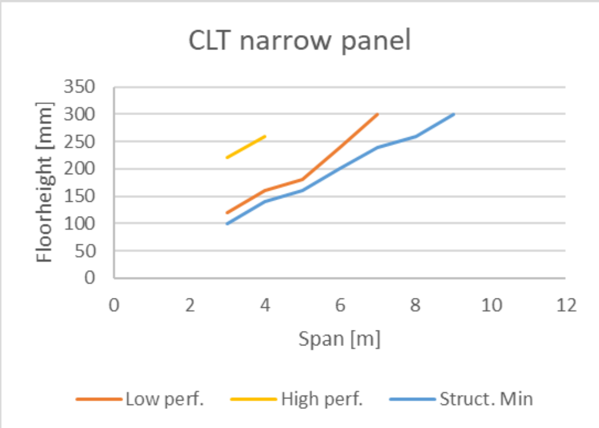


Figure 5.5: CLT, Floor performance wide floor(left), narrow floor (right)

Figure 5.6 shows the difference between the high and low performance level and the structural minimum floor height. For the wide floor panel, the low performance level is negative, this means that the structural minimum floor already has a low performance level. For a high performance level, approximately 60mm extra floor height is necessary. For a narrow floor, the minimum extra floor height for a low performance floor is 20mm and when floor span increases, this goes up to 60mm extra floor height. When a high performance floor is preferred, an extra floor height of 120mm is necessary above the structural minimum.

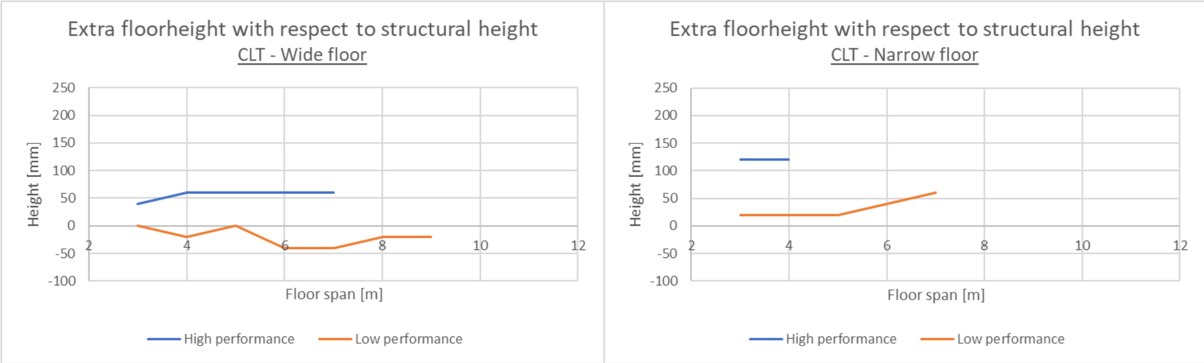


Figure 5.6: CLT, Extra floor height above structural minimum

LVL box floor

Figure 5.7 shows the vibrational performance of a narrow floor with the floor height necessary for a high performance floor, low performance floor and the minimal structural height floor. The figure shows that for a wide panel the difference between a high and low performance floor are smaller than for a narrow floor. Due to the use of a box floor the total height of the floors is higher than for CLT, but in material volume it is less. But the same principles occur as with the CLT. The wide panel's structural minimum already has the low performance level.

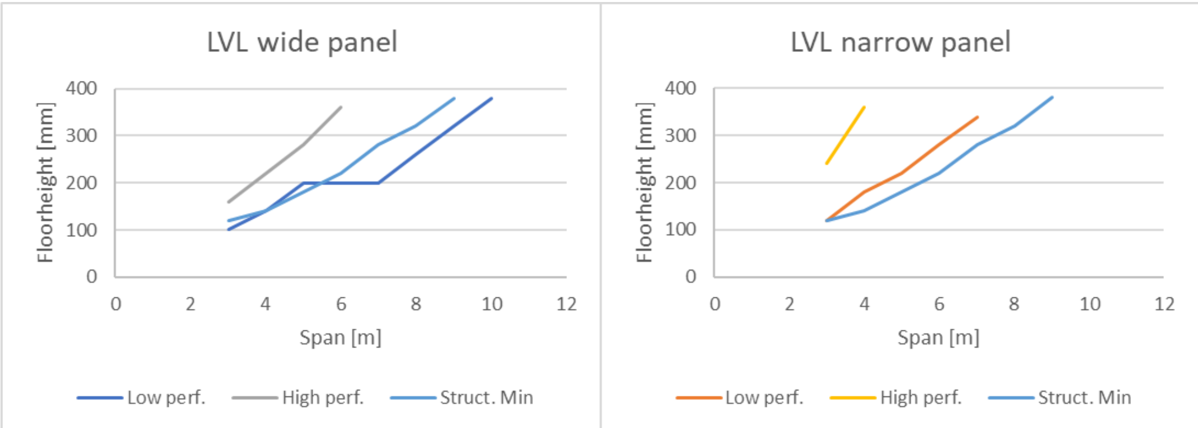


Figure 5.7: LVL box floor, Floor performance wide floor(left), narrow floor (right)

Figure 5.8 shows the difference between the high and low performance level and the structural minimum floor height for LVL box floor. For the wide floor panel, the low performance level is negative, this means that the structural minimum floor already has a low performance level. For a high performance level, approximately 50mm to 150mm extra floor height is necessary. For a narrow floor, the minimum extra floor height for a low performance floor is approximately 50mm and when floor span increases. When a high performance floor is preferred, an extra floor height of 140mm to 220mm is necessary above the structural minimum. This is a large increase in floor height due to the box floor. This can be reduced by increasing the thickness of the top and bottom plate.

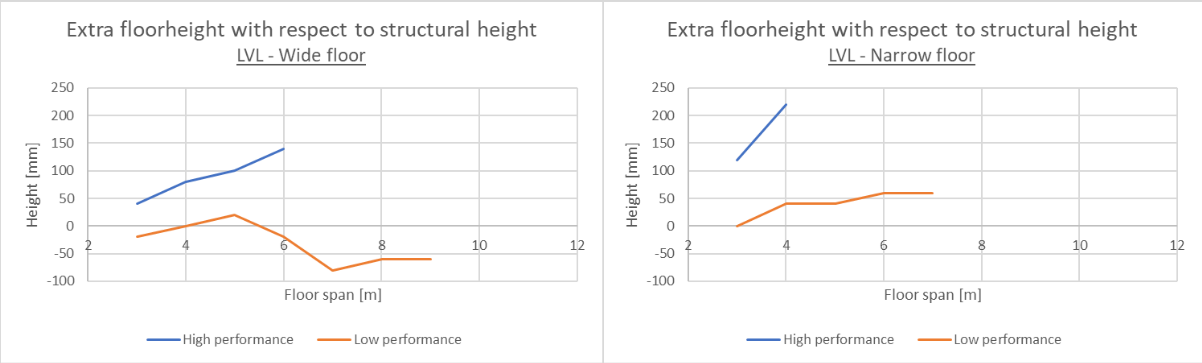


Figure 5.8: LVL boxfloor, Extra floor height above structural minimum

Timber Concrete Composite

Figure 5.9 show the vibrational performance of a narrow floor with the necessary floor height for a high performance, low performance and the minimum structural floor height. The wide panel has less variation between the high and low performance floors than the narrow panels. Due to the relative high damping value of the TCC floor, the difference between the high and low performance floor are smaller than the CLT or LVL floors. The structural minimum floor with the wide panels can even have a high performance level. Where the low performance level is below the structural minimum. For the narrow panel, the structural minimum also has a low performance level, but some material has to be added in order to let it be a high performance floor.

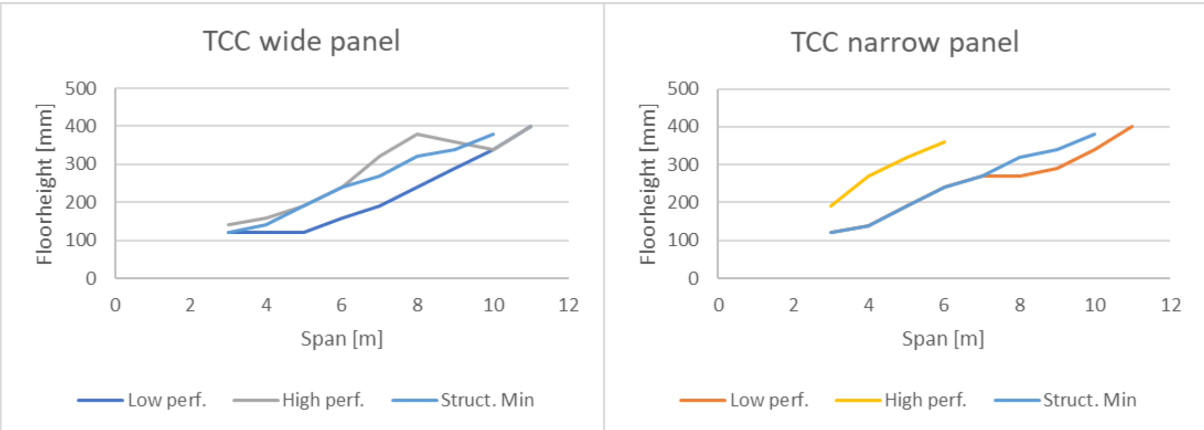


Figure 5.9: TCC, Floor performance wide floor(left), narrow floor (right)

Figure 5.10 shows the difference between the high and low performance level and the structural minimum floor height for the TCC floor. It shows that for a wide panel, it always is of low performance and for certain parts only small amounts of material have to be added in order to make it a high performance floor. The same can be said about the narrow panel, the structural minimum floor already has a low performance, but approximately 120mm of floor height should be added to make it a high performance floor.

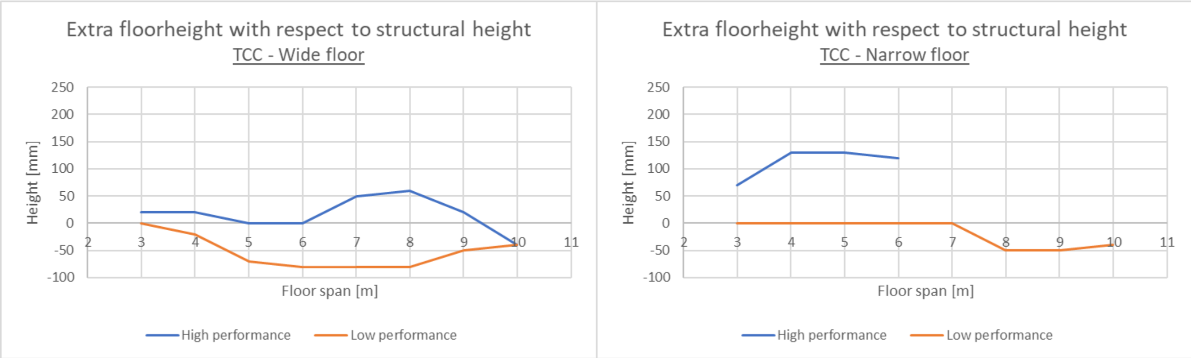


Figure 5.10: TCC, Extra floor height above structural minimum

Concrete insitu

Figure 5.11 show the vibrational performance of a narrow floor with the necessary floor height for a high performance, low performance and the minimum structural floor height. The wide panels performs slightly better than the narrow panel. The wide panel's structural minimum floor height has already a low performance and at some point a high performance. The narrow panel is at least a low performance but more material should be added to make it a high performance floor.

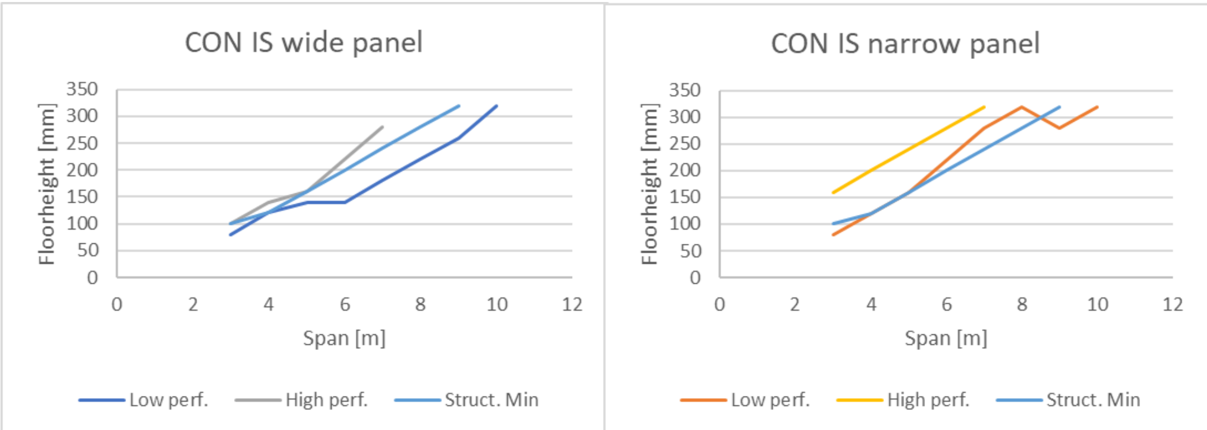


Figure 5.11: Concrete insitu, Floor performance wide floor(left), narrow floor (right)

Figure 5.12 shows the difference between the high and low performance level and the structural minimum floor height for the concrete insitu floor. The wide panels structural minimum has always a low performance level, For a high performance level, only small floor height increasements are necessary. For narrow floors, the structural minimum has a low performance level, for larger floor spans, additional floor height is necessary for a low performance. What can be seen is that for the high performance, the solutions are limited to 7m floor span. This is a technical limit for which a high performance floor is possible under the circumstances in this research.

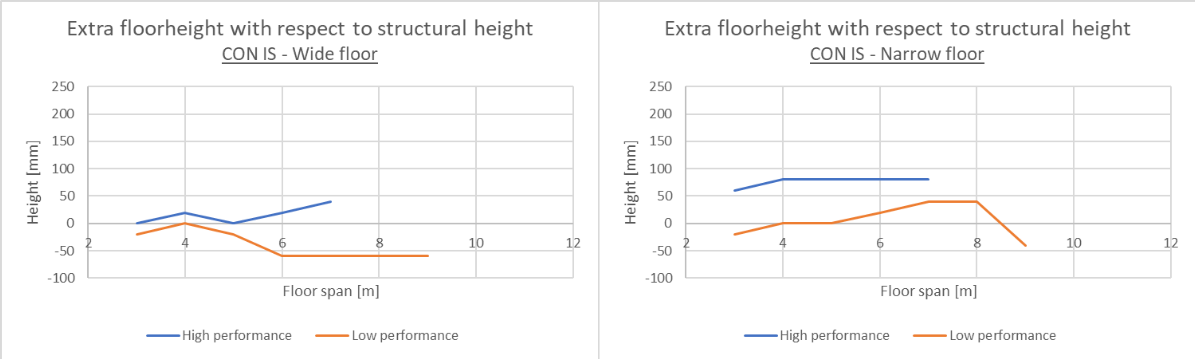


Figure 5.12: Concrete insitu, Extra floor height above structural minimum

Concrete hollow core

Figure 5.13 show the vibrational performance of a narrow floor with the necessary floor height for a high performance, low performance and the minimum structural floor height. The wide panel is a theoretical exercise, since hollow core panels are only produced in 1,2m width. Bu the wide panel performs better than the narrow panel. The wide panel's structural minimum floor height increases in steps due to the few floor heights available. The dip is seen at the 10m mark, this is the dip explained in previous paragraphs, caused by the change in validation criterium. The narrow panel needs more floor height to get a high floor performance.

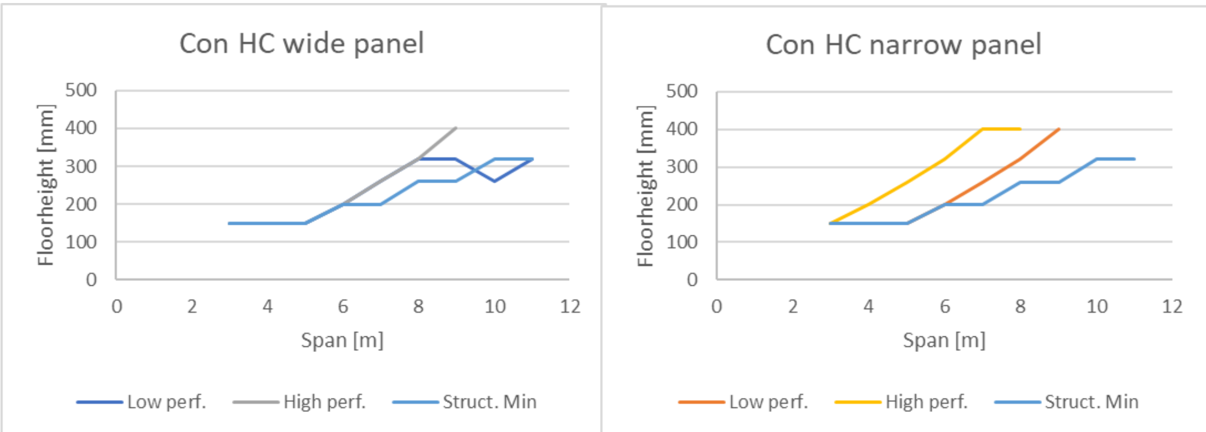


Figure 5.13: Concrete hollow core, Floor performance wide floor(left), narrow floor (right)

Figure 5.14 shows the difference between the high and low performance level and the structural minimum floor height for the concrete hollow core floor. The wide panel performs the same for high and low performance, this is due to the small set of available floor heights. The low performance also includes the highest performing. For the narrow floor, these is a difference apparent between the high and low performance floor. The high performance floor needs clearly more material to fulfil the criteria.

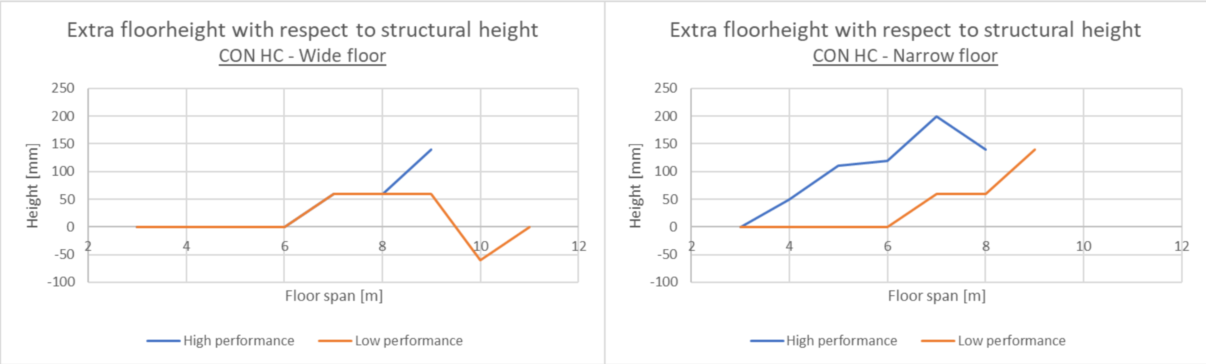


Figure 5.14: Concrete hollow core, Extra floor height above structural minimum

5.5 Observations from vibrational scenarios

In figure 5.15 all floor types are arranged on their scenario, in this overview common results can be derived about the differences in floor configuration and the differences in high and low performance floors. The figure shows the governing floor height at each floor span for each floor type regarding the vibrational performance and floor configuration above the graph. This means that the governing floor height is taken from the vibrational performance level and the minimum structural height.

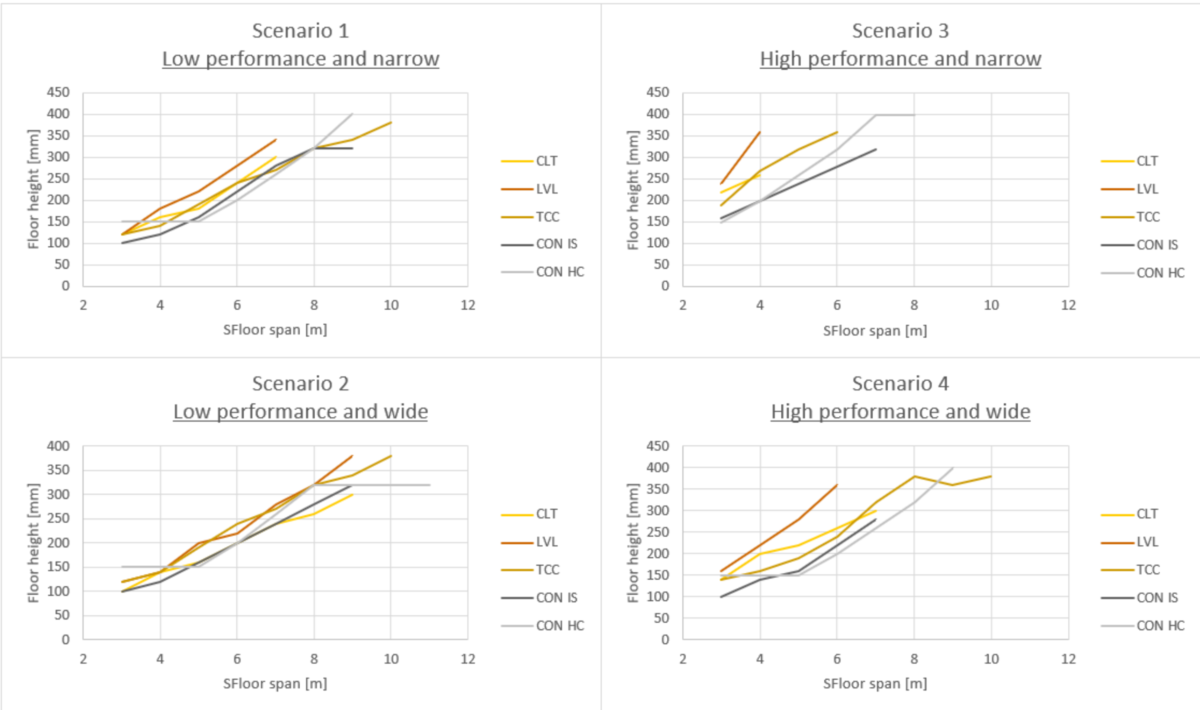


Figure 5.15: overview of results based on scenario

Some observations can be made from figure 5.15 regarding the difference between a high and low vibrational performance and the difference between the narrow and wide floor. The difference between scenario 1 and 2 is de use of a narrow and wide floor, what can be seen is that a wide floor has more solutions and the average floor height is lower for a wide floor than a narrow floor. For example at a floor span of 6 meters the floor height with a narrow floor is averaged on approximately 230mm as for a wide floor the average floor height over all floor types is approximately 210mm, where timber based floor are more sensible for the effect of the floor configuration.

Looking at the difference between scenario 2 and 4 as well as scenario 1 and 3 it shows the difference between a low and high performance floor for a narrow and wide floor. An observation which can be made is the amount of solutions, a high performance floor has less solutions given the assumptions and parameters in this research. Timber based floors are more sensible to the difference in high and low performance floors. The use of TCC increases the possible floor span for timber based panels, partly due to the higher damping value. Concrete based floors are less sensible for the high and low performance flooring, this results in a higher spread in height for high performance floors.

Floors can be designed for a high performance, this can be done by increasing the damping of the floor by using a different top floor and by constraining the floor more by using more supports or clamping, or by adding walls onto the floors. This results in higher damping as well as smaller floor spans. Although timber floors are more sensible to vibrational performance, concrete floors perform better on vibrational performance. When comparing a timber floor and concrete floor the vibrational performance should be checked for the timber floor as well as the concrete floor, especially for high performance floor where concrete floor might also need extra measures to fulfil the vibrational criteria.

6. Environmental impact of floors

This chapter discusses the environmental impact of timber and conventional floors. Environmental Product Declarations (EPD's) are compared for the different floor types. For each floor type several EPD's are found in 2 databases, OneClickLCA an GPR. The EPD's show the quantified environmental impact per category for each floor type. These EPD's are analysed for the range of the impact categories and the resulting Environmental Cost Indication(ECI). This results in a mean, high and low value for the ECI and impact categories. The values will then be used for a static comparison of the several floor types.

6.1 Method, data sources and strategy

The environmental impact of the floors in the analysis are discussed in this chapter. The method of Environmental Cost indication is used, using data from OneClickLCA and GPR material. The floors are being analysed using the scenarios stated in chapter 4.

Strategy

To be able to make a valid comparison between the materials, a strategy is chosen based on the available data. This means that data from EPD's from several sources is used. Once Click LCA and GPR material provide environmental data for several products. A list of EPD's used in this strategy can be found in *Appendix C: Sustainability – Overview of resources.* The environmental data form the materials is compared on a m3 basis. From which the environmental impact per floor height is then specified. Except the concrete hollow core floors, these floors are product specific, due to the different amount of material used per floor height. This data is compared on m2 basis. The data which is compared is data from Europe and Netherlands specific. The modules A1-A3: Production are taken into account and for Module C: End-Of-Life the scenario of Incineration is taken for timber products and crushing is taken into account for Concrete products. A mean value for each impact category is distilled from this data and a range for the accuracy of the material is also stated. From this data, a table is made with the mean, low and high values of the environmental impact of each floor type.

6.2 Environmental impact analysis

The materials considered for the floors are CLT, LVL boxfloors, Timber Concrete Composite, Concrete insitu and concrete hollowcore floors. These floors are discussed in the paragraphs below. Each material shows the means values and ranges of the impact categories per life cycle module. The range of the material is given using the standard deviation of the data set and shown in a boxplot. The graphs used show the normalised deviation of the mean values of the data from the impact categories per life cycle module.

CLT

For CLT, the GPR software has 5 available datasets from different manufacturers. Of those, 3 are category 1 datasets and 2 are category 3 datasets. Based on suppliers data and generalised data. From OneClickLCA, a dataset of 12 sources is available, from which 9 are category 1 data and 3 are category 3 data. From both OneClickLCA, the biogenic carbon content is subtracted from the Global Warming Potential and showed separately. To make a fair comparison, the biogenic carbon content from the GPR data is also subtracted and showed separately. The biogenic carbon content is calculated according to the formula found in chapter 4. The carbon content for spruce is taken as 715 kg CO2 / m3. The environmental data from GPR has 11 impact categories and the data from OneClickLCA has 7 impact categories. For the analysis, the data from the Human Toxicity Potential, Freshwater Aquatic Ecotoxicity Potential, Marine Aquatic Ecotoxicity Potential and Terrestrial Ecotoxicity Potential are based on the GPR data, since no data is known for these categories from OneClickLCA.

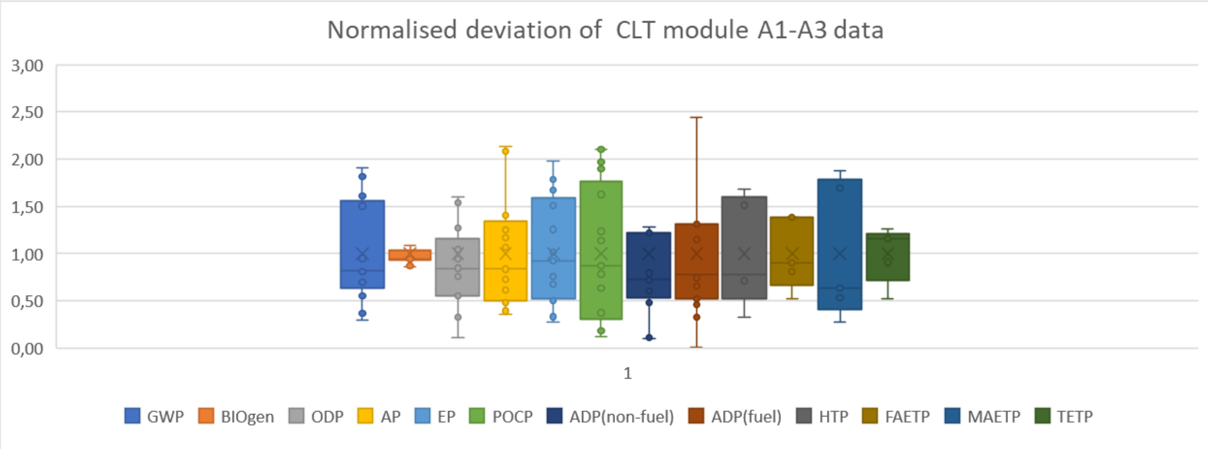


Figure 6.1: Normalised environmental data CLT A1-A3

The boxplot in figure 6.1 shows the normalised environmental data of 17 EPD's from around Europe. The data is normalised to show the range per impact category. Roughly spoken, the deviation is around 50% from the mean values. This gives an insight in the available environmental data, but more importantly what is the effect of these values on the Environmental Cost Indication. Which impact categories have the highest impact when weighted for environmental impact. Figure 6.2 gives an overview of the ECI values of CLT in module A1-A3. What can be seen is that the Global Warming Potential(GWP), Acidification Potential(AP), Eutrophication Potential (EP) and Human Toxicity Potential(HTP) have the highest impact on the Environmental cost indication. On the other side when Biogenic carbon is taken into account the ECI will become negative for module A1-A3.The values for the environmental impact and Environmental Cost Indication including the range can be found in table 6.1 and table 6.2.

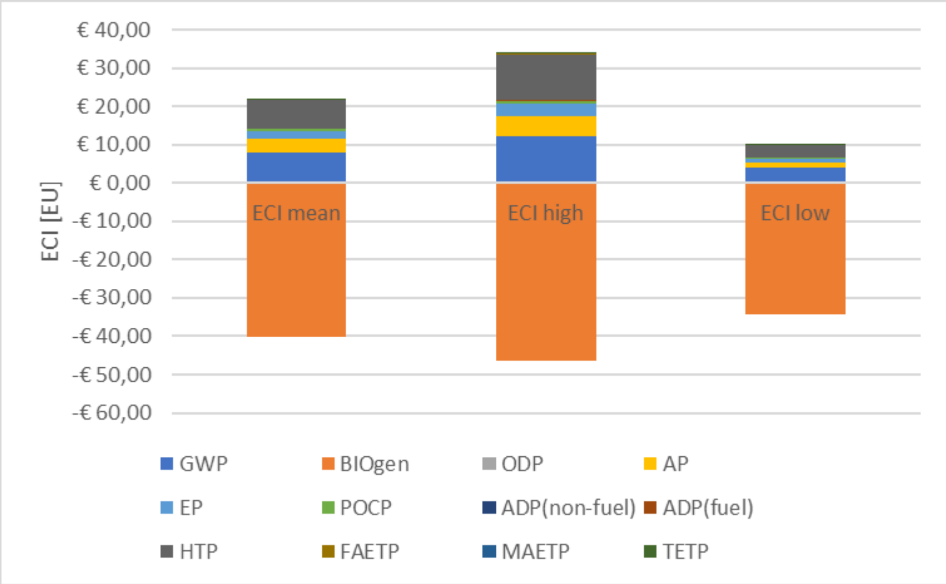


Figure 6.2: ECI values with the high and low range for CLT A1-A3 per m3

Table 6.1: Environmental values for CLT per m3

CLT			Module A1-A3		Module C	
			Average	Standard deviation	Average	Standard deviation
Global warming potential	*GWP*	[kg CO2e]	1,61E+02	8,20E+01	7,75E+00	1,95E+01
Biogenic carbon storage	*BIOgen*	[kg CO2e bio]	8,07E+02	1,23E+02	0,00E+00	0,00E+00
Ozone Depletion	*ODP*	[kg CFC11e]	2,39E-05	1,89E-05	1,33E-06	9,26E-07
Acidification	*AP*	[kg SO2e]	8,56E-01	4,73E-01	8,80E-02	4,62E-02
Eutrophication	*EP*	[kg PO4e]	2,42E-01	1,35E-01	2,50E-02	8,87E-03
Formation of ozone of lower atmosphere	*POCP*	[kg Ethenee]	1,82E-01	1,31E-01	6,92E-03	9,84E-03
Abiotic depletion potential for non fossil resources	*ADP(non-fuel)*	[kg Sbe]	7,26E-04	6,16E-04	1,02E-02	6,26E-03
Abiotic depletion potential for fossil resources	*ADP(fuel)*	[kg Sbe]	8,79E-01	6,36E-01	7,09E-02	3,40E-02
Human Toxicity potential	*HTP*	[kg 1,4-DCB eq]	8,33E+01	4,79E+01	1,63E+01	2,64E+00
Freshwater Aquatic Ecotoxicity	*FAETP*	[kg 1,4-DCB eq]	3,10E+00	1,17E+00	2,25E-01	4,56E-02
Marine Aquatic Ecotoxicity	*MAETP*	[kg 1,4-DCB eq]	5,70E+03	4,17E+03	7,23E+02	1,54E+02
Terrestrial Ecotoxicity	*TETP*	[kg 1,4-DCB eq]	9,06E-01	2,71E-01	3,23E-02	1,83E-02

Table 6.2: ECI values for CLT per m3

CLT	Module A1-A3		Module C
	Excluding Biogenic	**Including biogenic**	**Excluding Biogenic**
ECI [EU] mean	€ 21,83	€ -18,51	€ 2,47
ECI [EU] high	€ 33,80	€ -12,68	€ 3,98
ECI [EU] low	€ 9,86	€ -24,35	€ 0,97

The same analysis is performed for module C data, the results can be found in figure 6.3 and 6.4. The data shows that the data from module C is more widely spread than module A1-A3. Furthermore, the impact categories with the highest ECI value are the same as in module A1-A3, namely: GWP,AP,EP and HTP. Although the environmental impact of module C according to the ECI shown in table 6.2 is much smaller than the environmental impact from module A1-A3.

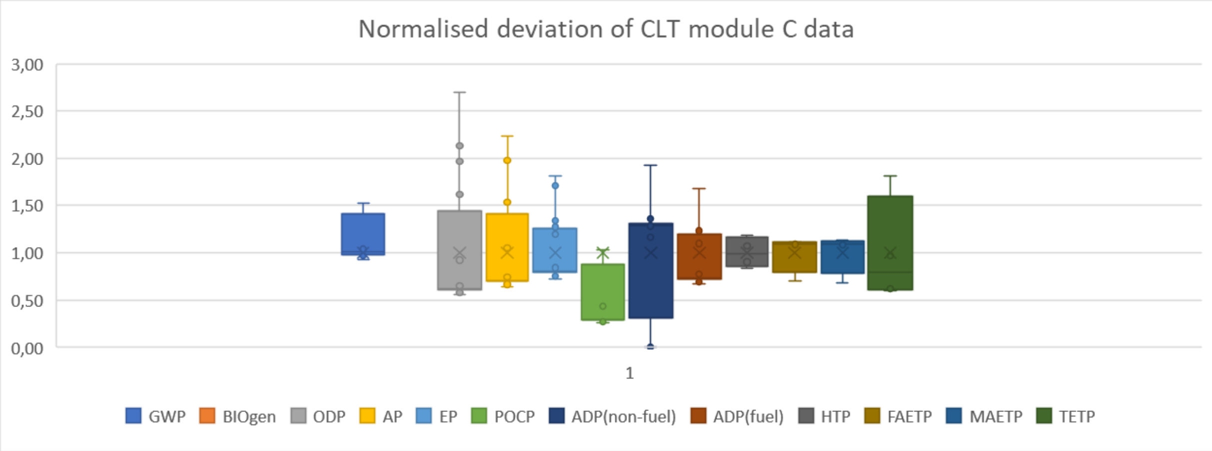


Figure 6.3: Normalised environmental data CLT C

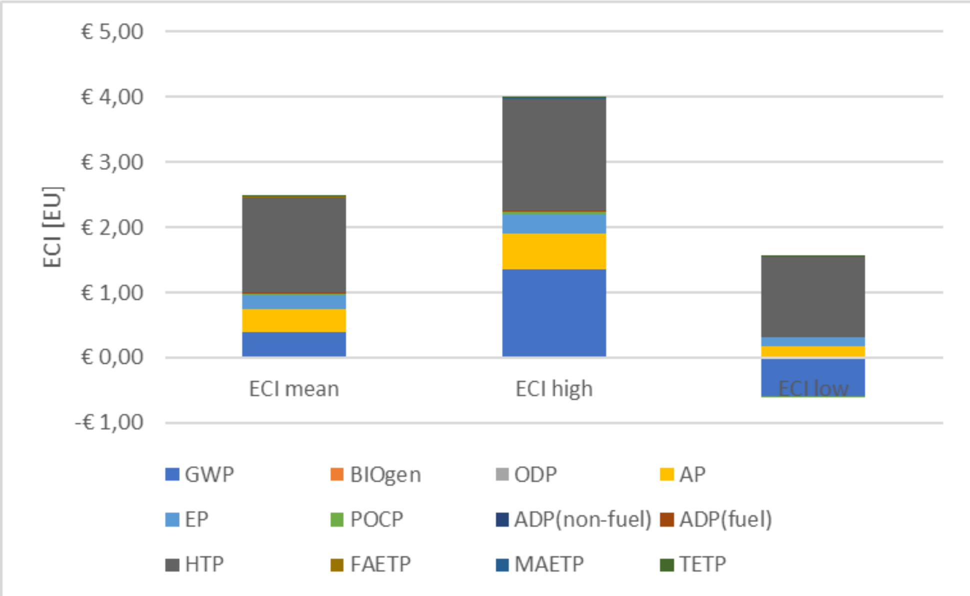


Figure 6.4: ECI values with the high and low range for CLT C per m3

Since CLT consist of several different components, some have a higher impact than others. The exact contribution of each component is difficult to find. But looking at the information of components given in an EPD it is possible to find reasons why EPD's can differ from each other. The components of CLT which can influence the environmental impact of CLT are the raw timber itself, the transport of the timber to the factory and the glue used in the CLT. These factors differ from supplier to supplier and thus influences the overall environmental impact. When the environmental impact from this analysis is compared to other literature on the matter, the data could be put into perspective. The Institution of Structural Engineers also did an analysis of the GWP of CLT in phase A1-A3 without biogenic carbon, they found a value of 0,25 kg CO2eq per kg CLT. From the analysis in this thesis the GWP of CLT in phase A1-A3 averaged on 0,32 kg CO2eq per kg CLT. This difference is probably because of the use of less EPD's and other calculations of energy resources. It also shows that the environmental data is volatile and the exact environmental impact is complex to calculate and subjected to a certain accuracy range.

LVL Boxfloor

For an LVL boxfloor, the GPR software has 1 available datasets from generic data. This is a category 3 dataset. OneClickLCA has 5 available EPD's, from which 4 category 1 and 1 category 3 data. The data from OneClick LCA has 7 impact categories and data from GPR has 11 impact categories. The data used for the HTP, FAETP, MAETP and TETP is based on one source from GPR. Furthermore the data used for module C has no data from GPR, so the data on which the LVL environmental calculations are based are limited. This is due to the limited use and production of LVL in Europe and thus limited availability of EPD's for LVL. The data for the LVL boxfloor is based on the raw material data for 1m3 LVL, so the production of the boxfloor is not taken into account. The data could be interpreted as on the positive side.

The results of the environmental data can be found in figure 6.5 and figure 6.6. The normalised environmental data in figure 6.5 show the range for the materials. What can be seen is the large range for Ozone Depletion Potential (ODP), Formation of Ozone in lower atmosphere (POCP) and Acidification Potential(AP). Roughly spoken, the average range is around 20% from the mean. This is partially because of the small dataset used and the limited impact categories.

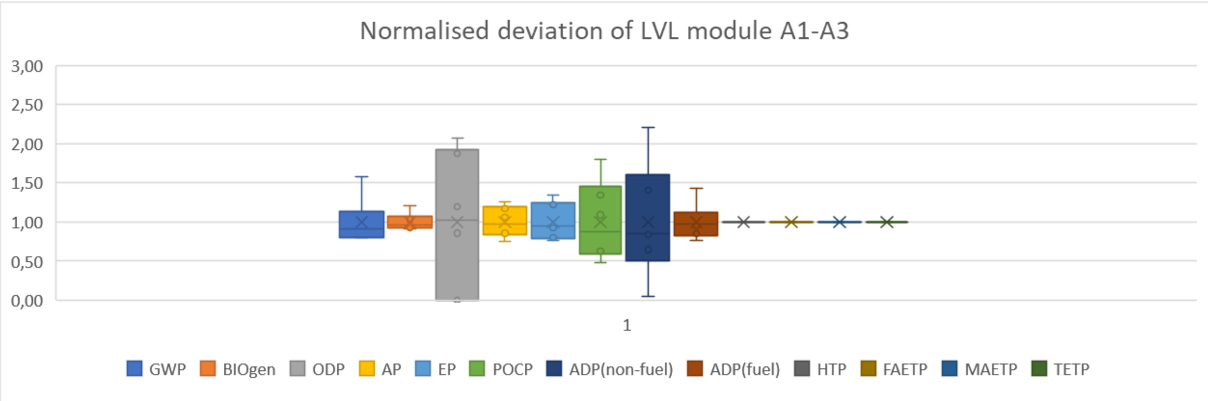


Figure 6.5: Normalised environmental data LVL A1-A3

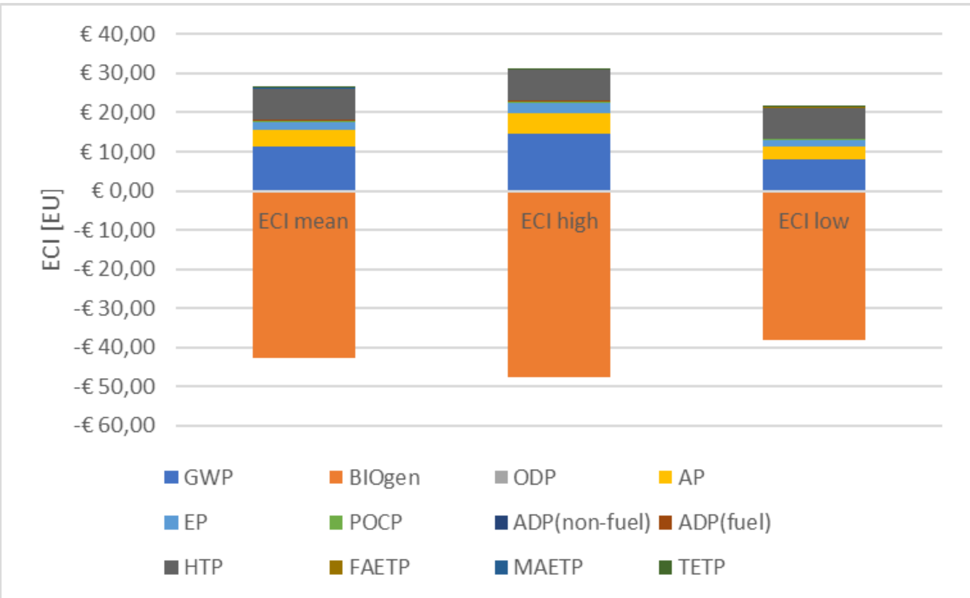


Figure 6.6: ECI values with the high and low range for LVL A1-A3 per m3

The main contributors to the ECI value for the LVL boxfloors are GWP, AP, EP and HTP. When biogenic carbon is taken into account, this contributes the most and influences the environmental impact positively. Table 6.3 gives the specific mean values and deviations per impact category for module A1-A3 and C. Table 6.4 gives the ECI values per module including and excluding biogenic carbon.

Table 6.3: Environmental values for LVL per m3

LVL Boxfloor			Module A1-A3		Module C	
			Average	**Standard deviation**	**Average**	**Standard deviation**
Global warming potential	*GWP*	[kg CO2e]	2,26E+02	6,58E+01	8,83E+00	4,22E-01
Biogenic carbon storage	*BIOgen*	[kg CO2e bio]	8,56E+02	9,33E+01	0,00E+00	0,00E+00
Ozone Depletion	*ODP*	[kg CFC11e]	2,10E-05	1,87E-05	9,14E-07	4,40E-08
Acidification	*AP*	[kg SO2e]	1,07E+00	2,09E-01	6,91E-02	3,30E-03
Eutrophication	*EP*	[kg PO4e]	2,38E-01	5,48E-02	2,23E-02	1,04E-03
Formation of ozone of lower atmosphere	*POCP*	[kg Ethenee]	1,45E-01	7,35E-02	2,23E-03	1,04E-04
Abiotic depletion potential for non fossil resources	*ADP(non-fuel)*	[kg Sbe]	9,35E-04	6,85E-04	1,47E-02	6,93E-04
Abiotic depletion potential for fossil resources	*ADP(fuel)*	[kg Sbe]	1,61E+00	3,74E-01	5,79E-02	2,73E-03
Human Toxicity potential	*HTP*	[kg 1,4-DCB eq]	8,68E+01	0,00E+00	0,00E+00	0,00E+00
Freshwater Aquatic Ecotoxicity	*FAETP*	[kg 1,4-DCB eq]	2,95E+00	0,00E+00	0,00E+00	0,00E+00
Marine Aquatic Ecotoxicity	*MAETP*	[kg 1,4-DCB eq]	6,80E+03	0,00E+00	0,00E+00	0,00E+00
Terrestrial Ecotoxicity	*TETP*	[kg 1,4-DCB eq]	7,85E-01	0,00E+00	0,00E+00	0,00E+00

Table 6.4: ECI values for LVL per m3

LVL Boxfloor	Module A1-A3		Module C
	Excluding Biogenic	**Including biogenic**	**Excluding Biogenic**
ECI [EU] mean	€ 26,25	€ -16,57	€ 0,93
ECI [EU] high	€ 31,07	€ -16,41	€ 0,98
ECI [EU] low	€ 21,42	€ -16,73	€ 0,89

The same analysis is performed for module C data, the results can be found in figure 6.7 and 6.8. The data shows that the data from module C is based on a small dataset with standard outcomes thus a low deviation from the mean value. The data excludes biogenic carbon. Due to the small amount of data available, the data for module C is based on 7 impact categories instead of 11. This is because there is no data available for module C with 11 impact categories.

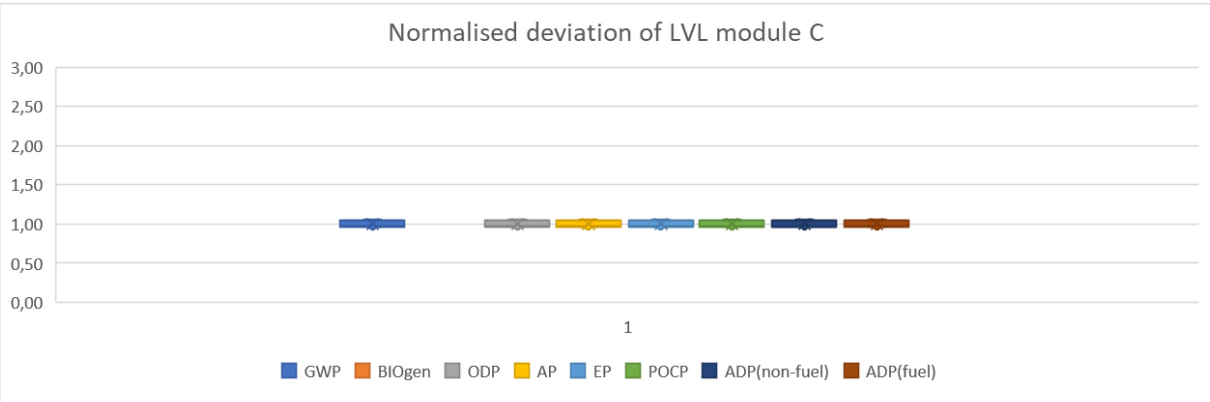


Figure 6.7: Normalised environmental data LVL C

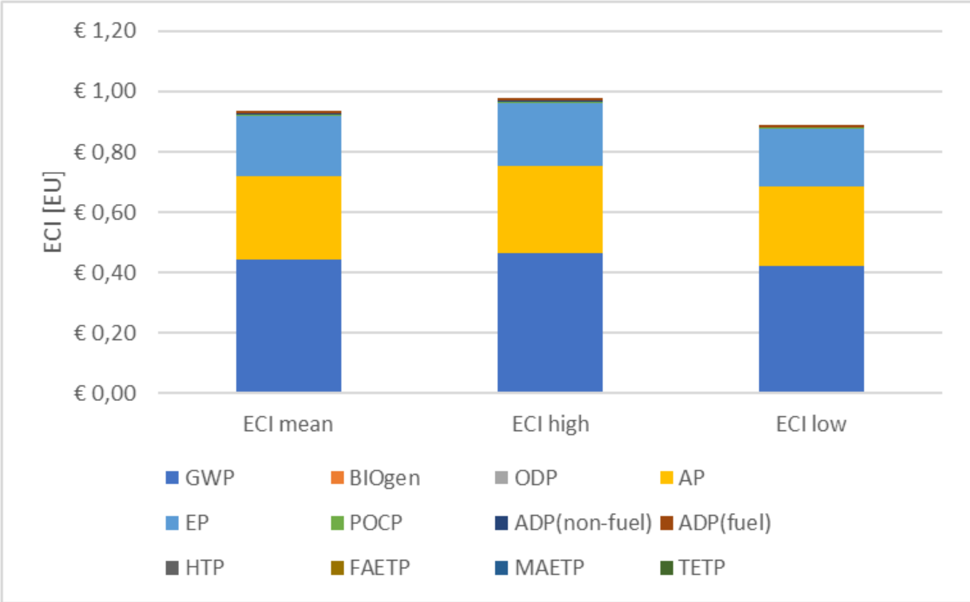


Figure 6.8: ECI values with the high and low range for LVL C per m3

LVL consist of several different components, some have a higher impact than others. The exact contribution of each component is difficult to find. But looking at the information of components given in an EPD it is possible to find reasons why EPD's can differ from each other. The components of LVL which can influence the environmental impact of LVL are the raw timber itself, the transport of the timber to the factory and the glue used in the LVL. The factor of glue is more important in LVL than in CLT, since the volume percentage of glue in LVL is higher than in CLT. The lack of the available data of the environmental impact of LVL contributes to the justified accuracy of the environmental impact. The small amount of EPD's available have relatively few impact categories stated in them, it also contains older EPD's. This is probably due to the low use of LVL in Europa at this moment. Due to the small data set, the accuracy of the available data is based upon comparison to the closest material which is CLT in this case. LVL has a higher amount of glue and less solid timber, thus the environmental impact per m3 of LVL should be higher than CLT. In this analysis, this is the case.

Concrete insitu

For concrete insitu, the GPR software has several datasets from different manufacturers and with different construction methods/product. There are category 1, 2 and 3 data available. 5 datasets are used from GPR. From OneClickLCA 8 datasets are used, all for C30/37 readymix concrete including rebar. From these 8 datasets, 5 are category 3 generic data, 1 is category 2 data and 2 are category 1 data. The data from GPR and OneClickLCA is all based on material from the Netherlands. The concrete insitu floor in this thesis are calculated using a 0,5% longitudinal reinforcement percentage. The environmental data is also based on a 0,5% reinforcement percentage in 2 directions, thus 1% total per m3 of material. The concrete is from several different recipes for C30/37 concrete. The datasets from OneClickLCA consist of 7 impact categories and GPR consist of 11 impact categories.

Figure 6.9 shows the normalised deviation of environmental impact of concrete insitu for module A1-A3. This shows the deviation of environmental impact. The factors with the highest range are Acidification Potential (ADP), Human Toxicity Potential (HTP) and Terrestrial Ecotoxicity Potential(TETP). Roughly spoken, the average range is 60% from the mean value.

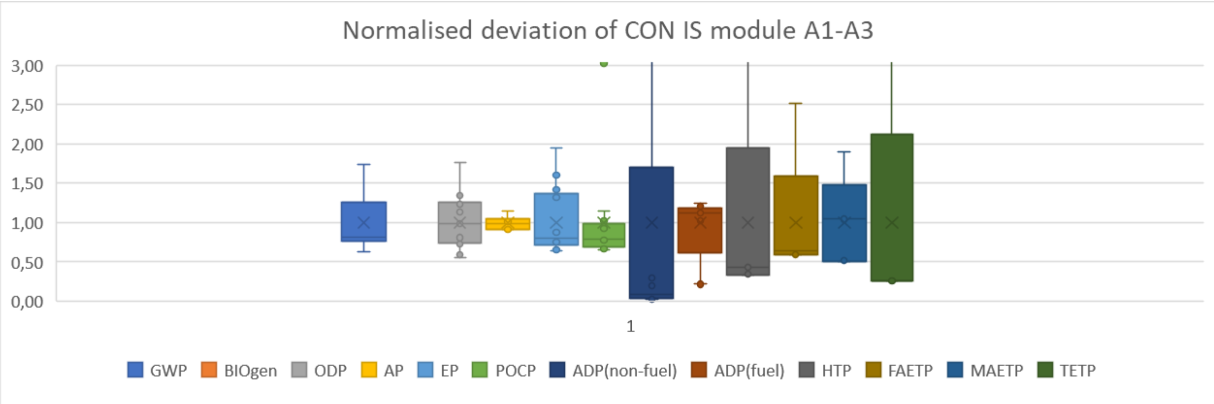


Figure 6.9: Normalised environmental data concrete insitu A1-A3

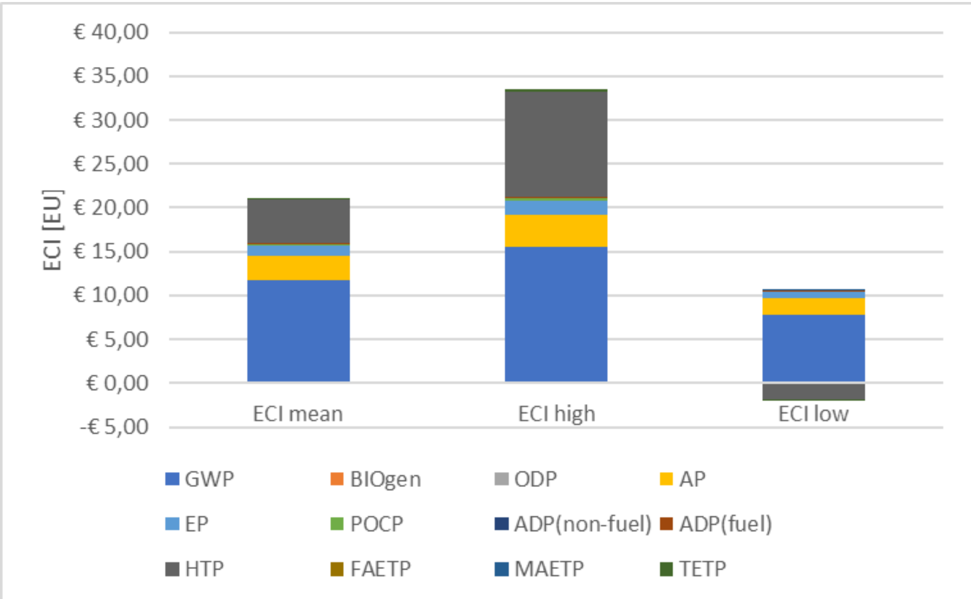


Figure 6.10: ECI values with the high and low range for concrete insitu A1-A3 per m3

The main contributors to the ECI value for the concrete insitu are GWP, AP, EP and HTP. Biogenic carbon is not present in the current concrete mixtures and thus has on influence on the environmental impact. Table 6.5 gives the specific mean values and deviations per impact category for module A1-A3 and C. Table 6.6 gives the ECI values per module.

Table 6.5: Environmental values for concrete insitu per m3

Concrete insitu			Module A1-A3		Module C	
			Average	Standard deviation	Average	Standard deviation
Global warming potential	*GWP*	[kg CO2e]	2,33E+02	7,84E+01	2,06E+01	1,74E+01
Biogenic carbon storage	*BIOgen*	[kg CO2e bio]	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Ozone Depletion	*ODP*	[kg CFC11e]	9,95E-06	3,41E-06	3,96E-06	3,07E-06
Acidification	*AP*	[kg SO2e]	7,07E-01	2,07E-01	1,08E-01	9,93E-02
Eutrophication	*EP*	[kg PO4e]	1,26E-01	5,34E-02	2,15E-02	1,91E-02
Formation of ozone of lower atmosphere	*POCP*	[kg Ethenee]	7,53E-02	4,73E-02	9,95E-03	1,47E-02
Abiotic depletion potential for non fossil resources	*ADP(non-fuel)*	[kg Sbe]	3,98E-03	6,92E-03	4,49E-02	3,69E-02
Abiotic depletion potential for fossil resources	*ADP(fuel)*	[kg Sbe]	7,38E-01	4,00E-01	1,92E-01	1,07E-01
Human Toxicity potential	*HTP*	[kg 1,4-DCB eq]	5,54E+01	7,64E+01	2,16E+01	1,06E+01
Freshwater Aquatic Ecotoxicity	*FAETP*	[kg 1,4-DCB eq]	7,27E-01	6,17E-01	7,73E-01	3,83E-01
Marine Aquatic Ecotoxicity	*MAETP*	[kg 1,4-DCB eq]	3,78E+03	2,15E+03	1,94E+03	8,84E+02
Terrestrial Ecotoxicity	*TETP*	[kg 1,4-DCB eq]	1,29E+00	2,14E+00	2,18E+00	1,21E+00

Table 6.6: ECI values for concrete insitu per m3

Concrete insitu	Module A1-A3		Module C
	Excluding Biogenic	Including biogenic	Excluding Biogenic
ECI [EU] mean	€ 21,03	€ 21,03	€ 3,83
ECI [EU] high	€ 33,46	€ 33,46	€ 6,36
ECI [EU] low	€ 8,59	€ 8,59	€ 1,29

The same analysis is performed for module C data, the results can be found in figure 6.11 and 6.12. The data shows that the data from module C is is more widely spread than module A1-A3 and where the range of ADP, HTP, FAETP, MAETP and TETP was high in A1-A3, the opposite is happening in module C where GWP, ODP, AP, EP and POCP have a wider range.

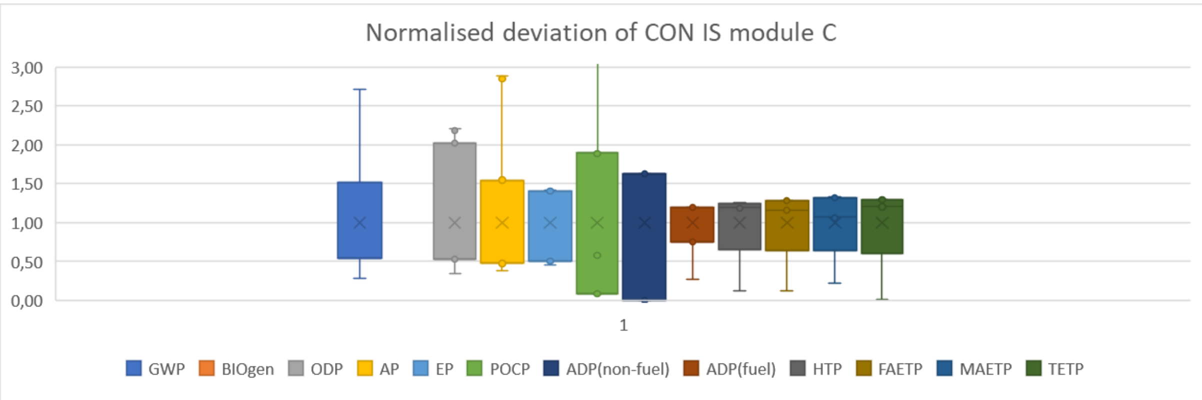


Figure 6.11: Normalised environmental data concrete insitu C

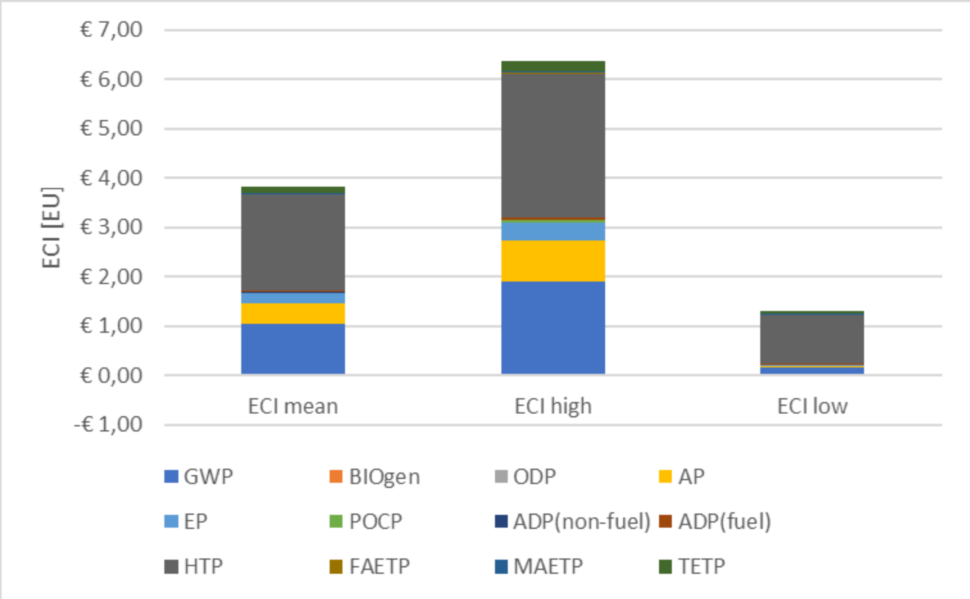


Figure 6.12: ECI values with the high and low range for concrete insitu C per m3

Concrete insitu consist of several different components, some have a higher impact than others. The exact contribution of each component is difficult to find. But looking at the information of components given in an EPD it is possible to find reasons why EPD's can differ from each other. The components of reinforced concrete insitu which can influence the environmental impact are cement, the transport of the raw material to the factory and especially the steel used for the reinforcement. The type and amount of cement has an influence on the environmental impact, whether it is CEM I or CEM III, CEM III would be more environmentally friendly but its use is dependent on the location and element for which it is used. Another large influence is the use of reinforcement steel. Most cast insitu elements contain steel throughout the element. A higher percentage of steel in the concrete has a direct negative impact on the environmental impact. The accuracy of the environmental data in from this analysis can be compared to literature. The average GWP of C30/37 concrete in this analysis is 233 kg CO2eq/m3. In a research by Kerr et al. an average GWP of 300 kg CO2eq/m3 of C30 concrete was found. This raises the question whether the data used gives a better picture than reality by using "green" concrete mixture in EPD's. This gives the insight that the real environmental impact of concrete might be higher than shown in the EPD's from this analysis.

Concrete hollow core

For concrete hollow core floors, the GPR software has a few datasets available, these are category 1 data from VBI. The VBI concrete hollow core floors have 4 standard heights and all of these heights have a specific EPD. These are used for the comparison. Due to the relative large height increments, sometimes more material is used than necessary. The data from OneClickLCA also varies per specific floor height. For Each floor height 3 datasets from OneClickLCA are taken and 2 datasets from GPR. The datasets from GPR are category 1 and from OneClickLCA 2 datasets are category 3 and one is category 1. All data is from manufacturers. To give an overview of the results, the 320mm concrete hollow core floor is used a reference. All other height floor have a similar range, but different ECI values due to the difference in height.

Figure 6.13 gives an overview of the ranges of the environmental impact per impact category. What can be seen is that Abiotic Depletion Potential for non-fuel(ADP non-fuel) gives the highest uncertainty factor. Roughly given, the deviation from the mean values is around 30%.

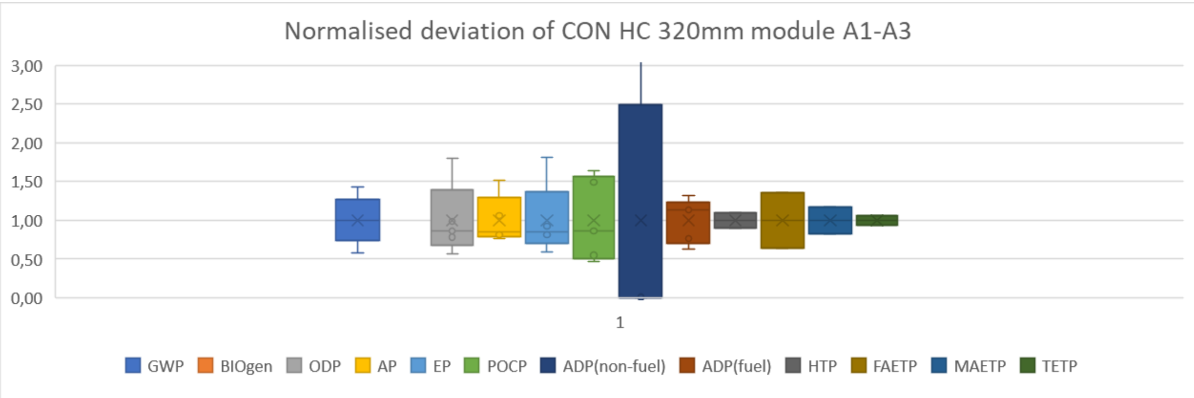


Figure 6.13: Normalised environmental data concrete hollow core A1-A3

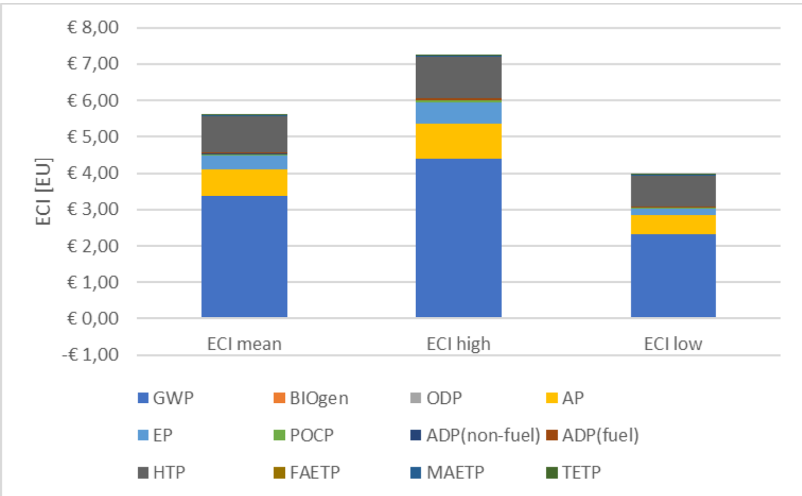


Figure 6.14: ECI values with the high and low range for 320mm concrete hollow core A1-A3

The main contributors to the ECI value for the concrete hollow core are GWP, AP, EP and HTP. Biogenic carbon is not present in the current concrete mixtures and thus has on influence on the environmental impact. Table 6.7 gives the specific mean values and deviations per impact category for module A1-A3 and C. Table 6.8 gives the ECI values per module.

Table 6.7: Environmental values for concrete hollow core

Concrete hollow core			Module A1-A3		Module C	
			Average	**Standard deviation**	**Average**	**Standard deviation**
Global warming potential	*GWP*	[kg CO2e]	6,72E+01	2,07E+01	1,64E+00	6,77E-01
Biogenic carbon storage	*BIOgen*	[kg CO2e bio]	0,00E+00	0,00E+00	0,00E+00	0,00E+00
Ozone Depletion	*ODP*	[kg CFC11e]	3,25E-06	1,54E-06	3,85E-07	1,95E-07
Acidification	*AP*	[kg SO2e]	1,85E-01	5,77E-02	8,92E-03	3,95E-03
Eutrophication	*EP*	[kg PO4e]	4,27E-02	2,02E-02	2,08E-03	1,25E-03
Formation of ozone of lower atmosphere	*POCP*	[kg Ethenee]	1,99E-02	1,07E-02	5,17E-04	6,84E-04
Abiotic depletion potential for non fossil resources	*ADP(non-fuel)*	[kg Sbe]	3,27E-02	7,29E-02	5,15E-03	4,70E-03
Abiotic depletion potential for fossil resources	*ADP(fuel)*	[kg Sbe]	2,30E-01	6,67E-02	1,59E-02	5,49E-03
Human Toxicity potential	*HTP*	[kg 1,4-DCB eq]	1,10E+01	1,52E+00	1,27E+00	1,84E-01
Freshwater Aquatic Ecotoxicity	*FAETP*	[kg 1,4-DCB eq]	3,16E-01	1,58E-01	7,39E-02	1,91E-03
Marine Aquatic Ecotoxicity	*MAETP*	[kg 1,4-DCB eq]	1,15E+03	2,79E+02	1,85E+02	8,77E+01
Terrestrial Ecotoxicity	*TETP*	[kg 1,4-DCB eq]	2,15E-01	1,98E-02	2,74E-01	1,07E-01

Table 6.8: ECI values for concrete hollow core

Concrete hollow core	Module A1-A3		Module C
	Excluding Biogenic	**Including biogenic**	**Excluding Biogenic**
ECI [EU] mean	€ 5,59	€ 5,59	€ 0,28
ECI [EU] high	€ 7,23	€ 7,23	€ 0,36
ECI [EU] low	€ 3,95	€ 3,95	€ 0,19

The same analysis is performed for module C data, the results can be found in figure 6.15 and 6.16. The data shows that the data from module C has approximately the same spread as module A1-A3. For module A1-A3, the ADP(non-fuel) has the widest range, where in module C POCP has the widest range.

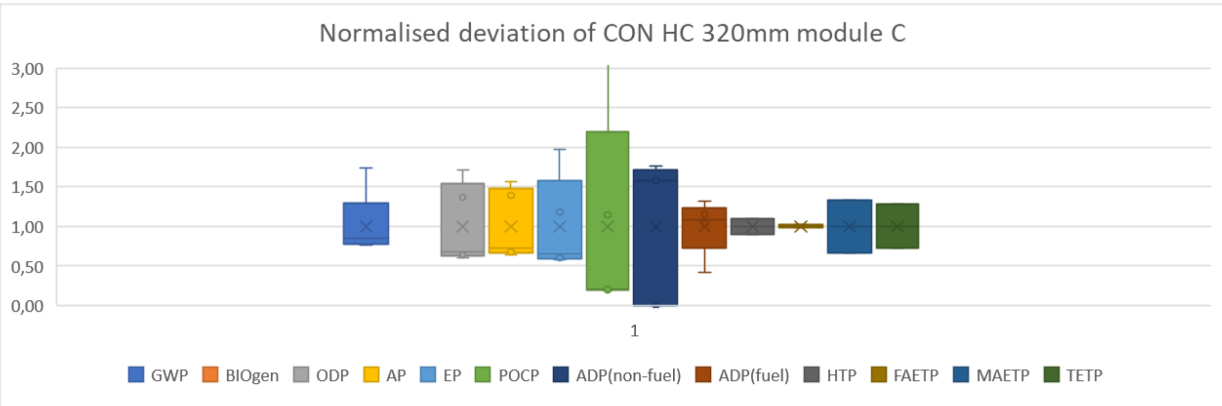


Figure 6.15: Normalised environmental data 320mm concrete hollow core C

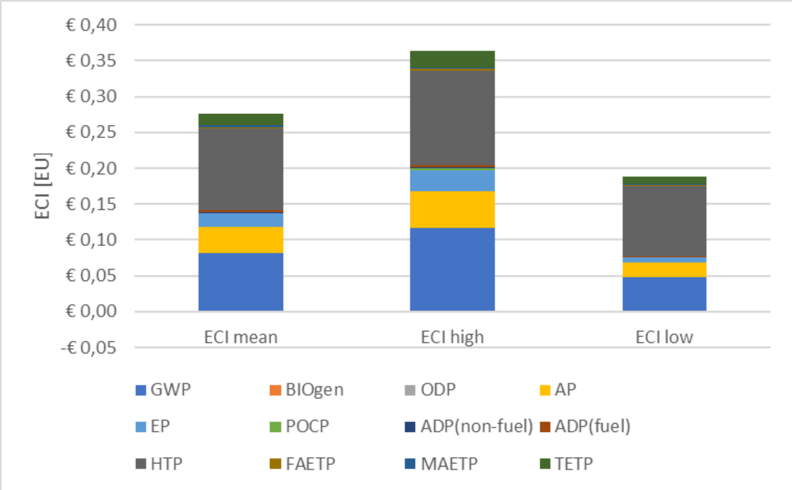


Figure 6.16: ECI values with the high and low range for 320mm concrete hollow core C

Concrete Hollow core consist of several different components, some have a higher impact than others. The exact contribution of each component is difficult to find. But looking at the information of components given in an EPD it is possible to find reasons why EPD's can differ from each other. The components of concrete hollow core which can influence the environmental impact are cement, the transport of the raw material to the factory and the steel used for the reinforcement.

Timber Concrete Composite

The timber concrete composite in this research is a combination of a CLT basis topped with a structurally connected concrete insitu layer. For the timber concrete composite, the GPR software has no available datasets, which means it is going to be a combination of the CLT environmental data and the Concrete insitu environmental data. The data for TCC is produced by combining the data from CLT and Concrete insitu. The ranges are also taken into account. The percentage of CLT and concrete differ per specific floor height due to the use of practical dimensions. The volume percentage of concrete differs from 20% to 30% depending on the floor thickness. Since the environmental data is compared based on the raw data from 2 different materials, the assumption is made that the production process of combining the CLT and concrete is not taken into account. A comparison of specific floors can be found in chapter 6.4, where all floor types are compared to each other.

6.3 Biogenic carbon content

The biogenic carbon content is a debated topic within the environmental impact discussion. As mentioned in chapter 4, the biogenic carbon content is the carbon storage in short cycle biomass, such as wood/timber. This can be seen as a storage of carbon within a material, such that the carbon is stored within a useful product for the lifetime of the material. At the end of the lifetime, it depends on the type of end of life scenario what happens to the biomass. Whether it is released back to the atmosphere, put into the ground by underground decomposition or stored in another way.

The biogenic carbon content of the floor types used in this thesis can be found in figure 6.17. The biogenic carbon content is calculated according to the formula found in chapter 4. And not taken from the specific EPD's. The carbon content for spruce timber is taken as 715 kg CO2 / m3. (See chapter 4). In figure 6.17 it can be seen that the timber based floors have a biogenic carbon content, CLT has the highest carbon content due to it's use of solid timber, TCC is based on a CLT panel and thus has also a high solid timber content, thus high biogenic carbon content. The LVL based boxfloor has a lower biogenic carbon content due to the box shape of the floor, a relative low amount of material is used in a certain height floor. This results in lower biogenic carbon content.

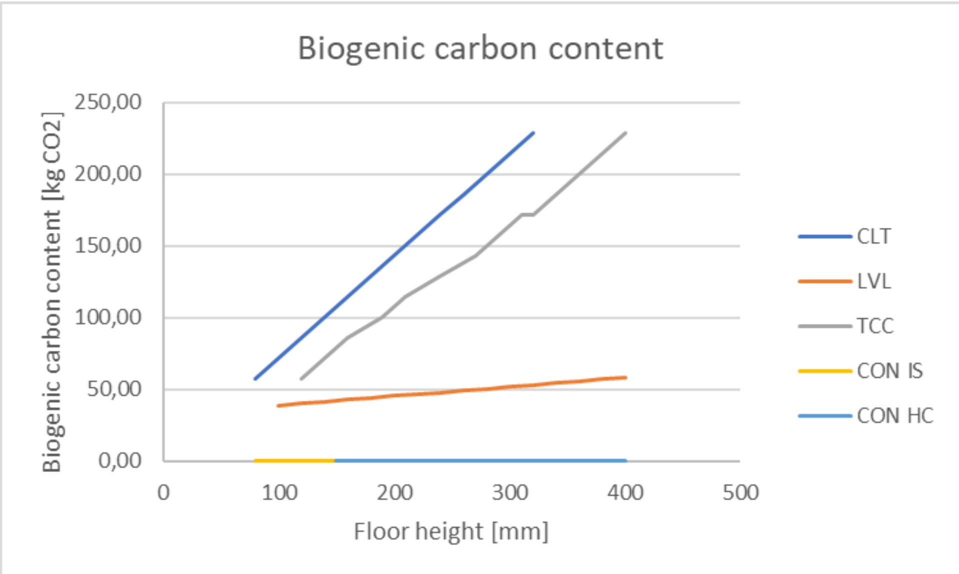


Figure 6.17: Biogenic carbon content per floor type

The biogenic carbon content is taken into account in EPD's in production phase A1-A3, where the biomass is stored within the raw material. The inclusion of biogenic carbon content reduces the emissions of CO2eq. In the end-of-life-phase C, the carbon within the material is released back into nature, but this can depend on the scenario. The standard end-of-life scenario for timber is the incineration, where the timber is burned, the CO2 is released back into the atmosphere. In this case, the energy which is produced could be seen as energy from biomass. This environmental advantage is calculated in the energy production, but has its origin in the raw timber material. Another scenario could be recycling, where the timber is being processed into a raw material for other timber passed products, such as OSB or chipboard. In this case the CO_2 emissions are not put back into the atmosphere, but some emissions occur due to the recycling process of timber back to raw material.

The incineration of timber could be seen as the worst case scenario where the biogenic carbon is released back into the atmosphere. But in reality, when timber is being processed, products such as glue are added to the timber to create a timber product. This contamination makes it harder to recycle the material back into a raw material. So part of the timber will become waste and is likely to be incinerated. Although the CO_2 could be released back into the atmosphere when the timber is at its end-of-life stage, during the lifetime of the product the CO_2 is captured and stored in a useful way. By recycling the timber, this storage could be further extended. By using timber from sustainably managed forests, more wood could be produced in the lifetime of the timber product, which also captures CO_2. The biomass within forest could then grow over time and captures even more CO_2. This effect is not taken into account within EPD’s. Bu all in all, the inclusion of biogenic carbon content should be taken into account. For now, this is only possible with biobased materials, but when CO_2 can be temporarily stored within concrete, this should also be accounted for within EPD’s. This would result in a fair comparison and the beneficial capture of CO_2 within useful buildings and constructions.

6.4 Comparison between materials & scenarios

In the previous subsections an insight in the environmental impact of each material used in this research was elaborated on. This gives an image of each material for a certain volume. In order to compare the materials for the use of floors, it is important to take structural properties into account. This way, an environmental impact comparison can be made based upon the structural performance of the floor. Table 6.9 shows the floors used in the comparison. The structural stiffness is taken as starting point, the stiffness "EI" have comparable values for each floor. The difference between the specific floor materials is especially seen in the floor heights, timber based panels are higher than the concrete based panels, this is due to the larger E-modulus of concrete. The LVL boxfloor has an even higher floor height, this is due to the box geometry, its stiffness is mainly based on the structural height of the floor. The overall stiffness "EI" is based on the static stiffness, creep is not taken into account.

Table 6.9: Properties of floors for comparison

Floor	Height [mm]	EI[Nmm2]
CLT 220 L7s-2	220	9,71E+12
LVL BX280	280	9,82E+12
TCC 210	210	1,03E+13
CON IS SC160	160	1,13E+13
CON HC KP150	150	1,08E+13

The environmental impact of the floor from table 6.9 is taken from the data gathered in the previous subsections, the environmental data per specific floor can be found in *Appendix C* . The environmental impact of each floor is shown for the sustainability scenarios stated in chapter 4. The scenarios will show the Environmental Cost Indication for module A1-A3 and for Module A1-A3 + C, furthermore the scenarios will show the Global Warming Potential for module A1-A3 and for Module A1-A3 + C. The results also show the difference when biogenic carbon is taken into account and not taken into account.

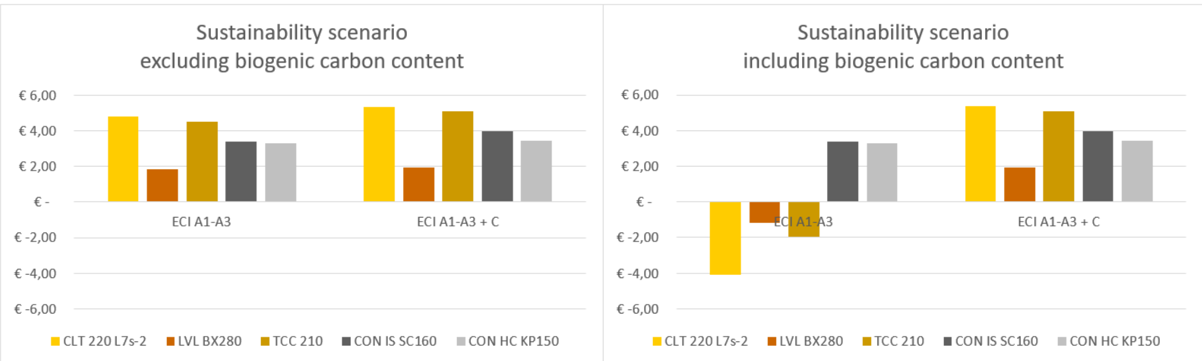


Figure 6.18: ECI comparison excluding and inclusion of biogenic carbon

Figure 6.18 and 6.19 show the results of the comparison between the 4 scenarios, including and excluding biogenic carbon content. Firstly the Environmental Cost Indication, it can be seen that excluding the biogenic carbon content, the CLT and TCC have the highest ECI value, the LVL has the lowest and the concrete insitu and hollow core have a similar value. The LVL has a low value due to the relative low amount of material in the floor due to the box floor geometry. When including the biogenic carbon content, the timber based panels have a negative impact in module A1-A3, especially CLT has a low ECI value due to the high amount of solid timber within the panel, which results in a high biogenic carbon content. In module A1-A3+C, the scenario of incineration is taken into account for timber and crushing for concrete. This results in the same results when biogenic carbon is included or excluded. Since biogenic carbon is released back into the air for this scenario.

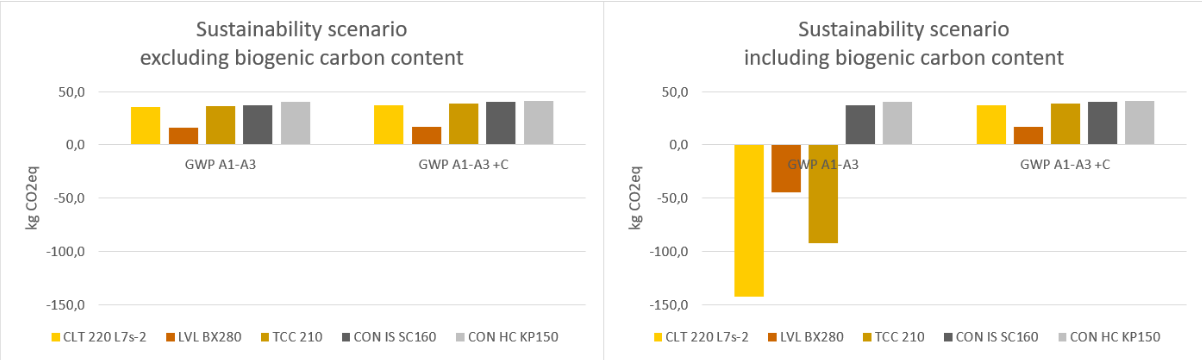


Figure 6.19: GWP comparison excluding and inclusion of biogenic carbon

Looking at the Global Warming potential the timber based panels have a lower score than the concrete floors. Independent of exclusion or inclusion of biogenic carbon. When biogenic carbon is taken into account in module A1-A3, the timber based panels have a negative value due to the storage of CO2 within the timber. In module A1-A3+C, the results are the same because of the scenarios taken.

From the results of this initial comparison some conclusions can be drawn. First, boundary conditions are important, which scenarios are taken into account, which specific products are used in the construction of an actual building, the conditions taken into account in the LCA itself and the accuracy of the EPD's. The average environmental impact per material can be difficult to guide from, since the materials have a large range in environmental impact and it is easy to be misguided by only the best possible EPD's. It might be possible that the EPD's of the "green" variants are published, this might result in a misleading design where the actual building eventually has a worse environmental impact than designed.

For the results of this comparison, timber and concrete for floors can have a comparable environmental impact, when biogenic carbon is taken into account, timber based panels have a lower environmental impact than concrete floors. When looking at the Global Warming

Potential, timber performs better than concrete. Especially when biogenic carbon is taken into account. When looking at the lifecycle of a building, the service life of a typical floor is 100 years. This means that the A1-A3 has an influence for the upcoming 50 to 100 year, after those years, module C get into action and adds to the environmental impact. For the short term in module A1-A3, timber is environmentally more friendly than concrete. In the long term A1-A3+C, they are comparable. The most environmentally friendly floor is the LVL based panel, due to the low amount of material used in the floor itself.

7. Relation between vibrational performance and sustainability of floors

This chapter discusses the combination of vibrational performance and environmental impact of timber and conventional floors. The results from the previous chapters are combined to show the environmental impact of different floor types over different spans including the vibrational performance of the floors for a low and high performance level.

7.1 Combining of vibrational performance and sustainability

In chapter 7 the vibrational performance of the floors and the environmental impact of the used materials and floor types are combined. The effect of vibrational performance on the sustainability of a floor is shown. In chapter 5 the vibrational performance of the floors is assessed for multiple scenarios. The vibrational performance is based on the method from the draft EN 1995-1-1 Eurocode 5. The results from the vibrational performance per floor type are combined with the quantification of sustainability analysis based on Environmental Cost Indication from chapter 6. For the quantification of sustainability 4 scenarios are described. These will also be used in this chapter. The inclusion and exclusion of biogenic carbon content will also be considered in this chapter.

The situation used for the sustainability assessment of the vibrational performance is the same as introduced in chapter 5, a simply supported floor with floor elements. To make a comparison between the floors, the results of the vibrational performance for a wide floor with a low floor performance (scenario 2) and high performance (scenario 4) will be assessed. These scenarios have the most results and give an insight in the difference in sustainability between a high and low floor performance. The overall environmental impact will be shown according to the results on certain floor spans. Additionally the environmental impact purely based on the difference between high and low performance floors will also be shown.

7.2 Results of vibrational performance and sustainability

The results of the comparison between the vibrational performance and sustainability are shown in the paragraphs below. For the sustainability, the average values are taken for simplicity of the comparison, but the ranges mentioned in chapter 6 are taken in mind. The results are based on the governing floor heights from the vibrational analysis. These are set against the floor span. To give an insight in the large dataset, the sustainability of the floors are shown for 3m, 6m and 9m span, to accommodate a small, medium and large span. For the sustainability the environmental cost indication and global warming potential are analysed for each research point. The effect of biogenic carbon content are also taken into account.

Low performance floors

Figure 7.1 shows the floor heights per floor type for different floor spans with a low floor performance level and a wide floor. The brownish coloured rods are timber based panels, CLT, LVL and TCC. The grey coloured rods are concrete cast in situ and concrete hollow core. The structural height increases for higher spans, at 10m span, only TCC and concrete hollow core have viable floors. At 11m only the concrete hollow core is applicable. This shows the technical limitations of the flooring materials. It can be seen that the LVL box floor increases in height more than CLT and TCC increase in height with a larger span. This is due to the necessary increase in stiffness is taken from the height of the floor, since there is less material added. Looking at the concrete floors, the concrete cast in situ also increases in height, but is a little less heigh than CLT. This is due to the higher stiffness of the concrete, but taken creep into account, it has a comparable slightly higher stiffness as CLT. Looking at the concrete hollow core floors the height step sizes have only limited possibilities, at the lower spans, it is over dimensioned. The technical applicability of the hollow core floor extends to the maximum tested floor span of 11meters, where other floors technical limitations already occurred.

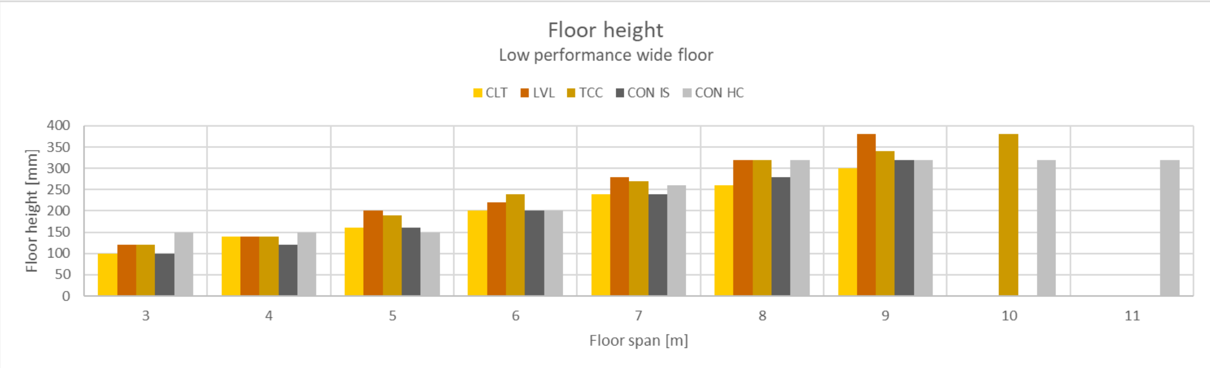


Figure 7.1:Floor height per type and per span, low performance

Figure 7.2 shows the sustainability of every floor type at the small span of 3m. The environmental cost indication and global warming potential are shown in the sustainability scenarios. It shows that taken biogenic carbon not into account, the environmental cost indication timber and concrete products are comparable. The LVL is has the lowest score due to the small amount of material in the floor. Looking at the global warming potential the timber based products score better than the concrete floors, especially the concrete hollow core has a relative high GWP and ECI value due to the practical over dimensioning. Taken biogenic carbon content into account, the timber based panels have a negative value for the GWP, which also influences the ECI, resulting in a negative ECI. For the long term environmental effect, gathered in the combination of module A1-A3 and C, it has the same values including or excluding biogenic carbon. This is due to the scenario taken in module C of incineration, where the biogenic carbon is released back into the atmosphere.

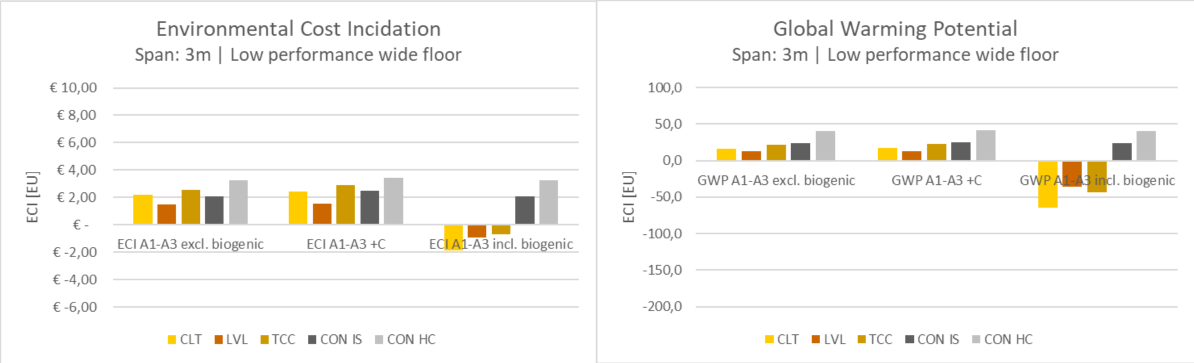


Figure 7.2: Sustainability of a 3m span, low performance wide floor

Figure 7.3 and 7.4 show the sustainability of every floor type at the medium span of 6m and large span of 9m. The environmental cost indication and global warming potential are shown in the sustainability scenarios including and excluding biogenic carbon content. The behaviour noted in the at the small span of 3m also apply to the larger spans. The effect of the small amount of material in the LVL has a bigger advantage in the longer spans, the negative side of this is the increased height necessary. Another difference with the 3m span is the concrete hollow core, since it isn't over dimensioned for larger spans, the environmental impact of this floor type decreases when compared to other floor types. Especially at the 9m floor span, the concrete hollow core has the lowest ECI value next to the LVL box floor.

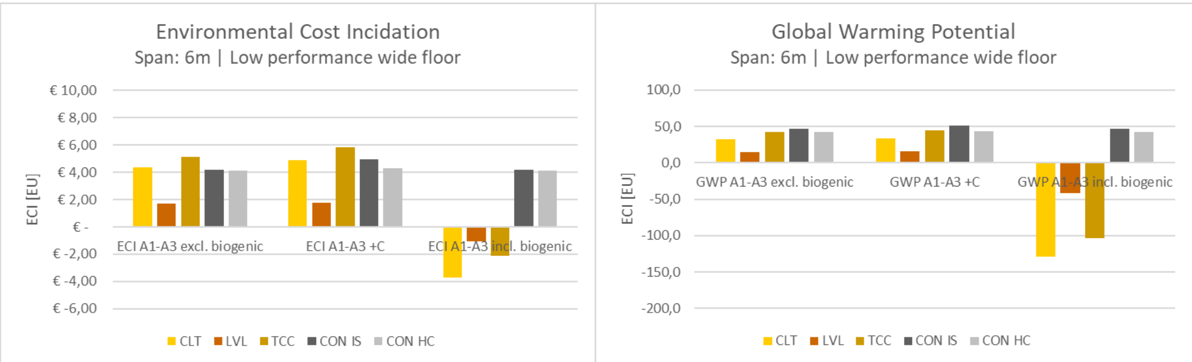


Figure 7.3: Sustainability of a 6m span, low performance wide floor

Looking at the environmental impact of the floor types including biogenic carbon, the GWP value is negative due to the carbon storage, this effect gets bigger due to the higher amount of timber in CLT and TCC as higher floors are used. Whether biogenic carbon is included or excluded, the timber based floors always perform better on global warming potential than concrete floors. The sustainability ranges mentioned in chapter 6 should be taken into mind, considering the floors excluding biogenic carbon, the environmental impact is supplier dependent and a good concrete product could be better than a bad timber product. This is also scenario dependent where in the future reuse or recycle is the preferred scenario for C, which has a positive influence on the timber based floors.

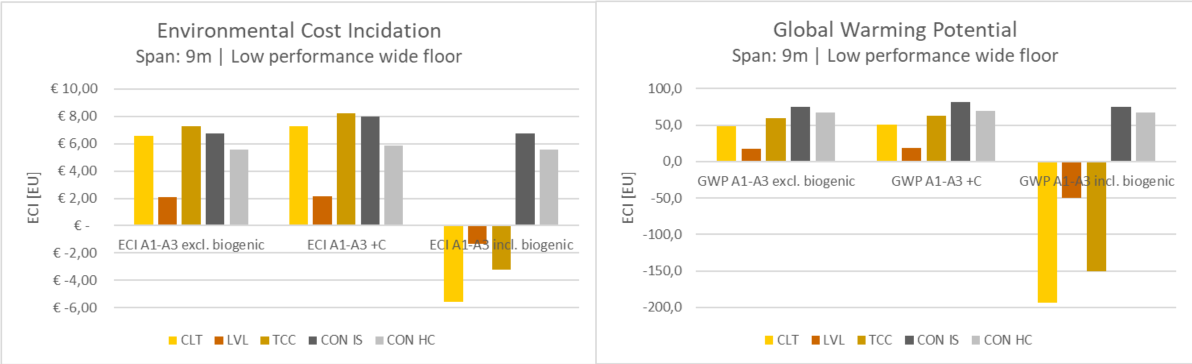


Figure 7.4: Sustainability of a 9m span, low performance wide floor

High performance floors

Figure 7.5 shows the floor heights per floor type for different floor spans with a high floor performance level and a wide floor. It shows the increased height of the floor types when the span increases. The height of the floors is higher than with the low performance, the height also increases quicker and the maximum feasible floor span is also decreased. The LVL floor height increases more than the other floor types. TCC is applicable to the largest floor span, the concrete hollow core floor reaches to 9m spans. Concrete floors need less material to have a high performance level compared to timber floors.

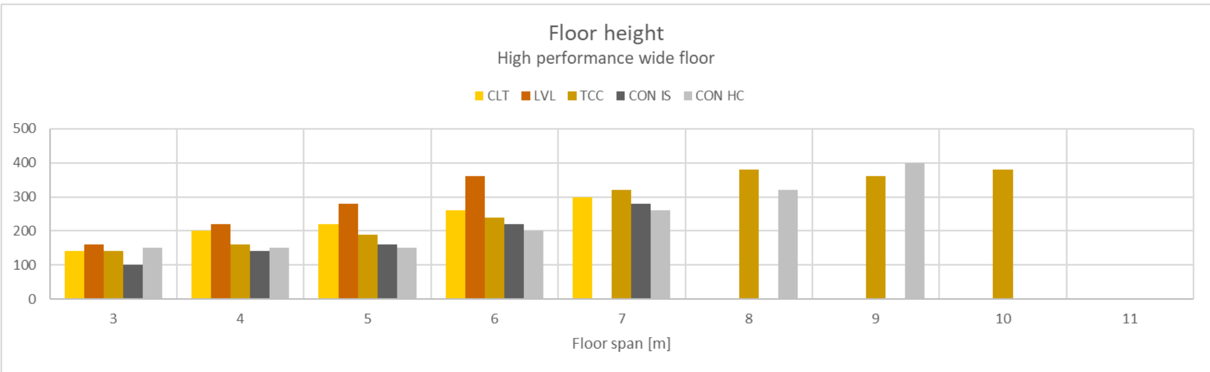


Figure 7.5:Floor height per type and per span, high performance

Figure 7.6 shows the sustainability of every floor type at the small span of 3m. The environmental cost indication and global warming potential are shown in the sustainability scenarios. The behaviour of the environmental impact is the same as for the low performance floors, except the impacts are higher. The concrete floors perform a little better than for the low performance floors. Timber floors have higher environmental impact due to the higher floor height needed. When biogenic carbon is taken into account the higher floor height have the benefit for the timber that more carbon is stored in the material. Thus a negative impact on the environment for the ECI as well as the GWP. Although when looking at the total environmental impact ECI for module A1-A3+C, concrete would have a lower environmental impact. The GWP would still be lower for timber, even when biogenic carbon is excluded.

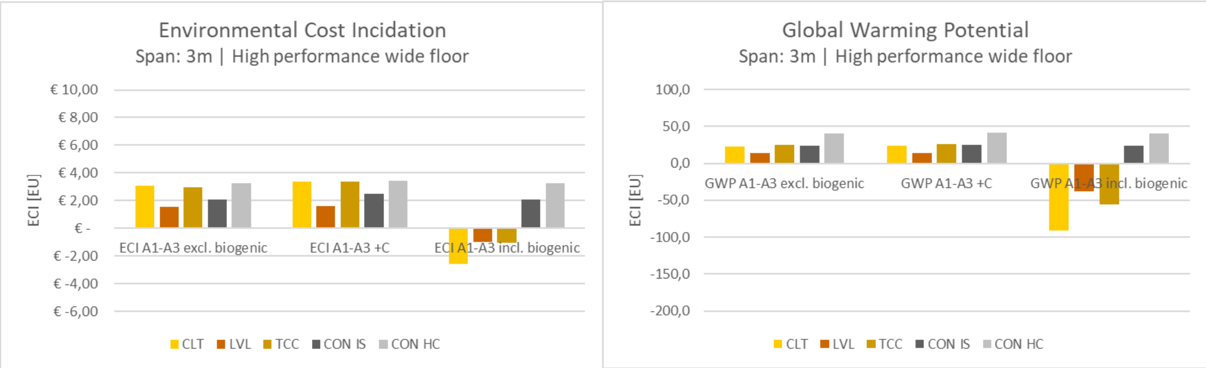


Figure 7.6: Sustainability of a 3m span, high performance wide floor

Figure 7.7 and 7.8 show the sustainability of every floor type at the medium span of 6m and large span of 9m. The environmental cost indication and global warming potential are shown in the sustainability scenarios including and excluding biogenic carbon content. The same behaviour is seen as in the small 3m span. For the large 9m span only the TCC and concrete hollow core are applicable for a high performance floor. For medium and large spans, the concrete hollow core becomes favourable with a good vibrational performance and apart from the LVL box floor the lowest ECI.

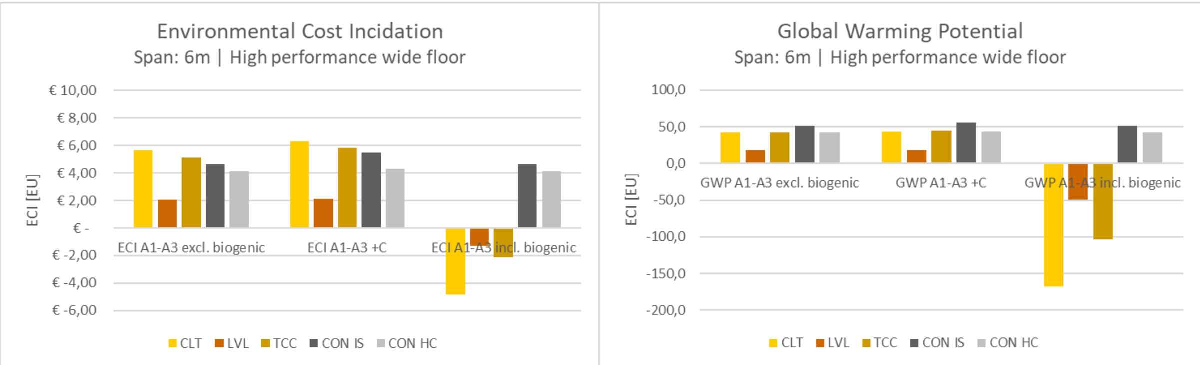


Figure 7.7: Sustainability of a 6m span, high performance wide floor

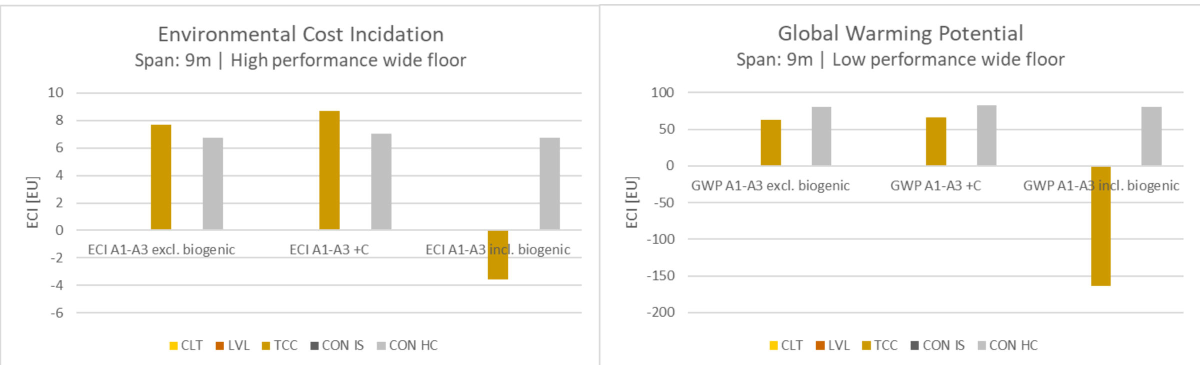


Figure 7.8: Sustainability of a 9m span, high performance wide floor

From the results of the analysis for the different floor types for low and high performance wide floors some trends can be found. The possible floor span for low and high performance floors differ, the spans can be found in table 7.1. A high performance floor has a smaller possible span. The concrete insitu floor has in these results a lower possible floor span. This can be extended by using concrete floors higher than 320mm, but these are not analysed in this thesis.

Table 7.1: Span ranges for low and high performance floor wide floors

	Span range	
	low [m]	high [m]
CLT	3 - 9	3 - 7
LVL	3 - 9	3 - 6
TCC	3 - 10	3 - 10
CON IS	3 - 9	3 - 7
CON HC	3 - 11	3 - 9

The difference in floor height and difference in ECI value for module A1-A3 for is show in table 7.2. The differences are referred to in percentages, this is the percentage which is necessary to go from a low to a high performance floor. Some interesting trends show. For CLT on short spans, 40% extra floor height as well as ECI value is needed. On larger spans his decreases to 25%. For the LVL box floor a different trends shows on short spans, the height has to increase approximately 30% but for larger spans the height increase has to be 65%. Due to the box floor geometry this increase in height causes less increase in ECI value, this needs between 10 % to 20% extra material to get a high performance floor. For heavier floors such as the TCC and concrete insitu an additional 0 to 20% is necessary to get a high performance floor. The concrete hollow core behaves differently due to the large height increase step size and the hollow geometry, overall the concrete hollow core fulfils for a low performance floor.

Table 7.2: Percentage difference between a low and high performance wide floor

	CLT		**LVL**		**TCC**		**CON IS**		**CON HC**	
Span	*Dif. Height*	*Dif. ECI*	*Dif. Height*	*Dif. ECI*	*Dif. Height*	*Dif. ECI*	*Dif. Height*	*Dif. ECI*	*Dif. Height*	*Dif. ECI*
3	40%	40%	33%	6%	17%	17%	0%	0%	0%	0%
4	43%	43%	57%	12%	14%	14%	17%	17%	0%	0%
5	38%	38%	40%	11%	0%	0%	0%	0%	0%	0%
6	30%	30%	64%	19%	0%	0%	10%	10%	0%	0%
7	25%	25%			19%	19%	17%	17%	0%	0%
8					19%	19%			0%	0%
9					6%	6%			25%	21%
10					0%	0%				
11										

Environmental impact ranges

The floors in this analysis are evaluated for their sustainability dependent taken the effect of the vibrational performance into account. To generalise the information, the mean values for the Environmental Cost Indication are taken into account. In reality the ECI values can vary dependent on the supplier. This is shown in chapter 6 where the sustainability is analysed. To show the effect of the final choice of material and supplier on the ECI value, the mean and range are shown for the low performance floors. The mean ECI values are shown in figure 7.9. The range of ECI values can be found in figure 7.10. The mean line is shown as a full line, where the higher and lower limit are shown as dotted lines per material. What can be seen is the variation in range, where it is sometimes difficult to show the floor type with the lowest environmental impact due to the uncertainty range of the specific floor type. The specific floor chosen can have a decisive effect on the ECI value and thus the most sustainable option. Generally spoken, the floor with the least amount of material has the lowest environmental impact and the taken biogenic carbon into account, timber floors have the lowest environmental impact.

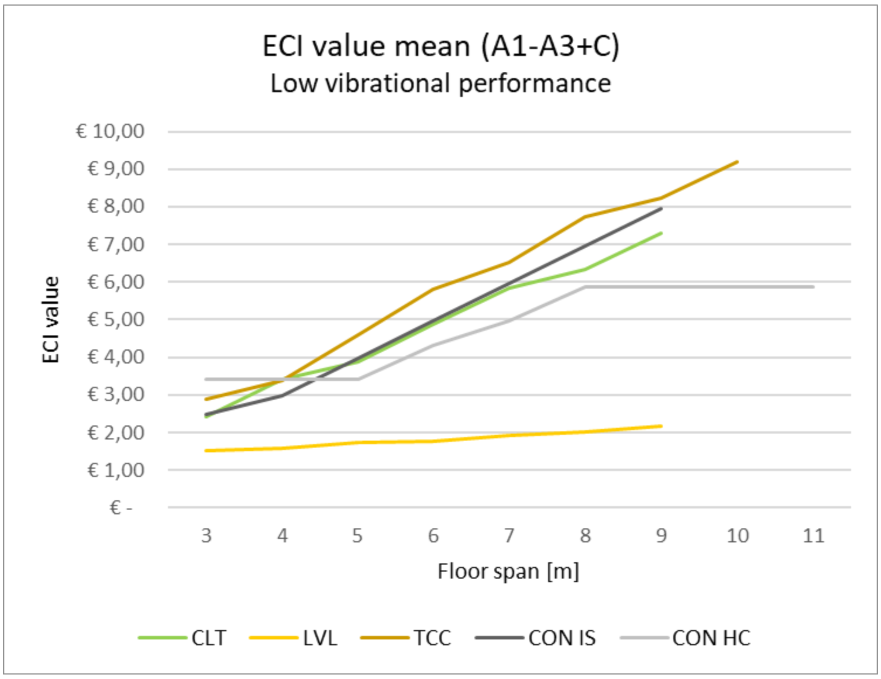


Figure 7.9: Mean ECI values for production and end-of-life phase

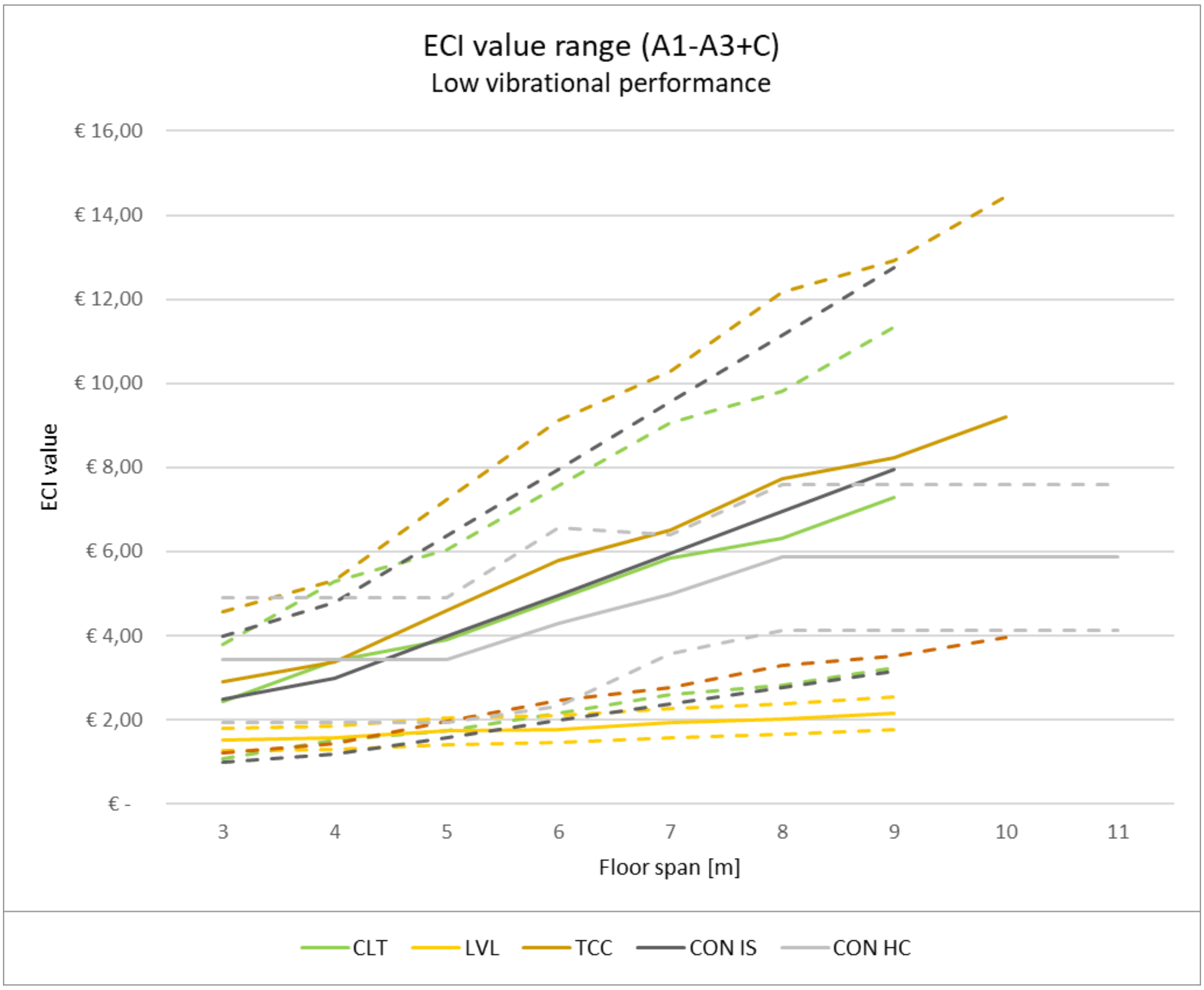
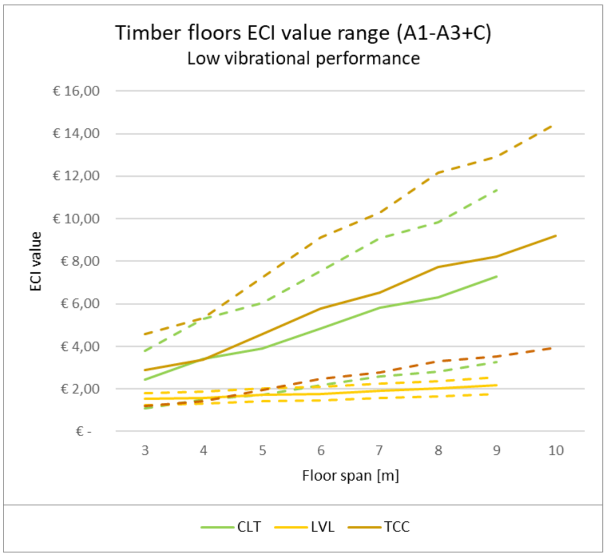


Figure 7.10: Range of ECI values for production and end-of-life phase excluding biogenic carbon for an end-of-life scenario of incineration for timber. Dotted lines show the range



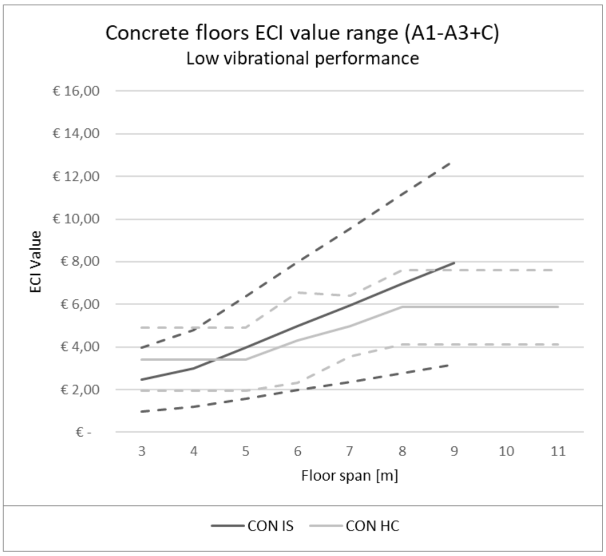


Figure 7.11: Range of ECI values separated for timber floors and concrete floors.

7.3 Conclusions of performance

From the combination of vibrational performance and the quantification of the environmental impact of materials, some conclusions can be drawn. These are based upon the performance of the floors between themselves and the difference between a low and high performance floor. The environmental impact is analysed for the short term and long term impact.

For the vibrational performance, it is shown that timber is more sensitive to vibrations and higher floor heights are necessary to accommodate the vibrational performance. Concrete floors are less prone to vibrations and thus need less extra floor height to accommodate the vibrational performance. Given the Environmental Cost Indication timber floors and concrete floors performance on average approximately the same, with an advantage for timber floors on the smaller spans and an advantage for concrete floors on the larger spans.

When the Global Warming Potential without biogenic carbon content is considered, the timber floors on average perform better than the concrete floors. At larger spans the concrete hollow core floors are comparable to the timber based floors. On average the LVL box floors have the best performance, but come at the cost of a high floor height, this can be reduced, but this will increase the environmental impact of the floor type.

Taking the biogenic carbon content into account, the timber floors are favourable due to the large quantity of wood, thus CO2 storage inside the floors. The mass timber floors will have the lowest environmental impact in that case due to the negative global warming potential in the production phase A1-A3. When the biogenic carbon is taken into account, the mass timber floors such as CLT and TCC have the lowest environmental impact in phase A1-A3, but due to the scenario of incineration in the end-of-life phase C, this CO2 storage advantage is compensated at the end of life. And in the end this will result in comparable ECI values for timber and concrete floors.

These results are in the situation of the raw structural floors, the top floors are not considered in the environmental impact, nor the vibrational performance. The scenario taken in the end-of-life phase has an impact on the design choice of the most sustainable floor. When a different end-of-life scenario is taken such as recycling or reuse, this reduces the environmental costs of especially timber, which will make it more favourable. Furthermore the environmental impact of a floor is dependent on the supplier, due to the large range in environmental impact per supplier, a bad timber product might be worse than a good concrete product. This is especially true in the production phase, where as in the end-of-life the supplier hasn’t got direct influence on.

When taken the low and high performance floors into consideration, timber floors need more measures to be able to cope with a higher floor performance than concrete floors. So on higher floor performances, the concrete floors have an advantage. Especially the concrete hollow core floors can handle large spans with high vibrational performance. Independent of the high or low performance floors, the long term environmental impact of the floors will be comparable taken the consideration from this research. In the short term of the service life of the floors, approximately 50 to 100 years, the timber floors have a large advantage in environmental impact when biogenic carbon is taken into account. The storage of CO2 with in a building should be counted in the quantification method. A disadvantage of this inclusion of biogenic carbon is that the timber floor with the highest mass will be used. For the floors this would be CLT or TCC, but in the end-of-life the LVL has a lower environmental cost and a lower GWP, when the LVL would be incinerated. So both situations should be assessed.

7.4 Case study

To put the information from the previous chapter into perspective a case study is performed in this chapter. The case study deals with 3 different situations, case A, B and C. For a small span luxury office floor (A), a medium span luxury office floor (B) and a large span basic office floor (C). The basis for the situations are shown below:

A. Small spanning luxury office floor
B. Medium spanning luxury office floor
C. Large spanning basic office floor

For each situation the 5 floor types used in the thesis are regarded and the option with the lowest environmental cost indication will be shown as well as the floor with the lowest Global Warming Potential for the production phase (A1-A3), since this has the largest impact and the uncertainty of the end-of-life phase is excluded in this comparison. These are shown including and excluding biogenic carbon content. The floor regarded has an office function and is structurally regarded as a simply supported floor on 2 supports. The floor is considered as a 3m wide floor, this results in better vibrational performance without the use of extra floor height or materials than a 1m wide floor.

There are 2 performance situations regarded, a luxury and a basic. These situations correspond to the high vibrational performance and the low vibrational performance. According to figure 3.23 and table 3.15 in chapter 3.4 in combinations with the vibrational performance levels seen in figure 3.15 (Draft prEN1995-1-1, 2021). The floor vibrations within the luxury office will be slightly perceptible to imperceptible for the occupants. The floor vibrations within the basic office will be perceptible to the point where most occupant will find it annoying. The amount of walking movements within the office is a design consideration to choose for a luxury or basic performance floor. The principle of Vibrational Dose Value can be taken into account here, the more often walking movements occur, the higher the discomfort of the floor occupants.

Case A: Small spanning luxury office floor
Case A will regard a small span of 3m for a luxury office floor. This floor span can be used for a hallway with some working spaces. This is an area with more walking movements and thus needs a higher vibrational performance.

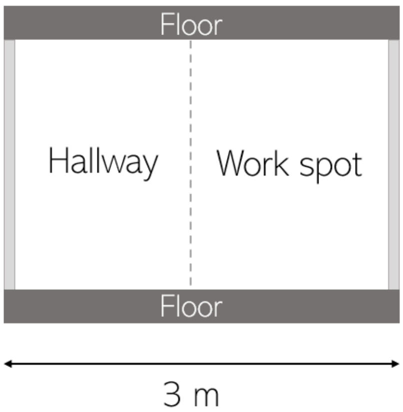


Figure 7.12: Example of cross section of hallway with adjacent work spots

To evaluate the floor, firstly the necessary floor height of a high performance floor is taken from figure 7.5 for a 3m spanning floor, the results are shown in figure 7.13. Then the according Environmental Cost Indication and Global Warming potential for the production phase (A1-A3) for a high performance floor are shown in figure 7.14.

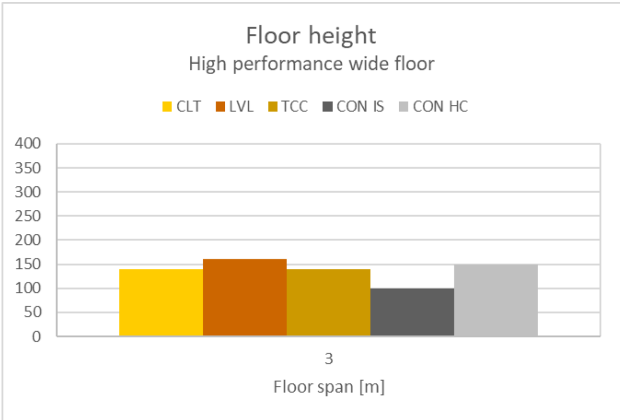


Figure 7.13: Floor heights for a 3m span high performance floor

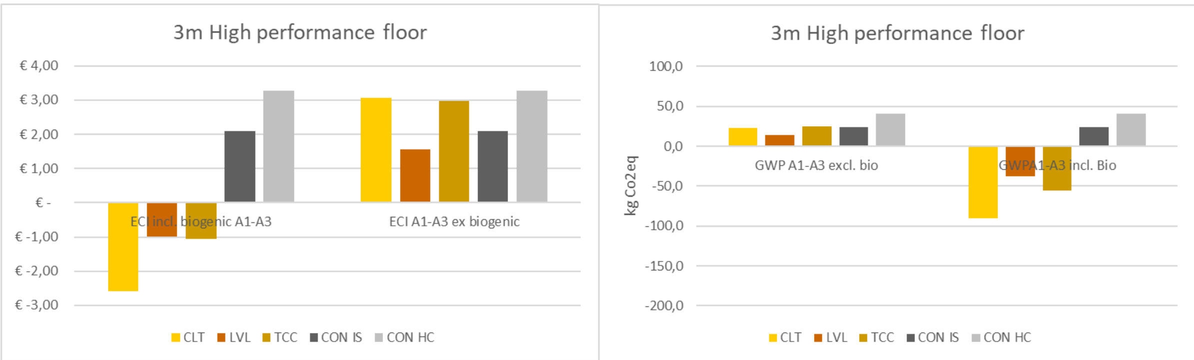


Figure 7.14: ECI values and GWP values for ahigh performance 3m span

The results show the ECI and GWP for the considered floor types for a 3m span for a luxury office floor. We can distinguish two types of results, when biogenic carbon is taken into account and without. When biogenic carbon is taken into account, CLT has the lowest ECI value and the lowest GWP. When biogenic carbon is not taken into account, the LVL box floor has the lowest ECI value and the lowest GWP. So independent of the inclusion or exclusion of biogenic carbon, timber based floors have the lowest environmental impact. Taken in account the use of the least amount of material to construct, the LVL floors have the advantage.

Case B: Medium spanning luxury office floor

Case B will regard a medium span of 6m for a luxury office floor. This floor span can be used for an open-plan office. This is an area with regular walking movements and thus needs a higher vibrational performance.

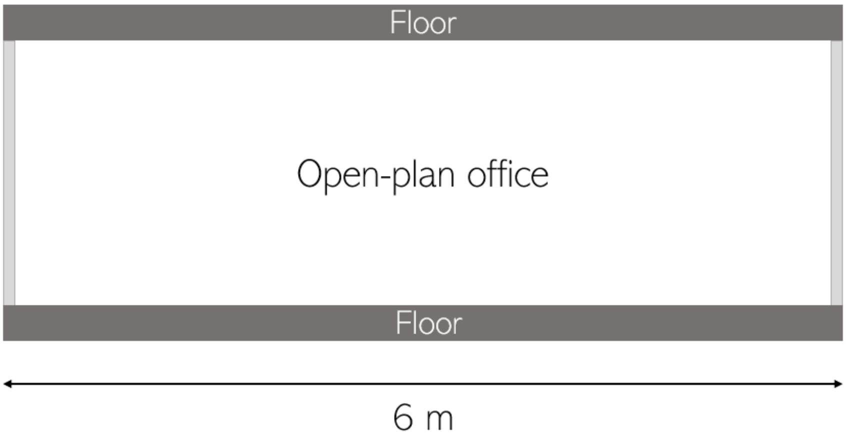


Figure 7.15: Example of cross section floor with open-plan office

To evaluate the floor, firstly the necessary floor height of a high performance floor is taken from figure 7.5 for a 6m spanning floor, the results are shown in figure 7.16. Then the according Environmental Cost Indication and Global Warming potential for the production phase (A1-A3) for a high performance floor are shown in figure 7.17.

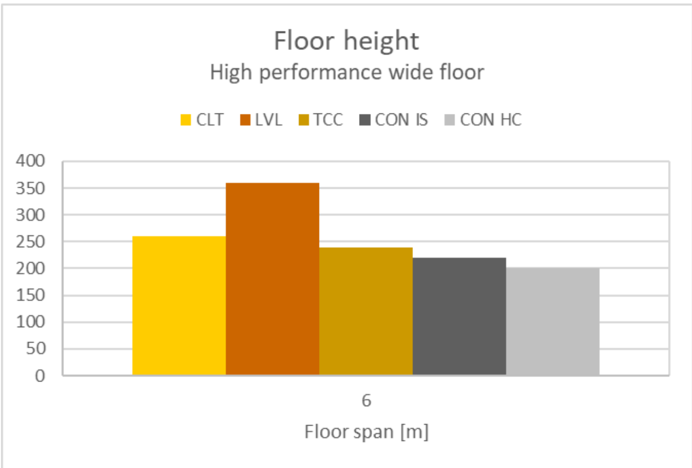


Figure 7.16: Floor heights for a 6m span high performance floor

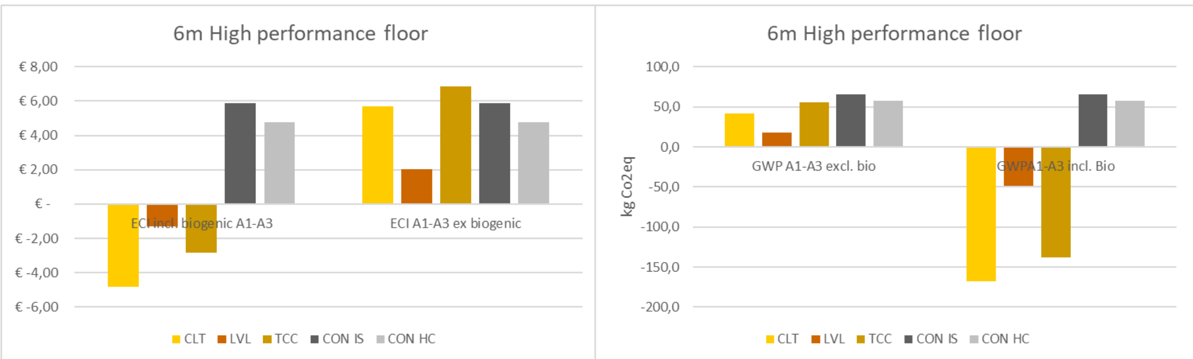


Figure 7.17: ECI values and GWP values for ahigh performance 6m span

The results show the ECI and GWP for the considered floor types for a 6m span for a luxury office floor. We can distinguish two types of results, when biogenic carbon is taken into account and without. When biogenic carbon is taken into account, CLT has the lowest ECI value and the lowest GWP. When biogenic carbon is not taken into account, the LVL box floor has the lowest ECI value and the lowest GWP. So independent of the inclusion or exclusion of biogenic carbon, timber based floors have the lowest environmental impact. Taken in account the use of the least amount of material to construct, the LVL floors have the advantage. The downside of the LVL box floors becomes more significant, the floor height increases to 360 mm. When a less tall floor is necessary and biogenic carbon is not taken into account, the concrete hollow core floor becomes the floor with the lowest ECI value. When biogenic carbon is taken into account, the CLT floor has the lowest ECI value.

Case C: Large spanning basic office floor

Case C will regard a small span of 9m for a basic office floor. This floor span can be used for a closed-plan cubicle office with possibly a less busy hallway perpendicular to the floor's main bearing direction. Within the closed-plan offices only few walking movements occur can thus be a low performance office floor.

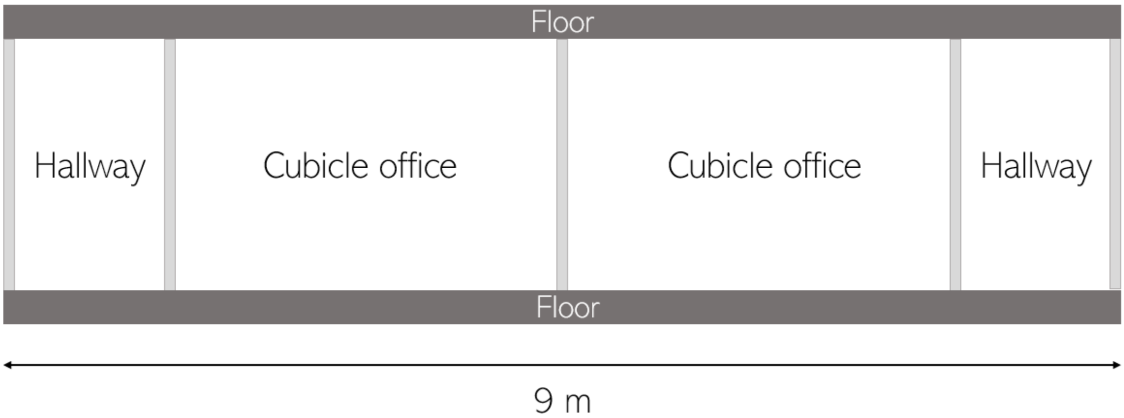


Figure 7.18: Example of cross section floor with cubicles and less busy hallways

To evaluate the floor, firstly the necessary floor height of a high performance floor is taken from figure 7.5 for a 9m spanning floor, the results are shown in figure 7.19. Then the according Environmental Cost Indication and Global Warming potential for the production phase (A1-A3) for a high performance floor are shown in figure 7.20.

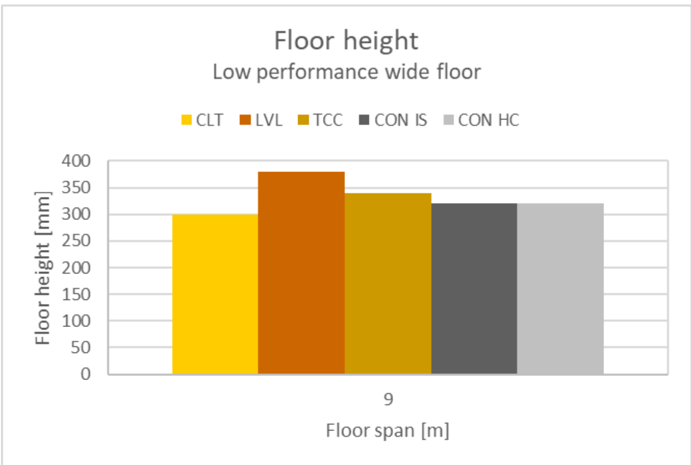


Figure 7.19: Floor heights for a 6m span high performance floor

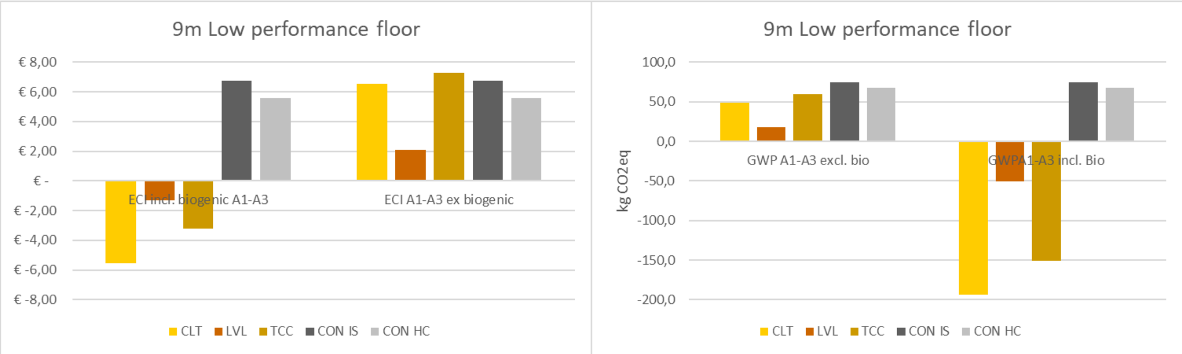


Figure 7.20: ECI values and GWP values for a low performance 9m span

The results show the ECI and GWP for the considered floor types for a 9m span for a basic office floor. We can distinguish two types of results, when biogenic carbon is taken into account and without. When biogenic carbon is taken into account, CLT has the lowest ECI value and the lowest GWP. When biogenic carbon is not taken into account, the LVL box floor has the lowest ECI value and the lowest GWP. So independent of the inclusion or exclusion of biogenic carbon, timber based floors have the lowest environmental impact. Taken in account the use of the least amount of material to construct, the LVL floors have the advantage.

Due to the low performance floor, the vibrational performance advantage of concrete becomes less significant. Thus the timber floors still have the lowest environmental impact. When a longer span with a higher vibrational performance is necessary, the concrete product become a more sustainable option due to the limitations of the timber products. One aspect which can result in higher ECI values is the acoustic performance of low weight floors in general and especially the LVL floor. The box floor design performs well due to the low amount of material, but the measures to take care of the acoustic performance might influence the ECI value largely.

Part IV

Discussion, conclusions and recommendations

8. Discussion

The results of the research performed in the previous paragraphs are discussed in this chapter. The goal of the research is to find the influence of vibrational performance levels on the environmental impact of timber floors and compare this to concrete floors. This is done using a vibrational assessment method from the renewed Eurocode 5: timber structures to assess the vibrational behaviour of floors and the environmental cost indication is used to quantify the environmental impact of the floors. The floors analysed are CLT, LVL box floor, Timber concrete Composite, concrete cast in situ and concrete hollow core floors. The following paragraphs will discuss the vibrational results of the floor assessment, the analysis of the environmental impact, the combination of vibrational performance and environmental impact and its will discuss 2 scenarios. These scenarios are based on the environmental impact of a specific floor in the year 2050 and for the year 2100.

Validity of results

The results of this thesis are based on assumptions on the vibrational performance as well as the sustainability. Underneath a list of assumptions taken into account. The majority of the results are based on the wide floor elements since these give better results than narrow elements without changing the floor height excessively.

Vibrations assumptions

- Office conditions are used for the assessment
- Step frequenct of 2 Hz, walking induced vibrations
- Acoustic vibrations are not taken into account
- Pathlength no longer than 5m
- Bare floors, no top layers and stiffness of screeds taken into account
- Damping percentages according to a bare floor
- High floor performance level for premium offices
- Low performance level for basic offices without comfort requirements
- Adjacent floor panels are not taken into account for vibrations
- Adjacent structural elements such as beams or columns are not taken in consideration
- The effective width of floors are taken into account in the vibrational model

Sustainability assumptions

- Incineration data for timber for Module C, crushing data of concrete for module C
- Based on data for Netherlands
- No transport etc A4-A5 and use B or module D
- Inclusion of 11 impact categories
- Effect of reuse not quantitatively taken into account

Vibrations

The vibrational performance of the floors are assessed for a high and low performance for an office function. Due to the low self-weight of timber based floors the vibrational performance can be governing, especially for high performance floor over all spans. This should be checked for when designing these floors. Concrete floors are less sensitive to vibrations, but the vibrational performance could also be governing. When for light buildings a comfort requirement such as vibrational performance should be fulfilled, also concrete floors should be tested accordingly to be able to make a fair comparison between the floor types. The criteria on which the vibrational performance levels are based should be used as testing criteria. When designing for a high performance floor, all floor types should be checked for the vibrational performance for all spans. Within the assumptions from this thesis the structural minimum floor generally meets the low performance floors demands.

The calculation on which the vibrational performance is based are simplified for practical use, which has its limitations. The frequency limits of 4,5 Hz and 8 Hz cause for some strange interpretations. For lightweight timber floors the lower limit of 4,5 Hz is useful to prevent large accelerations of the 2nd harmonic resonance. For heavier concrete floors the lower limit could be slightly lowered to accept 2nd harmonic vibrations. For heavy floors this results in lower acceleration when resonance occurs. The higher limit of 8Hz seems reasonable due to the limit of the 3rd harmonic. These limits apply for vibrations induced by walking. According to the TGB 1990 the lower limit of the first eigenfrequency is 3 Hz, this is a reasonable limit for heavier floors due to the higher modal mass which reduces the acceleration due to resonance. Floor with a mass of 500kg/m2 are less vulnerable for vibrations, the results show this as well for concrete insitu floors. Although for high performance floors the vibrational performance of heavy floors should still be calculated.

The damping used for the floors is an assumption on which the calculations are based. The damping of the floor has effect on the vibrational performance. A higher damping results in lower floor vibrations. The floor type itself has a certain damping ratio, this effect can be increased by using more constraint floors, such as clamps or more supports. Another way to increase the damping is to create a damping layer in the top floor, this reduces the dynamic force onto the floor. Hamm et al.(2010) suggested that the addition of mass would also improve the vibrational performance, although tests performed by Johansson(2009) show that the addition of mass increases the damping ratio. But this will lower the eigen frequency which results in more acceleration of the floor and this neglects the direct effect of the added mass, this effect is shown in the hivoss guideline and also stated by Cobelens (2018).

The difference in floor height between a low performance floor and a high performance floor is significant, especially when the span of a floor gets larger. The floor height difference for timber based floors is more than for concrete floors. Thus timber floors are more sensitive to vibrational performance. Concrete floors are less sensitive to the vibrations, which is confirmed by the lower floor height increase between low and high performance floors. Another effect of the high performance floor is the technical feasibility of the floors. High performance timber floors are only possible on small spans up to 7m, given the parameters used in this research. As mentioned before the spans for high performance could be increased by increasing the damping or changing the floor configuration. The geometry of the floor could also increase the vibrational performance of the floor, in this research this is done using wider floor elements to be able to cope with the floor vibrations. Other improvements could be to coupling floor elements, add more structural constraints or increase the damping of the floor.

Sustainability

The sustainability of the floors is assessed using the environmental cost indication, this indication is based on several environmental impact categories which are weighed according to their harm to the environment. For this research, the total environmental costs and the global warming potential are used. These are used for the production phase A1-A3 and the end-of-life phase C. The production phase has the most accurate estimate of the environmental impact of a material, all other phases are based on scenarios and are thus less accurate. The end-of-life phase takes place after 50-100 years, the environmental impact then is hard to estimate now, because of the possibility what would happen to the material at the end-of-life. Although this impact is smaller than the production phase, it is important when the biogenic carbon is taken into account. This biogenic carbon might be released back into the atmosphere when incinerated and thus loses its CO_2 storage advantage. Keeping the CO_2 captured within the material by reuse or downgrading it with recycling ensures the elongation of the environmental advantages of timber.

The CO_2 storage advantage is important for the global warming potential. Timber emits less CO_2 than concrete, this is the advantage of using timber in construction. But when the total environmental costs in the environmental cost indication are considered, the timber and concrete have comparable values. The advantage for timber lays in the production phase and the service life, where the CO_2 is stored within the timber, it is important to use the timber as long as possible to keep the CO_2 stored. This can also be done by reuse or recycling. In the calculation of the environmental costs the biogenic carbon content should be taken into account. The subtraction CO_2 from the atmosphere is an important factor to reduce the global warming, thus the storage of CO_2 gathered from the atmosphere should be an advantage for a material. When CO_2 from the atmosphere or waste processes could be stored within concrete, this should also be possible to account for.

Considering the aim for a circular economy (Ministerie van Infrastructuur en Waterstaat, 2023) the end of life scenario of incineration is not favourable. The CO_2 captured in the timber should be preserved by reuse or recycling of the material. This cuts the CO_2 emissions from the incineration process, which will result in a better environmental impact of the floors. The use of timber in the past shows that service life longer than 100 years is possible (Van Der Lugt, 2020), this makes the incineration scenario after 50-100 years not likely.

When the environmental data for materials are compared from EPD's an important factor in the environmental assessment shows up. The environmental impact of a material differ from supplier to supplier, due to the differences in production process. The range of a material can have a significant variation. When biogenic carbon is not taken into account, it could be the case that a good concrete mixture with small amounts of steel rebar has a lower environmental impact than a bad timber product. Although the most actual data from EPD's is used in this research, it could be that the calculation of the environmental impact of concrete products don't show the most commonly used concrete mixtures. The EPD's available show mixtures with low environmental impact recipes. The result can be that the environmental impact of concrete might be higher than the analysis in this research shows.
For the LVL the small amount of available EPD's causes the environmental data to be less accurate, due to the low amount of comparable EPD's. This results in a low environmental impact, but this can be larger when data from different suppliers are analysed. Timber products have on average a smaller global warming potential than concrete products. When biogenic carbon is taken into account, timber has a negative environmental impact, which indicates an environmental gain.

Vibrations and sustainability

Combining the knowledge and results of vibrational performance and sustainability the environmental impact of floors regarding a low and high vibrational performance can be assessed. For a high performance floor, a higher floor height is necessary than for a low performance floor. Timber floors need more extra floor height to get from a low performance to a high performance floor For CLT floors 25% to 40% higher floors are necessary, accordingly the environmental cost indication increases with 25% to 40%. The LVL box floor has an advantage from its geometry. An increase of 30% up to 65% is necessary to get a high performance floor. The box floor geometry causes the environmental costs to increase with only 10% to 20%. Concrete or TCC floors need more extra floor height to counter the difference in vibrational performance, approximately 0% to 20%, For the height as well as the environmental impact. This gives the concrete and TCC floors an advantage for high performance floors. The technical feasibility of timber floors regarding vibrations also limits timber. For high performance timber floors, CLT and LVL box floors are only possible on small spans(3-6m), the use of TCC increases the technical feasibility and accommodates larger spans(6-10m) as well as high performance floors. When a high performance large span floor is necessary, a TCC floor based on CLT is the most environmentally friendly option.

When the environmental impact is combined with the vibrational data, it shows that for small spans the timber floors have the lowest environmental impact, when larger spans(6-10m) are necessary the concrete hollow core floors can be a sustainable option, as well as the use of TCC. Although on global warming potential, timber floor are in advantage, for low and high performance floors. But in the end the floors are comparable, depending on the supplier for the floors. When biogenic carbon is taken into account, this changes the result in favour of timber. The storage of CO2 in the timber has a big environmental advantage. In this case timber will have the lowest environmental impact. Especially the use of LVL box floors have an advantage, since a low amount of material is used in the floors. This reduces the environmental impact, although this has the consequence of a large floor height. The LVL box floor has a downside as it is prone to acoustic vibrations, which is out of the scope of this research. In a research of Wijnen (2020) a LVL box floor was considered a less environmentally friendly than CLT. This is due to the amount of material used in the LVL box floor (different built up and thicknesses), the compared specific EPD with low values of the CLT panel and the use of only 7 impact categories in his research. This addresses again the range of environmental impact per specific supplier. The effect of biogenic carbon in LVL box floors compared to CLT is also less due to the amount of timber within the floor.

When lowering the Global warming potential is the main focus, mass timber structures will be the best option. When the long term effect on the environmental impact is taken into account and the basic principles of building with the least material as possible in a construction, the LVL box floor will be the best solution considering the vibrational performance. When a large span and a high performance floor is necessary, the best option might be the TCC or concrete hollow core floor. Although it has no biogenic carbon content, it is in the end the floor with the lowest environmental impact. So building with mass timber just to decrease the global warming potential might in the end result in a worse environmental cost indication. The reuse or recycling of the timber product can decrease the environmental impact. The option with the lowest environmental impact can be a consequence of design choices and building requirements. Designing for smaller spans and lower vibrational performances can decrease the environmental impact of a building due to the possibility to build with timber.

Scenario 2050 and 2100

When a building is built now, it has environmental impact for production right now, when the building reaches its service life, the end-of-life scenario is put in action. This has an effect in the future environmental impact. In 2050 the building is still in its service life and in 2100 the building reached its end-of-life phase. This could be a timeframe for which a certain choice in floor type has different effects.

When the environmental impact of the building in 2050 is assessed the end-of-life is not yet reached. In this case the biogenic carbon content still gives an environmental gain. Timber based floors would in this case give the lowest environmental impact. Which floor is used is dependent on the comfort requirements and structural design e.g. spans of the building. A CLT floor would give the lowest environmental impact due to the large amount of mass timber. When larger spans or higher performance is required, a TCC floor would have the lowest environmental impact. The LVL floor is in this case the least favourable timber based panel from these three, due to the low amount of biogenic carbon, although it has a low . The concrete floors have the highest environmental impact, of which the concrete cast in situ floors have a higher impact than the concrete hollow core. Looking at the comfort requirement of vibrations, on beforehand it should be clear which vibrational level is necessary for the occupation of the building, since an unnecessary high vibrational performance could result in unwanted high environmental costs.

When the impact of the building in 2100 is assessed, it is taken that the end-of-life has reached. In this case when the timber floors scenario is to incinerate the timber, the advantage of stored CO_2 is gone. This will result in a comparison for module A1-A3 and C as if biogenic carbon is not taken into account. All floors, timber or concrete have a comparable environmental impact, except the LVL box floor. This has the lowest environmental impact due to the small amount of material. For concrete floors, the concrete hollow core floor would have the lowest environmental impact. Considering the possible service life of timber, after 100 years, the timber would still be eligible for reuse or recycling. When this different end-of-life scenario is taken, the CLT or TCC floor can have an advantage since the CO_2 is still stored in the material. CLT might also be better recyclable due to the high mass timber content, compared to LVL with a higher glue content. In the end timber floors have the lowest environmental impact, especially if a reuse or recycle end-of-life scenario taken into account.

9. Conclusions & recommendations

9.1 Conclusions

As stated in the introduction the goal of this research is to find for different design configurations the influence of vibrational performance levels on the environmental impact of different timber floor systems and compare this to the performance of conventional concrete floors. This is translated into the following main question:

How do vibrational performance levels influence the sustainability of several timber floor systems, considering multiple design configurations, compared to conventional concrete floor systems?

The main research question can be answered after the research in this thesis and the discussion in chapter 8. The vibrational performance and sustainability are analysed for timber based floors and conventional concrete floors. The timber floors analysed are CLT floors, LVL box floors and timber concrete composite floor. The conventional concrete floors analysed are concrete cast in situ floors and concrete hollow core floors. The results in this thesis are derived using 2 methods. Firstly the vibration method from the new draft Eurocode 5 is used for the vibrational analysis. Secondly the sustainability of the floors is assessed using the environmental cost indication(ECI) with 11 impact categories.

The vibrational performance of timber floors do influence the sustainability of the floors. For the design assumptions in this thesis a low and high floor performance are assessed. The structurally safe minimum floor height generally fulfils the low performance floor criteria. To get a high performance floor from a low performance floor for solid timber floors such as CLT an increase of the ECI by 25% to 40% is needed. For LVL box floors an increase of 10 % to 20 % is needed and for timber concrete composite floors an increase of 0% to 20% is needed. Comparing these results with the conventional concrete floors, the concrete cast in situ & hollow core floors need 0% to 20% higher ECI.

The lightweight timber floors are more sensitive to vibrations than heavy concreate floors. The design configurations can mitigate the vibrations and reduce the increase in environmental impact. This conclusion is valid for the assumptions taken into account in the vibrational and sustainability analysis for a simply supported floor. These are generally on the conservative side.

9.2 Recommendations

During the research some topics were touched which fell out of the scope of this research but are interesting to be researched further. Below are some areas of interest which can be further researched.

The vibrational calculations used in the simplified method from the draft EN 1995-1-1 , might be limited to the simplest situations. In order to give a good insight in the actual vibrations within a building it could be interesting to do vibrational calculations using FEM for the specific building, due to the boundary conditions which influence the vibrations. The limits of the calculations could be researched further as well as to what degree the limits are applicable to other materials, as mentioned before, for concrete the lower frequency limit could be lowered.

The damping ratio used in buildings could also be further analysed and the effect of different boundary conditions and the effect of damping layers on top of the floor could be researched to be able to better determine the actual damping of the floor.

When designing a building the comfort should also be a requirement, for timber as well as for concrete. Since a high performance vibrating floor can also influence the floor height of a concrete floor. Although timber is more prone to vibrations than concrete, the vibrational performance assessment results in a fair comparison between concrete and timber.

In this research, the floors were seen as individual panels, by coupling the floor elements together, a stronger floor might result in less vibration. The effect of coupling the floors can be interesting to investigate and which fixation gives the best collaboration between the floor elements.

The vibrational performance levels can be further investigated into which performance levels are fit for the buildings in the Netherlands. The sensitivity of Dutch occupants in buildings can differ from other countries in Europe. Setting the appropriate level can influence the environmental impact of a building or the use of timber based materials.

The effect of the acoustics requirements of the floor on the environmental impact could be further investigated. Where the LVL floor in this thesis has overall the lowest environmental impact, the necessary acoustic insulation could increase the ECI value and make another floor type more sustainable.

For the sustainability of materials more EPD's should be available and analysed for the difference per supplier and find out whether some supply lines are more sustainable than others and where these differences originate from.

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Part V

Appendices

Appendices

Appendix A: Structural calculations
Appendix B: vibrational calculations
Appendix C: sustainability; overview of sources

Appendix A: Structural calculation of floors

In this chapter, the structural calculations needed to verify the structural safety of the floors considered in this thesis will be explained. This thesis considers several types of materials and floors. The first calculations are performed using criteria such as moment capacity, shear resistance and deflection of the beam on a simply supported beam. Classic beam theory is used, due to the elemental components of the floors, this seems realistic. The floors are subjected to a standardised load according to the Eurocode 1991. Firstly the methods of verification is explained for each material of the floor. Secondly, the calculations are performed for a floor in a specific situation stated under general properties and the specific calculations.

1. General properties

The calculations performed are under a certain standard situation. The floor is an office floor with partition walls, considered in consequence class 2 (CC2) and has a service life of 50 years. The floor is calculated as a simply supported beam as shown in figure 1, with a distributed load over a certain span.

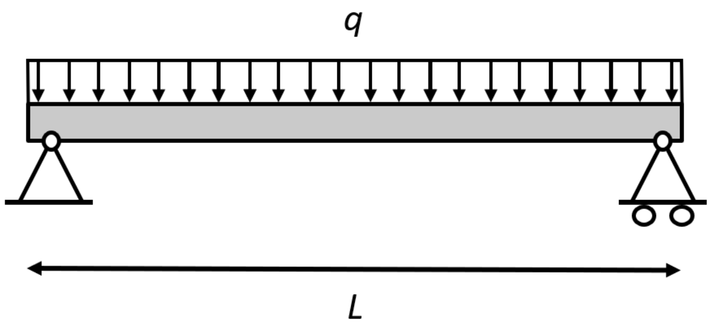


Figure 1: Simply supported beam

To verify strength, the occurring maximum moment M_{Ed} and maximum shear V_{Ed} are calculated using standard structural mechanics formulas (1.1) and (1.2). The maximum moment occurs in the middle of the span, the maximum shear occurs at the supports. To verify the stiffness, the occurring deflection w is calculated using the structural mechanics formulas (1.3), the maximum deflection in the middle of the span is used for verification.

$$M_{Ed} = \frac{q*l^2}{8} \qquad (1.1)$$

$$V_{Ed} = \frac{q*l}{2} \qquad (1.2)$$

$$w_{max} = \frac{5*q*l^4}{384*EI} \qquad (1.3)$$

The loads and load cases are according to NEN-EN 1991-1-1. The variable load is based on an office space with partition walls and a permanent load is based on a floor build up and the self-weight of the floor. An example of a possible floor construction can be found in figure 2, this floor construction can include materials such as insulation and a floor finishes. The weight and according loads of the top floor can be found in table 1.

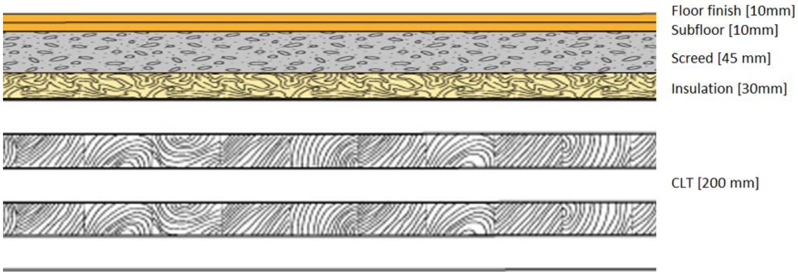


Figure 2: Example of floor construction of CLT.

Table 1: Layers of top floor and according load

Material	Density	Thickness	Load
Floor finish (carpet)	260 kg/m3	10 mm	25,5 N/m2
Subfloor	500 kg/m3	10 mm	49,1 N/m2
Screed	2000 kg/m3	45 mm	882,9 N/m2
Insulation	100 kg/m3	30 mm	29,4 N/m2
	Total	95 mm	1,0 kN/m2

The loads on the structural floor can be found in table 2. The permanent load consist of the floor finish, installations and self-weight of the floor. The variable load is taken from NEN-EN 1991-1-1, table 6.1. Category B: office floor loads. The top floor configuration from figure 2 is taken for all structural floors, timber or concrete.

Table 2: Loads on floor [NEN-EN 1991-1-1 (6.1)]

Permanent load G		
Floor finish	1,0	kN/m2
Installations	0,5	kN/m2
Self-weight	Depending on floor	kN/m2
Variable load Q		
B: Office floor	3,0	kN/m2

The loads are used in load cases according to the NEN-EN-1991-1-1. Load cases for ultimate limit state (ULS) and for serviceability limit state (SLS) are used. These are stated in (1.4), (1.5) and (1.6). According the NEN-EN 1990-1-1 the combination factor for offices is $\psi_{0\ office}$=0,7. This combination factor is taken from table A.1.7.

$$ULS\ 1 = 1{,}35 * G + 1{,}5 * \psi 0 * Q \qquad (1.4)$$

$$ULS\ 2 = 1{,}2 * G + 1{,}5 * Q \qquad (1.5)$$

$$SLS = 1{,}0 * G + 1{,}0 * Q \qquad (1.6)$$

2. Timber calculations

The timber floors composed of materials such as CLT, LVL boxfloor and Timber Concrete Composite(TCC) are verified for its strength and stiffness according to the NEN EN-1995. The strength is verified using the moment capacity and shear resistance of the floor. The stiffness is verified according to the deflection limits stated in the NEN EN-1995 national annex for the Netherlands. The formulas, criteria's and specifics are explained below.

The NEN EN-1995-1-1: 2011 specifically is used to verify the floors. First, the design values of the material properties differ from the characteristics values. To cope with this, the Eurocode 5 gives formula (1.7). The characteristic value is divided by a material factor *γm* (table 4.6 draft EN 1995-1-1) and multiplied by a modification factor *kmod* (table 5.1 draft EN 1995-1-1) depending on the decisive load duration, which according to EC5 is the shortest load duration. Selfweight has a permanent load duration and imposed floor loads have a medium term load duration according to table 4.1 of draft EN 1995-1-1 . The material factors are stated in table 4.6 of Eurocode 5. The modification factor is stated in table 5.1 in the renewed Eurocode 5.

$$X_d = k_{mod}\frac{X_k}{\gamma_M} \qquad (2.1)$$

Moment capacity

The moment capacity can be calculated using the formulas found in "8.1.8 Bending" of Eurocode 5. The occurring stresses from the bending of the floor are checked by the allowable stress for the timber. The formula (2.2) is used for 2 directions, but due to the force direction, only the stress in y direction is used. The factor *km* , is used to compensate for cross section heterogeneity. The moment resistance of the cross section is calculated using formula (2.3).

$$\frac{\sigma_{m,y,d}}{f_{m,y,d}} + k_m\frac{\sigma_{m,z,d}}{f_{m,z,d}} < 1 \qquad (2.2)$$

$$\sigma = \frac{M*z}{I}:\ M_{Rd} = \frac{f_{m,y,d}*I}{z} \qquad (2.3)$$

Shear capacity

The shear resistance of the floor is verified using the formulas found in "8.1.11 Shear" of Eurocode 5. The verification in (2.4) is used. The formula to calculate the maximum shear in a rectangular cross section is found in (2.5). Due to possible cracks in the timber, the width needs to be adjusted according to formula (2.6). A factor *kcr* is multiplied to get an effective width for the shear in the element. The value for *kcr* can be found in 6.1.7(2) in Eurocode 5.

$$\tau_d < f_{v,d} \qquad (2.4)$$

` $$\tau_{max,rect} = \frac{3*V}{2*A}: V_{Rd} = \frac{2*A*f_{v,d}}{3} \quad (2.5)$$

$$b_{ef} = k_{cr} * b \quad (2.6)$$

Deflection including creep

The deflection of the timber floors are calculated taken creep in consideration. This is according to Eurocode 5 calculated using a *kdef* factor. Formula (2.7),(2.8) and (2.9) can be used to calculate the initial deflection and the final deflection including creep. To calculate the deformation, formula 1.3 is used.

$$u_{fin} = u_{fin,G} + u_{fin,Q1} + \Sigma u_{fin,Qi} \quad (2.7)$$

$$u_{fin,G} = u_{inst,G}(1 + k_{\mathrm{def}}) \quad (2.8)$$

$$u_{fin,Q1} = u_{inst,Q1}(1 + \varphi_{2,1} k_{\mathrm{def}}) \quad (2.9)$$

The factor *kdef* can be found in table 3.2 of Eurocode 5. Depending on the climate class, a storey floor inside a building is usually in a climate class 1. The deflection should be checked according to a maximum deflection of L/250 including creep (2.10).

$$w_{max} = \frac{L}{250} \quad (2.10)$$

Unity Checks

In order to check whether the floor structurally satisfies the requirements, unity checks are carried out. This checks whether the occurring bending moment, shear or deflection, is higher or lower than the resisting bending moment, shear or deflection. In order to comply, the unity check should be less than 1.

$$UC\ M: \frac{M_{Ed}}{M_{Rd}} < 1 \quad (2.11)$$

$$UC\ V: \frac{V_{Ed}}{V_{Rd}} < 1 \quad (2.12)$$

$$UC\ w: \frac{u_{fin}}{w_{max}} < 1 \quad (2.13)$$

3. Concrete calculations

The concrete floors composed of in-situ concrete are verified for its strength and stiffness according to the NEN EN-1992. The strength is verified using the moment capacity and shear resistance of the floor. The stiffness is verified according to the deflection limits stated in the NEN EN-1992 national annex for the Netherlands. The formulas, criteria's and specifics are explained below.

The calculations for the moment capacity of the concrete in-situ floors are based on lecture notes of Prof. Dick Hordijk, November 2017, these notes are based on Eurocode 2. The moment capacity is calculated using some assumptions, these are firstly stated and checked in the calculations. The floor is calculated as a beam, to be able to compare these to the timber floors. First, the assumption is made that the reinforcement is activated and thus the concrete in the tension region surpasses the tensile strength of the concrete. The reinforcement percentage is stated as 0,5% and only the main bending reinforcement is taken into account.

Moment capacity

Two moment capacities are calculated, the yield moment capacity and the cracked moment capacity. These are stated in (3.5) and (3.6). Formulas used are from NEN-EN 1992-1-1 NB2016(6.1).

$$z \approx 0{,}9 * d \tag{3.1}$$

$$d \approx 0{,}9 * h \tag{3.2}$$

$$N_s = A_s * f_{yd} \tag{3.3}$$

$$A_s = A_c * 0{,}01 \tag{3.4}$$

$$M_{Rd} = N_s * z = A_s * f_{yd} * 0{,}81 * h \tag{3.5}$$

$$M_{cr} = f_{ctm} * W = f_{ctm} * \frac{1}{6} * b * h^2 \tag{3.6}$$

$$M_{Ed} > M_{cr} \tag{3.7}$$

Shear capacity

The shear resistance of the floor is also calculated using the lecture notes of Prof. Dick Hordijk, November 2017, these are based on the Eurocode 2 (table 6.2a, table 6.2b, 6.9). The shear resistance is based on the concrete shear resistance ($V_{Rd,c}$) and a maximum shear reinforcement($V_{Rd,max}$) calculation. For the simple calculation approach for the concrete structure, only the concrete shear resistance is tested. The formulas used can be found below.

$$V_{Rd,c} = \max\begin{Bmatrix} 0{,}12 * k * (100 * \rho_l * f_{ck})^{\frac{1}{3}} \\ 0{,}035 * k^{\frac{3}{2}} * \sqrt{f_{ck}} \end{Bmatrix} * A \tag{3.8}$$

$$k = \min\begin{Bmatrix} 1 + \sqrt{\frac{200}{d}} \\ 2{,}0 \end{Bmatrix} \tag{3.9}$$

$$V_{Rd,max} = \frac{\alpha_{cw} * b * z * v_1 * f_{cd}}{\cot(\theta) + \tan(\theta)} \tag{3.10}$$

The concrete shear resistance ($V_{Rd,c}$) is the shear resistance that the concrete itself can withstand, the maximum reinforcement shear resistance ($V_{Rd,max}$) is the maximum shear resistance the cross section of the floor can withstand with shear reinforcement. In the calculations, the punching shear is not taken into account. The assumptions used in the shear calculations are a reinforcement percentage of 0,5% of the cross section area, no normal force within the floor, a rectangular cross section and a concrete strength of C30/37. The other parameters are stated within the calculation itself.

Deflection including creep

The deflection of the concrete floor is calculated based on the commonly used formula (1.3), with creep included using formula (3.11). A reduction of the effective concrete modulus of elasticity. According to the EC2, the creep factor is dependent on the height, concrete strength and time between pouring the concrete and loading. For the purpose of this thesis, an average is taken(3.12), based on C30/37 concrete strength and a time gap of 90 days. See table 5.1 of compendium Eurocode 2 (febelcem,2017) for other values. For the purpose of the calculations of these floors, the crack width is not taken into account. Neither is precamber taken into account. The deflection should be checked according to a maximum deflection of L/250 including creep.

$$E_{c,eff} = \frac{E_{cm}}{1+\varphi(\infty,t_0)} \qquad (3.11)$$

$$\varphi(\infty,t_0) = 2 \qquad (3.12)$$

$$w_{max} = \frac{L}{250} \qquad (3.13)$$

Unity Checks

In order to check whether the floor structurally satisfies the requirements, unity checks are carried out. This checks whether the occurring bending moment, shear or deflection, is higher or lower than the resisting bending moment, shear or deflection. In order to comply, the unity check should be less than 1.

$$UC\ M\colon \frac{M_{Ed}}{M_{Rd}} < 1 \qquad (3.14)$$

$$UC\ V\colon \frac{V_{Ed}}{V_{Rd}} < 1 \qquad (3.15)$$

$$UC\ w\colon \frac{w_{fin}}{w_{max}} < 1 \qquad (3.16)$$

Concrete hollow core

For the structural calculations of the concrete hollow core floors, the VBI calculation tool for Hollow core floors is used to analyse the structural safety of the floor. The situation and loads from chapter 1:General are used. For the specific calculations see 5. Structural Calculations.

4. Timber Concrete Composite

The considered timber concrete composite(TCC) is based on a CLT panel with a reinforced layer on top. The verification of this panel is performed in a simple manner according to the NEN EN-1995. The fastener for the panel is not specified nor verified, only a certain γ-factor resulting from a slip factor is taken into account to accommodate the collaboration of the timber and concrete materials. The floor is verified for bending strength, shear strength and creep using the same base as the timber calculations from chapter 2:Timber calculations. Due to the composite working of the timber and concrete a normal force is created within the concrete zone and timber zone. This is accounted for within the calculations. The formulas used below are from the WG4 document on structural timber concrete composite.

Moment capacity

The moment capacity is calculated two situations, the moment capacity of the timber part of the floor and the moment capacity for the concrete part of the floor. The internal forces in the floor are also taken into account. Due to these internal forces, a normal force in the timber occurs and in the concrete. This is taken into account in the moment capacity calculations. The formulas used can be found below. The moment capacity is calculated for 4 positions, the top and bottom of the concrete and timber section. The following are considered:

(4.1) Maximum compression at the top of the concrete section
(4.2) Maximum tension at the bottom of the concrete section
(4.3) Maximum compression at the top of the timber section
(4.4) Maximum tension at the bottom of the timber section

$$M_{Rd,c1} = \frac{f_{cd} EI_{eff}}{\gamma_1 E_1 a_1 + 0{,}5 E_1 h_1} \qquad (4.1)$$

$$M_{Rd,c2} = \frac{f_{ctd} EI_{eff}}{0{,}5 E_1 h_1 - \gamma_1 E_1 a_1} \qquad (4.2)$$

$$M_{Rd,t1} = \frac{f_d EI_{eff}}{0{,}5 E_2 h_2 - \gamma_2 E_2 a_2} \qquad (4.3)$$

$$M_{Rd,t2} = \frac{f_{t,0,d} EI_{eff}}{\gamma_2 E_2 a_2 + 0{,}5 E_2 h_2} \qquad (4.4)$$

Shear capacity

The shear capacity is tested within the timber part of the floor, which is the decisive part of the floor considering shear. The formula can be found below.

$$V_{Rd,t} = \frac{f_{v,d} EI_{eff}}{0{,}5 E_2 (0{,}5 h_2 + a_2)^2}$$

Deflection including creep

The deflection of the floor is calculated including creep, this is done using a decreased E-modulus, this depends on the material. A new effective bending stiffness is calculated and then used to calculate the deflection including creep. See formulas below.

$$E_{c,creep} = \frac{E_{cm}}{1 + \varphi(\infty, t_0)} = \frac{E_{cm}}{2}$$

$$E_{t,creep} = \frac{E_{CLT}}{(1 + k_{def})} = \frac{E_{CLT}}{1{,}8}$$

$$w_{max} = \frac{5 * q * l^4}{384 * EI_{eff,creep}}$$

Unity Checks

In order to check whether the floor structurally satisfies the requirements, unity checks are carried out. This checks whether the occurring bending moment, shear or deflection, is higher or lower than the resisting bending moment, shear or deflection. In order to comply, the unity check should be less than 1.

$$UC\ M: \frac{M_{Ed}}{M_{Rd}} < 1 \qquad (3.14)$$

$$UC\ V: \frac{V_{Ed}}{V_{Rd}} < 1 \qquad (3.15)$$

$$UC\ w: \frac{w_{fin}}{w_{max}} < 1 \qquad (3.16)$$

5. Structural calculations

The structural calculations of the floors are carried out according to the explained calculations in previous sections. Examples of the calculations of the cross sectional properties are shown below as well as the resulting moment capacity, shear capacity and occurring deflection for a standard situation mentioned below.

Standardised situation

The standardised situation is a floor which has a span *L* and a floor width of W. The structural calculations are performed per unit width. The floor is simply supported, see figure 3. The floor is inside an office building, for timber this means it has a service class 1. For the calculations, a span of 5 meters is taken.

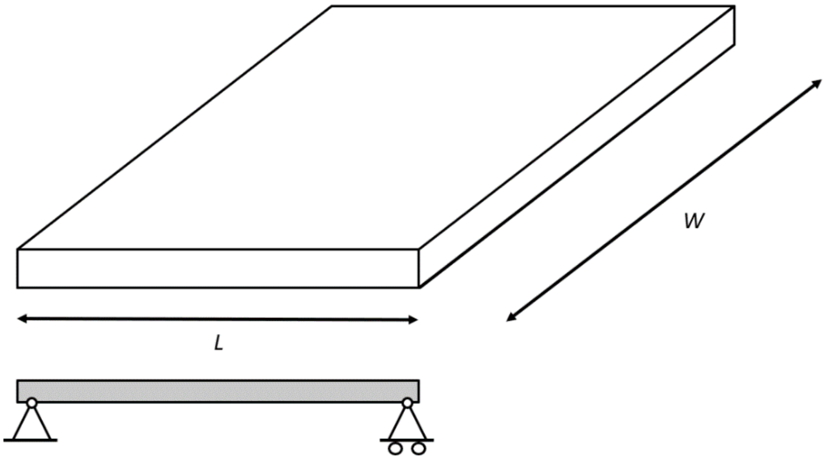


Figure 3: Simplified presentation of standardised situation

CLT floor

The calculation in this section is specifically for CLT. The common properties are CLT specific and the strength properties are also for CLT with C24 strength class. The cross sectional properties calculation gives an example for a CLT 200 L5s floor. The formulas are specifically for CLT floors, other CLT floors are calculated in the same way. An overview of these properties can be found in the Annex.

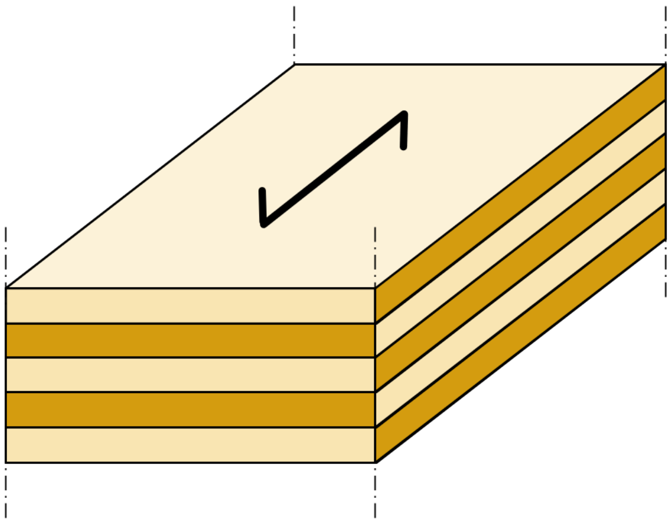


Figure 4: Simplified section of CLT

Common properties

SC	1	[-]
γM	1,25	[-]
kdef	0,8	[-]
kmod	0,8	[-]
rho	510	kg/m3

Strength properties

fk	24	N/mm2
fd	15,36	N/mm2
fvk	4	N/mm2
fvd	2,56	N/mm2
E mod	12000	N/mm2

<u>Cross sectional properties calculations</u>

The cross sectional properties are calculated based on the formulas below, based on the geometry shown in figure 5. Where h1=…=h5=40 mm. This calculation is for a 5 layered CLT panel with the top and bottom layer in the longitudinal direction of the floor. The calculations are per unit width.

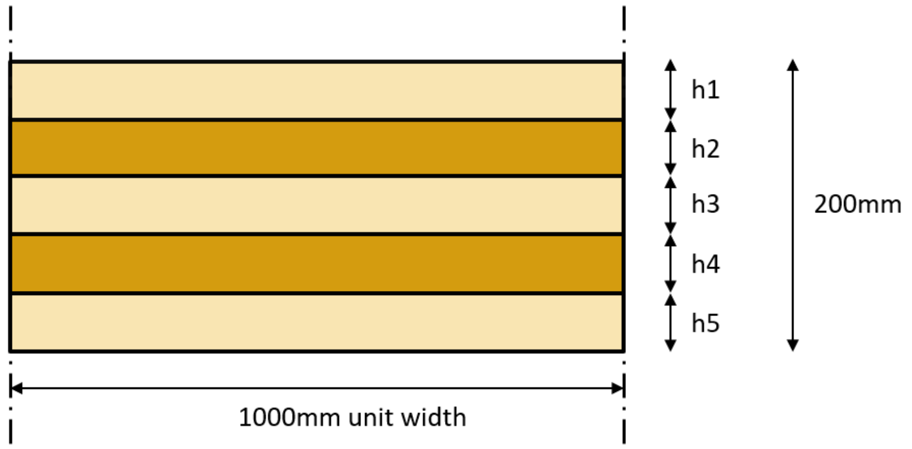


Figure 5: cross section geometry of CLT 200 L5s

Total cross sectional area (A_{tot})

$$A_{tot} = h_{tot} * b = 200 * 1000 = 2 * 10^5 \; mm^2$$

Cross sectional area for timber in length direction for shear force (A_{net})

$$A_{net} = (h_1 + h_3 + h_5) * b = 120 * 1000 = 1{,}2 * 10^5 \; mm^2$$

Moment of inertia in length (I_L):

$$I_L = \Sigma(I_{self} + a^2 * A) = \frac{1}{12} * b * {h_3}^3 + 2 * (\frac{1}{12} * b * {h_1}^3 + (\frac{h_3}{2} + h_2 + \frac{h_1}{2})^2 * (h_1 * b))$$

$$I_L = \frac{1}{12} * 1000 * 40^3 + 2 * \left(\frac{1}{12} * 1000 * 40^3 + \left((\frac{40}{2} + 40 + \frac{40}{2})^2 * (40 * 1000)\right)\right) = 5{,}28 * 10^8 \; mm^4$$

Moment of inertia in width(I_B):

$$I_B = \Sigma(I_{self} + a^2 * A) = 2 * (\frac{1}{12} * b * {h_2}^3 + (\frac{h_3}{2} + \frac{h_2}{2})^2 * (h_2 * b))$$

$$I_B = 2 * \left(\tfrac{1}{12} * 1000 * 40^3 + \left((\frac{40}{2} + \frac{40}{2})^2 * (40 * 1000)\right)\right) = 1{,}66 * 10^8 \; mm^4$$

Stiffness in length direction (EI_L):

$$EI_L = E * I_L = 1{,}2 * 10^4 * 5{,}28 * 10^8 = 6{,}34 * 10^{12} \; Nmm^2$$

Stiffness in width direction (EI_B)

$$EI_B = E * I_B = 1{,}2 * 10^4 * 1{,}66 * 10^8 = 1{,}66 * 10^{12} \; Nmm^2$$

Self-weight

$$Weight_{self} = A_{tot} * rho = 2 * 10^5 * 10^{-6} * 510 = 102 \; kg/m^2$$

Overview of cross sectional properties

Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4] p.u.w.	IB [mm4] p.u.w.	(EI)L [Nmm2] p.u.w.	(EI)B [Nmm2] p.u.w.	Selfweight [kg/m2]
CLT	200 L5s	200	1,2E+05	2,0E+05	5,28E+08	1,39E+08	6,34E+12	1,66E+12	102

Moment capacity

The formulas from chapter 2: timber calculations are used to calculate the moment capacity of this specific floor. Using the input properties from the table. Z is in this case the height from the middle of the cross section to the upper most fibre of the cross section.

Properties

f;myd	15,36	N/mm2
I	5,28E+08	mm4
z	100	mm

$$M_{Rd} = \frac{f_{m,y,d} * I}{z} = 8{,}11 * 10^7 Nmm = 81{,}1 \; kNm$$

Shear capacity

The formulas from chapter 2: timber calculations are used to calculate the shear capacity of this specific floor. Using the input properties from the table.

Properties

f;vd	2,56	N/mm2
Anet	1,20E+05	mm2

$$V_{Rd} = \frac{2 * A * f_{v,d}}{3} = 2{,}05 * 10^5 \; N = 204{,}8 \; kN$$

<u>Deflection including creep</u>

The formulas from chapter 1: general are used to calculate the deflection of this specific floor under the imposed loads, which is calculated according to the previously given directions, including creep. The input properties from the table are used. The load is calculated according to the serviceability limit state (SLS), the load in the table are including self-weight.

Loads

Weight	102	kg/m2
qG	2,50	kN/m
qQ	3	kN/m

Properties

(EI)L	6,34E+12	Nmm2
L	5000	mm
φ2	0,6	[-]
kdef	0,8	[-]

$$u_{inst,G} = \frac{5 * q_G * l^4}{384 * EI_L} = 3{,}21 \text{ mm}$$

$$u_{inst,Q} = \frac{5 * q_Q * l^4}{384 * EI_L} = 3{,}85 \text{ mm}$$

$$u_{fin} = u_{fin,G} + u_{fin,Q1} = u_{inst,G}\left(1 + k_{def}\right) + u_{inst,Q1}\left(1 + \varphi_2 k_{def}\right)$$

$$u_{fin} = 11{,}48 \ mm$$

<u>Unity checks</u>

The unity checks below are executed to validate whether the floor complies with the structural safety requirements. The unity checks for moment capacity, shear capacity and deformation limits are shown below. All the checks comply, thus this floor is structurally safe.

Loads

Weight	102	kg/m2
qG	2,50	kN/m
qQ	3	kN/m
φ0	0,7	[-]

Decisive load

ULS1	6,53	kN/m
ULS2	7,50	kN/m

L	5000	mm

$$M_{Ed} = \frac{q * l^2}{8} = 23{,}4 \ kNm : UC \ M = \frac{M_{Ed}}{M_{Rd}} = \frac{23{,}4}{81{,}1} = 0{,}29$$

$$V_{Ed} = \frac{q * l}{2} = 18{,}8 \ kN : UC \ V = \frac{V_{Ed}}{V_{Rd}} = \frac{18{,}8}{204{,}8} = 0{,}09$$

$$w_{lim} = \frac{L}{250} = 20 \ mm : UC \ w = \frac{u_{fin}}{w_{lim}} = \frac{11{,}48}{20} = 0{,}57$$

LVL floor

The calculation in this section is specifically for LVL box floors. The common properties are LVL specific and the strength properties are also for LVL with 2 types of LVL used. For the beams LVL-P is used and for the plates LVL-C is used. LVL-P is stronger in the main load carrying direction, because the veneer's grain direction is in 1 direction. LVL-C has cross lamination in 2 directions. The cross sectional properties calculation gives an example for a LVL 220 box floor. The formulas are specifically for this LVL floors, other LVL floors are calculated in the same way. An overview of these properties can be found in the Annex.

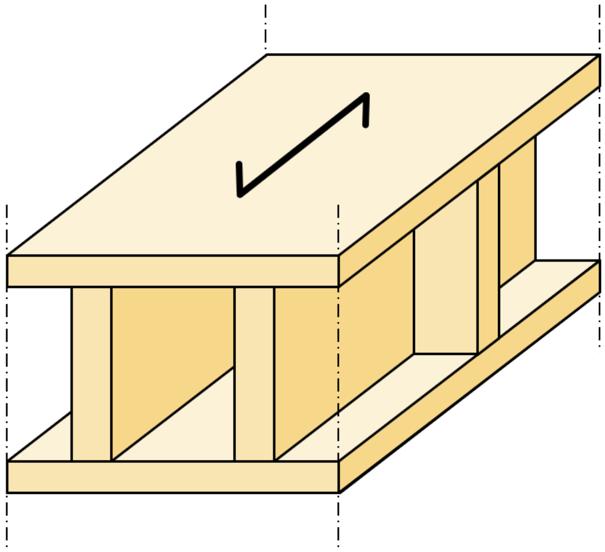


Figure 6: Simplified section of LVL Box floor

Common properties

SC	1	[-]
γM	1,2	[-]
kdef,LVL-C	0,8	[-]
kdef,LVL P	0,6	[-]
kmod	0,8	[-]
rho	510	kg/m3

Strength properties LVL-P

fk	44	N/mm2
fd	29,33	N/mm2
fvk	4,2	N/mm2
fvd	2,80	N/mm2
E mod	13800	N/mm2

Strength properties LVL-C

fk	36	N/mm2
fd	24,00	N/mm2
fvk	2,2	N/mm2
fvd	1,47	N/mm2
E mod	10500	N/mm2

<u>Cross sectional properties calculations</u>

The cross sectional properties are calculated based on the formulas below, based on the geometry shown in figure 7. Where Tp=25mm and Tb=45mm, the beams have a centre-to-centre distance of 500mm (CTC_{beam}). And blocking is placed every 1000mm(CTC_{block}) in the depth of the floor. The different types of LVL have different material properties, these are shown above in the table. The calculations are per unit width

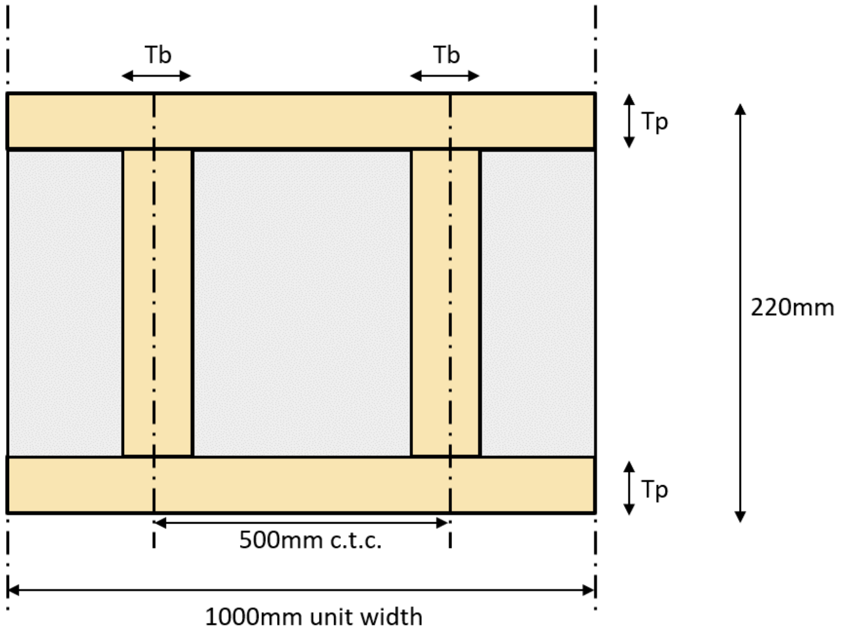


Figure 7: cross section geometry of LVL box floor 220

Total cross sectional area (A_{tot})

$$A_{tot} = 2 * (T_p * b) + (\frac{b}{CTC_{beam}}) * T_b * (h_t - 2 * T_p) = 6{,}53 * 10^4\ mm^2$$

Cross sectional area for timber in length direction for shear force (A_{net})

$$A_{net} = (\frac{b}{CTC_{beam}}) * T_b * (h_t - 2 * T_p) = 1{,}53 * 10^4\ mm^2$$

Moment of inertia in length (I_L):

$$I_L = \Sigma(I_{self} + a^2 * A) = (\frac{b}{CTC_{beam}}) * (\frac{1}{12} * T_b * (h_t - 2 * T_p)^3) + 2 * (\frac{1}{12} * b * T_p{}^3 + (\frac{h_t}{2} + \frac{T_p}{2})^2 * (b * T_p))$$

$$I_L = 5{,}15 * 10^8\ mm^4$$

Moment of inertia in width(I_B):

$$I_B = \Sigma(I_{self} + a^2 * A) = (\frac{b}{CTC_{block}}) * (\frac{1}{12} * T_b * (h_t - 2 * T_p)^3) + 2 * (\frac{1}{12} * b * T_p{}^3 + (\frac{h_t}{2} + \frac{T_p}{2})^2 * (b * T_p))$$

$$I_B = 4{,}96 * 10^8\ mm^4$$

Stiffness in length direction (EI_L):

$$EI_L = E_{LVLp} * I_{L,LVLp} + E_{LVLc} * I_{L,LVLc}$$

$$EI_L = E_{LVLp} * \left(\frac{b}{CTC_{beam}}\right) * \left(\frac{1}{12} * T_b * (h_t - 2 * T_p)^3\right) + E_{LVLc} * 2 * (\frac{1}{12} * b * T_p{}^3 + (\frac{h_t}{2} + \frac{T_p}{2})^2 * (b * T_p))$$

$$EI_L = 1{,}38 * 10^4 * 3{,}68 * 10^7 + 1{,}05 * 10^4 * 4{,}78 * 10^8 = 5{,}53 * 10^{12}$$

Stiffness in width direction (EI_B)

$$EI_L = E_{LVLp} * I_{L,LVLp} + E_{LVLc} * I_{L,LVLc}$$

$$EI_B = E_{LVLp} * \left(\frac{b}{CTC_{block}}\right) * \left(\frac{1}{12} * T_b * \left(h_t - 2 * T_p\right)^3\right) + E_{LVLc} * 2 * \left(\frac{1}{12} * b * T_p{}^3 + \left(\frac{h_t}{2} + \frac{T_p}{2}\right)^2 * \left(b * T_p\right)\right)$$

$$EI_B = 1{,}38 * 10^4 * 1{,}84 * 10^7 + 1{,}05 * 10^4 * 4{,}78 * 10^8 = 5{,}27 * 10^{12}$$

Self-weight

$$Weight_{self} = \left(A_{tot} + (b - 2 * T_b) * T_b * \left(h_t - 2 * T_p\right)\right) * rho = 7{,}23 * 10^{-2} * 510 = 36{,}9\ kg/m^2$$

Overview of cross sectional properties

Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4] p.u.w.	IB [mm4] p.u.w.	(EI)L [Nmm2] p.u.w.	(EI)B [Nmm2] p.u.w.	Selfweight [kg/m2]
LVL	BX220	220	1,5E+04	6,5E+04	5,15E+08	4,96E+08	5,53E+12	5,27E+12	36,9

Moment capacity

The formulas from chapter 2: timber calculations are used to calculate the moment capacity of this specific floor. Using the input properties from the table. Due to the 2 different LVL panel's strength, two checks need to be carried out. One for the moment capacity based on the web strength and the other based on the flange strength. Z1 is the height from the middle of the cross section to the upper most fibre of the LVL-P web of the cross section. Z2 is the height from the middle of the cross section to the upper most fibre of the LVL-C flange of the cross section.

Properties

f;myd,lvlp	29,33	N/mm2
f;myd,lvlc	24,00	N/mm2
I	5,15E+08	mm4
z1	85	mm
z2	110	mm

$$M_{Rd1} = \frac{f_{m,y,d,lvlp} * I}{z1} = 1{,}78 * 10^8\ Nmm$$

$$M_{Rd2} = \frac{f_{m,y,d,lvlc} * I}{z2} = 1{,}12 * 10^8\ Nmm$$

$$M_{Rd} = 1{,}12 * 10^8\ Nmm = 1{,}12 * 10^2\ kNm$$

Shear capacity

The formulas from chapter 2: timber calculations are used to calculate the shear capacity of this specific floor. Using the input properties from the table, Anet is the area of the web per unit width. The shear through the web of the LVL box floor is calculated and checked.

Properties

f;vd	2,80	N/mm2
Anet	1,53E+04	mm2

$$V_{Rd} = \frac{2 * Anet * f_{v,d}}{3} = 2{,}86 * 10^4\ N = 28{,}6\ kN$$

Deflection including creep

The formulas from chapter 1: general are used to calculate the deflection of this specific floor under the imposed loads, which is calculated according to the previously given directions, including creep. The input properties from the table are used. The load is calculated according to the serviceability limit state (SLS), the load in the table are including self-weight.

Loads

Weight	37	kg/m2
qG	1,86	kN/m
qQ	3	kN/m

Properties

(EI)L	5,53E+12	Nmm2
L	5000	mm
φ2	0,6	[-]
kdef	0,80	[-]

$$u_{inst,G} = \frac{5 * q_G * l^4}{384 * EI_L} = 2{,}74\ \text{mm}$$

$$u_{inst,Q} = \frac{5 * q_Q * l^4}{384 * EI_L} = 4{,}42\ \text{mm}$$

$$u_{fin} = u_{fin,G} + u_{fin,Q1} = u_{inst,G}(1 + k_{def}) + u_{inst,Q1}(1 + \varphi_2 k_{def})$$

$$u_{fin} = 11{,}47\ mm$$

Unity checks

The unity checks below are executed to validate whether the floor complies with the structural safety requirements. The unity checks for moment capacity, shear capacity and deformation limits are shown below. All the checks comply, thus this floor is structurally safe.

Loads

Weight	37	kg/m2
qG	1,86	kN/m
qQ	3	kN/m
φ0	0,7	[-]

Decisive load

ULS1	5,66	kN/m
ULS2	6,73	kN/m

L	5000	mm

$$M_{Ed} = \frac{q * l^2}{8} = 21{,}0\ kNm : UC\ M = \frac{M_{Ed}}{M_{Rd}} = \frac{21{,}0}{112} = 0{,}19$$

$$V_{Ed} = \frac{q*l}{2} = 16{,}8\ kN : UC\ V = \frac{V_{Ed}}{V_{Rd}} = \frac{16{,}8}{28{,}6} = 0{,}59$$

$$w_{lim} = \frac{L}{250} = 20\ mm : UC\ w = \frac{u_{fin}}{w_{lim}} = \frac{11{,}47}{20} = 0{,}57$$

Timber Concrete Composite - CLT

The calculation in this section is specifically for timber concrete composite based on a CLT panel. The CLT has a strength class C24 and the concrete top layer is C25/30. The cross sectional properties calculation gives an example for a TCC 210 floor, consisting of a CLT160 base panel with 50mm concrete on top. An overview of these properties can be found in the Annex.

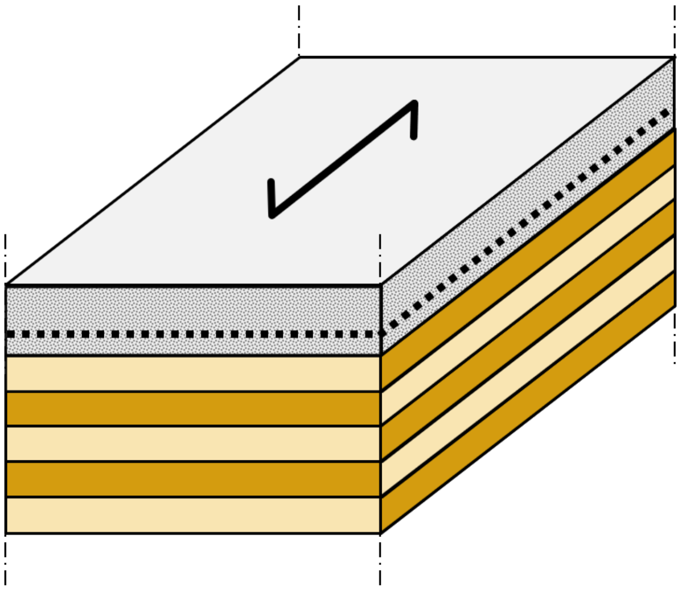


Figure 8: Simplified section of Timber concrete composite

Common properties

SC	1	[-]
γM;clt	1,25	[-]
γM;con	1,5	[-]
kdef	0,8	[-]
kmod	0,8	[-]
rho_CLT	510	kg/m3
rho_Con	2500	kg/m3

Strength properties CLT

fk	24	N/mm2
fd	15,36	N/mm2
fvk	4	N/mm2
fvd	2,56	N/mm2
E mod	7500	N/mm2

Strength properties Concrete

Class	C25/30	
fck	25,00	N/mm2
fcd	16,67	N/mm2
fctm	2,90	N/mm2
E mod	15500	N/mm2

TCC

Cross sectional properties calculations

The cross sectional properties are calculated based on the formulas below, based on the geometry shown in figure 11. This is a concrete cast in situ floor, with reinforcement of 200mm height. Calculations are per unit width.

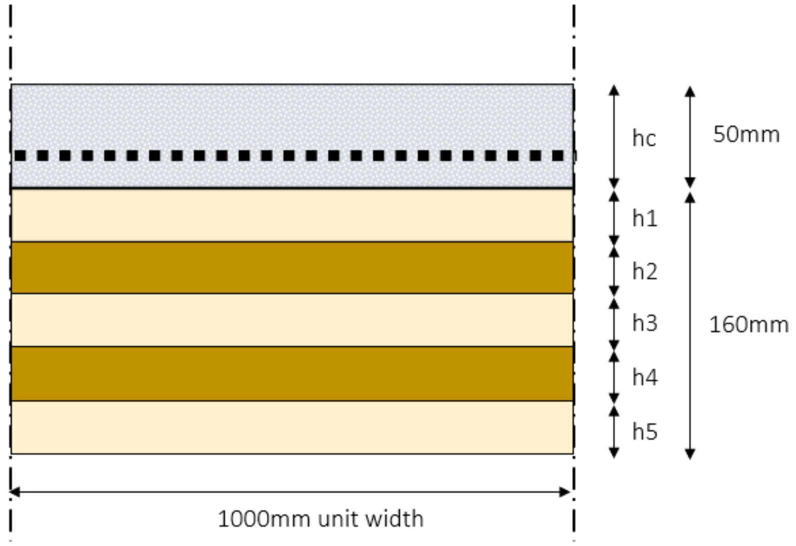


Figure 9: cross section geometry of 200mm concrete insitu

Total cross sectional area (A_{tot})

$$A_{tot} = h_{tot} * b = 210 * 1000 = 2{,}1 * 10^5\ mm^2$$

Moment of inertia in length (I_L):

$$I_L = (I_{self}(I_{self}) = \frac{1}{12} * b * {h_3}^3 = \frac{1}{12} * 1000 * 200^3 = 6{,}05 * 10^8\ mm^4$$

Moment of inertia in width(I_B):

$$I_B = (I_{self}) = \frac{1}{12} * b * {h_3}^3 = \frac{1}{12} * 1000 * 200^3 = 2{,}45 * 10^8\ mm^4$$

Stiffness in length direction (EI_L):

$$EI_L = E * I_L = 3{,}3 * 10^4 * 6{,}67 * 10^8 = 1{,}03 * 10^{13}\ Nmm^2$$

Stiffness in width direction (EI_B)

$$EI_B = E * I_B = 3{,}3 * 10^4 * 6{,}67 * 10^8 = 5{,}99 * 10^{12}\ Nmm^2$$

Self-weight

$$Weight_{self} = A_{tot} * rho = 1{,}6 * 10^5 10^{-6} * 500 + 0{,}05 * 10^5 * 10^{-6} * 2500 = 206{,}6\ kg/m^2$$

Overview of cross sectional properties

Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4]	IB [mm4]	(EI)L _eff [Nmm2]	(EI)B _eff [Nmm2]	Selfweight [kg/m2]
TCC	TC210	210	1,7E+05	2,1E+05	6,05E+08	2,45E+08	1,03E+13	5,99E+12	206,6

Concrete insitu floor

The calculation in this section is specifically for concrete cast insitu. The common properties are concrete cast insitu specific and the strength properties are also for concrete cast insitu with C30/37 strength class and a reinforcement percentage of 0,5% with steel strength FeB500. The cross sectional properties calculation gives an example for a concrete cast insitu floor of 200mm high. The formulas are specifically for concrete insitu floors and this is a simplified calculation. An overview of these properties can be found in the Annex.

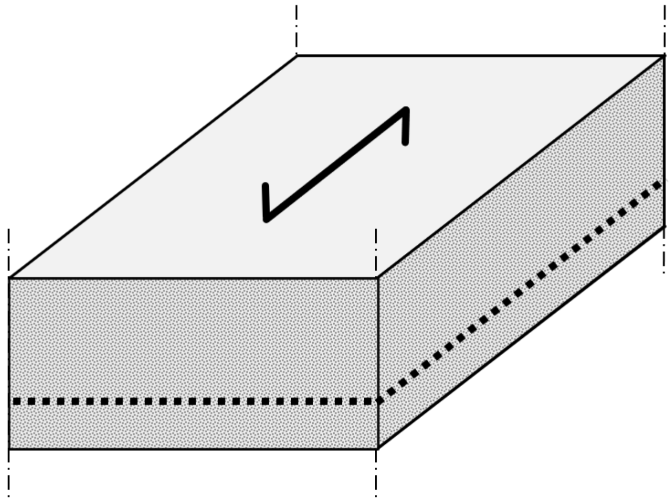


Figure 10: Simplified section of concrete cast insitu

Common properties

γMc	1,5	[-]
γMs	1,15	[-]
ρl	0,5	[%]
$\varphi(\infty, t_0)$	2	[-]
rho	2500	kg/m3

Strength properties

fck	30	N/mm2
fyk	500	N/mm2
fyd	435	N/mm2
fctm	2,9	N/mm2
Ecm mod	33000	N/mm2

Cross sectional properties calculations

The cross sectional properties are calculated based on the formulas below, based on the geometry shown in figure 11. This is a concrete cast in situ floor, with reinforcement of 200mm height. Calculations are per unit width.

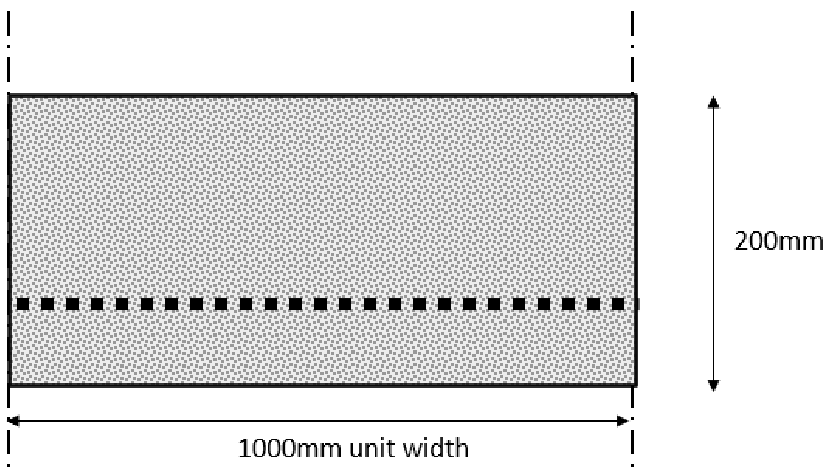


Figure 11: cross section geometry of 200mm concrete insitu

Total cross sectional area (A_{tot})

$$A_{tot} = h_{tot} * b = 200 * 1000 = 2 * 10^5\ mm^2$$

Moment of inertia in length (I_L):

$$I_L = (I_{self}) = \frac{1}{12} * b * {h_3}^3 = \frac{1}{12} * 1000 * 200^3 = 6{,}67 * 10^8\ mm^4$$

Moment of inertia in width(I_B):

$$I_B = (I_{self}) = \frac{1}{12} * b * {h_3}^3 = \frac{1}{12} * 1000 * 200^3 = 6{,}67 * 10^8\ mm^4$$

Stiffness in length direction (EI_L):

$$EI_L = E * I_L = 3{,}3 * 10^4 * 6{,}67 * 10^8 = 2{,}2 * 10^{13}\ Nmm^2$$

Stiffness in width direction (EI_B)

$$EI_B = E * I_B = 3{,}3 * 10^4 * 6{,}67 * 10^8 = 2{,}2 * 10^{13}\ Nmm^2$$

Self-weight

$$Weight_{self} = A_{tot} * rho = 2 * 10^5 * 10^{-6} * 2500 = 500\ kg/m^2$$

Overview of cross sectional properties

Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4] p.u.w.	IB [mm4] p.u.w.	(EI)L [Nmm2] p.u.w.	(EI)B [Nmm2] p.u.w.	Selfweight [kg/m2]
CON IS	SC200	200	2,0E+05	2,0E+05	6,67E+08	6,67E+08	2,20E+13	2,20E+13	500

Moment capacity

The formulas from chapter 3: concrete calculations are used to calculate the moment capacity of this specific floor. Using the input properties from the table. Two moments are calculated below. First the Resistance Moment (MRd), this is the moment capacity of the cross section. Secondly a Cracking Moment (Mcr) is calculated, this si the moment on which the concrete cracks and the steel reinforcement is activated. For these calculations, the assumption is made, that the concrete needs to be cracked. The Cracking Moment needs to be lower than the occurring moment(MEd).

Properties MRd

f;yd	435	N/mm2
Atot	2,00E+05	mm4
ρl	0,50	%
h	200	mm

Properties Mcr

f;ctm	2,9	N/mm2
h	200	mm

$$M_{Rd} = A_s * f_{yd} * 0{,}81 * h = A_{tot} * \rho_l * f_{yd} * 0{,}81 * h = 70{,}4\ kNm$$

$$M_{cr} = f_{ctm} * W = f_{ctm} * \frac{1}{6} * b * h^2 = 19{,}3\ kNm$$

Shear capacity

The formulas from chapter 3: concrete calculations are used to calculate the shear capacity of this specific floor. Using the input properties from the table.

Properties

f;ck	30	N/mm2
Atot	2,00E+05	mm2
ρl	0,50	%
h	200	mm
k	2	[-]

$$V_{Rd,c} = \max \begin{Bmatrix} 0{,}12 * k * (100 * \rho_l * f_{ck})^{\frac{1}{3}} \\ 0{,}035 * k^{\frac{3}{2}} * \sqrt{f_{ck}} \end{Bmatrix} * A = 118{,}4\ kN$$

Deflection including creep

The formulas from chapter 1: general are used to calculate the deflection of this specific floor under the imposed loads, which is calculated according to the in chapter 3: concrete calculations given directions, including creep. The input properties from the table are used. The load is calculated according to the serviceability limit state (SLS), the load in the table are including self-weight.

Loads

Weight	500	kg/m2
qG	6,41	kN/m
qQ	3	kN/m

Properties

(EI)L	2,20E+13	Nmm2
L	5000	mm
$\varphi(\infty, t_0)$	2	[-]
Ecm	33000	N/mm2

$$w_{fin} = \frac{5*(q_G+q_Q)*l^4}{384*\frac{EI_L}{1+\varphi}} = 10{,}44 \text{ mm}$$

Unity checks

The unity checks below are executed to validate whether the floor complies with the structural safety requirements. The unity checks for moment capacity, shear capacity and deformation limits are shown below. All the checks comply, thus this floor is structurally safe.

Loads

Weight	500	kg/m2
qG	6,41	kN/m
qQ	3	kN/m
φ0	0,7	[-]

Decisive load

ULS1	11,80	kN/m
ULS2	12,19	kN/m

L	5000	mm

$$M_{Ed} = \frac{q*l^2}{8} = 38{,}1\ kNm : UC\ M = \frac{M_{Ed}}{M_{Rd}} = \frac{38{,}1}{70{,}4} = 0{,}54$$

$$M_{cr} = 19{,}3: M_{cr} < M_{Ed}$$

$$V_{Ed} = \frac{q*l}{2} = 30{,}5\ kN : UC\ V = \frac{V_{Ed}}{V_{Rd}} = \frac{30{,}5}{118{,}4} = 0{,}26$$

$$w_{lim} = \frac{L}{250} = 20\ mm : UC\ w = \frac{u_{fin}}{w_{lim}} = \frac{10{,}44}{20} = 0{,}52$$

Concrete hollow core floor

The calculation in this section is specifically for concrete hollow core floor. The calculation for the concrete hollow core floor are performed using the VBI calculation tool. The same assumptions and settings from the standard situation are used as well as the same loads. The common properties of the floors are derived from the product datasheet of the VBI hollow core floors. These can be found in the table below. Other properties are calculated from this and other datasheets. An overview of the properties can be found in the Annex.

Material	Type	Height [mm]	Ac [mm2]	IL [mm4]	Selfweight [kg/m2]	Strength class	fck [N/mm2]	Ecm [N/mm2]
CON HC	KP150	150	1,3E+05	3,1E+08	268	C40/50	40	3,50E+04
CON HC	KP200	200	1,4E+05	6,8E+08	308	C45/55	45	3,60E+04
CON HC	KP260	260	1,8E+05	1,4E+09	383	C45/55	45	3,60E+04
CON HC	KP320	320	2,0E+05	2,5E+09	429	C45/55	45	3,60E+04
CON HC	KP400	400	2,3E+05	4,4E+09	490	C45/55	45	3,60E+04

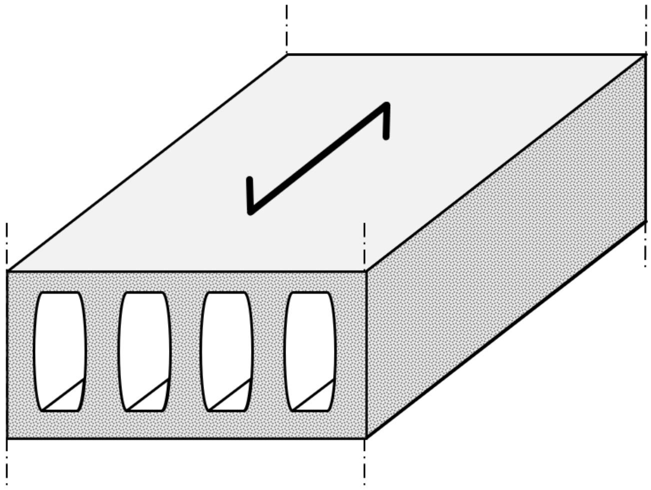


Figure 12: Simplified section of concrete hollow core

<u>Additional cross sectional properties</u>

In addition to the cross sectional properties found in the datasheets of the floor, more properties need to be calculated for application and calculation of the vibrational performance. The properties which need to be calculated are the transverse moment of inertia (I_b) and the stiffness in longitudinal(EI_L) and transverse(EI_b) direction. The moment of inertia is approximated by using a cross section over the length and using the top and bottom flange as only area in the cross section. The height of the top and lower flange is deducted from the cross section drawings found in the annex. The formulas below are used to find the according cross sectional properties. The E-modulus of the concrete according to the strength class is used. The outcome for each floor can be seen in the table below.

Moment of inertia in width(I_B):

$$I_B = \Sigma(I_{self} + a^2 * A) = 2 * (\frac{1}{12} * b * {T_f}^3 + a^2 * b * T_f)$$

Stiffness in length direction (EI_L):

$$EI_L = E * I_L$$

Stiffness in width direction (EI_B)

$$EI_B = E * I_B$$

Type	Flange thickness Tf [mm]	a [mm]	IB [mm4]	IL [mm4]	(EI)L [Nmm2]	(EI)B [Nmm2]
KP150	30	60,0	2,65E+08	3,08E+08	1,08E+13	9,26E+12
KP200	30	85,0	5,26E+08	6,77E+08	2,44E+13	1,89E+13
KP260	38	111,0	1,13E+09	1,43E+09	5,17E+13	4,08E+13
KP320	38	141,0	1,82E+09	2,47E+09	8,89E+13	6,57E+13
KP400	40	180,0	3,12E+09	4,42E+09	1,59E+14	1,12E+14

Structural calculations

The structural calculations are performed with the VBI hollow core calculation tool. The calculations are performed for spans of 3m, 5m, 8m and 11m and for the maximum floor span possible with each floor height. The specific calculations can be found in the annex. The results are shown below. The structure is tested for moment capacity, shear capacity and final deflection. The final deflection is including precamber for these calculations. Figure 13 shows the decisive unity check for each floor type over the span of the floor.

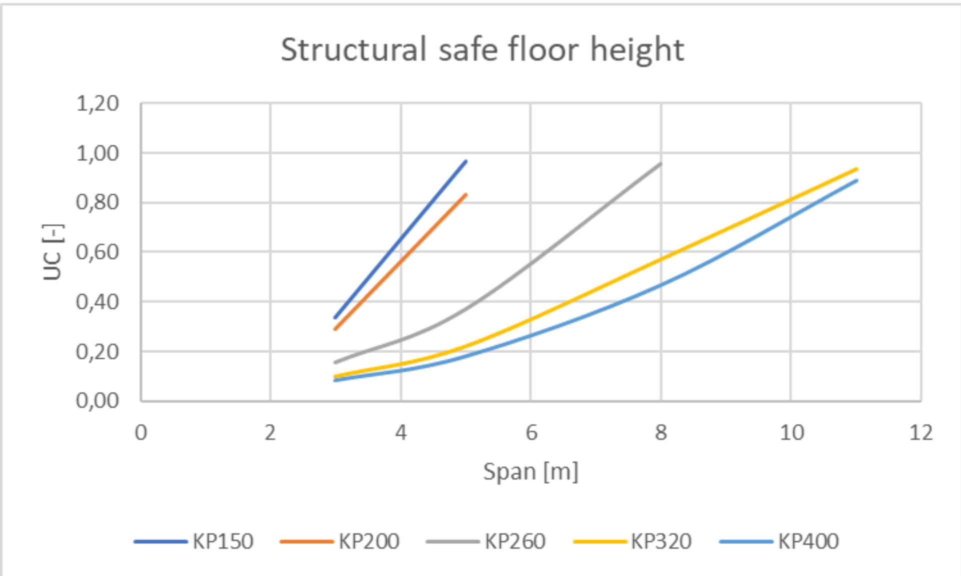


Figure 13: Structural safe floor height: decisive unity check

6. Cross sectional properties

The calculated cross sectional properties are calculated for a set of floor heights for each floor. The cross sectional properties of different floor heights per floor types can be found below. The sectional properties are per unit width of 1m. Excluding concrete hollow core, these are in a unit width of 1,2m. All floors have a unique ID for this thesis, this number can be found in the first column.

CLT

ID	Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4]	IB [mm4]	(EI)L [Nmm2]	(EI)B [Nmm2]	Selfweight [kg/m2]
1	CLT	080 L3s	80	4,0E+04	8,0E+04	3,73E+07	5,33E+06	4,48E+11	6,40E+10	40,8
2	CLT	100 L3s	100	6,0E+04	1,0E+05	7,80E+07	5,33E+06	9,36E+11	6,40E+10	51
3	CLT	100 L5s	100	6,0E+04	1,0E+05	6,60E+07	1,73E+07	7,92E+11	2,08E+11	51
4	CLT	120 L3s	120	8,0E+04	1,2E+05	1,39E+08	5,33E+06	1,66E+12	6,40E+10	61,2
5	CLT	120 L5s	120	8,0E+04	1,2E+05	1,27E+08	1,73E+07	1,52E+12	2,08E+11	61,2
6	CLT	140 L5s	140	1,0E+05	1,4E+05	2,11E+08	1,73E+07	2,54E+12	2,08E+11	71,4
7	CLT	160 L5s	160	1,2E+05	1,6E+05	3,04E+08	3,73E+07	3,65E+12	4,48E+11	81,6
8	CLT	160 L5s-2	160	1,2E+05	1,6E+05	3,36E+08	5,33E+06	4,03E+12	6,40E+10	81,6
9	CLT	180 L5s	180	1,2E+05	1,8E+05	4,08E+08	7,80E+07	4,90E+12	9,36E+11	91,8
10	CLT	180 L7s	180	1,2E+05	1,8E+05	3,84E+08	1,02E+08	4,61E+12	1,22E+12	91,8
11	CLT	200 L5s	200	1,2E+05	2,0E+05	5,28E+08	1,39E+08	6,34E+12	1,66E+12	102
12	CLT	200 L7s	200	8,0E+04	2,0E+05	3,63E+08	3,04E+08	4,35E+12	3,65E+12	102
13	CLT	220 L7s-2	220	1,6E+05	2,2E+05	8,09E+08	7,80E+07	9,71E+12	9,36E+11	112,2
14	CLT	240 L7s	240	1,2E+05	2,4E+05	7,44E+08	4,08E+08	8,93E+12	4,90E+12	122,4
15	CLT	240 L7s-2	240	2,0E+05	2,4E+05	1,11E+09	3,73E+07	1,34E+13	4,48E+11	122,4
16	CLT	260 L7s-2	260	2,0E+05	2,6E+05	1,39E+09	7,80E+07	1,66E+13	9,36E+11	132,6
17	CLT	280 L7s-2	280	2,0E+05	2,8E+05	1,69E+09	1,39E+08	2,03E+13	1,66E+12	142,8
18	CLT	300 L8s-2	300	2,4E+05	3,0E+05	2,06E+09	1,86E+08	2,48E+13	2,23E+12	153
19	CLT	320 L8s-2	320	2,4E+05	3,2E+05	2,43E+09	2,99E+08	2,92E+13	3,58E+12	163,2

LVL boxfloor

ID	Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4]	IB [mm4]	(EI)L [Nmm2]	(EI)B [Nmm2]	Selfweight [kg/m2]
20	LVL	BX100	100	4,5E+03	5,5E+04	7,39E+07	7,34E+07	7,79E+11	7,72E+11	28,8
21	LVL	BX120	120	6,3E+03	5,6E+04	1,18E+08	1,17E+08	1,25E+12	1,23E+12	30,2
22	LVL	BX140	140	8,1E+03	5,8E+04	1,73E+08	1,71E+08	1,84E+12	1,80E+12	31,5
23	LVL	BX160	160	9,9E+03	6,0E+04	2,40E+08	2,35E+08	2,56E+12	2,49E+12	32,8
24	LVL	BX180	180	1,2E+04	6,2E+04	3,19E+08	3,11E+08	3,41E+12	3,29E+12	34,2
25	LVL	BX200	200	1,4E+04	6,4E+04	4,11E+08	3,98E+08	4,40E+12	4,22E+12	35,5
26	LVL	BX220	220	1,5E+04	6,5E+04	5,15E+08	4,96E+08	5,53E+12	5,27E+12	36,9
27	LVL	BX240	240	1,7E+04	6,7E+04	6,32E+08	6,06E+08	6,80E+12	6,45E+12	38,2
28	LVL	BX260	260	1,9E+04	6,9E+04	7,62E+08	7,28E+08	8,23E+12	7,75E+12	39,5
29	LVL	BX280	280	2,1E+04	7,1E+04	9,07E+08	8,61E+08	9,82E+12	9,19E+12	40,9
30	LVL	BX300	300	2,3E+04	7,3E+04	1,07E+09	1,01E+09	1,16E+13	1,08E+13	42,2
31	LVL	BX320	320	2,4E+04	7,4E+04	1,24E+09	1,16E+09	1,35E+13	1,25E+13	43,5
32	LVL	BX340	340	2,6E+04	7,6E+04	1,43E+09	1,33E+09	1,56E+13	1,43E+13	44,9
33	LVL	BX360	360	2,8E+04	7,8E+04	1,63E+09	1,52E+09	1,78E+13	1,63E+13	46,2
34	LVL	BX380	380	3,0E+04	8,0E+04	1,85E+09	1,71E+09	2,03E+13	1,84E+13	47,5
35	LVL	BX400	400	3,2E+04	8,2E+04	2,08E+09	1,92E+09	2,29E+13	2,07E+13	48,9

TCC

ID	Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4]	IB [mm4]	(EI)L _eff [Nmm2]	(EI)B _eff [Nmm2]	Selfweight [kg/m2]
36	TCC	TC120	120	8,0E+04	1,2E+05	9,75E+07	6,55E+07	1,79E+12	1,41E+12	1,41E+02
37	TCC	TC140	140	1,0E+05	1,4E+05	1,71E+08	8,42E+07	3,01E+12	1,96E+12	1,51E+02
38	TCC	TC140-2	140	1,0E+05	1,4E+05	1,59E+08	9,62E+07	2,86E+12	2,11E+12	1,51E+02
39	TCC	TC160	160	1,2E+05	1,6E+05	2,70E+08	1,07E+08	4,61E+12	2,66E+12	1,61E+02
40	TCC	TC160-2	160	1,2E+05	1,6E+05	2,58E+08	1,19E+08	4,47E+12	2,80E+12	1,61E+02
41	TCC	TC190	190	1,5E+05	1,9E+05	4,49E+08	1,86E+08	7,71E+12	4,56E+12	1,96E+02
42	TCC	TC210	210	1,7E+05	2,1E+05	6,05E+08	2,45E+08	1,03E+13	5,99E+12	2,07E+02
43	TCC	TC210-2	210	1,7E+05	2,1E+05	6,37E+08	2,13E+08	1,07E+13	5,60E+12	2,07E+02
44	TCC	TC240	240	1,8E+05	2,4E+05	8,52E+08	4,22E+08	1,48E+13	9,68E+12	2,42E+02
45	TCC	TC240-2	240	1,8E+05	2,4E+05	8,28E+08	4,46E+08	1,46E+13	9,97E+12	2,42E+02
46	TCC	TC270	270	1,9E+05	2,7E+05	1,15E+09	6,69E+08	2,04E+13	1,47E+13	2,77E+02
47	TCC	TC270-2	270	1,5E+05	2,7E+05	8,93E+08	9,25E+08	1,74E+13	1,78E+13	2,77E+02
48	TCC	TC290	290	2,3E+05	2,9E+05	1,60E+09	6,40E+08	2,73E+13	1,58E+13	2,87E+02
49	TCC	TC310	310	1,9E+05	3,1E+05	1,53E+09	1,19E+09	2,80E+13	2,40E+13	2,97E+02
50	TCC	TC320	320	2,8E+05	3,2E+05	2,29E+09	7,33E+08	3,84E+13	1,98E+13	3,22E+02
51	TCC	TC340	340	2,8E+05	3,4E+05	2,67E+09	9,37E+08	4,49E+13	2,41E+13	3,33E+02
52	TCC	TC360	360	2,8E+05	3,6E+05	3,09E+09	1,17E+09	5,21E+13	2,91E+13	3,43E+02
53	TCC	TC380	380	3,2E+05	3,8E+05	3,72E+09	1,28E+09	6,19E+13	3,27E+13	3,53E+02
54	TCC	TC400	400	3,2E+05	4,0E+05	4,22E+09	1,59E+09	7,04E+13	3,88E+13	3,63E+02

Concrete in situ

ID	Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4]	IB [mm4]	(EI)L [Nmm2]	(EI)B [Nmm2]	Selfweight [kg/m2]
55	CON IS	SC080	80	8,0E+04	8,0E+04	4,27E+07	4,27E+07	1,41E+12	1,41E+12	200
56	CON IS	SC100	100	1,0E+05	1,0E+05	8,33E+07	8,33E+07	2,75E+12	2,75E+12	250
57	CON IS	SC120	120	1,2E+05	1,2E+05	1,44E+08	1,44E+08	4,75E+12	4,75E+12	300
58	CON IS	SC140	140	1,4E+05	1,4E+05	2,29E+08	2,29E+08	7,55E+12	7,55E+12	350
59	CON IS	SC160	160	1,6E+05	1,6E+05	3,41E+08	3,41E+08	1,13E+13	1,13E+13	400
60	CON IS	SC180	180	1,8E+05	1,8E+05	4,86E+08	4,86E+08	1,60E+13	1,60E+13	450
61	CON IS	SC200	200	2,0E+05	2,0E+05	6,67E+08	6,67E+08	2,20E+13	2,20E+13	500
62	CON IS	SC220	220	2,2E+05	2,2E+05	8,87E+08	8,87E+08	2,93E+13	2,93E+13	550
63	CON IS	SC240	240	2,4E+05	2,4E+05	1,15E+09	1,15E+09	3,80E+13	3,80E+13	600
64	CON IS	SC260	260	2,6E+05	2,6E+05	1,46E+09	1,46E+09	4,83E+13	4,83E+13	650
65	CON IS	SC280	280	2,8E+05	2,8E+05	1,83E+09	1,83E+09	6,04E+13	6,04E+13	700
66	CON IS	SC300	300	3,0E+05	3,0E+05	2,25E+09	2,25E+09	7,43E+13	7,43E+13	750
67	CON IS	SC320	320	3,2E+05	3,2E+05	2,73E+09	2,73E+09	9,01E+13	9,01E+13	800

Concrete hollow core (VBI)

ID	Material	Type	Height [mm]	(A)net [mm2]	(A)tot [mm2]	IL [mm4]	IB [mm4]	(EI)L [Nmm2]	(EI)B [Nmm2]	Selfweight [kg/m2]
68	CON HC	KP150	150	1,3E+05	1,3E+05	3,08E+08	2,65E+08	1,08E+13	9,26E+12	268
69	CON HC	KP200	200	1,4E+05	1,4E+05	6,77E+08	5,26E+08	2,44E+13	1,89E+13	308
70	CON HC	KP260	260	1,8E+05	1,8E+05	1,43E+09	1,13E+09	5,17E+13	4,08E+13	383
71	CON HC	KP320	320	2,0E+05	2,0E+05	2,47E+09	1,82E+09	8,89E+13	6,57E+13	429
72	CON HC	KP400	400	2,3E+05	2,3E+05	4,42E+09	3,12E+09	1,59E+14	1,12E+14	490

Annex

Tables from Eurocode

Table A.1.7 (NDP) — Combination factors for buildings

Action	ψ_0	ψ_1	ψ_2
Imposed loads in buildings (see EN 1991-1-1):	0,7	0,5	0,3
Category A: domestic, residential areas	0,7	0,5	0,3
Category B: office areas	0,7	0,7	0,6
Category C: congregation areas	0,7	0,7	0,6
Category D: shopping areas	1,0	0,9	0,8
Category E: storage areas			
Category F: traffic area,	0,7	0,7	0,6
vehicle weight ≤ 30 kN	0,7	0,5	0,3
Category G: traffic area,	0,7	0	0
30 kN < vehicle weight ≤ 160 kN			
Category H: roofs accessible for normal maintenance and repair only (see EN 1991-1-1)			
Construction loads (see EN 1991-1-6)	0,6 to 1,0	--	0,2
Snow loads on buildings (see EN 1991-1-3)[a] — Finland, Iceland, Norway, Sweden	0,7	0,5	0,2
— Remainder of CEN Member States, for sites located at altitude H > 1000 m a.s.l.	0,7	0,5	0,2
— Remainder of CEN Member States, for sites located at altitude H ≤ 1000 m a.s.l.	0,5	0,2	0
Wind loads on buildings (see EN 1991-1-4)	0,6	0,2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0,6	0,5	0
Icing (see EN 1991-1-9)	0,5	0,2	0
Standing water (see the other Eurocodes)	-	-	-
Waves and currents (see EN 1991-1-8)			

NOTE Where ranges are given, the recommended value is underlined.

[a] For countries not mentioned, see the National Annex or relevant local guidance.

EC0

Table 6.1 — (NDP) Categories of use and values for q_k and Q_k

Category	Specific Use	Example	q_k [kN/m²]	Q_k [kN]	Typical dimension of the area loaded by Q_k expressed in (m × m)
A	Areas for domestic and residential activities	**A1** Rooms in residential buildings and houses, including corridors.	2,0	2,0	0,05 × 0,05
		A2 Bedrooms, wards, dormitories, private bathrooms and toilets in hospitals, hotels, hostels and other institutional residential occupancies.	2,0	2,0	0,05 × 0,05
B[a]	Public areas (not susceptible to crowding)	**B1** Office areas for general use including corridors other than archive / storage areas (see Category E)	3,0	3,0	0,05 × 0,05
		B2 Kitchens, communal bathrooms and toilets in hospitals, hotels, hostels and other institutional residential occupancies.	3,0	3,0	0,05 × 0,05

EC1

Table 4.1 (NDP) — Load-duration classes and examples of load-duration assignment

Load-duration class	Order of accumulated duration of characteristic load	Examples of loading
Permanent	more than 10 years	self-weight, prestress
Long-term	6 months – 10 years	storage
Medium-term	1 week – 6 months	imposed floor load, snow
Short-term	less than one week	snow, wind
Instantaneous	less than one minute	wind, impact, seismic action

EC5: load duration class

Table 4.6 (NDP) – Partial factors γ_M and γ_R

Persistent and transient design situations **Material**		**Standard**	**Partial factor**
Structural timber (ST)		EN 14081-1	γ_M = 1,3
Structural finger-jointed timber (FST)		EN 15497	γ_M = 1,3
Glued laminated timber (GLT)		EN 14080 or EAD 130320-00-0304	γ_M = 1,25
Glued solid timber (GST)		EN 14080	γ_M = 1,25
Solid wood panel (SWP)		EN 13353	γ_M = 1,25
Cross laminated timber (CLT)		EAD 130005-00-0304	γ_M = 1,25
Laminated veneer lumber (LVL)		EN 14374	γ_M = 1,2
Glued laminated veneer lumber made of beech (GLVL-d)		EAD 130010-01-0304	γ_M = 1,2
Plywood (PLY)		EN 636	γ_M = 1,2
Oriented strand board (OSB)		EN 300	γ_R = 1,2
Particleboard (WPB)		EN 312	γ_M = 1,3
Fibreboard, hard (HB)		EN 622-2	γ_M = 1,3
Fibreboard, medium (MB)		EN 622-3	γ_M = 1,3
Softboards (SB)		EN 622-4	γ_M = 1,3
Fibreboard, MDF		EN 622-5	γ_M = 1,3
Cement-bonded particleboard (CPB)		EN 633	γ_M = 1,3
Gypsum plasterboard (GPB)		EN 520	γ_M = 1,3
Gypsum fibreboard (GFB)		EN 15283-2	γ_M = 1,3
Connections with dowel-type fasteners		EN 14592 or EAD 130118-00-0603	γ_R = 1,3
Connections with punched metal plate fastener	Anchorage strength	EN 14545	γ_R = 1,3
	Steel plate strength		γ_R = 1,1
Connections with shear connectors		EN 14545	γ_R = 1,3
Connections with 2D- and 3D-connectors			γ_R = 1,3
Timber foundation piles			γ_M = 1,3
Bond-line failure			γ_M = 1,3
Failure of steel in connections (Steel plate strength of PMPF or tensile strength of dowel-type fastener)			$\gamma_{M,2}$ = 1,25
Accidental design situations – all materials and connectors			γ_M = γ_R = 1,0

EC5

Table 5.1 — Values of k_{mod}

Material	Standard or EAD	Service class	Permanent	Load-duration of action Long-term	Medium-term	Short-term	Instanta-neous
Structural timber (ST)	EN 14081-1	1	0,60	0,70	0,80	0,90	1,10
		2	0,60	0,70	0,80	0,90	1,10
		3	0,55	0,60	0,70	0,80	1,00
		4	0,50	0,55	0,65	0,70	0,90
Glued laminated timber (GLT)	EN 14080 or EAD 130320-00-0304	1	0,60	0,70	0,80	0,90	1,10
		2	0,60	0,70	0,80	0,90	1,10
LVL	EN 14374	3	0,55	0,60	0,70	0,80	1,00
Structural finger-jointed timber (FST) Cross laminated timber (CLT) Solid wood panel (SWP)	EN 15497 EAD 130005-00-0304 EN 13353	1	0,60	0,70	0,80	0,90	1,10
GLVL made of beech Glued solid timber (GST)	EAD 130010-01-0304 EN 14080	2	0,60	0,70	0,80	0,90	1,10
Plywood (PLY)	EN 636						
	Type EN 636-1	1	0,60	0,70	0,80	0,90	1,10
	Type EN 636-2	2	0,60	0,70	0,80	0,90	1,10
	Type EN 636-3	3	0,55	0,60	0,70	0,80	1,00
OSB	EN 300						
	OSB/2	1	0,30	0,45	0,65	0,85	1,10
	OSB/3, OSB/4	1	0,40	0,50	0,70	0,90	1,10
	OSB/3, OSB/4	2	0,30	0,40	0,55	0,70	0,90
Particleboard	EN 312						
	Type 4, Type 5	1	0,30	0,45	0,65	0,85	1,10
	Type 5	2	0,20	0,30	0,45	0,60	0,80
	Type 6, Type 7	1	0,40	0,50	0,70	0,90	1,10
	Type 7	2	0,30	0,40	0,55	0,70	0,90
Fibreboard, hard	EN 622-2						
	HB.LA, HB.HLA 1 or 2	1	0,30	0,45	0,65	0,85	1,10
	HB.HLA1 or 2	2	0,20	0,30	0,45	0,60	0,80
Fibreboard, medium	EN 622-3						
	MBH.LA1 or 2	1	0,20	0,40	0,60	0,80	1,10
	MBH.HLS1 or 2	1	0,20	0,40	0,60	0,80	1,10
		2	–	–	–	0,45	0,80
Softboard	EN 622-4						
	SB.LS or SB.HLS	1	–	–	–	0,65	1,00
	SB.HLS	2	–	–	–	0,40	0,60
Fibreboard, MDF	EN 622-5						
	MDF.LA, MDF.HLS	1	0,20	0,40	0,60	0,80	1,10
	MDF.HLS	2	–	–	–	0,45	0,80
Gypsum plasterboard	EN 520	1	0,20	0,40	0,60	0,80	1,10
Gypsum fibreboard	EN 15283-2	2	0,15	0,30	0,45	0,60	0,80
Cement bonded parti-cleboard	EN 633	1	0,30	0,45	0,65	0,85	1,10
		2	0,20	0,30	0,45	0,60	0,80

EC5

Table 5.2 — Values of k_{def}

Material	Standard	Service class		
		1	2	3
Structural timber (ST) [b]	EN 14081-1	0,60	0,80	2,00 [a]
Structural finger-jointed timber (FST)	EN 15497	0,60	0,80	–
Glued laminated timber (GLT)	EN 14080 or EAD 130320-00-0304	0,60	0,80	2,00
Glued solid timber (GST)	EN 14080	0,60	0,80	–
LVL-P	EN 14374	0,60	0,80	2,00
LVL-C, except if subjected to flatwise bending or flatwise shear	EN 14374	0,60	0,80	2,00
LVL-C subjected to flatwise bending or flatwise shear		0,80	1,00	2,50
GLVL-P	EAD 130010-01-0304 (beech)	0,60	0,80	–
GLVL-C, except if subjected to flatwise bending or flatwise shear	EAD 130010-01-0304 (beech)	0,60	0,80	–
GLVL-C, subjected to flatwise bending or flatwise shear		0,80	1,00	–
Cross laminated timber (CLT)	EAD 130005-00-0304	0,80	1,00	–
Solid wood panel (SWP)	EN 13353	0,80	1,00	–
Plywood (PLY)	EN 636			
	Type EN 636-1	0,80	–	–
	Type EN 636-2	0,80	1,00	–
	Type EN 636-3	0,80	1,00	2,50
OSB	EN 300			
	OSB/2	2,25	–	–
	OSB/3, OSB/4	1,50	2,25	–
Particleboard	EN 312			
	Type 4	2,25	–	–
	Type 5	2,25	3,00	–
	Type 6	1,50	–	–
	Type 7	1,50	2,25	–
Fibreboard, hard	EN 622-2			
	HB.LA	2,25	–	–
	HB.HLA1, HB.HLA2	2,25	3,00	–
Fibreboard, medium	EN 622-3			
	MBH.LA1, MBH.LA2	3,00	–	–
	MBH.HLS1, MBH.HLS2	3,00	4,00	–
Fibreboard, MDF	EN 622-5			
	MDF.LA	2,25	–	–
	MDF.HLS	2,25	3,00	–
Cement-bonded particleboard	EN 633	2,25	3,00	–
Gypsum fibreboard	EN 15283-2	3,00	4,00	–
Gypsum plasterboard	EN 520	3,00	4,00	–
Connections with bonded-in rods	–	0,60	0,80	–

[a] Also applies to service class SC 4.

[b] For structural timber members that are installed at or near their fibre saturation point and that are likely to dry out under load, the values of k_{def} should be increased by 1,0.

EC5

Tabel 3.1 — Sterkte- en vervormingeigenschappen voor beton

Sterkteklassen voor beton															Vergelijking/Verklaring
f_{ck} (MPa)	12	16	20	25	30	35	40	45	50	55	60	70	80	90	
$f_{ck,cube}$ (MPa)	15	20	25	30	37	45	50	55	60	67	75	85	95	105	
f_{cm} (MPa)	20	24	28	33	38	43	48	53	58	63	68	78	88	98	$f_{cm} = f_{ck}+8$(MPa)
f_{ctm} (MPa)	1,6	1,9	2,2	2,6	2,9	3,2	3,5	3,8	4,1	4,2	4,4	4,6	4,8	5,0	$f_{ctm}=0,30\times f_{ck}^{(2/3)} \leq$C50/60 $f_{ctm}=2,12\cdot\ln(1+(f_{cm}/10))$ > C50/60
$f_{ctk,0,05}$ (MPa)	1,1	1,3	1,5	1,8	2,0	2,2	2,5	2,7	2,9	3,0	3,1	3,2	3,4	3,5	$f_{ctk;0,05} = 0,7\times f_{ctm}$ 5 % fractiel
$f_{ctk,0,95}$ (MPa)	2,0	2,5	2,9	3,3	3,8	4,2	4,6	4,9	5,3	5,5	5,7	6,0	6,3	6,6	$f_{ctk;0,95} = 1,3\times f_{ctm}$ 95 % fractiel
E_{cm} (GPa)	27	29	30	31	33	34	35	36	37	38	39	41	42	44	$E_{cm} = 22[(f_{cm})/10]^{0,3}$ (f_{cm} in MPa)
ε_{c1} (‰)	1,8	1,9	2,0	2,1	2,2	2,25	2,3	2,4	2,45	2,5	2,6	2,7	2,8	2,8	zie figuur 3.2 ε_{c1} (‰) $= 0,7\ f_{cm}^{0,31} \leq 2,8$
ε_{cu1} (‰)	3,5									3,2	3,0	2,8	2,8	2,8	zie figuur 3.2 voor $f_{ck} \geq 50$ MPa ε_{cu1}(‰)$=2,8+27[(98-f_{cm})/100]^4$
ε_{c2} (‰)	2,0									2,2	2,3	2,4	2, 5	2,6	zie figuur 3.3 voor $f_{ck} \geq 50$ MPa ε_{c2}(‰)$=2,0+0,085(f_{ck}-50)^{0,53}$
ε_{cu2} (‰)	3,5									3,1	2,9	2,7	2,6	2,6	zie figuur 3.3 voor $f_{ck} \geq 50$ MPa ε_{cu2}(‰)$=2,6+35[(90-f_{ck})/100]^4$
n	2,0									1,75	1,6	1,45	1,4	1,4	voor $f_{ck} \geq 50$ MPa $n=1,4+23,4[(90-f_{ck})/100]^4$
ε_{c3} (‰)	1,75									1,8	1,9	2,0	2,2	2,3	zie figuur 3.4 voor $f_{ck} \geq 50$ MPa ε_{c3}(‰)$=1,75+0,55[(f_{ck}-50)/40]$
ε_{cu3} (‰)	3,5									3,1	2,9	2,7	2,6	2,6	zie figuur 3.4 voor $f_{ck} \geq 50$ MPa ε_{cu3}(‰)$=2,6+35[(90-f_{ck})/100]^4$

EC2

Tabel 2.1N — Partiële factoren voor materialen voor uiterste grenstoestanden

Ontwerpsituaties	γ_C voor beton	γ_S voor betonstaal	γ_S voor voorspanstaal
Blijvend en tijdelijk	1,5	1,15	1,15
Buitengewoon	1,2	1,0	1,0

EC2

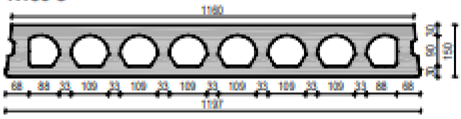
Tabel 5.1: Waarden van de kruipcoëfficiënt $\varphi(\infty, t_0)$ voor cementen van het type N

Beton C20/25	**Langeduur kruip $\phi(\infty, t_0)$, (cementtype 'N')**					
ouderdom t_0 van het beton op het ogenblik van belasten in dagen	fictieve dikte $2 \cdot A_c / u$ in [mm]					
	50	150	600	50	150	600
	Droge omgeving (binnen) *RH* = 50 %			Vochtige omgeving (buiten) *RH* = 80 %		
1	6.8	5.6	4.6	4.5	4.0	3.6
3	5.6	4.6	3.8	3.6	3.2	2.9
7	4.7	3.9	3.2	3.1	2.8	2.5
28	3.7	3.0	2.5	2.4	2.1	1.9
90	2.9	2.4	2.0	1.9	1.7	1.5
365	2.2	1.8	1.5	1.5	1.3	1.2
Beton C25/30	**Langeduur kruip $\phi(\infty, t_0)$, (cementtype 'N')**					
ouderdom t_0 van het beton op het ogenblik van belasten in dagen	fictieve dikte $2 \cdot A_c / u$ in [mm]					
	50	150	600	50	150	600
	Droge omgeving (binnen) *RH* = 50 %			Vochtige omgeving (buiten) *RH* = 80 %		
1	6.3	5.2	4.2	4.1	3.7	3.3
3	5.1	4.2	3.5	3.4	3.0	2.7
7	4.4	3.6	3.0	2.9	2.6	2.3
28	3.4	2.8	2.3	2.2	2.0	1.8
90	2.7	2.2	1.8	1.8	1.6	1.4
365	2.1	1.7	1.4	1.3	1.2	1.1
Beton C30/37	**Langeduur kruip $\phi(\infty, t_0)$, (cementtype 'N')**					
ouderdom t_0 van het beton op het ogenblik van belasten in dagen	fictieve dikte $2 \cdot A_c / u$ in [mm]					
	50	150	600	50	150	600
	Droge omgeving (binnen) *RH* = 50 %			Vochtige omgeving (buiten) *RH* = 80 %		
1	5.9	4.9	4.0	3.8	3.4	3.0
3	4.9	4.0	3.2	3.1	2.8	2.5
7	4.1	3.4	2.8	2.7	2.4	2.1
28	3.2	2.6	2.1	2.1	1.8	1.6
90	2.6	2.1	1.7	1.6	1.5	1.3
365	1.9	1.6	1.3	1.3	1.1	1.0
Beton C35/45	**Langeduur kruip $\phi(\infty, t_0)$, (cementtype 'N')**					
ouderdom t_0 van het beton op het ogenblik van belasten in dagen	fictieve dikte $2 \cdot A_c / u$ in [mm]					
	50	150	600	50	150	600
	Droge omgeving (binnen) *RH* = 50 %			Vochtige omgeving (buiten) *RH* = 80 %		
1	5.7	4.7	3.8	3.6	3.2	2.8
3	4.7	3.8	3.1	3.0	2.6	2.3
7	4.0	3.3	2.6	2.5	2.2	2.0
28	3.1	2.5	2.0	2.0	1.7	1.5
90	2.5	2.0	1.6	1.6	1.4	1.2
365	1.9	1.5	1.2	1.2	1.1	0.9
Beton C40/50	**Langeduur kruip $\phi(\infty, t_0)$, (cementtype 'N')**					
ouderdom t_0 van het beton op het ogenblik van belasten in dagen	fictieve dikte $2 \cdot A_c / u$ in [mm]					
	50	150	600	50	150	600
	Droge omgeving (binnen) *RH* = 50 %			Vochtige omgeving (buiten) *RH* = 80 %		
1	5.6	4.5	3.6	3.5	3.0	2.7
3	4.6	3.7	2.9	2.8	2.5	2.2
7	3.9	3.1	2.5	2.4	2.1	1.9
28	3.0	2.4	1.9	1.9	1.6	1.4
90	2.4	1.9	1.5	1.5	1.3	1.2
365	1.8	1.5	1.2	1.1	1.0	0.9
Beton C45/55	**Langeduur kruip $\phi(\infty, t_0)$, (cementtype 'N')**					
ouderdom t_0 van het beton op het ogenblik van belasten in dagen	fictieve dikte $2 \cdot A_c / u$ in [mm]					
	50	150	600	50	150	600
	Droge omgeving (binnen) *RH* = 50 %			Vochtige omgeving (buiten) *RH* = 80 %		
1	5.4	4.4	3.5	3.3	2.9	2.5
3	4.4	3.6	2.8	2.7	2.4	2.1
7	3.8	3.0	2.4	2.3	2.0	1.8
28	2.9	2.3	1.9	1.8	1.6	1.4
90	2.3	1.9	1.5	1.4	1.2	1.1
365	1.8	1.4	1.1	1.1	1.0	0.8

EC2: creepfactor from compendium EC2: FEBELCEM,2017

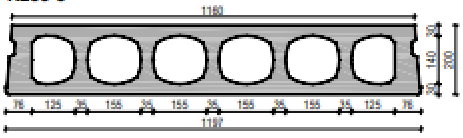
Assortiment

K150-8



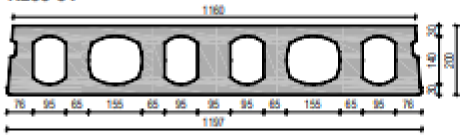
tot ca. 6 m 249 kg/m² incl. voegvulling

K200-6



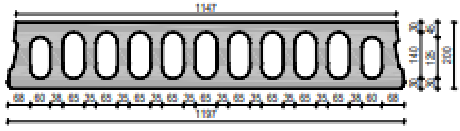
tot ca. 8 m 283 kg/m² incl. voegvulling

K200-6V



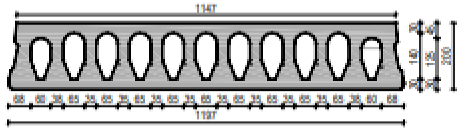
tot ca. 10 m 323 kg/m² incl. voegvulling

K200-11



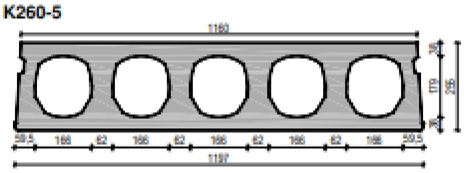
tot ca. 8 m 318 kg/m² incl. voegvulling

K200-11V



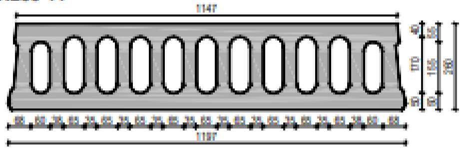
tot ca. 8 m 339 kg/m² incl. voegvulling

K260-5



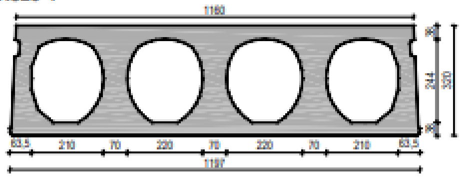
tot ca. 12 m 379 kg/m² incl. voegvulling

K260-11



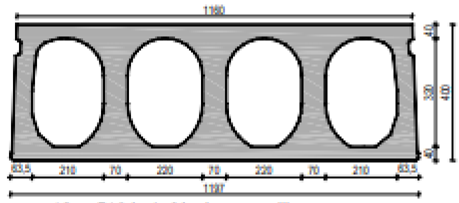
tot ca. 12 m 440 kg/m² incl. voegvulling

K320-4



tot ca. 15 m 441 kg/m² incl. voegvulling

K400-4



tot ca. 18 m 510 kg/m² incl. voegvulling

Maattoleranties

	NEN 2889
elementlengte	± 28 mm
elementlengte bij afschuining	-
elementbreedte	± 12 mm
elementbreedte pasplaten	± 12 mm
elementdikte	± 12 mm
sparingafmeting	± 50 mm
sparingplaats	± 50 mm

Overige toleranties conform NEN 2889 en NEN-EN 1168

Appendix B: Vibrational calculations

The vibrational performance is calculated using 4 criteria: Eigenfrequency, deflection, resonant response and transient response. The formulas used can be found below. The values used in the calculations can be found in the cross sectional properties of the floor or are stated with the formulas.

Eigenfrequency of floor (beam)

$$f_1 = k_{e,1}\, k_{e,2}\, \frac{\pi}{2L^2} \sqrt{\frac{(EI)_L}{m}} \qquad k_{e,2} = \sqrt{1 + \frac{\left(\frac{L}{B}\right)^4 (EI)_T}{(EI)_L}}$$

Deflection of floor under a 1kN load

$$w_{1kN} = \frac{F\, L^3}{48\, (EI)_L\, B_{ef}}$$

$$B_{ef} = \min\left\{0{,}95\, L\, \left(\frac{(EI)_T}{(EI)_L}\right)^{0{,}25} ; B\right\}$$

Resonant response

$$a_{rms} = \frac{k_{res}\, \mu\, F_h}{\sqrt{2}\, 2\, \zeta\, M^*}$$

$$k_{res} = \max\left\{0{,}192\left(\frac{B}{L}\right)\left(\frac{(EI)_L}{(EI)_T}\right)^{0{,}25} ; 1{,}0\right\}$$

$$M^* = \frac{m * L * B}{2}$$

Transient repsonse

$$I_m = \frac{42\, f_w^{1{,}43}}{f_1^{1{,}3}}$$

$$v_{1,peak} = k_{red}\, \frac{I_M}{(M^* + 70\text{ kg})}$$

$$k_{imp} = \max\left\{0{,}48\left(\frac{B}{L}\right)\left[\frac{(EI)_L}{(EI)_T}\right]^{0{,}25} ; 1{,}0\right\}$$

$$v_{tot,peak} = k_{imp}\, v_{1,peak}$$

$$v_{rms} = v_{tot,peak}\, (0{,}65 - 0{,}01\, f_1)(1{,}22 - 11{,}0\, \zeta)\, \eta$$

$$\eta = \begin{cases} 1{,}35 - 0{,}4\, k_{imp} & \text{when } 1{,}0 \le k_{imp} \le 1{,}9 \text{ else } \eta = 0{,}59 \text{ (for joisted floors)} \\ 1{,}35 - 0{,}4\, k_{imp} & \text{when } 1{,}0 \le k_{imp} \le 1{,}7 \text{ else } \eta = 0{,}67 \text{ (for all other floors)} \end{cases}$$

The results of the calculations of the floors are put against the criteria found in the table below. The results give the vibrational performance class.

	Floor performance levels					
Criteria	**I**	**II**	**III**	**IV**	**V**	**VI**
Response factor R	4	8	12	24	36	48
Upper defelction limit $w_{lim,max}$ mm	0,25		0,5	1,0	1,5	2,0
Stiffness criteria for all floors w_{1kN} mm ≤	w_{lim} calculated with Formula 9.30					
Frequency criteria for all floors f_1 Hz ≥	4,5					
Acceleration criteria for resonant vibration ($f_1 < f_{1,lim}$) design situations a_{rms} m/s² ≤	0,005 R					
Velocity criteria for all floors v_{rms} m/s ≤	0,0001 R					

(Draft prEN 1995:1-1)

List of vibrational results

[1.3] Vibrational results for a narrow floor (1m) and 3m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	3	7	Resonant	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	1,256	5	224	1	1	8	7,80	Resonant	1	336	1,051	210,2	7	2	7,83	0,0135	1	0,0135	0,95	0,0073	73,3	7	7
CLT	1	1	1	0,02	3	6	Transient	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	0,601	4	234	1	1	8	11,03	Transient	1	352	1,005	201,0	7	2	4,99	0,0083	1	0,0083	0,95	0,0043	42,5	6	6
CLT	1	1	1	0,02	3	7	Transient	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	0,710	4	234	1	1	8	10,14	Transient	1	352	1,005	201,0	7	2	5,57	0,0092	1	0,0092	0,95	0,0048	48,2	7	7
CLT	1	1	1	0,02	3	5	Transient	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	0,338	3	245	1	1	8	14,39	Transient	1	367	0,963	192,7	7	2	3,53	0,0057	1	0,0057	0,95	0,0027	27,2	5	5
CLT	1	1	1	0,02	3	5	Transient	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	0,370	3	245	1	1	8	13,76	Transient	1	367	0,963	192,7	7	2	3,75	0,0060	1	0,0060	0,95	0,0029	29,2	5	5
CLT	1	1	1	0,02	3	4	Transient	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	0,222	1	255	1	1	8	17,41	Transient	1	382	0,925	184,9	7	2	2,76	0,0043	1	0,0043	0,95	0,0019	19,3	4	4
CLT	1	1	1	0,02	3	4	Transient	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	0,154	1	265	1	1	8	20,47	Transient	1	398	0,889	177,8	7	2	2,23	0,0033	1	0,0033	0,95	0,0014	14,1	4	4
CLT	1	1	1	0,02	3	4	Transient	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	0,140	1	265	1	1	8	21,53	Transient	1	398	0,889	177,8	7	2	2,09	0,0031	1	0,0031	0,95	0,0013	12,9	4	4
CLT	1	1	1	0,02	3	3	Transient	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	0,115	1	275	1	1	8	23,28	Transient	1	413	0,856	171,2	7	2	1,89	0,0027	1	0,0027	0,95	0,0011	10,9	3	3
CLT	1	1	1	0,02	3	3	Transient	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	0,122	1	275	1	1	8	22,58	Transient	1	413	0,856	171,2	7	2	1,97	0,0029	1	0,0029	0,95	0,0011	11,5	3	3
CLT	1	1	1	0,02	3	3	Transient	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	0,089	1	285	1	1	8	26,00	Transient	1	428	0,826	165,1	7	2	1,64	0,0023	1	0,0023	0,95	0,0009	8,5	3	3
CLT	1	1	1	0,02	3	4	Transient	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	0,129	1	285	1	1	8	21,55	Transient	1	428	0,826	165,1	7	2	2,09	0,0029	1	0,0029	0,95	0,0012	12,1	4	4
CLT	1	1	1	0,02	3	2	Transient	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	0,058	1	296	1	1	8	31,63	Transient	1	444	0,797	159,4	7	2	1,27	0,0017	1	0,0017	0,95	0,0005	5,5	2	2
CLT	1	1	1	0,02	3	2	Transient	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	0,063	1	306	1	1	8	29,82	Transient	1	459	0,771	154,1	7	2	1,37	0,0018	1	0,0018	0,95	0,0006	6,1	2	2
CLT	1	1	1	0,02	3	1	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	0,042	1	306	1	1	8	36,50	Transient	1	459	0,771	154,1	7	2	1,05	0,0014	1	0,0014	0,95	0,0004	3,8	1	1
CLT	1	1	1	0,02	3	1	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	0,034	1	316	1	1	8	40,05	Transient	1	474	0,746	149,1	7	2	0,93	0,0012	1	0,0012	0,95	0,0003	2,8	1	1
CLT	1	1	1	0,02	3	1	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	0,028	1	326	1	1	8	43,52	Transient	1	489	0,722	144,5	7	2	0,84	0,0010	1	0,0010	0,95	0,0002	2,1	1	1
CLT	1	1	1	0,02	3	1	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,023	1	336	1	1	8	47,35	Transient	1	505	0,700	140,1	7	2	0,75	0,0009	1	0,0009	0,95	0,0002	1,5	1	1
CLT	1	1	1	0,02	3	1	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,019	1	347	1	1	8	50,64	Transient	1	520	0,680	136,0	7	2	0,69	0,0008	1	0,0008	0,95	0,0001	1,1	1	1
CON HC	1	1	1	0,005	3	2	Transient	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	0,052	1	451	1	1	8	26,97	Transient	1	677	2,088	417,6	7	2	1,56	0,0015	1	0,0015	0,95	0,0006	6,2	2	2
CON HC	1	1	1	0,005	3	1	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,023	1	491	1	1	8	38,88	Transient	1	737	1,918	383,7	7	2	0,97	0,0008	1	0,0008	0,95	0,0002	2,4	1	1
CON HC	1	1	1	0,005	3	1	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,011	1	566	1	1	8	52,70	Transient	1	850	1,664	332,9	7	2	0,65	0,0005	1	0,0005	0,95	0,0001	0,7	1	1
CON HC	1	1	1	0,005	3	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,006	1	612	1	1	8	66,49	Transient	1	919	1,539	307,9	7	2	0,48	0,0003	1	0,0003	0,95	0,0000	-0,1	1	1
CON HC	1	1	1	0,005	3	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,004	1	673	1	1	8	84,84	Transient	1	1010	1,400	280,0	7	2	0,35	0,0002	1	0,0002	0,95	-0,0001	-0,5	1	1
CON IS	1	1	1	0,01	3	5	Transient	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	0,400	3	383	1	1	8	10,58	Transient	1	575	1,229	245,9	7	2	5,27	0,0057	1	0,0057	0,95	0,0033	32,8	5	5
CON IS	1	1	1	0,01	3	4	Transient	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	0,205	1	433	1	1	8	13,90	Transient	1	650	1,087	217,5	7	2	3,70	0,0036	1	0,0036	0,95	0,0019	19,4	4	4
CON IS	1	1	1	0,01	3	4	Transient	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	0,118	1	483	1	1	8	17,30	Transient	1	725	0,975	195,0	7	2	2,78	0,0024	1	0,0024	0,95	0,0012	12,3	4	4
CON IS	1	1	1	0,01	3	3	Transient	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	0,075	1	533	1	1	8	20,76	Transient	1	800	0,884	176,7	7	2	2,19	0,0018	1	0,0018	0,95	0,0008	8,2	3	3
CON IS	1	1	1	0,01	3	2	Transient	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	0,050	1	583	1	1	8	24,25	Transient	1	875	0,808	161,6	7	2	1,79	0,0013	1	0,0013	0,95	0,0006	5,7	2	2
CON IS	1	1	1	0,01	3	2	Transient	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	0,035	1	633	1	1	8	27,77	Transient	1	950	0,744	148,8	7	2	1,50	0,0010	1	0,0010	0,95	0,0004	4,0	2	2
CON IS	1	1	1	0,01	3	1	Transient	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,026	1	683	1	1	8	31,31	Transient	1	1025	0,690	137,9	7	2	1,29	0,0008	1	0,0008	0,95	0,0003	2,9	1	1
CON IS	1	1	1	0,01	3	1	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,019	1	733	1	1	8	34,87	Transient	1	1100	0,643	128,5	7	2	1,12	0,0007	1	0,0007	0,95	0,0002	2,1	1	1
CON IS	1	1	1	0,01	3	1	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,015	1	783	1	1	8	38,45	Transient	1	1175	0,602	120,3	7	2	0,98	0,0006	1	0,0006	0,95	0,0002	1,6	1	1
CON IS	1	1	1	0,01	3	1	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,012	1	833	1	1	8	42,03	Transient	1	1250	0,566	113,1	7	2	0,88	0,0005	1	0,0005	0,95	0,0001	1,1	1	1
CON IS	1	1	1	0,01	3	1	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,009	1	883	1	1	8	45,62	Transient	1	1325	0,534	106,7	7	2	0,79	0,0004	1	0,0004	0,95	0,0001	0,8	1	1
CON IS	1	1	1	0,01	3	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,008	1	933	1	1	8	49,22	Transient	1	1400	0,505	101,0	7	2	0,71	0,0003	1	0,0003	0,95	0,0001	0,6	1	1
CON IS	1	1	1	0,01	3	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,006	1	983	1	1	8	52,83	Transient	1	1475	0,479	95,9	7	2	0,65	0,0003	1	0,0003	0,95	0,0000	0,4	1	1
LVL	1	1	1	0,02	3	7	Transient	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	0,722	4	212	1	1	8	10,57	Transient	1	318	1,110	222,0	7	2	5,28	0,0095	1	0,0095	0,95	0,0049	49,2	7	7
LVL	1	1	1	0,02	3	5	Transient	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	0,451	3	214	1	1	8	13,34	Transient	1	320	1,103	220,6	7	2	3,90	0,0070	1	0,0070	0,95	0,0034	34,3	5	5
LVL	1	1	1	0,02	3	5	Transient	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	0,306	3	215	1	1	8	16,14	Transient	1	322	1,096	219,3	7	2	3,04	0,0054	1	0,0054	0,95	0,0025	25,2	5	5
LVL	1	1	1	0,02	3	4	Transient	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	0,220	1	216	1	1	8	18,98	Transient	1	324	1,090	217,9	7	2	2,47	0,0044	1	0,0044	0,95	0,0019	19,1	4	4
LVL	1	1	1	0,02	3	4	Transient	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	0,165	1	218	1	1	8	21,84	Transient	1	327	1,083	216,6	7	2	2,05	0,0036	1	0,0036	0,95	0,0015	14,9	4	4
LVL	1	1	1	0,02	3	3	Transient	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	0,128	1	219	1	1	8	24,73	Transient	1	329	1,076	215,2	7	2	1,75	0,0031	1	0,0031	0,95	0,0012	11,7	3	3
LVL	1	1	1	0,02	3	3	Transient	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	0,102	1	220	1	1	8	27,64	Transient	1	331	1,070	213,9	7	2	1,51	0,0026	1	0,0026	0,95	0,0009	9,4	3	3
LVL	1	1	1	0,02	3	2	Transient	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	0,083	1	222	1	1	8	30,58	Transient	1	333	1,063	212,7	7	2	1,33	0,0023	1	0,0023	0,95	0,0008	7,5	2	2
LVL	1	1	1	0,02	3	2	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	0,068	1	223	1	1	8	33,54	Transient	1	335	1,057	211,4	7	2	1,18	0,0020	1	0,0020	0,95	0,0006	6,1	2	2
LVL	1	1	1	0,02	3	2	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	0,057	1	224	1	1	8	36,52	Transient	1	337	1,051	210,1	7	2	1,05	0,0018	1	0,0018	0,95	0,0005	4,9	2	2
LVL	1	1	1	0,02	3	1	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	0,049	1	226	1	1	8	39,52	Transient	1	339	1,044	208,9	7	2	0,95	0,0016	1	0,0016	0,95	0,0004	3,9	1	1
LVL	1	1	1	0,02	3	1	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	0,042	1	227	1	1	8	42,54	Transient	1	341	1,038	207,7	7	2	0,86	0,0015	1	0,0015	0,95	0,0003	3,1	1	1
LVL	1	1	1	0,02	3	1	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	0,036	1	228	1	1	8	45,58	Transient	1	343	1,032	206,4	7	2	0,79	0,0013	1	0,0013	0,95	0,0002	2,5	1	1
LVL	1	1	1	0,02	3	1	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	0,032	1	230	1	1	8	48,64	Transient	1	345	1,026	205,2	7	2	0,73	0,0012	1	0,0012	0,95	0,0002	1,9	1	1
LVL	1	1	1	0,02	3	1	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	0,028	1	231	1	1	8	51,72	Transient	1	347	1,020	204,0	7	2	0,67	0,0011	1	0,0011	0,95	0,0001	1,4	1	1
LVL	1	1	1	0,02	3	1	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,025	1	232	1	1	8	54,82	Transient	1	349	1,014	202,9	7	2	0,62	0,0010	1	0,0010	0,95	0,0001	1,0	1	1
TCC	1	1	1	0,025	3	4	Transient	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	0,314	3	324	1	1	8	12,98	Transient	1	486	0,581	116,3	7	2	4,04	0,0051	1	0,0051	0,95	0,0024	23,7	4	4
TCC	1	1	1	0,025	3	4	Transient	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	0,187	1	334	1	1	8	16,55	Transient	1	502	0,564	112,7	7	2	2,95	0,0036	1	0,0036	0,95	0,0016	15,7	4	4
TCC	1	1	1	0,025	3	4	Transient	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	0,196	1	334	1	1	8	16,15	Transient	1	502	0,564	112,7	7	2	3,04	0,0037	1	0,0037	0,95	0,0016	16,3	4	4
TCC	1	1	1	0,025	3	3	Transient	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	0,122	1	345	1	1	8	20,19	Transient	1	517	0,547	109,4	7	2	2,28	0,0027	1	0,0027	0,95	0,0011	10,9	3	3
TCC	1	1	1	0,025	3	3	Transient	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	0,126	1	345	1	1	8	19,87	Transient	1	517	0,547	109,4	7	2	2,32	0,0028	1	0,0028	0,95	0,0011	11,2	3	3
TCC	1	1	1	0,025	3	2	Transient	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	0,073	1	380	1	1	8	24,87	Transient	1	570	0,496	99,3	7	2	1,74	0,0019	1	0,0019	0,95	0,0007	6,8	2	2
TCC	1	1	1	0,025	3	2	Transient	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	0,055	1	390	1	1	8	28,38	Transient	1	585	0,483	96,7	7	2	1,46	0,0016	1	0,0016	0,95	0,0005	5,1	2	2
TCC	1	1	1	0,025	3	2	Transient	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	0,053	1	390	1	1	8	28,90	Transient	1	585	0,483	96,7	7	2	1,43	0,0015	1	0,0015	0,95	0,0005	4,9	2	2
TCC	1	1	1	0,025	3	1	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	0,038	1	425	1	1	8	32,61	Transient	1	638	0,443	88,7	7	2	1,22	0,0012	1	0,0012	0,95	0,0004	3,5	1	1
TCC	1	1	1	0,025	3	1	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	0,039	1	425	1	1	8	32,29	Transient	1	638	0,443	88,7	7	2	1,24	0,0012	1	0,0012	0,95	0,0004	3,6	1	1
TCC	1	1	1	0,025	3	1	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	0,028	1	460	1	1	8	36,77	Transient	1	691	0,409	81,9	7	2	1,04	0,0010	1	0,0010	0,95	0,0002	2,4	1	1
TCC	1	1	1	0,025	3	1	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	0,032	1	460	1	1	8	33,90	Transient	1	691	0,409	81,9	7	2	1,16	0,0011	1	0,0011	0,95	0,0003	3,0	1	1
TCC	1	1	1	0,025	3	1	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,021	1	471	1	1	8	42,02	Transient	1	706	0,401	80,1	7	2	0,88	0,0008	1	0,0008	0,95	0,0002	1,6	1	1
TCC	1	1	1	0,025	3	1	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,020	1	481	1	1	8	42,12	Transient	1	721	0,392	78,4	7	2	0,87	0,0008	1	0,0008	0,95	0,0002	1,6	1	1
TCC	1	1	1	0,025	3	1	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,015	1	506	1	1	8	48,08	Transient	1	759	0,373	74,5	7	2	0,74	0,0006	1	0,0006	0,95	0,0001	0,9	1	1
TCC	1	1	1	0,025	3	1	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,013	1	516	1	1	8	51,49	Transient	1	774	0,365	73,1	7	2	0,67	0,0006	1	0,0006	0,95	0,0001	0,7	1	1
TCC	1	1	1	0,025	3	1	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,011	1	526	1	1	8	54,91	Transient	1	789	0,358	71,7	7	2	0,62	0,0005	1	0,0005	0,95	0,0000	0,5	1	1
TCC	1	1	1	0,025	3	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,009	1	536	1	1	8	59,27	Transient	1	805	0,351	70,3	7	2	0,56	0,0004	1	0,0004	0,95	0,0000	0,2	1	1
TCC	1	1	1	0,025	3	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,008	1	547	1	1	8	62,64	Transient	1	820	0,345	69,0	7	2	0,52	0,0004	1	0,0004	0,95	0,0000	0,1	1	1

[1.4] Vibrational results for a narrow floor (1m) and 4m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	I_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	4	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	2,976	7	224	1	1	8	4,39	Lower limit	1	449	0,788	157,6	7	2	16,55	0,0223	1	0,0223	0,95	0,0129	128,6	7	0
CLT	1	1	1	0,02	4	7	Resonant	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	1,425	6	234	1	1	8	6,20	Resonant	1	469	0,754	150,8	7	2	10,55	0,0137	1	0,0137	0,95	0,0077	76,6	7	7
CLT	1	1	1	0,02	4	7	Resonant	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	1,684	6	234	1	1	8	5,71	Resonant	1	469	0,754	150,8	7	2	11,76	0,0153	1	0,0153	0,95	0,0086	86,1	7	7
CLT	1	1	1	0,02	4	7	Transient	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	0,801	4	245	1	1	8	8,10	Transient	1	489	0,722	144,5	7	2	7,46	0,0093	1	0,0093	0,95	0,0050	50,5	7	7
CLT	1	1	1	0,02	4	7	Resonant	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	0,877	4	245	1	1	8	7,74	Resonant	1	489	0,722	144,5	7	2	7,92	0,0099	1	0,0099	0,95	0,0054	53,9	7	7
CLT	1	1	1	0,02	4	6	Transient	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	0,526	4	255	1	1	8	9,79	Transient	1	510	0,694	138,7	7	2	5,83	0,0070	1	0,0070	0,95	0,0037	36,9	6	6
CLT	1	1	1	0,02	4	5	Transient	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	0,365	3	265	1	1	8	11,52	Transient	1	530	0,667	133,4	7	2	4,72	0,0055	1	0,0055	0,95	0,0028	28,0	5	5
CLT	1	1	1	0,02	4	5	Transient	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	0,331	3	265	1	1	8	12,11	Transient	1	530	0,667	133,4	7	2	4,42	0,0052	1	0,0052	0,95	0,0026	25,9	5	5
CLT	1	1	1	0,02	4	4	Transient	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	0,272	3	275	1	1	8	13,09	Transient	1	551	0,642	128,4	7	2	4,00	0,0045	1	0,0045	0,95	0,0022	22,2	4	4
CLT	1	1	1	0,02	4	4	Transient	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	0,289	3	275	1	1	8	12,70	Transient	1	551	0,642	128,4	7	2	4,16	0,0047	1	0,0047	0,95	0,0023	23,3	4	4
CLT	1	1	1	0,02	4	4	Transient	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	0,210	1	285	1	1	8	14,63	Transient	1	571	0,619	123,8	7	2	3,46	0,0038	1	0,0038	0,95	0,0018	18,1	4	4
CLT	1	1	1	0,02	4	5	Transient	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	0,306	3	285	1	1	8	12,12	Transient	1	571	0,619	123,8	7	2	4,42	0,0048	1	0,0048	0,95	0,0024	24,2	5	5
CLT	1	1	1	0,02	4	4	Transient	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	0,137	1	296	1	1	8	17,79	Transient	1	591	0,598	119,6	7	2	2,68	0,0028	1	0,0028	0,95	0,0013	12,7	4	4
CLT	1	1	1	0,02	4	4	Transient	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	0,149	1	306	1	1	8	16,77	Transient	1	612	0,578	115,6	7	2	2,90	0,0030	1	0,0030	0,95	0,0014	13,6	4	4
CLT	1	1	1	0,02	4	3	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	0,100	1	306	1	1	8	20,53	Transient	1	612	0,578	115,6	7	2	2,23	0,0023	1	0,0023	0,95	0,0010	9,7	3	3
CLT	1	1	1	0,02	4	2	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	0,080	1	316	1	1	8	22,53	Transient	1	632	0,559	111,9	7	2	1,97	0,0020	1	0,0020	0,95	0,0008	7,9	2	2
CLT	1	1	1	0,02	4	2	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	0,066	1	326	1	1	8	24,48	Transient	1	653	0,542	108,4	7	2	1,77	0,0017	1	0,0017	0,95	0,0007	6,6	2	2
CLT	1	1	1	0,02	4	2	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,054	1	336	1	1	8	26,64	Transient	1	673	0,525	105,1	7	2	1,59	0,0015	1	0,0015	0,95	0,0005	5,5	2	2
CLT	1	1	1	0,02	4	2	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,046	1	347	1	1	8	28,48	Transient	1	693	0,510	102,0	7	2	1,45	0,0013	1	0,0013	0,95	0,0005	4,6	2	2
CON HC	1	1	1	0,005	4	4	Transient	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	0,124	1	451	1	1	8	15,17	Transient	1	903	1,566	313,2	7	2	3,30	0,0024	1	0,0024	0,95	0,0013	13,1	4	4
CON HC	1	1	1	0,005	4	2	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,055	1	491	1	1	8	21,87	Transient	1	983	1,439	287,7	7	2	2,05	0,0014	1	0,0014	0,95	0,0007	6,5	2	2
CON HC	1	1	1	0,005	4	1	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,026	1	566	1	1	8	29,65	Transient	1	1133	1,248	249,6	7	2	1,38	0,0008	1	0,0008	0,95	0,0003	3,1	1	1
CON HC	1	1	1	0,005	4	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,015	1	612	1	1	8	37,40	Transient	1	1225	1,154	230,9	7	2	1,02	0,0006	1	0,0006	0,95	0,0002	1,7	1	1
CON HC	1	1	1	0,005	4	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,008	1	673	1	1	8	47,73	Transient	1	1347	1,050	210,0	7	2	0,74	0,0004	1	0,0004	0,95	0,0001	0,7	1	1
CON IS	1	1	1	0,01	4	7	Resonant	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	0,947	5	383	1	1	8	5,95	Resonant	1	767	0,922	184,4	7	2	11,14	0,0093	1	0,0093	0,95	0,0058	58,0	7	7
CON IS	1	1	1	0,01	4	7	Resonant	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	0,485	3	433	1	1	8	7,82	Resonant	1	867	0,816	163,1	7	2	7,81	0,0058	1	0,0058	0,95	0,0035	35,2	5	7
CON IS	1	1	1	0,01	4	4	Transient	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	0,281	3	483	1	1	8	9,73	Transient	1	967	0,731	146,3	7	2	5,87	0,0040	1	0,0040	0,95	0,0023	23,1	4	4
CON IS	1	1	1	0,01	4	4	Transient	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	0,177	1	533	1	1	8	11,68	Transient	1	1067	0,663	132,5	7	2	4,64	0,0029	1	0,0029	0,95	0,0016	16,1	4	4
CON IS	1	1	1	0,01	4	3	Transient	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	0,118	1	583	1	1	8	13,64	Transient	1	1167	0,606	121,2	7	2	3,79	0,0021	1	0,0021	0,95	0,0012	11,6	3	3
CON IS	1	1	1	0,01	4	3	Transient	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	0,083	1	633	1	1	8	15,62	Transient	1	1267	0,558	111,6	7	2	3,18	0,0017	1	0,0017	0,95	0,0009	8,7	3	3
CON IS	1	1	1	0,01	4	2	Transient	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,061	1	683	1	1	8	17,61	Transient	1	1367	0,517	103,5	7	2	2,72	0,0013	1	0,0013	0,95	0,0007	6,6	2	2
CON IS	1	1	1	0,01	4	2	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,046	1	733	1	1	8	19,62	Transient	1	1467	0,482	96,4	7	2	2,36	0,0011	1	0,0011	0,95	0,0005	5,1	2	2
CON IS	1	1	1	0,01	4	2	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,035	1	783	1	1	8	21,63	Transient	1	1567	0,451	90,3	7	2	2,08	0,0009	1	0,0009	0,95	0,0004	4,1	2	2
CON IS	1	1	1	0,01	4	1	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,028	1	833	1	1	8	23,64	Transient	1	1667	0,424	84,8	7	2	1,85	0,0007	1	0,0007	0,95	0,0003	3,3	1	1
CON IS	1	1	1	0,01	4	1	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,022	1	883	1	1	8	25,66	Transient	1	1767	0,400	80,0	7	2	1,67	0,0006	1	0,0006	0,95	0,0003	2,6	1	1
CON IS	1	1	1	0,01	4	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,018	1	933	1	1	8	27,69	Transient	1	1867	0,379	75,7	7	2	1,51	0,0005	1	0,0005	0,95	0,0002	2,1	1	1
CON IS	1	1	1	0,01	4	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,015	1	983	1	1	8	29,72	Transient	1	1967	0,359	71,9	7	2	1,38	0,0005	1	0,0005	0,95	0,0002	1,8	1	1
LVL	1	1	1	0,02	4	7	Resonant	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	1,713	6	212	1	1	8	5,94	Resonant	1	425	0,833	166,5	7	2	11,15	0,0158	1	0,0158	0,95	0,0089	88,5	7	7
LVL	1	1	1	0,02	4	7	Resonant	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	1,069	5	214	1	1	8	7,50	Resonant	1	427	0,827	165,5	7	2	8,24	0,0116	1	0,0116	0,95	0,0063	63,4	7	7
LVL	1	1	1	0,02	4	6	Transient	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	0,725	4	215	1	1	8	9,08	Transient	1	430	0,822	164,4	7	2	6,43	0,0090	1	0,0090	0,95	0,0048	47,8	6	6
LVL	1	1	1	0,02	4	6	Transient	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	0,521	4	216	1	1	8	10,67	Transient	1	433	0,817	163,4	7	2	5,21	0,0073	1	0,0073	0,95	0,0037	37,5	6	6
LVL	1	1	1	0,02	4	5	Transient	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	0,391	3	218	1	1	8	12,28	Transient	1	435	0,812	162,4	7	2	4,34	0,0060	1	0,0060	0,95	0,0030	30,1	5	5
LVL	1	1	1	0,02	4	5	Transient	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	0,303	3	219	1	1	8	13,91	Transient	1	438	0,807	161,4	7	2	3,69	0,0051	1	0,0051	0,95	0,0025	24,7	5	5
LVL	1	1	1	0,02	4	4	Transient	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	0,241	1	220	1	1	8	15,55	Transient	1	441	0,802	160,5	7	2	3,20	0,0044	1	0,0044	0,95	0,0021	20,6	4	4
LVL	1	1	1	0,02	4	4	Transient	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	0,196	1	222	1	1	8	17,20	Transient	1	443	0,797	159,5	7	2	2,80	0,0038	1	0,0038	0,95	0,0017	17,4	4	4
LVL	1	1	1	0,02	4	4	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	0,162	1	223	1	1	8	18,86	Transient	1	446	0,793	158,5	7	2	2,49	0,0034	1	0,0034	0,95	0,0015	14,8	4	4
LVL	1	1	1	0,02	4	4	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	0,136	1	224	1	1	8	20,54	Transient	1	449	0,788	157,6	7	2	2,22	0,0030	1	0,0030	0,95	0,0013	12,7	4	4
LVL	1	1	1	0,02	4	3	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	0,115	1	226	1	1	8	22,23	Transient	1	451	0,783	156,7	7	2	2,01	0,0027	1	0,0027	0,95	0,0011	11,0	3	3
LVL	1	1	1	0,02	4	3	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	0,099	1	227	1	1	8	23,93	Transient	1	454	0,779	155,7	7	2	1,82	0,0024	1	0,0024	0,95	0,0010	9,5	3	3
LVL	1	1	1	0,02	4	3	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	0,086	1	228	1	1	8	25,64	Transient	1	457	0,774	154,8	7	2	1,67	0,0022	1	0,0022	0,95	0,0008	8,3	3	3
LVL	1	1	1	0,02	4	2	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	0,075	1	230	1	1	8	27,36	Transient	1	459	0,770	153,9	7	2	1,53	0,0020	1	0,0020	0,95	0,0007	7,2	2	2
LVL	1	1	1	0,02	4	2	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	0,066	1	231	1	1	8	29,09	Transient	1	462	0,765	153,0	7	2	1,42	0,0019	1	0,0019	0,95	0,0006	6,4	2	2
LVL	1	1	1	0,02	4	2	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,058	1	232	1	1	8	30,84	Transient	1	465	0,761	152,2	7	2	1,31	0,0017	1	0,0017	0,95	0,0006	5,6	2	2
TCC	1	1	1	0,025	4	7	Resonant	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	0,744	4	324	1	1	8	7,30	Resonant	1	649	0,436	87,2	7	2	8,54	0,0083	1	0,0083	0,95	0,0043	43,1	6	7
TCC	1	1	1	0,025	4	5	Transient	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	0,443	3	334	1	1	8	9,31	Transient	1	669	0,423	84,6	7	2	6,23	0,0059	1	0,0059	0,95	0,0029	29,5	5	5
TCC	1	1	1	0,025	4	5	Transient	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	0,466	3	334	1	1	8	9,08	Transient	1	669	0,423	84,6	7	2	6,43	0,0061	1	0,0061	0,95	0,0031	30,6	5	5
TCC	1	1	1	0,025	4	4	Transient	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	0,289	3	345	1	1	8	11,36	Transient	1	689	0,410	82,1	7	2	4,81	0,0044	1	0,0044	0,95	0,0021	21,3	4	4
TCC	1	1	1	0,025	4	4	Transient	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	0,298	3	345	1	1	8	11,18	Transient	1	689	0,410	82,1	7	2	4,91	0,0045	1	0,0045	0,95	0,0022	21,9	4	4
TCC	1	1	1	0,025	4	4	Transient	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	0,173	1	380	1	1	8	13,99	Transient	1	760	0,372	74,5	7	2	3,67	0,0031	1	0,0031	0,95	0,0014	14,2	4	4
TCC	1	1	1	0,025	4	3	Transient	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	0,129	1	390	1	1	8	15,96	Transient	1	780	0,363	72,5	7	2	3,09	0,0025	1	0,0025	0,95	0,0011	11,2	3	3
TCC	1	1	1	0,025	4	3	Transient	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	0,125	1	390	1	1	8	16,26	Transient	1	780	0,363	72,5	7	2	3,02	0,0025	1	0,0025	0,95	0,0011	10,9	3	3
TCC	1	1	1	0,025	4	3	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	0,090	1	425	1	1	8	18,34	Transient	1	851	0,333	66,5	7	2	2,58	0,0020	1	0,0020	0,95	0,0008	8,2	3	3
TCC	1	1	1	0,025	4	3	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	0,092	1	425	1	1	8	18,16	Transient	1	851	0,333	66,5	7	2	2,61	0,0020	1	0,0020	0,95	0,0008	8,3	3	3
TCC	1	1	1	0,025	4	2	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	0,065	1	460	1	1	8	20,68	Transient	1	921	0,307	61,4	7	2	2,20	0,0016	1	0,0016	0,95	0,0006	6,2	2	2
TCC	1	1	1	0,025	4	2	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	0,077	1	460	1	1	8	19,07	Transient	1	921	0,307	61,4	7	2	2,45	0,0017	1	0,0017	0,95	0,0007	7,1	2	2
TCC	1	1	1	0,025	4	2	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,049	1	471	1	1	8	23,63	Transient	1	941	0,300	60,1	7	2	1,85	0,0013	1	0,0013	0,95	0,0005	4,8	2	2
TCC	1	1	1	0,025	4	2	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,048	1	481	1	1	8	23,69	Transient	1	962	0,294	58,8	7	2	1,85	0,0013	1	0,0013	0,95	0,0005	4,7	2	2
TCC	1	1	1	0,025	4	1	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,035	1	506	1	1	8	27,04	Transient	1	1012	0,280	55,9	7	2	1,56	0,0010	1	0,0010	0,95	0,0003	3,4	1	1
TCC	1	1	1	0,025	4	1	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,030	1	516	1	1	8	28,96	Transient	1	1032	0,274	54,8	7	2	1,42	0,0009	1	0,0009	0,95	0,0003	2,9	1	1
TCC	1	1	1	0,025	4	1	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,026	1	526	1	1	8	30,89	Transient	1	1053	0,269	53,7	7	2	1,31	0,0008	1	0,0008	0,95	0,0003	2,5	1	1
TCC	1	1	1	0,025	4	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,022	1	536	1	1	8	33,34	Transient	1	1073	0,264	52,7	7	2	1,19	0,0007	1	0,0007	0,95	0,0002	2,1	1	1
TCC	1	1	1	0,025	4	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,019	1	547	1	1	8	35,23	Transient	1	1093	0,259	51,7	7	2	1,10	0,0007	1	0,0007	0,95	0,0002	1,8	1	1

[1.5] Vibrational results for a narrow floor (1m) and 5m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	5	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	5,813	7	224	1	1	8	2,81	Lower limit	1	561	0,631	126,1	7	2	29,57	0,0328	1	0,0328	0,95	0,0194	193,9	7	0
CLT	1	1	1	0,02	5	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	2,782	7	234	1	1	8	3,97	Lower limit	1	586	0,603	120,6	7	2	18,85	0,0201	1	0,0201	0,95	0,0117	116,6	7	0
CLT	1	1	1	0,02	5	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	3,288	7	234	1	1	8	3,65	Lower limit	1	586	0,603	120,6	7	2	21,01	0,0224	1	0,0224	0,95	0,0131	130,6	7	0
CLT	1	1	1	0,02	5	7	Resonant	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	1,565	7	245	1	1	8	5,18	Resonant	1	612	0,578	115,6	7	2	13,33	0,0137	1	0,0137	0,95	0,0078	77,8	7	7
CLT	1	1	1	0,02	5	7	Resonant	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	1,713	7	245	1	1	8	4,95	Resonant	1	612	0,578	115,6	7	2	14,14	0,0145	1	0,0145	0,95	0,0083	82,8	7	7
CLT	1	1	1	0,02	5	7	Resonant	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	1,027	5	255	1	1	8	6,27	Resonant	1	637	0,555	111,0	7	2	10,41	0,0103	1	0,0103	0,95	0,0057	57,5	7	7
CLT	1	1	1	0,02	5	7	Resonant	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	0,714	4	265	1	1	8	7,37	Resonant	1	663	0,533	106,7	7	2	8,43	0,0081	1	0,0081	0,95	0,0044	44,1	6	7
CLT	1	1	1	0,02	5	7	Resonant	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	0,646	4	265	1	1	8	7,75	Resonant	1	663	0,533	106,7	7	2	7,90	0,0075	1	0,0075	0,95	0,0041	41,1	6	7
CLT	1	1	1	0,02	5	6	Transient	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	0,565	4	275	1	1	8	8,13	Transient	1	688	0,514	102,7	7	2	7,42	0,0069	1	0,0069	0,95	0,0037	37,0	6	6
CLT	1	1	1	0,02	5	7	Resonant	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	0,598	4	285	1	1	8	7,76	Resonant	1	714	0,495	99,1	7	2	7,89	0,0070	1	0,0070	0,95	0,0038	38,3	6	7
CLT	1	1	1	0,02	5	5	Transient	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	0,532	4	275	1	1	8	8,38	Transient	1	688	0,514	102,7	7	2	7,14	0,0066	1	0,0066	0,95	0,0035	35,4	5	5
CLT	1	1	1	0,02	5	5	Transient	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	0,411	3	285	1	1	8	9,36	Transient	1	714	0,495	99,1	7	2	6,18	0,0055	1	0,0055	0,95	0,0029	29,2	5	5
CLT	1	1	1	0,02	5	4	Transient	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	0,268	3	296	1	1	8	11,39	Transient	1	739	0,478	95,7	7	2	4,79	0,0041	1	0,0041	0,95	0,0021	21,1	4	4
CLT	1	1	1	0,02	5	4	Transient	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	0,292	3	306	1	1	8	10,73	Transient	1	765	0,462	92,5	7	2	5,17	0,0043	1	0,0043	0,95	0,0022	22,4	4	4
CLT	1	1	1	0,02	5	4	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	0,195	1	306	1	1	8	13,14	Transient	1	765	0,462	92,5	7	2	3,98	0,0033	1	0,0033	0,95	0,0016	16,4	4	4
CLT	1	1	1	0,02	5	4	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	0,157	1	316	1	1	8	14,42	Transient	1	790	0,447	89,5	7	2	3,53	0,0029	1	0,0029	0,95	0,0014	13,8	4	4
CLT	1	1	1	0,02	5	3	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	0,128	1	326	1	1	8	15,67	Transient	1	816	0,433	86,7	7	2	3,16	0,0025	1	0,0025	0,95	0,0012	11,7	3	3
CLT	1	1	1	0,02	5	3	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,105	1	336	1	1	8	17,05	Transient	1	841	0,420	84,1	7	2	2,84	0,0022	1	0,0022	0,95	0,0010	9,9	3	3
CLT	1	1	1	0,02	5	3	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,089	1	347	1	1	8	18,23	Transient	1	867	0,408	81,6	7	2	2,60	0,0019	1	0,0019	0,95	0,0009	8,6	3	3
CON HC	1	1	1	0,005	5	4	Transient	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	0,241	1	451	1	1	8	9,71	Transient	1	1129	1,253	250,6	7	2	5,89	0,0034	1	0,0034	0,95	0,0021	21,1	4	4
CON HC	1	1	1	0,005	5	3	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,107	1	491	1	1	8	14,00	Transient	1	1229	1,151	230,2	7	2	3,66	0,0020	1	0,0020	0,95	0,0011	11,1	3	3
CON HC	1	1	1	0,005	5	2	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,050	1	566	1	1	8	18,97	Transient	1	1416	0,999	199,7	7	2	2,47	0,0012	1	0,0012	0,95	0,0006	5,9	2	2
CON HC	1	1	1	0,005	5	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,029	1	612	1	1	8	23,94	Transient	1	1531	0,924	184,7	7	2	1,82	0,0008	1	0,0008	0,95	0,0004	3,6	1	1
CON HC	1	1	1	0,005	5	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,016	1	673	1	1	8	30,54	Transient	1	1684	0,840	168,0	7	2	1,33	0,0005	1	0,0005	0,95	0,0002	2,0	1	1
CON IS	1	1	1	0,01	5	7	Resonant	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	0,947	5	433	1	1	8	5,00	Resonant	1	1084	0,652	130,5	7	2	13,95	0,0085	1	0,0085	0,95	0,0054	53,5	7	7
CON IS	1	1	1	0,01	5	7	Resonant	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	0,548	4	483	1	1	8	6,23	Resonant	1	1209	0,585	117,0	7	2	10,49	0,0057	1	0,0057	0,95	0,0036	35,6	5	7
CON IS	1	1	1	0,01	5	7	Resonant	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	0,345	3	533	1	1	8	7,47	Resonant	1	1334	0,530	106,0	7	2	8,28	0,0041	1	0,0041	0,95	0,0025	25,1	5	7
CON IS	1	1	1	0,01	5	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	1,850	7	383	1	1	8	3,81	Lower limit	1	959	0,738	147,5	7	2	19,90	0,0135	1	0,0135	0,95	0,0087	87,4	7	0
CON IS	1	1	1	0,01	5	4	Transient	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	0,231	1	583	1	1	8	8,73	Transient	1	1459	0,485	96,9	7	2	6,77	0,0031	1	0,0031	0,95	0,0018	18,4	4	4
CON IS	1	1	1	0,01	5	4	Transient	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	0,162	1	633	1	1	8	10,00	Transient	1	1584	0,446	89,3	7	2	5,67	0,0024	1	0,0024	0,95	0,0014	13,9	4	4
CON IS	1	1	1	0,01	5	3	Transient	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,118	1	683	1	1	8	11,27	Transient	1	1709	0,414	82,8	7	2	4,85	0,0019	1	0,0019	0,95	0,0011	10,8	3	3
CON IS	1	1	1	0,01	5	3	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,089	1	733	1	1	8	12,55	Transient	1	1834	0,386	77,1	7	2	4,22	0,0016	1	0,0016	0,95	0,0009	8,6	3	3
CON IS	1	1	1	0,01	5	2	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,069	1	783	1	1	8	13,84	Transient	1	1959	0,361	72,2	7	2	3,72	0,0013	1	0,0013	0,95	0,0007	6,9	2	2
CON IS	1	1	1	0,01	5	2	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,054	1	833	1	1	8	15,13	Transient	1	2084	0,339	67,9	7	2	3,31	0,0011	1	0,0011	0,95	0,0006	5,7	2	2
CON IS	1	1	1	0,01	5	2	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,043	1	883	1	1	8	16,42	Transient	1	2209	0,320	64,0	7	2	2,98	0,0009	1	0,0009	0,95	0,0005	4,7	2	2
CON IS	1	1	1	0,01	5	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,035	1	933	1	1	8	17,72	Transient	1	2334	0,303	60,6	7	2	2,70	0,0008	1	0,0008	0,95	0,0004	3,9	1	1
CON IS	1	1	1	0,01	5	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,029	1	983	1	1	8	19,02	Transient	1	2459	0,288	57,5	7	2	2,46	0,0007	1	0,0007	0,95	0,0003	3,3	1	1
LVL	1	1	1	0,02	5	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	3,345	7	212	1	1	8	3,80	Lower limit	1	531	0,666	133,2	7	2	19,92	0,0232	1	0,0232	0,95	0,0135	134,9	7	0
LVL	1	1	1	0,02	5	7	Resonant	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	2,088	7	214	1	1	8	4,80	Resonant	1	534	0,662	132,4	7	2	14,72	0,0171	1	0,0171	0,95	0,0098	97,6	7	7
LVL	1	1	1	0,02	5	7	Resonant	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	1,416	6	215	1	1	8	5,81	Resonant	1	537	0,658	131,6	7	2	11,49	0,0132	1	0,0132	0,95	0,0074	74,4	7	7
LVL	1	1	1	0,02	5	7	Resonant	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	1,018	5	216	1	1	8	6,83	Resonant	1	541	0,654	130,7	7	2	9,31	0,0107	1	0,0107	0,95	0,0059	58,9	7	7
LVL	1	1	1	0,02	5	7	Resonant	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	0,764	5	218	1	1	8	7,86	Resonant	1	544	0,650	129,9	7	2	7,75	0,0088	1	0,0088	0,95	0,0048	48,0	6	7
LVL	1	1	1	0,02	5	6	Transient	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	0,592	4	219	1	1	8	8,90	Transient	1	548	0,646	129,1	7	2	6,60	0,0075	1	0,0075	0,95	0,0040	39,9	6	6
LVL	1	1	1	0,02	5	5	Transient	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	0,471	3	220	1	1	8	9,95	Transient	1	551	0,642	128,4	7	2	5,71	0,0064	1	0,0064	0,95	0,0034	33,7	5	5
LVL	1	1	1	0,02	5	5	Transient	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	0,383	3	222	1	1	8	11,01	Transient	1	554	0,638	127,6	7	2	5,01	0,0056	1	0,0056	0,95	0,0029	28,8	5	5
LVL	1	1	1	0,02	5	5	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	0,316	3	223	1	1	8	12,07	Transient	1	558	0,634	126,8	7	2	4,44	0,0050	1	0,0050	0,95	0,0025	24,9	5	5
LVL	1	1	1	0,02	5	4	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	0,265	3	224	1	1	8	13,15	Transient	1	561	0,630	126,1	7	2	3,97	0,0044	1	0,0044	0,95	0,0022	21,7	4	4
LVL	1	1	1	0,02	5	4	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	0,225	1	226	1	1	8	14,23	Transient	1	564	0,627	125,3	7	2	3,59	0,0040	1	0,0040	0,95	0,0019	19,1	4	4
LVL	1	1	1	0,02	5	4	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	0,193	1	227	1	1	8	15,31	Transient	1	568	0,623	124,6	7	2	3,26	0,0036	1	0,0036	0,95	0,0017	16,9	4	4
LVL	1	1	1	0,02	5	4	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	0,167	1	228	1	1	8	16,41	Transient	1	571	0,619	123,9	7	2	2,98	0,0033	1	0,0033	0,95	0,0015	15,0	4	4
LVL	1	1	1	0,02	5	4	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	0,146	1	230	1	1	8	17,51	Transient	1	574	0,616	123,1	7	2	2,74	0,0030	1	0,0030	0,95	0,0013	13,4	4	4
LVL	1	1	1	0,02	5	4	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	0,128	1	231	1	1	8	18,62	Transient	1	578	0,612	122,4	7	2	2,53	0,0027	1	0,0027	0,95	0,0012	12,0	4	4
LVL	1	1	1	0,02	5	3	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,114	1	232	1	1	8	19,73	Transient	1	581	0,609	121,7	7	2	2,34	0,0025	1	0,0025	0,95	0,0011	10,8	3	3
TCC	1	1	1	0,025	5	7	Resonant	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	1,453	7	324	1	1	8	4,67	Resonant	1	811	0,349	69,8	7	2	15,25	0,0121	1	0,0121	0,95	0,0066	65,7	7	7
TCC	1	1	1	0,025	5	7	Resonant	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	0,866	5	334	1	1	8	5,96	Resonant	1	836	0,338	67,6	7	2	11,12	0,0086	1	0,0086	0,95	0,0046	45,5	6	7
TCC	1	1	1	0,025	5	7	Resonant	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	0,910	5	334	1	1	8	5,81	Resonant	1	836	0,338	67,6	7	2	11,48	0,0089	1	0,0089	0,95	0,0047	47,1	6	7
TCC	1	1	1	0,025	5	7	Resonant	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	0,565	4	345	1	1	8	7,27	Resonant	1	862	0,328	65,6	7	2	8,59	0,0065	1	0,0065	0,95	0,0033	33,4	5	7
TCC	1	1	1	0,025	5	7	Resonant	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	0,583	4	345	1	1	8	7,15	Resonant	1	862	0,328	65,6	7	2	8,77	0,0066	1	0,0066	0,95	0,0034	34,2	5	7
TCC	1	1	1	0,025	5	4	Transient	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	0,338	3	380	1	1	8	8,95	Transient	1	950	0,298	59,6	7	2	6,55	0,0045	1	0,0045	0,95	0,0023	22,6	4	4
TCC	1	1	1	0,025	5	4	Transient	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	0,252	3	390	1	1	8	10,22	Transient	1	975	0,290	58,0	7	2	5,52	0,0037	1	0,0037	0,95	0,0018	18,2	4	4
TCC	1	1	1	0,025	5	4	Transient	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	0,243	1	390	1	1	8	10,41	Transient	1	975	0,290	58,0	7	2	5,39	0,0036	1	0,0036	0,95	0,0018	17,7	4	4
TCC	1	1	1	0,025	5	4	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	0,175	1	425	1	1	8	11,74	Transient	1	1063	0,266	53,2	7	2	4,60	0,0028	1	0,0028	0,95	0,0014	13,6	4	4
TCC	1	1	1	0,025	5	4	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	0,179	1	425	1	1	8	11,63	Transient	1	1063	0,266	53,2	7	2	4,66	0,0029	1	0,0029	0,95	0,0014	13,8	4	4
TCC	1	1	1	0,025	5	3	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	0,127	1	460	1	1	8	13,24	Transient	1	1151	0,246	49,1	7	2	3,94	0,0023	1	0,0023	0,95	0,0010	10,5	3	3
TCC	1	1	1	0,025	5	3	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	0,150	1	460	1	1	8	12,20	Transient	1	1151	0,246	49,1	7	2	4,38	0,0025	1	0,0025	0,95	0,0012	11,9	3	3
TCC	1	1	1	0,025	5	3	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,095	1	471	1	1	8	15,13	Transient	1	1177	0,240	48,1	7	2	3,31	0,0019	1	0,0019	0,95	0,0008	8,3	3	3
TCC	1	1	1	0,025	5	3	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,093	1	481	1	1	8	15,16	Transient	1	1202	0,235	47,1	6	2	3,30	0,0018	1	0,0018	0,95	0,0008	8,1	3	3
TCC	1	1	1	0,025	5	2	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,068	1	506	1	1	8	17,31	Transient	1	1265	0,224	44,7	6	2	2,78	0,0015	1	0,0015	0,95	0,0006	6,2	2	2
TCC	1	1	1	0,025	5	2	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,058	1	516	1	1	8	18,53	Transient	1	1290	0,219	43,8	6	2	2,54	0,0013	1	0,0013	0,95	0,0005	5,5	2	2
TCC	1	1	1	0,025	5	2	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,050	1	526	1	1	8	19,77	Transient	1	1316	0,215	43,0	6	2	2,34	0,0012	1	0,0012	0,95	0,0005	4,8	2	2
TCC	1	1	1	0,025	5	2	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,042	1	536	1	1	8	21,34	Transient	1	1341	0,211	42,2	6	2	2,12	0,0011	1	0,0011	0,95	0,0004	4,1	2	2
TCC	1	1	1	0,025	5	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,037	1	547	1	1	8	22,55	Transient	1	1367	0,207	41,4	6	2	1,97	0,0010	1	0,0010	0,95	0,0004	3,7	1	1

[1.6] Vibrational results for a narrow floor (1m) and 6m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	6	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	10,045	7	224	1	1	8	1,95	Lower limit	1	673	0,525	105,1	7	2	47,50	0,0448	1	0,0448	0,95	0,0268	268,1	7	0
CLT	1	1	1	0,02	6	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	4,808	7	234	1	1	8	2,76	Lower limit	1	703	0,503	100,5	7	2	30,28	0,0274	1	0,0274	0,95	0,0162	162,1	7	0
CLT	1	1	1	0,02	6	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	5,682	7	234	1	1	8	2,54	Lower limit	1	703	0,503	100,5	7	2	33,76	0,0306	1	0,0306	0,95	0,0181	181,3	7	0
CLT	1	1	1	0,02	6	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	2,704	7	245	1	1	8	3,60	Lower limit	1	734	0,482	96,3	7	2	21,42	0,0186	1	0,0186	0,95	0,0109	108,8	7	0
CLT	1	1	1	0,02	6	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	2,961	7	245	1	1	8	3,44	Lower limit	1	734	0,482	96,3	7	2	22,72	0,0198	1	0,0198	0,95	0,0116	115,7	7	0
CLT	1	1	1	0,02	6	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	1,774	7	255	1	1	8	4,35	Lower limit	1	765	0,462	92,5	7	2	16,73	0,0140	1	0,0140	0,95	0,0081	80,8	7	0
CLT	1	1	1	0,02	6	7	Resonant	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	1,234	7	265	1	1	8	5,12	Resonant	1	795	0,445	88,9	7	2	13,55	0,0110	1	0,0110	0,95	0,0062	62,3	7	7
CLT	1	1	1	0,02	6	7	Resonant	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	1,116	6	265	1	1	8	5,38	Resonant	1	795	0,445	88,9	7	2	12,69	0,0103	1	0,0103	0,95	0,0058	58,2	7	7
CLT	1	1	1	0,02	6	7	Resonant	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	0,919	6	275	1	1	8	5,82	Resonant	1	826	0,428	85,6	7	2	11,47	0,0090	1	0,0090	0,95	0,0050	50,4	7	7
CLT	1	1	1	0,02	6	7	Resonant	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	0,977	6	275	1	1	8	5,65	Resonant	1	826	0,428	85,6	7	2	11,93	0,0093	1	0,0093	0,95	0,0053	52,6	7	7
CLT	1	1	1	0,02	6	7	Resonant	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	0,710	5	285	1	1	8	6,50	Resonant	1	856	0,413	82,6	7	2	9,93	0,0075	1	0,0075	0,95	0,0042	41,7	6	7
CLT	1	1	1	0,02	6	7	Resonant	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	1,034	6	285	1	1	8	5,39	Resonant	1	856	0,413	82,6	7	2	12,67	0,0096	1	0,0096	0,95	0,0054	54,2	7	7
CLT	1	1	1	0,02	6	7	Resonant	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	0,463	3	296	1	1	8	7,91	Resonant	1	887	0,399	79,7	7	2	7,70	0,0056	1	0,0056	0,95	0,0031	30,5	5	7
CLT	1	1	1	0,02	6	7	Resonant	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	0,504	4	306	1	1	8	7,45	Resonant	1	918	0,385	77,1	7	2	8,31	0,0059	1	0,0059	0,95	0,0032	32,2	5	7
CLT	1	1	1	0,02	6	5	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	0,336	3	306	1	1	8	9,12	Transient	1	918	0,385	77,1	7	2	6,39	0,0045	1	0,0045	0,95	0,0024	24,0	5	5
CLT	1	1	1	0,02	6	4	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	0,270	3	316	1	1	8	10,01	Transient	1	948	0,373	74,6	7	2	5,66	0,0039	1	0,0039	0,95	0,0020	20,3	4	4
CLT	1	1	1	0,02	6	4	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	0,222	1	326	1	1	8	10,88	Transient	1	979	0,361	72,2	7	2	5,08	0,0034	1	0,0034	0,95	0,0017	17,4	4	4
CLT	1	1	1	0,02	6	4	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,182	1	336	1	1	8	11,84	Transient	1	1009	0,350	70,0	7	2	4,55	0,0030	1	0,0030	0,95	0,0015	14,9	4	4
CLT	1	1	1	0,02	6	4	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,154	1	347	1	1	8	12,66	Transient	1	1040	0,340	68,0	7	2	4,17	0,0026	1	0,0026	0,95	0,0013	13,1	4	4
CON HC	1	1	1	0,005	6	7	Resonant	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	0,417	3	451	1	1	8	6,74	Resonant	1	1354	1,044	208,8	7	2	9,47	0,0047	1	0,0047	0,95	0,0030	30,0	5	7
CON HC	1	1	1	0,005	6	4	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,185	1	491	1	1	8	9,72	Transient	1	1474	0,959	191,8	7	2	5,89	0,0027	1	0,0027	0,95	0,0016	16,3	4	4
CON HC	1	1	1	0,005	6	3	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,087	1	566	1	1	8	13,18	Transient	1	1699	0,832	166,4	7	2	3,96	0,0016	1	0,0016	0,95	0,0009	9,0	3	3
CON HC	1	1	1	0,005	6	2	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,051	1	612	1	1	8	16,62	Transient	1	1837	0,770	153,9	7	2	2,93	0,0011	1	0,0011	0,95	0,0006	5,8	2	2
CON HC	1	1	1	0,005	6	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,028	1	673	1	1	8	21,21	Transient	1	2020	0,700	140,0	7	2	2,13	0,0007	1	0,0007	0,95	0,0003	3,5	1	1
CON IS	1	1	1	0,01	6	7	Resonant	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	0,596	4	533	1	1	8	5,19	Resonant	1	1600	0,442	88,4	7	2	13,31	0,0056	1	0,0056	0,95	0,0035	35,2	5	7
CON IS	1	1	1	0,01	6	7	Resonant	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	0,400	3	583	1	1	8	6,06	Resonant	1	1750	0,404	80,8	7	2	10,87	0,0042	1	0,0042	0,95	0,0026	26,0	5	7
CON IS	1	1	1	0,01	6	7	Resonant	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	0,281	3	633	1	1	8	6,94	Resonant	1	1900	0,372	74,4	7	2	9,11	0,0032	1	0,0032	0,95	0,0020	19,8	4	7
CON IS	1	1	1	0,01	6	7	Resonant	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,205	1	683	1	1	8	7,83	Resonant	1	2050	0,345	69,0	7	2	7,80	0,0026	1	0,0026	0,95	0,0016	15,5	4	7
CON IS	1	1	1	0,01	6	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	3,196	7	383	1	1	8	2,64	Lower limit	1	1150	0,615	122,9	7	2	31,97	0,0183	1	0,0183	0,95	0,0121	120,6	7	0
CON IS	1	1	1	0,01	6	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	1,636	7	433	1	1	8	3,48	Lower limit	1	1300	0,544	108,7	7	2	22,41	0,0114	1	0,0114	0,95	0,0074	74,3	7	0
CON IS	1	1	1	0,01	6	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	0,947	6	483	1	1	8	4,33	Lower limit	1	1450	0,488	97,5	7	2	16,86	0,0078	1	0,0078	0,95	0,0050	49,7	7	0
CON IS	1	1	1	0,01	6	4	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,154	1	733	1	1	8	8,72	Transient	1	2200	0,321	64,3	7	2	6,78	0,0021	1	0,0021	0,95	0,0012	12,4	4	4
CON IS	1	1	1	0,01	6	3	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,118	1	783	1	1	8	9,61	Transient	1	2350	0,301	60,2	7	2	5,97	0,0017	1	0,0017	0,95	0,0010	10,1	3	3
CON IS	1	1	1	0,01	6	3	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,093	1	833	1	1	8	10,51	Transient	1	2500	0,283	56,6	7	2	5,32	0,0014	1	0,0014	0,95	0,0008	8,3	3	3
CON IS	1	1	1	0,01	6	2	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,075	1	883	1	1	8	11,41	Transient	1	2650	0,267	53,4	7	2	4,78	0,0012	1	0,0012	0,95	0,0007	7,0	2	2
CON IS	1	1	1	0,01	6	2	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,061	1	933	1	1	8	12,31	Transient	1	2800	0,252	50,5	7	2	4,33	0,0011	1	0,0011	0,95	0,0006	5,9	2	2
CON IS	1	1	1	0,01	6	2	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,050	1	983	1	1	8	13,21	Transient	1	2950	0,240	47,9	6	2	3,95	0,0009	1	0,0009	0,95	0,0005	5,0	2	2
LVL	1	1	1	0,02	6	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	5,780	7	212	1	1	8	2,64	Lower limit	1	637	0,555	111,0	7	2	32,00	0,0317	1	0,0317	0,95	0,0188	187,7	7	0
LVL	1	1	1	0,02	6	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	3,608	7	214	1	1	8	3,33	Lower limit	1	641	0,552	110,3	7	2	23,65	0,0233	1	0,0233	0,95	0,0136	136,4	7	0
LVL	1	1	1	0,02	6	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	2,448	7	215	1	1	8	4,03	Lower limit	1	645	0,548	109,6	7	2	18,46	0,0181	1	0,0181	0,95	0,0105	104,6	7	0
LVL	1	1	1	0,02	6	7	Resonant	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	1,760	7	216	1	1	8	4,74	Resonant	1	649	0,545	109,0	7	2	14,95	0,0146	1	0,0146	0,95	0,0083	83,3	7	7
LVL	1	1	1	0,02	6	7	Resonant	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	1,320	7	218	1	1	8	5,46	Resonant	1	653	0,541	108,3	7	2	12,46	0,0121	1	0,0121	0,95	0,0068	68,2	7	7
LVL	1	1	1	0,02	6	7	Resonant	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	1,024	6	219	1	1	8	6,18	Resonant	1	657	0,538	107,6	7	2	10,60	0,0102	1	0,0102	0,95	0,0057	57,0	7	7
LVL	1	1	1	0,02	6	7	Resonant	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	0,814	5	220	1	1	8	6,91	Resonant	1	661	0,535	107,0	7	2	9,17	0,0088	1	0,0088	0,95	0,0048	48,5	7	7
LVL	1	1	1	0,02	6	7	Resonant	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	0,661	5	222	1	1	8	7,64	Resonant	1	665	0,532	106,3	7	2	8,04	0,0077	1	0,0077	0,95	0,0042	41,7	6	7
LVL	1	1	1	0,02	6	6	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	0,547	4	223	1	1	8	8,38	Transient	1	669	0,528	105,7	7	2	7,13	0,0068	1	0,0068	0,95	0,0036	36,3	6	6
LVL	1	1	1	0,02	6	5	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	0,458	3	224	1	1	8	9,13	Transient	1	673	0,525	105,1	7	2	6,38	0,0060	1	0,0060	0,95	0,0032	31,9	5	5
LVL	1	1	1	0,02	6	5	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	0,389	3	226	1	1	8	9,88	Transient	1	677	0,522	104,4	7	2	5,76	0,0054	1	0,0054	0,95	0,0028	28,3	5	5
LVL	1	1	1	0,02	6	5	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	0,334	3	227	1	1	8	10,64	Transient	1	681	0,519	103,8	7	2	5,24	0,0049	1	0,0049	0,95	0,0025	25,2	5	5
LVL	1	1	1	0,02	6	4	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	0,289	3	228	1	1	8	11,40	Transient	1	685	0,516	103,2	7	2	4,79	0,0044	1	0,0044	0,95	0,0023	22,6	4	4
LVL	1	1	1	0,02	6	4	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	0,252	3	230	1	1	8	12,16	Transient	1	689	0,513	102,6	7	2	4,40	0,0041	1	0,0041	0,95	0,0020	20,4	4	4
LVL	1	1	1	0,02	6	4	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	0,222	1	231	1	1	8	12,93	Transient	1	693	0,510	102,0	7	2	4,06	0,0037	1	0,0037	0,95	0,0018	18,4	4	4
LVL	1	1	1	0,02	6	4	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,196	1	232	1	1	8	13,70	Transient	1	697	0,507	101,4	7	2	3,77	0,0034	1	0,0034	0,95	0,0017	16,7	4	4
TCC	1	1	1	0,025	6	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	2,510	7	324	1	1	8	3,24	Lower limit	1	973	0,291	58,1	7	2	24,51	0,0164	1	0,0164	0,95	0,0091	91,2	7	0
TCC	1	1	1	0,025	6	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	1,496	7	334	1	1	8	4,14	Lower limit	1	1003	0,282	56,4	7	2	17,86	0,0116	1	0,0116	0,95	0,0064	63,7	7	0
TCC	1	1	1	0,025	6	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	1,572	7	334	1	1	8	4,04	Lower limit	1	1003	0,282	56,4	7	2	18,44	0,0120	1	0,0120	0,95	0,0066	65,8	7	0
TCC	1	1	1	0,025	6	7	Resonant	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	0,976	6	345	1	1	8	5,05	Resonant	1	1034	0,274	54,7	7	2	13,80	0,0087	1	0,0087	0,95	0,0047	47,1	6	7
TCC	1	1	1	0,025	6	7	Resonant	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	1,007	6	345	1	1	8	4,97	Resonant	1	1034	0,274	54,7	7	2	14,08	0,0089	1	0,0089	0,95	0,0048	48,1	7	7
TCC	1	1	1	0,025	6	7	Resonant	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	0,584	4	380	1	1	8	6,22	Resonant	1	1140	0,248	49,6	7	2	10,52	0,0061	1	0,0061	0,95	0,0032	32,1	5	7
TCC	1	1	1	0,025	6	7	Resonant	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	0,436	3	390	1	1	8	7,10	Resonant	1	1170	0,242	48,3	7	2	8,86	0,0050	1	0,0050	0,95	0,0026	26,0	5	7
TCC	1	1	1	0,025	6	7	Resonant	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	0,421	3	390	1	1	8	7,23	Resonant	1	1170	0,242	48,3	7	2	8,65	0,0049	1	0,0049	0,95	0,0025	25,3	5	7
TCC	1	1	1	0,025	6	4	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	0,303	3	425	1	1	8	8,15	Transient	1	1276	0,222	44,3	6	2	7,40	0,0038	1	0,0038	0,95	0,0020	19,6	4	4
TCC	1	1	1	0,025	6	4	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	0,309	3	425	1	1	8	8,07	Transient	1	1276	0,222	44,3	6	2	7,49	0,0039	1	0,0039	0,95	0,0020	19,9	4	4
TCC	1	1	1	0,025	6	4	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	0,220	1	460	1	1	8	9,19	Transient	1	1381	0,205	40,9	6	2	6,33	0,0031	1	0,0031	0,95	0,0015	15,3	4	4
TCC	1	1	1	0,025	6	4	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	0,259	3	460	1	1	8	8,48	Transient	1	1381	0,205	40,9	6	2	7,03	0,0034	1	0,0034	0,95	0,0017	17,2	4	4
TCC	1	1	1	0,025	6	4	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,165	1	471	1	1	8	10,50	Transient	1	1412	0,200	40,1	6	2	5,32	0,0025	1	0,0025	0,95	0,0012	12,3	4	4
TCC	1	1	1	0,025	6	4	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,161	1	481	1	1	8	10,53	Transient	1	1443	0,196	39,2	6	2	5,30	0,0025	1	0,0025	0,95	0,0012	12,0	4	4
TCC	1	1	1	0,025	6	3	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,117	1	506	1	1	8	12,02	Transient	1	1518	0,186	37,3	6	2	4,47	0,0020	1	0,0020	0,95	0,0009	9,4	3	3
TCC	1	1	1	0,025	6	3	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,100	1	516	1	1	8	12,87	Transient	1	1548	0,183	36,5	6	2	4,09	0,0018	1	0,0018	0,95	0,0008	8,3	3	3
TCC	1	1	1	0,025	6	2	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,086	1	526	1	1	8	13,73	Transient	1	1579	0,179	35,8	5	2	3,76	0,0016	1	0,0016	0,95	0,0007	7,3	2	2
TCC	1	1	1	0,025	6	2	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,073	1	536	1	1	8	14,82	Transient	1	1609	0,176	35,1	5	2	3,40	0,0014	1	0,0014	0,95	0,0006	6,4	2	2
TCC	1	1	1	0,025	6	2	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,064	1	547	1	1	8	15,66	Transient	1	1640	0,172	34,5	5	2	3,17	0,0013	1	0,0013	0,95	0,0006	5,7	2	2

[1.7] Vibrational results for a narrow floor (1m) and 7m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	7	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	15,951	7	224	1	1	8	1,43	Lower limit	1	785	0,450	90,1	7	2	70,91	0,0581	1	0,0581	0,95	0,0351	350,6	7	0
CLT	1	1	1	0,02	7	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	7,634	7	234	1	1	8	2,03	Lower limit	1	821	0,431	86,2	7	2	45,21	0,0355	1	0,0355	0,95	0,0213	212,6	7	0
CLT	1	1	1	0,02	7	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	9,023	7	234	1	1	8	1,86	Lower limit	1	821	0,431	86,2	7	2	50,40	0,0396	1	0,0396	0,95	0,0238	237,6	7	0
CLT	1	1	1	0,02	7	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	4,294	7	245	1	1	8	2,64	Lower limit	1	856	0,413	82,6	7	2	31,98	0,0242	1	0,0242	0,95	0,0143	143,1	7	0
CLT	1	1	1	0,02	7	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	4,701	7	245	1	1	8	2,53	Lower limit	1	856	0,413	82,6	7	2	33,92	0,0256	1	0,0256	0,95	0,0152	152,1	7	0
CLT	1	1	1	0,02	7	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	2,818	7	255	1	1	8	3,20	Lower limit	1	892	0,396	79,3	7	2	24,97	0,0182	1	0,0182	0,95	0,0107	106,7	7	0
CLT	1	1	1	0,02	7	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	1,959	7	265	1	1	8	3,76	Lower limit	1	928	0,381	76,2	7	2	20,22	0,0142	1	0,0142	0,95	0,0083	82,5	7	0
CLT	1	1	1	0,02	7	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	1,772	7	265	1	1	8	3,95	Lower limit	1	928	0,381	76,2	7	2	18,95	0,0133	1	0,0133	0,95	0,0077	77,1	7	0
CLT	1	1	1	0,02	7	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	1,460	7	275	1	1	8	4,28	Lower limit	1	964	0,367	73,4	7	2	17,12	0,0116	1	0,0116	0,95	0,0067	66,9	7	0
CLT	1	1	1	0,02	7	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	1,551	7	275	1	1	8	4,15	Lower limit	1	964	0,367	73,4	7	2	17,81	0,0121	1	0,0121	0,95	0,0070	69,7	7	0
CLT	1	1	1	0,02	7	7	Resonant	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	1,128	7	285	1	1	8	4,78	Resonant	1	999	0,354	70,8	7	2	14,82	0,0097	1	0,0097	0,95	0,0056	55,5	7	7
CLT	1	1	1	0,02	7	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	1,642	7	285	1	1	8	3,96	Lower limit	1	999	0,354	70,8	7	2	18,92	0,0124	1	0,0124	0,95	0,0072	71,8	7	0
CLT	1	1	1	0,02	7	7	Resonant	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	0,736	5	296	1	1	8	5,81	Resonant	1	1035	0,342	68,3	7	2	11,49	0,0073	1	0,0073	0,95	0,0041	40,9	6	7
CLT	1	1	1	0,02	7	7	Resonant	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	0,800	6	306	1	1	8	5,48	Resonant	1	1071	0,330	66,0	7	2	12,41	0,0076	1	0,0076	0,95	0,0043	43,1	6	7
CLT	1	1	1	0,02	7	7	Resonant	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	0,534	5	306	1	1	8	6,70	Resonant	1	1071	0,330	66,0	7	2	9,54	0,0059	1	0,0059	0,95	0,0032	32,4	5	7
CLT	1	1	1	0,02	7	7	Resonant	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	0,429	3	316	1	1	8	7,36	Resonant	1	1106	0,320	63,9	7	2	8,46	0,0050	1	0,0050	0,95	0,0028	27,6	5	7
CLT	1	1	1	0,02	7	7	Resonant	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	0,352	3	326	1	1	8	7,99	Resonant	1	1142	0,310	61,9	7	2	7,59	0,0044	1	0,0044	0,95	0,0024	23,7	4	7
CLT	1	1	1	0,02	7	4	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,289	3	336	1	1	8	8,70	Transient	1	1178	0,300	60,0	7	2	6,80	0,0038	1	0,0038	0,95	0,0020	20,4	4	4
CLT	1	1	1	0,02	7	4	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,245	1	347	1	1	8	9,30	Transient	1	1213	0,291	58,3	7	2	6,23	0,0034	1	0,0034	0,95	0,0018	18,0	4	4
CON HC	1	1	1	0,005	7	7	Resonant	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	0,663	5	451	1	1	8	4,95	Resonant	1	1580	0,895	179,0	7	2	14,13	0,0060	1	0,0060	0,95	0,0040	39,8	6	7
CON HC	1	1	1	0,005	7	7	Resonant	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,293	3	491	1	1	8	7,14	Resonant	1	1720	0,822	164,4	7	2	8,79	0,0034	1	0,0034	0,95	0,0022	22,0	4	7
CON HC	1	1	1	0,005	7	4	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,138	1	566	1	1	8	9,68	Transient	1	1983	0,713	142,7	7	2	5,92	0,0020	1	0,0020	0,95	0,0012	12,4	4	4
CON HC	1	1	1	0,005	7	3	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,080	1	612	1	1	8	12,21	Transient	1	2144	0,660	131,9	7	2	4,37	0,0014	1	0,0014	0,95	0,0008	8,1	3	3
CON HC	1	1	1	0,005	7	2	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,045	1	673	1	1	8	15,58	Transient	1	2357	0,600	120,0	7	2	3,19	0,0009	1	0,0009	0,95	0,0005	5,0	2	2
CON IS	1	1	1	0,01	7	7	Resonant	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	0,446	3	633	1	1	8	5,10	Resonant	1	2217	0,319	63,8	7	2	13,61	0,0042	1	0,0042	0,95	0,0026	26,3	5	7
CON IS	1	1	1	0,01	7	7	Resonant	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,325	3	683	1	1	8	5,75	Resonant	1	2392	0,296	59,1	7	2	11,64	0,0033	1	0,0033	0,95	0,0021	20,7	4	7
CON IS	1	1	1	0,01	7	7	Resonant	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,244	1	733	1	1	8	6,41	Resonant	1	2567	0,275	55,1	7	2	10,12	0,0027	1	0,0027	0,95	0,0017	16,6	4	7
CON IS	1	1	1	0,01	7	7	Resonant	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,188	1	783	1	1	8	7,06	Resonant	1	2742	0,258	51,6	7	2	8,92	0,0022	1	0,0022	0,95	0,0014	13,6	4	7
CON IS	1	1	1	0,01	7	7	Resonant	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,148	1	833	1	1	8	7,72	Resonant	1	2917	0,242	48,5	7	2	7,94	0,0019	1	0,0019	0,95	0,0011	11,2	3	7
CON IS	1	1	1	0,01	7	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	5,075	7	383	1	1	8	1,94	Lower limit	1	1342	0,527	105,4	7	2	47,74	0,0237	1	0,0237	0,95	0,0157	157,3	7	0
CON IS	1	1	1	0,01	7	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	2,598	7	433	1	1	8	2,55	Lower limit	1	1517	0,466	93,2	7	2	33,46	0,0148	1	0,0148	0,95	0,0097	97,2	7	0
CON IS	1	1	1	0,01	7	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	1,504	7	483	1	1	8	3,18	Lower limit	1	1692	0,418	83,6	7	2	25,17	0,0100	1	0,0100	0,95	0,0065	65,2	7	0
CON IS	1	1	1	0,01	7	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	0,947	6	533	1	1	8	3,81	Lower limit	1	1867	0,379	75,7	7	2	19,87	0,0072	1	0,0072	0,95	0,0046	46,3	6	0
CON IS	1	1	1	0,01	7	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	0,634	5	583	1	1	8	4,45	Lower limit	1	2042	0,346	69,2	7	2	16,23	0,0054	1	0,0054	0,95	0,0034	34,3	5	0
CON IS	1	1	1	0,01	7	3	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,118	1	883	1	1	8	8,38	Transient	1	3092	0,229	45,7	6	2	7,14	0,0016	1	0,0016	0,95	0,0009	9,4	3	3
CON IS	1	1	1	0,01	7	3	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,096	1	933	1	1	8	9,04	Transient	1	3267	0,216	43,3	6	2	6,47	0,0014	1	0,0014	0,95	0,0008	8,0	3	3
CON IS	1	1	1	0,01	7	2	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,079	1	983	1	1	8	9,70	Transient	1	3442	0,205	41,1	6	2	5,90	0,0012	1	0,0012	0,95	0,0007	6,9	2	2
LVL	1	1	1	0,02	7	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	9,178	7	212	1	1	8	1,94	Lower limit	1	743	0,476	95,2	7	2	47,78	0,0411	1	0,0411	0,95	0,0246	246,4	7	0
LVL	1	1	1	0,02	7	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	5,729	7	214	1	1	8	2,45	Lower limit	1	748	0,473	94,6	7	2	35,31	0,0302	1	0,0302	0,95	0,0180	179,6	7	0
LVL	1	1	1	0,02	7	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	3,887	7	215	1	1	8	2,96	Lower limit	1	752	0,470	94,0	7	2	27,55	0,0235	1	0,0235	0,95	0,0138	138,2	7	0
LVL	1	1	1	0,02	7	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	2,794	7	216	1	1	8	3,49	Lower limit	1	757	0,467	93,4	7	2	22,33	0,0189	1	0,0189	0,95	0,0110	110,4	7	0
LVL	1	1	1	0,02	7	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	2,097	7	218	1	1	8	4,01	Lower limit	1	762	0,464	92,8	7	2	18,60	0,0157	1	0,0157	0,95	0,0091	90,7	7	0
LVL	1	1	1	0,02	7	7	Resonant	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	1,625	7	219	1	1	8	4,54	Resonant	1	767	0,461	92,2	7	2	15,82	0,0132	1	0,0132	0,95	0,0076	76,1	7	7
LVL	1	1	1	0,02	7	7	Resonant	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	1,293	7	220	1	1	8	5,08	Resonant	1	771	0,458	91,7	7	2	13,69	0,0114	1	0,0114	0,95	0,0065	64,9	7	7
LVL	1	1	1	0,02	7	7	Resonant	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	1,050	7	222	1	1	8	5,62	Resonant	1	776	0,456	91,1	7	2	12,01	0,0099	1	0,0099	0,95	0,0056	56,1	7	7
LVL	1	1	1	0,02	7	7	Resonant	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	0,868	6	223	1	1	8	6,16	Resonant	1	781	0,453	90,6	7	2	10,65	0,0088	1	0,0088	0,95	0,0049	49,0	7	7
LVL	1	1	1	0,02	7	7	Resonant	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	0,728	5	224	1	1	8	6,71	Resonant	1	785	0,450	90,1	7	2	9,53	0,0078	1	0,0078	0,95	0,0043	43,2	6	7
LVL	1	1	1	0,02	7	7	Resonant	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	0,618	5	226	1	1	8	7,26	Resonant	1	790	0,448	89,5	7	2	8,60	0,0070	1	0,0070	0,95	0,0038	38,4	6	7
LVL	1	1	1	0,02	7	7	Resonant	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	0,530	5	227	1	1	8	7,81	Resonant	1	795	0,445	89,0	7	2	7,82	0,0063	1	0,0063	0,95	0,0034	34,4	5	7
LVL	1	1	1	0,02	7	5	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	0,459	3	228	1	1	8	8,37	Transient	1	799	0,442	88,5	7	2	7,15	0,0058	1	0,0058	0,95	0,0031	31,0	5	5
LVL	1	1	1	0,02	7	5	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	0,401	3	230	1	1	8	8,93	Transient	1	804	0,440	88,0	7	2	6,57	0,0053	1	0,0053	0,95	0,0028	28,0	5	5
LVL	1	1	1	0,02	7	5	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	0,352	3	231	1	1	8	9,50	Transient	1	809	0,437	87,4	7	2	6,06	0,0048	1	0,0048	0,95	0,0025	25,5	5	5
LVL	1	1	1	0,02	7	4	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,312	3	232	1	1	8	10,07	Transient	1	813	0,435	86,9	7	2	5,62	0,0045	1	0,0045	0,95	0,0023	23,2	4	4
TCC	1	1	1	0,025	7	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	3,986	7	324	1	1	8	2,38	Lower limit	1	1135	0,249	49,8	7	2	36,59	0,0213	1	0,0213	0,95	0,0119	119,5	7	0
TCC	1	1	1	0,025	7	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	2,376	7	334	1	1	8	3,04	Lower limit	1	1171	0,242	48,3	7	2	26,67	0,0150	1	0,0150	0,95	0,0084	83,7	7	0
TCC	1	1	1	0,025	7	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	2,496	7	334	1	1	8	2,97	Lower limit	1	1171	0,242	48,3	7	2	27,54	0,0155	1	0,0155	0,95	0,0087	86,5	7	0
TCC	1	1	1	0,025	7	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	1,549	7	345	1	1	8	3,71	Lower limit	1	1206	0,234	46,9	6	2	20,60	0,0113	1	0,0113	0,95	0,0062	62,2	7	0
TCC	1	1	1	0,025	7	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	1,599	7	345	1	1	8	3,65	Lower limit	1	1206	0,234	46,9	6	2	21,03	0,0115	1	0,0115	0,95	0,0064	63,5	7	0
TCC	1	1	1	0,025	7	6	Resonant	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	0,927	6	380	1	1	8	4,57	Resonant	1	1330	0,213	42,5	6	2	15,71	0,0079	1	0,0079	0,95	0,0043	42,6	6	6
TCC	1	1	1	0,025	7	6	Resonant	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	0,693	5	390	1	1	8	5,21	Resonant	1	1365	0,207	41,4	6	2	13,23	0,0065	1	0,0065	0,95	0,0035	34,6	5	6
TCC	1	1	1	0,025	7	6	Resonant	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	0,668	5	390	1	1	8	5,31	Resonant	1	1365	0,207	41,4	6	2	12,92	0,0063	1	0,0063	0,95	0,0034	33,8	5	6
TCC	1	1	1	0,025	7	6	Resonant	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	0,481	3	425	1	1	8	5,99	Resonant	1	1489	0,190	38,0	6	2	11,04	0,0050	1	0,0050	0,95	0,0026	26,3	5	6
TCC	1	1	1	0,025	7	6	Resonant	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	0,491	3	425	1	1	8	5,93	Resonant	1	1489	0,190	38,0	6	2	11,18	0,0050	1	0,0050	0,95	0,0027	26,6	5	6
TCC	1	1	1	0,025	7	5	Resonant	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	0,350	3	460	1	1	8	6,75	Resonant	1	1612	0,175	35,1	5	2	9,45	0,0039	1	0,0039	0,95	0,0021	20,6	4	5
TCC	1	1	1	0,025	7	5	Resonant	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	0,411	3	460	1	1	8	6,23	Resonant	1	1612	0,175	35,1	5	2	10,50	0,0044	1	0,0044	0,95	0,0023	23,1	4	5
TCC	1	1	1	0,025	7	5	Resonant	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,262	3	471	1	1	8	7,72	Resonant	1	1647	0,172	34,3	5	2	7,94	0,0032	1	0,0032	0,95	0,0017	16,6	4	5
TCC	1	1	1	0,025	7	5	Resonant	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,255	3	481	1	1	8	7,74	Resonant	1	1683	0,168	33,6	5	2	7,92	0,0032	1	0,0032	0,95	0,0016	16,3	4	5
TCC	1	1	1	0,025	7	4	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,186	1	506	1	1	8	8,83	Transient	1	1771	0,160	31,9	5	2	6,67	0,0025	1	0,0025	0,95	0,0013	12,8	4	4
TCC	1	1	1	0,025	7	3	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,159	1	516	1	1	8	9,46	Transient	1	1806	0,157	31,3	5	2	6,10	0,0023	1	0,0023	0,95	0,0011	11,3	3	3
TCC	1	1	1	0,025	7	3	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,137	1	526	1	1	8	10,09	Transient	1	1842	0,154	30,7	5	2	5,61	0,0021	1	0,0021	0,95	0,0010	10,1	3	3
TCC	1	1	1	0,025	7	3	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,115	1	536	1	1	8	10,89	Transient	1	1878	0,151	30,1	5	2	5,08	0,0018	1	0,0018	0,95	0,0009	8,9	3	3
TCC	1	1	1	0,025	7	3	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,101	1	547	1	1	8	11,50	Transient	1	1913	0,148	29,6	5	2	4,73	0,0017	1	0,0017	0,95	0,0008	8,0	3	3

[1.8] Vibrational results for a narrow floor (1m) and 8m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	I_m	v1_peak	k_imp	v_tot_peak	n	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	8	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	23,810	7	224	1	1	8	1,10	Lower limit	1	897	0,394	78,8	7	2	100,34	0,0726	1	0,0726	0,95	0,0441	440,9	7	0
CLT	1	1	1	0,02	8	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	11,396	7	234	1	1	8	1,55	Lower limit	1	938	0,377	75,4	7	2	63,98	0,0444	1	0,0444	0,95	0,0268	267,8	7	0
CLT	1	1	1	0,02	8	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	13,468	7	234	1	1	8	1,43	Lower limit	1	938	0,377	75,4	7	2	71,32	0,0495	1	0,0495	0,95	0,0299	299,1	7	0
CLT	1	1	1	0,02	8	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	6,410	7	245	1	1	8	2,02	Lower limit	1	979	0,361	72,2	7	2	45,25	0,0302	1	0,0302	0,95	0,0181	180,7	7	0
CLT	1	1	1	0,02	8	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	7,018	7	245	1	1	8	1,93	Lower limit	1	979	0,361	72,2	7	2	48,00	0,0320	1	0,0320	0,95	0,0192	191,9	7	0
CLT	1	1	1	0,02	8	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	4,206	7	255	1	1	8	2,45	Lower limit	1	1020	0,347	69,4	7	2	35,34	0,0227	1	0,0227	0,95	0,0135	134,9	7	0
CLT	1	1	1	0,02	8	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	2,924	7	265	1	1	8	2,88	Lower limit	1	1060	0,333	66,7	7	2	28,62	0,0177	1	0,0177	0,95	0,0105	104,6	7	0
CLT	1	1	1	0,02	8	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	2,646	7	265	1	1	8	3,03	Lower limit	1	1060	0,333	66,7	7	2	26,82	0,0166	1	0,0166	0,95	0,0098	97,8	7	0
CLT	1	1	1	0,02	8	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	2,179	7	275	1	1	8	3,27	Lower limit	1	1101	0,321	64,2	7	2	24,22	0,0145	1	0,0145	0,95	0,0085	84,9	7	0
CLT	1	1	1	0,02	8	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	2,315	7	275	1	1	8	3,18	Lower limit	1	1101	0,321	64,2	7	2	25,20	0,0151	1	0,0151	0,95	0,0088	88,5	7	0
CLT	1	1	1	0,02	8	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	1,684	7	285	1	1	8	3,66	Lower limit	1	1142	0,310	61,9	7	2	20,98	0,0121	1	0,0121	0,95	0,0071	70,6	7	0
CLT	1	1	1	0,02	8	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	2,451	7	285	1	1	8	3,03	Lower limit	1	1142	0,310	61,9	7	2	26,78	0,0155	1	0,0155	0,95	0,0091	91,1	7	0
CLT	1	1	1	0,02	8	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	1,098	7	296	1	1	8	4,45	Lower limit	1	1183	0,299	59,8	7	2	16,26	0,0091	1	0,0091	0,95	0,0052	52,3	7	0
CLT	1	1	1	0,02	8	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	1,195	7	306	1	1	8	4,19	Lower limit	1	1224	0,289	57,8	7	2	17,56	0,0095	1	0,0095	0,95	0,0055	54,9	7	0
CLT	1	1	1	0,02	8	7	Resonant	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	0,797	6	306	1	1	8	5,13	Resonant	1	1224	0,289	57,8	7	2	13,50	0,0073	1	0,0073	0,95	0,0042	41,5	6	7
CLT	1	1	1	0,02	8	7	Resonant	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	0,641	5	316	1	1	8	5,63	Resonant	1	1264	0,280	55,9	7	2	11,97	0,0063	1	0,0063	0,95	0,0035	35,4	5	7
CLT	1	1	1	0,02	8	7	Resonant	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	0,526	5	326	1	1	8	6,12	Resonant	1	1305	0,271	54,2	7	2	10,74	0,0055	1	0,0055	0,95	0,0031	30,6	5	7
CLT	1	1	1	0,02	8	7	Resonant	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,431	3	336	1	1	8	6,66	Resonant	1	1346	0,263	52,5	7	2	9,62	0,0048	1	0,0048	0,95	0,0026	26,4	5	7
CLT	1	1	1	0,02	8	7	Resonant	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,365	3	347	1	1	8	7,12	Resonant	1	1387	0,255	51,0	7	2	8,82	0,0042	1	0,0042	0,95	0,0023	23,3	4	7
CON HC	1	1	1	0,005	8	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	0,989	7	451	1	1	8	3,79	Lower limit	1	1806	0,783	156,6	7	2	20,00	0,0075	1	0,0075	0,95	0,0051	50,6	7	0
CON HC	1	1	1	0,005	8	7	Resonant	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,437	3	491	1	1	8	5,47	Resonant	1	1966	0,719	143,9	7	2	12,43	0,0043	1	0,0043	0,95	0,0028	28,2	5	7
CON HC	1	1	1	0,005	8	7	Resonant	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,206	1	566	1	1	8	7,41	Resonant	1	2266	0,624	124,8	7	2	8,37	0,0025	1	0,0025	0,95	0,0016	16,0	4	7
CON HC	1	1	1	0,005	8	3	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,120	1	612	1	1	8	9,35	Transient	1	2450	0,577	115,4	7	2	6,19	0,0017	1	0,0017	0,95	0,0011	10,6	3	3
CON HC	1	1	1	0,005	8	2	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,067	1	673	1	1	8	11,93	Transient	1	2694	0,525	105,0	7	2	4,51	0,0011	1	0,0011	0,95	0,0007	6,7	2	2
CON IS	1	1	1	0,01	8	7	Resonant	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,364	3	733	1	1	8	4,90	Resonant	1	2934	0,241	48,2	7	2	14,32	0,0033	1	0,0033	0,95	0,0021	21,2	4	7
CON IS	1	1	1	0,01	8	6	Resonant	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,281	3	783	1	1	8	5,41	Resonant	1	3134	0,226	45,1	6	2	12,62	0,0028	1	0,0028	0,95	0,0017	17,3	4	6
CON IS	1	1	1	0,01	8	6	Resonant	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,221	1	833	1	1	8	5,91	Resonant	1	3334	0,212	42,4	6	2	11,24	0,0023	1	0,0023	0,95	0,0014	14,4	4	6
CON IS	1	1	1	0,01	8	6	Resonant	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,177	1	883	1	1	8	6,42	Resonant	1	3534	0,200	40,0	6	2	10,10	0,0020	1	0,0020	0,95	0,0012	12,1	4	6
CON IS	1	1	1	0,01	8	6	Resonant	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,144	1	933	1	1	8	6,92	Resonant	1	3734	0,189	37,9	6	2	9,15	0,0017	1	0,0017	0,95	0,0010	10,3	3	6
CON IS	1	1	1	0,01	8	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	7,576	7	383	1	1	8	1,49	Lower limit	1	1534	0,461	92,2	7	2	67,55	0,0295	1	0,0295	0,95	0,0197	197,5	7	0
CON IS	1	1	1	0,01	8	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	3,879	7	433	1	1	8	1,95	Lower limit	1	1734	0,408	81,6	7	2	47,34	0,0184	1	0,0184	0,95	0,0122	122,1	7	0
CON IS	1	1	1	0,01	8	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	2,245	7	483	1	1	8	2,43	Lower limit	1	1934	0,366	73,1	7	2	35,62	0,0124	1	0,0124	0,95	0,0082	82,1	7	0
CON IS	1	1	1	0,01	8	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	1,414	7	533	1	1	8	2,92	Lower limit	1	2134	0,331	66,3	7	2	28,11	0,0089	1	0,0089	0,95	0,0058	58,5	7	0
CON IS	1	1	1	0,01	8	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	0,947	7	583	1	1	8	3,41	Lower limit	1	2334	0,303	60,6	7	2	22,97	0,0067	1	0,0067	0,95	0,0043	43,4	6	0
CON IS	1	1	1	0,01	8	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	0,665	5	633	1	1	8	3,91	Lower limit	1	2534	0,279	55,8	7	2	19,26	0,0052	1	0,0052	0,95	0,0033	33,4	5	0
CON IS	1	1	1	0,01	8	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,485	3	683	1	1	8	4,40	Lower limit	1	2734	0,259	51,7	7	2	16,47	0,0041	1	0,0041	0,95	0,0026	26,3	5	0
CON IS	1	1	1	0,01	8	5	Resonant	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,118	1	983	1	1	8	7,43	Resonant	1	3934	0,180	35,9	5	2	8,35	0,0015	1	0,0015	0,95	0,0009	8,9	3	5
LVL	1	1	1	0,02	8	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	13,700	7	212	1	1	8	1,49	Lower limit	1	849	0,416	83,3	7	2	67,61	0,0515	1	0,0515	0,95	0,0311	310,6	7	0
LVL	1	1	1	0,02	8	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	8,551	7	214	1	1	8	1,88	Lower limit	1	855	0,414	82,7	7	2	49,97	0,0378	1	0,0378	0,95	0,0227	226,9	7	0
LVL	1	1	1	0,02	8	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	5,802	7	215	1	1	8	2,27	Lower limit	1	860	0,411	82,2	7	2	38,99	0,0293	1	0,0293	0,95	0,0175	174,9	7	0
LVL	1	1	1	0,02	8	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	4,171	7	216	1	1	8	2,67	Lower limit	1	865	0,409	81,7	7	2	31,59	0,0236	1	0,0236	0,95	0,0140	140,0	7	0
LVL	1	1	1	0,02	8	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	3,130	7	218	1	1	8	3,07	Lower limit	1	871	0,406	81,2	7	2	26,32	0,0196	1	0,0196	0,95	0,0115	115,2	7	0
LVL	1	1	1	0,02	8	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	2,426	7	219	1	1	8	3,48	Lower limit	1	876	0,404	80,7	7	2	22,39	0,0166	1	0,0166	0,95	0,0097	96,8	7	0
LVL	1	1	1	0,02	8	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	1,930	7	220	1	1	8	3,89	Lower limit	1	881	0,401	80,2	7	2	19,37	0,0143	1	0,0143	0,95	0,0083	82,8	7	0
LVL	1	1	1	0,02	8	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	1,568	7	222	1	1	8	4,30	Lower limit	1	887	0,399	79,7	7	2	16,99	0,0124	1	0,0124	0,95	0,0072	71,7	7	0
LVL	1	1	1	0,02	8	7	Resonant	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	1,295	7	223	1	1	8	4,72	Resonant	1	892	0,396	79,3	7	2	15,07	0,0110	1	0,0110	0,95	0,0063	62,8	7	7
LVL	1	1	1	0,02	8	7	Resonant	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	1,086	7	224	1	1	8	5,14	Resonant	1	897	0,394	78,8	7	2	13,49	0,0098	1	0,0098	0,95	0,0056	55,5	7	7
LVL	1	1	1	0,02	8	7	Resonant	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	0,922	7	226	1	1	8	5,56	Resonant	1	903	0,392	78,3	7	2	12,17	0,0088	1	0,0088	0,95	0,0049	49,5	7	7
LVL	1	1	1	0,02	8	7	Resonant	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	0,791	6	227	1	1	8	5,98	Resonant	1	908	0,389	77,9	7	2	11,06	0,0079	1	0,0079	0,95	0,0044	44,4	6	7
LVL	1	1	1	0,02	8	7	Resonant	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	0,685	6	228	1	1	8	6,41	Resonant	1	913	0,387	77,4	7	2	10,11	0,0072	1	0,0072	0,95	0,0040	40,1	6	7
LVL	1	1	1	0,02	8	7	Resonant	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	0,598	5	230	1	1	8	6,84	Resonant	1	919	0,385	77,0	7	2	9,29	0,0066	1	0,0066	0,95	0,0036	36,3	6	7
LVL	1	1	1	0,02	8	7	Resonant	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	0,526	5	231	1	1	8	7,27	Resonant	1	924	0,383	76,5	7	2	8,58	0,0060	1	0,0060	0,95	0,0033	33,1	5	7
LVL	1	1	1	0,02	8	7	Resonant	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,465	3	232	1	1	8	7,71	Resonant	1	929	0,380	76,1	7	2	7,96	0,0056	1	0,0056	0,95	0,0030	30,3	5	7
TCC	1	1	1	0,025	8	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	5,949	7	324	1	1	8	1,82	Lower limit	1	1297	0,218	43,6	6	2	51,77	0,0265	1	0,0265	0,95	0,0150	150,3	7	0
TCC	1	1	1	0,025	8	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	3,547	7	334	1	1	8	2,33	Lower limit	1	1338	0,211	42,3	6	2	37,74	0,0188	1	0,0188	0,95	0,0106	105,6	7	0
TCC	1	1	1	0,025	8	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	3,725	7	334	1	1	8	2,27	Lower limit	1	1338	0,211	42,3	6	2	38,97	0,0194	1	0,0194	0,95	0,0109	109,1	7	0
TCC	1	1	1	0,025	8	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	2,313	7	345	1	1	8	2,84	Lower limit	1	1379	0,205	41,0	6	2	29,15	0,0141	1	0,0141	0,95	0,0079	78,6	7	0
TCC	1	1	1	0,025	8	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	2,387	7	345	1	1	8	2,79	Lower limit	1	1379	0,205	41,0	6	2	29,75	0,0144	1	0,0144	0,95	0,0080	80,3	7	0
TCC	1	1	1	0,025	8	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	1,383	7	380	1	1	8	3,50	Lower limit	1	1520	0,186	37,2	6	2	22,23	0,0098	1	0,0098	0,95	0,0054	54,1	7	0
TCC	1	1	1	0,025	8	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	1,034	7	390	1	1	8	3,99	Lower limit	1	1560	0,181	36,3	6	2	18,72	0,0080	1	0,0080	0,95	0,0044	44,0	6	0
TCC	1	1	1	0,025	8	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	0,997	7	390	1	1	8	4,06	Lower limit	1	1560	0,181	36,3	6	2	18,28	0,0078	1	0,0078	0,95	0,0043	42,9	6	0
TCC	1	1	1	0,025	8	6	Resonant	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	0,718	6	425	1	1	8	4,59	Resonant	1	1701	0,166	33,3	5	2	15,63	0,0062	1	0,0062	0,95	0,0033	33,5	5	6
TCC	1	1	1	0,025	8	6	Resonant	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	0,733	6	425	1	1	8	4,54	Resonant	1	1701	0,166	33,3	5	2	15,83	0,0063	1	0,0063	0,95	0,0034	34,0	5	6
TCC	1	1	1	0,025	8	5	Resonant	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	0,522	5	460	1	1	8	5,17	Resonant	1	1842	0,154	30,7	5	2	13,37	0,0049	1	0,0049	0,95	0,0026	26,3	5	5
TCC	1	1	1	0,025	8	5	Resonant	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	0,614	5	460	1	1	8	4,77	Resonant	1	1842	0,154	30,7	5	2	14,86	0,0054	1	0,0054	0,95	0,0029	29,4	5	5
TCC	1	1	1	0,025	8	5	Resonant	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,391	3	471	1	1	8	5,91	Resonant	1	1883	0,150	30,0	5	2	11,24	0,0040	1	0,0040	0,95	0,0021	21,4	4	5
TCC	1	1	1	0,025	8	5	Resonant	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,381	3	481	1	1	8	5,92	Resonant	1	1924	0,147	29,4	5	2	11,21	0,0039	1	0,0039	0,95	0,0021	20,9	4	5
TCC	1	1	1	0,025	8	5	Resonant	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,278	3	506	1	1	8	6,76	Resonant	1	2024	0,140	28,0	5	2	9,43	0,0032	1	0,0032	0,95	0,0016	16,5	4	5
TCC	1	1	1	0,025	8	5	Resonant	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,238	1	516	1	1	8	7,24	Resonant	1	2064	0,137	27,4	5	2	8,63	0,0028	1	0,0028	0,95	0,0015	14,7	4	5
TCC	1	1	1	0,025	8	5	Resonant	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,205	1	526	1	1	8	7,72	Resonant	1	2105	0,134	26,9	5	2	7,94	0,0026	1	0,0026	0,95	0,0013	13,1	4	5
TCC	1	1	1	0,025	8	3	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,172	1	536	1	1	8	8,34	Transient	1	2146	0,132	26,4	5	2	7,19	0,0023	1	0,0023	0,95	0,0012	11,5	3	3
TCC	1	1	1	0,025	8	3	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,151	1	547	1	1	8	8,81	Transient	1	2187	0,129	25,9	5	2	6,69	0,0021	1	0,0021	0,95	0,0010	10,5	3	3

[1.9] Vibrational results for a narrow floor (1m) and 9m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	I_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	9	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	33,901	7	224	1	1	8	0,87	Lower limit	1	1009	0,350	70,1	7	2	136,30	0,0884	1	0,0884	0,95	0,0539	538,6	7	0
CLT	1	1	1	0,02	9	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	16,226	7	234	1	1	8	1,23	Lower limit	1	1055	0,335	67,0	7	2	86,90	0,0541	1	0,0541	0,95	0,0328	327,6	7	0
CLT	1	1	1	0,02	9	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	19,176	7	234	1	1	8	1,13	Lower limit	1	1055	0,335	67,0	7	2	96,87	0,0603	1	0,0603	0,95	0,0366	365,7	7	0
CLT	1	1	1	0,02	9	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	9,127	7	245	1	1	8	1,60	Lower limit	1	1101	0,321	64,2	7	2	61,47	0,0367	1	0,0367	0,95	0,0221	221,3	7	0
CLT	1	1	1	0,02	9	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	9,992	7	245	1	1	8	1,53	Lower limit	1	1101	0,321	64,2	7	2	65,19	0,0390	1	0,0390	0,95	0,0235	235,0	7	0
CLT	1	1	1	0,02	9	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	5,989	7	255	1	1	8	1,93	Lower limit	1	1147	0,308	61,6	7	2	48,00	0,0276	1	0,0276	0,95	0,0165	165,4	7	0
CLT	1	1	1	0,02	9	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	4,163	7	265	1	1	8	2,27	Lower limit	1	1193	0,296	59,3	7	2	38,87	0,0215	1	0,0215	0,95	0,0128	128,4	7	0
CLT	1	1	1	0,02	9	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	3,767	7	265	1	1	8	2,39	Lower limit	1	1193	0,296	59,3	7	2	36,43	0,0202	1	0,0202	0,95	0,0120	120,1	7	0
CLT	1	1	1	0,02	9	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	3,102	7	275	1	1	8	2,59	Lower limit	1	1239	0,285	57,1	7	2	32,90	0,0176	1	0,0176	0,95	0,0104	104,4	7	0
CLT	1	1	1	0,02	9	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	3,296	7	275	1	1	8	2,51	Lower limit	1	1239	0,285	57,1	7	2	34,23	0,0183	1	0,0183	0,95	0,0109	108,7	7	0
CLT	1	1	1	0,02	9	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	2,397	7	285	1	1	8	2,89	Lower limit	1	1285	0,275	55,0	7	2	28,49	0,0147	1	0,0147	0,95	0,0087	86,9	7	0
CLT	1	1	1	0,02	9	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	3,490	7	285	1	1	8	2,39	Lower limit	1	1285	0,275	55,0	7	2	36,37	0,0188	1	0,0188	0,95	0,0112	111,8	7	0
CLT	1	1	1	0,02	9	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	1,564	7	296	1	1	8	3,51	Lower limit	1	1331	0,266	53,1	7	2	22,08	0,0110	1	0,0110	0,95	0,0064	64,5	7	0
CLT	1	1	1	0,02	9	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	1,701	7	306	1	1	8	3,31	Lower limit	1	1376	0,257	51,4	7	2	23,85	0,0115	1	0,0115	0,95	0,0068	67,6	7	0
CLT	1	1	1	0,02	9	0	Lower limit	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	1,135	7	306	1	1	8	4,06	Lower limit	1	1376	0,257	51,4	7	2	18,34	0,0089	1	0,0089	0,95	0,0051	51,4	7	0
CLT	1	1	1	0,02	9	0	Lower limit	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	0,913	7	316	1	1	8	4,45	Lower limit	1	1422	0,249	49,7	7	2	16,25	0,0076	1	0,0076	0,95	0,0044	43,9	6	0
CLT	1	1	1	0,02	9	7	Resonant	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	0,749	6	326	1	1	8	4,84	Resonant	1	1468	0,241	48,2	7	2	14,59	0,0066	1	0,0066	0,95	0,0038	37,9	6	7
CLT	1	1	1	0,02	9	6	Resonant	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,613	6	336	1	1	8	5,26	Resonant	1	1514	0,233	46,7	6	2	13,07	0,0058	1	0,0058	0,95	0,0033	32,8	5	6
CLT	1	1	1	0,02	9	6	Resonant	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,520	5	347	1	1	8	5,63	Resonant	1	1560	0,227	45,3	6	2	11,98	0,0051	1	0,0051	0,95	0,0029	29,0	5	6
CON HC	1	1	1	0,005	9	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	1,408	7	451	1	1	8	3,00	Lower limit	1	2032	0,696	139,2	7	2	27,17	0,0090	1	0,0090	0,95	0,0062	62,1	7	0
CON HC	1	1	1	0,005	9	0	Lower limit	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,623	6	491	1	1	8	4,32	Lower limit	1	2212	0,639	127,9	7	2	16,89	0,0052	1	0,0052	0,95	0,0035	34,8	5	0
CON HC	1	1	1	0,005	9	7	Resonant	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,294	3	566	1	1	8	5,86	Resonant	1	2549	0,555	111,0	7	2	11,37	0,0030	1	0,0030	0,95	0,0020	19,9	4	7
CON HC	1	1	1	0,005	9	7	Resonant	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,171	1	612	1	1	8	7,39	Resonant	1	2756	0,513	102,6	7	2	8,41	0,0021	1	0,0021	0,95	0,0013	13,3	4	7
CON HC	1	1	1	0,005	9	3	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,095	1	673	1	1	8	9,43	Transient	1	3031	0,467	93,3	7	2	6,12	0,0014	1	0,0014	0,95	0,0009	8,5	3	3
CON IS	1	1	1	0,01	9	6	Resonant	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,314	3	833	1	1	8	4,67	Resonant	1	3751	0,189	37,7	6	2	15,26	0,0028	1	0,0028	0,95	0,0018	17,8	4	6
CON IS	1	1	1	0,01	9	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	10,787	7	383	1	1	8	1,18	Lower limit	1	1726	0,410	82,0	7	2	91,76	0,0358	1	0,0358	0,95	0,0241	240,7	7	0
CON IS	1	1	1	0,01	9	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	5,523	7	433	1	1	8	1,54	Lower limit	1	1951	0,362	72,5	7	2	64,31	0,0223	1	0,0223	0,95	0,0149	149,1	7	0
CON IS	1	1	1	0,01	9	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	3,196	7	483	1	1	8	1,92	Lower limit	1	2176	0,325	65,0	7	2	48,38	0,0151	1	0,0151	0,95	0,0100	100,3	7	0
CON IS	1	1	1	0,01	9	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	2,013	7	533	1	1	8	2,31	Lower limit	1	2401	0,295	58,9	7	2	38,19	0,0108	1	0,0108	0,95	0,0072	71,5	7	0
CON IS	1	1	1	0,01	9	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	1,348	7	583	1	1	8	2,69	Lower limit	1	2626	0,269	53,9	7	2	31,20	0,0081	1	0,0081	0,95	0,0053	53,2	7	0
CON IS	1	1	1	0,01	9	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	0,947	7	633	1	1	8	3,09	Lower limit	1	2851	0,248	49,6	7	2	26,16	0,0063	1	0,0063	0,95	0,0041	40,9	6	0
CON IS	1	1	1	0,01	9	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,690	6	683	1	1	8	3,48	Lower limit	1	3076	0,230	46,0	6	2	22,38	0,0050	1	0,0050	0,95	0,0032	32,3	5	0
CON IS	1	1	1	0,01	9	0	Lower limit	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,519	5	733	1	1	8	3,87	Lower limit	1	3301	0,214	42,8	6	2	19,45	0,0040	1	0,0040	0,95	0,0026	26,0	5	0
CON IS	1	1	1	0,01	9	0	Lower limit	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,400	3	783	1	1	8	4,27	Lower limit	1	3526	0,201	40,1	6	2	17,14	0,0033	1	0,0033	0,95	0,0021	21,4	4	0
CON IS	1	1	1	0,01	9	5	Resonant	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,252	3	883	1	1	8	5,07	Resonant	1	3976	0,178	35,6	5	2	13,72	0,0024	1	0,0024	0,95	0,0015	15,0	4	5
CON IS	1	1	1	0,01	9	5	Resonant	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,205	1	933	1	1	8	5,47	Resonant	1	4201	0,168	33,7	5	2	12,43	0,0020	1	0,0020	0,95	0,0013	12,8	4	5
CON IS	1	1	1	0,01	9	5	Resonant	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,169	1	983	1	1	8	5,87	Resonant	1	4426	0,160	32,0	5	2	11,34	0,0018	1	0,0018	0,95	0,0011	11,0	3	5
LVL	1	1	1	0,02	9	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	19,507	7	212	1	1	8	1,17	Lower limit	1	955	0,370	74,0	7	2	91,83	0,0627	1	0,0627	0,95	0,0380	380,1	7	0
LVL	1	1	1	0,02	9	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	12,176	7	214	1	1	8	1,48	Lower limit	1	961	0,368	73,5	7	2	67,88	0,0461	1	0,0461	0,95	0,0278	278,0	7	0
LVL	1	1	1	0,02	9	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	8,260	7	215	1	1	8	1,79	Lower limit	1	967	0,365	73,1	7	2	52,96	0,0357	1	0,0357	0,95	0,0215	214,6	7	0
LVL	1	1	1	0,02	9	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	5,939	7	216	1	1	8	2,11	Lower limit	1	973	0,363	72,6	7	2	42,91	0,0288	1	0,0288	0,95	0,0172	172,0	7	0
LVL	1	1	1	0,02	9	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	4,456	7	218	1	1	8	2,43	Lower limit	1	980	0,361	72,2	7	2	35,75	0,0238	1	0,0238	0,95	0,0142	141,7	7	0
LVL	1	1	1	0,02	9	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	3,455	7	219	1	1	8	2,75	Lower limit	1	986	0,359	71,7	7	2	30,42	0,0202	1	0,0202	0,95	0,0119	119,3	7	0
LVL	1	1	1	0,02	9	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	2,748	7	220	1	1	8	3,07	Lower limit	1	992	0,357	71,3	7	2	26,32	0,0174	1	0,0174	0,95	0,0102	102,1	7	0
LVL	1	1	1	0,02	9	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	2,232	7	222	1	1	8	3,40	Lower limit	1	998	0,354	70,9	7	2	23,08	0,0151	1	0,0151	0,95	0,0089	88,6	7	0
LVL	1	1	1	0,02	9	0	Lower limit	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	1,844	7	223	1	1	8	3,73	Lower limit	1	1004	0,352	70,5	7	2	20,47	0,0133	1	0,0133	0,95	0,0078	77,7	7	0
LVL	1	1	1	0,02	9	0	Lower limit	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	1,546	7	224	1	1	8	4,06	Lower limit	1	1010	0,350	70,0	7	2	18,32	0,0119	1	0,0119	0,95	0,0069	68,8	7	0
LVL	1	1	1	0,02	9	0	Lower limit	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	1,313	7	226	1	1	8	4,39	Lower limit	1	1016	0,348	69,6	7	2	16,53	0,0107	1	0,0107	0,95	0,0061	61,4	7	0
LVL	1	1	1	0,02	9	7	Resonant	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	1,126	7	227	1	1	8	4,73	Resonant	1	1022	0,346	69,2	7	2	15,02	0,0096	1	0,0096	0,95	0,0055	55,2	7	7
LVL	1	1	1	0,02	9	7	Resonant	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	0,975	7	228	1	1	8	5,06	Resonant	1	1028	0,344	68,8	7	2	13,73	0,0088	1	0,0088	0,95	0,0050	49,9	7	7
LVL	1	1	1	0,02	9	7	Resonant	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	0,851	7	230	1	1	8	5,40	Resonant	1	1034	0,342	68,4	7	2	12,62	0,0080	1	0,0080	0,95	0,0045	45,3	6	7
LVL	1	1	1	0,02	9	7	Resonant	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	0,749	6	231	1	1	8	5,75	Resonant	1	1040	0,340	68,0	7	2	11,65	0,0074	1	0,0074	0,95	0,0041	41,4	6	7
LVL	1	1	1	0,02	9	7	Resonant	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,663	6	232	1	1	8	6,09	Resonant	1	1046	0,338	67,6	7	2	10,81	0,0068	1	0,0068	0,95	0,0038	37,9	6	7
TCC	1	1	1	0,025	9	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	8,471	7	324	1	1	8	1,44	Lower limit	1	1459	0,194	38,8	6	2	70,32	0,0322	1	0,0322	0,95	0,0184	183,7	7	0
TCC	1	1	1	0,025	9	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	5,050	7	334	1	1	8	1,84	Lower limit	1	1505	0,188	37,6	6	2	51,27	0,0228	1	0,0228	0,95	0,0129	129,2	7	0
TCC	1	1	1	0,025	9	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	5,304	7	334	1	1	8	1,79	Lower limit	1	1505	0,188	37,6	6	2	52,93	0,0235	1	0,0235	0,95	0,0133	133,5	7	0
TCC	1	1	1	0,025	9	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	3,293	7	345	1	1	8	2,24	Lower limit	1	1551	0,182	36,5	6	2	39,59	0,0171	1	0,0171	0,95	0,0096	96,3	7	0
TCC	1	1	1	0,025	9	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	3,399	7	345	1	1	8	2,21	Lower limit	1	1551	0,182	36,5	6	2	40,41	0,0175	1	0,0175	0,95	0,0098	98,4	7	0
TCC	1	1	1	0,025	9	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	1,969	7	380	1	1	8	2,76	Lower limit	1	1709	0,165	33,1	5	2	30,19	0,0119	1	0,0119	0,95	0,0066	66,4	7	0
TCC	1	1	1	0,025	9	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	1,472	7	390	1	1	8	3,15	Lower limit	1	1755	0,161	32,2	5	2	25,43	0,0098	1	0,0098	0,95	0,0054	54,1	7	0
TCC	1	1	1	0,025	9	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	1,420	7	390	1	1	8	3,21	Lower limit	1	1755	0,161	32,2	5	2	24,83	0,0095	1	0,0095	0,95	0,0053	52,8	7	0
TCC	1	1	1	0,025	9	0	Lower limit	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	1,023	7	425	1	1	8	3,62	Lower limit	1	1914	0,148	29,6	5	2	21,23	0,0075	1	0,0075	0,95	0,0041	41,3	6	0
TCC	1	1	1	0,025	9	0	Lower limit	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	1,043	7	425	1	1	8	3,59	Lower limit	1	1914	0,148	29,6	5	2	21,50	0,0076	1	0,0076	0,95	0,0042	41,8	6	0
TCC	1	1	1	0,025	9	0	Lower limit	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	0,743	6	460	1	1	8	4,09	Lower limit	1	2072	0,136	27,3	5	2	18,16	0,0059	1	0,0059	0,95	0,0032	32,4	5	0
TCC	1	1	1	0,025	9	0	Lower limit	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	0,874	7	460	1	1	8	3,77	Lower limit	1	2072	0,136	27,3	5	2	20,18	0,0066	1	0,0066	0,95	0,0036	36,3	6	0
TCC	1	1	1	0,025	9	5	Resonant	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,557	5	471	1	1	8	4,67	Resonant	1	2118	0,134	26,7	5	2	15,27	0,0049	1	0,0049	0,95	0,0026	26,5	5	5
TCC	1	1	1	0,025	9	5	Resonant	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,542	5	481	1	1	8	4,68	Resonant	1	2164	0,131	26,1	5	2	15,22	0,0048	1	0,0048	0,95	0,0026	25,8	5	5
TCC	1	1	1	0,025	9	5	Resonant	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,396	3	506	1	1	8	5,34	Resonant	1	2276	0,124	24,8	5	2	12,81	0,0038	1	0,0038	0,95	0,0020	20,5	4	5
TCC	1	1	1	0,025	9	5	Resonant	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,338	3	516	1	1	8	5,72	Resonant	1	2322	0,122	24,4	5	2	11,72	0,0034	1	0,0034	0,95	0,0018	18,3	4	5
TCC	1	1	1	0,025	9	4	Resonant	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,292	3	526	1	1	8	6,10	Resonant	1	2368	0,119	23,9	4	2	10,78	0,0031	1	0,0031	0,95	0,0016	16,4	4	4
TCC	1	1	1	0,025	9	4	Resonant	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,245	1	536	1	1	8	6,59	Resonant	1	2414	0,117	23,4	4	2	9,76	0,0028	1	0,0028	0,95	0,0014	14,4	4	4
TCC	1	1	1	0,025	9	4	Resonant	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,216	1	547	1	1	8	6,96	Resonant	1	2460	0,115	23,0	4	2	9,09	0,0025	1	0,0025	0,95	0,0013	13,1	4	4

[1.10] Vibrational results for a narrow floor (1m) and 10m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	1	0,02	10	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	46,503	7	224	1	1	8	0,70	Lower limit	1	1121	0,315	63,1	7	2	179,25	0,1053	1	0,1053	0,95	0,0643	643,3	7	0
CLT	1	1	1	0,02	10	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	22,258	7	234	1	1	8	0,99	Lower limit	1	1172	0,302	60,3	7	2	114,29	0,0644	1	0,0644	0,95	0,0392	391,6	7	0
CLT	1	1	1	0,02	10	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	26,305	7	234	1	1	8	0,91	Lower limit	1	1172	0,302	60,3	7	2	127,40	0,0718	1	0,0718	0,95	0,0437	437,0	7	0
CLT	1	1	1	0,02	10	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	12,520	7	245	1	1	8	1,30	Lower limit	1	1223	0,289	57,8	7	2	80,84	0,0437	1	0,0437	0,95	0,0265	264,8	7	0
CLT	1	1	1	0,02	10	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	13,706	7	245	1	1	8	1,24	Lower limit	1	1223	0,289	57,8	7	2	85,74	0,0464	1	0,0464	0,95	0,0281	281,1	7	0
CLT	1	1	1	0,02	10	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	8,215	7	255	1	1	8	1,57	Lower limit	1	1274	0,277	55,5	7	2	63,12	0,0329	1	0,0329	0,95	0,0198	198,1	7	0
CLT	1	1	1	0,02	10	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	5,711	7	265	1	1	8	1,84	Lower limit	1	1325	0,267	53,3	7	2	51,12	0,0256	1	0,0256	0,95	0,0154	153,9	7	0
CLT	1	1	1	0,02	10	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	5,167	7	265	1	1	8	1,94	Lower limit	1	1325	0,267	53,3	7	2	47,90	0,0240	1	0,0240	0,95	0,0144	144,0	7	0
CLT	1	1	1	0,02	10	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	4,255	7	275	1	1	8	2,09	Lower limit	1	1376	0,257	51,4	7	2	43,27	0,0209	1	0,0209	0,95	0,0125	125,2	7	0
CLT	1	1	1	0,02	10	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	4,521	7	275	1	1	8	2,03	Lower limit	1	1376	0,257	51,4	7	2	45,01	0,0218	1	0,0218	0,95	0,0130	130,3	7	0
CLT	1	1	1	0,02	10	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	3,288	7	285	1	1	8	2,34	Lower limit	1	1427	0,248	49,5	7	2	37,47	0,0175	1	0,0175	0,95	0,0104	104,3	7	0
CLT	1	1	1	0,02	10	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	4,787	7	285	1	1	8	1,94	Lower limit	1	1427	0,248	49,5	7	2	47,84	0,0224	1	0,0224	0,95	0,0134	134,0	7	0
CLT	1	1	1	0,02	10	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	2,145	7	296	1	1	8	2,85	Lower limit	1	1478	0,239	47,8	6	2	29,04	0,0131	1	0,0131	0,95	0,0078	77,5	7	0
CLT	1	1	1	0,02	10	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	2,333	7	306	1	1	8	2,68	Lower limit	1	1529	0,231	46,2	6	2	31,36	0,0137	1	0,0137	0,95	0,0081	81,3	7	0
CLT	1	1	1	0,02	10	0	Lower limit	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	1,558	7	306	1	1	8	3,28	Lower limit	1	1529	0,231	46,2	6	2	24,11	0,0106	1	0,0106	0,95	0,0062	61,9	7	0
CLT	1	1	1	0,02	10	0	Lower limit	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	1,252	7	316	1	1	8	3,60	Lower limit	1	1580	0,224	44,7	6	2	21,37	0,0091	1	0,0091	0,95	0,0053	52,9	7	0
CLT	1	1	1	0,02	10	0	Lower limit	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	1,027	7	326	1	1	8	3,92	Lower limit	1	1631	0,217	43,3	6	2	19,18	0,0079	1	0,0079	0,95	0,0046	45,8	6	0
CLT	1	1	1	0,02	10	0	Lower limit	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	0,841	7	336	1	1	8	4,26	Lower limit	1	1682	0,210	42,0	6	2	17,19	0,0069	1	0,0069	0,95	0,0040	39,6	6	0
CLT	1	1	1	0,02	10	6	Resonant	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,714	6	347	1	1	8	4,56	Resonant	1	1733	0,204	40,8	6	2	15,75	0,0061	1	0,0061	0,95	0,0035	35,1	5	6
CON HC	1	1	1	0,005	10	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	1,932	7	451	1	1	8	2,43	Lower limit	1	2257	0,626	125,3	7	2	35,73	0,0107	1	0,0107	0,95	0,0074	74,4	7	0
CON HC	1	1	1	0,005	10	0	Lower limit	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	0,854	7	491	1	1	8	3,50	Lower limit	1	2457	0,575	115,1	7	2	22,21	0,0062	1	0,0062	0,95	0,0042	41,9	6	0
CON HC	1	1	1	0,005	10	7	Resonant	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,403	3	566	1	1	8	4,74	Resonant	1	2832	0,499	99,9	7	2	14,96	0,0036	1	0,0036	0,95	0,0024	24,1	5	7
CON HC	1	1	1	0,005	10	7	Resonant	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,234	1	612	1	1	8	5,98	Resonant	1	3062	0,462	92,4	7	2	11,06	0,0025	1	0,0025	0,95	0,0016	16,1	4	7
CON HC	1	1	1	0,005	10	7	Resonant	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,131	1	673	1	1	8	7,64	Resonant	1	3367	0,420	84,0	7	2	8,05	0,0016	1	0,0016	0,95	0,0010	10,4	3	7
CON IS	1	1	1	0,01	10	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	14,796	7	383	1	1	8	0,95	Lower limit	1	1917	0,369	73,8	7	2	120,67	0,0425	1	0,0425	0,95	0,0287	287,1	7	0
CON IS	1	1	1	0,01	10	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	7,576	7	433	1	1	8	1,25	Lower limit	1	2167	0,326	65,2	7	2	84,57	0,0265	1	0,0265	0,95	0,0178	177,9	7	0
CON IS	1	1	1	0,01	10	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	4,384	7	483	1	1	8	1,56	Lower limit	1	2417	0,293	58,5	7	2	63,63	0,0179	1	0,0179	0,95	0,0120	119,8	7	0
CON IS	1	1	1	0,01	10	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	2,761	7	533	1	1	8	1,87	Lower limit	1	2667	0,265	53,0	7	2	50,22	0,0128	1	0,0128	0,95	0,0085	85,5	7	0
CON IS	1	1	1	0,01	10	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	1,850	7	583	1	1	8	2,18	Lower limit	1	2917	0,242	48,5	7	2	41,03	0,0096	1	0,0096	0,95	0,0064	63,7	7	0
CON IS	1	1	1	0,01	10	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	1,299	7	633	1	1	8	2,50	Lower limit	1	3167	0,223	44,6	6	2	34,40	0,0074	1	0,0074	0,95	0,0049	49,0	7	0
CON IS	1	1	1	0,01	10	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	0,947	7	683	1	1	8	2,82	Lower limit	1	3417	0,207	41,4	6	2	29,43	0,0059	1	0,0059	0,95	0,0039	38,7	6	0
CON IS	1	1	1	0,01	10	0	Lower limit	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,711	6	733	1	1	8	3,14	Lower limit	1	3667	0,193	38,6	6	2	25,58	0,0048	1	0,0048	0,95	0,0031	31,3	5	0
CON IS	1	1	1	0,01	10	0	Lower limit	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,548	6	783	1	1	8	3,46	Lower limit	1	3917	0,181	36,1	6	2	22,54	0,0040	1	0,0040	0,95	0,0026	25,7	5	0
CON IS	1	1	1	0,01	10	0	Lower limit	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,431	3	833	1	1	8	3,78	Lower limit	1	4167	0,170	33,9	5	2	20,07	0,0033	1	0,0033	0,95	0,0021	21,4	4	0
CON IS	1	1	1	0,01	10	0	Lower limit	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,345	3	883	1	1	8	4,11	Lower limit	1	4417	0,160	32,0	5	2	18,04	0,0028	1	0,0028	0,95	0,0018	18,1	4	0
CON IS	1	1	1	0,01	10	0	Lower limit	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,281	3	933	1	1	8	4,43	Lower limit	1	4667	0,151	30,3	5	2	16,34	0,0024	1	0,0024	0,95	0,0015	15,4	4	0
CON IS	1	1	1	0,01	10	5	Resonant	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,231	1	983	1	1	8	4,75	Resonant	1	4917	0,144	28,8	5	2	14,91	0,0021	1	0,0021	0,95	0,0013	13,3	4	5
LVL	1	1	1	0,02	10	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	26,759	7	212	1	1	8	0,95	Lower limit	1	1062	0,333	66,6	7	2	120,77	0,0747	1	0,0747	0,95	0,0455	454,6	7	0
LVL	1	1	1	0,02	10	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	16,702	7	214	1	1	8	1,20	Lower limit	1	1068	0,331	66,2	7	2	89,27	0,0549	1	0,0549	0,95	0,0333	332,7	7	0
LVL	1	1	1	0,02	10	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	11,331	7	215	1	1	8	1,45	Lower limit	1	1075	0,329	65,8	7	2	69,65	0,0426	1	0,0426	0,95	0,0257	257,1	7	0
LVL	1	1	1	0,02	10	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	8,147	7	216	1	1	8	1,71	Lower limit	1	1082	0,327	65,4	7	2	56,44	0,0343	1	0,0343	0,95	0,0206	206,3	7	0
LVL	1	1	1	0,02	10	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	6,113	7	218	1	1	8	1,97	Lower limit	1	1088	0,325	65,0	7	2	47,01	0,0284	1	0,0284	0,95	0,0170	170,1	7	0
LVL	1	1	1	0,02	10	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	4,739	7	219	1	1	8	2,23	Lower limit	1	1095	0,323	64,6	7	2	40,00	0,0240	1	0,0240	0,95	0,0143	143,3	7	0
LVL	1	1	1	0,02	10	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	3,770	7	220	1	1	8	2,49	Lower limit	1	1102	0,321	64,2	7	2	34,61	0,0207	1	0,0207	0,95	0,0123	122,8	7	0
LVL	1	1	1	0,02	10	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	3,062	7	222	1	1	8	2,75	Lower limit	1	1108	0,319	63,8	7	2	30,35	0,0180	1	0,0180	0,95	0,0107	106,6	7	0
LVL	1	1	1	0,02	10	0	Lower limit	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	2,530	7	223	1	1	8	3,02	Lower limit	1	1115	0,317	63,4	7	2	26,92	0,0159	1	0,0159	0,95	0,0094	93,6	7	0
LVL	1	1	1	0,02	10	0	Lower limit	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	2,121	7	224	1	1	8	3,29	Lower limit	1	1122	0,315	63,0	7	2	24,10	0,0142	1	0,0142	0,95	0,0083	83,0	7	0
LVL	1	1	1	0,02	10	0	Lower limit	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	1,801	7	226	1	1	8	3,56	Lower limit	1	1128	0,313	62,7	7	2	21,75	0,0127	1	0,0127	0,95	0,0074	74,1	7	0
LVL	1	1	1	0,02	10	0	Lower limit	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	1,545	7	227	1	1	8	3,83	Lower limit	1	1135	0,311	62,3	7	2	19,76	0,0115	1	0,0115	0,95	0,0067	66,7	7	0
LVL	1	1	1	0,02	10	0	Lower limit	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	1,338	7	228	1	1	8	4,10	Lower limit	1	1142	0,310	61,9	7	2	18,06	0,0104	1	0,0104	0,95	0,0060	60,4	7	0
LVL	1	1	1	0,02	10	0	Lower limit	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	1,168	7	230	1	1	8	4,38	Lower limit	1	1148	0,308	61,6	7	2	16,60	0,0095	1	0,0095	0,95	0,0055	54,9	7	0
LVL	1	1	1	0,02	10	7	Resonant	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	1,027	7	231	1	1	8	4,65	Resonant	1	1155	0,306	61,2	7	2	15,33	0,0088	1	0,0088	0,95	0,0050	50,2	7	7
LVL	1	1	1	0,02	10	7	Resonant	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	0,909	7	232	1	1	8	4,93	Resonant	1	1162	0,304	60,9	7	2	14,21	0,0081	1	0,0081	0,95	0,0046	46,1	6	7
TCC	1	1	1	0,025	10	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	11,620	7	324	1	1	8	1,17	Lower limit	1	1621	0,174	34,9	5	2	92,48	0,0383	1	0,0383	0,95	0,0219	219,3	7	0
TCC	1	1	1	0,025	10	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	6,928	7	334	1	1	8	1,49	Lower limit	1	1672	0,169	33,8	5	2	67,42	0,0271	1	0,0271	0,95	0,0154	154,4	7	0
TCC	1	1	1	0,025	10	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	7,276	7	334	1	1	8	1,45	Lower limit	1	1672	0,169	33,8	5	2	69,61	0,0280	1	0,0280	0,95	0,0160	159,5	7	0
TCC	1	1	1	0,025	10	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	4,517	7	345	1	1	8	1,82	Lower limit	1	1723	0,164	32,8	5	2	52,06	0,0203	1	0,0203	0,95	0,0115	115,3	7	0
TCC	1	1	1	0,025	10	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	4,662	7	345	1	1	8	1,79	Lower limit	1	1723	0,164	32,8	5	2	53,15	0,0207	1	0,0207	0,95	0,0118	117,7	7	0
TCC	1	1	1	0,025	10	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	2,702	7	380	1	1	8	2,24	Lower limit	1	1899	0,149	29,8	5	2	39,71	0,0141	1	0,0141	0,95	0,0080	79,5	7	0
TCC	1	1	1	0,025	10	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	2,020	7	390	1	1	8	2,55	Lower limit	1	1950	0,145	29,0	5	2	33,44	0,0116	1	0,0116	0,95	0,0065	65,0	7	0
TCC	1	1	1	0,025	10	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	1,947	7	390	1	1	8	2,60	Lower limit	1	1950	0,145	29,0	5	2	32,66	0,0113	1	0,0113	0,95	0,0063	63,4	7	0
TCC	1	1	1	0,025	10	0	Lower limit	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	1,403	7	425	1	1	8	2,93	Lower limit	1	2126	0,133	26,6	5	2	27,92	0,0089	1	0,0089	0,95	0,0050	49,6	7	0
TCC	1	1	1	0,025	10	0	Lower limit	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	1,431	7	425	1	1	8	2,91	Lower limit	1	2126	0,133	26,6	5	2	28,27	0,0090	1	0,0090	0,95	0,0050	50,2	7	0
TCC	1	1	1	0,025	10	0	Lower limit	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	1,019	7	460	1	1	8	3,31	Lower limit	1	2302	0,123	24,6	5	2	23,88	0,0070	1	0,0070	0,95	0,0039	39,0	6	0
TCC	1	1	1	0,025	10	0	Lower limit	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	1,199	7	460	1	1	8	3,05	Lower limit	1	2302	0,123	24,6	5	2	26,54	0,0078	1	0,0078	0,95	0,0044	43,6	6	0
TCC	1	1	1	0,025	10	0	Lower limit	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	0,764	7	471	1	1	8	3,78	Lower limit	1	2353	0,120	24,0	5	2	20,08	0,0058	1	0,0058	0,95	0,0032	31,9	5	0
TCC	1	1	1	0,025	10	0	Lower limit	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,744	7	481	1	1	8	3,79	Lower limit	1	2404	0,118	23,5	4	2	20,02	0,0057	1	0,0057	0,95	0,0031	31,1	5	0
TCC	1	1	1	0,025	10	0	Lower limit	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,543	6	506	1	1	8	4,33	Lower limit	1	2529	0,112	22,4	4	2	16,85	0,0045	1	0,0045	0,95	0,0025	24,7	5	0
TCC	1	1	1	0,025	10	4	Resonant	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,464	3	516	1	1	8	4,63	Resonant	1	2580	0,110	21,9	4	2	15,42	0,0041	1	0,0041	0,95	0,0022	22,1	4	4
TCC	1	1	1	0,025	10	4	Resonant	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,400	3	526	1	1	8	4,94	Resonant	1	2631	0,107	21,5	4	2	14,18	0,0037	1	0,0037	0,95	0,0020	19,8	4	4
TCC	1	1	1	0,025	10	4	Resonant	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,337	3	536	1	1	8	5,33	Resonant	1	2682	0,105	21,1	4	2	12,84	0,0033	1	0,0033	0,95	0,0017	17,5	4	4
TCC	1	1	1	0,025	10	4	Resonant	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,296	3	547	1	1	8	5,64	Resonant	1	2733	0,103	20,7	4	2	11,95	0,0030	1	0,0030	0,95	0,0016	15,9	4	4

[1.11] Vibrational results for a narrow floor (1m) and 11m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn		
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn
CLT	1	1	1	0,02	11	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,00	61,895	7
CLT	1	1	1	0,02	11	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,00	29,625	7
CLT	1	1	1	0,02	11	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	1,00	35,012	7
CLT	1	1	1	0,02	11	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,00	16,664	7
CLT	1	1	1	0,02	11	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,00	18,243	7
CLT	1	1	1	0,02	11	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,00	10,934	7
CLT	1	1	1	0,02	11	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,00	7,601	7
CLT	1	1	1	0,02	11	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,00	6,877	7
CLT	1	1	1	0,02	11	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,00	5,664	7
CLT	1	1	1	0,02	11	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	1,00	6,018	7
CLT	1	1	1	0,02	11	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	1,00	4,376	7
CLT	1	1	1	0,02	11	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	1,00	6,372	7
CLT	1	1	1	0,02	11	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,00	2,855	7
CLT	1	1	1	0,02	11	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	1,00	3,106	7
CLT	1	1	1	0,02	11	0	Lower limit	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,00	2,073	7
CLT	1	1	1	0,02	11	0	Lower limit	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,00	1,666	7
CLT	1	1	1	0,02	11	0	Lower limit	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,00	1,367	7
CLT	1	1	1	0,02	11	0	Lower limit	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,00	1,120	7
CLT	1	1	1	0,02	11	0	Lower limit	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,00	0,950	7
CON HC	1	1	1	0,005	11	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	1,00	2,571	7
CON HC	1	1	1	0,005	11	0	Lower limit	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	1,00	1,137	7
CON HC	1	1	1	0,005	11	0	Lower limit	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	1,00	0,537	6
CON HC	1	1	1	0,005	11	7	Resonant	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	1,00	0,312	3
CON HC	1	1	1	0,005	11	7	Resonant	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	1,00	0,174	1
CON IS	1	1	1	0,01	11	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	1,00	19,694	7
CON IS	1	1	1	0,01	11	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	1,00	10,083	7
CON IS	1	1	1	0,01	11	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	1,00	5,835	7
CON IS	1	1	1	0,01	11	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	1,00	3,675	7
CON IS	1	1	1	0,01	11	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	1,00	2,462	7
CON IS	1	1	1	0,01	11	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	1,00	1,729	7
CON IS	1	1	1	0,01	11	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	1,00	1,260	7
CON IS	1	1	1	0,01	11	0	Lower limit	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	1,00	0,947	7
CON IS	1	1	1	0,01	11	0	Lower limit	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	1,00	0,729	7
CON IS	1	1	1	0,01	11	0	Lower limit	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	1,00	0,574	6
CON IS	1	1	1	0,01	11	0	Lower limit	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	1,00	0,459	3
CON IS	1	1	1	0,01	11	0	Lower limit	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	1,00	0,373	3
CON IS	1	1	1	0,01	11	0	Lower limit	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	1,00	0,308	3
LVL	1	1	1	0,02	11	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	1,00	35,616	7
LVL	1	1	1	0,02	11	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	1,00	22,230	7
LVL	1	1	1	0,02	11	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	1,00	15,082	7
LVL	1	1	1	0,02	11	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	1,00	10,844	7
LVL	1	1	1	0,02	11	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	1,00	8,136	7
LVL	1	1	1	0,02	11	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	1,00	6,308	7
LVL	1	1	1	0,02	11	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	1,00	5,017	7
LVL	1	1	1	0,02	11	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	1,00	4,075	7
LVL	1	1	1	0,02	11	0	Lower limit	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	1,00	3,368	7
LVL	1	1	1	0,02	11	0	Lower limit	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	1,00	2,823	7
LVL	1	1	1	0,02	11	0	Lower limit	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	1,00	2,397	7
LVL	1	1	1	0,02	11	0	Lower limit	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	1,00	2,056	7
LVL	1	1	1	0,02	11	0	Lower limit	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	1,00	1,780	7
LVL	1	1	1	0,02	11	0	Lower limit	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	1,00	1,554	7
LVL	1	1	1	0,02	11	0	Lower limit	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	1,00	1,367	7
LVL	1	1	1	0,02	11	0	Lower limit	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	1,00	1,210	7
TCC	1	1	1	0,025	11	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	1,00	15,466	7
TCC	1	1	1	0,025	11	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	1,00	9,221	7
TCC	1	1	1	0,025	11	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	1,00	9,685	7
TCC	1	1	1	0,025	11	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	1,00	6,012	7
TCC	1	1	1	0,025	11	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	1,00	6,206	7
TCC	1	1	1	0,025	11	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	1,00	3,596	7
TCC	1	1	1	0,025	11	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	1,00	2,688	7
TCC	1	1	1	0,025	11	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	1,00	2,592	7
TCC	1	1	1	0,025	11	0	Lower limit	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	1,00	1,868	7
TCC	1	1	1	0,025	11	0	Lower limit	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	1,00	1,905	7
TCC	1	1	1	0,025	11	0	Lower limit	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	1,00	1,357	7
TCC	1	1	1	0,025	11	0	Lower limit	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	1,00	1,596	7
TCC	1	1	1	0,025	11	0	Lower limit	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	1,00	1,016	7
TCC	1	1	1	0,025	11	0	Lower limit	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	1,00	0,990	7
TCC	1	1	1	0,025	11	0	Lower limit	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	1,00	0,722	7
TCC	1	1	1	0,025	11	0	Lower limit	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	1,00	0,617	6
TCC	1	1	1	0,025	11	0	Lower limit	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	1,00	0,532	6
TCC	1	1	1	0,025	11	0	Lower limit	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	1,00	0,448	3
TCC	1	1	1	0,025	11	4	Resonant	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	1,00	0,394	3

	Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Floortype	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
080 L3s	224	1	1	8	0,58	Lower limit	1	1234	0,287	57,3	7	2	229,66	0,1233	1	0,1233	0,95	0,0755	754,7	7	0
100 L3s	234	1	1	8	0,82	Lower limit	1	1290	0,274	54,8	7	2	146,43	0,0754	1	0,0754	0,95	0,0460	459,6	7	0
100 L5s	234	1	1	8	0,75	Lower limit	1	1290	0,274	54,8	7	2	163,23	0,0840	1	0,0840	0,95	0,0513	512,9	7	0
120 L3s	245	1	1	8	1,07	Lower limit	1	1346	0,263	52,5	7	2	103,57	0,0512	1	0,0512	0,95	0,0311	311,0	7	0
120 L5s	245	1	1	8	1,02	Lower limit	1	1346	0,263	52,5	7	2	109,85	0,0543	1	0,0543	0,95	0,0330	330,1	7	0
140 L5s	255	1	1	8	1,29	Lower limit	1	1402	0,252	50,4	7	2	80,88	0,0385	1	0,0385	0,95	0,0233	232,8	7	0
160 L5s	265	1	1	8	1,52	Lower limit	1	1458	0,242	48,5	7	2	65,50	0,0300	1	0,0300	0,95	0,0181	181,0	7	0
160 L5s-2	265	1	1	8	1,60	Lower limit	1	1458	0,242	48,5	7	2	61,38	0,0281	1	0,0281	0,95	0,0169	169,4	7	0
180 L5s	275	1	1	8	1,73	Lower limit	1	1514	0,234	46,7	6	2	55,44	0,0245	1	0,0245	0,95	0,0147	147,3	7	0
180 L7s	275	1	1	8	1,68	Lower limit	1	1514	0,234	46,7	6	2	57,67	0,0255	1	0,0255	0,95	0,0153	153,3	7	0
200 L5s	285	1	1	8	1,93	Lower limit	1	1570	0,225	45,0	6	2	48,01	0,0205	1	0,0205	0,95	0,0123	122,8	7	0
200 L7s	285	1	1	8	1,60	Lower limit	1	1570	0,225	45,0	6	2	61,29	0,0262	1	0,0262	0,95	0,0158	157,5	7	0
220 L7s-2	296	1	1	8	2,35	Lower limit	1	1626	0,217	43,5	6	2	37,21	0,0154	1	0,0154	0,95	0,0091	91,4	7	0
240 L7s	306	1	1	8	2,22	Lower limit	1	1682	0,210	42,0	6	2	40,18	0,0161	1	0,0161	0,95	0,0096	95,7	7	0
240 L7s-2	306	1	1	8	2,71	Lower limit	1	1682	0,210	42,0	6	2	30,90	0,0123	1	0,0123	0,95	0,0073	73,0	7	0
260 L7s-2	316	1	1	8	2,98	Lower limit	1	1738	0,203	40,7	6	2	27,38	0,0106	1	0,0106	0,95	0,0062	62,5	7	0
280 L7s-2	326	1	1	8	3,24	Lower limit	1	1795	0,197	39,4	6	2	24,58	0,0092	1	0,0092	0,95	0,0054	54,1	7	0
300 L8s-2	336	1	1	8	3,52	Lower limit	1	1851	0,191	38,2	6	2	22,02	0,0080	1	0,0080	0,95	0,0047	46,9	6	0
320 L8s-2	347	1	1	8	3,77	Lower limit	1	1907	0,185	37,1	6	2	20,18	0,0071	1	0,0071	0,95	0,0042	41,6	6	0
KP150	451	1	1	8	2,01	Lower limit	1	2483	0,570	113,9	7	2	45,77	0,0125	1	0,0125	0,95	0,0087	87,5	7	0
KP200	491	1	1	8	2,89	Lower limit	1	2703	0,523	104,6	7	2	28,46	0,0072	1	0,0072	0,95	0,0049	49,4	7	0
KP260	566	1	1	8	3,92	Lower limit	1	3116	0,454	90,8	7	2	19,16	0,0042	1	0,0042	0,95	0,0028	28,5	5	0
KP320	612	1	1	8	4,95	Resonant	1	3369	0,420	84,0	7	2	14,17	0,0029	1	0,0029	0,95	0,0019	19,2	4	7
KP400	673	1	1	8	6,31	Resonant	1	3704	0,382	76,4	7	2	10,32	0,0019	1	0,0019	0,95	0,0012	12,4	4	7
SC080	383	1	1	8	0,79	Lower limit	1	2109	0,335	67,1	7	2	154,61	0,0497	1	0,0497	0,95	0,0336	336,3	7	0
SC100	433	1	1	8	1,03	Lower limit	1	2384	0,297	59,3	7	2	108,36	0,0309	1	0,0309	0,95	0,0208	208,5	7	0
SC120	483	1	1	8	1,29	Lower limit	1	2659	0,266	53,2	7	2	81,52	0,0209	1	0,0209	0,95	0,0140	140,5	7	0
SC140	533	1	1	8	1,54	Lower limit	1	2934	0,241	48,2	7	2	64,34	0,0150	1	0,0150	0,95	0,0100	100,3	7	0
SC160	583	1	1	8	1,80	Lower limit	1	3209	0,220	44,1	6	2	52,57	0,0112	1	0,0112	0,95	0,0075	74,8	7	0
SC180	633	1	1	8	2,07	Lower limit	1	3484	0,203	40,6	6	2	44,07	0,0087	1	0,0087	0,95	0,0058	57,6	7	0
SC200	683	1	1	8	2,33	Lower limit	1	3759	0,188	37,6	6	2	37,70	0,0069	1	0,0069	0,95	0,0046	45,6	6	0
SC220	733	1	1	8	2,59	Lower limit	1	4034	0,175	35,1	5	2	32,78	0,0056	1	0,0056	0,95	0,0037	36,8	6	0
SC240	783	1	1	8	2,86	Lower limit	1	4309	0,164	32,8	5	2	28,88	0,0046	1	0,0046	0,95	0,0030	30,2	5	0
SC260	833	1	1	8	3,13	Lower limit	1	4584	0,154	30,8	5	2	25,72	0,0039	1	0,0039	0,95	0,0025	25,2	5	0
SC280	883	1	1	8	3,39	Lower limit	1	4859	0,146	29,1	5	2	23,11	0,0033	1	0,0033	0,95	0,0021	21,3	4	0
SC300	933	1	1	8	3,66	Lower limit	1	5134	0,138	27,5	5	2	20,94	0,0028	1	0,0028	0,95	0,0018	18,2	4	0
SC320	983	1	1	8	3,93	Lower limit	1	5409	0,131	26,1	5	2	19,10	0,0024	1	0,0024	0,95	0,0016	15,7	4	0
BX100	212	1	1	8	0,79	Lower limit	1	1168	0,303	60,6	7	2	154,74	0,0875	1	0,0875	0,95	0,0534	533,8	7	0
BX120	214	1	1	8	0,99	Lower limit	1	1175	0,301	60,2	7	2	114,37	0,0643	1	0,0643	0,95	0,0391	391,0	7	0
BX140	215	1	1	8	1,20	Lower limit	1	1182	0,299	59,8	7	2	89,24	0,0499	1	0,0499	0,95	0,0302	302,3	7	0
BX160	216	1	1	8	1,41	Lower limit	1	1190	0,297	59,4	7	2	72,31	0,0402	1	0,0402	0,95	0,0243	242,7	7	0
BX180	218	1	1	8	1,62	Lower limit	1	1197	0,295	59,1	7	2	60,23	0,0333	1	0,0333	0,95	0,0200	200,3	7	0
BX200	219	1	1	8	1,84	Lower limit	1	1205	0,294	58,7	7	2	51,25	0,0281	1	0,0281	0,95	0,0169	168,9	7	0
BX220	220	1	1	8	2,06	Lower limit	1	1212	0,292	58,3	7	2	44,34	0,0242	1	0,0242	0,95	0,0145	144,8	7	0
BX240	222	1	1	8	2,27	Lower limit	1	1219	0,290	58,0	7	2	38,89	0,0211	1	0,0211	0,95	0,0126	125,8	7	0
BX260	223	1	1	8	2,49	Lower limit	1	1227	0,288	57,6	7	2	34,49	0,0186	1	0,0186	0,95	0,0111	110,6	7	0
BX280	224	1	1	8	2,72	Lower limit	1	1234	0,287	57,3	7	2	30,87	0,0166	1	0,0166	0,95	0,0098	98,1	7	0
BX300	226	1	1	8	2,94	Lower limit	1	1241	0,285	57,0	7	2	27,86	0,0149	1	0,0149	0,95	0,0088	87,7	7	0
BX320	227	1	1	8	3,16	Lower limit	1	1249	0,283	56,6	7	2	25,32	0,0134	1	0,0134	0,95	0,0079	78,9	7	0
BX340	228	1	1	8	3,39	Lower limit	1	1256	0,282	56,3	7	2	23,14	0,0122	1	0,0122	0,95	0,0072	71,5	7	0
BX360	230	1	1	8	3,62	Lower limit	1	1263	0,280	56,0	7	2	21,27	0,0112	1	0,0112	0,95	0,0065	65,1	7	0
BX380	231	1	1	8	3,85	Lower limit	1	1271	0,278	55,6	7	2	19,64	0,0103	1	0,0103	0,95	0,0060	59,6	7	0
BX400	232	1	1	8	4,08	Lower limit	1	1278	0,277	55,3	7	2	18,21	0,0095	1	0,0095	0,95	0,0055	54,7	7	0
TC120	324	1	1	8	0,97	Lower limit	1	1784	0,159	31,7	5	2	118,49	0,0447	1	0,0447	0,95	0,0257	257,2	7	0
TC140	334	1	1	8	1,23	Lower limit	1	1840	0,154	30,7	5	2	86,38	0,0317	1	0,0317	0,95	0,0181	181,3	7	0
TC140-2	334	1	1	8	1,20	Lower limit	1	1840	0,154	30,7	5	2	89,18	0,0327	1	0,0327	0,95	0,0187	187,2	7	0
TC160	345	1	1	8	1,50	Lower limit	1	1896	0,149	29,8	5	2	66,71	0,0238	1	0,0238	0,95	0,0135	135,4	7	0
TC160-2	345	1	1	8	1,48	Lower limit	1	1896	0,149	29,8	5	2	68,10	0,0242	1	0,0242	0,95	0,0138	138,3	7	0
TC190	380	1	1	8	1,85	Lower limit	1	2089	0,135	27,1	5	2	50,88	0,0165	1	0,0165	0,95	0,0094	93,5	7	0
TC210	390	1	1	8	2,11	Lower limit	1	2145	0,132	26,4	5	2	42,84	0,0135	1	0,0135	0,95	0,0076	76,4	7	0
TC210-2	390	1	1	8	2,15	Lower limit	1	2145	0,132	26,4	5	2	41,84	0,0132	1	0,0132	0,95	0,0075	74,6	7	0
TC240	425	1	1	8	2,43	Lower limit	1	2339	0,121	24,2	5	2	35,77	0,0104	1	0,0104	0,95	0,0058	58,4	7	0
TC240-2	425	1	1	8	2,40	Lower limit	1	2339	0,121	24,2	5	2	36,22	0,0105	1	0,0105	0,95	0,0059	59,2	7	0
TC270	460	1	1	8	2,74	Lower limit	1	2533	0,112	22,3	4	2	30,59	0,0082	1	0,0082	0,95	0,0046	46,0	6	0
TC270-2	460	1	1	8	2,52	Lower limit	1	2533	0,112	22,3	4	2	34,00	0,0091	1	0,0091	0,95	0,0051	51,3	7	0
TC290	471	1	1	8	3,13	Lower limit	1	2589	0,109	21,9	4	2	25,73	0,0068	1	0,0068	0,95	0,0038	37,6	6	0
TC310	481	1	1	8	3,13	Lower limit	1	2645	0,107	21,4	4	2	25,65	0,0066	1	0,0066	0,95	0,0037	36,7	6	0
TC320	506	1	1	8	3,58	Lower limit	1	2782	0,102	20,3	4	2	21,59	0,0053	1	0,0053	0,95	0,0029	29,2	5	0
TC340	516	1	1	8	3,83	Lower limit	1	2838	0,100	19,9	4	2	19,75	0,0048	1	0,0048	0,95	0,0026	26,1	5	0
TC360	526	1	1	8	4,08	Lower limit	1	2895	0,098	19,5	4	2	18,17	0,0043	1	0,0043	0,95	0,0023	23,5	4	0
TC380	536	1	1	8	4,41	Lower limit	1	2951	0,096	19,2	4	2	16,45	0,0038	1	0,0038	0,95	0,0021	20,7	4	0
TC400	547	1	1	8	4,66	Resonant	1	3007	0,094	18,8	4	2	15,31	0,0035	1	0,0035	0,95	0,0019	18,9	4	4

[3.3] Vibrational results for a wide floor (3m) and 3m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	I_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	3	4	Transient	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,46	0,412	3	234	1	1	8	11,03	Transient	1	1055	0,335	67,0	7	2	4,99	0,0031	1	0,0031	0,95	0,0016	15,9	4	4
CLT	1	1	3	0,02	3	4	Transient	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	2,04	0,348	3	234	1	1	8	10,14	Transient	1	1055	0,335	67,0	7	2	5,57	0,0035	1	0,0035	0,95	0,0018	18,1	4	4
CLT	1	1	3	0,02	3	3	Transient	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,26	0,268	3	245	1	1	8	14,39	Transient	1	1101	0,321	64,2	7	2	3,53	0,0021	1,0839	0,0023	0,92	0,0011	10,6	3	3
CLT	1	1	3	0,02	3	3	Transient	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	1,73	0,213	1	245	1	1	8	13,76	Transient	1	1101	0,321	64,2	7	2	3,75	0,0022	1	0,0022	0,95	0,0011	10,9	3	3
CLT	1	1	3	0,02	3	7	Resonant	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	1,75	0,717	4	224	1	1	8	7,80	Resonant	1	1009	0,350	70,1	7	2	7,83	0,0051	1	0,0051	0,95	0,0028	27,6	5	7
CLT	1	1	3	0,02	3	2	Transient	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	1,53	0,145	1	255	1	1	8	17,41	Transient	1	1147	0,308	61,6	7	2	2,76	0,0016	1	0,0016	0,95	0,0007	7,2	2	2
CLT	1	1	3	0,02	3	2	Transient	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	1,69	0,091	1	265	1	1	8	20,47	Transient	1	1193	0,296	59,3	7	2	2,23	0,0012	1	0,0012	0,95	0,0005	5,2	2	2
CLT	1	1	3	0,02	3	2	Transient	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,01	0,138	1	265	1	1	8	21,53	Transient	1	1193	0,296	59,3	7	2	2,09	0,0012	1,3523	0,0016	0,81	0,0006	5,5	2	2
CLT	1	1	3	0,02	3	2	Transient	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	1,88	0,061	1	275	1	1	8	23,28	Transient	1	1239	0,285	57,1	7	2	1,89	0,0010	1	0,0010	0,95	0,0004	4,0	2	2
CLT	1	1	3	0,02	3	2	Transient	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	2,05	0,060	1	275	1	1	8	22,58	Transient	1	1239	0,285	57,1	7	2	1,97	0,0011	1	0,0011	0,95	0,0004	4,2	2	2
CLT	1	1	3	0,02	3	1	Transient	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	2,04	0,044	1	285	1	1	8	26,00	Transient	1	1285	0,275	55,0	7	2	1,64	0,0008	1	0,0008	0,95	0,0003	3,1	1	1
CLT	1	1	3	0,02	3	2	Transient	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	2,73	0,047	1	285	1	1	8	21,55	Transient	1	1285	0,275	55,0	7	2	2,09	0,0011	1	0,0011	0,95	0,0004	4,5	2	2
CLT	1	1	3	0,02	3	1	Transient	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	1,59	0,036	1	296	1	1	8	31,63	Transient	1	1331	0,266	53,1	7	2	1,27	0,0006	1	0,0006	0,95	0,0002	2,0	1	1
CLT	1	1	3	0,02	3	1	Transient	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	2,45	0,026	1	306	1	1	8	29,82	Transient	1	1376	0,257	51,4	7	2	1,37	0,0007	1	0,0007	0,95	0,0002	2,2	1	1
CLT	1	1	3	0,02	3	1	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,22	0,034	1	306	1	1	8	36,50	Transient	1	1376	0,257	51,4	7	2	1,05	0,0005	1,122	0,0006	0,90	0,0001	1,5	1	1
CLT	1	1	3	0,02	3	1	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,39	0,024	1	316	1	1	8	40,05	Transient	1	1422	0,249	49,7	7	2	0,93	0,0004	1	0,0004	0,95	0,0001	1,0	1	1
CLT	1	1	3	0,02	3	1	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	1,53	0,018	1	326	1	1	8	43,52	Transient	1	1468	0,241	48,2	7	2	0,84	0,0004	1	0,0004	0,95	0,0001	0,8	1	1
CLT	1	1	3	0,02	3	1	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	1,56	0,015	1	336	1	1	8	47,35	Transient	1	1514	0,233	46,7	6	2	0,75	0,0003	1	0,0003	0,95	0,0001	0,6	1	1
CLT	1	1	3	0,02	3	1	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	1,69	0,011	1	347	1	1	8	50,64	Transient	1	1560	0,227	45,3	6	2	0,69	0,0003	1	0,0003	0,95	0,0000	0,4	1	1
CON HC	1	1	3	0,005	3	1	Transient	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	2,74	0,019	1	451	1	1	8	26,97	Transient	1	2032	0,696	139,2	7	2	1,56	0,0005	1	0,0005	0,95	0,0002	2,2	1	1
CON HC	1	1	3	0,005	3	1	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	2,67	0,009	1	491	1	1	8	38,88	Transient	1	2212	0,639	127,9	7	2	0,97	0,0003	1	0,0003	0,95	0,0001	0,9	1	1
CON HC	1	1	3	0,005	3	1	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	2,69	0,004	1	566	1	1	8	52,70	Transient	1	2549	0,555	111,0	7	2	0,65	0,0002	1	0,0002	0,95	0,0000	0,2	1	1
CON HC	1	1	3	0,005	3	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	2,64	0,002	1	612	1	1	8	66,49	Transient	1	2756	0,513	102,6	7	2	0,48	0,0001	1	0,0001	0,95	0,0000	0,0	1	1
CON HC	1	1	3	0,005	3	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	2,61	0,001	1	673	1	1	8	84,84	Transient	1	3031	0,467	93,3	7	2	0,35	0,0001	1	0,0001	0,95	0,0000	-0,2	1	1
CON IS	1	1	3	0,01	3	1	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	2,85	0,003	1	883	1	1	8	45,62	Transient	1	3976	0,178	35,6	5	2	0,79	0,0001	1	0,0001	0,95	0,0000	0,3	1	1
CON IS	1	1	3	0,01	3	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	2,85	0,003	1	933	1	1	8	49,22	Transient	1	4201	0,168	33,7	5	2	0,71	0,0001	1	0,0001	0,95	0,0000	0,2	1	1
CON IS	1	1	3	0,01	3	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	2,85	0,002	1	983	1	1	8	52,83	Transient	1	4426	0,160	32,0	5	2	0,65	0,0001	1	0,0001	0,95	0,0000	0,1	1	1
CON IS	1	1	3	0,01	3	1	Transient	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	2,85	0,009	1	683	1	1	8	31,31	Transient	1	3076	0,230	46,0	6	2	1,29	0,0003	1	0,0003	0,95	0,0001	1,0	1	1
CON IS	1	1	3	0,01	3	1	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	2,85	0,007	1	733	1	1	8	34,87	Transient	1	3301	0,214	42,8	6	2	1,12	0,0002	1	0,0002	0,95	0,0001	0,7	1	1
CON IS	1	1	3	0,01	3	1	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	2,85	0,005	1	783	1	1	8	38,45	Transient	1	3526	0,201	40,1	6	2	0,98	0,0002	1	0,0002	0,95	0,0001	0,5	1	1
CON IS	1	1	3	0,01	3	1	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	2,85	0,004	1	833	1	1	8	42,03	Transient	1	3751	0,189	37,7	6	2	0,88	0,0002	1	0,0002	0,95	0,0000	0,4	1	1
CON IS	1	1	3	0,01	3	1	Transient	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	2,85	0,026	1	533	1	1	8	20,76	Transient	1	2401	0,295	58,9	7	2	2,19	0,0006	1	0,0006	0,95	0,0003	2,9	1	1
CON IS	1	1	3	0,01	3	1	Transient	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	2,85	0,018	1	583	1	1	8	24,25	Transient	1	2626	0,269	53,9	7	2	1,79	0,0005	1	0,0005	0,95	0,0002	2,0	1	1
CON IS	1	1	3	0,01	3	1	Transient	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	2,85	0,012	1	633	1	1	8	27,77	Transient	1	2851	0,248	49,6	7	2	1,50	0,0004	1	0,0004	0,95	0,0001	1,4	1	1
CON IS	1	1	3	0,01	3	2	Transient	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	2,85	0,072	1	433	1	1	8	13,90	Transient	1	1951	0,362	72,5	7	2	3,70	0,0013	1	0,0013	0,95	0,0007	6,9	2	2
CON IS	1	1	3	0,01	3	2	Transient	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	2,85	0,042	1	483	1	1	8	17,30	Transient	1	2176	0,325	65,0	7	2	2,78	0,0009	1	0,0009	0,95	0,0004	4,4	2	2
CON IS	1	1	3	0,01	3	3	Transient	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	2,85	0,140	1	383	1	1	8	10,58	Transient	1	1726	0,410	82,0	7	2	5,27	0,0021	1	0,0021	0,95	0,0012	11,8	3	3
LVL	1	1	3	0,02	3	4	Transient	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	2,84	0,254	3	212	1	1	8	10,57	Transient	1	955	0,370	74,0	7	2	5,28	0,0036	1	0,0036	0,95	0,0019	18,6	4	4
LVL	1	1	3	0,02	3	4	Transient	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	2,84	0,159	1	214	1	1	8	13,34	Transient	1	961	0,368	73,5	7	2	3,90	0,0026	1	0,0026	0,95	0,0013	13,0	4	4
LVL	1	1	3	0,02	3	3	Transient	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	2,84	0,108	1	215	1	1	8	16,14	Transient	1	967	0,365	73,1	7	2	3,04	0,0021	1	0,0021	0,95	0,0010	9,5	3	3
LVL	1	1	3	0,02	3	2	Transient	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	2,83	0,078	1	216	1	1	8	18,98	Transient	1	973	0,363	72,6	7	2	2,47	0,0017	1	0,0017	0,95	0,0007	7,2	2	2
LVL	1	1	3	0,02	3	2	Transient	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	2,83	0,058	1	218	1	1	8	21,84	Transient	1	980	0,361	72,2	7	2	2,05	0,0014	1	0,0014	0,95	0,0006	5,6	2	2
LVL	1	1	3	0,02	3	2	Transient	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	2,82	0,045	1	219	1	1	8	24,73	Transient	1	986	0,359	71,7	7	2	1,75	0,0012	1	0,0012	0,95	0,0004	4,4	2	2
LVL	1	1	3	0,02	3	1	Transient	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	2,82	0,036	1	220	1	1	8	27,64	Transient	1	992	0,357	71,3	7	2	1,51	0,0010	1	0,0010	0,95	0,0004	3,5	1	1
LVL	1	1	3	0,02	3	1	Transient	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	2,81	0,029	1	222	1	1	8	30,58	Transient	1	998	0,354	70,9	7	2	1,33	0,0009	1	0,0009	0,95	0,0003	2,8	1	1
LVL	1	1	3	0,02	3	1	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	2,81	0,024	1	223	1	1	8	33,54	Transient	1	1004	0,352	70,5	7	2	1,18	0,0008	1	0,0008	0,95	0,0002	2,3	1	1
LVL	1	1	3	0,02	3	1	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	2,80	0,020	1	224	1	1	8	36,52	Transient	1	1010	0,350	70,0	7	2	1,05	0,0007	1	0,0007	0,95	0,0002	1,8	1	1
LVL	1	1	3	0,02	3	1	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	2,80	0,017	1	226	1	1	8	39,52	Transient	1	1016	0,348	69,6	7	2	0,95	0,0006	1	0,0006	0,95	0,0001	1,5	1	1
LVL	1	1	3	0,02	3	1	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	2,79	0,015	1	227	1	1	8	42,54	Transient	1	1022	0,346	69,2	7	2	0,86	0,0006	1	0,0006	0,95	0,0001	1,2	1	1
LVL	1	1	3	0,02	3	1	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	2,79	0,013	1	228	1	1	8	45,58	Transient	1	1028	0,344	68,8	7	2	0,79	0,0005	1	0,0005	0,95	0,0001	0,9	1	1
LVL	1	1	3	0,02	3	1	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	2,79	0,011	1	230	1	1	8	48,64	Transient	1	1034	0,342	68,4	7	2	0,73	0,0005	1	0,0005	0,95	0,0001	0,7	1	1
LVL	1	1	3	0,02	3	1	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	2,78	0,010	1	231	1	1	8	51,72	Transient	1	1040	0,340	68,0	7	2	0,67	0,0004	1	0,0004	0,95	0,0001	0,5	1	1
LVL	1	1	3	0,02	3	1	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	2,78	0,009	1	232	1	1	8	54,82	Transient	1	1046	0,338	67,6	7	2	0,62	0,0004	1	0,0004	0,95	0,0000	0,4	1	1
TCC	1	1	3	0,025	3	3	Transient	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	2,68	0,117	1	324	1	1	8	12,98	Transient	1	1459	0,194	38,8	6	2	4,04	0,0019	1	0,0019	0,95	0,0009	8,6	3	3
TCC	1	1	3	0,025	3	2	Transient	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	2,56	0,073	1	334	1	1	8	16,55	Transient	1	1505	0,188	37,6	6	2	2,95	0,0013	1	0,0013	0,95	0,0006	5,7	2	2
TCC	1	1	3	0,025	3	2	Transient	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	2,64	0,074	1	334	1	1	8	16,15	Transient	1	1505	0,188	37,6	6	2	3,04	0,0014	1	0,0014	0,95	0,0006	5,9	2	2
TCC	1	1	3	0,025	3	1	Transient	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	2,48	0,049	1	345	1	1	8	20,19	Transient	1	1551	0,182	36,5	6	2	2,28	0,0010	1	0,0010	0,95	0,0004	4,0	1	1
TCC	1	1	3	0,025	3	2	Transient	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	2,54	0,050	1	345	1	1	8	19,87	Transient	1	1551	0,182	36,5	6	2	2,32	0,0010	1	0,0010	0,95	0,0004	4,1	2	2
TCC	1	1	3	0,025	3	1	Transient	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	2,50	0,029	1	380	1	1	8	24,87	Transient	1	1709	0,165	33,1	5	2	1,74	0,0007	1	0,0007	0,95	0,0002	2,5	1	1
TCC	1	1	3	0,025	3	1	Transient	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	2,49	0,022	1	390	1	1	8	28,38	Transient	1	1755	0,161	32,2	5	2	1,46	0,0006	1	0,0006	0,95	0,0002	1,8	1	1
TCC	1	1	3	0,025	3	1	Transient	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	2,42	0,022	1	390	1	1	8	28,90	Transient	1	1755	0,161	32,2	5	2	1,43	0,0005	1	0,0005	0,95	0,0002	1,8	1	1
TCC	1	1	3	0,025	3	1	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	2,56	0,015	1	425	1	1	8	32,61	Transient	1	1914	0,148	29,6	5	2	1,22	0,0004	1	0,0004	0,95	0,0001	1,3	1	1
TCC	1	1	3	0,025	3	1	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	2,59	0,015	1	425	1	1	8	32,29	Transient	1	1914	0,148	29,6	5	2	1,24	0,0004	1	0,0004	0,95	0,0001	1,3	1	1
TCC	1	1	3	0,025	3	1	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	2,62	0,010	1	460	1	1	8	36,77	Transient	1	2072	0,136	27,3	5	2	1,04	0,0003	1	0,0003	0,95	0,0001	0,9	1	1
TCC	1	1	3	0,025	3	1	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	2,87	0,011	1	460	1	1	8	33,90	Transient	1	2072	0,136	27,3	5	2	1,16	0,0004	1	0,0004	0,95	0,0001	1,1	1	1
TCC	1	1	3	0,025	3	1	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	2,48	0,008	1	471	1	1	8	42,02	Transient	1	2118	0,134	26,7	5	2	0,88	0,0003	1	0,0003	0,95	0,0001	0,6	1	1
TCC	1	1	3	0,025	3	1	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	2,74	0,007	1	481	1	1	8	42,12	Transient	1	2164	0,131	26,1	5	2	0,87	0,0003	1	0,0003	0,95	0,0001	0,6	1	1
TCC	1	1	3	0,025	3	1	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	2,41	0,006	1	506	1	1	8	48,08	Transient	1	2276	0,124	24,8	5	2	0,74	0,0002	1	0,0002	0,95	0,0000	0,3	1	1
TCC	1	1	3	0,025	3	1	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	2,44	0,005	1	516	1	1	8	51,49	Transient	1	2322	0,122	24,4	5	2	0,67	0,0002	1	0,0002	0,95	0,0000	0,2	1	1
TCC	1	1	3	0,025	3	1	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	2,46	0,004	1	526	1	1	8	54,91	Transient	1	2368	0,119	23,9	4	2	0,62	0,0002	1	0,0002	0,95	0,0000	0,2	1	1
TCC	1	1	3	0,025	3	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	2,43	0,004	1	536	1	1	8	59,27	Transient	1	2414	0,117	23,4	4	2	0,56	0,0002	1	0,0002	0,95	0,0000	0,1	1	1

[3.4] Vibrational results for a wide floor (3m) and 4m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	4	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	2,34	1,274	5	224	1	1	8	4,39	Lower limit	1	1346	0,263	52,5	7	2	16,55	0,0082	1	0,0082	0,95	0,0047	47,1	6	0
CLT	1	1	3	0,02	4	7	Resonant	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	1,94	0,733	4	234	1	1	8	6,20	Resonant	1	1407	0,251	50,3	7	2	10,55	0,0050	1	0,0050	0,95	0,0028	27,9	5	7
CLT	1	1	3	0,02	4	7	Resonant	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	2,72	0,619	4	234	1	1	8	5,71	Resonant	1	1407	0,251	50,3	7	2	11,76	0,0056	1	0,0056	0,95	0,0031	31,4	5	7
CLT	1	1	3	0,02	4	4	Transient	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	1,68	0,476	3	245	1	1	8	8,10	Transient	1	1468	0,241	48,2	7	2	7,46	0,0034	1	0,0034	0,95	0,0018	18,4	4	4
CLT	1	1	3	0,02	4	7	Resonant	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	2,31	0,380	3	245	1	1	8	7,74	Resonant	1	1468	0,241	48,2	7	2	7,92	0,0036	1	0,0036	0,95	0,0020	19,6	4	7
CLT	1	1	3	0,02	4	4	Transient	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	2,03	0,259	3	255	1	1	8	9,79	Transient	1	1529	0,231	46,2	6	2	5,83	0,0026	1	0,0026	0,95	0,0013	13,4	4	4
CLT	1	1	3	0,02	4	3	Transient	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	2,25	0,162	1	265	1	1	8	11,52	Transient	1	1591	0,222	44,5	6	2	4,72	0,0020	1	0,0020	0,95	0,0010	10,1	3	3
CLT	1	1	3	0,02	4	3	Transient	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,35	0,245	1	265	1	1	8	12,11	Transient	1	1591	0,222	44,5	6	2	4,42	0,0019	1,0142	0,0019	0,94	0,0009	9,4	3	3
CLT	1	1	3	0,02	4	3	Transient	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	2,51	0,108	1	275	1	1	8	13,09	Transient	1	1652	0,214	42,8	6	2	4,00	0,0016	1	0,0016	0,95	0,0008	8,0	3	3
CLT	1	1	3	0,02	4	3	Transient	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	2,73	0,106	1	275	1	1	8	12,70	Transient	1	1652	0,214	42,8	6	2	4,16	0,0017	1	0,0017	0,95	0,0008	8,4	3	3
CLT	1	1	3	0,02	4	2	Transient	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	2,72	0,077	1	285	1	1	8	14,63	Transient	1	1713	0,206	41,3	6	2	3,46	0,0014	1	0,0014	0,95	0,0007	6,5	2	2
CLT	1	1	3	0,02	4	3	Transient	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	0,102	1	285	1	1	8	12,12	Transient	1	1713	0,206	41,3	6	2	4,42	0,0017	1	0,0017	0,95	0,0009	8,7	3	3
CLT	1	1	3	0,02	4	2	Transient	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	2,12	0,065	1	296	1	1	8	17,79	Transient	1	1774	0,199	39,9	6	2	2,68	0,0010	1	0,0010	0,95	0,0005	4,6	2	2
CLT	1	1	3	0,02	4	2	Transient	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	0,050	1	306	1	1	8	16,77	Transient	1	1835	0,193	38,5	6	2	2,90	0,0011	1	0,0011	0,95	0,0005	4,9	2	2
CLT	1	1	3	0,02	4	1	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	1,63	0,061	1	306	1	1	8	20,53	Transient	1	1835	0,193	38,5	6	2	2,23	0,0008	1	0,0008	0,95	0,0003	3,5	1	1
CLT	1	1	3	0,02	4	1	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	1,85	0,043	1	316	1	1	8	22,53	Transient	1	1897	0,186	37,3	6	2	1,97	0,0007	1	0,0007	0,95	0,0003	2,8	1	1
CLT	1	1	3	0,02	4	1	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	2,03	0,032	1	326	1	1	8	24,48	Transient	1	1958	0,181	36,1	6	2	1,77	0,0006	1	0,0006	0,95	0,0002	2,4	1	1
CLT	1	1	3	0,02	4	1	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	2,08	0,026	1	336	1	1	8	26,64	Transient	1	2019	0,175	35,0	5	2	1,59	0,0005	1	0,0005	0,95	0,0002	1,9	1	1
CLT	1	1	3	0,02	4	1	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	2,25	0,020	1	347	1	1	8	28,48	Transient	1	2080	0,170	34,0	5	2	1,45	0,0005	1	0,0005	0,95	0,0002	1,6	1	1
CON HC	1	1	3	0,005	4	2	Transient	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,041	1	451	1	1	8	15,17	Transient	1	2709	0,522	104,4	7	2	3,30	0,0008	1	0,0008	0,95	0,0005	4,6	2	2
CON HC	1	1	3	0,005	4	1	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,018	1	491	1	1	8	21,87	Transient	1	2949	0,480	95,9	7	2	2,05	0,0005	1	0,0005	0,95	0,0002	2,3	1	1
CON HC	1	1	3	0,005	4	1	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,009	1	566	1	1	8	29,65	Transient	1	3399	0,416	83,2	7	2	1,38	0,0003	1	0,0003	0,95	0,0001	1,1	1	1
CON HC	1	1	3	0,005	4	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,005	1	612	1	1	8	37,40	Transient	1	3675	0,385	77,0	7	2	1,02	0,0002	1	0,0002	0,95	0,0001	0,6	1	1
CON HC	1	1	3	0,005	4	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,003	1	673	1	1	8	47,73	Transient	1	4041	0,350	70,0	7	2	0,74	0,0001	1	0,0001	0,95	0,0000	0,2	1	1
CON IS	1	1	3	0,01	4	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,005	1	983	1	1	8	29,72	Transient	1	5901	0,120	24,0	4	2	1,38	0,0002	1	0,0002	0,95	0,0001	0,6	1	1
CON IS	1	1	3	0,01	4	1	Transient	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,020	1	683	1	1	8	17,61	Transient	1	4101	0,172	34,5	5	2	2,72	0,0005	1	0,0005	0,95	0,0002	2,3	1	1
CON IS	1	1	3	0,01	4	1	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,015	1	733	1	1	8	19,62	Transient	1	4401	0,161	32,1	5	2	2,36	0,0004	1	0,0004	0,95	0,0002	1,8	1	1
CON IS	1	1	3	0,01	4	1	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,012	1	783	1	1	8	21,63	Transient	1	4701	0,150	30,1	5	2	2,08	0,0003	1	0,0003	0,95	0,0001	1,4	1	1
CON IS	1	1	3	0,01	4	1	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,009	1	833	1	1	8	23,64	Transient	1	5001	0,141	28,3	5	2	1,85	0,0003	1	0,0003	0,95	0,0001	1,1	1	1
CON IS	1	1	3	0,01	4	1	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,007	1	883	1	1	8	25,66	Transient	1	5301	0,133	26,7	5	2	1,67	0,0002	1	0,0002	0,95	0,0001	0,9	1	1
CON IS	1	1	3	0,01	4	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,006	1	933	1	1	8	27,69	Transient	1	5601	0,126	25,2	5	2	1,51	0,0002	1	0,0002	0,95	0,0001	0,7	1	1
CON IS	1	1	3	0,01	4	1	Transient	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,028	1	633	1	1	8	15,62	Transient	1	3801	0,186	37,2	6	2	3,18	0,0006	1	0,0006	0,95	0,0003	3,0	1	1
CON IS	1	1	3	0,01	4	2	Transient	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	0,059	1	533	1	1	8	11,68	Transient	1	3201	0,221	44,2	6	2	4,64	0,0010	1	0,0010	0,95	0,0006	5,6	2	2
CON IS	1	1	3	0,01	4	2	Transient	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,039	1	583	1	1	8	13,64	Transient	1	3501	0,202	40,4	6	2	3,79	0,0007	1	0,0007	0,95	0,0004	4,0	2	2
CON IS	1	1	3	0,01	4	3	Transient	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	0,094	1	483	1	1	8	9,73	Transient	1	2901	0,244	48,8	7	2	5,87	0,0014	1	0,0014	0,95	0,0008	8,1	3	3
CON IS	1	1	3	0,01	4	7	Resonant	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	0,316	3	383	1	1	8	5,95	Resonant	1	2301	0,307	61,5	7	2	11,14	0,0033	1	0,0033	0,95	0,0020	20,5	4	7
CON IS	1	1	3	0,01	4	7	Resonant	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	0,162	1	433	1	1	8	7,82	Resonant	1	2601	0,272	54,4	7	2	7,81	0,0020	1	0,0020	0,95	0,0012	12,3	4	7
LVL	1	1	3	0,02	4	7	Resonant	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	0,571	4	212	1	1	8	5,94	Resonant	1	1274	0,278	55,5	7	2	11,15	0,0058	1	0,0058	0,95	0,0033	32,6	5	7
LVL	1	1	3	0,02	4	7	Resonant	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	0,356	3	214	1	1	8	7,50	Resonant	1	1282	0,276	55,2	7	2	8,24	0,0043	1	0,0043	0,95	0,0023	23,3	4	7
LVL	1	1	3	0,02	4	4	Transient	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	0,242	1	215	1	1	8	9,08	Transient	1	1290	0,274	54,8	7	2	6,43	0,0033	1	0,0033	0,95	0,0018	17,6	4	4
LVL	1	1	3	0,02	4	4	Transient	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	0,174	1	216	1	1	8	10,67	Transient	1	1298	0,272	54,5	7	2	5,21	0,0027	1	0,0027	0,95	0,0014	13,8	4	4
LVL	1	1	3	0,02	4	3	Transient	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	0,130	1	218	1	1	8	12,28	Transient	1	1306	0,271	54,1	7	2	4,34	0,0022	1	0,0022	0,95	0,0011	11,1	3	3
LVL	1	1	3	0,02	4	3	Transient	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	0,101	1	219	1	1	8	13,91	Transient	1	1314	0,269	53,8	7	2	3,69	0,0019	1	0,0019	0,95	0,0009	9,1	3	3
LVL	1	1	3	0,02	4	2	Transient	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	0,080	1	220	1	1	8	15,55	Transient	1	1322	0,267	53,5	7	2	3,20	0,0016	1	0,0016	0,95	0,0008	7,5	2	2
LVL	1	1	3	0,02	4	2	Transient	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	0,065	1	222	1	1	8	17,20	Transient	1	1330	0,266	53,2	7	2	2,80	0,0014	1	0,0014	0,95	0,0006	6,4	2	2
LVL	1	1	3	0,02	4	2	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	3,00	0,054	1	223	1	1	8	18,86	Transient	1	1338	0,264	52,8	7	2	2,49	0,0012	1	0,0012	0,95	0,0005	5,4	2	2
LVL	1	1	3	0,02	4	2	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,045	1	224	1	1	8	20,54	Transient	1	1346	0,263	52,5	7	2	2,22	0,0011	1	0,0011	0,95	0,0005	4,6	2	2
LVL	1	1	3	0,02	4	2	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,038	1	226	1	1	8	22,23	Transient	1	1354	0,261	52,2	7	2	2,01	0,0010	1	0,0010	0,95	0,0004	4,0	2	2
LVL	1	1	3	0,02	4	1	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,033	1	227	1	1	8	23,93	Transient	1	1362	0,260	51,9	7	2	1,82	0,0009	1	0,0009	0,95	0,0003	3,5	1	1
LVL	1	1	3	0,02	4	1	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,029	1	228	1	1	8	25,64	Transient	1	1370	0,258	51,6	7	2	1,67	0,0008	1	0,0008	0,95	0,0003	3,0	1	1
LVL	1	1	3	0,02	4	1	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,025	1	230	1	1	8	27,36	Transient	1	1378	0,257	51,3	7	2	1,53	0,0007	1	0,0007	0,95	0,0003	2,6	1	1
LVL	1	1	3	0,02	4	1	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,022	1	231	1	1	8	29,09	Transient	1	1386	0,255	51,0	7	2	1,42	0,0007	1	0,0007	0,95	0,0002	2,3	1	1
LVL	1	1	3	0,02	4	1	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,019	1	232	1	1	8	30,84	Transient	1	1394	0,254	50,7	7	2	1,31	0,0006	1	0,0006	0,95	0,0002	2,0	1	1
TCC	1	1	3	0,025	4	5	Resonant	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	0,248	1	324	1	1	8	7,30	Resonant	1	1946	0,145	29,1	5	2	8,54	0,0030	1	0,0030	0,95	0,0015	15,4	4	5
TCC	1	1	3	0,025	4	3	Transient	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	0,148	1	334	1	1	8	9,31	Transient	1	2007	0,141	28,2	5	2	6,23	0,0021	1	0,0021	0,95	0,0010	10,5	3	3
TCC	1	1	3	0,025	4	3	Transient	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	0,155	1	334	1	1	8	9,08	Transient	1	2007	0,141	28,2	5	2	6,43	0,0022	1	0,0022	0,95	0,0011	10,9	3	3
TCC	1	1	3	0,025	4	2	Transient	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	0,096	1	345	1	1	8	11,36	Transient	1	2068	0,137	27,4	5	2	4,81	0,0016	1	0,0016	0,95	0,0008	7,6	2	2
TCC	1	1	3	0,025	4	2	Transient	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	0,099	1	345	1	1	8	11,18	Transient	1	2068	0,137	27,4	5	2	4,91	0,0016	1	0,0016	0,95	0,0008	7,8	2	2
TCC	1	1	3	0,025	4	2	Transient	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	0,058	1	380	1	1	8	13,99	Transient	1	2279	0,124	24,8	5	2	3,67	0,0011	1	0,0011	0,95	0,0005	5,0	2	2
TCC	1	1	3	0,025	4	1	Transient	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,043	1	390	1	1	8	15,96	Transient	1	2341	0,121	24,2	5	2	3,09	0,0009	1	0,0009	0,95	0,0004	3,9	1	1
TCC	1	1	3	0,025	4	1	Transient	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,042	1	390	1	1	8	16,26	Transient	1	2341	0,121	24,2	5	2	3,02	0,0009	1	0,0009	0,95	0,0004	3,8	1	1
TCC	1	1	3	0,025	4	1	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,030	1	425	1	1	8	18,34	Transient	1	2552	0,111	22,2	4	2	2,58	0,0007	1	0,0007	0,95	0,0003	2,9	1	1
TCC	1	1	3	0,025	4	1	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,031	1	425	1	1	8	18,16	Transient	1	2552	0,111	22,2	4	2	2,61	0,0007	1	0,0007	0,95	0,0003	2,9	1	1
TCC	1	1	3	0,025	4	1	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,022	1	460	1	1	8	20,68	Transient	1	2763	0,102	20,5	4	2	2,20	0,0005	1	0,0005	0,95	0,0002	2,2	1	1
TCC	1	1	3	0,025	4	1	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,026	1	460	1	1	8	19,07	Transient	1	2763	0,102	20,5	4	2	2,45	0,0006	1	0,0006	0,95	0,0002	2,5	1	1
TCC	1	1	3	0,025	4	1	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,016	1	471	1	1	8	23,63	Transient	1	2824	0,100	20,0	4	2	1,85	0,0004	1	0,0004	0,95	0,0002	1,7	1	1
TCC	1	1	3	0,025	4	1	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,016	1	481	1	1	8	23,69	Transient	1	2885	0,098	19,6	4	2	1,85	0,0004	1	0,0004	0,95	0,0002	1,6	1	1
TCC	1	1	3	0,025	4	1	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,012	1	506	1	1	8	27,04	Transient	1	3035	0,093	18,6	4	2	1,56	0,0004	1	0,0004	0,95	0,0001	1,2	1	1
TCC	1	1	3	0,025	4	1	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,010	1	516	1	1	8	28,96	Transient	1	3097	0,091	18,3	4	2	1,42	0,0003	1	0,0003	0,95	0,0001	1,0	1	1
TCC	1	1	3	0,025	4	1	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,009	1	526	1	1	8	30,89	Transient	1	3158	0,090	17,9	4	2	1,31	0,0003	1	0,0003	0,95	0,0001	0,9	1	1
TCC	1	1	3	0,025	4	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,007	1	536	1	1	8	33,34	Transient	1	3219	0,088	17,6	4	2	1,19	0,0003	1	0,0003	0,95	0,0001	0,7	1	1
TCC	1	1	3	0,025	4	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	3,00	0,006	1	547	1	1	8	35,23	Transient	1	3280	0,086	17,2	4	2	1,10	0,0002	1	0,0002	0,95	0,0001	0,6	1	1

[3.5] Vibrational results for a wide floor (3m) and 5m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	5	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	2,92	1,991	7	224	1	1	8	2,81	Lower limit	1	1682	0,210	42,0	6	2	29,57	0,0118	1	0,0118	0,95	0,0070	69,8	7	0
CLT	1	1	3	0,02	5	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	2,43	1,145	6	234	1	1	8	3,97	Lower limit	1	1759	0,201	40,2	6	2	18,85	0,0072	1	0,0072	0,95	0,0042	41,8	6	0
CLT	1	1	3	0,02	5	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	3,00	1,096	6	234	1	1	8	3,65	Lower limit	1	1759	0,201	40,2	6	2	21,01	0,0080	1	0,0080	0,95	0,0047	46,9	6	0
CLT	1	1	3	0,02	5	6	Resonant	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	2,10	0,744	5	245	1	1	8	5,18	Resonant	1	1835	0,193	38,5	6	2	13,33	0,0049	1	0,0049	0,95	0,0028	27,8	5	6
CLT	1	1	3	0,02	5	6	Resonant	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	2,89	0,593	4	245	1	1	8	4,95	Resonant	1	1835	0,193	38,5	6	2	14,14	0,0052	1	0,0052	0,95	0,0030	29,6	5	6
CLT	1	1	3	0,02	5	6	Resonant	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	2,54	0,404	3	255	1	1	8	6,27	Resonant	1	1912	0,185	37,0	6	2	10,41	0,0037	1	0,0037	0,95	0,0021	20,5	4	6
CLT	1	1	3	0,02	5	5	Resonant	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	2,81	0,254	3	265	1	1	8	7,37	Resonant	1	1988	0,178	35,6	5	2	8,43	0,0029	1	0,0029	0,95	0,0016	15,7	4	5
CLT	1	1	3	0,02	5	5	Resonant	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	1,69	0,383	3	265	1	1	8	7,75	Resonant	1	1988	0,178	35,6	5	2	7,90	0,0027	1	0,0027	0,95	0,0015	14,6	4	5
CLT	1	1	3	0,02	5	4	Transient	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	3,00	0,177	1	275	1	1	8	8,38	Transient	1	2065	0,171	34,2	5	2	7,14	0,0023	1	0,0023	0,95	0,0013	12,6	4	4
CLT	1	1	3	0,02	5	4	Transient	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	3,00	0,188	1	275	1	1	8	8,13	Transient	1	2065	0,171	34,2	5	2	7,42	0,0024	1	0,0024	0,95	0,0013	13,2	4	4
CLT	1	1	3	0,02	5	3	Transient	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	3,00	0,137	1	285	1	1	8	9,36	Transient	1	2141	0,165	33,0	5	2	6,18	0,0020	1	0,0020	0,95	0,0010	10,3	3	3
CLT	1	1	3	0,02	5	5	Resonant	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	0,199	1	285	1	1	8	7,76	Resonant	1	2141	0,165	33,0	5	2	7,89	0,0025	1	0,0025	0,95	0,0014	13,6	4	5
CLT	1	1	3	0,02	5	2	Transient	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	2,65	0,101	1	296	1	1	8	11,39	Transient	1	2218	0,159	31,9	5	2	4,79	0,0015	1	0,0015	0,95	0,0007	7,5	2	2
CLT	1	1	3	0,02	5	2	Transient	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	0,097	1	306	1	1	8	10,73	Transient	1	2294	0,154	30,8	5	2	5,17	0,0015	1	0,0015	0,95	0,0008	7,9	2	2
CLT	1	1	3	0,02	5	2	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	2,03	0,096	1	306	1	1	8	13,14	Transient	1	2294	0,154	30,8	5	2	3,98	0,0012	1	0,0012	0,95	0,0006	5,8	2	2
CLT	1	1	3	0,02	5	2	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	2,31	0,068	1	316	1	1	8	14,42	Transient	1	2371	0,149	29,8	5	2	3,53	0,0010	1	0,0010	0,95	0,0005	4,9	2	2
CLT	1	1	3	0,02	5	2	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	2,54	0,050	1	326	1	1	8	15,67	Transient	1	2447	0,144	28,9	5	2	3,16	0,0009	1	0,0009	0,95	0,0004	4,1	2	2
CLT	1	1	3	0,02	5	1	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	2,60	0,040	1	336	1	1	8	17,05	Transient	1	2524	0,140	28,0	5	2	2,84	0,0008	1	0,0008	0,95	0,0003	3,5	1	1
CLT	1	1	3	0,02	5	1	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	2,81	0,032	1	347	1	1	8	18,23	Transient	1	2600	0,136	27,2	5	2	2,60	0,0007	1	0,0007	0,95	0,0003	3,0	1	1
CON HC	1	1	3	0,005	5	2	Transient	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,080	1	451	1	1	8	9,71	Transient	1	3386	0,418	83,5	7	2	5,89	0,0012	1	0,0012	0,95	0,0007	7,3	2	2
CON HC	1	1	3	0,005	5	1	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,036	1	491	1	1	8	14,00	Transient	1	3686	0,384	76,7	7	2	3,66	0,0007	1	0,0007	0,95	0,0004	3,9	1	1
CON HC	1	1	3	0,005	5	1	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,017	1	566	1	1	8	18,97	Transient	1	4249	0,333	66,6	7	2	2,47	0,0004	1	0,0004	0,95	0,0002	2,0	1	1
CON HC	1	1	3	0,005	5	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,010	1	612	1	1	8	23,94	Transient	1	4594	0,308	61,6	7	2	1,82	0,0003	1	0,0003	0,95	0,0001	1,2	1	1
CON HC	1	1	3	0,005	5	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,005	1	673	1	1	8	30,54	Transient	1	5051	0,280	56,0	7	2	1,33	0,0002	1	0,0002	0,95	0,0001	0,7	1	1
CON IS	1	1	3	0,01	5	1	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,018	1	833	1	1	8	15,13	Transient	1	6251	0,113	22,6	4	2	3,31	0,0004	1	0,0004	0,95	0,0002	1,9	1	1
CON IS	1	1	3	0,01	5	1	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,014	1	883	1	1	8	16,42	Transient	1	6626	0,107	21,3	4	2	2,98	0,0003	1	0,0003	0,95	0,0002	1,6	1	1
CON IS	1	1	3	0,01	5	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,012	1	933	1	1	8	17,72	Transient	1	7001	0,101	20,2	4	2	2,70	0,0003	1	0,0003	0,95	0,0001	1,3	1	1
CON IS	1	1	3	0,01	5	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,010	1	983	1	1	8	19,02	Transient	1	7376	0,096	19,2	4	2	2,46	0,0002	1	0,0002	0,95	0,0001	1,1	1	1
CON IS	1	1	3	0,01	5	1	Transient	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,039	1	683	1	1	8	11,27	Transient	1	5126	0,138	27,6	5	2	4,85	0,0007	1	0,0007	0,95	0,0004	3,7	1	1
CON IS	1	1	3	0,01	5	1	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,030	1	733	1	1	8	12,55	Transient	1	5501	0,129	25,7	5	2	4,22	0,0005	1	0,0005	0,95	0,0003	2,9	1	1
CON IS	1	1	3	0,01	5	1	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,023	1	783	1	1	8	13,84	Transient	1	5876	0,120	24,1	5	2	3,72	0,0004	1	0,0004	0,95	0,0002	2,4	1	1
CON IS	1	1	3	0,01	5	2	Transient	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,077	1	583	1	1	8	8,73	Transient	1	4376	0,162	32,3	5	2	6,77	0,0011	1	0,0011	0,95	0,0006	6,3	2	2
CON IS	1	1	3	0,01	5	2	Transient	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,054	1	633	1	1	8	10,00	Transient	1	4751	0,149	29,8	5	2	5,67	0,0008	1	0,0008	0,95	0,0005	4,8	2	2
CON IS	1	1	3	0,01	5	5	Resonant	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	0,115	1	533	1	1	8	7,47	Resonant	1	4001	0,177	35,3	5	2	8,28	0,0014	1	0,0014	0,95	0,0009	8,6	3	5
CON IS	1	1	3	0,01	5	6	Resonant	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	0,316	3	433	1	1	8	5,00	Resonant	1	3251	0,217	43,5	6	2	13,95	0,0029	1	0,0029	0,95	0,0019	18,6	4	6
CON IS	1	1	3	0,01	5	6	Resonant	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	0,183	1	483	1	1	8	6,23	Resonant	1	3626	0,195	39,0	6	2	10,49	0,0020	1	0,0020	0,95	0,0012	12,3	4	6
CON IS	1	1	3	0,01	5	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	0,617	4	383	1	1	8	3,81	Lower limit	1	2876	0,246	49,2	7	2	19,90	0,0047	1	0,0047	0,95	0,0031	30,5	5	0
LVL	1	1	3	0,02	5	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	1,115	6	212	1	1	8	3,80	Lower limit	1	1592	0,222	44,4	6	2	19,92	0,0084	1	0,0084	0,95	0,0049	48,8	7	0
LVL	1	1	3	0,02	5	6	Resonant	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	0,696	4	214	1	1	8	4,80	Resonant	1	1602	0,221	44,1	6	2	14,72	0,0062	1	0,0062	0,95	0,0035	35,2	5	6
LVL	1	1	3	0,02	5	6	Resonant	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	0,472	3	215	1	1	8	5,81	Resonant	1	1612	0,219	43,9	6	2	11,49	0,0048	1	0,0048	0,95	0,0027	26,9	5	6
LVL	1	1	3	0,02	5	6	Resonant	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	0,339	3	216	1	1	8	6,83	Resonant	1	1622	0,218	43,6	6	2	9,31	0,0038	1	0,0038	0,95	0,0021	21,3	4	6
LVL	1	1	3	0,02	5	6	Resonant	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	0,255	3	218	1	1	8	7,86	Resonant	1	1633	0,217	43,3	6	2	7,75	0,0032	1	0,0032	0,95	0,0017	17,3	4	6
LVL	1	1	3	0,02	5	4	Transient	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	0,197	1	219	1	1	8	8,90	Transient	1	1643	0,215	43,0	6	2	6,60	0,0027	1	0,0027	0,95	0,0014	14,4	4	4
LVL	1	1	3	0,02	5	4	Transient	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	0,157	1	220	1	1	8	9,95	Transient	1	1653	0,214	42,8	6	2	5,71	0,0023	1	0,0023	0,95	0,0012	12,1	4	4
LVL	1	1	3	0,02	5	3	Transient	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	0,128	1	222	1	1	8	11,01	Transient	1	1663	0,213	42,5	6	2	5,01	0,0020	1	0,0020	0,95	0,0010	10,4	3	3
LVL	1	1	3	0,02	5	3	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	3,00	0,105	1	223	1	1	8	12,07	Transient	1	1673	0,211	42,3	6	2	4,44	0,0018	1	0,0018	0,95	0,0009	9,0	3	3
LVL	1	1	3	0,02	5	2	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,088	1	224	1	1	8	13,15	Transient	1	1683	0,210	42,0	6	2	3,97	0,0016	1	0,0016	0,95	0,0008	7,8	2	2
LVL	1	1	3	0,02	5	2	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,075	1	226	1	1	8	14,23	Transient	1	1693	0,209	41,8	6	2	3,59	0,0014	1	0,0014	0,95	0,0007	6,9	2	2
LVL	1	1	3	0,02	5	2	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,064	1	227	1	1	8	15,31	Transient	1	1703	0,208	41,5	6	2	3,26	0,0013	1	0,0013	0,95	0,0006	6,1	2	2
LVL	1	1	3	0,02	5	2	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,056	1	228	1	1	8	16,41	Transient	1	1713	0,206	41,3	6	2	2,98	0,0012	1	0,0012	0,95	0,0005	5,4	2	2
LVL	1	1	3	0,02	5	2	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,049	1	230	1	1	8	17,51	Transient	1	1723	0,205	41,0	6	2	2,74	0,0011	1	0,0011	0,95	0,0005	4,8	2	2
LVL	1	1	3	0,02	5	2	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,043	1	231	1	1	8	18,62	Transient	1	1733	0,204	40,8	6	2	2,53	0,0010	1	0,0010	0,95	0,0004	4,3	2	2
LVL	1	1	3	0,02	5	1	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,038	1	232	1	1	8	19,73	Transient	1	1743	0,203	40,6	6	2	2,34	0,0009	1	0,0009	0,95	0,0004	3,9	1	1
TCC	1	1	3	0,025	5	4	Resonant	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	0,484	3	324	1	1	8	4,67	Resonant	1	2432	0,116	23,3	4	2	15,25	0,0043	1	0,0043	0,95	0,0023	23,1	4	4
TCC	1	1	3	0,025	5	4	Resonant	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	0,289	3	334	1	1	8	5,96	Resonant	1	2509	0,113	22,5	4	2	11,12	0,0030	1	0,0030	0,95	0,0016	16,0	4	4
TCC	1	1	3	0,025	5	4	Resonant	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	0,303	3	334	1	1	8	5,81	Resonant	1	2509	0,113	22,5	4	2	11,48	0,0031	1	0,0031	0,95	0,0017	16,6	4	4
TCC	1	1	3	0,025	5	4	Resonant	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	0,188	1	345	1	1	8	7,27	Resonant	1	2585	0,109	21,9	4	2	8,59	0,0023	1	0,0023	0,95	0,0012	11,7	3	4
TCC	1	1	3	0,025	5	4	Resonant	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	0,194	1	345	1	1	8	7,15	Resonant	1	2585	0,109	21,9	4	2	8,77	0,0023	1	0,0023	0,95	0,0012	12,0	4	4
TCC	1	1	3	0,025	5	2	Transient	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	0,113	1	380	1	1	8	8,95	Transient	1	2849	0,099	19,9	4	2	6,55	0,0016	1	0,0016	0,95	0,0008	7,9	2	2
TCC	1	1	3	0,025	5	2	Transient	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,084	1	390	1	1	8	10,22	Transient	1	2926	0,097	19,3	4	2	5,52	0,0013	1	0,0013	0,95	0,0006	6,3	2	2
TCC	1	1	3	0,025	5	2	Transient	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,081	1	390	1	1	8	10,41	Transient	1	2926	0,097	19,3	4	2	5,39	0,0013	1	0,0013	0,95	0,0006	6,2	2	2
TCC	1	1	3	0,025	5	2	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,058	1	425	1	1	8	11,74	Transient	1	3190	0,089	17,7	4	2	4,60	0,0010	1	0,0010	0,95	0,0005	4,7	2	2
TCC	1	1	3	0,025	5	2	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,060	1	425	1	1	8	11,63	Transient	1	3190	0,089	17,7	4	2	4,66	0,0010	1	0,0010	0,95	0,0005	4,8	2	2
TCC	1	1	3	0,025	5	1	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,042	1	460	1	1	8	13,24	Transient	1	3454	0,082	16,4	4	2	3,94	0,0008	1	0,0008	0,95	0,0004	3,6	1	1
TCC	1	1	3	0,025	5	2	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,050	1	460	1	1	8	12,20	Transient	1	3454	0,082	16,4	4	2	4,38	0,0009	1	0,0009	0,95	0,0004	4,1	2	2
TCC	1	1	3	0,025	5	1	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,032	1	471	1	1	8	15,13	Transient	1	3530	0,080	16,0	4	2	3,31	0,0006	1	0,0006	0,95	0,0003	2,9	1	1
TCC	1	1	3	0,025	5	1	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,031	1	481	1	1	8	15,16	Transient	1	3607	0,078	15,7	4	2	3,30	0,0006	1	0,0006	0,95	0,0003	2,8	1	1
TCC	1	1	3	0,025	5	1	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,023	1	506	1	1	8	17,31	Transient	1	3794	0,075	14,9	4	2	2,78	0,0005	1	0,0005	0,95	0,0002	2,2	1	1
TCC	1	1	3	0,025	5	1	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,019	1	516	1	1	8	18,53	Transient	1	3871	0,073	14,6	4	2	2,54	0,0005	1	0,0005	0,95	0,0002	1,9	1	1
TCC	1	1	3	0,025	5	1	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,017	1	526	1	1	8	19,77	Transient	1	3947	0,072	14,3	4	2	2,34	0,0004	1	0,0004	0,95	0,0002	1,7	1	1
TCC	1	1	3	0,025	5	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,014	1	536	1	1	8	21,34	Transient	1	4024	0,070	14,1	4	2	2,12	0,0004	1	0,0004	0,95	0,0001	1,4	1	1
TCC	1	1	3	0,025	5	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	3,00	0,012	1	547	1	1	8	22,55	Transient	1	4100	0,069	13,8	4	2	1,97	0,0003	1	0,0003	0,95	0,0001	1,3	1	1

[3.6] Vibrational results for a wide floor (3m) and 6m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	6	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	3,00	3,348	7	224	1	1	8	1,95	Lower limit	1	2019	0,175	35,0	5	2	47,50	0,0159	1	0,0159	0,95	0,0095	95,3	7	0
CLT	1	1	3	0,02	6	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	2,91	1,649	7	234	1	1	8	2,76	Lower limit	1	2110	0,168	33,5	5	2	30,28	0,0097	1	0,0097	0,95	0,0057	57,5	7	0
CLT	1	1	3	0,02	6	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	3,00	1,894	7	234	1	1	8	2,54	Lower limit	1	2110	0,168	33,5	5	2	33,76	0,0108	1	0,0108	0,95	0,0064	64,3	7	0
CLT	1	1	3	0,02	6	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	2,52	1,071	6	245	1	1	8	3,60	Lower limit	1	2202	0,161	32,1	5	2	21,42	0,0066	1	0,0066	0,95	0,0038	38,5	6	0
CLT	1	1	3	0,02	6	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	3,00	0,987	6	245	1	1	8	3,44	Lower limit	1	2202	0,161	32,1	5	2	22,72	0,0070	1	0,0070	0,95	0,0041	40,9	6	0
CLT	1	1	3	0,02	6	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	3,00	0,591	4	255	1	1	8	4,35	Lower limit	1	2294	0,154	30,8	5	2	16,73	0,0050	1	0,0050	0,95	0,0029	28,5	5	0
CLT	1	1	3	0,02	6	5	Resonant	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	3,00	0,411	3	265	1	1	8	5,12	Resonant	1	2386	0,148	29,6	5	2	13,55	0,0039	1	0,0039	0,95	0,0022	22,0	4	5
CLT	1	1	3	0,02	6	5	Resonant	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	2,02	0,552	4	265	1	1	8	5,38	Resonant	1	2386	0,148	29,6	5	2	12,69	0,0036	1	0,0036	0,95	0,0020	20,5	4	5
CLT	1	1	3	0,02	6	5	Resonant	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	3,00	0,306	3	275	1	1	8	5,82	Resonant	1	2478	0,143	28,5	5	2	11,47	0,0032	1	0,0032	0,95	0,0018	17,7	4	5
CLT	1	1	3	0,02	6	5	Resonant	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	3,00	0,326	3	275	1	1	8	5,65	Resonant	1	2478	0,143	28,5	5	2	11,93	0,0033	1	0,0033	0,95	0,0018	18,5	4	5
CLT	1	1	3	0,02	6	5	Resonant	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	3,00	0,237	1	285	1	1	8	6,50	Resonant	1	2569	0,138	27,5	5	2	9,93	0,0026	1	0,0026	0,95	0,0015	14,6	4	5
CLT	1	1	3	0,02	6	5	Resonant	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	0,345	3	285	1	1	8	5,39	Resonant	1	2569	0,138	27,5	5	2	12,67	0,0034	1	0,0034	0,95	0,0019	19,0	4	5
CLT	1	1	3	0,02	6	5	Resonant	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	3,00	0,154	1	296	1	1	8	7,91	Resonant	1	2661	0,133	26,6	5	2	7,70	0,0020	1	0,0020	0,95	0,0011	10,7	3	5
CLT	1	1	3	0,02	6	5	Resonant	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	0,168	1	306	1	1	8	7,45	Resonant	1	2753	0,128	25,7	5	2	8,31	0,0021	1	0,0021	0,95	0,0011	11,3	3	5
CLT	1	1	3	0,02	6	3	Transient	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	2,44	0,138	1	306	1	1	8	9,12	Transient	1	2753	0,128	25,7	5	2	6,39	0,0016	1	0,0016	0,95	0,0008	8,4	3	3
CLT	1	1	3	0,02	6	2	Transient	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	2,78	0,097	1	316	1	1	8	10,01	Transient	1	2845	0,124	24,9	5	2	5,66	0,0014	1	0,0014	0,95	0,0007	7,1	2	2
CLT	1	1	3	0,02	6	2	Transient	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	3,00	0,074	1	326	1	1	8	10,88	Transient	1	2937	0,120	24,1	5	2	5,08	0,0012	1	0,0012	0,95	0,0006	6,1	2	2
CLT	1	1	3	0,02	6	2	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	3,00	0,061	1	336	1	1	8	11,84	Transient	1	3028	0,117	23,3	4	2	4,55	0,0010	1	0,0010	0,95	0,0005	5,2	2	2
CLT	1	1	3	0,02	6	2	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	3,00	0,051	1	347	1	1	8	12,66	Transient	1	3120	0,113	22,7	4	2	4,17	0,0009	1	0,0009	0,95	0,0005	4,6	2	2
CON HC	1	1	3	0,005	6	7	Resonant	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,139	1	451	1	1	8	6,74	Resonant	1	4063	0,348	69,6	7	2	9,47	0,0016	1	0,0016	0,95	0,0010	10,3	3	7
CON HC	1	1	3	0,005	6	2	Transient	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,062	1	491	1	1	8	9,72	Transient	1	4423	0,320	63,9	7	2	5,89	0,0009	1	0,0009	0,95	0,0006	5,6	2	2
CON HC	1	1	3	0,005	6	1	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,029	1	566	1	1	8	13,18	Transient	1	5098	0,277	55,5	7	2	3,96	0,0005	1	0,0005	0,95	0,0003	3,1	1	1
CON HC	1	1	3	0,005	6	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,017	1	612	1	1	8	16,62	Transient	1	5512	0,257	51,3	7	2	2,93	0,0004	1	0,0004	0,95	0,0002	2,0	1	1
CON HC	1	1	3	0,005	6	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,009	1	673	1	1	8	21,21	Transient	1	6061	0,233	46,7	6	2	2,13	0,0002	1	0,0002	0,95	0,0001	1,2	1	1
CON IS	1	1	3	0,01	6	1	Transient	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,039	1	783	1	1	8	9,61	Transient	1	7051	0,100	20,1	4	2	5,97	0,0006	1	0,0006	0,95	0,0003	3,4	1	1
CON IS	1	1	3	0,01	6	1	Transient	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,031	1	833	1	1	8	10,51	Transient	1	7501	0,094	18,9	4	2	5,32	0,0005	1	0,0005	0,95	0,0003	2,8	1	1
CON IS	1	1	3	0,01	6	1	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,025	1	883	1	1	8	11,41	Transient	1	7951	0,089	17,8	4	2	4,78	0,0004	1	0,0004	0,95	0,0002	2,4	1	1
CON IS	1	1	3	0,01	6	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,020	1	933	1	1	8	12,31	Transient	1	8401	0,084	16,8	4	2	4,33	0,0004	1	0,0004	0,95	0,0002	2,0	1	1
CON IS	1	1	3	0,01	6	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,017	1	983	1	1	8	13,21	Transient	1	8851	0,080	16,0	4	2	3,95	0,0003	1	0,0003	0,95	0,0002	1,7	1	1
CON IS	1	1	3	0,01	6	4	Resonant	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,068	1	683	1	1	8	7,83	Resonant	1	6151	0,115	23,0	4	2	7,80	0,0009	1	0,0009	0,95	0,0005	5,3	2	4
CON IS	1	1	3	0,01	6	2	Transient	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,051	1	733	1	1	8	8,72	Transient	1	6601	0,107	21,4	4	2	6,78	0,0007	1	0,0007	0,95	0,0004	4,2	2	2
CON IS	1	1	3	0,01	6	5	Resonant	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,094	1	633	1	1	8	6,94	Resonant	1	5701	0,124	24,8	5	2	9,11	0,0011	1	0,0011	0,95	0,0007	6,8	2	5
CON IS	1	1	3	0,01	6	5	Resonant	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,133	1	583	1	1	8	6,06	Resonant	1	5251	0,135	26,9	5	2	10,87	0,0014	1	0,0014	0,95	0,0009	8,9	3	5
CON IS	1	1	3	0,01	6	5	Resonant	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	0,199	1	533	1	1	8	5,19	Resonant	1	4801	0,147	29,5	5	2	13,31	0,0019	1	0,0019	0,95	0,0012	12,1	4	5
CON IS	1	1	3	0,01	6	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	0,316	3	483	1	1	8	4,33	Lower limit	1	4351	0,163	32,5	5	2	16,86	0,0027	1	0,0027	0,95	0,0017	17,1	4	0
CON IS	1	1	3	0,01	6	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	0,545	4	433	1	1	8	3,48	Lower limit	1	3901	0,181	36,2	6	2	22,41	0,0039	1	0,0039	0,95	0,0026	25,6	5	0
CON IS	1	1	3	0,01	6	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	1,065	6	383	1	1	8	2,64	Lower limit	1	3451	0,205	41,0	6	2	31,97	0,0064	1	0,0064	0,95	0,0042	41,8	6	0
LVL	1	1	3	0,02	6	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	1,927	7	212	1	1	8	2,64	Lower limit	1	1911	0,185	37,0	6	2	32,00	0,0113	1	0,0113	0,95	0,0067	67,0	7	0
LVL	1	1	3	0,02	6	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	1,203	7	214	1	1	8	3,33	Lower limit	1	1923	0,184	36,8	6	2	23,65	0,0083	1	0,0083	0,95	0,0049	48,7	7	0
LVL	1	1	3	0,02	6	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	0,816	5	215	1	1	8	4,03	Lower limit	1	1935	0,183	36,5	6	2	18,46	0,0064	1	0,0064	0,95	0,0037	37,3	6	0
LVL	1	1	3	0,02	6	6	Resonant	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	0,587	4	216	1	1	8	4,74	Resonant	1	1947	0,182	36,3	6	2	14,95	0,0052	1	0,0052	0,95	0,0030	29,7	5	6
LVL	1	1	3	0,02	6	6	Resonant	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	0,440	3	218	1	1	8	5,46	Resonant	1	1959	0,180	36,1	6	2	12,46	0,0043	1	0,0043	0,95	0,0024	24,3	5	6
LVL	1	1	3	0,02	6	5	Resonant	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	0,341	3	219	1	1	8	6,18	Resonant	1	1971	0,179	35,9	5	2	10,60	0,0036	1	0,0036	0,95	0,0020	20,3	4	5
LVL	1	1	3	0,02	6	5	Resonant	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	0,271	3	220	1	1	8	6,91	Resonant	1	1983	0,178	35,7	5	2	9,17	0,0031	1	0,0031	0,95	0,0017	17,3	4	5
LVL	1	1	3	0,02	6	5	Resonant	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	0,220	1	222	1	1	8	7,64	Resonant	1	1995	0,177	35,4	5	2	8,04	0,0027	1	0,0027	0,95	0,0015	14,9	4	5
LVL	1	1	3	0,02	6	4	Transient	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	3,00	0,182	1	223	1	1	8	8,38	Transient	1	2007	0,176	35,2	5	2	7,13	0,0024	1	0,0024	0,95	0,0013	12,9	4	4
LVL	1	1	3	0,02	6	3	Transient	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,153	1	224	1	1	8	9,13	Transient	1	2019	0,175	35,0	5	2	6,38	0,0021	1	0,0021	0,95	0,0011	11,4	3	3
LVL	1	1	3	0,02	6	3	Transient	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,130	1	226	1	1	8	9,88	Transient	1	2031	0,174	34,8	5	2	5,76	0,0019	1	0,0019	0,95	0,0010	10,1	3	3
LVL	1	1	3	0,02	6	3	Transient	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,111	1	227	1	1	8	10,64	Transient	1	2043	0,173	34,6	5	2	5,24	0,0017	1	0,0017	0,95	0,0009	9,0	3	3
LVL	1	1	3	0,02	6	3	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,096	1	228	1	1	8	11,40	Transient	1	2055	0,172	34,4	5	2	4,79	0,0016	1	0,0016	0,95	0,0008	8,0	3	3
LVL	1	1	3	0,02	6	2	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,084	1	230	1	1	8	12,16	Transient	1	2067	0,171	34,2	5	2	4,40	0,0014	1	0,0014	0,95	0,0007	7,2	2	2
LVL	1	1	3	0,02	6	2	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,074	1	231	1	1	8	12,93	Transient	1	2079	0,170	34,0	5	2	4,06	0,0013	1	0,0013	0,95	0,0007	6,5	2	2
LVL	1	1	3	0,02	6	2	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,065	1	232	1	1	8	13,70	Transient	1	2091	0,169	33,8	5	2	3,77	0,0012	1	0,0012	0,95	0,0006	5,9	2	2
TCC	1	1	3	0,025	6	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	0,837	5	324	1	1	8	3,24	Lower limit	1	2919	0,097	19,4	4	2	24,51	0,0057	1	0,0057	0,95	0,0032	31,8	5	0
TCC	1	1	3	0,025	6	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	0,499	3	334	1	1	8	4,14	Lower limit	1	3010	0,094	18,8	4	2	17,86	0,0041	1	0,0041	0,95	0,0022	22,2	4	0
TCC	1	1	3	0,025	6	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	0,524	4	334	1	1	8	4,04	Lower limit	1	3010	0,094	18,8	4	2	18,44	0,0042	1	0,0042	0,95	0,0023	22,9	4	0
TCC	1	1	3	0,025	6	4	Resonant	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	0,325	3	345	1	1	8	5,05	Resonant	1	3102	0,091	18,2	4	2	13,80	0,0030	1	0,0030	0,95	0,0016	16,4	4	4
TCC	1	1	3	0,025	6	4	Resonant	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	0,336	3	345	1	1	8	4,97	Resonant	1	3102	0,091	18,2	4	2	14,08	0,0031	1	0,0031	0,95	0,0017	16,7	4	4
TCC	1	1	3	0,025	6	4	Resonant	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	0,195	1	380	1	1	8	6,22	Resonant	1	3419	0,083	16,5	4	2	10,52	0,0021	1	0,0021	0,95	0,0011	11,1	3	4
TCC	1	1	3	0,025	6	4	Resonant	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,145	1	390	1	1	8	7,10	Resonant	1	3511	0,081	16,1	4	2	8,86	0,0017	1	0,0017	0,95	0,0009	9,0	3	4
TCC	1	1	3	0,025	6	4	Resonant	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,140	1	390	1	1	8	7,23	Resonant	1	3511	0,081	16,1	4	2	8,65	0,0017	1	0,0017	0,95	0,0009	8,8	3	4
TCC	1	1	3	0,025	6	2	Transient	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,101	1	425	1	1	8	8,15	Transient	1	3828	0,074	14,8	4	2	7,40	0,0013	1	0,0013	0,95	0,0007	6,8	2	2
TCC	1	1	3	0,025	6	2	Transient	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,103	1	425	1	1	8	8,07	Transient	1	3828	0,074	14,8	4	2	7,49	0,0013	1	0,0013	0,95	0,0007	6,9	2	2
TCC	1	1	3	0,025	6	2	Transient	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,073	1	460	1	1	8	9,19	Transient	1	4144	0,068	13,6	4	2	6,33	0,0011	1	0,0011	0,95	0,0005	5,3	2	2
TCC	1	1	3	0,025	6	2	Transient	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,086	1	460	1	1	8	8,48	Transient	1	4144	0,068	13,6	4	2	7,03	0,0012	1	0,0012	0,95	0,0006	5,9	2	2
TCC	1	1	3	0,025	6	2	Transient	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,055	1	471	1	1	8	10,50	Transient	1	4236	0,067	13,4	4	2	5,32	0,0009	1	0,0009	0,95	0,0004	4,2	2	2
TCC	1	1	3	0,025	6	2	Transient	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,054	1	481	1	1	8	10,53	Transient	1	4328	0,065	13,1	4	2	5,30	0,0008	1	0,0008	0,95	0,0004	4,1	2	2
TCC	1	1	3	0,025	6	1	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,039	1	506	1	1	8	12,02	Transient	1	4553	0,062	12,4	4	2	4,47	0,0007	1	0,0007	0,95	0,0003	3,2	1	1
TCC	1	1	3	0,025	6	1	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,033	1	516	1	1	8	12,87	Transient	1	4645	0,061	12,2	4	2	4,09	0,0006	1	0,0006	0,95	0,0003	2,8	1	1
TCC	1	1	3	0,025	6	1	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,029	1	526	1	1	8	13,73	Transient	1	4737	0,060	11,9	3	2	3,76	0,0005	1	0,0005	0,95	0,0003	2,5	1	1
TCC	1	1	3	0,025	6	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,024	1	536	1	1	8	14,82	Transient	1	4828	0,059	11,7	3	2	3,40	0,0005	1	0,0005	0,95	0,0002	2,2	1	1
TCC	1	1	3	0,025	6	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	3,00	0,021	1	547	1	1	8	15,66	Transient	1	4920	0,057	11,5	3	2	3,17	0,0004	1	0,0004	0,95	0,0002	2,0	1	1

[3.7] Vibrational results for a wide floor (3m) and 7m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	7	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	3,00	5,317	7	224	1	1	8	1,43	Lower limit	1	2355	0,150	30,0	5	2	70,91	0,0205	1	0,0205	0,95	0,0124	123,6	7	0
CLT	1	1	3	0,02	7	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	3,00	2,545	7	234	1	1	8	2,03	Lower limit	1	2462	0,144	28,7	5	2	45,21	0,0125	1	0,0125	0,95	0,0075	74,8	7	0
CLT	1	1	3	0,02	7	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	3,00	3,008	7	234	1	1	8	1,86	Lower limit	1	2462	0,144	28,7	5	2	50,40	0,0139	1	0,0139	0,95	0,0084	83,6	7	0
CLT	1	1	3	0,02	7	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	2,94	1,458	7	245	1	1	8	2,64	Lower limit	1	2569	0,138	27,5	5	2	31,98	0,0085	1	0,0085	0,95	0,0050	50,2	7	0
CLT	1	1	3	0,02	7	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	3,00	1,567	7	245	1	1	8	2,53	Lower limit	1	2569	0,138	27,5	5	2	33,92	0,0090	1	0,0090	0,95	0,0053	53,4	7	0
CLT	1	1	3	0,02	7	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	3,00	0,939	6	255	1	1	8	3,20	Lower limit	1	2676	0,132	26,4	5	2	24,97	0,0064	1	0,0064	0,95	0,0037	37,4	6	0
CLT	1	1	3	0,02	7	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	3,00	0,653	5	265	1	1	8	3,76	Lower limit	1	2783	0,127	25,4	5	2	20,22	0,0050	1	0,0050	0,95	0,0029	28,9	5	0
CLT	1	1	3	0,02	7	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	2,36	0,751	5	265	1	1	8	3,95	Lower limit	1	2783	0,127	25,4	5	2	18,95	0,0046	1	0,0046	0,95	0,0027	27,0	5	0
CLT	1	1	3	0,02	7	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	3,00	0,487	3	275	1	1	8	4,28	Lower limit	1	2891	0,122	24,5	5	2	17,12	0,0040	1	0,0040	0,95	0,0023	23,4	4	0
CLT	1	1	3	0,02	7	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	3,00	0,517	5	275	1	1	8	4,15	Lower limit	1	2891	0,122	24,5	5	2	17,81	0,0042	1	0,0042	0,95	0,0024	24,3	5	0
CLT	1	1	3	0,02	7	4	Resonant	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	3,00	0,376	3	285	1	1	8	4,78	Resonant	1	2998	0,118	23,6	4	2	14,82	0,0034	1	0,0034	0,95	0,0019	19,4	4	4
CLT	1	1	3	0,02	7	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	0,547	5	285	1	1	8	3,96	Lower limit	1	2998	0,118	23,6	4	2	18,92	0,0043	1	0,0043	0,95	0,0025	25,0	5	0
CLT	1	1	3	0,02	7	4	Resonant	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	3,00	0,245	1	296	1	1	8	5,81	Resonant	1	3105	0,114	22,8	4	2	11,49	0,0025	1	0,0025	0,95	0,0014	14,2	4	4
CLT	1	1	3	0,02	7	4	Resonant	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	0,267	3	306	1	1	8	5,48	Resonant	1	3212	0,110	22,0	4	2	12,41	0,0026	1	0,0026	0,95	0,0015	15,0	4	4
CLT	1	1	3	0,02	7	4	Resonant	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	2,84	0,188	1	306	1	1	8	6,70	Resonant	1	3212	0,110	22,0	4	2	9,54	0,0020	1	0,0020	0,95	0,0011	11,3	3	4
CLT	1	1	3	0,02	7	4	Resonant	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	3,00	0,143	1	316	1	1	8	7,36	Resonant	1	3319	0,107	21,3	4	2	8,46	0,0017	1	0,0017	0,95	0,0010	9,6	3	4
CLT	1	1	3	0,02	7	4	Resonant	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	3,00	0,117	1	326	1	1	8	7,99	Resonant	1	3426	0,103	20,6	4	2	7,59	0,0015	1	0,0015	0,95	0,0008	8,2	3	4
CLT	1	1	3	0,02	7	2	Transient	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	3,00	0,096	1	336	1	1	8	8,70	Transient	1	3533	0,100	20,0	4	2	6,80	0,0013	1	0,0013	0,95	0,0007	7,1	2	2
CLT	1	1	3	0,02	7	2	Transient	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	3,00	0,082	1	347	1	1	8	9,30	Transient	1	3640	0,097	19,4	4	2	6,23	0,0012	1	0,0012	0,95	0,0006	6,2	2	2
CON HC	1	1	3	0,005	7	7	Resonant	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,221	1	451	1	1	8	4,95	Resonant	1	4741	0,298	59,7	7	2	14,13	0,0021	1	0,0021	0,95	0,0014	13,7	4	7
CON HC	1	1	3	0,005	7	7	Resonant	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,098	1	491	1	1	8	7,14	Resonant	1	5161	0,274	54,8	7	2	8,79	0,0012	1	0,0012	0,95	0,0008	7,5	2	7
CON HC	1	1	3	0,005	7	2	Transient	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,046	1	566	1	1	8	9,68	Transient	1	5948	0,238	47,6	6	2	5,92	0,0007	1	0,0007	0,95	0,0004	4,2	2	2
CON HC	1	1	3	0,005	7	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,027	1	612	1	1	8	12,21	Transient	1	6431	0,220	44,0	6	2	4,37	0,0005	1	0,0005	0,95	0,0003	2,8	1	1
CON HC	1	1	3	0,005	7	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,015	1	673	1	1	8	15,58	Transient	1	7072	0,200	40,0	6	2	3,19	0,0003	1	0,0003	0,95	0,0002	1,7	1	1
CON IS	1	1	3	0,01	7	4	Resonant	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,049	1	833	1	1	8	7,72	Resonant	1	8752	0,081	16,2	4	2	7,94	0,0006	1	0,0006	0,95	0,0004	3,8	1	4
CON IS	1	1	3	0,01	7	1	Transient	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,039	1	883	1	1	8	8,38	Transient	1	9277	0,076	15,2	4	2	7,14	0,0005	1	0,0005	0,95	0,0003	3,2	1	1
CON IS	1	1	3	0,01	7	1	Transient	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,032	1	933	1	1	8	9,04	Transient	1	9802	0,072	14,4	4	2	6,47	0,0005	1	0,0005	0,95	0,0003	2,7	1	1
CON IS	1	1	3	0,01	7	1	Transient	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,026	1	983	1	1	8	9,70	Transient	1	10327	0,068	13,7	4	2	5,90	0,0004	1	0,0004	0,95	0,0002	2,3	1	1
CON IS	1	1	3	0,01	7	4	Resonant	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,108	1	683	1	1	8	5,75	Resonant	1	7177	0,099	19,7	4	2	11,64	0,0011	1	0,0011	0,95	0,0007	7,0	2	4
CON IS	1	1	3	0,01	7	4	Resonant	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,081	1	733	1	1	8	6,41	Resonant	1	7702	0,092	18,4	4	2	10,12	0,0009	1	0,0009	0,95	0,0006	5,6	2	4
CON IS	1	1	3	0,01	7	4	Resonant	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,063	1	783	1	1	8	7,06	Resonant	1	8227	0,086	17,2	4	2	8,92	0,0008	1	0,0008	0,95	0,0005	4,6	2	4
CON IS	1	1	3	0,01	7	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,211	1	583	1	1	8	4,45	Lower limit	1	6127	0,115	23,1	4	2	16,23	0,0018	1	0,0018	0,95	0,0012	11,7	3	0
CON IS	1	1	3	0,01	7	4	Resonant	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,149	1	633	1	1	8	5,10	Resonant	1	6652	0,106	21,3	4	2	13,61	0,0014	1	0,0014	0,95	0,0009	9,0	3	4
CON IS	1	1	3	0,01	7	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	0,501	4	483	1	1	8	3,18	Lower limit	1	5077	0,139	27,9	5	2	25,17	0,0034	1	0,0034	0,95	0,0022	22,3	4	0
CON IS	1	1	3	0,01	7	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	0,316	3	533	1	1	8	3,81	Lower limit	1	5602	0,126	25,2	5	2	19,87	0,0025	1	0,0025	0,95	0,0016	15,8	4	0
CON IS	1	1	3	0,01	7	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	0,866	6	433	1	1	8	2,55	Lower limit	1	4552	0,155	31,1	5	2	33,46	0,0051	1	0,0051	0,95	0,0033	33,4	5	0
CON IS	1	1	3	0,01	7	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	1,692	7	383	1	1	8	1,94	Lower limit	1	4027	0,176	35,1	5	2	47,74	0,0082	1	0,0082	0,95	0,0054	54,2	7	0
LVL	1	1	3	0,02	7	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	3,059	7	212	1	1	8	1,94	Lower limit	1	2229	0,159	31,7	5	2	47,78	0,0145	1	0,0145	0,95	0,0087	87,1	7	0
LVL	1	1	3	0,02	7	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	1,910	7	214	1	1	8	2,45	Lower limit	1	2243	0,158	31,5	5	2	35,31	0,0107	1	0,0107	0,95	0,0063	63,5	7	0
LVL	1	1	3	0,02	7	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	1,296	7	215	1	1	8	2,96	Lower limit	1	2257	0,157	31,3	5	2	27,55	0,0083	1	0,0083	0,95	0,0049	48,8	7	0
LVL	1	1	3	0,02	7	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	0,931	6	216	1	1	8	3,49	Lower limit	1	2271	0,156	31,1	5	2	22,33	0,0067	1	0,0067	0,95	0,0039	39,0	6	0
LVL	1	1	3	0,02	7	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	0,699	5	218	1	1	8	4,01	Lower limit	1	2286	0,155	30,9	5	2	18,60	0,0055	1	0,0055	0,95	0,0032	32,0	5	0
LVL	1	1	3	0,02	7	5	Resonant	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	0,542	5	219	1	1	8	4,54	Resonant	1	2300	0,154	30,7	5	2	15,82	0,0047	1	0,0047	0,95	0,0027	26,8	5	5
LVL	1	1	3	0,02	7	5	Resonant	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	0,431	3	220	1	1	8	5,08	Resonant	1	2314	0,153	30,6	5	2	13,69	0,0040	1	0,0040	0,95	0,0023	22,9	4	5
LVL	1	1	3	0,02	7	5	Resonant	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	0,350	3	222	1	1	8	5,62	Resonant	1	2328	0,152	30,4	5	2	12,01	0,0035	1	0,0035	0,95	0,0020	19,8	4	5
LVL	1	1	3	0,02	7	5	Resonant	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,88	260	8,23E+12	7,75E+12	3,00	0,289	3	223	1	1	8	6,16	Resonant	1	2342	0,151	30,2	5	2	10,65	0,0031	1	0,0031	0,95	0,0017	17,3	4	5
LVL	1	1	3	0,02	7	5	Resonant	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,243	1	224	1	1	8	6,71	Resonant	1	2356	0,150	30,0	5	2	9,53	0,0028	1	0,0028	0,95	0,0015	15,2	4	5
LVL	1	1	3	0,02	7	5	Resonant	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,206	1	226	1	1	8	7,26	Resonant	1	2370	0,149	29,8	5	2	8,60	0,0025	1	0,0025	0,95	0,0014	13,5	4	5
LVL	1	1	3	0,02	7	5	Resonant	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,177	1	227	1	1	8	7,81	Resonant	1	2384	0,148	29,7	5	2	7,82	0,0022	1	0,0022	0,95	0,0012	12,1	4	5
LVL	1	1	3	0,02	7	3	Transient	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,153	1	228	1	1	8	8,37	Transient	1	2398	0,147	29,5	5	2	7,15	0,0020	1	0,0020	0,95	0,0011	10,9	3	3
LVL	1	1	3	0,02	7	3	Transient	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,134	1	230	1	1	8	8,93	Transient	1	2412	0,147	29,3	5	2	6,57	0,0019	1	0,0019	0,95	0,0010	9,9	3	3
LVL	1	1	3	0,02	7	3	Transient	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,117	1	231	1	1	8	9,50	Transient	1	2426	0,146	29,1	5	2	6,06	0,0017	1	0,0017	0,95	0,0009	9,0	3	3
LVL	1	1	3	0,02	7	3	Transient	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,104	1	232	1	1	8	10,07	Transient	1	2440	0,145	29,0	5	2	5,62	0,0016	1	0,0016	0,95	0,0008	8,2	3	3
TCC	1	1	3	0,025	7	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	1,329	7	324	1	1	8	2,38	Lower limit	1	3405	0,083	16,6	4	2	36,59	0,0074	1	0,0074	0,95	0,0041	41,4	6	0
TCC	1	1	3	0,025	7	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	0,792	6	334	1	1	8	3,04	Lower limit	1	3512	0,081	16,1	4	2	26,67	0,0052	1	0,0052	0,95	0,0029	29,0	5	0
TCC	1	1	3	0,025	7	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	0,832	6	334	1	1	8	2,97	Lower limit	1	3512	0,081	16,1	4	2	27,54	0,0054	1	0,0054	0,95	0,0030	30,0	5	0
TCC	1	1	3	0,025	7	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	0,516	5	345	1	1	8	3,71	Lower limit	1	3619	0,078	15,6	4	2	20,60	0,0039	1	0,0039	0,95	0,0022	21,5	4	0
TCC	1	1	3	0,025	7	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	0,533	5	345	1	1	8	3,65	Lower limit	1	3619	0,078	15,6	4	2	21,03	0,0040	1	0,0040	0,95	0,0022	22,0	4	0
TCC	1	1	3	0,025	7	4	Resonant	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	0,309	3	380	1	1	8	4,57	Resonant	1	3989	0,071	14,2	4	2	15,71	0,0027	1	0,0027	0,95	0,0015	14,7	4	4
TCC	1	1	3	0,025	7	4	Resonant	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,231	1	390	1	1	8	5,21	Resonant	1	4096	0,069	13,8	4	2	13,23	0,0022	1	0,0022	0,95	0,0012	11,9	3	4
TCC	1	1	3	0,025	7	4	Resonant	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,223	1	390	1	1	8	5,31	Resonant	1	4096	0,069	13,8	4	2	12,92	0,0022	1	0,0022	0,95	0,0012	11,6	3	4
TCC	1	1	3	0,025	7	4	Resonant	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,160	1	425	1	1	8	5,99	Resonant	1	4466	0,063	12,7	4	2	11,04	0,0017	1	0,0017	0,95	0,0009	9,0	3	4
TCC	1	1	3	0,025	7	4	Resonant	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,164	1	425	1	1	8	5,93	Resonant	1	4466	0,063	12,7	4	2	11,18	0,0017	1	0,0017	0,95	0,0009	9,2	3	4
TCC	1	1	3	0,025	7	3	Resonant	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,117	1	460	1	1	8	6,75	Resonant	1	4835	0,058	11,7	3	2	9,45	0,0013	1	0,0013	0,95	0,0007	7,0	2	3
TCC	1	1	3	0,025	7	3	Resonant	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,137	1	460	1	1	8	6,23	Resonant	1	4835	0,058	11,7	3	2	10,50	0,0015	1	0,0015	0,95	0,0008	7,9	2	3
TCC	1	1	3	0,025	7	3	Resonant	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,087	1	471	1	1	8	7,72	Resonant	1	4942	0,057	11,4	3	2	7,94	0,0011	1	0,0011	0,95	0,0006	5,7	2	3
TCC	1	1	3	0,025	7	3	Resonant	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,085	1	481	1	1	8	7,74	Resonant	1	5049	0,056	11,2	3	2	7,92	0,0011	1	0,0011	0,95	0,0006	5,6	2	3
TCC	1	1	3	0,025	7	2	Transient	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,062	1	506	1	1	8	8,83	Transient	1	5312	0,053	10,6	3	2	6,67	0,0009	1	0,0009	0,95	0,0004	4,4	2	2
TCC	1	1	3	0,025	7	1	Transient	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,053	1	516	1	1	8	9,46	Transient	1	5419	0,052	10,4	3	2	6,10	0,0008	1	0,0008	0,95	0,0004	3,9	1	1
TCC	1	1	3	0,025	7	1	Transient	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,046	1	526	1	1	8	10,09	Transient	1	5526	0,051	10,2	3	2	5,61	0,0007	1	0,0007	0,95	0,0003	3,5	1	1
TCC	1	1	3	0,025	7	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,038	1	536	1	1	8	10,89	Transient	1	5633	0,050	10,0	3	2	5,08	0,0006	1	0,0006	0,95	0,0003	3,0	1	1
TCC	1	1	3	0,025	7	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	3,00	0,034	1	547	1	1	8	11,50	Transient	1	5740	0,049	9,9	3	2	4,73	0,0006	1	0,0006	0,95	0,0003	2,7	1	1

[3.8] Vibrational results for a wide floor (3m) and 8m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	n	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	8	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	3,00	7,937	7	224	1	1	8	1,10	Lower limit	1	2691	0,131	26,3	5	2	100,34	0,0254	1	0,0254	0,95	0,0154	154,4	7	0
CLT	1	1	3	0,02	8	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	3,00	3,799	7	234	1	1	8	1,55	Lower limit	1	2814	0,126	25,1	5	2	63,98	0,0155	1	0,0155	0,95	0,0094	93,6	7	0
CLT	1	1	3	0,02	8	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	3,00	4,489	7	234	1	1	8	1,43	Lower limit	1	2814	0,126	25,1	5	2	71,32	0,0173	1	0,0173	0,95	0,0105	104,6	7	0
CLT	1	1	3	0,02	8	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	3,00	2,137	7	245	1	1	8	2,02	Lower limit	1	2936	0,120	24,1	5	2	45,25	0,0105	1	0,0105	0,95	0,0063	63,0	7	0
CLT	1	1	3	0,02	8	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	3,00	2,339	7	245	1	1	8	1,93	Lower limit	1	2936	0,120	24,1	5	2	48,00	0,0112	1	0,0112	0,95	0,0067	67,0	7	0
CLT	1	1	3	0,02	8	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	3,00	1,402	7	255	1	1	8	2,45	Lower limit	1	3059	0,116	23,1	4	2	35,34	0,0079	1	0,0079	0,95	0,0047	47,0	6	0
CLT	1	1	3	0,02	8	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	3,00	0,975	7	265	1	1	8	2,88	Lower limit	1	3181	0,111	22,2	4	2	28,62	0,0062	1	0,0062	0,95	0,0036	36,4	6	0
CLT	1	1	3	0,02	8	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	2,70	0,981	7	265	1	1	8	3,03	Lower limit	1	3181	0,111	22,2	4	2	26,82	0,0058	1	0,0058	0,95	0,0034	34,0	5	0
CLT	1	1	3	0,02	8	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	3,00	0,726	6	275	1	1	8	3,27	Lower limit	1	3303	0,107	21,4	4	2	24,22	0,0050	1	0,0050	0,95	0,0029	29,5	5	0
CLT	1	1	3	0,02	8	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	3,00	0,772	6	275	1	1	8	3,18	Lower limit	1	3303	0,107	21,4	4	2	25,20	0,0052	1	0,0052	0,95	0,0031	30,7	5	0
CLT	1	1	3	0,02	8	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	3,00	0,561	5	285	1	1	8	3,66	Lower limit	1	3426	0,103	20,6	4	2	20,98	0,0042	1	0,0042	0,95	0,0024	24,5	5	0
CLT	1	1	3	0,02	8	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	0,817	6	285	1	1	8	3,03	Lower limit	1	3426	0,103	20,6	4	2	26,78	0,0054	1	0,0054	0,95	0,0032	31,6	5	0
CLT	1	1	3	0,02	8	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	3,00	0,366	3	296	1	1	8	4,45	Lower limit	1	3548	0,100	19,9	4	2	16,26	0,0031	1	0,0031	0,95	0,0018	18,1	4	0
CLT	1	1	3	0,02	8	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	0,398	3	306	1	1	8	4,19	Lower limit	1	3671	0,096	19,3	4	2	17,56	0,0033	1	0,0033	0,95	0,0019	19,0	4	0
CLT	1	1	3	0,02	8	4	Resonant	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	3,00	0,266	3	306	1	1	8	5,13	Resonant	1	3671	0,096	19,3	4	2	13,50	0,0025	1	0,0025	0,95	0,0014	14,4	4	4
CLT	1	1	3	0,02	8	4	Resonant	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	3,00	0,214	1	316	1	1	8	5,63	Resonant	1	3793	0,093	18,6	4	2	11,97	0,0022	1	0,0022	0,95	0,0012	12,2	4	4
CLT	1	1	3	0,02	8	4	Resonant	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	3,00	0,175	1	326	1	1	8	6,12	Resonant	1	3915	0,090	18,1	4	2	10,74	0,0019	1	0,0019	0,95	0,0011	10,5	3	4
CLT	1	1	3	0,02	8	4	Resonant	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	3,00	0,144	1	336	1	1	8	6,66	Resonant	1	4038	0,088	17,5	4	2	9,62	0,0016	1	0,0016	0,95	0,0009	9,1	3	4
CLT	1	1	3	0,02	8	4	Resonant	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	3,00	0,122	1	347	1	1	8	7,12	Resonant	1	4160	0,085	17,0	4	2	8,82	0,0015	1	0,0015	0,95	0,0008	8,0	3	4
CON HC	1	1	3	0,005	8	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,330	3	451	1	1	8	3,79	Lower limit	1	5418	0,261	52,2	7	2	20,00	0,0026	1	0,0026	0,95	0,0017	17,3	4	0
CON HC	1	1	3	0,005	8	6	Resonant	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,146	1	491	1	1	8	5,47	Resonant	1	5898	0,240	48,0	6	2	12,43	0,0015	1	0,0015	0,95	0,0010	9,6	3	6
CON HC	1	1	3	0,005	8	6	Resonant	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,069	1	566	1	1	8	7,41	Resonant	1	6798	0,208	41,6	6	2	8,37	0,0009	1	0,0009	0,95	0,0005	5,4	2	6
CON HC	1	1	3	0,005	8	1	Transient	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,040	1	612	1	1	8	9,35	Transient	1	7350	0,192	38,5	6	2	6,19	0,0006	1	0,0006	0,95	0,0004	3,6	1	1
CON HC	1	1	3	0,005	8	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,022	1	673	1	1	8	11,93	Transient	1	8082	0,175	35,0	5	2	4,51	0,0004	1	0,0004	0,95	0,0002	2,3	1	1
CON IS	1	1	3	0,01	8	3	Resonant	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,039	1	983	1	1	8	7,43	Resonant	1	11802	0,060	12,0	3	2	8,35	0,0005	1	0,0005	0,95	0,0003	3,0	1	3
CON IS	1	1	3	0,01	8	4	Resonant	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,048	1	933	1	1	8	6,92	Resonant	1	11202	0,063	12,6	4	2	9,15	0,0006	1	0,0006	0,95	0,0003	3,5	1	4
CON IS	1	1	3	0,01	8	4	Resonant	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,121	1	733	1	1	8	4,90	Resonant	1	8802	0,080	16,1	4	2	14,32	0,0011	1	0,0011	0,95	0,0007	7,2	2	4
CON IS	1	1	3	0,01	8	4	Resonant	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,094	1	783	1	1	8	5,41	Resonant	1	9402	0,075	15,0	4	2	12,62	0,0009	1	0,0009	0,95	0,0006	5,9	2	4
CON IS	1	1	3	0,01	8	4	Resonant	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,074	1	833	1	1	8	5,91	Resonant	1	10002	0,071	14,1	4	2	11,24	0,0008	1	0,0008	0,95	0,0005	4,9	2	4
CON IS	1	1	3	0,01	8	4	Resonant	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,059	1	883	1	1	8	6,42	Resonant	1	10602	0,067	13,3	4	2	10,10	0,0007	1	0,0007	0,95	0,0004	4,1	2	4
CON IS	1	1	3	0,01	8	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,222	1	633	1	1	8	3,91	Lower limit	1	7602	0,093	18,6	4	2	19,26	0,0018	1	0,0018	0,95	0,0011	11,3	3	0
CON IS	1	1	3	0,01	8	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,162	1	683	1	1	8	4,40	Lower limit	1	8202	0,086	17,2	4	2	16,47	0,0014	1	0,0014	0,95	0,0009	8,9	3	0
CON IS	1	1	3	0,01	8	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	0,471	3	533	1	1	8	2,92	Lower limit	1	6402	0,110	22,1	4	2	28,11	0,0030	1	0,0030	0,95	0,0020	19,9	4	0
CON IS	1	1	3	0,01	8	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,316	3	583	1	1	8	3,41	Lower limit	1	7002	0,101	20,2	4	2	22,97	0,0023	1	0,0023	0,95	0,0015	14,8	4	0
CON IS	1	1	3	0,01	8	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	0,748	6	483	1	1	8	2,43	Lower limit	1	5802	0,122	24,4	5	2	35,62	0,0042	1	0,0042	0,95	0,0028	28,0	5	0
CON IS	1	1	3	0,01	8	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	1,293	7	433	1	1	8	1,95	Lower limit	1	5202	0,136	27,2	5	2	47,34	0,0063	1	0,0063	0,95	0,0042	41,8	6	0
CON IS	1	1	3	0,01	8	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	2,525	7	383	1	1	8	1,49	Lower limit	1	4602	0,154	30,7	5	2	67,55	0,0101	1	0,0101	0,95	0,0068	67,8	7	0
LVL	1	1	3	0,02	8	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	4,567	7	212	1	1	8	1,49	Lower limit	1	2548	0,139	27,8	5	2	67,61	0,0181	1	0,0181	0,95	0,0109	109,1	7	0
LVL	1	1	3	0,02	8	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	2,850	7	214	1	1	8	1,88	Lower limit	1	2564	0,138	27,6	5	2	49,97	0,0133	1	0,0133	0,95	0,0080	79,6	7	0
LVL	1	1	3	0,02	8	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	1,934	7	215	1	1	8	2,27	Lower limit	1	2580	0,137	27,4	5	2	38,99	0,0103	1	0,0103	0,95	0,0061	61,4	7	0
LVL	1	1	3	0,02	8	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	1,390	7	216	1	1	8	2,67	Lower limit	1	2596	0,136	27,2	5	2	31,59	0,0083	1	0,0083	0,95	0,0049	49,1	7	0
LVL	1	1	3	0,02	8	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	1,043	7	218	1	1	8	3,07	Lower limit	1	2612	0,135	27,1	5	2	26,32	0,0069	1	0,0069	0,95	0,0040	40,4	6	0
LVL	1	1	3	0,02	8	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	0,809	6	219	1	1	8	3,48	Lower limit	1	2628	0,135	26,9	5	2	22,39	0,0058	1	0,0058	0,95	0,0034	34,0	5	0
LVL	1	1	3	0,02	8	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	0,643	5	220	1	1	8	3,89	Lower limit	1	2644	0,134	26,7	5	2	19,37	0,0050	1	0,0050	0,95	0,0029	29,0	5	0
LVL	1	1	3	0,02	8	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	0,523	5	222	1	1	8	4,30	Lower limit	1	2660	0,133	26,6	5	2	16,99	0,0044	1	0,0044	0,95	0,0025	25,1	5	0
LVL	1	1	3	0,02	8	5	Resonant	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	3,00	0,432	3	223	1	1	8	4,72	Resonant	1	2676	0,132	26,4	5	2	15,07	0,0038	1	0,0038	0,95	0,0022	22,0	4	5
LVL	1	1	3	0,02	8	5	Resonant	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,362	3	224	1	1	8	5,14	Resonant	1	2692	0,131	26,3	5	2	13,49	0,0034	1	0,0034	0,95	0,0019	19,4	4	5
LVL	1	1	3	0,02	8	5	Resonant	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,307	3	226	1	1	8	5,56	Resonant	1	2708	0,131	26,1	5	2	12,17	0,0031	1	0,0031	0,95	0,0017	17,3	4	5
LVL	1	1	3	0,02	8	5	Resonant	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,264	3	227	1	1	8	5,98	Resonant	1	2724	0,130	26,0	5	2	11,06	0,0028	1	0,0028	0,95	0,0016	15,5	4	5
LVL	1	1	3	0,02	8	5	Resonant	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,228	1	228	1	1	8	6,41	Resonant	1	2740	0,129	25,8	5	2	10,11	0,0025	1	0,0025	0,95	0,0014	14,0	4	5
LVL	1	1	3	0,02	8	5	Resonant	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,199	1	230	1	1	8	6,84	Resonant	1	2756	0,128	25,7	5	2	9,29	0,0023	1	0,0023	0,95	0,0013	12,7	4	5
LVL	1	1	3	0,02	8	5	Resonant	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,175	1	231	1	1	8	7,27	Resonant	1	2772	0,128	25,5	5	2	8,58	0,0021	1	0,0021	0,95	0,0012	11,6	3	5
LVL	1	1	3	0,02	8	5	Resonant	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,155	1	232	1	1	8	7,71	Resonant	1	2788	0,127	25,4	5	2	7,96	0,0019	1	0,0019	0,95	0,0011	10,6	3	5
TCC	1	1	3	0,025	8	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	1,983	7	324	1	1	8	1,82	Lower limit	1	3891	0,073	14,5	4	2	51,77	0,0091	1	0,0091	0,95	0,0052	51,9	7	0
TCC	1	1	3	0,025	8	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	1,182	7	334	1	1	8	2,33	Lower limit	1	4014	0,070	14,1	4	2	37,74	0,0065	1	0,0065	0,95	0,0036	36,4	6	0
TCC	1	1	3	0,025	8	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	1,242	7	334	1	1	8	2,27	Lower limit	1	4014	0,070	14,1	4	2	38,97	0,0067	1	0,0067	0,95	0,0038	37,6	6	0
TCC	1	1	3	0,025	8	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	0,771	6	345	1	1	8	2,84	Lower limit	1	4136	0,068	13,7	4	2	29,15	0,0049	1	0,0049	0,95	0,0027	27,1	5	0
TCC	1	1	3	0,025	8	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	0,796	6	345	1	1	8	2,79	Lower limit	1	4136	0,068	13,7	4	2	29,75	0,0050	1	0,0050	0,95	0,0028	27,7	5	0
TCC	1	1	3	0,025	8	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	0,461	3	380	1	1	8	3,50	Lower limit	1	4559	0,062	12,4	4	2	22,23	0,0034	1	0,0034	0,95	0,0019	18,6	4	0
TCC	1	1	3	0,025	8	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,345	3	390	1	1	8	3,99	Lower limit	1	4681	0,060	12,1	4	2	18,72	0,0028	1	0,0028	0,95	0,0015	15,1	4	0
TCC	1	1	3	0,025	8	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,332	3	390	1	1	8	4,06	Lower limit	1	4681	0,060	12,1	4	2	18,28	0,0027	1	0,0027	0,95	0,0015	14,7	4	0
TCC	1	1	3	0,025	8	3	Resonant	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,239	1	425	1	1	8	4,59	Resonant	1	5103	0,055	11,1	3	2	15,63	0,0021	1	0,0021	0,95	0,0011	11,5	3	3
TCC	1	1	3	0,025	8	3	Resonant	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,244	1	425	1	1	8	4,54	Resonant	1	5103	0,055	11,1	3	2	15,83	0,0021	1	0,0021	0,95	0,0012	11,6	3	3
TCC	1	1	3	0,025	8	3	Resonant	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,174	1	460	1	1	8	5,17	Resonant	1	5526	0,051	10,2	3	2	13,37	0,0017	1	0,0017	0,95	0,0009	9,0	3	3
TCC	1	1	3	0,025	8	3	Resonant	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,205	1	460	1	1	8	4,77	Resonant	1	5526	0,051	10,2	3	2	14,86	0,0019	1	0,0019	0,95	0,0010	10,0	3	3
TCC	1	1	3	0,025	8	3	Resonant	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,130	1	471	1	1	8	5,91	Resonant	1	5648	0,050	10,0	3	2	11,24	0,0014	1	0,0014	0,95	0,0007	7,3	2	3
TCC	1	1	3	0,025	8	3	Resonant	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,127	1	481	1	1	8	5,92	Resonant	1	5771	0,049	9,8	3	2	11,21	0,0013	1	0,0013	0,95	0,0007	7,1	2	3
TCC	1	1	3	0,025	8	3	Resonant	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,093	1	506	1	1	8	6,76	Resonant	1	6071	0,047	9,3	3	2	9,43	0,0011	1	0,0011	0,95	0,0006	5,6	2	3
TCC	1	1	3	0,025	8	3	Resonant	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,079	1	516	1	1	8	7,24	Resonant	1	6193	0,046	9,1	3	2	8,63	0,0010	1	0,0010	0,95	0,0005	5,0	2	3
TCC	1	1	3	0,025	8	3	Resonant	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,068	1	526	1	1	8	7,72	Resonant	1	6315	0,045	9,0	3	2	7,94	0,0009	1	0,0009	0,95	0,0004	4,5	2	3
TCC	1	1	3	0,025	8	1	Transient	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,057	1	536	1	1	8	8,34	Transient	1	6438	0,044	8,8	3	2	7,19	0,0008	1	0,0008	0,95	0,0004	3,9	1	1
TCC	1	1	3	0,025	8	1	Transient	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	3,00	0,050	1	547	1	1	8	8,81	Transient	1	6560	0,043	8,6	3	2	6,69	0,0007	1	0,0007	0,95	0,0004	3,6	1	1

[3.9] Vibrational results for a wide floor (3m) and 9m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	I_m	v1_peak	k_imp	v_tot_peak	n	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	9	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	3,00	11,300	7	224	1	1	8	0,87	Lower limit	1	3028	0,117	23,4	4	2	136,30	0,0308	1	0,0308	0,95	0,0188	187,6	7	0
CLT	1	1	3	0,02	9	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	3,00	5,409	7	234	1	1	8	1,23	Lower limit	1	3166	0,112	22,3	4	2	86,90	0,0188	1	0,0188	0,95	0,0114	113,9	7	0
CLT	1	1	3	0,02	9	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	3,00	6,392	7	234	1	1	8	1,13	Lower limit	1	3166	0,112	22,3	4	2	96,87	0,0210	1	0,0210	0,95	0,0127	127,2	7	0
CLT	1	1	3	0,02	9	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	3,00	3,042	7	245	1	1	8	1,60	Lower limit	1	3303	0,107	21,4	4	2	61,47	0,0128	1	0,0128	0,95	0,0077	76,8	7	0
CLT	1	1	3	0,02	9	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	3,00	3,331	7	245	1	1	8	1,53	Lower limit	1	3303	0,107	21,4	4	2	65,19	0,0135	1	0,0135	0,95	0,0082	81,6	7	0
CLT	1	1	3	0,02	9	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	3,00	1,996	7	255	1	1	8	1,93	Lower limit	1	3441	0,103	20,5	4	2	48,00	0,0096	1	0,0096	0,95	0,0057	57,3	7	0
CLT	1	1	3	0,02	9	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	3,00	1,388	7	265	1	1	8	2,27	Lower limit	1	3579	0,099	19,8	4	2	38,87	0,0075	1	0,0075	0,95	0,0044	44,4	6	0
CLT	1	1	3	0,02	9	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	3,00	1,256	7	265	1	1	8	2,39	Lower limit	1	3579	0,099	19,8	4	2	36,43	0,0070	1	0,0070	0,95	0,0042	41,6	6	0
CLT	1	1	3	0,02	9	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	3,00	1,034	7	275	1	1	8	2,59	Lower limit	1	3716	0,095	19,0	4	2	32,90	0,0061	1	0,0061	0,95	0,0036	36,1	6	0
CLT	1	1	3	0,02	9	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	3,00	1,099	7	275	1	1	8	2,51	Lower limit	1	3716	0,095	19,0	4	2	34,23	0,0063	1	0,0063	0,95	0,0038	37,6	6	0
CLT	1	1	3	0,02	9	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	3,00	0,799	6	285	1	1	8	2,89	Lower limit	1	3854	0,092	18,3	4	2	28,49	0,0051	1	0,0051	0,95	0,0030	30,0	5	0
CLT	1	1	3	0,02	9	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	1,163	7	285	1	1	8	2,39	Lower limit	1	3854	0,092	18,3	4	2	36,37	0,0065	1	0,0065	0,95	0,0039	38,6	6	0
CLT	1	1	3	0,02	9	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	3,00	0,521	5	296	1	1	8	3,51	Lower limit	1	3992	0,089	17,7	4	2	22,08	0,0038	1	0,0038	0,95	0,0022	22,2	4	0
CLT	1	1	3	0,02	9	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	0,567	5	306	1	1	8	3,31	Lower limit	1	4129	0,086	17,1	4	2	23,85	0,0040	1	0,0040	0,95	0,0023	23,3	4	0
CLT	1	1	3	0,02	9	0	Lower limit	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	3,00	0,378	3	306	1	1	8	4,06	Lower limit	1	4129	0,086	17,1	4	2	18,34	0,0031	1	0,0031	0,95	0,0018	17,7	4	0
CLT	1	1	3	0,02	9	0	Lower limit	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	3,00	0,304	3	316	1	1	8	4,45	Lower limit	1	4267	0,083	16,6	4	2	16,25	0,0026	1	0,0026	0,95	0,0015	15,1	4	0
CLT	1	1	3	0,02	9	4	Resonant	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	3,00	0,250	1	326	1	1	8	4,84	Resonant	1	4405	0,080	16,1	4	2	14,59	0,0023	1	0,0023	0,95	0,0013	13,0	4	4
CLT	1	1	3	0,02	9	4	Resonant	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	3,00	0,204	1	336	1	1	8	5,26	Resonant	1	4543	0,078	15,6	4	2	13,07	0,0020	1	0,0020	0,95	0,0011	11,3	3	4
CLT	1	1	3	0,02	9	4	Resonant	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	3,00	0,173	1	347	1	1	8	5,63	Resonant	1	4680	0,076	15,1	4	2	11,98	0,0018	1	0,0018	0,95	0,0010	10,0	3	4
CON HC	1	1	3	0,005	9	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,469	3	451	1	1	8	3,00	Lower limit	1	6095	0,232	46,4	6	2	27,17	0,0031	1	0,0031	0,95	0,0021	21,2	4	0
CON HC	1	1	3	0,005	9	0	Lower limit	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,208	1	491	1	1	8	4,32	Lower limit	1	6635	0,213	42,6	6	2	16,89	0,0018	1	0,0018	0,95	0,0012	11,8	3	0
CON HC	1	1	3	0,005	9	6	Resonant	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,098	1	566	1	1	8	5,86	Resonant	1	7648	0,185	37,0	6	2	11,37	0,0010	1	0,0010	0,95	0,0007	6,8	2	6
CON HC	1	1	3	0,005	9	5	Resonant	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,057	1	612	1	1	8	7,39	Resonant	1	8269	0,171	34,2	5	2	8,41	0,0007	1	0,0007	0,95	0,0005	4,5	2	5
CON HC	1	1	3	0,005	9	1	Transient	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,032	1	673	1	1	8	9,43	Transient	1	9092	0,156	31,1	5	2	6,12	0,0005	1	0,0005	0,95	0,0003	2,9	1	1
CON IS	1	1	3	0,01	9	3	Resonant	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,056	1	983	1	1	8	5,87	Resonant	1	13277	0,053	10,7	3	2	11,34	0,0006	1	0,0006	0,95	0,0004	3,7	1	3
CON IS	1	1	3	0,01	9	3	Resonant	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,084	1	883	1	1	8	5,07	Resonant	1	11927	0,059	11,9	3	2	13,72	0,0008	1	0,0008	0,95	0,0005	5,1	2	3
CON IS	1	1	3	0,01	9	3	Resonant	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,068	1	933	1	1	8	5,47	Resonant	1	12602	0,056	11,2	3	2	12,43	0,0007	1	0,0007	0,95	0,0004	4,3	2	3
CON IS	1	1	3	0,01	9	0	Lower limit	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,133	1	783	1	1	8	4,27	Lower limit	1	10577	0,067	13,4	4	2	17,14	0,0011	1	0,0011	0,95	0,0007	7,2	2	0
CON IS	1	1	3	0,01	9	4	Resonant	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,105	1	833	1	1	8	4,67	Resonant	1	11252	0,063	12,6	4	2	15,26	0,0009	1	0,0009	0,95	0,0006	6,0	2	4
CON IS	1	1	3	0,01	9	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,230	1	683	1	1	8	3,48	Lower limit	1	9227	0,077	15,3	4	2	22,38	0,0017	1	0,0017	0,95	0,0011	10,9	3	0
CON IS	1	1	3	0,01	9	0	Lower limit	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,173	1	733	1	1	8	3,87	Lower limit	1	9902	0,071	14,3	4	2	19,45	0,0014	1	0,0014	0,95	0,0009	8,8	3	0
CON IS	1	1	3	0,01	9	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,449	3	583	1	1	8	2,69	Lower limit	1	7877	0,090	18,0	4	2	31,20	0,0027	1	0,0027	0,95	0,0018	18,1	4	0
CON IS	1	1	3	0,01	9	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,316	3	633	1	1	8	3,09	Lower limit	1	8552	0,083	16,5	4	2	26,16	0,0021	1	0,0021	0,95	0,0014	13,9	4	0
CON IS	1	1	3	0,01	9	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	1,065	7	483	1	1	8	1,92	Lower limit	1	6527	0,108	21,7	4	2	48,38	0,0051	1	0,0051	0,95	0,0034	34,1	5	0
CON IS	1	1	3	0,01	9	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	0,671	6	533	1	1	8	2,31	Lower limit	1	7202	0,098	19,6	4	2	38,19	0,0037	1	0,0037	0,95	0,0024	24,3	5	0
CON IS	1	1	3	0,01	9	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	3,596	7	383	1	1	8	1,18	Lower limit	1	5177	0,137	27,3	5	2	91,76	0,0122	1	0,0122	0,95	0,0082	82,4	7	0
CON IS	1	1	3	0,01	9	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	1,841	7	433	1	1	8	1,54	Lower limit	1	5852	0,121	24,2	5	2	64,31	0,0076	1	0,0076	0,95	0,0051	50,9	7	0
LVL	1	1	3	0,02	9	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	6,502	7	212	1	1	8	1,17	Lower limit	1	2866	0,123	24,7	5	2	91,83	0,0219	1	0,0219	0,95	0,0133	132,7	7	0
LVL	1	1	3	0,02	9	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	4,059	7	214	1	1	8	1,48	Lower limit	1	2884	0,123	24,5	5	2	67,88	0,0161	1	0,0161	0,95	0,0097	97,0	7	0
LVL	1	1	3	0,02	9	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	2,753	7	215	1	1	8	1,79	Lower limit	1	2902	0,122	24,4	5	2	52,96	0,0125	1	0,0125	0,95	0,0075	74,9	7	0
LVL	1	1	3	0,02	9	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	1,980	7	216	1	1	8	2,11	Lower limit	1	2920	0,121	24,2	5	2	42,91	0,0100	1	0,0100	0,95	0,0060	60,0	7	0
LVL	1	1	3	0,02	9	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	1,485	7	218	1	1	8	2,43	Lower limit	1	2939	0,120	24,1	5	2	35,75	0,0083	1	0,0083	0,95	0,0049	49,4	7	0
LVL	1	1	3	0,02	9	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	1,152	7	219	1	1	8	2,75	Lower limit	1	2957	0,120	23,9	4	2	30,42	0,0070	1	0,0070	0,95	0,0042	41,6	6	0
LVL	1	1	3	0,02	9	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	0,916	7	220	1	1	8	3,07	Lower limit	1	2975	0,119	23,8	4	2	26,32	0,0061	1	0,0061	0,95	0,0036	35,6	5	0
LVL	1	1	3	0,02	9	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	0,744	6	222	1	1	8	3,40	Lower limit	1	2993	0,118	23,6	4	2	23,08	0,0053	1	0,0053	0,95	0,0031	30,9	5	0
LVL	1	1	3	0,02	9	0	Lower limit	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	3,00	0,615	6	223	1	1	8	3,73	Lower limit	1	3011	0,117	23,5	4	2	20,47	0,0047	1	0,0047	0,95	0,0027	27,1	5	0
LVL	1	1	3	0,02	9	0	Lower limit	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,515	5	224	1	1	8	4,06	Lower limit	1	3029	0,117	23,3	4	2	18,32	0,0041	1	0,0041	0,95	0,0024	24,0	4	0
LVL	1	1	3	0,02	9	0	Lower limit	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,438	3	226	1	1	8	4,39	Lower limit	1	3047	0,116	23,2	4	2	16,53	0,0037	1	0,0037	0,95	0,0021	21,4	4	0
LVL	1	1	3	0,02	9	4	Resonant	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,375	3	227	1	1	8	4,73	Resonant	1	3065	0,115	23,1	4	2	15,02	0,0034	1	0,0034	0,95	0,0019	19,2	4	4
LVL	1	1	3	0,02	9	4	Resonant	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,325	3	228	1	1	8	5,06	Resonant	1	3083	0,115	22,9	4	2	13,73	0,0030	1	0,0030	0,95	0,0017	17,4	4	4
LVL	1	1	3	0,02	9	4	Resonant	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,284	3	230	1	1	8	5,40	Resonant	1	3101	0,114	22,8	4	2	12,62	0,0028	1	0,0028	0,95	0,0016	15,8	4	4
LVL	1	1	3	0,02	9	4	Resonant	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,250	1	231	1	1	8	5,75	Resonant	1	3119	0,113	22,7	4	2	11,65	0,0026	1	0,0026	0,95	0,0014	14,4	4	4
LVL	1	1	3	0,02	9	4	Resonant	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,221	1	232	1	1	8	6,09	Resonant	1	3137	0,113	22,5	4	2	10,81	0,0024	1	0,0024	0,95	0,0013	13,2	4	4
TCC	1	1	3	0,025	9	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	2,824	7	324	1	1	8	1,44	Lower limit	1	4378	0,065	12,9	4	2	70,32	0,0111	1	0,0111	0,95	0,0063	63,1	7	0
TCC	1	1	3	0,025	9	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	1,683	7	334	1	1	8	1,84	Lower limit	1	4516	0,063	12,5	4	2	51,27	0,0078	1	0,0078	0,95	0,0044	44,4	6	0
TCC	1	1	3	0,025	9	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	1,768	7	334	1	1	8	1,79	Lower limit	1	4516	0,063	12,5	4	2	52,93	0,0081	1	0,0081	0,95	0,0046	45,8	6	0
TCC	1	1	3	0,025	9	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	1,098	7	345	1	1	8	2,24	Lower limit	1	4653	0,061	12,2	4	2	39,59	0,0059	1	0,0059	0,95	0,0033	33,1	5	0
TCC	1	1	3	0,025	9	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	1,133	7	345	1	1	8	2,21	Lower limit	1	4653	0,061	12,2	4	2	40,41	0,0060	1	0,0060	0,95	0,0034	33,8	5	0
TCC	1	1	3	0,025	9	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	0,656	6	380	1	1	8	2,76	Lower limit	1	5128	0,055	11,0	3	2	30,19	0,0041	1	0,0041	0,95	0,0023	22,7	4	0
TCC	1	1	3	0,025	9	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,491	3	390	1	1	8	3,15	Lower limit	1	5266	0,054	10,7	3	2	25,43	0,0033	1	0,0033	0,95	0,0019	18,5	4	0
TCC	1	1	3	0,025	9	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,473	3	390	1	1	8	3,21	Lower limit	1	5266	0,054	10,7	3	2	24,83	0,0033	1	0,0033	0,95	0,0018	18,1	4	0
TCC	1	1	3	0,025	9	0	Lower limit	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,341	3	425	1	1	8	3,62	Lower limit	1	5741	0,049	9,9	3	2	21,23	0,0026	1	0,0026	0,95	0,0014	14,1	4	0
TCC	1	1	3	0,025	9	0	Lower limit	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,348	3	425	1	1	8	3,59	Lower limit	1	5741	0,049	9,9	3	2	21,50	0,0026	1	0,0026	0,95	0,0014	14,3	4	0
TCC	1	1	3	0,025	9	0	Lower limit	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,248	1	460	1	1	8	4,09	Lower limit	1	6217	0,045	9,1	3	2	18,16	0,0020	1	0,0020	0,95	0,0011	11,1	3	0
TCC	1	1	3	0,025	9	0	Lower limit	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,291	3	460	1	1	8	3,77	Lower limit	1	6217	0,045	9,1	3	2	20,18	0,0022	1	0,0022	0,95	0,0012	12,4	4	0
TCC	1	1	3	0,025	9	3	Resonant	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,186	1	471	1	1	8	4,67	Resonant	1	6354	0,045	8,9	3	2	15,27	0,0017	1	0,0017	0,95	0,0009	9,0	3	3
TCC	1	1	3	0,025	9	3	Resonant	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,181	1	481	1	1	8	4,68	Resonant	1	6492	0,044	8,7	3	2	15,22	0,0016	1	0,0016	0,95	0,0009	8,8	3	3
TCC	1	1	3	0,025	9	3	Resonant	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,132	1	506	1	1	8	5,34	Resonant	1	6829	0,041	8,3	3	2	12,81	0,0013	1	0,0013	0,95	0,0007	7,0	2	3
TCC	1	1	3	0,025	9	3	Resonant	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,113	1	516	1	1	8	5,72	Resonant	1	6967	0,041	8,1	3	2	11,72	0,0012	1	0,0012	0,95	0,0006	6,2	2	3
TCC	1	1	3	0,025	9	2	Resonant	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,097	1	526	1	1	8	6,10	Resonant	1	7105	0,040	8,0	2	2	10,78	0,0011	1	0,0011	0,95	0,0006	5,6	2	2
TCC	1	1	3	0,025	9	2	Resonant	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,082	1	536	1	1	8	6,59	Resonant	1	7243	0,039	7,8	2	2	9,76	0,0009	1	0,0009	0,95	0,0005	4,9	2	2
TCC	1	1	3	0,025	9	2	Resonant	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	3,00	0,072	1	547	1	1	8	6,96	Resonant	1	7380	0,038	7,7	2	2	9,09	0,0009	1	0,0009	0,95	0,0004	4,4	2	2

[3.10] Vibrational results for a wide floor (3m) and 10m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	Bef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	I_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	10	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	3,00	15,501	7	224	1	1	8	0,70	Lower limit	1	3364	0,105	21,0	4	2	179,25	0,0365	1	0,0365	0,95	0,0223	223,2	7	0
CLT	1	1	3	0,02	10	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	3,00	7,419	7	234	1	1	8	0,99	Lower limit	1	3517	0,101	20,1	4	2	114,29	0,0223	1	0,0223	0,95	0,0136	135,6	7	0
CLT	1	1	3	0,02	10	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	3,00	8,768	7	234	1	1	8	0,91	Lower limit	1	3517	0,101	20,1	4	2	127,40	0,0249	1	0,0249	0,95	0,0151	151,4	7	0
CLT	1	1	3	0,02	10	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	3,00	4,173	7	245	1	1	8	1,30	Lower limit	1	3670	0,096	19,3	4	2	80,84	0,0151	1	0,0151	0,95	0,0092	91,6	7	0
CLT	1	1	3	0,02	10	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	3,00	4,569	7	245	1	1	8	1,24	Lower limit	1	3670	0,096	19,3	4	2	85,74	0,0160	1	0,0160	0,95	0,0097	97,2	7	0
CLT	1	1	3	0,02	10	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	3,00	2,738	7	255	1	1	8	1,57	Lower limit	1	3823	0,092	18,5	4	2	63,12	0,0113	1	0,0113	0,95	0,0068	68,4	7	0
CLT	1	1	3	0,02	10	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	3,00	1,904	7	265	1	1	8	1,84	Lower limit	1	3976	0,089	17,8	4	2	51,12	0,0088	1	0,0088	0,95	0,0053	53,1	7	0
CLT	1	1	3	0,02	10	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	3,00	1,722	7	265	1	1	8	1,94	Lower limit	1	3976	0,089	17,8	4	2	47,90	0,0083	1	0,0083	0,95	0,0050	49,6	7	0
CLT	1	1	3	0,02	10	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	3,00	1,418	7	275	1	1	8	2,09	Lower limit	1	4129	0,086	17,1	4	2	43,27	0,0072	1	0,0072	0,95	0,0043	43,1	6	0
CLT	1	1	3	0,02	10	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	3,00	1,507	7	275	1	1	8	2,03	Lower limit	1	4129	0,086	17,1	4	2	45,01	0,0075	1	0,0075	0,95	0,0045	44,9	6	0
CLT	1	1	3	0,02	10	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	3,00	1,096	7	285	1	1	8	2,34	Lower limit	1	4282	0,083	16,5	4	2	37,47	0,0060	1	0,0060	0,95	0,0036	35,9	5	0
CLT	1	1	3	0,02	10	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	1,596	7	285	1	1	8	1,94	Lower limit	1	4282	0,083	16,5	4	2	47,84	0,0077	1	0,0077	0,95	0,0046	46,1	6	0
CLT	1	1	3	0,02	10	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	3,00	0,715	6	296	1	1	8	2,85	Lower limit	1	4435	0,080	15,9	4	2	29,04	0,0045	1	0,0045	0,95	0,0027	26,6	5	0
CLT	1	1	3	0,02	10	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	0,778	7	306	1	1	8	2,68	Lower limit	1	4588	0,077	15,4	4	2	31,36	0,0047	1	0,0047	0,95	0,0028	27,9	5	0
CLT	1	1	3	0,02	10	0	Lower limit	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	3,00	0,519	5	306	1	1	8	3,28	Lower limit	1	4588	0,077	15,4	4	2	24,11	0,0036	1	0,0036	0,95	0,0021	21,2	4	0
CLT	1	1	3	0,02	10	0	Lower limit	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	3,00	0,417	3	316	1	1	8	3,60	Lower limit	1	4741	0,075	14,9	4	2	21,37	0,0031	1	0,0031	0,95	0,0018	18,1	4	0
CLT	1	1	3	0,02	10	0	Lower limit	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	3,00	0,342	3	326	1	1	8	3,92	Lower limit	1	4894	0,072	14,4	4	2	19,18	0,0027	1	0,0027	0,95	0,0016	15,7	4	0
CLT	1	1	3	0,02	10	0	Lower limit	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	3,00	0,280	3	336	1	1	8	4,26	Lower limit	1	5047	0,070	14,0	4	2	17,19	0,0024	1	0,0024	0,95	0,0014	13,6	4	0
CLT	1	1	3	0,02	10	4	Resonant	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	3,00	0,238	1	347	1	1	8	4,56	Resonant	1	5200	0,068	13,6	4	2	15,75	0,0021	1	0,0021	0,95	0,0012	12,0	4	4
CON HC	1	1	3	0,005	10	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,644	6	451	1	1	8	2,43	Lower limit	1	6772	0,209	41,8	6	2	35,73	0,0037	1	0,0037	0,95	0,0025	25,3	5	0
CON HC	1	1	3	0,005	10	0	Lower limit	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,285	3	491	1	1	8	3,50	Lower limit	1	7372	0,192	38,4	6	2	22,21	0,0021	1	0,0021	0,95	0,0014	14,2	4	0
CON HC	1	1	3	0,005	10	5	Resonant	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,134	1	566	1	1	8	4,74	Resonant	1	8497	0,166	33,3	5	2	14,96	0,0012	1	0,0012	0,95	0,0008	8,1	3	5
CON HC	1	1	3	0,005	10	5	Resonant	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,078	1	612	1	1	8	5,98	Resonant	1	9187	0,154	30,8	5	2	11,06	0,0008	1	0,0008	0,95	0,0005	5,5	2	5
CON HC	1	1	3	0,005	10	5	Resonant	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,044	1	673	1	1	8	7,64	Resonant	1	10102	0,140	28,0	5	2	8,05	0,0006	1	0,0006	0,95	0,0004	3,5	1	5
CON IS	1	1	3	0,01	10	0	Lower limit	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,144	1	833	1	1	8	3,78	Lower limit	1	12502	0,057	11,3	3	2	20,07	0,0011	1	0,0011	0,95	0,0007	7,2	2	0
CON IS	1	1	3	0,01	10	0	Lower limit	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,115	1	883	1	1	8	4,11	Lower limit	1	13252	0,053	10,7	3	2	18,04	0,0009	1	0,0009	0,95	0,0006	6,1	2	0
CON IS	1	1	3	0,01	10	0	Lower limit	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,094	1	933	1	1	8	4,43	Lower limit	1	14002	0,050	10,1	3	2	16,34	0,0008	1	0,0008	0,95	0,0005	5,2	2	0
CON IS	1	1	3	0,01	10	3	Resonant	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,077	1	983	1	1	8	4,75	Resonant	1	14752	0,048	9,6	3	2	14,91	0,0007	1	0,0007	0,95	0,0004	4,5	2	3
CON IS	1	1	3	0,01	10	0	Lower limit	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,237	1	733	1	1	8	3,14	Lower limit	1	11002	0,064	12,9	4	2	25,58	0,0016	1	0,0016	0,95	0,0011	10,6	3	0
CON IS	1	1	3	0,01	10	0	Lower limit	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,183	1	783	1	1	8	3,46	Lower limit	1	11752	0,060	12,0	4	2	22,54	0,0013	1	0,0013	0,95	0,0009	8,7	3	0
CON IS	1	1	3	0,01	10	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,617	6	583	1	1	8	2,18	Lower limit	1	8752	0,081	16,2	4	2	41,03	0,0033	1	0,0033	0,95	0,0022	21,6	4	0
CON IS	1	1	3	0,01	10	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,433	3	633	1	1	8	2,50	Lower limit	1	9502	0,074	14,9	4	2	34,40	0,0025	1	0,0025	0,95	0,0017	16,6	4	0
CON IS	1	1	3	0,01	10	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,316	3	683	1	1	8	2,82	Lower limit	1	10252	0,069	13,8	4	2	29,43	0,0020	1	0,0020	0,95	0,0013	13,1	4	0
CON IS	1	1	3	0,01	10	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	0,920	7	533	1	1	8	1,87	Lower limit	1	8002	0,088	17,7	4	2	50,22	0,0044	1	0,0044	0,95	0,0029	29,0	5	0
CON IS	1	1	3	0,01	10	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	1,461	7	483	1	1	8	1,56	Lower limit	1	7252	0,098	19,5	4	2	63,63	0,0061	1	0,0061	0,95	0,0041	40,7	6	0
CON IS	1	1	3	0,01	10	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	2,525	7	433	1	1	8	1,25	Lower limit	1	6502	0,109	21,7	4	2	84,57	0,0090	1	0,0090	0,95	0,0061	60,6	7	0
CON IS	1	1	3	0,01	10	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	4,932	7	383	1	1	8	0,95	Lower limit	1	5752	0,123	24,6	5	2	120,67	0,0145	1	0,0145	0,95	0,0098	98,0	7	0
LVL	1	1	3	0,02	10	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	8,920	7	212	1	1	8	0,95	Lower limit	1	3185	0,111	22,2	4	2	120,77	0,0260	1	0,0260	0,95	0,0158	158,0	7	0
LVL	1	1	3	0,02	10	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	5,567	7	214	1	1	8	1,20	Lower limit	1	3205	0,110	22,1	4	2	89,27	0,0191	1	0,0191	0,95	0,0116	115,6	7	0
LVL	1	1	3	0,02	10	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	3,777	7	215	1	1	8	1,45	Lower limit	1	3225	0,110	21,9	4	2	69,65	0,0148	1	0,0148	0,95	0,0089	89,3	7	0
LVL	1	1	3	0,02	10	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	2,716	7	216	1	1	8	1,71	Lower limit	1	3245	0,109	21,8	4	2	56,44	0,0119	1	0,0119	0,95	0,0072	71,7	7	0
LVL	1	1	3	0,02	10	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	2,038	7	218	1	1	8	1,97	Lower limit	1	3265	0,108	21,7	4	2	47,01	0,0099	1	0,0099	0,95	0,0059	59,1	7	0
LVL	1	1	3	0,02	10	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	1,580	7	219	1	1	8	2,23	Lower limit	1	3285	0,108	21,5	4	2	40,00	0,0083	1	0,0083	0,95	0,0050	49,8	7	0
LVL	1	1	3	0,02	10	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	1,257	7	220	1	1	8	2,49	Lower limit	1	3305	0,107	21,4	4	2	34,61	0,0072	1	0,0072	0,95	0,0043	42,6	6	0
LVL	1	1	3	0,02	10	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	1,021	7	222	1	1	8	2,75	Lower limit	1	3325	0,106	21,3	4	2	30,35	0,0063	1	0,0063	0,95	0,0037	37,0	6	0
LVL	1	1	3	0,02	10	0	Lower limit	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	3,00	0,843	7	223	1	1	8	3,02	Lower limit	1	3345	0,106	21,1	4	2	26,92	0,0055	1	0,0055	0,95	0,0032	32,5	5	0
LVL	1	1	3	0,02	10	0	Lower limit	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,707	6	224	1	1	8	3,29	Lower limit	1	3365	0,105	21,0	4	2	24,10	0,0049	1	0,0049	0,95	0,0029	28,8	5	0
LVL	1	1	3	0,02	10	0	Lower limit	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,600	6	226	1	1	8	3,56	Lower limit	1	3385	0,104	20,9	4	2	21,75	0,0044	1	0,0044	0,95	0,0026	25,7	5	0
LVL	1	1	3	0,02	10	0	Lower limit	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,515	5	227	1	1	8	3,83	Lower limit	1	3405	0,104	20,8	4	2	19,76	0,0040	1	0,0040	0,95	0,0023	23,1	4	0
LVL	1	1	3	0,02	10	0	Lower limit	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,446	3	228	1	1	8	4,10	Lower limit	1	3425	0,103	20,6	4	2	18,06	0,0036	1	0,0036	0,95	0,0021	20,9	4	0
LVL	1	1	3	0,02	10	0	Lower limit	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,389	3	230	1	1	8	4,38	Lower limit	1	3445	0,103	20,5	4	2	16,60	0,0033	1	0,0033	0,95	0,0019	19,0	4	0
LVL	1	1	3	0,02	10	4	Resonant	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,342	3	231	1	1	8	4,65	Resonant	1	3465	0,102	20,4	4	2	15,33	0,0030	1	0,0030	0,95	0,0017	17,4	4	4
LVL	1	1	3	0,02	10	4	Resonant	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,303	3	232	1	1	8	4,93	Resonant	1	3485	0,101	20,3	4	2	14,21	0,0028	1	0,0028	0,95	0,0016	16,0	4	4
TCC	1	1	3	0,025	10	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	3,873	7	324	1	1	8	1,17	Lower limit	1	4864	0,058	11,6	3	2	92,48	0,0131	1	0,0131	0,95	0,0075	75,2	7	0
TCC	1	1	3	0,025	10	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	2,309	7	334	1	1	8	1,49	Lower limit	1	5017	0,056	11,3	3	2	67,42	0,0093	1	0,0093	0,95	0,0053	52,9	7	0
TCC	1	1	3	0,025	10	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	2,425	7	334	1	1	8	1,45	Lower limit	1	5017	0,056	11,3	3	2	69,61	0,0096	1	0,0096	0,95	0,0055	54,6	7	0
TCC	1	1	3	0,025	10	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	1,506	7	345	1	1	8	1,82	Lower limit	1	5170	0,055	10,9	3	2	52,06	0,0070	1	0,0070	0,95	0,0039	39,4	6	0
TCC	1	1	3	0,025	10	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	1,554	7	345	1	1	8	1,79	Lower limit	1	5170	0,055	10,9	3	2	53,15	0,0071	1	0,0071	0,95	0,0040	40,3	6	0
TCC	1	1	3	0,025	10	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	0,901	7	380	1	1	8	2,24	Lower limit	1	5698	0,050	9,9	3	2	39,71	0,0048	1	0,0048	0,95	0,0027	27,2	5	0
TCC	1	1	3	0,025	10	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,673	6	390	1	1	8	2,55	Lower limit	1	5851	0,048	9,7	3	2	33,44	0,0040	1	0,0040	0,95	0,0022	22,2	4	0
TCC	1	1	3	0,025	10	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,649	6	390	1	1	8	2,60	Lower limit	1	5851	0,048	9,7	3	2	32,66	0,0039	1	0,0039	0,95	0,0022	21,6	4	0
TCC	1	1	3	0,025	10	0	Lower limit	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,468	3	425	1	1	8	2,93	Lower limit	1	6379	0,044	8,9	3	2	27,92	0,0030	1	0,0030	0,95	0,0017	16,9	4	0
TCC	1	1	3	0,025	10	0	Lower limit	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,477	3	425	1	1	8	2,91	Lower limit	1	6379	0,044	8,9	3	2	28,27	0,0031	1	0,0031	0,95	0,0017	17,1	4	0
TCC	1	1	3	0,025	10	0	Lower limit	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,340	3	460	1	1	8	3,31	Lower limit	1	6907	0,041	8,2	3	2	23,88	0,0024	1	0,0024	0,95	0,0013	13,3	4	0
TCC	1	1	3	0,025	10	0	Lower limit	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,400	3	460	1	1	8	3,05	Lower limit	1	6907	0,041	8,2	3	2	26,54	0,0027	1	0,0027	0,95	0,0015	14,8	4	0
TCC	1	1	3	0,025	10	0	Lower limit	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,255	3	471	1	1	8	3,78	Lower limit	1	7060	0,040	8,0	3	2	20,08	0,0020	1	0,0020	0,95	0,0011	10,8	3	0
TCC	1	1	3	0,025	10	0	Lower limit	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,248	1	481	1	1	8	3,79	Lower limit	1	7213	0,039	7,8	2	2	20,02	0,0019	1	0,0019	0,95	0,0011	10,6	3	0
TCC	1	1	3	0,025	10	0	Lower limit	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,181	1	506	1	1	8	4,33	Lower limit	1	7588	0,037	7,5	2	2	16,85	0,0015	1	0,0015	0,95	0,0008	8,4	3	0
TCC	1	1	3	0,025	10	2	Resonant	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,155	1	516	1	1	8	4,63	Resonant	1	7741	0,037	7,3	2	2	15,42	0,0014	1	0,0014	0,95	0,0007	7,5	2	2
TCC	1	1	3	0,025	10	2	Resonant	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,133	1	526	1	1	8	4,94	Resonant	1	7894	0,036	7,2	2	2	14,18	0,0012	1	0,0012	0,95	0,0007	6,7	2	2
TCC	1	1	3	0,025	10	2	Resonant	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,112	1	536	1	1	8	5,33	Resonant	1	8047	0,035	7,0	2	2	12,84	0,0011	1	0,0011	0,95	0,0006	5,9	2	2
TCC	1	1	3	0,025	10	2	Resonant	54	TC400	363,2	5,06	3,00	9,99	10,58	10,58	8,06	400	7,04E+13	3,88E+13	3,00	0,099	1	547	1	1	8	5,64	Resonant	1	8200	0,034	6,9	2	2	11,95	0,0010	1	0,0010	0,95	0,0005	5,4	2	2

[3.11] Vibrational results for a wide floor (3m) and 11m span

	Input					Output		Floor selection		Loads							Properties			Vibrations, w1_kn			Vibrations, f1						Vibrations, a_rms					Vibrations, v_rms									
Material	n-direction [-]	n-span [-]	Width [m]	Damping [%]	Span [m]	Vibrational Performance class	Validation type	# ID	Floortype	Selfweight [kg/m2]	Load G [kN/m2]	Load Q [kN/m2]	ULS 1 [kN/m2]	ULS 2 [kN/m2]	ULS Max [kN/m2]	SLS [kN/m2]	Height [mm]	(EI)L [Nmm2]	(EI)B [Nmm2]	B;ef [m]	w1_kn [mm]	FP class # w1_kn	m [kg/m2]	ke1 [-]	ke2 [-]	f1_lim [Hz]	f1 [Hz]	Validation type2	k_res [-]	M* [kg]	a_rms [m/s2]	Response factor A_rms	FP class # A_rms	f_w [Hz]	l_m	v1_peak	k_imp	v_tot_peak	η	v_rms	Response factor V_rms	FP class # V_rms	Decisive class
CLT	1	1	3	0,02	11	0	Lower limit	1	080 L3s	40,8	1,90	3,00	5,72	6,78	6,78	4,90	80	4,48E+11	6,40E+10	3,00	20,632	7	224	1	1	8	0,58	Lower limit	1	3701	0,096	19,1	4	2	229,66	0,0426	1	0,0426	0,95	0,0261	260,9	7	0
CLT	1	1	3	0,02	11	0	Lower limit	2	100 L3s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	9,36E+11	6,40E+10	3,00	9,875	7	234	1	1	8	0,82	Lower limit	1	3869	0,091	18,3	4	2	146,43	0,0260	1	0,0260	0,95	0,0159	158,7	7	0
CLT	1	1	3	0,02	11	0	Lower limit	3	100 L5s	51,0	2,00	3,00	5,85	6,90	6,90	5,00	100	7,92E+11	2,08E+11	3,00	11,671	7	234	1	1	8	0,75	Lower limit	1	3869	0,091	18,3	4	2	163,23	0,0290	1	0,0290	0,95	0,0177	177,0	7	0
CLT	1	1	3	0,02	11	0	Lower limit	4	120 L3s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,66E+12	6,40E+10	3,00	5,555	7	245	1	1	8	1,07	Lower limit	1	4037	0,088	17,5	4	2	103,57	0,0177	1	0,0177	0,95	0,0107	107,2	7	0
CLT	1	1	3	0,02	11	0	Lower limit	5	120 L5s	61,2	2,10	3,00	5,99	7,02	7,02	5,10	120	1,52E+12	2,08E+11	3,00	6,081	7	245	1	1	8	1,02	Lower limit	1	4037	0,088	17,5	4	2	109,85	0,0187	1	0,0187	0,95	0,0114	113,8	7	0
CLT	1	1	3	0,02	11	0	Lower limit	6	140 L5s	71,4	2,20	3,00	6,12	7,14	7,14	5,20	140	2,54E+12	2,08E+11	3,00	3,645	7	255	1	1	8	1,29	Lower limit	1	4206	0,084	16,8	4	2	80,88	0,0132	1	0,0132	0,95	0,0080	80,1	7	0
CLT	1	1	3	0,02	11	0	Lower limit	7	160 L5s	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	3,65E+12	4,48E+11	3,00	2,534	7	265	1	1	8	1,52	Lower limit	1	4374	0,081	16,2	4	2	65,50	0,0103	1	0,0103	0,95	0,0062	62,2	7	0
CLT	1	1	3	0,02	11	0	Lower limit	8	160 L5s-2	81,6	2,30	3,00	6,26	7,26	7,26	5,30	160	4,03E+12	6,40E+10	3,00	2,292	7	265	1	1	8	1,60	Lower limit	1	4374	0,081	16,2	4	2	61,38	0,0097	1	0,0097	0,95	0,0058	58,2	7	0
CLT	1	1	3	0,02	11	0	Lower limit	9	180 L5s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,90E+12	9,36E+11	3,00	1,888	7	275	1	1	8	1,73	Lower limit	1	4542	0,078	15,6	4	2	55,44	0,0084	1	0,0084	0,95	0,0051	50,6	7	0
CLT	1	1	3	0,02	11	0	Lower limit	10	180 L7s	91,8	2,40	3,00	6,39	7,38	7,38	5,40	180	4,61E+12	1,22E+12	3,00	2,006	7	275	1	1	8	1,68	Lower limit	1	4542	0,078	15,6	4	2	57,67	0,0088	1	0,0088	0,95	0,0053	52,7	7	0
CLT	1	1	3	0,02	11	0	Lower limit	11	200 L5s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	6,34E+12	1,66E+12	3,00	1,459	7	285	1	1	8	1,93	Lower limit	1	4711	0,075	15,0	4	2	48,01	0,0070	1	0,0070	0,95	0,0042	42,1	6	0
CLT	1	1	3	0,02	11	0	Lower limit	12	200 L7s	102,0	2,50	3,00	6,53	7,50	7,50	5,50	200	4,35E+12	3,65E+12	3,00	2,124	7	285	1	1	8	1,60	Lower limit	1	4711	0,075	15,0	4	2	61,29	0,0090	1	0,0090	0,95	0,0054	54,0	7	0
CLT	1	1	3	0,02	11	0	Lower limit	13	220 L7s-2	112,2	2,60	3,00	6,66	7,62	7,62	5,60	220	9,71E+12	9,36E+11	3,00	0,952	7	296	1	1	8	2,35	Lower limit	1	4879	0,072	14,5	4	2	37,21	0,0053	1	0,0053	0,95	0,0031	31,3	5	0
CLT	1	1	3	0,02	11	0	Lower limit	14	240 L7s	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	8,93E+12	4,90E+12	3,00	1,035	7	306	1	1	8	2,22	Lower limit	1	5047	0,070	14,0	4	2	40,18	0,0055	1	0,0055	0,95	0,0033	32,8	5	0
CLT	1	1	3	0,02	11	0	Lower limit	15	240 L7s-2	122,4	2,70	3,00	6,80	7,74	7,74	5,70	240	1,34E+13	4,48E+11	3,00	0,691	7	306	1	1	8	2,71	Lower limit	1	5047	0,070	14,0	4	2	30,90	0,0042	1	0,0042	0,95	0,0025	25,0	5	0
CLT	1	1	3	0,02	11	0	Lower limit	16	260 L7s-2	132,6	2,80	3,00	6,93	7,86	7,86	5,80	260	1,66E+13	9,36E+11	3,00	0,555	6	316	1	1	8	2,98	Lower limit	1	5215	0,068	13,6	4	2	27,38	0,0036	1	0,0036	0,95	0,0021	21,4	4	0
CLT	1	1	3	0,02	11	0	Lower limit	17	280 L7s-2	142,8	2,90	3,00	7,07	7,98	7,98	5,90	280	2,03E+13	1,66E+12	3,00	0,456	3	326	1	1	8	3,24	Lower limit	1	5384	0,066	13,1	4	2	24,58	0,0032	1	0,0032	0,95	0,0019	18,5	4	0
CLT	1	1	3	0,02	11	0	Lower limit	18	300 L8s-2	153,0	3,00	3,00	7,20	8,10	8,10	6,00	300	2,48E+13	2,23E+12	3,00	0,373	3	336	1	1	8	3,52	Lower limit	1	5552	0,064	12,7	4	2	22,02	0,0027	1	0,0027	0,95	0,0016	16,0	4	0
CLT	1	1	3	0,02	11	0	Lower limit	19	320 L8s-2	163,2	3,10	3,00	7,34	8,22	8,22	6,10	320	2,92E+13	3,58E+12	3,00	0,317	3	347	1	1	8	3,77	Lower limit	1	5720	0,062	12,4	4	2	20,18	0,0024	1	0,0024	0,95	0,0014	14,2	4	0
CON HC	1	1	3	0,005	11	0	Lower limit	68	KP150	268,0	4,13	3,00	8,72	9,45	9,45	7,13	150	1,08E+13	9,26E+12	3,00	0,857	7	451	1	1	8	2,01	Lower limit	1	7450	0,190	38,0	6	2	45,77	0,0043	1	0,0043	0,95	0,0030	29,7	5	0
CON HC	1	1	3	0,005	11	0	Lower limit	69	KP200	308,0	4,52	3,00	9,25	9,93	9,93	7,52	200	2,44E+13	1,89E+13	3,00	0,379	3	491	1	1	8	2,89	Lower limit	1	8110	0,174	34,9	5	2	28,46	0,0024	1	0,0024	0,95	0,0017	16,7	4	0
CON HC	1	1	3	0,005	11	0	Lower limit	70	KP260	383,0	5,26	3,00	10,25	10,81	10,81	8,26	260	5,17E+13	4,08E+13	3,00	0,179	1	566	1	1	8	3,92	Lower limit	1	9347	0,151	30,3	5	2	19,16	0,0014	1	0,0014	0,95	0,0010	9,6	3	0
CON HC	1	1	3	0,005	11	5	Resonant	71	KP320	429,0	5,71	3,00	10,86	11,35	11,35	8,71	320	8,89E+13	6,57E+13	3,00	0,104	1	612	1	1	8	4,95	Resonant	1	10106	0,140	28,0	5	2	14,17	0,0010	1	0,0010	0,95	0,0006	6,5	2	5
CON HC	1	1	3	0,005	11	5	Resonant	72	KP400	490,0	6,31	3,00	11,66	12,07	12,07	9,31	400	1,59E+14	1,12E+14	3,00	0,058	1	673	1	1	8	6,31	Resonant	1	11113	0,127	25,5	5	2	10,32	0,0006	1	0,0006	0,95	0,0004	4,2	2	5
CON IS	1	1	3	0,01	11	0	Lower limit	65	SC280	700,0	8,37	3,00	14,45	14,54	14,54	11,37	280	6,04E+13	6,04E+13	3,00	0,153	1	883	1	1	8	3,39	Lower limit	1	14578	0,049	9,7	3	2	23,11	0,0011	1	0,0011	0,95	0,0007	7,2	2	0
CON IS	1	1	3	0,01	11	0	Lower limit	66	SC300	750,0	8,86	3,00	15,11	15,13	15,13	11,86	300	7,43E+13	7,43E+13	3,00	0,124	1	933	1	1	8	3,66	Lower limit	1	15403	0,046	9,2	3	2	20,94	0,0009	1	0,0009	0,95	0,0006	6,1	2	0
CON IS	1	1	3	0,01	11	0	Lower limit	67	SC320	800,0	9,35	3,00	15,77	15,72	15,77	12,35	320	9,01E+13	9,01E+13	3,00	0,103	1	983	1	1	8	3,93	Lower limit	1	16228	0,044	8,7	3	2	19,10	0,0008	1	0,0008	0,95	0,0005	5,3	2	0
CON IS	1	1	3	0,01	11	0	Lower limit	63	SC240	600,0	7,39	3,00	13,12	13,36	13,36	10,39	240	3,80E+13	3,80E+13	3,00	0,243	1	783	1	1	8	2,86	Lower limit	1	12928	0,055	10,9	3	2	28,88	0,0016	1	0,0016	0,95	0,0010	10,2	3	0
CON IS	1	1	3	0,01	11	0	Lower limit	64	SC260	650,0	7,88	3,00	13,78	13,95	13,95	10,88	260	4,83E+13	4,83E+13	3,00	0,191	1	833	1	1	8	3,13	Lower limit	1	13753	0,051	10,3	3	2	25,72	0,0013	1	0,0013	0,95	0,0008	8,5	3	0
CON IS	1	1	3	0,01	11	0	Lower limit	62	SC220	550,0	6,90	3,00	12,46	12,77	12,77	9,90	220	2,93E+13	2,93E+13	3,00	0,316	3	733	1	1	8	2,59	Lower limit	1	12103	0,058	11,7	3	2	32,78	0,0019	1	0,0019	0,95	0,0012	12,4	4	0
CON IS	1	1	3	0,01	11	0	Lower limit	60	SC180	450,0	5,91	3,00	11,13	11,60	11,60	8,91	180	1,60E+13	1,60E+13	3,00	0,576	6	633	1	1	8	2,07	Lower limit	1	10453	0,068	13,5	4	2	44,07	0,0029	1	0,0029	0,95	0,0019	19,5	4	0
CON IS	1	1	3	0,01	11	0	Lower limit	61	SC200	500,0	6,41	3,00	11,80	12,19	12,19	9,41	200	2,20E+13	2,20E+13	3,00	0,420	3	683	1	1	8	2,33	Lower limit	1	11278	0,063	12,5	4	2	37,70	0,0023	1	0,0023	0,95	0,0015	15,4	4	0
CON IS	1	1	3	0,01	11	0	Lower limit	58	SC140	350,0	4,93	3,00	9,81	10,42	10,42	7,93	140	7,55E+12	7,55E+12	3,00	1,225	7	533	1	1	8	1,54	Lower limit	1	8803	0,080	16,1	4	2	64,34	0,0051	1	0,0051	0,95	0,0034	34,0	5	0
CON IS	1	1	3	0,01	11	0	Lower limit	59	SC160	400,0	5,42	3,00	10,47	11,01	11,01	8,42	160	1,13E+13	1,13E+13	3,00	0,821	7	583	1	1	8	1,80	Lower limit	1	9628	0,073	14,7	4	2	52,57	0,0038	1	0,0038	0,95	0,0025	25,3	5	0
CON IS	1	1	3	0,01	11	0	Lower limit	57	SC120	300,0	4,44	3,00	9,15	9,83	9,83	7,44	120	4,75E+12	4,75E+12	3,00	1,945	7	483	1	1	8	1,29	Lower limit	1	7978	0,089	17,7	4	2	81,52	0,0071	1	0,0071	0,95	0,0048	47,6	6	0
CON IS	1	1	3	0,01	11	0	Lower limit	55	SC080	200,0	3,46	3,00	7,82	8,65	8,65	6,46	80	1,41E+12	1,41E+12	3,00	6,565	7	383	1	1	8	0,79	Lower limit	1	6328	0,112	22,4	4	2	154,61	0,0169	1	0,0169	0,95	0,0115	114,5	7	0
CON IS	1	1	3	0,01	11	0	Lower limit	56	SC100	250,0	3,95	3,00	8,49	9,24	9,24	6,95	100	2,75E+12	2,75E+12	3,00	3,361	7	433	1	1	8	1,03	Lower limit	1	7153	0,099	19,8	4	2	108,36	0,0105	1	0,0105	0,95	0,0071	70,8	7	0
LVL	1	1	3	0,02	11	0	Lower limit	20	BX100	28,8	1,78	3,00	5,56	6,64	6,64	4,78	100	7,79E+11	7,72E+11	3,00	11,872	7	212	1	1	8	0,79	Lower limit	1	3503	0,101	20,2	4	2	154,74	0,0303	1	0,0303	0,95	0,0185	184,9	7	0
LVL	1	1	3	0,02	11	0	Lower limit	21	BX120	30,2	1,80	3,00	5,57	6,66	6,66	4,80	120	1,25E+12	1,23E+12	3,00	7,410	7	214	1	1	8	0,99	Lower limit	1	3525	0,100	20,1	4	2	114,37	0,0223	1	0,0223	0,95	0,0135	135,4	7	0
LVL	1	1	3	0,02	11	0	Lower limit	22	BX140	31,5	1,81	3,00	5,59	6,67	6,67	4,81	140	1,84E+12	1,80E+12	3,00	5,027	7	215	1	1	8	1,20	Lower limit	1	3547	0,100	19,9	4	2	89,24	0,0173	1	0,0173	0,95	0,0105	104,7	7	0
LVL	1	1	3	0,02	11	0	Lower limit	23	BX160	32,8	1,82	3,00	5,61	6,69	6,69	4,82	160	2,56E+12	2,49E+12	3,00	3,615	7	216	1	1	8	1,41	Lower limit	1	3569	0,099	19,8	4	2	72,31	0,0139	1	0,0139	0,95	0,0084	84,0	7	0
LVL	1	1	3	0,02	11	0	Lower limit	24	BX180	34,2	1,84	3,00	5,63	6,70	6,70	4,84	180	3,41E+12	3,29E+12	3,00	2,712	7	218	1	1	8	1,62	Lower limit	1	3592	0,098	19,7	4	2	60,23	0,0115	1	0,0115	0,95	0,0069	69,3	7	0
LVL	1	1	3	0,02	11	0	Lower limit	25	BX200	35,5	1,85	3,00	5,65	6,72	6,72	4,85	200	4,40E+12	4,22E+12	3,00	2,103	7	219	1	1	8	1,84	Lower limit	1	3614	0,098	19,6	4	2	51,25	0,0097	1	0,0097	0,95	0,0058	58,4	7	0
LVL	1	1	3	0,02	11	0	Lower limit	26	BX220	36,9	1,86	3,00	5,66	6,73	6,73	4,86	220	5,53E+12	5,27E+12	3,00	1,672	7	220	1	1	8	2,06	Lower limit	1	3636	0,097	19,4	4	2	44,34	0,0084	1	0,0084	0,95	0,0050	50,1	7	0
LVL	1	1	3	0,02	11	0	Lower limit	27	BX240	38,2	1,87	3,00	5,68	6,75	6,75	4,87	240	6,80E+12	6,45E+12	3,00	1,358	7	222	1	1	8	2,27	Lower limit	1	3658	0,097	19,3	4	2	38,89	0,0073	1	0,0073	0,95	0,0044	43,5	6	0
LVL	1	1	3	0,02	11	0	Lower limit	28	BX260	39,5	1,89	3,00	5,70	6,77	6,77	4,89	260	8,23E+12	7,75E+12	3,00	1,123	7	223	1	1	8	2,49	Lower limit	1	3680	0,096	19,2	4	2	34,49	0,0064	1	0,0064	0,95	0,0038	38,2	6	0
LVL	1	1	3	0,02	11	0	Lower limit	29	BX280	40,9	1,90	3,00	5,72	6,78	6,78	4,90	280	9,82E+12	9,19E+12	3,00	0,941	7	224	1	1	8	2,72	Lower limit	1	3702	0,096	19,1	4	2	30,87	0,0057	1	0,0057	0,95	0,0034	33,9	5	0
LVL	1	1	3	0,02	11	0	Lower limit	30	BX300	42,2	1,91	3,00	5,73	6,80	6,80	4,91	300	1,16E+13	1,08E+13	3,00	0,799	7	226	1	1	8	2,94	Lower limit	1	3724	0,095	19,0	4	2	27,86	0,0051	1	0,0051	0,95	0,0030	30,3	5	0
LVL	1	1	3	0,02	11	0	Lower limit	31	BX320	43,5	1,93	3,00	5,75	6,81	6,81	4,93	320	1,35E+13	1,25E+13	3,00	0,685	7	227	1	1	8	3,16	Lower limit	1	3746	0,094	18,9	4	2	25,32	0,0046	1	0,0046	0,95	0,0027	27,3	5	0
LVL	1	1	3	0,02	11	0	Lower limit	32	BX340	44,9	1,94	3,00	5,77	6,83	6,83	4,94	340	1,56E+13	1,43E+13	3,00	0,593	6	228	1	1	8	3,39	Lower limit	1	3768	0,094	18,8	4	2	23,14	0,0042	1	0,0042	0,95	0,0025	24,7	5	0
LVL	1	1	3	0,02	11	0	Lower limit	33	BX360	46,2	1,95	3,00	5,79	6,84	6,84	4,95	360	1,78E+13	1,63E+13	3,00	0,518	6	230	1	1	8	3,62	Lower limit	1	3790	0,093	18,7	4	2	21,27	0,0039	1	0,0039	0,95	0,0022	22,5	4	0
LVL	1	1	3	0,02	11	0	Lower limit	34	BX380	47,5	1,97	3,00	5,80	6,86	6,86	4,97	380	2,03E+13	1,84E+13	3,00	0,456	3	231	1	1	8	3,85	Lower limit	1	3812	0,093	18,5	4	2	19,64	0,0035	1	0,0035	0,95	0,0021	20,6	4	0
LVL	1	1	3	0,02	11	0	Lower limit	35	BX400	48,9	1,98	3,00	5,82	6,88	6,88	4,98	400	2,29E+13	2,07E+13	3,00	0,403	3	232	1	1	8	4,08	Lower limit	1	3834	0,092	18,4	4	2	18,21	0,0033	1	0,0033	0,95	0,0019	18,9	4	0
TCC	1	1	3	0,025	11	0	Lower limit	36	TC120	140,8	2,88	3,00	7,04	7,96	7,96	5,88	120	1,79E+12	1,41E+12	3,00	5,155	7	324	1	1	8	0,97	Lower limit	1	5351	0,053	10,6	3	2	118,49	0,0153	1	0,0153	0,95	0,0088	88,0	7	0
TCC	1	1	3	0,025	11	0	Lower limit	37	TC140	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	3,01E+12	1,96E+12	3,00	3,074	7	334	1	1	8	1,23	Lower limit	1	5519	0,051	10,2	3	2	86,38	0,0108	1	0,0108	0,95	0,0062	61,9	7	0
TCC	1	1	3	0,025	11	0	Lower limit	38	TC140-2	151,0	2,98	3,00	7,17	8,08	8,08	5,98	140	2,86E+12	2,11E+12	3,00	3,228	7	334	1	1	8	1,20	Lower limit	1	5519	0,051	10,2	3	2	89,18	0,0112	1	0,0112	0,95	0,0064	64,0	7	0
TCC	1	1	3	0,025	11	0	Lower limit	39	TC160	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,61E+12	2,66E+12	3,00	2,004	7	345	1	1	8	1,50	Lower limit	1	5687	0,050	9,9	3	2	66,71	0,0081	1	0,0081	0,95	0,0046	46,2	6	0
TCC	1	1	3	0,025	11	0	Lower limit	40	TC160-2	161,2	3,08	3,00	7,31	8,20	8,20	6,08	160	4,47E+12	2,80E+12	3,00	2,069	7	345	1	1	8	1,48	Lower limit	1	5687	0,050	9,9	3	2	68,10	0,0083	1	0,0083	0,95	0,0047	47,2	6	0
TCC	1	1	3	0,025	11	0	Lower limit	41	TC190	196,4	3,43	3,00	7,78	8,61	8,61	6,43	190	7,71E+12	4,56E+12	3,00	1,199	7	380	1	1	8	1,85	Lower limit	1	6268	0,045	9,0	3	2	50,88	0,0056	1	0,0056	0,95	0,0032	31,9	5	0
TCC	1	1	3	0,025	11	0	Lower limit	42	TC210	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,03E+13	5,99E+12	3,00	0,896	7	390	1	1	8	2,11	Lower limit	1	6436	0,044	8,8	3	2	42,84	0,0046	1	0,0046	0,95	0,0026	26,0	5	0
TCC	1	1	3	0,025	11	0	Lower limit	43	TC210-2	206,6	3,53	3,00	7,91	8,73	8,73	6,53	210	1,07E+13	5,60E+12	3,00	0,864	7	390	1	1	8	2,15	Lower limit	1	6436	0,044	8,8	3	2	41,84	0,0045	1	0,0045	0,95	0,0025	25,4	5	0
TCC	1	1	3	0,025	11	0	Lower limit	44	TC240	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,48E+13	9,68E+12	3,00	0,623	6	425	1	1	8	2,43	Lower limit	1	7017	0,040	8,1	3	2	35,77	0,0035	1	0,0035	0,95	0,0020	19,8	4	0
TCC	1	1	3	0,025	11	0	Lower limit	45	TC240-2	241,8	3,87	3,00	8,38	9,15	9,15	6,87	240	1,46E+13	9,97E+12	3,00	0,635	6	425	1	1	8	2,40	Lower limit	1	7017	0,040	8,1	3	2	36,22	0,0036	1	0,0036	0,95	0,0020	20,1	4	0
TCC	1	1	3	0,025	11	0	Lower limit	46	TC270	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	2,04E+13	1,47E+13	3,00	0,452	3	460	1	1	8	2,74	Lower limit	1	7598	0,037	7,4	2	2	30,59	0,0028	1	0,0028	0,95	0,0016	15,6	4	0
TCC	1	1	3	0,025	11	0	Lower limit	47	TC270-2	277,0	4,22	3,00	8,84	9,56	9,56	7,22	270	1,74E+13	1,78E+13	3,00	0,532	6	460	1	1	8	2,52	Lower limit	1	7598	0,037	7,4	2	2	34,00	0,0031	1	0,0031	0,95	0,0017	17,4	4	0
TCC	1	1	3	0,025	11	0	Lower limit	48	TC290	287,2	4,32	3,00	8,98	9,68	9,68	7,32	290	2,73E+13	1,58E+13	3,00	0,339	3	471	1	1	8	3,13	Lower limit	1	7766	0,036	7,3	2	2	25,73	0,0023	1	0,0023	0,95	0,0013	12,8	4	0
TCC	1	1	3	0,025	11	0	Lower limit	49	TC310	297,4	4,42	3,00	9,11	9,80	9,80	7,42	310	2,80E+13	2,40E+13	3,00	0,330	3	481	1	1	8	3,13	Lower limit	1	7935	0,036	7,1	2	2	25,65	0,0022	1	0,0022	0,95	0,0012	12,5	4	0
TCC	1	1	3	0,025	11	0	Lower limit	50	TC320	322,4	4,66	3,00	9,44	10,10	10,10	7,66	320	3,84E+13	1,98E+13	3,00	0,241	1	506	1	1	8	3,58	Lower limit	1	8347	0,034	6,8	2	2	21,59	0,0018	1	0,0018	0,95	0,0010	9,9	3	0
TCC	1	1	3	0,025	11	0	Lower limit	51	TC340	332,6	4,76	3,00	9,58	10,22	10,22	7,76	340	4,49E+13	2,41E+13	3,00	0,206	1	516	1	1	8	3,83	Lower limit	1	8515	0,033	6,6	2	2	19,75	0,0016	1	0,0016	0,95	0,0009	8,8	3	0
TCC	1	1	3	0,025	11	0	Lower limit	52	TC360	342,8	4,86	3,00	9,71	10,34	10,34	7,86	360	5,21E+13	2,91E+13	3,00	0,177	1	526	1	1	8	4,08	Lower limit	1	8684	0,033	6,5	2	2	18,17	0,0015	1	0,0015	0,95	0,0008	7,9	2	0
TCC	1	1	3	0,025	11	0	Lower limit	53	TC380	353,0	4,96	3,00	9,85	10,46	10,46	7,96	380	6,19E+13	3,27E+13	3,00	0,149	1	536	1	1	8	4,41	Lower limit	1	8852	0,032	6,4	2	2	16,45	0,0013	1	0,0013	0,95	0,0007	7,0	2	0

Appendix C: Sustainability - Overview of resources

Overview of environmental data resources for CLT and LVL based floors, sources: GPR Materials and OneClickLCA.

Name	Supplier	Country	Data type	Year	Verification	Category	# impact categories	Source	Date of reference	Biogenic carbon
One Click LCA source										
CLT wood panels, biogenic CO2 not subtracted (for CML), 710 ...	Bois de france	France	Manufacturer specific	2022	Third party	1	9	OneClickLCA	28-5-2023	Not substracted
Cross laminated timber (CLT), glued, biogenic CO2 not subtra...	Stabilame	Belgium	Manufacturer specific	2021	Third party	1	9	OneClickLCA	28-5-2023	Not substracted
Cross-laminated timber (CLT), biogenic CO2 not subtracted (f...	Stora Enso	France	Manufacturer specific	2022	Third party	1	6	OneClickLCA	28-5-2023	Not substracted
CLT Panels, 448 kg/m3, biogenic CO2 not subtracted (for CML)...	Schillinger Bois SAS	France	Manufacturer specific	2020	Third party	1	9	OneClickLCA	28-5-2023	Not substracted
Cross laminated timber (CLT), biogenic CO2 not subtracted (f...	Lignatec	France	Manufacturer specific	2022	Third party	1	9	OneClickLCA	28-5-2023	Not substracted
Cross Laminated Timber (CLT), Brettsperrholz BBS (spruce) (B...	Binderholz GmbH	Austria	Manufacturer specific	2018	Internally	1	6	OneClickLCA	28-5-2023	Not substracted
Cross Laminated Timber (CLT), Massivholzplatte (KLH Massivho...	KLH Massivholz GmbH	Austria	Manufacturer specific	2018	Internally	1	6	OneClickLCA	28-5-2023	Not substracted
Cross Laminated Timber (CLT), Thickness: up to 400 mm, 470 k...	Derix GmbH	Netherlands	Manufacturer specific	2019	Third party	1	11	OneClickLCA	28-5-2023	Not substracted
Cross laminated timber (CLT), 481 kg/m3, 12% (± 3%) moisture...	OneClickLCA	Netherlands	Local generic	2023	Internally	3	7	OneClickLCA	28-5-2023	Not substracted
Cross laminated timber (CLT), 470 kg/m3, X-LAM (W. u. J. Der...	Derix GmbH	Germany	Manufacturer specific	2020	Third party	1	7	OneClickLCA	28-5-2023	Not substracted
CLT (cross laminated timber), 430 kg/m3, moisture content 12...	Sodra Skogsagarna	Sweden	Manufacturer specific	2020	Third party	1	9	OneClickLCA	28-5-2023	Not substracted
Cross laminated timber (CLT) board, 60-300 mm, 485 kg/m3, mo...	Crosslam Kuhmo	Finland	Manufacturer specific	2021	Third party	1	11	OneClickLCA	28-5-2023	Not substracted
GPR Material Source										
CLT by Stora Enso vloeren, constructief	Stora Enso	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	Substracted, compensated in data
KLH CLT massive vloer	KLH Massivholz GmbH	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	Substracted, compensated in data
Hamlet, CLT toegepast als constructieve vrijgragende vloer	Hamlet	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	Not substracted
Kruislings gemlamineerde houten vloer, 5 laags	GPR material	Netherlands	Local generic	2023	Internally	3	11	GPR Material	28-5-2023	Not substracted
Vrijdragende Vloer, Massief houtenvloer	GPR Material	Netherlands	Local generic	2023	Internally	3	11	GPR Material	28-5-2023	Not substracted
One Click LCA source										
Laminated veneer lumber (LVL), biogenic CO2 not subtracted (...	Stora Enso France	France	Manufacturer specific	2021	Third party	1	7	OneClickLCA	28-5-2023	Not substracted
Laminated veneer lumber (LVL), biogenic CO2 not subtracted (...	Steico SE	Germany	Manufacturer specific	2021	Third party	1	7	OneClickLCA	28-5-2023	Not substracted
Laminated veneer lumber (LVL), 9% moisture content, 510 kg/m...	Stora Enso	Finland	Manufacturer specific	2019	Third party	1	7	OneClickLCA	28-5-2023	Not substracted
Laminated veneer lumber (LVL), 563 kg/m3, 6% moisture conten...	OneClickLCA	Netherlands	Local generic	2023	Internally	3	7	OneClickLCA	28-5-2023	Not substracted
Laminated veneer lumber (LVL) (Metsä Wood)	Metsa Wood	Finland	Manufacturer specific	2015	Third party	1	6	OneClickLCA	28-5-2023	Not substracted
GPR Material Source										
Vrijdragende Vloeren, houten kanaalplaatvloer	GPR Material	Netherlands	Local generic	2023	Internally	3	11	GPR Material	28-5-2023	Not substracted

Overview of environmental data resources for concrete in situ and concrete hollow core, sources: GPR Materials and OneClickLCA.

#	Material	Name	Supplier	Country	Data type	Year	Verification	Category	# impact categories	Source	Date of reference	Biogenic carbon
		One Click LCA source										
24	CON IS	Ready-mix concrete, normal strength, generic, C30/37 (4400/5...	OneCLickLCA	Netherlands	Local generic	2021	Internally	3	6	OneClickLCA	28-5-2023	N.A.
25	CON IS	Ready-mix concrete, normal strength, generic, C30/37 (4400/5...	OneCLickLCA	Netherlands	Local generic	2021	Internally	3	6	OneClickLCA	28-5-2023	N.A.
26	CON IS	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5...	OneCLickLCA	Netherlands	Local generic	2018	Internally	3	6	OneClickLCA	28-5-2023	N.A.
27	CON IS	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5...	OneCLickLCA	Netherlands	Local generic	2018	Internally	3	6	OneClickLCA	28-5-2023	N.A.
28	CON IS	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5...	OneCLickLCA	Netherlands	Local generic	2023	Internally	3	6	OneClickLCA	28-5-2023	N.A.
29	CON IS	Ready-mix concrete, C30/37 XC1 S3, with 50% concrete granul...	Betonhuis	Netherlands	Manufacturer specific	2019	Third party	2	6	OneClickLCA	28-5-2023	N.A.
30	CON IS	Ready-mix concrete, C30/37, PLUS beton (Van Nieuwpoort)	Van Nieuwpoort	Netherlands	Manufacturer specific	2019	Third party	1	6	OneClickLCA	28-5-2023	N.A.
31	CON IS	Ready-mix concrete, C30/37, PLUS groen beton laag CO2 (Van N...	Van Nieuwpoort	Netherlands	Manufacturer specific	2019	Third party	1	6	OneClickLCA	28-5-2023	N.A.
		GPR Material Source										
32	CON IS	Vrijdragende vloeren; Beton i.h.w.g. C30/37, CEMIII, incl. wapening	Betonhuis	Netherlands	Local generic	2023	Third party	2	11	GPR Material	28-5-2023	N.A.
33	CON IS	Vrijdragende vloeren; Beton i.h.w.g. C30/37, CEMIII, 20%betongranull	Betonhuis	Netherlands	Local generic	2023	Third party	2	11	GPR Material	28-5-2023	N.A.
34	CON IS	Vrijdragende vloeren; Beton i.h.w.g. C30/37,incl. wapening	GPR Material	Netherlands	Local generic	2023	Internally	3	11	GPR Material	28-5-2023	N.A.
35	CON IS	Vloer, C30/37, 0% granulaat, incl. wapening	LafargeHolcim Limburg	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
36	CON IS	Vloer, C30/37 20%granulaat, incl. wapening	LafargeHolcim Limburg	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
		One Click LCA source										
		150mm										
37	CON HC	Hollow core concrete slab, 150 mm, 202 kg/m2 (Betoniteollisu...	Betoniteollisuus ry	Finland	Manufacturer specific	2021	Internally	3	6	OneClickLCA	28-5-2023	N.A.
38	CON HC	Precast hollow core flooring, 150 mm, 2000 kg/m3 (PFF, BPCF)	PFF, BPCF	United Kingdom	Manufacturer specific	2017	Third party	1	6	OneClickLCA	28-5-2023	N.A.
39	CON HC	Hollow core concrete slab, 150 mm, 296 kg/m2, 3.0 kN/m, Quin...	Quinn Building Products	Ireland	Manufacturer specific	2020	Third party	1	6	OneClickLCA	28-5-2023	N.A.
		200mm										
40	CON HC	Hollow core concrete slab, 200 mm, 247 kg/m2 (Betoniteollisu...	Betoniteollisuus ry	Finland	Manufacturer specific	2021	Internally	3	6	OneClickLCA	28-5-2023	N.A.
41	CON HC	Hollow core concrete slab, 200 mm, 276 kg/m2, 2.89 kN/m, Qui...	Quinn Building Products	Ireland	Manufacturer specific	2020	Third party	1	6	OneClickLCA	28-5-2023	N.A.
42	CON HC	Hollow core concrete slab, C45/55 (B45 M40), HD200, 263.16 k...	Element NOR	Norway	Manufacturer specific	2020	Internally	3	6	OneClickLCA	28-5-2023	N.A.
		260mm										
43	CON HC	Hollow core concrete slab, 265 mm, 350 kg/m2 (Betoniteollisu...	Betoniteollisuus ry	Finland	Manufacturer specific	2021	Internally	3	6	OneClickLCA	28-5-2023	N.A.
44	CON HC	Hollow core concrete slab, 250 mm, 329 kg/m2, 3.43 kN/m, Qui...	Quinn Building Products	Ireland	Manufacturer specific	2020	Third party	1	6	OneClickLCA	28-5-2023	N.A.
45	CON HC	Hollow core concrete slab, C45/55 (B45 M40), HD265, 357.14 k...	Element NOR	Norway	Manufacturer specific	2020	Internally	3	6	OneClickLCA	28-5-2023	N.A.
		320mm										
46	CON HC	Hollow core concrete slab, 320 mm, 382 kg/m2 (Betoniteollisu...	Betoniteollisuus ry	Finland	Manufacturer specific	2021	Internally	3	6	OneClickLCA	28-5-2023	N.A.
47	CON HC	Hollow core concrete slab, 320 mm, 426 kg/m2, 4.42 kN/m, Qui...	Quinn Building Products	Ireland	Manufacturer specific	2020	Third party	1	6	OneClickLCA	28-5-2023	N.A.
48	CON HC	Hollow core concrete slab, C45/55 (B45 M40), HD320, 400 kg/m...	Element NOR	Norway	Manufacturer specific	2020	Internally	3	6	OneClickLCA	28-5-2023	N.A.
		400mm										
49	CON HC	Hollow core concrete slab, 400 mm, 446 kg/m2 (Betoniteollisu...	Betoniteollisuus ry	Finland	Manufacturer specific	2021	Internally	3	6	OneClickLCA	28-5-2023	N.A.
50	CON HC	Hollow core concrete slab, 400 mm, 482 kg/m2, 5.02 kN/m, Qui...	Quinn Building Products	Ireland	Manufacturer specific	2020	Third party	1	6	OneClickLCA	28-5-2023	N.A.
51	CON HC	Hollow core concrete slab, C45/55 (B45 M40), HD400, 500 kg/m...	Element NOR	Norway	Manufacturer specific	2020	Internally	3	6	OneClickLCA	28-5-2023	N.A.
		GPR Material Source										
		150mm										
52	CON HC	150mm VBI HC groen	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
53	CON HC	150mm VBI HC	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
		200mm										
54	CON HC	200mm VBI HC groen	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
55	CON HC	200mm VBI HC	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
		260mm										
56	CON HC	260mm VBI HC groen	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
57	CON HC	260mm VBI HC	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
		320mm										
58	CON HC	320mm VBI HC groen	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
59	CON HC	320mm VBI HC	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
		400mm										
60	CON HC	400mm VBI HC groen	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.
61	CON HC	400mm VBI HC	VBI	Netherlands	Manufacturer specific	2023	Third party	1	11	GPR Material	28-5-2023	N.A.

Environmental data for CLT

Excluding Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
Material	**Type**	**Height**	€ 9,86	€ 21,83	€ 33,80	€ 10,83	€ 24,31	€ 37,78	78,6	160,6	242,5	66,9	168,3	269,8
CLT	080 L3s	80	€ 0,79	€ 1,75	€ 2,70	€ 0,87	€ 1,94	€ 3,02	6,3	12,8	19,4	5,3	13,5	21,6
CLT	100 L3s	100	€ 0,99	€ 2,18	€ 3,38	€ 1,08	€ 2,43	€ 3,78	7,9	16,1	24,3	6,7	16,8	27,0
CLT	100 L5s	100	€ 0,99	€ 2,18	€ 3,38	€ 1,08	€ 2,43	€ 3,78	7,9	16,1	24,3	6,7	16,8	27,0
CLT	120 L3s	120	€ 1,18	€ 2,62	€ 4,06	€ 1,30	€ 2,92	€ 4,53	9,4	19,3	29,1	8,0	20,2	32,4
CLT	120 L5s	120	€ 1,18	€ 2,62	€ 4,06	€ 1,30	€ 2,92	€ 4,53	9,4	19,3	29,1	8,0	20,2	32,4
CLT	140 L5s	140	€ 1,38	€ 3,06	€ 4,73	€ 1,52	€ 3,40	€ 5,29	11,0	22,5	34,0	9,4	23,6	37,8
CLT	160 L5s	160	€ 1,58	€ 3,49	€ 5,41	€ 1,73	€ 3,89	€ 6,05	12,6	25,7	38,8	10,7	26,9	43,2
CLT	160 L5s-2	160	€ 1,58	€ 3,49	€ 5,41	€ 1,73	€ 3,89	€ 6,05	12,6	25,7	38,8	10,7	26,9	43,2
CLT	180 L5s	180	€ 1,78	€ 3,93	€ 6,08	€ 1,95	€ 4,38	€ 6,80	14,2	28,9	43,7	12,0	30,3	48,6
CLT	180 L7s	180	€ 1,78	€ 3,93	€ 6,08	€ 1,95	€ 4,38	€ 6,80	14,2	28,9	43,7	12,0	30,3	48,6
CLT	200 L5s	200	€ 1,97	€ 4,37	€ 6,76	€ 2,17	€ 4,86	€ 7,56	15,7	32,1	48,5	13,4	33,7	54,0
CLT	200 L7s	200	€ 1,97	€ 4,37	€ 6,76	€ 2,17	€ 4,86	€ 7,56	15,7	32,1	48,5	13,4	33,7	54,0
CLT	220 L7s-2	220	€ 2,17	€ 4,80	€ 7,44	€ 2,38	€ 5,35	€ 8,31	17,3	35,3	53,4	14,7	37,0	59,4
CLT	240 L7s	240	€ 2,37	€ 5,24	€ 8,11	€ 2,60	€ 5,83	€ 9,07	18,9	38,5	58,2	16,0	40,4	64,7
CLT	240 L7s-2	240	€ 2,37	€ 5,24	€ 8,11	€ 2,60	€ 5,83	€ 9,07	18,9	38,5	58,2	16,0	40,4	64,7
CLT	260 L7s-2	260	€ 2,56	€ 5,68	€ 8,79	€ 2,82	€ 6,32	€ 9,82	20,4	41,7	63,1	17,4	43,8	70,1
CLT	280 L7s-2	280	€ 2,76	€ 6,11	€ 9,46	€ 3,03	€ 6,81	€ 10,58	22,0	45,0	67,9	18,7	47,1	75,5
CLT	300 L8s-2	300	€ 2,96	€ 6,55	€ 10,14	€ 3,25	€ 7,29	€ 11,34	23,6	48,2	72,8	20,1	50,5	80,9
CLT	320 L8s-2	320	€ 3,16	€ 6,99	€ 10,82	€ 3,47	€ 7,78	€ 12,09	25,2	51,4	77,6	21,4	53,9	86,3

Including Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
Material	**Type**	**Height**	€ -24,35	€ -18,51	€ -12,68	€ 10,83	€ 24,31	€ 37,78	-605,6	-646,3	-687,1	66,9	168,3	269,8
CLT	080 L3s	80	€ -1,95	€ -1,48	€ -1,01	€ 0,87	€ 1,94	€ 3,02	-48,4	-51,7	-55,0	5,3	13,5	21,6
CLT	100 L3s	100	€ -2,43	€ -1,85	€ -1,27	€ 1,08	€ 2,43	€ 3,78	-60,6	-64,6	-68,7	6,7	16,8	27,0
CLT	100 L5s	100	€ -2,43	€ -1,85	€ -1,27	€ 1,08	€ 2,43	€ 3,78	-60,6	-64,6	-68,7	6,7	16,8	27,0
CLT	120 L3s	120	€ -2,92	€ -2,22	€ -1,52	€ 1,30	€ 2,92	€ 4,53	-72,7	-77,6	-82,4	8,0	20,2	32,4
CLT	120 L5s	120	€ -2,92	€ -2,22	€ -1,52	€ 1,30	€ 2,92	€ 4,53	-72,7	-77,6	-82,4	8,0	20,2	32,4
CLT	140 L5s	140	€ -3,41	€ -2,59	€ -1,77	€ 1,52	€ 3,40	€ 5,29	-84,8	-90,5	-96,2	9,4	23,6	37,8
CLT	160 L5s	160	€ -3,90	€ -2,96	€ -2,03	€ 1,73	€ 3,89	€ 6,05	-96,9	-103,4	-109,9	10,7	26,9	43,2
CLT	160 L5s-2	160	€ -3,90	€ -2,96	€ -2,03	€ 1,73	€ 3,89	€ 6,05	-96,9	-103,4	-109,9	10,7	26,9	43,2
CLT	180 L5s	180	€ -4,38	€ -3,33	€ -2,28	€ 1,95	€ 4,38	€ 6,80	-109,0	-116,3	-123,7	12,0	30,3	48,6
CLT	180 L7s	180	€ -4,38	€ -3,33	€ -2,28	€ 1,95	€ 4,38	€ 6,80	-109,0	-116,3	-123,7	12,0	30,3	48,6
CLT	200 L5s	200	€ -4,87	€ -3,70	€ -2,54	€ 2,17	€ 4,86	€ 7,56	-121,1	-129,3	-137,4	13,4	33,7	54,0
CLT	200 L7s	200	€ -4,87	€ -3,70	€ -2,54	€ 2,17	€ 4,86	€ 7,56	-121,1	-129,3	-137,4	13,4	33,7	54,0
CLT	220 L7s-2	220	€ -5,36	€ -4,07	€ -2,79	€ 2,38	€ 5,35	€ 8,31	-133,2	-142,2	-151,2	14,7	37,0	59,4
CLT	240 L7s	240	€ -5,84	€ -4,44	€ -3,04	€ 2,60	€ 5,83	€ 9,07	-145,3	-155,1	-164,9	16,0	40,4	64,7
CLT	240 L7s-2	240	€ -5,84	€ -4,44	€ -3,04	€ 2,60	€ 5,83	€ 9,07	-145,3	-155,1	-164,9	16,0	40,4	64,7
CLT	260 L7s-2	260	€ -6,33	€ -4,81	€ -3,30	€ 2,82	€ 6,32	€ 9,82	-157,5	-168,0	-178,6	17,4	43,8	70,1
CLT	280 L7s-2	280	€ -6,82	€ -5,18	€ -3,55	€ 3,03	€ 6,81	€ 10,58	-169,6	-181,0	-192,4	18,7	47,1	75,5
CLT	300 L8s-2	300	€ -7,30	€ -5,55	€ -3,80	€ 3,25	€ 7,29	€ 11,34	-181,7	-193,9	-206,1	20,1	50,5	80,9
CLT	320 L8s-2	320	€ -7,79	€ -5,92	€ -4,06	€ 3,47	€ 7,78	€ 12,09	-193,8	-206,8	-219,9	21,4	53,9	86,3

Environmental data for LVL

Excluding Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
Material	**Type**	**Height**	€ 21,42	€ 26,25	€ 31,07	€ 22,31	€ 27,18	€ 32,05	159,92	225,67	291,42	168,32	234,50	300,67
LVL	BX100	100	€ 1,17	€ 1,43	€ 1,69	€ 1,22	€ 1,48	€ 1,75	8,7	12,3	15,9	9,2	12,8	16,4
LVL	BX120	120	€ 1,21	€ 1,48	€ 1,75	€ 1,26	€ 1,53	€ 1,80	9,0	12,7	16,4	9,5	13,2	16,9
LVL	BX140	140	€ 1,24	€ 1,52	€ 1,81	€ 1,30	€ 1,58	€ 1,86	9,3	13,1	16,9	9,8	13,6	17,5
LVL	BX160	160	€ 1,28	€ 1,57	€ 1,86	€ 1,34	€ 1,63	€ 1,92	9,6	13,5	17,5	10,1	14,0	18,0
LVL	BX180	180	€ 1,32	€ 1,62	€ 1,92	€ 1,38	€ 1,68	€ 1,98	9,9	13,9	18,0	10,4	14,5	18,6
LVL	BX200	200	€ 1,36	€ 1,67	€ 1,97	€ 1,42	€ 1,73	€ 2,04	10,2	14,3	18,5	10,7	14,9	19,1
LVL	BX220	220	€ 1,40	€ 1,71	€ 2,03	€ 1,46	€ 1,77	€ 2,09	10,4	14,7	19,0	11,0	15,3	19,6
LVL	BX240	240	€ 1,44	€ 1,76	€ 2,08	€ 1,50	€ 1,82	€ 2,15	10,7	15,1	19,6	11,3	15,7	20,2
LVL	BX260	260	€ 1,48	€ 1,81	€ 2,14	€ 1,54	€ 1,87	€ 2,21	11,0	15,5	20,1	11,6	16,2	20,7
LVL	BX280	280	€ 1,51	€ 1,86	€ 2,20	€ 1,58	€ 1,92	€ 2,27	11,3	16,0	20,6	11,9	16,6	21,3
LVL	BX300	300	€ 1,55	€ 1,90	€ 2,25	€ 1,62	€ 1,97	€ 2,32	11,6	16,4	21,1	12,2	17,0	21,8
LVL	BX320	320	€ 1,59	€ 1,95	€ 2,31	€ 1,66	€ 2,02	€ 2,38	11,9	16,8	21,7	12,5	17,4	22,3
LVL	BX340	340	€ 1,63	€ 2,00	€ 2,36	€ 1,70	€ 2,07	€ 2,44	12,2	17,2	22,2	12,8	17,8	22,9
LVL	BX360	360	€ 1,67	€ 2,04	€ 2,42	€ 1,74	€ 2,12	€ 2,50	12,5	17,6	22,7	13,1	18,3	23,4
LVL	BX380	380	€ 1,71	€ 2,09	€ 2,48	€ 1,78	€ 2,17	€ 2,55	12,7	18,0	23,2	13,4	18,7	24,0
LVL	BX400	400	€ 1,75	€ 2,14	€ 2,53	€ 1,82	€ 2,22	€ 2,61	13,0	18,4	23,8	13,7	19,1	24,5

Including Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
Material	**Type**	**Height**	€ 21,42	€ 26,25	€ 31,07	€ 22,31	€ 27,18	€ 32,05	159,9	225,7	291,4	168,32	234,50	300,67
LVL	BX100	100	€ -0,91	€ -0,90	€ -0,89	€ 1,22	€ 1,48	€ 1,75	-32,9	-34,4	-35,9	9,2	12,8	16,4
LVL	BX120	120	€ -0,94	€ -0,93	€ -0,92	€ 1,26	€ 1,53	€ 1,80	-34,0	-35,5	-37,1	9,5	13,2	16,9
LVL	BX140	140	€ -0,97	€ -0,96	€ -0,95	€ 1,30	€ 1,58	€ 1,86	-35,0	-36,6	-38,2	9,8	13,6	17,5
LVL	BX160	160	€ -1,00	€ -0,99	€ -0,98	€ 1,34	€ 1,63	€ 1,92	-36,1	-37,8	-39,4	10,1	14,0	18,0
LVL	BX180	180	€ -1,03	€ -1,02	€ -1,01	€ 1,38	€ 1,68	€ 1,98	-37,2	-38,9	-40,6	10,4	14,5	18,6
LVL	BX200	200	€ -1,06	€ -1,05	€ -1,04	€ 1,42	€ 1,73	€ 2,04	-38,3	-40,0	-41,8	10,7	14,9	19,1
LVL	BX220	220	€ -1,09	€ -1,08	€ -1,07	€ 1,46	€ 1,77	€ 2,09	-39,4	-41,2	-43,0	11,0	15,3	19,6
LVL	BX240	240	€ -1,12	€ -1,11	€ -1,10	€ 1,50	€ 1,82	€ 2,15	-40,5	-42,3	-44,2	11,3	15,7	20,2
LVL	BX260	260	€ -1,15	€ -1,14	€ -1,13	€ 1,54	€ 1,87	€ 2,21	-41,6	-43,5	-45,4	11,6	16,2	20,7
LVL	BX280	280	€ -1,18	€ -1,17	€ -1,16	€ 1,58	€ 1,92	€ 2,27	-42,6	-44,6	-46,5	11,9	16,6	21,3
LVL	BX300	300	€ -1,21	€ -1,20	€ -1,19	€ 1,62	€ 1,97	€ 2,32	-43,7	-45,7	-47,7	12,2	17,0	21,8
LVL	BX320	320	€ -1,24	€ -1,23	€ -1,22	€ 1,66	€ 2,02	€ 2,38	-44,8	-46,9	-48,9	12,5	17,4	22,3
LVL	BX340	340	€ -1,27	€ -1,26	€ -1,25	€ 1,70	€ 2,07	€ 2,44	-45,9	-48,0	-50,1	12,8	17,8	22,9
LVL	BX360	360	€ -1,30	€ -1,29	€ -1,28	€ 1,74	€ 2,12	€ 2,50	-47,0	-49,1	-51,3	13,1	18,3	23,4
LVL	BX380	380	€ -1,33	€ -1,32	€ -1,31	€ 1,78	€ 2,17	€ 2,55	-48,1	-50,3	-52,5	13,4	18,7	24,0
LVL	BX400	400	€ -1,36	€ -1,35	€ -1,34	€ 1,82	€ 2,22	€ 2,61	-49,2	-51,4	-53,6	13,7	19,1	24,5

Environmental data for TCC

Excluding Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
			€ 9,86	€ 21,83	€ 33,80	€ 10,83	€ 24,31	€ 37,78	78,6	160,6	242,5	66,9	168,3	269,8
Material	**Type**	**Height**	€ 7,55	€ 20,01	€ 32,46	€ 8,72	€ 23,76	€ 38,79	140,17	218,81	297,44	141,82	238,40	334,99
TCC	TC120	120	€ 1,09	€ 2,55	€ 4,00	€ 1,22	€ 2,89	€ 4,57	11,9	21,6	31,3	11,0	23,0	35,0
TCC	TC140	140	€ 1,29	€ 2,98	€ 4,68	€ 1,43	€ 3,38	€ 5,33	13,5	24,8	36,2	12,4	26,4	40,4
TCC	TC140-2	140	€ 1,29	€ 2,98	€ 4,68	€ 1,43	€ 3,38	€ 5,33	13,5	24,8	36,2	12,4	26,4	40,4
TCC	TC160	160	€ 1,49	€ 3,42	€ 5,35	€ 1,65	€ 3,87	€ 6,09	15,0	28,0	41,0	13,7	29,7	45,8
TCC	TC160-2	160	€ 1,49	€ 3,42	€ 5,35	€ 1,65	€ 3,87	€ 6,09	15,0	28,0	41,0	13,7	29,7	45,8
TCC	TC190	190	€ 1,76	€ 4,06	€ 6,36	€ 1,95	€ 4,59	€ 7,23	18,0	33,4	48,8	16,5	35,5	54,5
TCC	TC210	210	€ 1,96	€ 4,49	€ 7,03	€ 2,17	€ 5,08	€ 7,99	19,6	36,6	53,7	17,8	38,9	59,9
TCC	TC210-2	210	€ 1,96	€ 4,49	€ 7,03	€ 2,17	€ 5,08	€ 7,99	19,6	36,6	53,7	17,8	38,9	59,9
TCC	TC240	240	€ 2,23	€ 5,13	€ 8,03	€ 2,47	€ 5,80	€ 9,13	22,6	42,0	61,5	20,5	44,6	68,7
TCC	TC240-2	240	€ 2,23	€ 5,13	€ 8,03	€ 2,47	€ 5,80	€ 9,13	22,6	42,0	61,5	20,5	44,6	68,7
TCC	TC270	270	€ 2,50	€ 5,77	€ 9,03	€ 2,78	€ 6,52	€ 10,27	25,5	47,4	69,3	23,3	50,4	77,4
TCC	TC270-2	270	€ 2,50	€ 5,77	€ 9,03	€ 2,78	€ 6,52	€ 10,27	25,5	47,4	69,3	23,3	50,4	77,4
TCC	TC290	290	€ 2,70	€ 6,20	€ 9,71	€ 2,99	€ 7,01	€ 11,03	27,1	50,6	74,2	24,6	53,7	82,8
TCC	TC310	310	€ 2,90	€ 6,64	€ 10,39	€ 3,21	€ 7,50	€ 11,78	28,7	53,9	79,0	26,0	57,1	88,2
TCC	TC320	320	€ 2,97	€ 6,84	€ 10,71	€ 3,30	€ 7,73	€ 12,17	30,1	56,0	82,0	27,4	59,5	91,5
TCC	TC340	340	€ 3,17	€ 7,28	€ 11,39	€ 3,51	€ 8,22	€ 12,93	31,7	59,3	86,9	28,7	62,8	96,9
TCC	TC360	360	€ 3,37	€ 7,71	€ 12,06	€ 3,73	€ 8,71	€ 13,68	33,2	62,5	91,7	30,1	66,2	102,3
TCC	TC380	380	€ 3,56	€ 8,15	€ 12,74	€ 3,95	€ 9,19	€ 14,44	34,8	65,7	96,6	31,4	69,6	107,7
TCC	TC400	400	€ 3,76	€ 8,59	€ 13,41	€ 4,16	€ 9,68	€ 15,19	36,4	68,9	101,4	32,7	72,9	113,1

Including Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
			€ -24,35	€ -18,51	€ -12,68	€ 10,83	€ 24,31	€ 37,78	-605,6	-646,3	-687,1	66,9	168,3	269,8
Material	**Type**	**Height**	€ 7,55	€ 20,01	€ 32,46	€ 8,72	€ 23,76	€ 38,79	140,17	218,81	297,44	141,82	238,40	334,99
TCC	TC120	120	€ -1,65	€ -0,68	€ 0,28	€ 1,22	€ 2,89	€ 4,57	-42,8	-43,0	-43,1	11,0	23,0	35,0
TCC	TC140	140	€ -2,13	€ -1,05	€ 0,03	€ 1,43	€ 3,38	€ 5,33	-55,0	-55,9	-56,8	12,4	26,4	40,4
TCC	TC140-2	140	€ -2,13	€ -1,05	€ 0,03	€ 1,43	€ 3,38	€ 5,33	-55,0	-55,9	-56,8	12,4	26,4	40,4
TCC	TC160	160	€ -2,62	€ -1,42	€ -0,22	€ 1,65	€ 3,87	€ 6,09	-67,1	-68,8	-70,6	13,7	29,7	45,8
TCC	TC160-2	160	€ -2,62	€ -1,42	€ -0,22	€ 1,65	€ 3,87	€ 6,09	-67,1	-68,8	-70,6	13,7	29,7	45,8
TCC	TC190	190	€ -3,03	€ -1,59	€ -0,15	€ 1,95	€ 4,59	€ 7,23	-77,8	-79,5	-81,3	16,5	35,5	54,5
TCC	TC210	210	€ -3,52	€ -1,96	€ -0,41	€ 2,17	€ 5,08	€ 7,99	-89,9	-92,5	-95,1	17,8	38,9	59,9
TCC	TC210-2	210	€ -3,52	€ -1,96	€ -0,41	€ 2,17	€ 5,08	€ 7,99	-89,9	-92,5	-95,1	17,8	38,9	59,9
TCC	TC240	240	€ -3,93	€ -2,13	€ -0,33	€ 2,47	€ 5,80	€ 9,13	-100,6	-103,2	-105,8	20,5	44,6	68,7
TCC	TC240-2	240	€ -3,93	€ -2,13	€ -0,33	€ 2,47	€ 5,80	€ 9,13	-100,6	-103,2	-105,8	20,5	44,6	68,7
TCC	TC270	270	€ -4,34	€ -2,30	€ -0,26	€ 2,78	€ 6,52	€ 10,27	-111,3	-114,0	-116,6	23,3	50,4	77,4
TCC	TC270-2	270	€ -4,34	€ -2,30	€ -0,26	€ 2,78	€ 6,52	€ 10,27	-111,3	-114,0	-116,6	23,3	50,4	77,4
TCC	TC290	290	€ -4,83	€ -2,67	€ -0,52	€ 2,99	€ 7,01	€ 11,03	-123,4	-126,9	-130,3	24,6	53,7	82,8
TCC	TC310	310	€ -5,31	€ -3,04	€ -0,77	€ 3,21	€ 7,50	€ 11,78	-135,5	-139,8	-144,1	26,0	57,1	88,2
TCC	TC320	320	€ -5,24	€ -2,84	€ -0,45	€ 3,30	€ 7,73	€ 12,17	-134,1	-137,6	-141,1	27,4	59,5	91,5
TCC	TC340	340	€ -5,73	€ -3,21	€ -0,70	€ 3,51	€ 8,22	€ 12,93	-146,2	-150,5	-154,8	28,7	62,8	96,9
TCC	TC360	360	€ -6,21	€ -3,58	€ -0,95	€ 3,73	€ 8,71	€ 13,68	-158,4	-163,5	-168,6	30,1	66,2	102,3
TCC	TC380	380	€ -6,70	€ -3,95	€ -1,21	€ 3,95	€ 9,19	€ 14,44	-170,5	-176,4	-182,3	31,4	69,6	107,7
TCC	TC400	400	€ -7,19	€ -4,32	€ -1,46	€ 4,16	€ 9,68	€ 15,19	-182,6	-189,3	-196,1	32,7	72,9	113,1

Environmental data for concrete in situ

Excluding Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
Material	**Type**	**Height**	€ 8,59	€ 21,03	€ 33,46	€ 9,89	€ 24,85	€ 39,82	155,0	233,4	311,8	158,2	254,0	349,7
CON IS	SC080	80	€ 0,69	€ 1,68	€ 2,68	€ 0,79	€ 1,99	€ 3,19	12,4	18,7	24,9	12,7	20,3	28,0
CON IS	SC100	100	€ 0,86	€ 2,10	€ 3,35	€ 0,99	€ 2,49	€ 3,98	15,5	23,3	31,2	15,8	25,4	35,0
CON IS	SC120	120	€ 1,03	€ 2,52	€ 4,02	€ 1,19	€ 2,98	€ 4,78	18,6	28,0	37,4	19,0	30,5	42,0
CON IS	SC140	140	€ 1,20	€ 2,94	€ 4,68	€ 1,38	€ 3,48	€ 5,57	21,7	32,7	43,7	22,2	35,6	49,0
CON IS	SC160	160	€ 1,38	€ 3,36	€ 5,35	€ 1,58	€ 3,98	€ 6,37	24,8	37,3	49,9	25,3	40,6	56,0
CON IS	SC180	180	€ 1,55	€ 3,78	€ 6,02	€ 1,78	€ 4,47	€ 7,17	27,9	42,0	56,1	28,5	45,7	63,0
CON IS	SC200	200	€ 1,72	€ 4,21	€ 6,69	€ 1,98	€ 4,97	€ 7,96	31,0	46,7	62,4	31,6	50,8	69,9
CON IS	SC220	220	€ 1,89	€ 4,63	€ 7,36	€ 2,18	€ 5,47	€ 8,76	34,1	51,4	68,6	34,8	55,9	76,9
CON IS	SC240	240	€ 2,06	€ 5,05	€ 8,03	€ 2,37	€ 5,96	€ 9,56	37,2	56,0	74,8	38,0	61,0	83,9
CON IS	SC260	260	€ 2,23	€ 5,47	€ 8,70	€ 2,57	€ 6,46	€ 10,35	40,3	60,7	81,1	41,1	66,0	90,9
CON IS	SC280	280	€ 2,41	€ 5,89	€ 9,37	€ 2,77	€ 6,96	€ 11,15	43,4	65,4	87,3	44,3	71,1	97,9
CON IS	SC300	300	€ 2,58	€ 6,31	€ 10,04	€ 2,97	€ 7,46	€ 11,95	46,5	70,0	93,5	47,5	76,2	104,9
CON IS	SC320	320	€ 2,75	€ 6,73	€ 10,71	€ 3,16	€ 7,95	€ 12,74	49,6	74,7	99,8	50,6	81,3	111,9

Including Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
			Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
Material	**Type**	**Height**	€ 8,59	€ 21,03	€ 33,46	€ 9,89	€ 24,85	€ 39,82	155,0	233,4	311,8	158,2	254,0	349,7
CON IS	SC080	80	€ 0,69	€ 1,68	€ 2,68	€ 0,79	€ 1,99	€ 3,19	12,4	18,7	24,9	12,7	20,3	28,0
CON IS	SC100	100	€ 0,86	€ 2,10	€ 3,35	€ 0,99	€ 2,49	€ 3,98	15,5	23,3	31,2	15,8	25,4	35,0
CON IS	SC120	120	€ 1,03	€ 2,52	€ 4,02	€ 1,19	€ 2,98	€ 4,78	18,6	28,0	37,4	19,0	30,5	42,0
CON IS	SC140	140	€ 1,20	€ 2,94	€ 4,68	€ 1,38	€ 3,48	€ 5,57	21,7	32,7	43,7	22,2	35,6	49,0
CON IS	SC160	160	€ 1,38	€ 3,36	€ 5,35	€ 1,58	€ 3,98	€ 6,37	24,8	37,3	49,9	25,3	40,6	56,0
CON IS	SC180	180	€ 1,55	€ 3,78	€ 6,02	€ 1,78	€ 4,47	€ 7,17	27,9	42,0	56,1	28,5	45,7	63,0
CON IS	SC200	200	€ 1,72	€ 4,21	€ 6,69	€ 1,98	€ 4,97	€ 7,96	31,0	46,7	62,4	31,6	50,8	69,9
CON IS	SC220	220	€ 1,89	€ 4,63	€ 7,36	€ 2,18	€ 5,47	€ 8,76	34,1	51,4	68,6	34,8	55,9	76,9
CON IS	SC240	240	€ 2,06	€ 5,05	€ 8,03	€ 2,37	€ 5,96	€ 9,56	37,2	56,0	74,8	38,0	61,0	83,9
CON IS	SC260	260	€ 2,23	€ 5,47	€ 8,70	€ 2,57	€ 6,46	€ 10,35	40,3	60,7	81,1	41,1	66,0	90,9
CON IS	SC280	280	€ 2,41	€ 5,89	€ 9,37	€ 2,77	€ 6,96	€ 11,15	43,4	65,4	87,3	44,3	71,1	97,9
CON IS	SC300	300	€ 2,58	€ 6,31	€ 10,04	€ 2,97	€ 7,46	€ 11,95	46,5	70,0	93,5	47,5	76,2	104,9
CON IS	SC320	320	€ 2,75	€ 6,73	€ 10,71	€ 3,16	€ 7,95	€ 12,74	49,6	74,7	99,8	50,6	81,3	111,9

Environmental data for concrete hollow core

Excluding Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
Material	**Type**	**Height**	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
CON HC	KP150	150	€ 1,83	€ 3,27	€ 4,71	€ 1,93	€ 3,42	€ 4,91	22,0	40,3	58,6	22,5	41,3	60,0
CON HC	KP200	200	€ 2,23	€ 4,12	€ 6,34	€ 2,33	€ 4,30	€ 6,57	30,4	42,5	54,7	31,0	43,6	56,3
CON HC	KP260	260	€ 3,41	€ 4,75	€ 6,09	€ 3,56	€ 4,98	€ 6,39	40,6	57,9	75,2	41,4	59,3	77,2
CON HC	KP320	320	€ 3,96	€ 5,59	€ 7,23	€ 4,13	€ 5,87	€ 7,59	46,5	67,2	87,9	47,5	68,8	90,2
CON HC	KP400	400	€ 4,86	€ 6,74	€ 8,63	€ 5,05	€ 7,07	€ 9,07	57,0	80,4	103,8	58,3	82,3	106,4

Including Biogenic Carbon Content

			ECI module A1-A3			ECI module A1-A3 + C			GWP module A1-A3			GWP module A1-A3 + C		
Material	**Type**	**Height**	Low	Mean	High	Low	Mean	High	Low	Mean	High	Low	Mean	High
CON HC	KP150	150	€ 1,83	€ 3,27	€ 4,71	€ 1,93	€ 3,42	€ 4,91	22,0	40,3	58,6	22,5	41,3	60,0
CON HC	KP200	200	€ 2,23	€ 4,12	€ 6,34	€ 2,33	€ 4,30	€ 6,57	30,4	42,5	54,7	31,0	43,6	56,3
CON HC	KP260	260	€ 3,41	€ 4,75	€ 6,09	€ 3,56	€ 4,98	€ 6,39	40,6	57,9	75,2	41,4	59,3	77,2
CON HC	KP320	320	€ 3,96	€ 5,59	€ 7,23	€ 4,13	€ 5,87	€ 7,59	46,5	67,2	87,9	47,5	68,8	90,2
CON HC	KP400	400	€ 4,86	€ 6,74	€ 8,63	€ 5,05	€ 7,07	€ 9,07	57,0	80,4	103,8	58,3	82,3	106,4