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Civil Engineering Consultancy Project
Feasibility Study - Cruise Port Paramaribo

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Royal HaskoningDHV
Enhancing Society Together

SUNECON
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Preface

Before you lies a feasibility study to the development of a cruise port in Paramaribo, Suriname. The project is commissioned by SUNECON Engineering Consultants and completed under the supervision of the Department of Hydraulic Engineering and the Department of Transport, Infrastructure & Logistics of the Faculty of Civil Engineering and Geo Sciences of Delft University of Technology. The report is written as part of the curriculum by students from different educational tracks for the course Multidisciplinary Project/Civil Engineering Consultancy Project (CIE4061-09).

Luke Boers, Tijn Bartelings, Maxime Penning and Hugo Stam
Paramaribo, April 2019

Acknowledgements

This study has been an advantageous and eye-opening experience for us. As a group of students with different study backgrounds, we have learned a lot from each other's point of view on particular cases. We have had great experiences in Suriname and we are glad that so many people were willing to tell about their expertise. We are grateful to all the people that we have met and their willingness to help us.

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The facilities and support by SUNECON Engineering Consultants have greatly helped in completing the report. We would like to thank J. Koornaar for his extensive knowledge and support and especially thank him for the extra attention he gave us regarding his full agenda. We have enjoyed and learned a lot from his expertise and knowledge about civil engineering in Suriname. Furthermore, we would therefore thank Brigitte Spalburg, Jayant Khoenkhoen and all the other colleagues for their enthusiasm and interest in our project.

We owe a special debt of gratitude to the company Royal HaskoningDHV for providing a sponsorship to cover part of the expenses that we have made to do this study.

Executive Summary

The Republic of Suriname is located on the north-eastern coast of South America between Guyana, French Guiana and Brazil and is one of the smallest countries in the region. The total population is estimated around 580.000 and a large part lives in the capital city Paramaribo, which is located at the Suriname River. The country is known for its rich Dutch colonial history and its export of coffee, cocoa and sugar, produced on plantations. Workforce was pulled away from agriculture industry when bauxite became an important export product. Nowadays, mining of minerals such as oils and gold is still very important for the economy of Suriname. The economy is therefore sensitive for global price fluctuations resulting in instability, raising a relevant question on searching for more sustainable resources like tourism, which has proven great potentials to contribute to a growth of economic development for the country. Especially eco-tourism and culture-tourism are major strengths for Suriname to attract tourists.

Cruise tourism is one of the fastest growing components of the tourism sector and is expected to continue even further. Today, South America has a low market share of cruise tourism but due to its geographic position, pleasant climate, cultural and ecological attractions, Suriname has great potential to cherry-pick from the benefits of the rising popularity of different cruise tourism markets. The government has the ambition to increase the number of annual tourists by investing in many projects such as the improvement of infrastructure and river dredging, but currently has no sufficient port facilities to accommodate potentials of the growth in cruise passengers. Therefore, the objective of this study is to determine a feasible and socially desirable way to develop a cruise port in Paramaribo so that it becomes clear how the economy of Suriname could benefit from the growing cruise tourism industry.

To be able to carry out this study, a stakeholder analysis is done from which it may be concluded that Governments, the IDB, cruise operators, STF and private property owners (indirectly) play a crucial role in the realisation of a cruise port. Their input is used to formulate the criteria attractiveness, accessibility, finance, complexity and indirect benefits resulting in the selection of the 'Marron Markt' alternative as the most optimal location compared to two other alternatives 'SMS Pier' and 'Nieuwe Haven Zuid'.

Furthermore, a detailed analysis of the land infrastructure, the physical environment of the Suriname River (such as topography, hydrology, bathymetry, etc.) is done. A limiting factor is the water depth of the navigation channel, but after the planned dredging activities the minimum water depth will become 5.5 m below Chart Datum (CD) at the most shallow parts of the navigation channel. Moreover, the coast near Paramaribo is classified as a mud-mangrove coast with highly dynamic migration of mudflats and mudbanks potentially limiting the navigation channel at the river entrance. To facilitate a (target) design vessel with a draught of 5.8 m, a tidal window above CD + 1.75 m is required. The tidal window restricts the sailing time up to 4 and 5 hours in case of neap and spring tide respectively, while a sailing time of less than 3 hours is required. Based on the cruise market analysis, this leaves 18 potential cruise ships able to enter the Suriname River, all with capacities between about 200 - 1250 passengers. The minimum water depth in front of the selected location is currently CD - 7.3 m within a reach of 20 m of the land, which is sufficient.

In the detailed design a quay wall, with double anchored sheet piles, is designed in order to accommodate vessel provisioning. Furthermore, a quay wall can combine the functions of soil retaining structures and a mooring structures. The required height of the quay wall is determined at CD + 3.8 m. The determination of the required sheet pile length and profile is done with Blum's schematisation first, resulting in a single anchored sheet pile wall of 40 m. An optimisation with double anchored sheet piles is done with MSheet. Due to the double anchoring, the sheet pile length can be reduced until a length of 26.0 m. The minimum width of the apron area should be 12 m. The terminal has a convertible lay-out and includes check-in, baggage screening, immigration facilities, a waiting area of 480m^2 and a baggage area of 570 m^2. The terminal has a total width of 53 m and a length of 45 m. The ground transportation area design has space for enough taxis, shuttle busses and walking facilities and has a required surface of 962 m^2.

From this study, it is concluded that a cruise port in Paramaribo may be feasible and contribute to a more stable and sustainable economy in Suriname. Since the design is made for a convertible terminal lay-out, its incorporation may add value and contribute to other urban projects which may increase the tourism potential for Paramaribo as a whole. The successfulness of this project depends on the execution of other urban projects, such as dredging of the Suriname River to be able to include specific cruise ship classes with a considerable draught, infrastructural improvements to prevent traffic congestion and urban rehabilitation projects to increase the attractiveness for cruise passengers and encourage them to revisit Suriname.

The most optimal design for a cruise port requires a large investment of more than \$9.5 million. With an annual revenue between \$0.5 and \$1.5 million, as a result of the passenger expenditures, the total revenue will be more than \$10 million in 20 years. Considering a lifetime of more than 20 years, the revenues will exceed the considered construction costs. Moreover, expenditures of cruise operators for on-board provisions and other indirect or induced benefits are not yet considered. However, besides the rough estimation of these construction costs, multiple type of costs are not yet taken into account. Even more important is that the revenues will not directly be earned by the government or by an investor. Therefore, the feasibility will mainly depend on the type of financing. The willingness from cruise operators and residents, investments and governmental participation is crucial, in which fund raising and further specification of a project plan timeline and a more detailed analysis of costs estimations are considered as the next step after this research.

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1 Introduction

This study introduces a feasibility study of building a cruise port in the port of Paramaribo in Suriname. This introducing chapter firstly describes the problem definition. After that, the purpose of the study is defined in the research objective and the research questions. The geographical boundaries of the study area are defined in the scope. The thesis outline finally gives a description of the content of this study.

1.1. Problem Definition

Suriname is located on the north-east side of the South American continent and is directly connected to the Atlantic Ocean. In the past, the main economy of Suriname profited from a rich worldwide trade of Bauxite, which is a raw material mainly used for the production of aluminium. These materials could be transported through the main port of Paramaribo. Since the production of the material stopped because of its expensiveness, it was a challenge for Suriname to look for alternatives. Considering the decreasing economy of the country, Suriname needs to shift to an economy which is sustainable and could contribute to wealth growth again.

Worldwide, the profit potential coming from the cruise industry is growing every year and According to the Cruise Lines International Association (CLIA) Dingle (2018) one of the fastest growing components in the tourist sector. The passenger numbers showed exploding growth rates with almost 21% increase in the past five years. The Caribbean/Bahama's is one of the most popular places for cruise destinations. The growing demand for river, eco and luxury cruises offers a great opportunity for Suriname. With an ideal geographic position major, cultural and ecological attractions and a pleasant climate, Suriname has great potential to cherry-pick the benefits from the popular cruise industry which could help the country to pursue the development of a sustainable economy.

In the past years, Suriname was added to some itineraries of international cruise operators offering ultra-luxury cruises in the area. However, the port facilities and arrival routes are currently not capable of accommodating cruise ships sufficiently. Suriname has great potential to profit from the growing popularity for cruises. In order to attract those cruises to the port of Paramaribo and benefit from the growing worldwide demand, it is necessary to invest into the development of cruise port handling facilities. Therefore, a new berth is required which includes land-side facilities to accommodate cruise passengers and connect them efficiently with the attractions on land. In order to advise for a feasible solution, insights into potential constraints for the arrival route, land facilities and local conditions needs to be known. With the information and conclusions of this study, Suriname could use their main selling points to target potential cruise markets effectively and build for a sustainable income source which could be the basis for a healthy national economy.

1.2. Research Objective

The objective of this study is to provide insights in feasibility and potentials of building a cruise port including on-land handling facilities and infrastructure connectivity for shore locations at the Suriname river near Paramaribo's city centre. Therefore, a cruise market analysis creates insights into possible opportunities for the tourism industry in Suriname.

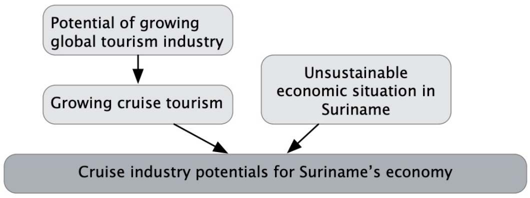


Figure 1.1: Outline of research

The cruise port needs to facilitate the handling of cruise passengers so that it contributes to a positive and sustainable economic development for the country. Three locations are considered and evaluated, based on several criteria, from which an optimal location is recommended. For this location, a design iteration is done by means of a structural design of the berth, a specification of land facilities and potential handling capacities. A rough estimate on the direct costs of the cruise port, together with a rough estimate of the direct revenues from the tourists is done.

1.3. Research Questions

From the above formulated problem definition and research objective the main research question of this study is formulated:

> "What is the most feasible and socially desirable way to develop a cruise port in Paramaribo?"

Furthermore, to help answering the main research question, some sub-questions are drafted to divide the problem into several relevant parts. The sub-questions are divided as follows:

1. What is the expected impact of a cruise port on Suriname?
2. Which aspects should be considered when designing a cruise port in Paramaribo?
3. What is the most optimal design for a cruise port in Paramaribo and how can this design be implemented?

1.4. Methodology

This chapter explains how the main research question can be answered and which methods are used. Three sub-questions are defined to help answer the main research question. There is also explained how these sub-questions relate to the main research question.

The first sub question is related to the impact of a cruise port on Suriname. To answer this question, a literature study will be performed to create an overview of relevant information already available. Firstly, the current economical, political and demographic situation is analysed. Secondly, the impact of global tourism is observed with the potential of the global cruise market. This cruise market is analysed thoroughly to predict if Suriname is an interesting destination for it and if the cruise market is an interesting industry to develop. Thirdly, an overview of projects in Suriname related to area development which are relevant to this research is given. The positive impact of these projects on Suriname will have a positive effect on the impact and the success of a cruise port.

With the second sub question, there is answered which aspects should be considered in the terminal design. To help answer this question, expert interviews are conducted and data is requested from involved actors. The minutes of an expert interview are always sent to the interviewee for verification and included in the appendix of the report. The tourism sector is analysed first and an actor analysis is conducted, in which the relations between actors are described. This analysis will later be used to choose the appropriate design criteria and weighing factors. Secondly, the land and infrastructure is analysed. This includes touristic destinations, the road network, the navigability of the river and potential locations for a cruise terminal. The physical environment is described in the next part, which will lead to a list of boundary conditions for the terminal design. Lastly, there is defined which type of cruise ships are likely to visit Suriname. Design alternatives can be based on the characteristics of these vessels.

Sub-question three will be answered using a systems engineering approach which will lead to the most optimal design for a cruise terminal. Firstly, a design problem definition is given with constraints, requirements, boundary conditions, starting points and assumptions. Moreover, design criteria are described with weighing factors based on the actor analysis. This will form the basis of the design. Alternatives are drafted in the second part, where per function design options as described in the analysis part of the report are combined. These alternatives are then assessed using the design criteria and a multi criteria analysis (MCA). An MCA is a suitable method for comparing the alternatives, because it is not possible to express all characteristics of the alternatives in monetary values. This is due to the fact that this research is a feasibility study and the level of detail of the elaboration of the alternatives is limited. Moreover, a MCA is an objective judgement tool in which the different views of actors are openly described. A limitation of a MCA is that there cannot be shown that an action adds more than it detracts (for Communities & Government, 2009). This is not seen as a problem when there is a significant difference between the final scores. Lastly, the design with the highest score is elaborated in more detail. The strong and weak characteristics of this design are evaluated with a SWOT analysis, which will give insight in the opportunities are explains which threats should be considered. A limitation of a SWOT analysis is that it is a result of the analysis of the current situation. It is not applicable to the past and the future, so in a future study, the SWOT analysis should be conducted again (Emet & Merba, 2017).

The research is divided into four parts. The first two sub questions are answered at the end of the ”Analysis” part and the third sub question is answered in the ”Design and Evaluation” part. The answer to the main research question is given in the fourth part: ”Synthesis”. An overview of the structure of the research and the used methods, as proposed in this chapter, can be found in the figure below.

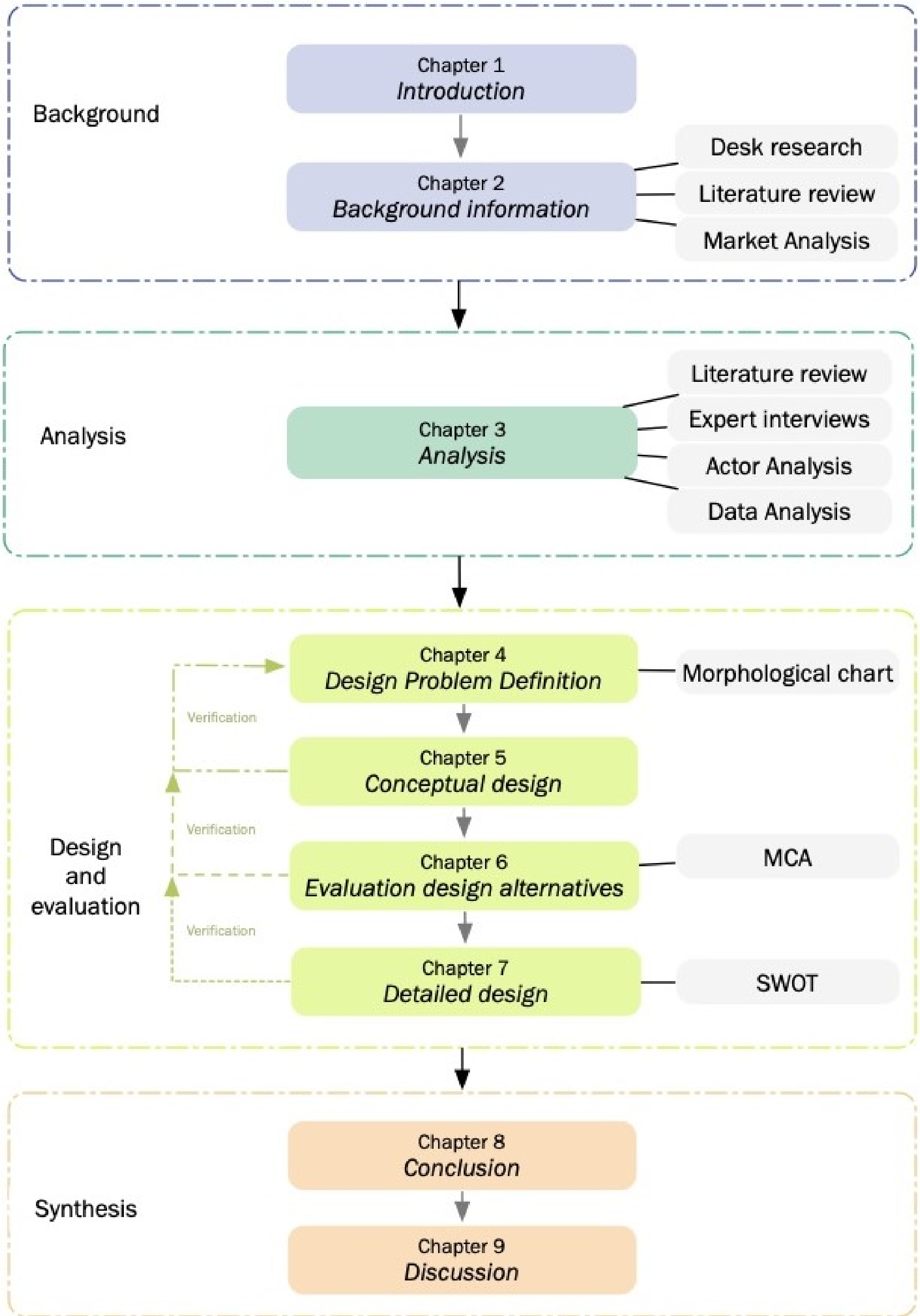


Figure 1.2: Methodology outline

1.5. Project Scope

The scope of this project is limited to the most relevant topics necessary for determining the most feasible and socially desirable cruise port design. Potential locations for a cruise port along the Suriname River in the city Paramaribo are reviewed (as shown by Figure 1.3). The research includes the morphological conditions from the estuary of the Suriname River till the city Paranam. Since this research is a feasibility study and not a final design, the level of technical depth will be limited.

Figure 1.3: The focus area of the project, marked by the red square (adapted from Google (2019))

Suriname is a developing country. Although the country is one of the most developed countries in the region, the political and economic situation can be unstable. This potentially affects the development of the cruise port. The outcome of this report is limited to the implementation steps necessary to create a feasible cruise port, whereby political and economic effects are limitary considered.

Financial aspects are partly defined for the final design. This includes an order of magnitude estimate for the construction costs and an expected cost/benefit ratio indication. An estimation of the operational costs is not seen as part of this feasibility study, because there are many uncertainties which would be defined in more detailed design.

2 Background Information

2.1. Suriname

In this section the history of Suriname is discussed in more detail together with the the political and the economic situation including the tourist market share. From this analysis the potential of tourism in Suriname is derived.

2.1.1. Geography

The Republic of Suriname is located on the north-eastern coast of South America, bordering the North Atlantic Ocean. Suriname lies between French Guiana on the east-side and Guyana on the west-side, bordering Brazil in the south. The coastal zone of Suriname consists of sandbanks and mud banks. These banks arise from the deposited mud and sand that is brought to Suriname by the southern equatorial currents, coming from the area surrounding the mouth of the Amazon River. Suriname can be divided into two parts. The northern part at the coast, which has a concentrated population and the southern part, which is only sparsely populated and consists mostly of rainforest. Suriname is divided into 10 districts, from which 8 are located in the northern part of Suriname near the coast. In Figure 2.1, the location of these districts are shown and Table 2.1 shows the density in the different districts in 2012, when the last population census took place.

District	Density population [km^2]
Paramaribo	1323.8
Wanica	266.9
Nickerie	6.4
Coronie	0.9
Saramacca	4.8
Commewijne	13.4
Marowijne	4.0
Para	4.6
Brokopondo	2.2
Sipaliwini	0.3
Totaal	**3.3**

Table 2.1: Population density per district in Suriname (ABS, 2012)

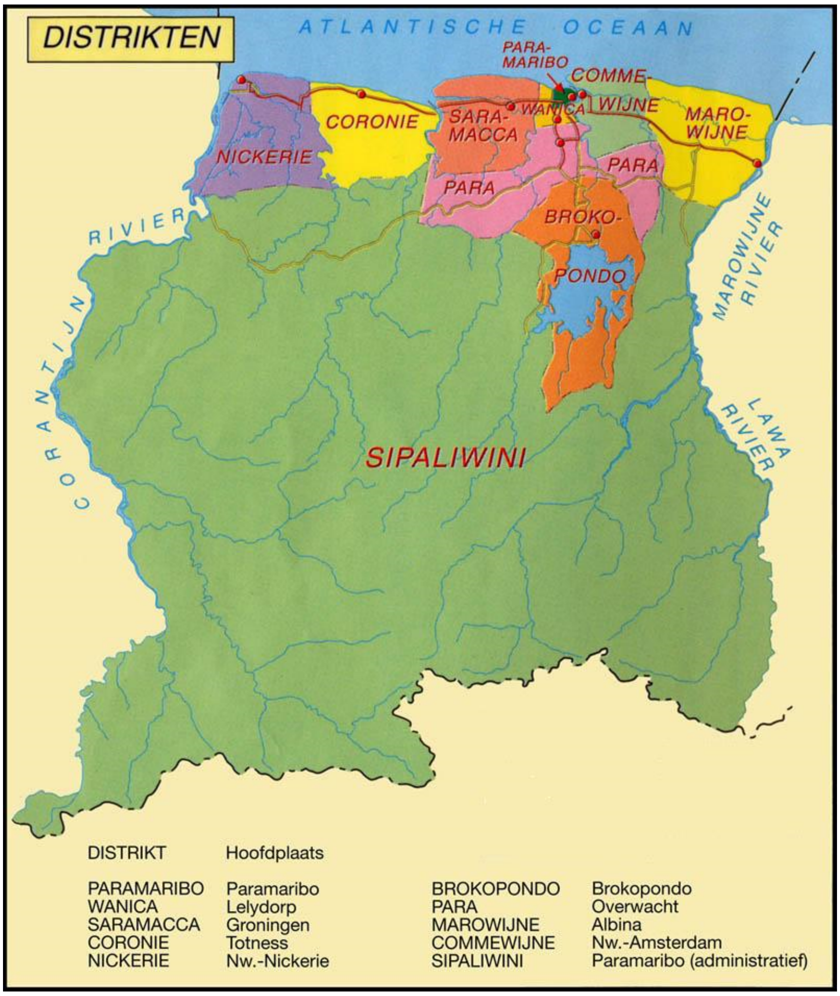


Figure 2.1: Districts of Suriname (ABS, 2005)

49,3% of the population (243 thousand inhabitants) lives in the district Paramaribo, where also the capital is located. The largest district of Suriname, Sipaliwini, has only 34 thousand inhabitants, which is 6,9% of the total population (ABS, 2012). The country has an area of 163,820 km^2 and is one of the smallest countries in South America. Yet its population, estimated in 2017 to consist of around 583,400 inhabitants (ABS, 2018), is one of the most ethnically diverse population in the region. This is due to the colonial history of Suriname.

2.1.2. Demography

Originally, the biggest native cultures that populated Suriname were the Arawaks and the Caribs, living near the coast of Suriname. Smaller groups of native cultures lived in the rainforest in the interior. In the 16th century, the French, Spanish and English started to explore the area.

The English were the first to colonise Suriname around 1650, where they constructed plantations. It was the intention of the English to use the indigenous people as slaves on the plantations. This failed due to large mortality by the diseases the English brought with them, and by the resistance that the indigenous people offered. In 1667 the Dutch acquired the colony during the second Anglo-Dutch war. Later that year, in the Treaty of Breda, it was agreed that the Dutch could keep Suriname in exchange for the former Dutch colony New Amsterdam (known as New York nowadays) (Davis, 2014). In 1683 the Society of Suriname was founded by the Dutch to manage and defend the colony. The main plantations were located along the rivers growing sugarcane, coffee, cocoa, cotton and tobacco. The planters relied heavily on the slaves, which were imported rapidly from Africa (mostly from Ghana, Togo, Benin, Loango/Angola, and also from other parts of West Africa (Eltis & Engerman, 2011)), because their dead rate was very high. Slavery in Suriname was extremely harsh compared to other colonies (de Kom, 1934). Some slaves managed to escape into the interior, where they lived with the indigenous people, forming independent tribes. These tribes were called the *Maroons*.

The Netherlands abolished slavery in 1863, but the slaves were still forced to work on the plantations for ten years, for minimal pay. In 1873 the Dutch transported contract labourers to Suriname, to make up for the labour deficit on the plantations. The contract labourers came from Dutch East Indies (known as Indonesia nowadays) and through arrangements with the British from India, which was a British colony. Also, small numbers of labourers from China and the Middle East were transported to Suriname in the late nineties (Bakker, 2009). In 1975 Suriname was granted full independence from the Netherlands (Keijzer-Baldé & van Ingen, 1985).

Figure 2.2 shows the share of the different ethnicities of the total population in Suriname, based on the last performed population census in 2012 (ABS, 2012). In this census the people could decide for themselves to which ethnicity they belonged. In Figure 2.3 the different religions and their share are shown.

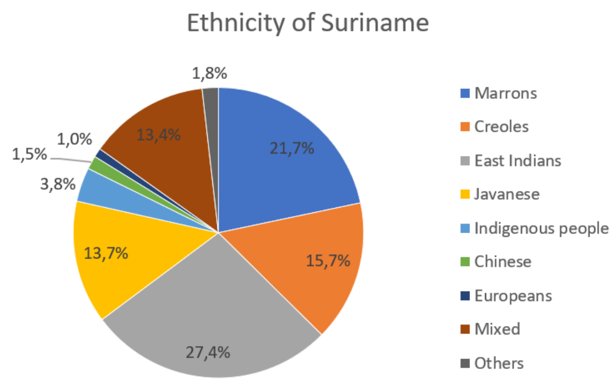


Figure 2.2: Contributions of the different ethnicities to the total population in Suriname.

Suriname remained a pluralistic society, where the Creoles and the Maroons together form the biggest ethnic group. The Creoles are the descendants of the slaves, mostly from African origin, or from a mixed European-African origin. The Maroons have the same origin, however they fled from the plantations, resulting in an isolation in the interior, they maintained a more African culture. The big share of the Javanese and the East Indians arises from the contract workers brought to Suriname.

Due to this diverse ethnicities, many different languages are spoken in Suriname. Dutch is the official language, however Sranang Tongo, the native language of the Creoles, Javanese and Caribbean Hindustani are widely spoken languages (Central Intelligence Agency, 2019).

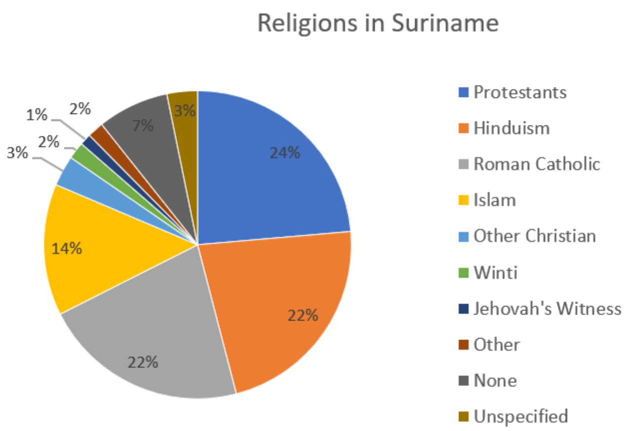


Figure 2.3: Contributions of the different religions to the total population in Suriname.

2.1.3. Politics

Until 1954 Suriname was a colony of the Dutch. In 1954 Suriname became equally part of the Dutch Kingdom as well as the Netherlands, Dutch East Indies and Curaçao (Parlement, 2019). From this moment Suriname gained more and more independence, especially after the Second World War. The first political parties were based on ethnicity. In 1949 the biggest parties were the NPS (a party representing the Creoles), the VHP (a party representing the Hindu's) and the KTPI (a party representing the Javanese) (Suriname Government, 2019). Also smaller parties emerged due to fragmentation of the bigger parties. In the 1960s the discussion about the independence of Suriname began. The contrasts between the political opinions about the independence dominated the political spectrum in Suriname for many years. On 25 November 1975 Suriname became an independent republic (Keijzer-Baldé & van Ingen, 1985). Many Surinamese people emigrated to the Netherlands, because they did not trust an independent Suriname (Mosart, 2017). After the independence of Suriname the political situation became less stable with internal conflicts in the government. It became hard to govern Suriname and the parliamentary work came to a halt. There was a lot of corruption and dissatisfaction among the people.

In 1987 the democracy returned, but only to be stalled again in 19991. Between 1996 till date, every 5 year elections are held. Suriname is a parliamentary representative democratic republic. The president is the head of the state and of the government. The government has the executive power, the legislative power is exercised by the government and the National Assembly. The judiciary is independent.

The unicameral National Assembly has 51 members, elected by proportional representation per district for 5 years. The National Assembly chooses the president by a two-thirds majority. The president appoints a cabinet of ministers. In the election of 2015 the NDP got 26 seats in the National Assembly, which gives them a majority and the possibility to rule Suriname as a sole party.

2.1.4. Social Economics

Before 1863 the agriculture was one of the most important businesses for the economy in Suriname due to the plantations. After the abolition of the slavery, the labour costs rose and the amount of plantations steadily declined. In 1874 the mining and quarrying business became more import. First with the mining of gold which had its record year in 1908 after which the business declined (Loor, 2013). In 1916 the mining for bauxite became important. Bauxite is a raw material for the production of aluminium. Especially, during the the Second World War bauxite became important for the construction of airplanes. The effects of the growing bauxite industry were very important for the economy of Suriname. The industry of the production of bauxite and alumina was located at Paranam, located at the Suriname river south of Paramaribo. The vessels exporting the bauxite and alumina had special propellers, keeping the river open. This was also favourable for the import and export of other goods. On the other hand, the agricultural industries declined even more because workforce was pulled away towards the mining industries (Loor, 2013). In the late nineties the mines got exhausted and in 2015 the bauxite industry was shut down completely. This did not only had an impact on the economy of Suriname, but also on the sedimentation of the Suriname River. Which was unfavourable for other import and export industries in Suriname.

The mining industry is still the most important industry for the economy of Suriname (Central Intelligence Agency, 2019). The export of mainly oil and gold accounts for approximately 90% of the foreign exchange earnings and for 45% of the government revenue (Falconi, Melandri, Thomas, & Edwards, 2016). Therefore, the economy of Suriname is still very reliable on the minerals, which is not a sustainable source and makes the economy highly sensitive for price fluctuations. During the past few years, the government revenue and national income reduced. To indicate the economic growth of a country, the Gross Value Added (GVA) in constant prices is a common indicator. This is the real growth of the Gross Domestic Product (GDP) at market prices in constant prices. The GVA of Suriname is shown in Figure 2.4. The drop in GDP between 2014 and 2017 was a result of the drop of the international prices of gold and oil (Falconi et al., 2016; Macrotrends LLC, 2019; Goldprice, 2019).

Figure 2.4: Real growth of the GDP at market prices

Suriname also suffered from a huge inflation compared to the rest of Latin America and the Caribbean (International Monetary Fund, 2018), as can be seen in Figure 2.5.

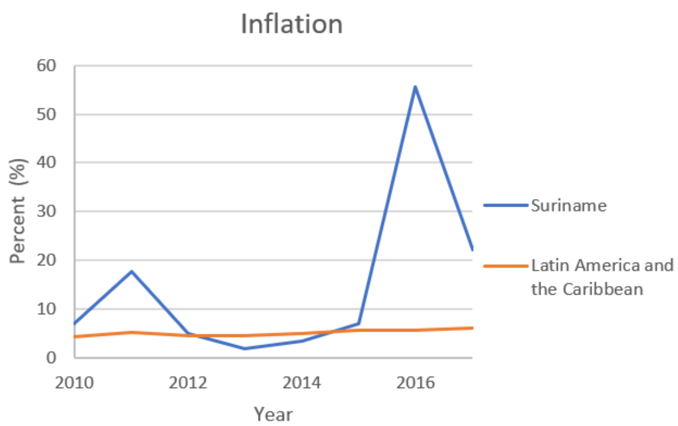


Figure 2.5: Inflation in Suriname in % per year.

Suriname relies on more than 80% on imports to satisfy most domestic demands. This also makes Suriname vulnerable for external shocks (Falconi et al., 2016).

2.2. Cruise Market Potential

In this section a global market analysis is done. The main goal of the market analysis is to see whether demand for a new cruise service can be created in the Suriname region, and also to estimate the impact cruise tourists can have.

2.2.1. General tourism impact

The tourism industry is complex and the development of it has a positive impact on multiple segments such as wholesale and retail trade, foreign investments, income from foreign currencies and employment. An overview made by the World Tourism Organisation UNWTO of the impact of tourism worldwide is shown in Figure 2.6.

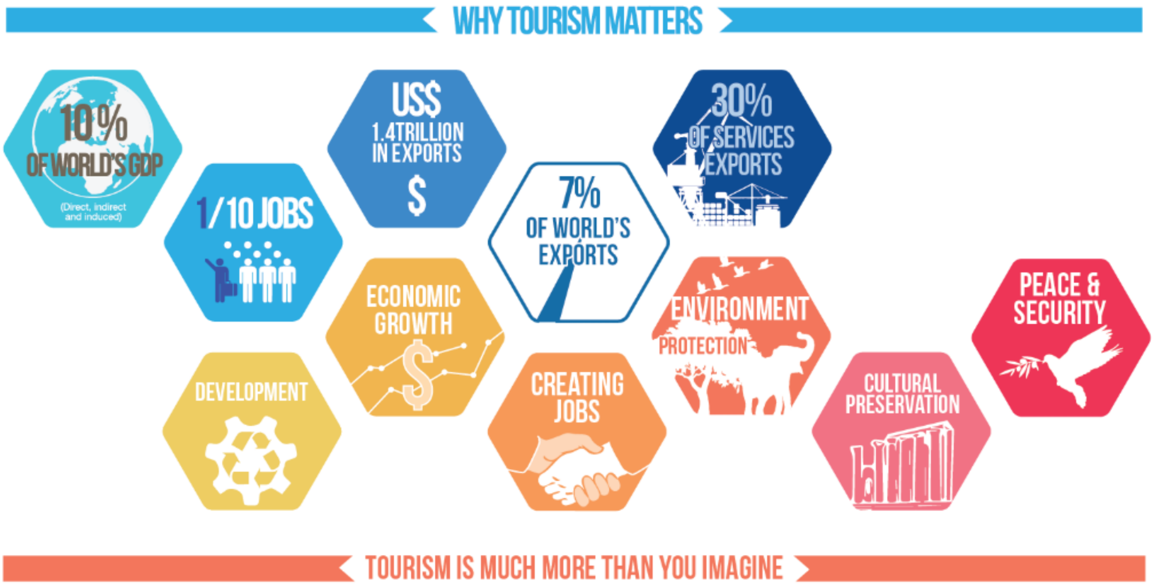


Figure 2.6: Why tourism matters (World Tourism Organization, 2018).

As is shown in Figure 2.6 tourism creates 1 out of the 10 jobs, it accounts for 10% of the worlds GDP (directly, indirectly and induced), it is responsible for 7% of the world's exports and 30% of services exports. Qualitatively it creates jobs, provides economic growth and social and cultural development. Tourism is a key driver for social-economic progress and especially developing countries can benefit from sustainable tourism and the process towards it (World Tourism Organization, 2018).

Next to the positive impact tourism has on a country, the touristic sector is also one of the the fastest growing economic sectors in the world. In Figure 2.7 the amount of international tourist arrivals between 1950 and now and the forecast of it until 2030 can be observed. In 2017 the international tourist arrivals grew by 7% worldwide.

2.2.2. Tourism impact near Suriname

When focusing on the region near Suriname, the tourism impact in South America or Latin America is most interesting. In 2017 the international tourist arrivals grew by 8% in the South of America (World Tourism Organization, 2018). Tourism is responsible for 8.6% of GDP in 2017 (with the provisional forecast to rise 3.4% in 2018) and 7.6% of total employment (with the provisional forecast to rise 2.4% in 2018) (Travel & Tourism, 2018). When focusing on the economic impact, there are three different contributions tourism can have on the country. These are direct, indirect and induced contributions. The direct contribution reflects the total spending on Travel & Tourism by residents and non-residents. The indirect contribution includes the spending of Travel & Tourism in investment and in their domestic purchases of goods and services. It also includes the government spending which helps Travel &

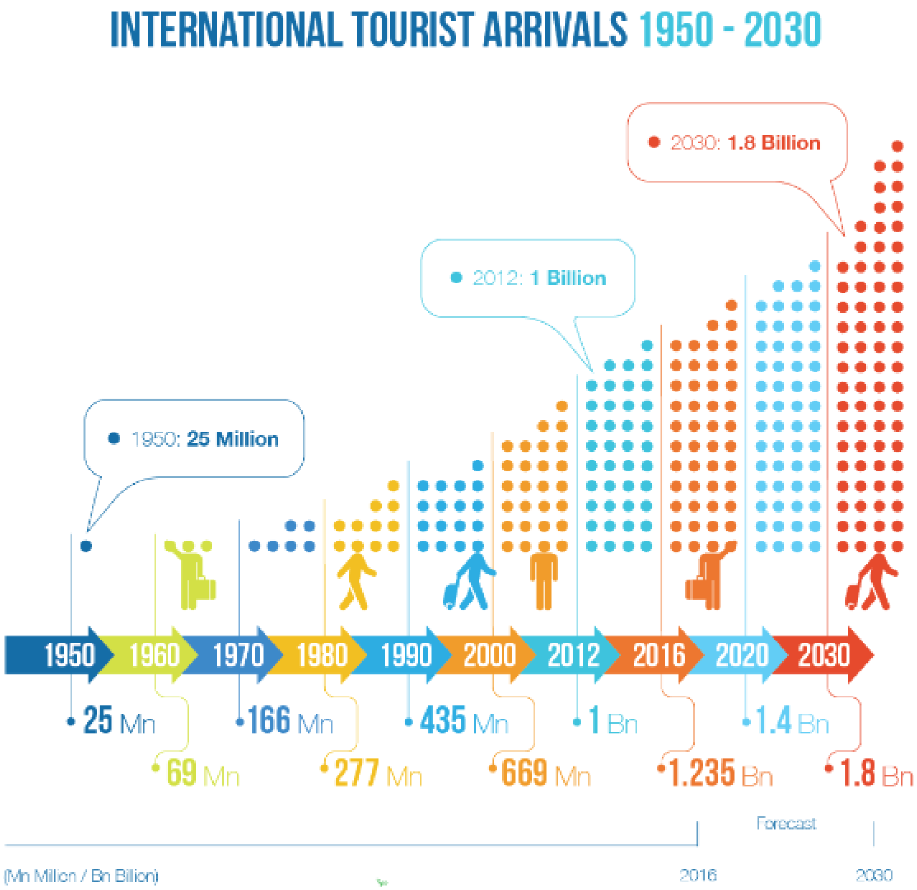


Figure 2.7: International Tourist Arrivals (World Tourism Organization, 2018).

Tourism activities (on areas such as marketing, administration or security). The induced contributions includes the spending of those who are directly or indirectly employed in the Travel & Tourism industry (Travel & Tourism, 2018). In Figure 2.8 the contribution of the Travel & Tourism industry (direct, indirect and induced) to the total GDP in Latin America is shown. For the employment in Latin America these same contributions, direct, indirect and induced hold. In Figure 2.9 the contribution of the employment in the Travel and Tourism industry to the total employment in Latin America is shown.

When looking at the current situation in Suriname 3.7% GDP but growing with 6.1%. 3.4% employment it is behind its neighbouring countries.

As mentioned before the current economic environment in Suriname is unsustainable, due to its focus on mining and unstable partly due to its sensitivity for price fluctuations of mineral resources and vulnerability for external shocks. The government of Suriname acknowledges tourism as one of the priority industries to contribute to the diversification and the growth of the economic development of the country (Mormon, Stüger-Gefferie, Bilkerdijk, Fräser, & Lila, 2017). Their vision is to become part of the top nature-culture tourist destinations in South America and the Caribbean, in which the touristic sector should drive the social economic development of Suriname.

Eco tourism is one of the two products that can strengthen the position of Suriname on the tourist market. Suriname is covered by almost 90% of rainforest, from which a part (Central Suriname Nature Reserve) is listed on the UNESCO World Heritage site. This reserve links the Raleighvallen Nature reserve, the Tafelberg and the Eilerts de Hann Gebergte Nature Reserves. Also the natural waterfalls, the rapids and the biodiversity characterise Suriname. The other important touristic product for Suriname is Culture tourism. The composition of the population in Suriname, due to its history, consists of many different ethnicities and religions, which are responsible for the unique cultural diversity in Suriname. Both material and immaterial cultural expressions are commercially usable. Museums, heritage

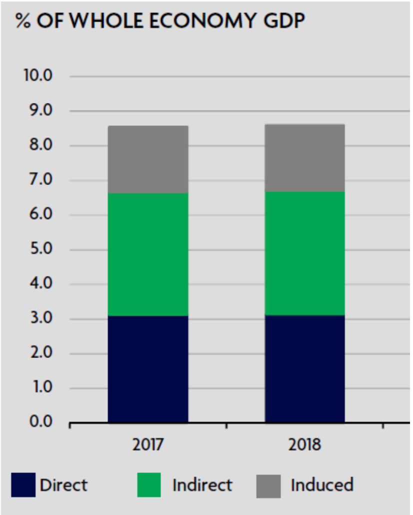


Figure 2.8: Contribution of travel & tourism to the total GDP in Latin America (Travel & Tourism, 2018).

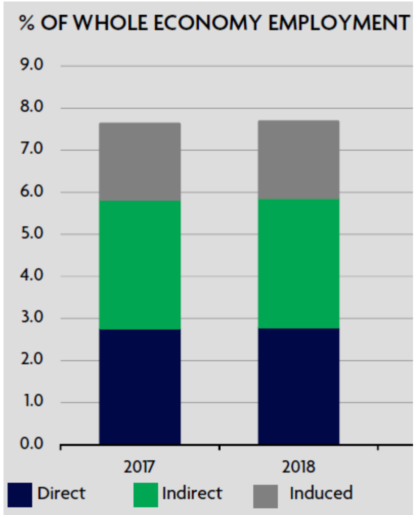


Figure 2.9: Contribution of travel & tourism to the total employment in Latin America (Travel & Tourism, 2018)

centres, old plantations and various works of art are examples of material cultural expressions and gastronomy, cultural events and festivals are examples of immaterial cultural examples. The Historic inner city of Paramaribo is another site of Suriname listed on the UNESCO World Heritage site. Innovations and professionalisation of products and services in the tourism sector focusing on nature and culture, will improve the competitiveness of Suriname.

Also the tropical climate of Suriname is very attractive for the tourism industry. There are four seasons, a minor rainy season (December-February), a minor dry season (February-April), a major rainy season (April-August) an a major dry season (August-September).

There are three major weaknesses of Suriname identified that will have to be tackled, before Suriname can work towards a touristic industry and benefit from its positive effects mentioned before:

- The lack of adequate legislation
- The lack of uniform quality standards with regard to accommodation and infrastructure
- The limited access to Suriname and fact that it is an unknown country

There are already some projects running tackling these weaknesses such as the Paramaribo Rehabilitation Program in which the infrastructure will be improved and in which more attention and awareness is created for maintenance of buildings. Also the access to Suriname will be improved due to dredging of the river and the airport renovation. It is especially important to acknowledge the unknown of Suriname and find ways to promote Suriname as a holiday destination.

2.2.3. Definition of global cruise market

The world cruise market is one of the fastest growing components of the tourism sector worldwide (de la Vina & Ford, 2012), measured in total number of cruise passengers. The cruise market was founded over a 100 years ago and started for many companies with cargo shipping routes. Nowadays, the cruise operating market contains the shipping of leisure passengers, facilitating cruise tours and offering entertainment. Most brands differ from each other on level of service, quality and specialities. It is common to categorise cruise brands and its characteristics into several market segments such as all-inclusive, expedition, luxury, budget and river cruise lines (Georgsdottir & Oskarsson, 2017).

Most brands try to sell their itinerary as a product to tourists. An itinerary is a loop of a shipping line beginning and ending in the same hub port, but stopping at different destinations. Itinerary loops could have different durations and therefore also have different profit margins. The longer the itinerary, the

Figure 2.10: Five market segments cruise industry

lower the profit margins for the cruise operators since the customers are inclined to spend less on board. (Rodrigue & Notteboom, 2013)

The worldwide market is dominated by several brand leaders, with the US-British company Carnaval Corporation ranked as the world largest and oldest cruise operator, building the first super large passenger ship: 'the Carnival Destiny' (Figure 2.11) in 1996. The second biggest cruise company is the Royal Caribbean Cruises followed by Norwegian and MSC. The combined market share of the largest operators is about 85% of the total cruise market (Chanev, 2017).

There are several new cruise operators, some of which are subsidised by governments (mostly in India and China). The new operators focus on the luxury market, offering high personalised service and using relatively small ships (500-800 passengers). These new operators are able to accommodate river cruises in Europe, China, Russia, Asia and Canada. The largest operator in South America is ATP River Cruises (Chanev, 2015).

Figure 2.11: The Carnival Destiny - world's biggest cruise ship

2.2.4. Review of the global cruise fleet and trends

Some economies, including some South American markets like Brazil, experienced mild growth in comparison with the world's average. While the Chinese economy kept decelerating in 2018, US growth still remains above trend (World Bank, n.d.). Growth in the US economy was about 2.9%, resulting in elevated dollar prices. Suriname itself has a decrease in national GDP in the previous years after a high peak in 2012. As a result, it is expected that less Suriname inhabitants are willing to book a cruise themselves (World Bank, n.d.). The International Monetary Fund expects that the world economy will grow slightly in 2019 as well, but the economic certainty for commodity exporters, such as Suriname, will continue to have uncertainties in growth potential.

The booking volume of 41% of the total cruise agents has increased with 10% in 2018 and an additional 22% of the agents say their sales were up to 6-10% in the same year. Over the past five years (2011-2016), the market increased with almost 21% in passenger numbers (CLIA, 2017). Parallel to passenger growth, it can be concluded that worldwide itineraries and destinations are increasing as well with the technical specifications of ships, including size and numbers. This makes it possible to benefit from economies of scale principles. Furthermore, the growth of the cruise market is expected to continue even further in the coming years (de la Vina & Ford, 2012).

Cruising is a major contributor to a local or national economy, with ships generating passenger visits providing jobs and business opportunities for local residents. In 2017 it was forecasted that 28.2 million passengers were planning to set sail on cruise ships across the globe, creating a total output contribution of 134 billion US dollar. 2017 created about 137 million onshore visits by passengers and crew, helping to generate about 61 billion US dollars of direct expenditures for cruise lines for goods and services of their cruise operations (CLIA, 2017). Compared to the 2016 data, the cruise market helped to create 8.5% of total employment contribution in FTE in 2017.

		Total Global Contribution of cruise sector		
Category	**Unit**	**2016 Global**	**2017 Global**	**Change**
Passengers and onshore visits	Million	129,38	136,87	+5,8%
Total direct expenditures	US$ Bil	57,93	61,02	+5,3%
Total output contribution	US$ Bil	125,96	133,96	+6,3%
Total income contribution	US$ Bil	41,09	45,57	+10,9%
Total employment contribution	-	1.021,681	1.108,677	+8,5%

Figure 2.12: Total global economic contribution of the cruise sector ((CLIA, 2019)

Figure 2.13 shows the expected number of passengers for 2019 will keep on growing and is projected to be 30 million (CLIA, 2019).

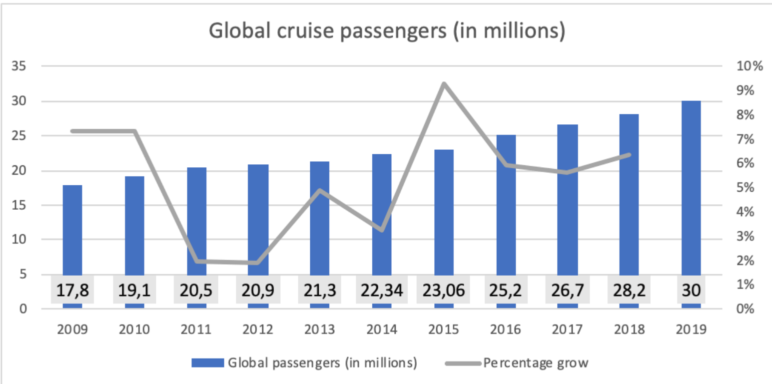


Figure 2.13: Growth in cruise numbers worldwide (CLIA, 2019)

The area having the highest demand worldwide is the Caribbean/Bahamas with a market share of 35% of the total global deployment of cruise itineraries. Especially within this area, the number of countries whose economies are fully reliant on the generation of revenue created by cruise market tourism grows, for example the ABC islands (Aruba, Bonaire and Curacao). The second most popular area for cruise visits is around the Mediterranean Sea, but it is expected for the coming years that the Chinese market will show significant grow possibilities as well (FCCA, 2018a).

2.2.5. Origins of cruise passengers

Most of the passengers (11,9 million, 49% of total) are coming from the United States, (see Figure 2.15) (CLIA, 2017). This number has increased by 26% since 2007, but the US total market share declined due to other upcoming cruise markets (66% in 2007 compared to 49% in 2017).

The successive biggest sources for the cruise markets are China and Europe with 2.4 million and 4.1 million passengers in 2018 respectively. Europe experienced a 10-year growth of 72%. Europe accounts for 26% of the total cruise market, remaining stable during the past years.

Interesting are the passenger numbers for the rest of the world (including South American markets), showing an exploding growth of 386% over a 10-year time frame. Their global market share increased from 8.6% to 25% with 6.67 million passengers in 2017. According to the Ministry of Tourism Brazil, more middle-class Brazilian inhabitants mention preferences for local cruise travel. This is the result of

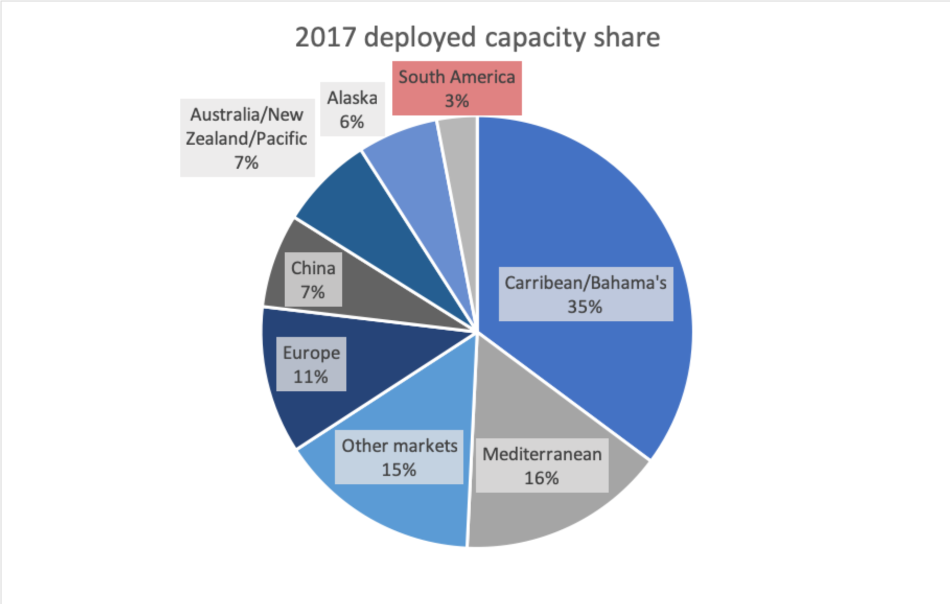


Figure 2.14: Total share South American cruise market (CLIA, 2019)

a higher Dollar/Euro rate, lower cost of travel in South America, as well as strengthening and increase of local cruise supply (FCCA, 2018a).

Since many itineraries' origin or finish in Brazilian ports, it may be assumed that greater interests for Brazilian cruises may also have positive effects on the popularity and cruise movements destining Suriname.

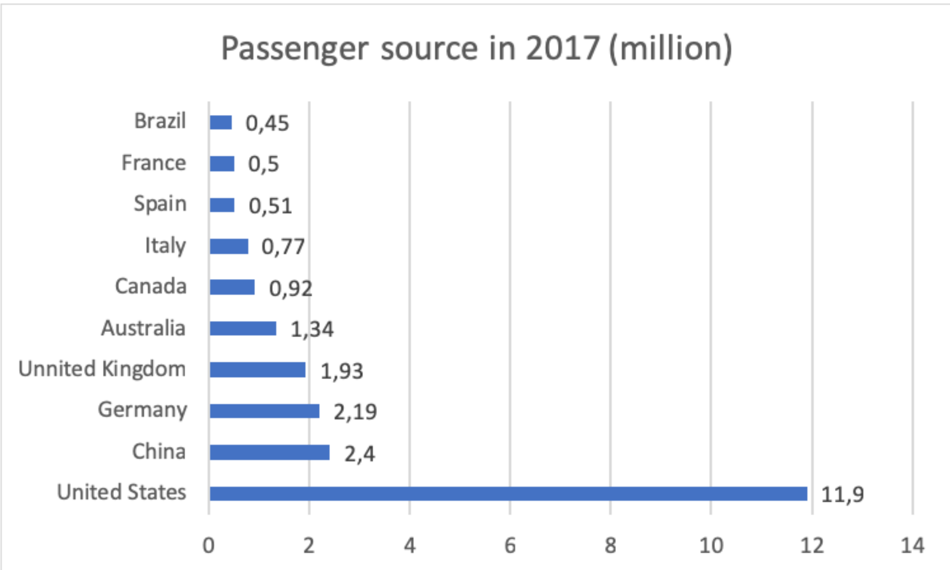


Figure 2.15: Cruise passenger origins (CLIA, 2017)

de la Vina and Ford (2012) conducted a logistic regression analysis in order to describe key factors in determining the demographic and trip attribute factors of potential cruise passengers based on a nationwide sample of persons. He concludes that previous cruise experiences, costs, duration of the cruise and visiting new destinations are important considerations and differ from the above passenger groups. Andereck and Caldwell (1994) divided passengers into four different consumer groups. This makes it possible for operators to effectively promote their products and services for different target groups. These user groups are separated on purpose, willingness to pay for services and expenditure

Cruise passenger numbers [million]	2007	2012	2013	2014	2015	2016	2017	10-year growth
North America	10.45	11.64	11.82	12.21	12.20	12.49	13.12	25.6%
Europe	4.05	6.23	6.4	6.39	6.58	6.79	6.96	71.9%
Subtotal	14.50	17.87	18.22	18.60	18.78	19.28	20.08	38.5%
Rest of the world (including South America)	1.37	3.03	3.09	3.74	4.40	5.87	6.67	386.6%
Total	15.87	20.90	21.31	22.34	23.18	25.15	26.75	68.5%

Figure 2.16: Growth in cruise numbers N-A en Europe in comparison with rest of the world (CLIA, 2017)

behaviour on land and on board.

- *Mass market*, includes passengers from the lower middle class with an expenditure pattern in between $125 and $200 a day.
- *Middle market*, includes passengers from an upper-middle class spending about $300 overnight.
- *Luxury market*, starts at $350 per day and serves the upper class.
- *Speciality market*, prices depend on the exclusivity and adventurous specifications but it is assumed that cruises are offered between $125 and over $350 per day. Most of the passengers do not consider the cruise ship itself as their main destination within this category, so the absence of on board facilities could be compensated by exceptional shore activities and experiences for which passengers are willing to pay for. Suriname as a destination has the ability to accommodate this.

There are several reasons for passengers to book a cruise holiday (FCCA, 2018b). Understanding the purposes and behaviour of cruise tourist could be a major contribution when investigating possibilities to add Paramaribo to existing cruise itineraries.

- A majority of the cruise passengers (93%) indicate that they are willing to book another cruise for a next holiday trip. Loyalty is visible in the fact that most average adult cruisers already take more than five cruises as an adult.
- More than half of the cruise passengers prefer cruise holiday above other vacations and say that the stay on the cruise vessel is better than then other types of stay such as on-land resorts, hotels etc.
- Family cruises are the most popular passenger category (especially families with children under 18).
- Younger generations are attracted to cruise holidays and this embracement grows.
- All cruise passengers choose cruise vacations to see and do new things and experiences and identified cruise destinations as their main argument to book a specific cruise holiday.

Different passenger generations have different priorities considering a cruise holiday. Elderly aged (65+) are influenced by programs of children and families. Middle aged (40-50 years) are interested in trips with good sight-seeing options, likeable destinations and ports, and on-land trip possibilities and lastly the younger aged generation (30 years and younger) are more concerned with cost, service and entertainment (Deloitte Consulting, 2018). The youngest generation is a very important sector for competition between cruise operators, since they have many vacations ahead of them and operators know that passengers are loyal to cruise vacations and likely to stick to the cruise operator in the future.

A last remarkable observation is the fact that cruise passengers remember the places that they visit during their cruise when booking for a next (land-based non-cruise) holiday. That means that if ports and cities that serve as stops in a cruise itinerary must optimise positive impressions of passengers so it is likeable that they come back in a next holiday.

Are cruises better or worse than land-based vacations in terms of:	% Better	% Worse
Relaxing and getting away from it all	88%	12%
Being hassle-free	82%	18%
Offers something for everyone	80%	20%
Being easy to plan and arrange	80%	20%
Being pampered	79%	21%
Chance to visit several different destinations	78%	22%
Being luxurious	78%	22%
Fun vacation	77%	23%
Fine dining	77%	23%
Variety of activities	77%	23%
High quality entertainment	76%	24%
Having good activities for children	78%	24%
Good vacation for the entire family	76%	24%
Being reliable	76%	24%

Figure 2.17: Comparison land-based factors with cruise (CLIA, 2017)

In Figure 2.17 are several subjects compared between land-based and cruise terminal, based on a questionnaire of cruise passengers (FCCA, 2018). The percentages show the number of people that prefer cruise over land-based holidays. Relaxing and getting away from the commitment of the daily life scores the highest for the cruise market. Three quarter of the respondents still choose 'reliability' and 'being a good vacation for the entire family' above land-based holidays, but there is room for improvement.

2.2.6. The South American cruise market

There is limited data available for the South American Cruise Market. Most of the data is based on Brazilian sources, since the most popular South American Ports are in particular in Brazil: Buenos Aires, Ushuia, Rio de Janeiro, Santos, Valparaiso, Manaus.

The number of cruise passengers from or to South America is about 3,3% of the total cruise market ass already outlined in Figure 2.14.

The number of bed days is an important indicator for the growth and distribution profile. The number of bed days (also referred to as pax-days) is the number of passengers (at full occupancy) multiplied by the total number of nights a ship occupied during a cruise. A cruise ship offering 10 days with a capacity of 2000 pax therefore incorporates 20.000 bed-days if fully utilised.

The number of bed days South American fluctuated between 2012 and 2017 between 3.79 and 4.93 million. The highest decline (-16%) of the capacity came from 2016 and 2017, but overall the global deployment of bed days showed a stable trend. It is not directly possible to link this decrease to a specific reason but these numbers underpin the dynamic behaviour of the global cruise market. It is expected that the number of bed days will increase in the coming years to averages between period 2012-2015.

Global deployment of capacity [millions of bed days]	2012	2013	2014	2015	2016	2017	1-year growth
Alaska	5.87	6.25	6.15	6.65	6.77	7.33	8.3%
Asia	3.21	4.72	6.17	11.33	15.06	17.76	17.9%
Australia/NZ/Pacific	5.49	6.51	7.09	8.36	9.97	10.21	2.4%
Caribbean	44.20	44.66	51.00	53.58	55.07	59.27	7.6%
Europe	12.71	14.37	14.88	17.48	19.16	18.80	-1.9%
Mediterranean	28.54	28.38	25.14	29.93	30.53	28.02	-8.2%
South America	4.80	4.93	4.42	4.27	4.50	3.79	-15.8%
Rest of the world	21.01	20.53	20.63	22.81	22.49	25.38	12.9%
Total	125.8	130.3	135.5	154.4	163.5	170.6	4.3%

Figure 2.18: Global deployment of capacity in bed-days (CLIA, 2017)

There are some operational challenges for cruise operators offering the South American market. The operational balance between sailing time vs. port time is difficult to reach since the continent has a huge surface and the ports are placed at a long distance from each other. The most popular itineraries are currently: (i) through the Amazon up to the Caribbean area (ii) up and down the Western coast and (iii) around Cape Horn to Alaska. Lastly, Transatlantic routes to Europe are common as well. Figure 2.19 shows relevant global passenger flows.

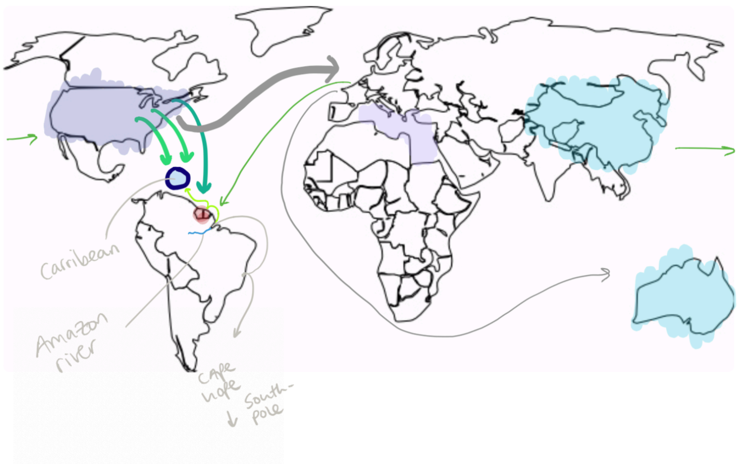


Figure 2.19: World map of passenger flows

Figure 2.20: Example popular itinerary (Holland America Line)

The largest passenger potential comes from the North American cruise market and is revealing more specific seasonality patterns. Rodrique (2013) compiled the monthly market demand based on the Cruise Market Watch and finds that the number of passengers is fairly stable throughout the year. Figure 2.20 shows the number of North American cruise passengers by destination in 2011 (CLIA, 2017). It is assumed that this distribution will be similar in 2019, but overall more passengers. The 'other' category includes passengers going to South America including Suriname.

When building a cruise port in Paramaribo, it is to be expected that the most passengers will arrive in April and between September and November, the periods of which the weather is the mostly dry.

2.2.7. Trends in cruise market

Several trends are related to the cruise industry (CLIA, 2019). However, the cruise market is very dynamic which makes it difficult to forecast demand. Cruise port planning involves the identification of these uncertainties in the cruise market demand and to incorporate flexible options for handling these uncertainties. A common used method for dealing with disruptive trends is Adaptive Port Planning, which takes several future trend developments into account (Prakoso, Taneja, & Velinga, 2018).

Overall, the cruise market expended in the past 20 years in an industry focusing on providing the best passenger experiences that happen on or near the cruise ship itself. It can be concluded that service offering can lead to advantages and flourishment of operators (Hadzic, 2005).

- Cruises become available for a broader public. That means that cruises are becoming less expensive or it could mean that the average holiday passenger has more money to spend on vacations on average.
- The demand for adventurous cruises and eco-cruises are rising.
- The focus of cruise operators on sustainability and environmental issues will have less impact on the environment which may attract passengers who now refuse to book a cruise vacation because of the related bad environmental image. Operators could also benefit from this trend, since the attraction of environmental conscious passenger will improve the on board and on land voluntary behaviour of for example recycling practices which will eventually have positive impact on the polluting image of the sector.
- The younger generation is attracted to small ships and river cruises, since they prefer a cruise ship above other modalities, such as coaches or car rental.
- The popularity of colder climate conditions is rising.
- The cruise industry is responding to the worldwide rising health awareness of humans by investing in facilities such as fitness programs, spa services and other weight management programs.
- Personalised programs that are based on preferences of individual passengers will focus on a broader market perspective.
- Digital connections and experiences are more common before a cruise and during a cruise in the form of check-in, research and planning.

Lastly, investing in better cooperation with local partners and their ecosystems will result in more program diversification, attracting different kind of passengers. Also, mutual-beneficial relationships between operator and local partners will create insights into the opportunities to give something back to the community, such as job creation or other potential benefits (Brida & Zapata-Aguirre, 2009).

These trends suggest that large brands have more possibilities to strengthen their market positions since they have more possibilities to invest into newer and bigger ships (able to benefit from economies of scale) and have better possibilities in targeting potential tourists. However, large brands are less able to accommodate high service, luxury or short trips which require smaller cruise vessels. For Suriname, it is this luxury and specialised target segment that is the most interesting target group in pursuing tourism popularity. This is because of the capacity of the port and the missing of sufficient infrastructure in order to accommodate major numbers of passengers at once (Spalburg, 2009).

In Section 3.3 a more detailed analysis is done to investigate the small cruise ships that are operating near Paramaribo.

2.2.8. Conclusion

- Cruise operators offer itineraries as products to passengers and distinguish themselves in terms of level of service, quality and specialities, related to four different market segments: all-inclusive, expedition, luxury, budget and river cruises. These user groups are separated on purpose, willingness and pay expenditure behaviour as well.
- The global cruise market is, with 21% growth in passenger numbers, one of the fastest growing components of the tourism sector worldwide and is expected to continue even further the coming years, generating about 61 billion US dollars annually of direct expenditures onshore.
- The area with the highest market share are the Carribean/Bahama's and the largest passenger potential comes from the USA and China.
- South America has a low market share but shows a stable market in bed-days over a 5-year time frame (except for the year 2017). This may be the result of smaller ship sizes or a lower number of total cruise passenger visits. Popularity for local cruises from Suriname inhabitants themselves do not show a growth which might be related to the decreasing national GDP.
- A majority of the cruise passengers are family cruises indicate that they are willing to book another cruise for a next holiday trip. The share of younger generations that book a cruise is growing as well, since cruises are becoming less expensive. This group is more loyal for sticking to cruise operators and are more likely to consider returning to ports and cities which they visited during their cruise on their next holiday. Secondly this group is attracted for environment friendly adventurous smaller ship and river cruises which are considered as more luxurious and expensive.

2.3. Relevant Projects

Tourism can not be discussed separately, without involving the development of and the synergy with other economic and social sectors, the care of the environment the safety in a country and an adequate legislation (VSB, 2014). The complexity of the tourism sector needs a pronounced formulation of the national development policy and a strategic policy for the tourism sector by the government. The first steps are now taken by the government by the formulation of different projects. The timing of the research on the feasibility and desirability of a cruise terminal in Paramaribo seems to be a perfect fit next to these other projects. 4 major projects stand out, in context with this project:

- Strategic Urban Mobility Plan for Paramaribo Historic Centre
- Suriname River Dredging Project
- Dr. Jules Sedney Terminal and access roads
- Airport renovation to increase flights to Suriname

Next to these ongoing projects, the realisation of a cruise terminal becomes a perfect complement on the vision of the government for Suriname. The main goals of these projects are shown here, focusing on the points which are most relevant for the realisation of a cruise terminal.

2.3.1. Strategic Urban Mobility Plan for Paramaribo Historic Centre

The Strategic Urban Mobility Plan (SUMP) is part of the Paramaribo Urban Rehabilitation Program (PURP). With the following objectives the project aims to regenerate the Historic Centre into a living dynamic and active urban attraction:

- Revitalise the Historic Centre
- Incentivise recreational use and tourism
- Enhance accessibility for all
- Develop commercial activity and mixed uses
- Catalyse the projects of the PURP

To achieve these goals, the priority for the use of private vehicles in the historic city centre has to shift towards the most sustainable transport modes. In an earlier report: "Diagnosis and Strategic Objectives", the problems that affected mobility in the Historic Centre were mapped. These results are shown in Appendix K together with the strategic objectives which could solve them. For every strategic objective a set of actions were identified and formulated into different projects. The projects are defined by a technical content, its costs and its own implementation time line. The projects also contain a plan for monitoring the execution and the impacts. The projects per strategic objective are shown Figure 2.21.

The overall project describes three different implementation phases from 2019 until 2021, from 2022 until 2024 and from 2025 until 2027. Especially the first objective 'A walk-able Historic Centre, bike inclusive that connects urban spots' is really necessary for a positive experience of the cruise tourists in Paramaribo. It aims to create a perception of comfort, security, walk-ability and integration. And to create space for other assertive ideas that in the future can develop the historic centre as a place of recreation. For the cruise tourists the first action plan is most important: 'Plan for a walk-able public space network'. This action plan will be discussed in more detail.

Plan for a walk-able public space network

For the first project 'Walk-ability improvement plan', the current main functions in the inner centre were identified. These are shown in Figure 2.22. For building the pedestrian network three different type of streets are defined: no car streets, shared streets, transit streets. The no car streets are pedestrian streets that connect the commercial and the heritage areas. The shared streets prioritise the pedestrians and the cyclists but also allow freight and private vehicles. They will have a speed limit to ensure

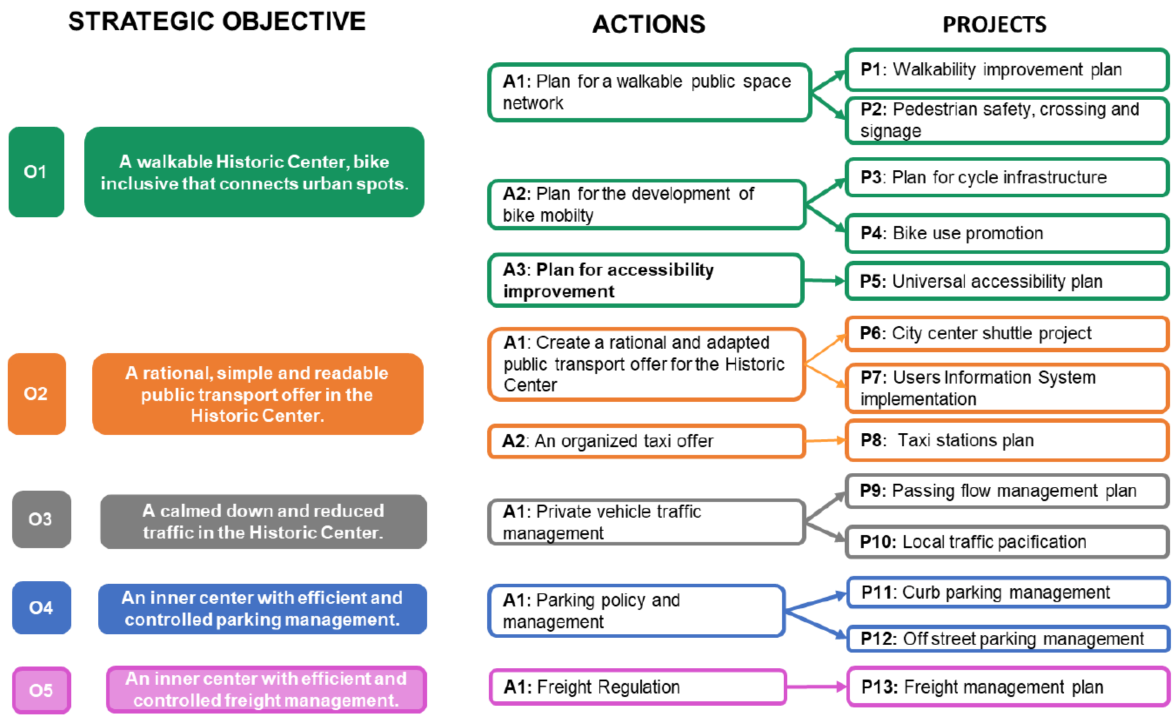


Figure 2.21: The action plan for the Strategic Urban Mobility Plan (Sinaí Lòpez Santos, 2018).

safety for the pedestrians and the cyclists. (30 km/h and 20 km/h) The transit streets will improve the flow of traffic that only passes through the centre. It aims to separate the destination traffic and the passing through traffic, which combination currently results into congestion. Figure 2.23 shows the proposed street network.

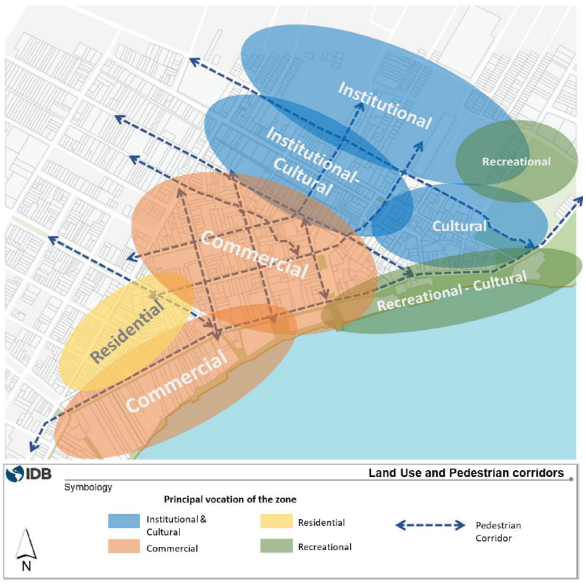


Figure 2.22: Relations between principal uses in the centre and identified pedestrian corridors (Sinaí Lòpez Santos, 2018).

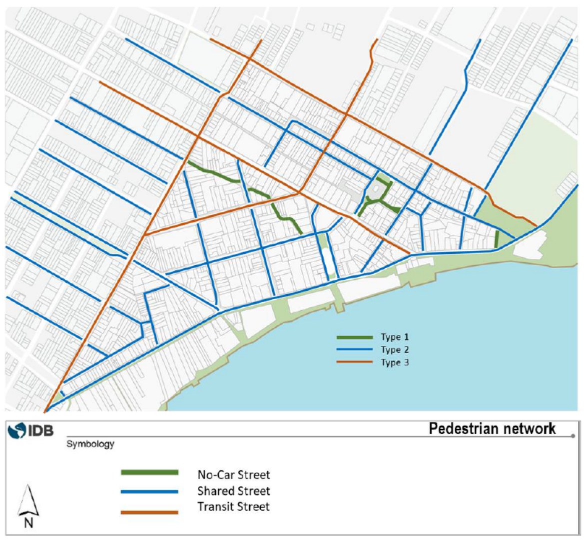


Figure 2.23: Street network proposal (Sinaí Lòpez Santos, 2018).

For every street type specific characteristics and criteria are defined creating a push/pull effect for the specific intended traffic participant. For the implementation different treatments are designed for specific streets or areas. One is in particular important for the design of the cruise terminal: the Waterkant. The treatment here aims to discourage vehicle traffic, decrease their speed, give more space to pedestrians and cyclists. The treatment considers:

- reduction of the roadway to one lane and one-way
- confined cycle lanes at both sides of the roadway
- increase of sidewalks
- tree placement
- signage and furniture

A visual design of this area is shown in Appendix K. It is proposed by the PURP to treat the Waterkant in the first phase, since it contains iconic and visible interventions. This meets the urgent need to improve walkability conditions in the most pedestrian-transited zone of the inner centre, which also applies for the cruise tourists. In the second phase the streets in the Heritage high-value area of the Historic centre will be treated. This will enhance the pedestrian link between the commercial area with the heritage area, also considered important for the cruise tourists. The last phase will complete the street treatment program.

2.3.2. Suriname River Dredging Project

The Maritime Authority Suriname (MAS) and the project financing consortium (BMS, Suralco, Staatsolie Maatschappij Suriname N.V.) planned a capital dredging program to remove 10 – 11 Mm^3 of sediment in 2009. It was designed to alter the existing navigation channel and create a larger, more-defined channel to allow an increase in the operational draught of vessels and increase the cargo efficiency (imports and exports) from Suriname. Over a period of 10 years, the project also should involve a maintenance dredging program and ocean and in-river disposal of sediments, including the creation of a habitat island in the mouth of the river.

The project area covered a 85 km stretch of the lower section of the Suriname River estuary acting as the major transport link for connecting the industrial centres of Paranam and Paramaribo with the Atlantic Ocean (SRK Consulting, 2009). Figure 2.24 depicts the proposed dredging locations for the Suriname River in 2009.

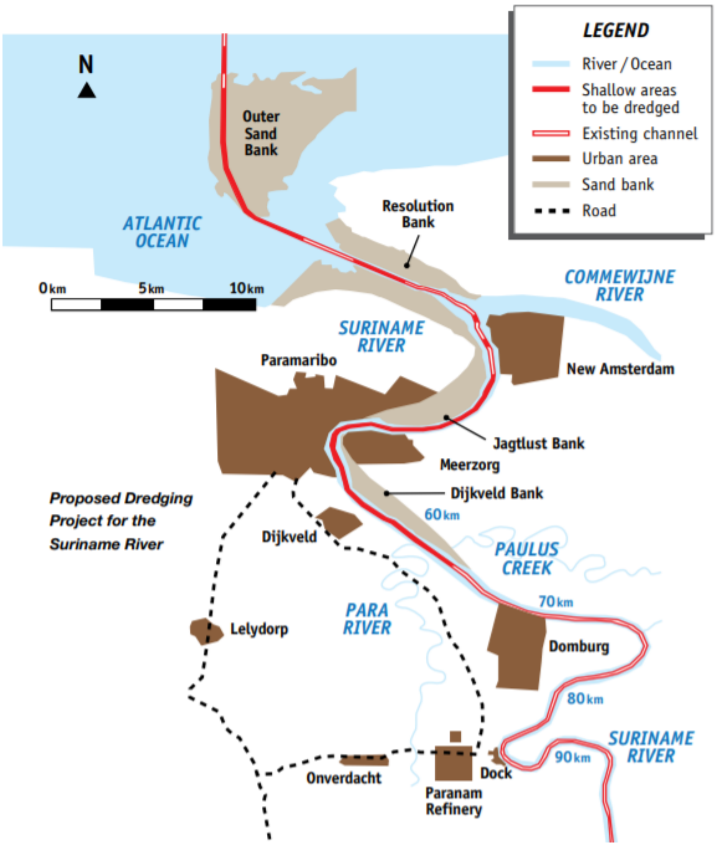


Figure 2.24: Overview Navigation Channel (SRK Consulting, 2018)

In March 2019 the dredging project is still not started. Though, the plans are still there to start with the dredging project. The vessels cannot pass fully loaded anymore and/or have to adapt their sailing times to a tidal window, a specific phase of the tide in order to avoid the hours around low water. Since 2013 a new dredging contract is foreseen consisting of capital and maintenance dredging over a period of 5 years. The project will start 'soon' as announced by President Bouterse. Preparations already have been made.

The planned dredging activities now contain almost the whole channel from the outer bank (km 0 - km 30) until the Simonspolder (km 85). The navigation channel is in principal a *single lane* channel, with two stretches where the channel is designed as a *two lane* channel. The Nominal Nautical Bottom Level (NNBL) is CD - 5.5 m and the Consolidated Bottom Level (CBL) is CD - 5.75 m at Paramaribo. The sided slopes are taken equal 1V:5H in channel sections km 0 – km 35 and 1V:3H in channel section km 35 – km 85.

2.3.3. Dr. Jules Sedney Terminal and access roads

The government of Suriname is working on a project to improve the competitiveness of Suriname in the fields of transport and logistics. One factor which as an positive impact on international trade is the accessibility of the Jules Sedney Terminal in the Port of Suriname. Currently, the area near the port is congested during a large part of the day. There are plans to change this by replacing the roundabout with an intersection with traffic lights, as shown in Figure 2.25. There is expected that this will decrease the travel time by 26% and 41% less fuel consumption (Ministerie van Openbare Werken, 2019).

Figure 2.25: Current (left) and future (right) road network near the port (Ministerie van Openbare Werken, 2019)

2.3.4. Suriname JAPI Airport Expansion Project

The Johan Adolf Pengel International (JAPI) Airport, also known as Paramaribo-Zanderij International Airport, is an airport located in the town of Zanderij, 45 km south of Paramaribo. Currently, between 450,000 and 500,000 PAX are handled.

The China Harbour Engineering Company Ltd (CHEC) envisages a new and full-flex (arrival & departure) terminal building for 1,000,000 PAX by 2027. One of the relevant benefits of the expansion is the facilitation of increased tourism. Furthermore, the execution of this project will directly create more than 250 jobs for local labours. (China Harbour Engineering Company Ltd, 2017)

2.4. Cruise Port Characteristics

The waterfront is a valuable asset in city and port development. Cruise terminals serve cities and ports and need closest proximity to the city centre as possible. Issues of access are both at the waterside and land side. There are three types of ports. A distinction is made between a home port, a port of call and interporting (MarCom, 2016).

Typical characteristics for a *home port* are: (i) turnaround operations, start and end of cruise itinerary, (ii) extensive connectivity including air, road and rail, (iii) extended stay facilities including hotels and attractions, (iv) high berth occupancy and (v) the terminal logistics are complex and extensive.

Typical characteristics for a *port of call* are: (i) short berth time typical 10 hours, 2 days maximum, (ii) geographic context, part of a itinerary, distance other ports of call and (iii) high capacity transfer to/from excursions. *Interporting* is when a port of call partly functions as a port of call or when a port of call partly functions as a home port.

Some typical terminal components are:

- A wide apron for provisioning logistics
- Freight storage facilities, in case of a multi-purpose terminal
- A high volume fresh water hook-ups
- Employee and passenger parking spaces
- A staging area for busses and taxis
- Crane availability
- Trash disposal
- Duty-free pier shops
- A terminal building (multifunctional - also for non-cruise events to generate year round revenues)

According to MarCom (2016), there are different types of cruise terminals. The building types can be divided into temporary terminal buildings, convertible buildings, purpose-built terminal buildings and mixed-use terminal buildings. When a port starts with developing the cruise business, often a temporary structure is used due to cost considerations. With a more developed cruise market, a convertible building can be built. This type of building requires all the facilities necessary for handling cruise ships. However, cruising is not the primary feature of this building since the building is also used for other purposes. If a terminal building is dedicated to cruising, it is called a purpose-built terminal. A mixed-use terminal has all the facilities of a purpose-built terminal and serves also other goals, like shopping and theatre.

3 Analysis

3.1. Physical Environment

A description is given of various environmental conditions which may influence the study. The structure of this part is achieved from an *Environmental & Social Impact Assesment* ((Environmental Sciences Limited, 2018)) of the Staatsolie Maatschappij Suriname N.V. for the 'Nearshore Exploration Drilling Project 2019'.

3.1.1. Geology

Based on geological division, four major geographical zones are distinguished:

1. The Precambrian Guyana Shield area
2. The Zanderij Belt (Late Tertiary)
3. The Old Coastal Plain (Pleistocene)
4. The Young Coastal Plain (Holocene)

The area near the estuary of the Suriname River, including Paramaribo, is located at the Young Coastal Plain (YCP), behind the Continental Shelf. The Young and Old Coastal Plain, together with those of French Guiana and Guyana, forms the Guiana Basin.

The sea level started to rise at the end of the Pleistocene and the Continental Shelf was flooded again. The predominant type of sediments changed from coarse to fine sand into Amazonian mud. The current coast of Suriname is part of the Guiana Coast, considered as the world's longest continuous mud coastline. It has been classified as muddy clay because immense volumes of argillaceous types of mud (pelite) are being deposited. The source of the pelite, including fine sands, is the Amazon Basin. Coarser sandy material is only supplied by rivers from French Guiana and the Marowijne River (Environmental Sciences Limited, 2018).

3.1.2. Topography & Soil type

Topography

The elevation of the coastal clay flats is estimated at 1.5 m above mean sea level (MSL), but further inland the land becomes slightly lower due to subsidence as a result of soil ripening. The soil conditions of the clay soils in the area are rather homogeneous, with slight differences in degree of ripening. Dominating soils can be characterised as very poorly drained.

The nearshore coastal zone is predominantly developed on extensive clay flats, but directly east of the Suriname River a beach is located, called Braamspunt. At Braamspunt, the beaches are formed on a number of spits. A spit is an extended stretch of beach material that projects out to sea and is joined to the mainland at one end. Spits are formed where the prevailing wind blows at an angle to the coastline, resulting in long-shore drift (Nag, 2017).

Soil Type - Paramaribo

Near the outer bank of the Suriname River in front of Paramaribo, 'Waterkant', Electric Cone penetration tests (CPTs) are done to determine soil types. Appendix B presents the results of multiple CPTs along 'Waterkant'. The soil consist mostly out of slightly sandy clay mixtures with low bearing capacities.

The indicative soil properties are determined using the Eurocode 7 (NEN-ENN9997), see Figure B.8 in Appendix B.1, and will be used in the design of Chapter 7.

3.1.3. Coastal Geomorphology

The coast near Paramaribo, classified as a mud-mangrove coast, is highly dynamic, and periods of retreat and accretion succeed each other. The coast often grows into seaward direction, based on long-term evolution. Furthermore, the coast erodes where human interventions (i.e. plantation & urbanisation) were too close to the sea. This is more or less true for all healthy mangrove-mud coasts, though often less dynamic than the Suriname coast. Figure 3.1 depicts the coastal stability of the Suriname Coast (Kroonenberg, Wong, & Augustinus, 2017).

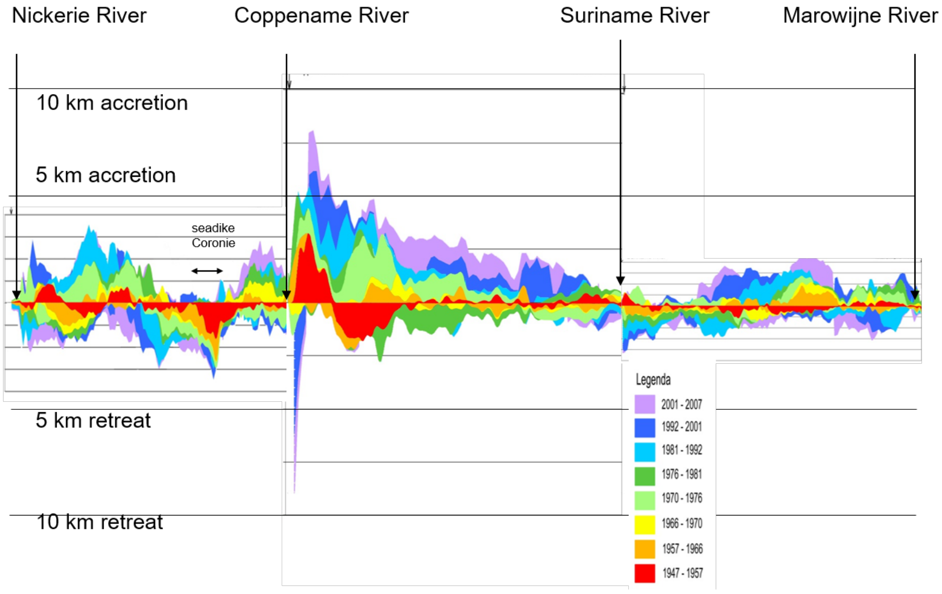


Figure 3.1: Coastal Stability of the Suriname Coast (1947 - 2007), image sent by P. Augustinus

Remarkable is the presence of shore-face-attached mudflats and mudbanks, the sub-tidal extension of the intertidal mudflats, which continuously migrate to the west. They are driven by the alongshore Guiana Current and wave action. Along the Suriname coast, there are large differences in accretion/erosion rates, i.e. ongoing retreat northwest of Paramaribo (Weg naar Zee area). Generally, accretion occurs at locations sheltered by the mudbanks, whereas coastal retreat occurs in between mudbanks, when the coast is unprotected from waves. (Augustinus, 1978)

The coast of Paramaribo is completely built up by clay from mudflats. Mudflats almost completely cover the coastline of the district. The interaction of the Suriname River and the westward-migrating mudbanks results in the changing magnitude and volume of Braamspunt (Toorman et al., 2018).

3.1.4. River Geomorphology

The topography of the Suriname River runs in a northerly direction and has large local meanders and sharp bends alternating with fairly long straight sections. The Suriname estuary, the alluvial coastal plan, and most of the banks consist of estuarine clays and loams (NEDECO, 1968).

There are four main sand bars in the section of the Suriname River proposed to be dredged, see Figure 2.24 in Section 2.3.2, known as:

- River Mouth Bank (Outer Bank)
- Resolutie Bank
- Jagtlust Bank
- Dijkveld Bank

The Outer Bank at the entrance of the Suriname River controls the entrance to Paramaribo. The minimum depth of the navigation channel through the Outer Bank is currently CD - 4.0 m with a length of 11 km. Thereafter, the Resolution Bank (CD - 5.20 m with a length of 8 km) is located until the entrance of the Commewijne River, the Jagtlust Bank (CD - 5.1 m with a length of 6.5 km) is located until Paramaribo and after the bridge the Dijkveld Bank (CD - 5.2 m with a length of 8 km) (SRK Consulting, 2018).

3.1.5. Hydrology

River discharge

The average mean monthly discharge of the Suriname river (Q) is 426 m^3/s. The river is regulated by the dam at Afobaka. Due to this, the discharge downstream of Afobaka is very gradual across the year, with only a minor increase in the May-June period. Figure 3.2 depicts the annual variation mean discharge of the Suriname River at Afobaka, downstream of Dam, compared with Pokigron, upstream of Dam. The river discharge arises from a catchment area, partly outside Suriname, of 16,500 km^2 (Noordam, 2018).

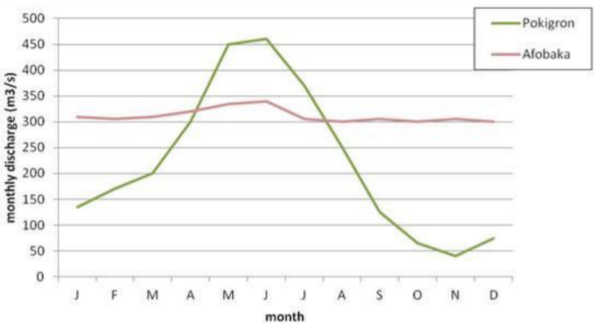


Figure 3.2: Annual Variation Mean Discharge of the Suriname River at Afobaka compared with Pokigron (Noordam, 2018)

Tidal Range

The estuary of the Suriname river shows a tidal character. The tide along the coast of Suriname is classified as semi-diurnal, with 2 high tide events and 2 low tide events per day. The tidal prism is equal to $125 \cdot 10^6$ m^3 reaching up to speeds of 25 km/h along the Suriname River. This results in a mean tidal range of 1.80 m at the river entrance and a mean tidal range of 1.85 m at Paramaribo (Noordam, 2018).

Table 3.1 presents the tidal levels referred to Chart Datum (CD) of soundings obtained from the Maritieme Autoriteit Suriname (MAS).

	Height in meters above Chart Datum			
Location	**MHWS**	**MHWN**	**MLWN**	**MLWS**
River entrance	2.6	2.0	0.9	0.3
Nieuw Amsterdam	2.8	2.1	0.9	0.4
Paramaribo	2.7	2.1	0.9	0.4
Domburg	3.1	2.4	1.2	0.8

Table 3.1: Tidal levels referred to Chart Datum (LLWS) obtained from the Maritieme Autoriteit Suriname (MAS). MHWS: Mean high water springs, MHWN: Mean high water neaps, MLWN: Mean low water neaps, MLWS: Mean low water springs

Figure 3.3 depicts the water depths of the 'Suriname River Entrance', depending on dredging activities as described in Section 2.3.2. These dredging activities will increase the water depths at the most shallow part of the river entrance to a depth of CD + 5.5 m.

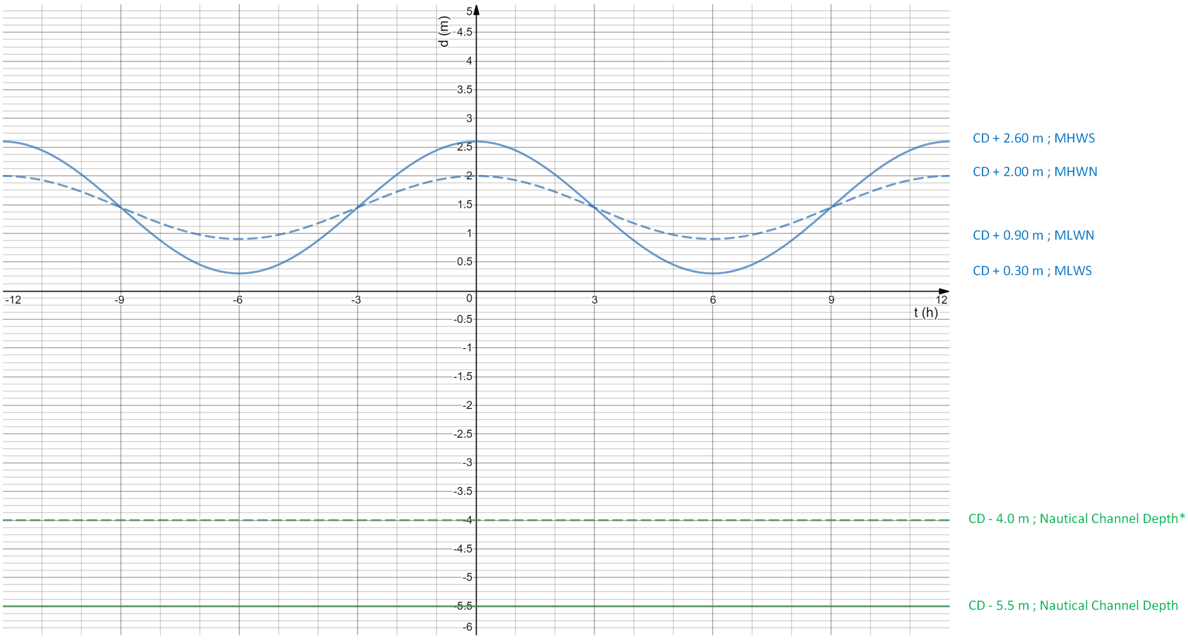


Figure 3.3: Water depths 'Suriname River Entrance', depending on dredging activities, derived from tidal data of the Maritieme Autoriteit Suriname (MAS)

The velocity of the currents can vary rather strongly and depends mainly on the range of the tide, the river discharge and the location. Maximum velocities during flood are higher than during ebb. At neap tide, the current velocities are about half of those during the spring tide. The highest current velocities occur in the mouths of the estuaries, up to about 1.8 m/s at spring tide. Farther up-river, the velocities gradually decrease. Average maximum flood flow occurs about 1.5 hours before local high water (Augustinus, 1978) (NEDECO, 1968).

Waves

Tables 3.2 and 3.3 present the wind wave characteristics in front of the coast and at the river mouth, respectively (Amatali & Noordam, 2010).

Physical wave characteristic	Value
Avg. significant wave height (H)	1.5 m
10% excellence sign.wave height (H) (December - March)	2.5 m
Average wave period (T)	7 s
Average wave length (L)	60 m

Table 3.2: Physical wave characteristics in front of the coast

Physical wave characteristic	Value
Appr. Extreme storm surge	2.5 m
1 per 10 years maximum water level, river mouth	2.6 m
1 per 100 years maximum water level, river mouth	3.1 m

Table 3.3: Physical wave characteristics at the river mouth

3.1.6. Climatology & Meteorology

Relevant data about climatology and meteorology will be described in this section. The data is obtained from records held by the Meteorological Service and the Hydraulic Research Division of the Ministry of Public Works.

Wind Speed & Direction

Generally, wind velocities are relatively high at the coast and decrease further inland. The meteorological station Cultuurtuin is an inland station located at the north side of Paramaribo. Wind speed values of 0.7 - 1.5 m/s, with an annual average of 1.2 m/s are recorded. The highest wind speeds occur during the short dry period February-April, when temperature gradients are highest, ranging between 1.4 and 1.5 m/s. Calm winds ($\leq$ 0.5 m/s) are very frequent in Paramaribo and most of Suriname, occurring over 50% of the time. The wind speeds at sea (meteorological station Lichtschip) and along exposed coastlines are much higher in comparison to those at Cultuurtuin.

The wind directions in Suriname correlate to the position of the ITCZ, see Figure B.9 in Appendix B.2. Hereby, the directions NE and ENE usually have the highest frequencies. At meteorological station Cultuurtuin, the most dominant wind direction varies between NE and ESE for the period 1931-1960. The wind direction is more easterly during the morning period than during the rest of the day when ENE winds dominate. Only during the long dry season (July - November) does the morning wind direction have a southerly component. In the remaining months, the morning wind has a northerly component, or is completely east oriented. This southern component is due to the land wind which is present during the long dry season.

Similar results were obtained during measurements at a meteorological station Weg naar Zee. Environmental Sciences Limited (2013) deployed a station at Weg naar Zee which recorded wind speed and direction during the period July to December 2017. The data of the long wet, long dry and short wet seasons is depicted in wind roses in Figure B.10 - B.12 in Appendix B.2.

Wind speed and direction data, for the period 2011 to 2017, were obtained from the CFSv2 global reanalysis (at 10 m height for 2 periods). The first is termed the short period, which ranges from early December 2016 to late April 2017 (the short wet and short dry seasons) and the second is termed the long period, from late April to early December 2017 (the long wet and long dry seasons) (Saha et al., 2014).

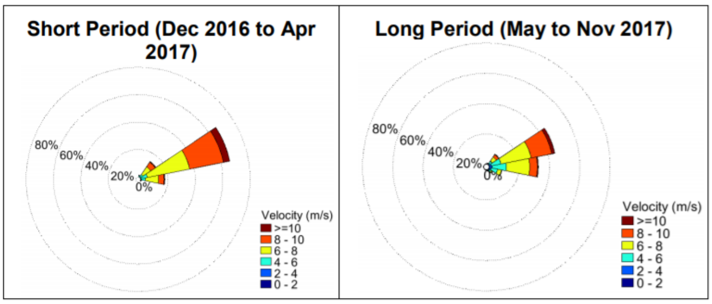


Figure 3.4: Wind Roses of the CFSv2 Wind Vectors in the Modelling Periods, based on CFSv2 global reanalysis data (2011 – 2017) (Saha et al., 2014)

Natural Disasters

Suriname does not experience either hurricanes, earthquakes or volcanic eruptions. However, Suriname is vulnerable to flooding caused by sea surges, sea level rise and heavy rainfalls, particularly in a coastal city like Paramaribo. Heavy rainfall can cause sudden rise of the water level of the Suriname River (Organization, 2010).

Sea level rise

Due to Sea Level Rise (SLR) four key climate change vulnerabilities are likely to appear in Suriname (UNDP, 2010).

1. Flooding from storms
2. Inundation from SLR
3. Salt water intrusion of ground water
4. Erosion with loss of mangroves

According to the UNDP (2010) the SLR will be between 0.18 - 0.55 m from 2010 to 2100. The SLR will be beneficial for the navigational depth, though the SLR should be considered for the required height of the berth. The influence of SLR reduces in upstream direction of the river. Therefore, a constant water level rise of 0.20 m in 2100 along the river banks of Paramaribo is assumed.

3.1.7. Bathymetry

Figure 3.5 presents the nautical map of the Suriname River from Braamspunt to the Dijkveld Bank, located south of Paramaribo. The water depths are in meters, reduced to Chart Datum (CD), the level of Lowest Astronomical Tide (LAT). The navigation channel for ships is visible as the deeper part of the river. Like all other rivers, the water is deeper in the outer bends of the river. According to the Maritieme Autoriteit Suriname (Interview I.7), the channel becomes shallower due to sedimentation. Therefore, the maximum draught of vessels in the Suriname River is currently limited. A more detailed nautical map of the outer bend of the Suriname River in front of Paramaribo is presented in Figure 3.6.

Figure 3.5: Nautical Map: Braamspunt - Dijkveld Bank, with the deeper part of the river in white (Maritieme Autoriteit Suriname).
Note: It was not possible to receive the nautical map digitally.

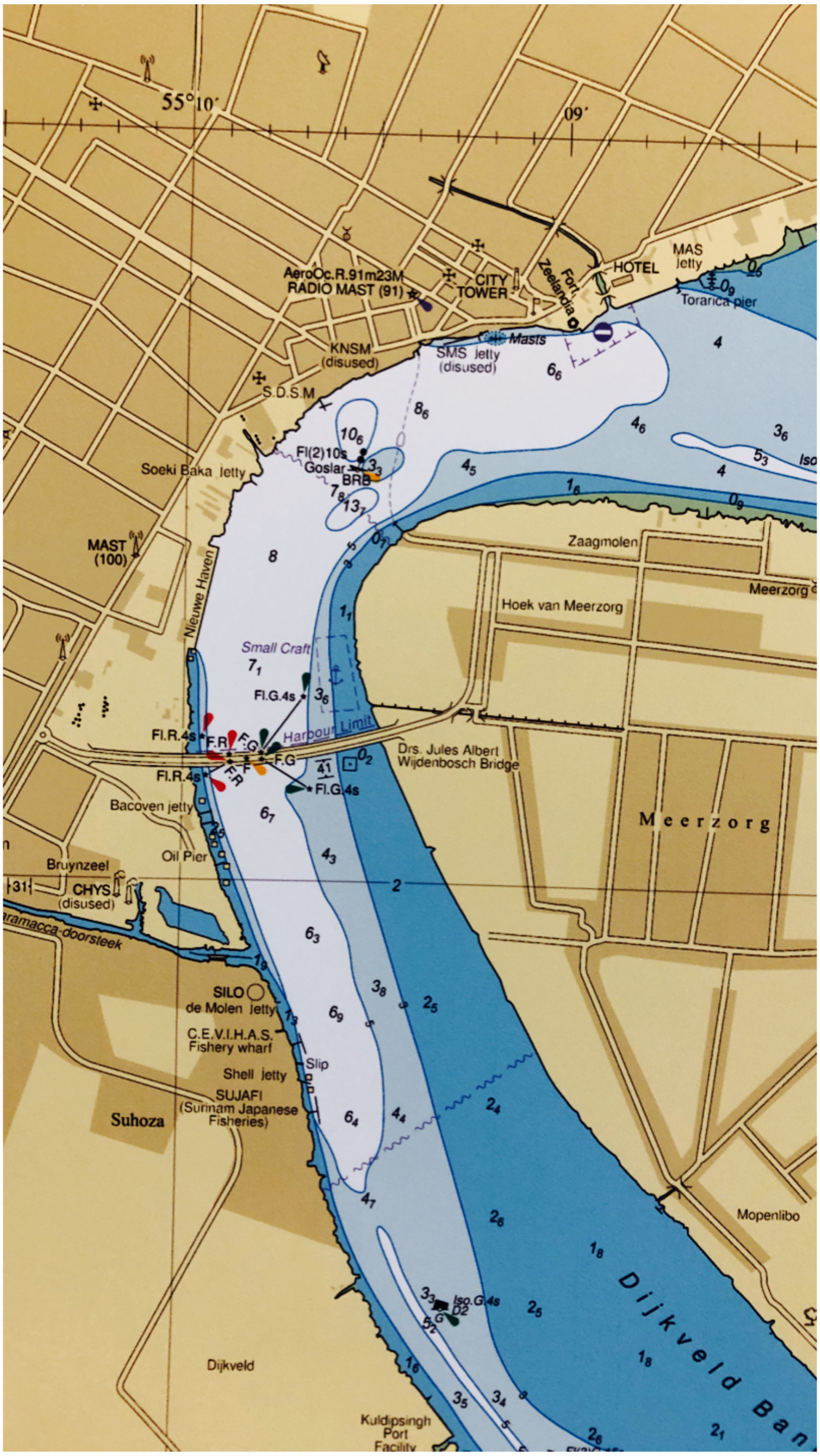


Figure 3.6: Nautical Map: Outer bend Suriname River - Paramaribo (Maritieme Autoriteit Suriname). *Note: It was not possible to receive the nautical map digitally.*

3.1.8. Oceanography

The Guiana Current flows parallel and close to the coast in NW direction. The discharge of the Guiana Current is estimated at 5 to 10 $\cdot$ 10^6 m^3/s over a width of 250 km off French Guiana up to 500 km off Suriname. The maximum velocity is 1.5 to 2.0 m/s at up-current locations off French Guiana and decreases in a westerly direction. The majority of observations in a study of ranged from 0.41 – 1.23 m/s (Febres-Ortega & Herrera, 1976).

As stated in Environmental Sciences Limited (2018), based on Kroonenberg et al. (2017), NEDECO (1968) and NEDECO (1982), measurements have indicated that the angle between the velocity vector at the surface and the bottom tends to become larger with increasing depth, due to the Ekman spiral type current, caused by the rotation of the earth. The resultant current velocities in the surface layer are 0.20 to 0.90 m/s and slightly directed offshore. In deeper layers, the current is flowing landward, at a velocity of about 0.10 to 0.60 m/s. This circulation pattern holds qualitatively for the area off French Guiana, adjacent Brazil, Suriname and Guyana.

Based on Eisma and Bennekom (1971), it can be concluded that the flow direction at the surface mainly varies between W and NW, whereby the flow is mainly seaward directed. Figure 3.7 depicts a current direction histogram based on Acoustic Doppler Current Profiler (ADCP) data from October – December 2017.

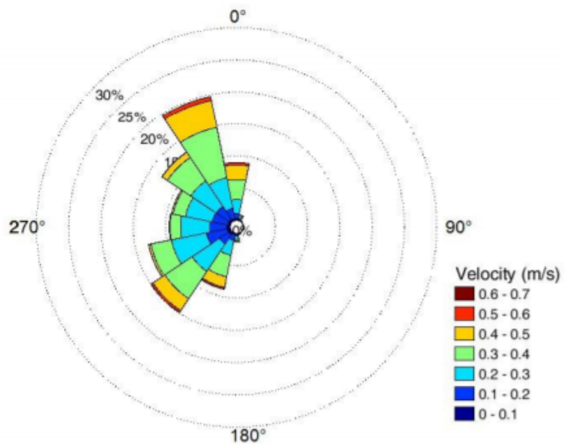


Figure 3.7: Current Direction Histogram, showing the Velocity (m/s) for the Intermediate layer of Measurements (based on ADCP Data; October – December 2017) ESL Nearshore ADCP data collected for MAS (October – December 2017)

3.2. Land & Infrastructure

In this chapter, the land use and infrastructure in Suriname are described and potential locations for a cruise terminal are determined. The land use is analysed at two different levels, which are the focus area as described in section 1.5 and the city centre of Paramaribo around Waterkant.

3.2.1. Suriname River

Relevant locations along the Suriname River and areas that may be suitable for a cruise terminal are shown in Figure 3.8, marked by a blue ferry. Area 1 is interesting because of the former bauxite port which was located in Paranam and the presence of beach. The former port received relatively large vessels with a relatively deep draft, so river to Paranam is relatively deep and a part of the infrastructure necessary for a cruise terminal has already been built.

The second area can be a good location for a cruise terminal because of the cultural destinations with the fortress New Amsterdam and several plantations nearby, which are popular as touristic destination. The River near this location is relatively deep, which minimises dredging costs and this increases the feasibility of a cruise terminal at this location.

Lastly, the areas 3-10 are located near the old city centre which makes them interesting for tourists. Especially since the historic inner city of Paramaribo is a UNESCO world heritage site (UNESCO, 2019). These locations are described in the next section.

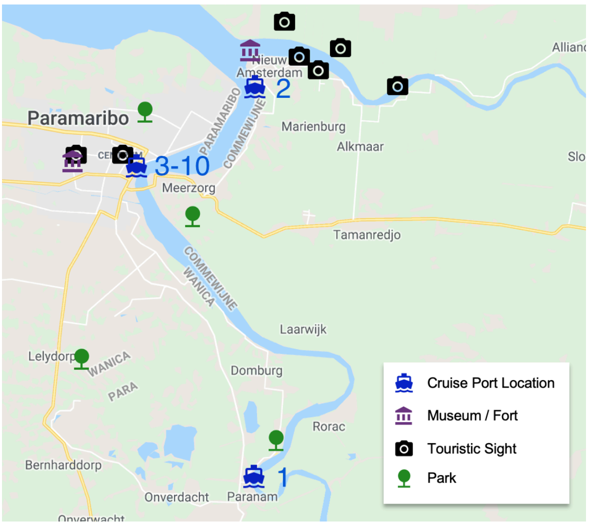


Figure 3.8: Relevant locations along the Suriname River (adapted from Google (2019)).

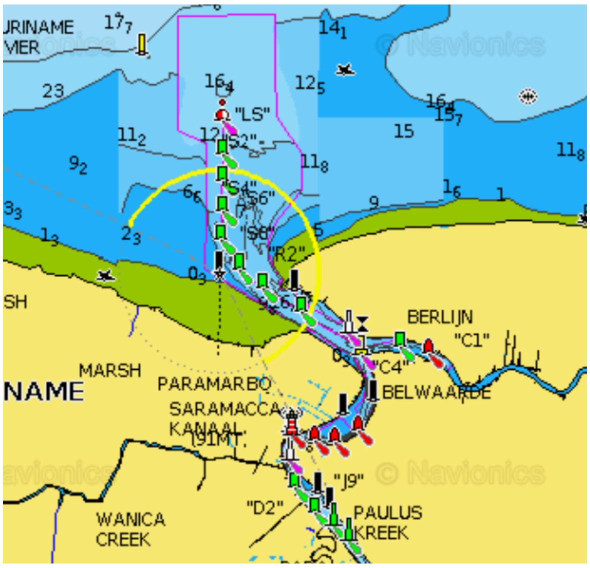


Figure 3.9: Navigation marks along the Suriname River (Navionics, 2019)

The port of Suriname is positioned near the city centre. The aids to navigation, which help the vessels reach the port, are shown in figure 3.9. In Suriname, the Maritieme Autoriteit Suriname (MAS) is responsible for pilotage (MAS, 2019). A pilot of the MAS enters the vessel near the northernmost buoy (as explained in interview I.7). The MAS does not own tug boats.

Figure 3.10: The Goslar in the Suriname River (Gemini, 2014)

Large ships have to take a remarkable circumstance into account when sailing on the Suriname River, since a warship wreck from the second world war has to be avoided. This wreck is called the Goslar and shown in Figure 3.10. Vessels can sail at either side of the wreck. Which side the ships will use depends on whether the vessel will go to the port of Suriname or further than the Jules Wijdenbosch bridge (as explained by the MAS in interview I.7).

3.2.2. Paramaribo

The city centre of Paramaribo is shown in Figure 3.11, together with a visual representation of the area functions along the Suriname River. This older part of the city shows the typical Surinamese houses, the presidential palace, the parliament building and the palm garden. Many hotels, restaurants and shopping areas are also located in this area. The port of Suriname is positioned at potential cruise terminal location 8.

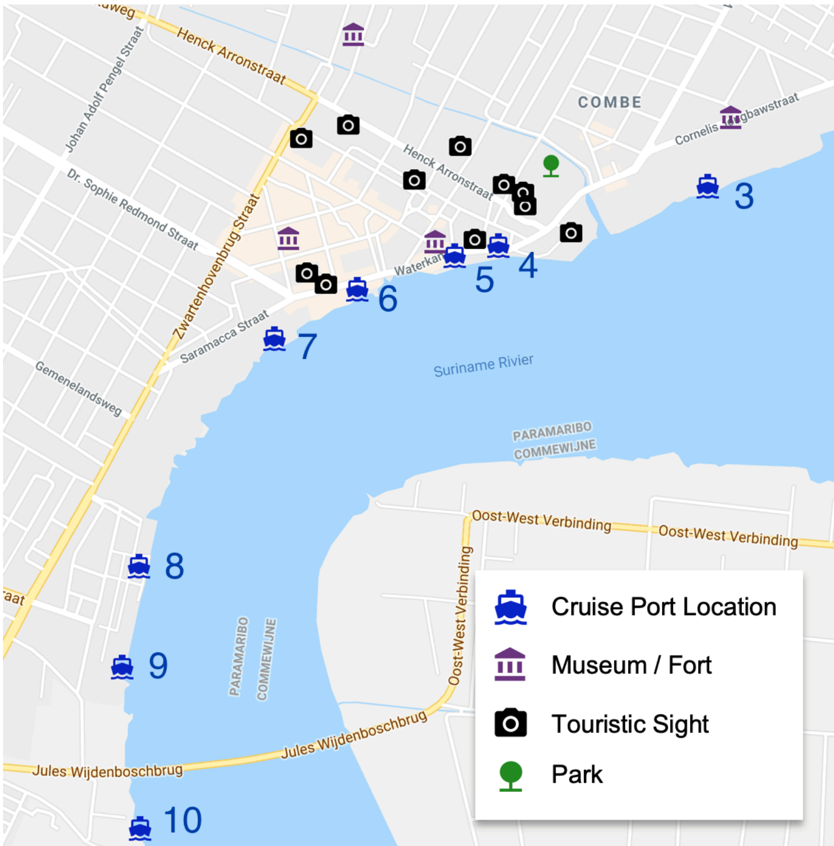


Figure 3.11: The city centre of Paramaribo (adapted from Google (2019)).

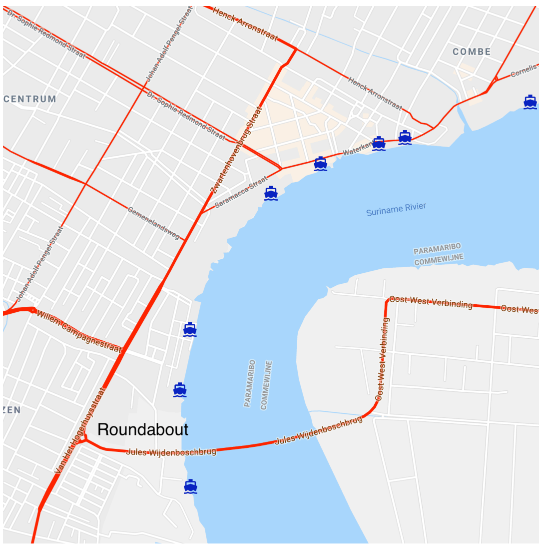
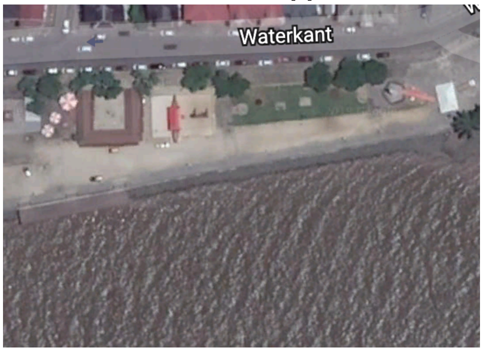
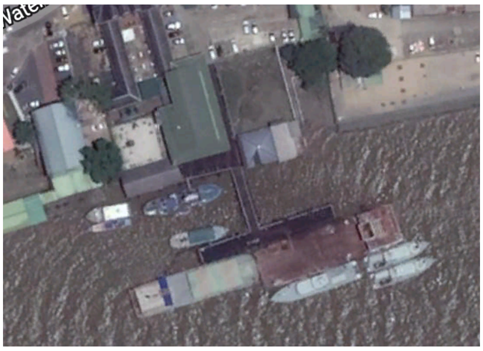
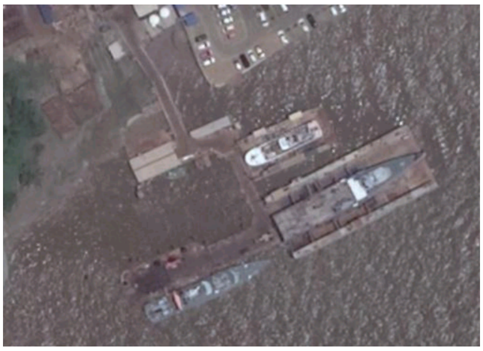


Figure 3.12: Road network in the city centre (adapted from Google (2019)). *Red: primary and secondary roads*

Locations where already a quay or pier exist, or where a sufficiently large piece of land is available are marked as a potential location for a cruise terminal nearby the city centre. These potential locations are marked in blue and shown in Figure 3.11. The road network in the city centre, together with these locations is displayed in Figure 3.12. The primary and secondary roads, in the figure shown in red, are already congested during a large part of the day. The lack of an efficient traffic light network and a relatively high percentage of people travelling by care are partial causes of this problem. This may be problematic for the accessibility of a terminal. Furthermore, the roundabout is increasingly becoming a bottleneck, since it is used by cars from all directions and trucks with their origin or destination at the harbour.

The current state of the locations is shown in table 3.4 and the locations are further discussed in chapter 5.

Table 3.4: Potential locations for a cruise terminal

1. Paranam  	**2. Nieuw Amsterdam** 
3. MAS 	**4. Waterkant/Marinetrappen** 
5. Maron Markt 	**6. SMS Pier** 
7. SDS Yard 	**8. Nieuwe Haven** 
9. Nieuwe Haven Zuid  	**10. Oil Terminal** 

3.3. Potential cruise ships operating near Paramaribo

3.3.1. Small ships definition

Since the technical characteristics of the port of Paramaribo are an important constraint in the handling of ships, this chapter investigates the availability of small ships that operate in the neighbour sees of the city in order to provide a clear overview of the opportunities to incorporate Paramaribo in existing itineraries.

Due to the relatively shallow ship route to the port of Paramaribo, major cruise ships will not able to reach the harbour. As a result, main focus for the cruise market should lie on specific features that are common with the characteristics of the small cruise concepts. Small cruise ships do have certain advantages above ships that are used for common cruise lines. The vessel is not the main attraction (and is not built with casino's, swimming pools or big theatres on board), but still offers private bedrooms, buffets and other premium services.

Small ships can go where big ships can't so that they can berth closer to city centres and are therefore easier to target for Paramaribo. They are better for the environment and offer more space and comfort attracting passengers that are interested in detailed exploration of destinations, willing to pay high amounts of money. High-quality services and offers are crucial both on ship and land-side. It must be considered that the on-land infrastructure must be developed in order to accommodate the high service expectation that is offered on-board. That means that the walking distance to the city centre is short or easy to find, the infrastructure is sufficient enough to prevent lines and delays and that the services, such as tourist information goods, first aid equipment and customs are good. In order to attract small cruise ships the technical facilities of the port, such as repair stations and process handling services (like waste or food supply), security services and energy supply facilities must be sufficient.

Since small ships do not have as much on-board entertainment as the major ships do, there exists an opportunity for the handling port to offer those services on land. On the other hand, it can be assumed that passengers did not chose for a major cruise ship are more interested in local details about the destinations they visit, so that opportunities exist about local excursions focused on history and culture. Since the culture of Paramaribo is a major attraction for tourists, it can be very advantageous to invest in on land offers and trips that outline these characteristics. Lastly, since small ships have limited space for big dining rooms, some passengers will want to go on land to dine at local restaurants or go to local pubs. However, some cruise operators will try to prevent passengers to eat on land because firstly it will increase risks of passenger sickness because of uncommon food and secondly operators miss income of on-board passenger expenditures. However, most small ships are ultra-luxurious so these opportunities are dependent on the ship design.

3.3.2. Possible vessel handling

Crucial for the cruise terminal design in the port of Paramaribo is the identification of potential ships that can be handled in terms of technical characteristics and passenger capacity. Overall, the average capacity of large cruise ships is 3000 guests and rising since the newest ships are becoming bigger. The average passenger capacity for ‘small’ and river cruise ships is around 250 passengers. Typically, the ship types can be categorised based on luxuriousness and size. Luxuriousness is related to the on-board services offered but also on the ratio crew versus passenger. The higher this ratio, the higher the luxuriousness. For simplicity the ship types are categorised into four kinds (Figure 3.13), small and very small ships are mostly very luxurious in terms of crew-passenger ratio, large and ultra large ships are more luxurious in terms of on-board facilities offered.

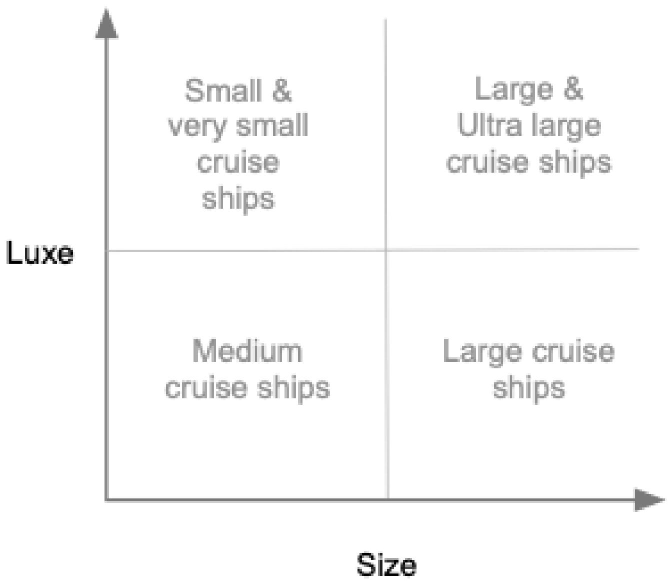


Figure 3.13: Matrix of size versus luxe cruise ships categories

Cruise ship size	Passengers
Very small	<100
Small (river)	100-450
Medium	451-1200
Large	1201-2500
Very large	2500-3500
Ultra large	>3501

Figure 3.14: Categorisation of small cruise ships

Due to the technical restrictions for the harbour of Paramaribo a review of the potential ships that can be handled is done. The cruise operators that incorporate destinations in the neighbour ports of Paramaribo are summed up in Table 3.5 below.

	Ship name	Capacity (pax)	LOA (m)	Beam (m)	Draft (m)
AZAMARA CLUB CRUISES	Pursuit	690	181	25,5	5,8
	Quest	690	181	25,5	5,8
CRUISE & MARITIME VOYAGES	Magallan	1250	176,5	22,6	6,1
HURTIGRUTEN	Fram	318	114	20,2	5,1
	MS Roald Amundsen	530	140	23,6	5,3
OCEANIA CRUISES	Insignia	684	181	25,5	6
	Marina	1250	181	25,5	5,8
	Sirena	684	181	25,5	5,8
PONANT	L'Austral	264	142,1	18	4,7
	Le Boreal	264	142,1	18	4,7
	Le Champlain	184	127	18	4,5
	Le Dumont d'Urville	184	127	18	4,5
	Le Lyrial	264	142,1	18	4,7
	Le Soleal	264	142,1	18	4,7
PRINCESS CRUISES	Pacific Princess	670	181	25,5	5,8
Regent SEVEN SEAS CRUISES	Seven Seas Mariner	700	216	28,8	6,8
	Seven Seas Navigator	490	174	24,8	6,8
	Seven Seas Voyager	700	206,5	28,8	7
SILVERSEA	Silver Cloud	254	155,8	21,4	5,3
	Silver Explorer	144	108	15,6	4,3
	Silver Galapagos	100	88,2	15,3	4
	Silver Shadow	388	186	24,8	6,1
	Silver Wind	298	155,8	21,4	5,3
SEABOURN	Quest	450	198	25,6	6,5
VIKING OCEAN CRUISES	Jupiter	930	277	28	6,3
	Sea	930	227	28,8	6,3
	Star	930	228	28,8	6,3
	Sun	930	227	28	6,3
WINDSTAR CRUISES	Star pride	212	133,8	19	5,2
Holland America Line	Amsterdam	1280	237	32,25	8,1
	Veendam	1340	210	31	7,7
	Volendam	1430	237	32,8	8,1
	Zaandam	1430	237	32,3	8

Table 3.5: Table of potential cruise ships cruising near Paramaribo

3.3.3. Preliminary selection of potential cruise ships and list of itineraries

Table 3.5 is a selection of cruise ships sailing near the coast of Suriname which can be handled according to their sizes and draft. Only 'medium' and 'small' vessels are selected for this analysis, based on a capacity between 450-1200 passengers. There are currently 33 ships worldwide operators by 12 cruise operators.

The boundaries for the usage of the port of Paramaribo are earlier concluded. Figure 3.15 shows an analysis of the draft versus the passenger capacity of cruise ships. Considering a tidal window, the target design vessel is set at a draught of 5.8 m. Section 7.1.2 will satisfy the required water depth in the navigation channel and in front of the berth.

CaSince the maximum draught is set at 5.8 meters, it can be easily concluded that most of the potential ships that are sailing nearby are able to sail to the cruise port. There are 18 ships able to enter the cruise port (operated by 7 operators).

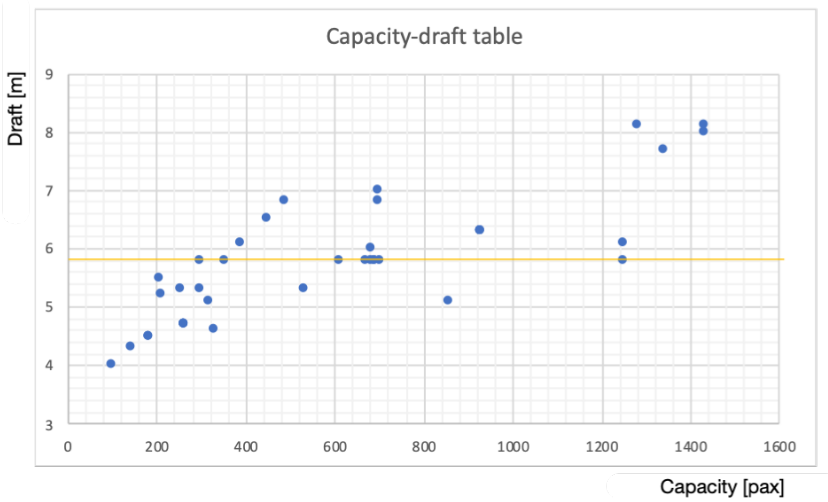


Figure 3.15: Graph of potential cruise ships cruising near Paramaribo

3.4. Actor analyse

Actors are those who have a certain interest in the system or have the ability to influence the system both directly and indirectly (Enserink, 2010). When designing a cruise terminal an actor analysis will help to formulate the criteria with which a cruise terminal must comply and their mutual importance, to be successful.

In Suriname it is hard to develop a correct and complete actor analysis. This is due to the constantly change in the structure of the ministries, the constantly disappearing of NGOs and the establishment of new NGOs, the overall power of the minister, the lack of adequate legislation and overall the lack of updated information that is available in general. The actor analysis made is based on the method described by Enserink (2010). A general problem is defined for which the actor analysis holds: 'How can the current cruise touristic sector be optimised to have a positive social economic impact on Paramaribo?'. Secondly an inventory is made on the actors involved, showing their interests, objectives and problem perceptions. From this inventory a formal chart is constructed and their interdependencies are depicted.

Overview of all the actors involved

A list of the most important and stable actors are given in Table 3.6, 3.7 and 3.8. A complete table showing their interests and objectives regarding the problem definition is shown in Appendix. This table also shows the existing situation in which a few cruise ships berth at the 'Nieuwe Haven' every year in relation with the objectives and the causes that could explain the gap between the objectives and the existing situation together with relating solutions.

Table 3.6: Overview government authorities concerning the cruise touristic sector.

Actors	Interests	Objectives	Existing situation	Causes	Possible solutions
Government authorities					
HI&T - Ministerie van Handel Industrie en Toerisme (Ministry of Trade, Industry and Tourism)	To create a sustainable and innovative economy.	To create a diversification of the economy by increasing the potential of the touristic sector by participating in the cruise market.	The cruises mooring Suriname are neglectable to influence the touristic sector, which is getting slightly bigger, but is still too small to create a diversification of the economy.	Suriname is not known by a lot of tourists and is not included in most cruise itineraries.	Branding Suriname at target tourists and at target cruise operators.
Ministerie van Arbeid (Ministry of Labour)	To create employment opportunities.	To create employment opportunities directly and indirectly derived from the cruise touristic sector.	The cruise touristic sector is too small and too inconsistent to create secure employment possibilities.	There are no stable facilities to receive boats.	Building cruise port facilities.
BuZa - Ministerie van Buitenlandse Zaken (Foreign affairs)	Support the national development, by having active interaction with other countries and international organizations.	To be in control and regulate passenger traffic in a structured manner, while also cruise tourists can enter Suriname.	Leaving the cruise to enter Suriname is for some tourists too complicated and time consuming. .	The legislations concerning passenger traffic is too complicated and too strict for cruise tourists.	Update the legislation concerning passenger traffic from cruises. Create cruise facilities to make passenger control more efficiënt.
OWT&C - Ministerie van Openbare werken, Transport & Communicatie (Ministry of Public works, Transport and Communication)	Develop, build and maintain public property to improve the quality of life in Suriname.	To have a structured layout of the city for the accessibility for everyone, including cruise tourists	It is complicated for the cruise tourists to reach the city centre or to walk around in the city centre. For the citizens of Paramaribo the cruise tourists increase the traffic congestion.	There are no suitable pavements or bikeroads. There is always a huge traffic congestion at the roundabout near the 'Niewe Haven'.	Restructure all the traffic in the city centre of Paramaribo, and include pavements and bikeroads. Relocate the cruise berth to a more suitable place.
MinOWC - Ministerie van Onderwijs, Wetenschap en Cultuur (Ministry of Education, Science and Culture)	To regulate the education system to play an important role in the development of Suriname and to preserve and protect the rich variety of cultural norms and values.	To have trained staff in the touristic, contributing to the development of the touristic sector in Suriname. To export the potential of the creative industry for the cruise tourists, while protecting the culture.	Suriname is not very costumer/tourism friendly. The creative industry is badly visible for the cruise tourists. The culture is protected from influences of the cruise tourism.	There is a shortage of suitable trained staff in the touristic sector. There are no facilities for the creative industry near the 'Nieuwe Haven' and only a few in general.	Increasing education possibilities concerning the touristic sector. Relocating the cruise port closer to the creative industry. Increase the creative industry possibilities in the city.
SHTTC (Suriname Hospitality and Tourism Training Centre)	Provide training and education for all employees and future employees in the hospitality and tourism sector.	To have a variety on educational possibilities to train the staff of the touristic sector, to become tourism friendly.	There are not enough trainings or education programs in the touristic sector.	There is not enough budget for the required programs in the touristic sector.	Increase the budget for educational possibilities concerning the touristic sector by the government.
SGES - Stichting gebouwd erfgoed Suriname (Suriname Built Heritage Foundation)	To preserve and protect the built heritage site of Paramaribo which is part of the UNESCO world heritage list.	To show the beauty of the built heritage site of Paramaribo to the tourists, while preserving it.	The potential of the built heritage site is not optimally used, to impress tourists. Some buildings are decaying.	Lack of budget from the citizens and the government for maintenance.	Start of a program to show how to make more profit out of renovated buildings.
STF - Suriname Tourism Foundation	Optimizing the tourism potential of Suriname and to contribute effectively to the country's national economy.	To increase the amount of tourists by the pariticipation of Suriname in the cruise market.	The cruise tourism sector is too small to significantly contribute to the amount of tourists in Suriname.	Suriname is not known by a lot of tourists and is not included in most cruise itineraries.	Branding Suriname at target tourists and at target cruise operators.

Table 3.7: Overview of companies concerning the cruise touristic sector.

Actors	Interests	Objectives	Existing situation	Causes	Possible solutions
Companies					
IDB - Inter-Americam development Bank	To make profit by providing loans, grant and technical assitance for countries working to reduce poverty and inequality.	Make profit from loans for improving cruise facilities which contributes to productivity and innovation in Suriname, and integrates with other projects financed by the IDB.	The cruise berth does not integrate with other projects financed by the IDB. The location interferes with the productivity of the cargo in the 'Nieuwe Haven'.	The location for the cruise berth is at the same location as for cargo transport.	Relocate the cruise berth to separate it from the cargo and to integrate it with the Paramaribo Urban Rehabilitation Programme financed by the IDB.
N.V. Havenbeheer (public L.L.C. Port Management)	Make profit, while managing the 'Nieuwe Haven' to stimulate economic activities in support of the national economy.	Have more ships in the Suriname river to keep the navigation channel open. Have a share in the participation of Suriname in the cruise market to make more profit.	The amount of cruise ships sailing to Suriname is very small. There is not much profit made by receiving cruise ships.	There are no cruise facilities at the 'Nieuwe Haven' and the passengers arrive on a port designed for cargo transport.	Redesign the 'Nieuwe Haven' where cargo and passenger transport is seperated and involves cruise facilities. Relocate the cruise port, while keeping N.V. Havenbeheer involved.
MAS - Martitieme Autoriteit Suriname (Maritime Authority Suriname)	To make profit, by initiating and facilitating maritime development.	To have enough ships sailing the Suriname river, to keep the navigation channel open and to make profit from navigating cruise ships.	There is a decrease in the amount of ships sailing the Suriname river, which causes river sedimentation.	The markets to sail to and from Suriname are dropping. The sedimentation of the river makes it harder for certain ships to sail the Suriname river, resulting in a circular problem.	Improving the cruise potential of Suriname will increase the amounts of ships sailing the Suriname river. Dredging.
Companies in the touristic sector (such as tour operators, catering industry, craftsman)	Make profit, by selling its product to tourists.	To broaden their target group, in which the cruise tourists have a significant share.	The cruise market is too unstable and too small to contribute to the target group of the companies in the touristic sector.	Suriname is not known by a lot of tourists and is not included in most cruise itineraries.	Branding Suriname at target tourists and at target cruise operators.
Cruise operators	Make profit, by selling its itineraries to the cruise tourists.	To have the possibility to add Suriname to their itineraries to be able to attract a new target group to expand and increase their market share.	Suriname is not added to many itineraries.	Mooring Suriname is technically hard due to the lack of cruise facilities and the shallow river.	Dredging of the Suriname river and its estuary. Building the facilities to moore the cruises.

Table 3.8: Overview of different interest groups, concerning the cruise touristic sector.

Actors	Interests	Objectives	Existing situation	Causes	Possible solutions
Local interest groups					
SHATA - Suriname Hospitality & Tourism Association	To promote the value of sustainable tourism in Suriname and jointly generate additional expenses from visitors for the public sector.	To generate significant expenses from cruise tourists for the private companies working in the touristic sector. To promote Suriname as a single holiday destination to a new market.	The cruise market is too unstable and too small to contribute to the target group of the companies in the touristic sector. There is no promotion of Suriname as a single holiday destination, when cruises do moore Suriname.	Suriname is not known by a lot of tourists and is not included in most cruise itineraries. The arrival of the ships is unpredictable and hard to prepare for.	Branding Suriname at target tourists and at target cruise operators. Improve communication between involved actors.
VSB - Vereniging Surinaams Bedrijfsleven (STIA - Suriname Trade and Industry Association)	Promoting the economic and social well-being of the Surinamese community, by operating in the private sector.	Create competitive entrepreneurship that produces high-quality goods and services directly and indirectly linked to the cruise tourists.	The cruise market is too unstable and too small to contribute to the target group of different companies in the touristic sector, or to generate a significant spin-off from the presence of the cruise tourists.	Suriname is not known by a lot of tourists and is not included in most cruise itineraries.	Branding Suriname at target tourists and at target cruise operators.
Non-organized interest groups					
Local residents	To be able to live in comfort.	To experience the advantages of the cruise market such as the economic opportunities, the increased investments in the infrastructure, the higher quality of hospitality and restail establishments.	The cruise market does not have an impact on the local residents.	The cruise market is too small and the ships berth too far away to influence the lives of the local residents.	Branding Suriname at target tourists and at target cruise operators. Develop a cruise port near the city centre.
Cruise tourists	To experience a relaxing holiday, while visiting a lot of different destinations.	To visit Suriname and experience its beauty in culture and nature in a comfortable way.	The first impression of Suriname when berthing at the 'Nieuwe Haven' is not positive. It takes uncomfortably long too pass the douanes and to reach the city centre. Walking through the city is chaotic.	The 'Nieuwe Haven' is not designed for passengers but for cargo. It is located in a chaotic part of Paramaribo in disrepair. The legislations concerning passenger traffic is very complicated and strict. The 'Nieuwe Haven' is located near a roundabout which experiences huge traffic congestion. The layout of the city is not built on pedestrians and pavements are missing often.	Restructure the traffic in the city centre of Paramaribo, include pavements. Relocate the cruise port to a more suitable place. Update the legislation concerning passenger traffic from cruises. Create a comfortable cruise terminal for structured crowd control.
Private property that has to be taken over	To be able to live in comfort or run a business smoothly	To benefit economically and socially from a potential buy out.	There is no private property in the way of receiving the cruise ships.	-	-

Formal chart

In the formal chart the most important formal relations between the different actors are mapped out. This chart is shown in Figure 3.16. The dashed boxes show a close relation ship between the actors within it. In some cases the actors between the dashed boxes even have the same relationships with other actors. This therefore simplifies the formal chart. One-directional arrows show an hierarchical relationship and two-directional arrows show a formal representative relationship or a collaboration (including a costumer relationship).

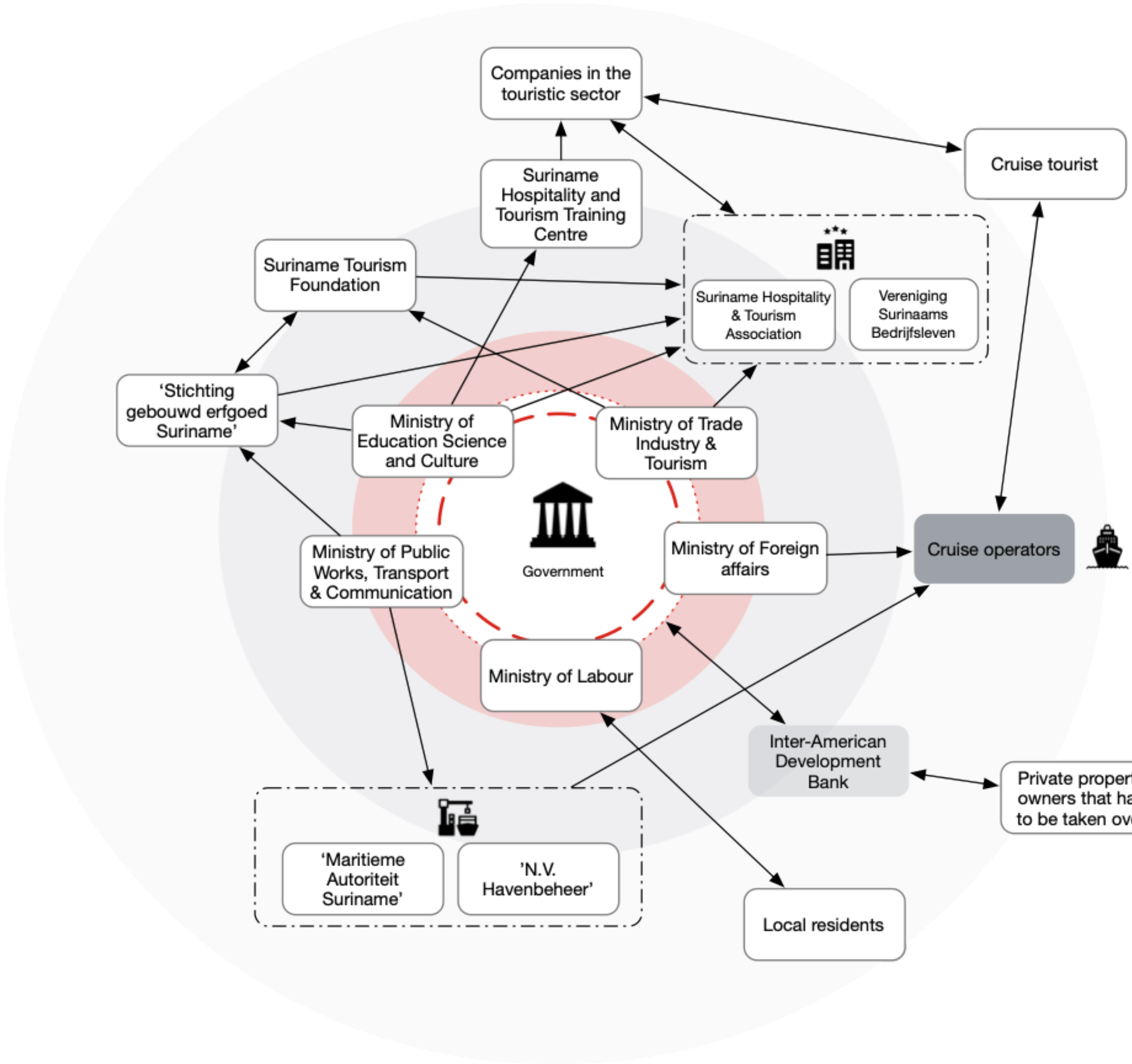


Figure 3.16: Formal chart of the important actors concerning the cruise touristic sector.

The government authorities are mainly responsible for the legislation. Since the political structure in Suriname is very hierarchical, the relationships with the other actors are mainly one-directional.The local residents can influence the government during the elections. Several governmental projects in Suriname are financed by the IDB. The IDB therefore also has a two-directional relationship with the government. In this formal chart the IDB is an example of an organisation that could finance the development of Suriname in the cruise market. They are also the once who have to find an agreement with owners of private property that has be taken over. This relationship is also two-directional. The governmental work forces as the STF, the SGES and the SHTTC and the semi-public organisations as N.V. Havenbeer and the MAS show these same characteristics as the government authorities.

The private companies such as the cruise operators and the companies in the touristic sector show a two-directional costumer relationship with the cruise tourists. The local interest groups such as the

VSB and the SHATA represent the companies in the touristic sector.

The informal relationships are harder to define but are still important. Most relationships shown in Figure 3.16 also have an informal character. Especially the relationships with the government, in which the connected actors also advice the government or inform the government about their interests and objectives. Some relationships are solely informal and are not shown yet in Figure 3.16. An example is the informal relationship between the STF and the cruise operators and the cruise tourists. The STF promotes Suriname towards these actors and it collects data from the cruise operators and cruise tourists arriving in Suriname. The cruise operators also have a lot of informal relationships. Their vision will influence the decisions of the governmental authorities, the semi-public and the public companies in an informal manner. If Suriname wants to engage the cruise market, they will have to meet the wishes of the cruise operators.

Power and interest of actors

The interdependencies of the actors are shown in a power/interest matrix. This matrix gives in insight in how different actors should be treated regarding the problem definition: 'How can the current cruise touristic sector be optimised to have a positive social economic impact on Paramaribo?'. The amount of power is based on the important resources that an actor has to realise a change in the current cruise touristic sector. The interests are based on the impact that a change in the cruise touristic sector can have on the actor. The power/interest matrix is shown in Figure 3.17.

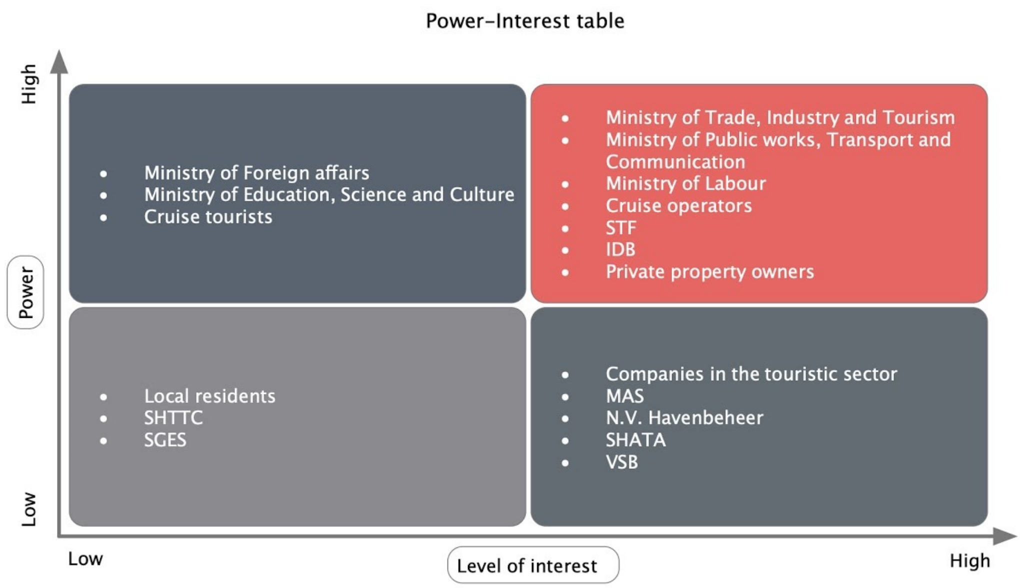


Figure 3.17: Power/interest matrix concerning the cruise touristic sector

There are four groups in general that can be related to the power/interest matrix (Bryson, 2004).

- **Crowd**: Has low interest and low power. Has minimal effect but can provide information that is valuable to make decisions.
- **Subjects**: Have high level of interest but lack of power. This actor group needs to be informed.
- **Context setters**: Have high power but a low interest. They should be kept satisfied.
- **Key players**: Have a high level of power and interest. These are the critical players and have to be taken along in the process.

4
Design Problem Definition

This chapter gives a definition of the design problem. The first section contains a problem definition, where the design objective, constrains and requirements are described. The design criteria and weighing factors are defined in the second section. Lastly, a morphological chart is given with all design options from the analysis.

4.1. Problem Definition

The objective of the design phase is to determine the most optimal design for a cruise ship terminal in Paramaribo, considering both technical and social economical aspects. Constraints and requirements for this design are determined, based on the analysis. These constrains and requirements define the boundary conditions for the design alternatives. An overview of the constraints, (non) functional requirements, starting points and assumptions is given below.

Constraints

- The design must have a mooring place for cruise ships.
- The design must have facilities to handle tourists.
- The design must have facilities to handle cruise ships.
- The design must have connections to touristic destinations.

Functional requirements

- The design should provide in the tourists needs.
- The design should be able to handle cruise ships.

Non-functional requirements

- The design should be attractive to tourists.
- The design should have a beneficial cost/benefit ratio.
- The design should be a catalyst for the development of Suriname.
- The design should not be an obstacle for regular shipping. traffic.
- The design should not aggravate road congestion.

Boundary Conditions

- The soil consist mostly out of slightly sandy clay mixtures with low bearing capacities.
- The average significant wave height is equal to 1.5 m in front of the coast.
- The tidal range at the river entrance is equal to 2.3 m with MLWS equal to 0.3 m above CD.
- The tidal range along Paramaribo is also equal to 2.3 m with a MLWS equal to 0.4 m above CD.

Starting points

- The dredging works as mentioned in section 2.3.2 are completed, so the Nominal Nautical Bottom Level (NNBL) is CD - 5.50 m.
- Tug assistance is provided.
- Each fender unit must be capable of absorbing the full impact energy since ships almost always contact only one fender on the first impact.
- The elevation of the mud and clay flats of the Young Coastal Plain are not taken into account. Their potential restrictions on the water depth are a major problem and therefore should the corresponding solution be out of an integral approach.
- Bed protection will be used to prevent local erosion if needed.
- The cruise ships will only sail during moderate conditions as specified below.
- SLR is not taken into account for the nautical channel depth after the planned dredging activities.

Assumptions

- The hull capacity of the cruise ship is sufficient to withstand the berthing impact.
- Ship-induced waves are not normative.
- Maximum wave overtopping is a non-limiting factor.
- A constant water level rise of 0.20 m in 2100 along the river banks of Paramaribo due to SLR.
- Rainfall and temperature (differences) will not affect the design specifications.
- During moderate conditions, maximum current velocities of 0.5 m/s occur at the river entrance.
- During moderate conditions, maximum wind velocities of 1.5 m/s occur inland.
- During moderate conditions, maximum wind velocities of 5.0 m/s occur at the river entrance.

4.2. Design Criteria

4.2.1. Criteria Specification

Based on the information learned about actors and technical insights, general design criteria have been determined. The design alternatives will be evaluated on these criteria, which leads to the most optimal design.

Attractiveness

- **Aesthetics terminal surroundings**
  The aesthetics of the terminal and it surroundings are of great importance for the experience of the tourist.
- **Sailing route**
  A cruise ship sails on different routes to the potential cruise terminal locations. The sailing route is an important factor for the first impression of the country.
- **Facilities**
  The facilities for handling tourists as well as handling cruise ships available at cruise terminals differ. Proper facilities lead to a comfortable experience for the tourist and a greater potential for sustainable development of the cruise market.

Accessibility

- **Touristic sights**
  A cruise ship is only for six to twelve hours in a country. Tourists should get the opportunity to see as much of the country as possible. Therefore, it is important that touristic sights can be reached within a foreseeable time.
- **Land**
  The road network in Paramaribo is congested for a large part of the day and the streets are not designed to be suited for many cyclists and pedestrians. This should be taken into account for a potential cruise terminal location.
- **Water**
  Most of the potential cruise terminal locations are positioned near the Port of Suriname and near the main sailing route. Cruise ships may not become an obstacle for regular shipping traffic.

Financial

- **Cost/Benefit indication**
  The ratio of costs and benefits is very important for the feasibility of a cruise terminal. As explained in the introduction, the financial evaluation of the project is limited to an order of magnitude estimate for the building costs and an estimate of the benefits for Suriname. The ratio of these values is used to give an indication of the cost/benefit ratio.

Complexity

- **Social resistance**
  The construction of a cruise terminal near residential areas and recreational areas will lead to social resistance from residents and entrepreneurs in the area. The cruise terminal will potentially also change the view of the city centre. The social resistance must be taken into account when determining the feasibility of a project.
- **Structural design**
  Another factor that determines the feasibility of a project is the level of technical complexity. The design should meets the requirements while limiting the complexity of the structural design.

Indirect Benefits

- **Employment**
  A cruise terminal will lead not only to jobs for handling cruise ships and tourists, but it also leads

indirectly to more jobs in the tourism sector. The cruise tourists will buy handy craft in the city centre and the tour sector will grow.

- **Infrastructure**
  The cruise terminal needs to be accessible and can also serve as a bus hub for example. This means that the infrastructure around the terminal needs to be improved.
- **Quality of Life**
  The quality of life can also be improved. The arrival of cruise tourists will create an incentive for the government to guarantee a safe and inviting environment in Paramaribo.
- **Growth Potential**
  A growing cruise market will create opportunities for area development near the cruise terminal. Hotels and shopping malls will improve the local economy.
- **Tourism**
  Tourism is an important source of income for Suriname and the government wants to strengthen the tourism sector. A cruise terminal can contribute to sustainable tourism.

4.2.2. Criteria Weighting

Because not all criteria are equally important, weighting criteria are determined. Weighting factors are determined for the five most important actors, as identified in the power-interest matrix. These actors are the government, the cruise operators, the STF, the IDB and the private property owners. A total of 10 points is divided over the criteria and the average score for each criterion is used for the evaluation of alternatives. The scores are based on interviews with experts, the analysis and the experience of the project group.

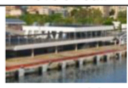
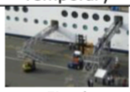
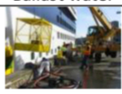
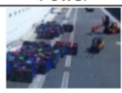
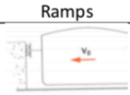
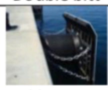
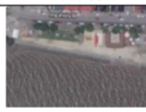
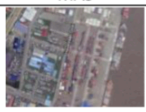
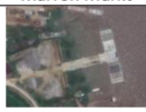
Table 4.1: Weighing factors for design criteria

	Government	Operators	STF	IDB	PP Owners	Average
Attractiveness						
Aesthetics	1,3	2	1,8	1	0,9	1,4
Sailing route	0,3	0,6	0,6	0,4	0,1	0,4
Facilities	0,5	2	1,5	0,8	0,2	1
Accessibility						
Touristic sights	0,6	0,8	1	0,8	0,8	0,8
Land	0,9	1,3	1	1,1	0,7	1
Water	0,2	0,4	0,1	0,1	0,2	0,2
Financial						
Cost/benefit ratio	2,4	1,7	1,8	2,6	1,5	2
Complexity						
Social resistance	1,1	0,2	0,2	1	2,5	1
Structural design	0,8	0,2	0,1	0,7	0,2	0,4
Indirect benefits						
Employment	0,3	0,1	0,2	0,2	0,2	0,2
Infrastructure	0,5	0,1	0,2	0,5	0,7	0,4
Quality of Life	0,6	0,2	0,4	0,6	1,2	0,6
Growth Potential	0,3	0,3	0,7	0,1	0,6	0,4
Tourism	0,2	0,1	0,4	0,1	0,2	0,2

4.3. Morphological Chart

All design options as result of the analysis part are shown in the morphological chart (see table 4.2). The PIANC guidelines (MarCom, 2016) are used to complete the overview of design options. The design alternatives in the next chapter will be based on these design options.

Table 4.2: Morphological Chart. Sources images: (MarCom, 2016) note 1, (Shibata Fender Team, 2019) note 2, (Google, 2019) note 3

Function	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6
Type port	Home port	Port of call	Interporting			
Type building[1]	 Temporary	 Convertible	 Purpose-built	 Mixed-use		
Gangway[1]	 Fixed	 Fixed telescoping	 Mobile adjustable			
Utilities	Food	Water	Communication	Bunkering	Oily wastes	Sewage
	Garbage	Ballast water	Power			
Luggage operations[1]	 Ramps	 Cranes	 Forklifts			
Quay structure[2]	 Solid	 Partly closed	 Open pile			
Mooring system[1]	 Single bitt	 Double bitt	 T-Head	 Stagehorn	 Kidney	 Cleats
Fender[1]	 Foam filled	 Buckling panel	 Stand-off barges			
Touristic sights	Plantations	Fort New Amst.	Fort Zeelandia	Palmentuin	Eco Tours	Sunny Beach
	Zoo	Waterkant	Maritage mall	Turtles		
Location[3]	 Paranam	 NieuwAmsterdam	 MAS	 Waterkant	 Marron Markt	
	 SMS Pier	 SDS Yard	 Nieuwe Haven	 NieuweHavenZuid	 Oil Terminal	
Connections	Public Traffic	Tour busses	Taxi's	Shuttle busses	Parking lots	Kiss & Ride
Urban functions	Stores	Park	Square	Market	ConventionCenter	Theater
	Event Center	Bus hub				

5 Conceptual Design

In this chapter a description of three design alternatives will be given. A first elaboration of the locations mentioned below is already given in Section 3.2.2. To be able to compare the different alternatives qualitatively, they are roughly analysed.

The starting point is the 'Nieuwe Haven', where currently cruise ships get the possibility to berth. The Nieuwe Haven is also called the Dr. Jules Sedney Terminal. This is a cargo terminal without any facilities designed for the arrival of cruise ships. Only a few ships per year berth here, which takes quite some preparations.

The first design alternative will be a small scale alternative integrated with the 'SMS Pier' along the 'Waterkant'. A new mooring facility for cruise ships will replace the SMS Pier itself for cruise ships of the 'Boreal-Class' with a length of 142.1 m and suites for 264 passengers. The second design alternative will be located at the Nieuwe Haven Zuid, which will be an expansion of the current Nieuwe Haven. The quay will be extended and cruise facilities will be built. The cruise terminal will be designed for up to 600 pax. The third and most comprehensive cruise terminal design alternative is located at the 'Marron Markt' and is designed for vessels up to 600 pax.

5.1. Alternative 0: Dr. Jules Sedney Terminal

Location

The route from the estuary of the Suriname River towards the Nieuwe Haven Zuid shows a combination of ecological and cultural qualities of Suriname, together with a chaotic decaying part of Paramaribo. The Nieuwe Haven is a cargo and container terminal with an industrial appearance. It lies next to the Jules Wijdenbosch bridge, which structure height is very special and imposant.

Accessibility

Main traffic from the 'Nieuwe Haven' is using the entrance at the 'Havenlaan Zuid' and 'Havenlaan West' and consist of (heavy) container or liquid trucks. This road is directly connected to the corridor 'van het Hogerhuysstraat'. The port area is widespread and at the main office of the port there are big parking facilities, offering a capacity of about 200 cars. Near this parking spot there are several (private) parking facilities available with a larger capacity. All parking facilities are currently in use and there is no possibility for expansion.

The 'Havenlaan Zuid' is a two-way one-lane street separated with a roadside. The street has a wide lay-out but does not offer specific walkways for pedestrians. This street is only used for destination traffic. A traffic light at the end regulates the cross-way 'Havenlaan West-van het Hogerhuysstraat-Willem Campagnestraat'.

The location of different tourist sights are discussed in the analysis. A list of these sights is shown in Appendix H. The sights in the inner city can be reached by bus or taxi. Due to the current congestion on the road towards the inner city, this can take some time. The tourist sights in the other parts of the city and the country can also be reached by bus or taxi. As mentioned before there is a good connection to

Figure 5.1: Zero alternative - Nieuwe Haven

these sites from the Nieuwe Haven Zuid. Dependent on the congestion travelling towards these sites could still take some time.

Vessel utilities

The 'zero-option' uses facilities that are already in place for the cargo-handling. Other facilities are created temporarily. Potable water for example is pumped out of a temporarily placed truck. Sewage, oily waste and garbage facilities are not present but were not required in the past. Power, bunkering and communication systems from the cargo area could be used.

Berth

The existing quay of the 'Nieuwe Haven' (600 m) occasionally handles cruise ships. Therefore, the berths will partly be used in case of a cruise ship mooring and limit the cargo capacity. The minimum water depth is around 7.2 m below Chart Datum along the quay. The size of the occasionally arriving cruise ships of 250 passengers, with a draugth of only 4.9 m, can therefore increase after the planned dredging activities of the navigation channel, see Section 2.3.2.

Navigability

Nieuwe Haven is positioned north to the Jules Wijdenboschbrug. The route of vessels passing the bridge should be considered during navigation, because the distance to the sailing route is small. The depth of the river is at least 7,3 meter in the current situation (MAS, 2016).

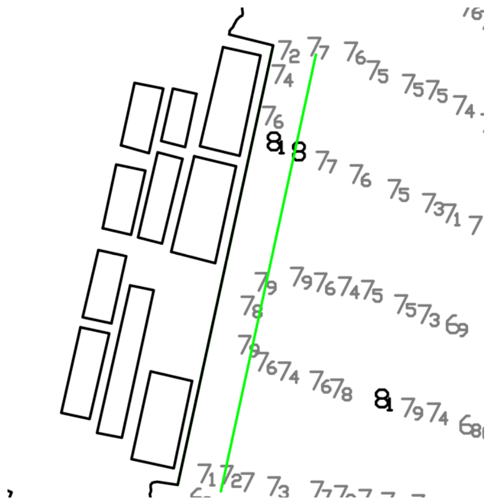


Figure 5.2: Depth of the river around Nieuwe Haven (MAS, 2016)

Costs & Revenues

The 0 alternative will not need any investments for new facilities or for a new quay, but if a ship arrives it costs a lot to organise its arrival. Since the Nieuwe Haven is a cargo terminal a lot of measures have to be taken to separate the passengers from the cargo, to guarantee safety, to set up improvised facilities and to provide enough transportation. This costs a lot and results in an uncomfortable arrival for the passengers. This causes a less profitable situation for Suriname. A lot of cruise passengers stay on board and less cruise passengers will promote Suriname as a holiday destination. Also less cruise ship operators will want to berth in Suriname.

5.2. Alternative 1: SMS Pier

Location

The route from the estuary of the Suriname River towards the 'SMS Pier' shows a combination of ecological and cultural qualities of Suriname. The SMS Pier itself is part of the historic inner city of Paramaribo (Appendix H.4) which is on the UNESCO World Heritage List. The area contains most tourist sights relevant for cruise tourist, as shown in Appendix H.1. The SMS Pier is located at the 'Waterkant', a street surrounded by characteristic Suriname architecture. The SMS Pier and the surrounding area are currently facilitating many restaurants and bars like De Waag, Riverside and Migos. Moreover, on the first sight a vacant property for a terminal building and a relatively small parking area are already located here. The restaurants and bars will be preserved and some additional deferred maintenance should be done.

Figure 5.3: Impression Waterkant from UNESCO World Heritage Sites

Accessibility

The terminal location of the SMS Pier is connected to a parking area. This area is currently separated from the public road with a fence and can be entered via one entrance where a movable gate is placed which can be opened and closed. The parking space is about 1200 m^2 and has a capacity of about 50 personal vehicles. There is limited potential to expand this area because of the situated buildings. The parking entrance is directly connected to the Waterkant, a two-way two-lane street with a length of approximately 2 km parallel to the coast line.

The historic inner city containing most tourist sights is within walking distance from the SMS Pier. The Waterkant road can be considered as the southern part of the traffic ring of the city and is intensively used by car, bus and truck traffic, which makes it an important part of the road network of Paramaribo. The exit of the parking lot is located near a conjunction with the Keizerstraat (two-way one-lane street with a north-east situation) and the Waterkant. The nearest bus station is located at the 'Knuffelsgracht' which is a 5-minute walk from the SMS Pier. Many public bus lines depart from this location. There are currently quite broad walking pavements available.

Vessel utilities

Since the SMS Pier alternative is positioned in a densely build area, expansion for vessel utilities is difficult. Provision facilities are not available. Also because of the risks for i.e. fire explosions bunkering facilities and high power stations for vessels are not advised. That also counts for oily wastes and other sewage. Garbage, waste water and oily waste cannot be stored at the location because of the potential risks for bacteria developments.

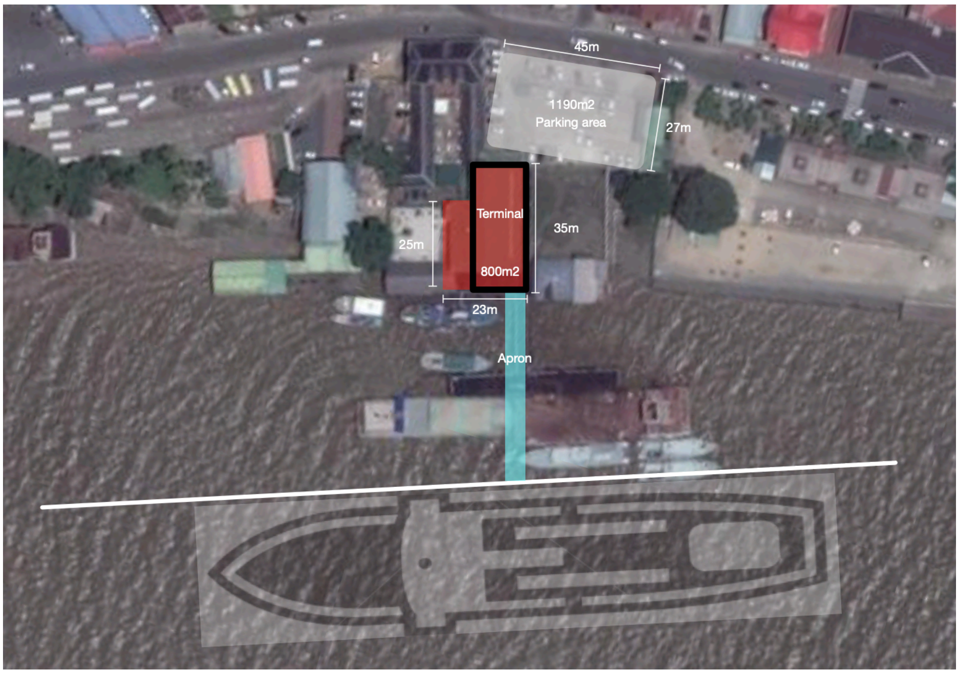


Figure 5.4: Design Alternative 1 - SMS Pier

Berth

A new mooring facility for cruise ships of the 'Boreal-Class' with a length of 142.1 m will be included in the design. A jetty of 155 m will be constructed, see Figure 5.4. The water depth is around 8.8 m below Chart Datum along the 'SMS Pier'.

Navigability

The SMS Pier is located in the deeper part of the river. The minimum depth is 6.4 m, as can be seen in Figure 5.5. It does not cross one of the sailing routes and the space required for manoeuvring as defined in Appendix A is available.

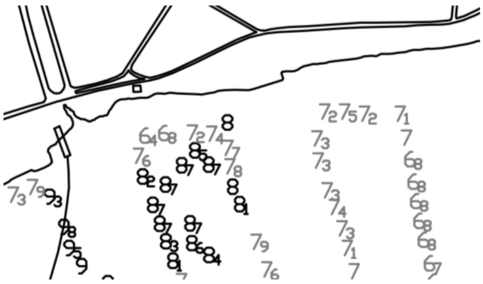


Figure 5.5: Depth of the river around SMS pier (MAS, 2016)

Costs & Revenues

A rough and qualitative indication of costs and benefits is given. Considering a small scale alternative, with a vacant property for a terminal building and an already available small parking area, some costs will be saved. Therefore, the investment costs will be manageable, despite the construction of a new jetty. The restaurants and bars will be preserved and some additional deferred maintenance should be done. The Boreal-Class ships are only up to 260 passengers and therefore the total expenditures per visit will be limited, knowing that the draught of the cruise ships can be larger.

5.3. Alternative 2: Nieuwe Haven Zuid

Location

The route from the estuary of the Suriname River towards the Nieuwe Haven Zuid shows a combination of ecological and cultural qualities of Suriname, together with a chaotic decaying part of Paramaribo. The Nieuwe Haven Zuid will be part of the Nieuwe Haven. Therefore the route towards the terminal will be the same as the route towards the 0 alternative. Also the location will be quite similar. The difference is found in the industrial appearance of the location. With the building of a modern cruise terminal containing comfortable facilities the appearance will become a bit more luxurious.

Figure 5.6: Design Alternative 2 - 'Nieuwe Haven' Zuid

Accessibility

Since the location Nieuwe Haven Zuid is a currently unused area, there is no direct connection with the existing infrastructure and the site, including a lack of connection with public transport. The closest road available is unnamed but has asphalt pavement until a certain point which can be used as an entrance in the design. The road is a two-way one-lane street where some cars are parked on the side, has a north-east position and has no walkways. This road is currently used for cargo traffic that is using the secondary entrance of the port. The primary entrance is located more north at the 'Havenlaan Zuid'.

The unnamed road is connected to the 'van Het Hogerhuysstraat', which is considered as a main corridor road for the entire city for all traffic coming from the south. That road is also for any traffic going to the airport and any (cargo) traffic and trucks that serve the main port and is used for traffic that is coming from the 'Jules Wijdenboschbrug', connecting the eastern part across the water with the centre of Paramaribo. It is known that this bridge is congested every day. Authorities tried to minimise delays and prohibit the usage of trucks during special times of the days (9.00-12.00 AM) because the trucks often do not have the power to reach to the top of the bridge, resulting in standstill blockages. Because of the traffic intense area, there are traffic lights used at the conjunction ‘van het Hogerhuysstraat-Willem Campagnestraat’.

Directly west of the site a road exists which starts at the port and is located parallel to the coastal line. This road is closed for public traffic since it only can be used for trucks serving the port. The infrastructure on the north is mainly designated for port industry use. Currently, there are no specified parking facilities, only some next to the connecting road. Going south, the road ends at the ‘Mangrovestraat’. This road is unpaved and has no walking facilities whatsoever. The connection to the tourist sights is the same as for the 0 alternative.

This location has great growth potential for the public transport network because of its geographic position near the highway. When, for example, the cruise terminal is designed for other purposes instead of only handling cruise passengers, its value could be improved. One possibility is the creation of a bus-hub. Busses lines may can depart from the terminal and could directly transport passengers to the city. These bus lines doesn’t even have to be public, because the location offers great opportunities for bus operators to park and store their busses. Secondly, with the operation of a direct connection between the airport and the bus hub, this terminal could function as a main and easy to use entry of passengers coming from the airport as well. From the bus terminal, facilities could be used for picking up passengers by taxi’s or transferring to the public transport network of Paramaribo, immediately reducing congestion at the highways cause by airport passengers and keeping the passengers out of the centre could lead to discharges of travelling passengers in the city centre. The stimulation of the usage of public transport for passengers and inhabitants could help to reduce the major congestion currently present in the city. Introducing the cruise terminal as a main public transport hub, connecting the city with the airport and offering bus lines to the city and across the river may have greater potentials for investments other than only those who are interested in cruise market.

Vessel utilities

Since the main port is located near this location, some vessel utilities are already present and could be shared and used from the port. Some utilities, like potable water and garbage, are not sufficient enough for cruise passenger purposes. On the other hand, bunkering, oily waste, communication, sewage and ballast water can all be handled with facilities that are in place (or near) already.

Berth

An extension of the already existing quay of the ’Nieuwe Haven’ will be constructed for cruise ships of the ’R-Class’ with a length of 181.0 m. The structure will be extended with 80 m, see Figure 5.6. The extension is only 80 m long, due to the limited area available in possession of ’NV Havenbeheer’. Therefore, the current berths will partly be used in case of a cruise ship mooring and limit the cargo capacity. The water depth is around 5.8 m below Chart Datum along the south-side of the current quay. The design vessel of 600 pax has a draugth of 5.8 m, resulting in a required water depth of 7.25 m, see Appendix A. Therefore, dredging activities will need to be applied.

Navigability

Nieuwe Haven Zuid is positioned north to the Jules Wijdenboschbrug, on the sailing route of vessels passing the bridge. The location is next to the Port of Suriname, so the cruise ships need to consider the container vessels sailing in the same area. This is especially important during manoeuvring. The depth of the rivier is at least 7,3 meter (MAS, 2016).

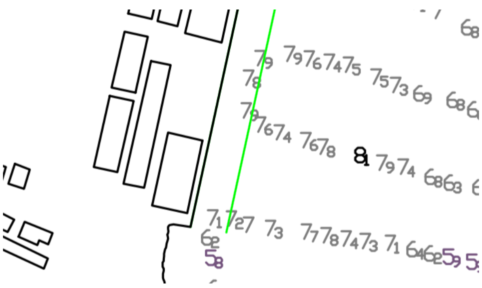


Figure 5.7: Depth of the river around Nieuwe Haven Zuid (MAS, 2016)

Costs & Revenues

The construction of the cruise port at this location will be relatively not expensive, since the existing quay wall is extended and only a building has to be built. The revenues will be increased compared to the current situation, since more services will be offered. The cruise operators will have to pay for these services.

5.4. Alternative 3: Marron Markt

Location

The route from the estuary of the Suriname River towards the Marron Markt is the same as towards the SMS pier. The Marron Markt is located next to the Historic Inner City of Paramaribo on the UNESCO World Heritage List. However, there are plans to expand this region, including the part of the Marron Markt. This proposed expansion is shown in Appendix H. As well as the SMS pier the Marron Markt lies on the 'Waterkant'. The surroundings are now somewhat chaotic but its rehabilitation is part of the first phase of the Paramaribo Urban Rehabilitation Program.

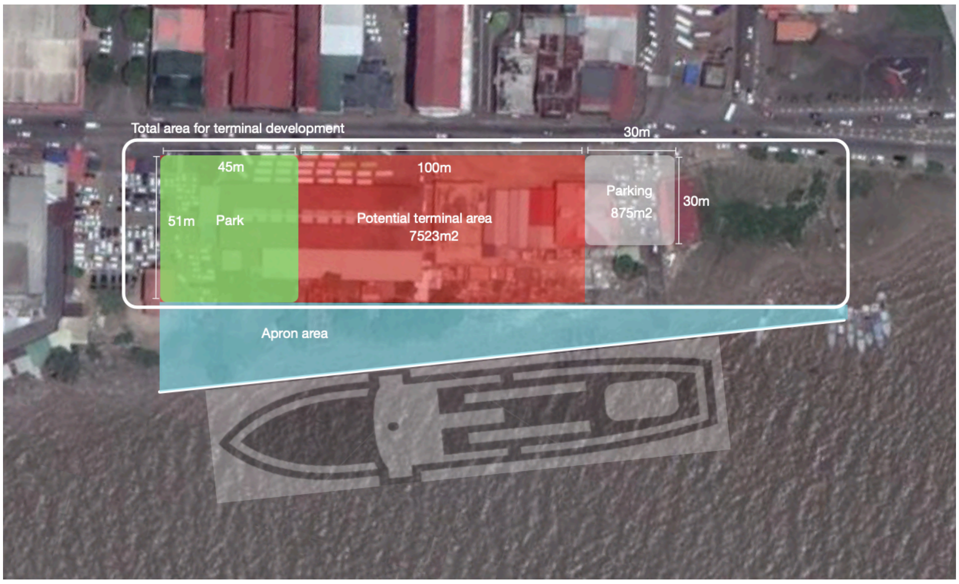


Figure 5.8: Design Alternative 3 - Marron Markt

Accessibility

The network connectivity of the Marron Market alternative is somewhat similar with that of the first alternative (SMS-pier) since it is also located at the 'Waterkant' road. This alternative is located more to the west, at the conjunction 'Heiligersweg/Knuffelsgracht-Waterkant'. The earlier described bus station is located even more close to the site (about 3-minute walk). Traffic from the 'Watermolen Straat' and the 'Waterkant' from the east, and the 'Heiligersweg' north comes together at this junction, making it a crucial node in the infrastructure network. The walking facilities to safely cross the road are not present yet, but there are plans to reconstruct the Waterkant in which case these facilities will be built. In that case the tourist sights in the historic inner city are again within walking distance.

In the current design, there are no designated parking facilities for private vehicles. However, some space is used for car parking with an estimating capacity of about 30 vehicles. The open space (of about 7500 m^2) could include a potentially large circulation area to accommodate arriving and departing pedestrians and traffic. It also has a great potential for expansion in the east, since there is already a parking lot that is used. The area in front of the Marron Market is currently designated for the parking of about 40 public busses. It is not known if the busses are accessible for travellers from that location as well.

Vessel utilities

The Marron Market's location is comparable with the SMS-pier alternative. However, the surface area of the Marron Market is expected to be larger and more open. One result could be that there becomes more space available for the building of handling facilities and storage areas such as potable water. However, oily wastes, bunkering facilities, sewage, ballast water and other dangerous storage should be prevented for local safety. Power and communication systems have potential to be designed in the large area.

Since the Marron market alternative is positioned in a dense build area, expansion for vessel utilities is difficult. Provision facilities are not available. Also because of the risks for fire explosions bunkering facilities and high power stations for vessels are not advised. That also counts for oily wastes and other sewage. Garbage, waste water and oily waste cannot be stored at the location because of the potential risks for bacteria developments.

Berth

A quay wall for cruise ships of the 'R-Class' with a length of 181.0 m will be included in the design in order to accommodate vessel provisioning. A sheet pile wall of 200 m will be constructed, see Figure 5.8. The water depth is, within a reach of 20 m, around 7.3 m below Chart Datum. Therefore, a sheet pile wall with anchors of more than 20 m is well executable as mooring structure and soil retaining structure. The design vessel of 600 pax has a draugth of 5.8 m, resulting in a required water depth of 7.25 m, see Appendix A.

Navigability

The Marron Markt is positioned close to the sailing route of vessels passing the bridge. There is enough space for manoeuvring. However, since regular shipping traffic may cross the manoeuvring area, careful coordination is required. The minimum depth of the river is 5,8 m (MAS, 2016).

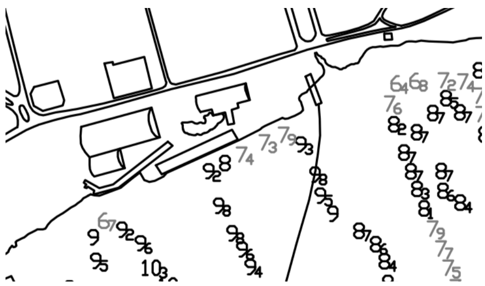


Figure 5.9: Depth of the river around Marron Markt (MAS, 2016)

Costs & Revenues

The construction and operation costs of this alternative will be high, since the design includes a new quay, a terminal building, ground transportation area and a square. The terminal won't be used every day for cruise tourism and the square will not lead to direct benefits. However, the direct and indirect benefits will be relatively high, since many services can be offered to cruise operators and the terminal will have a positive impact on the living environment and local economy.

6
Evaluation Design Alternatives

Figure 6.1 presents the Multi Criteria Analysis (MCA). The evaluation of the criteria, scored qualitative, is mentioned in the sections below. The temporary facilities located at the Dr. Jules Sedney Terminal (alt. 0) scores average for all criteria and serves as reference.

	Nieuwe Haven	SMS Pier	Nieuwe Haven Zuid	Marron Markt
Criteria	Alt. 0	Alt. 1	Alt. 2	Alt. 3
Attractiveness				
- Aesthetics Surrounding Area	0	+++	+	+++
- Sailing Route	0	+++	0	+++
- Facilities	0	++	+++	+++
Accessibility				
- Touristic Sights	0	+++	0	++
- Land	0	+++	+	+++
- Water	0	++	-	++
Cost-Benefit Indication	0	-	+	++
Complexity				
- Social Resistance	0	--	++	--
- Structural Design	0	--	--	--
Indirect Benefits				
- Employment	0	+	++	+++
- Infrastructure	0	+	+++	++
- Liveability	0	++	++	+++
- Growth potential	0	+	+++	+++
- Tourism	0	+	++	+++
	0	**+**	**+**	**++**

Figure 6.1: Multi Criteria Analysis, qualitative scores

To gain insight into the qualitative scores, the scores are converted into quantitative scores, see Figure 6.2. The total scores for the alternatives are calculated by the sum of the scores multiplied with the corresponding weighting factors for the different criteria. Design alternative 3 'Marron Markt' is the best rated alternative with a score of 19.60 out of 30.0.

Criteria	Weighting Factor	Nieuwe Haven Alt. 0	SMS Pier Alt. 1	Nieuwe Haven Zuid Alt. 2	Marron Markt Alt. 3
Attractiveness (2.8)					
- Aesthetics Surrounding Area	1.4	0	3	1	3
- Sailing Route	0.4	0	3	0	3
- Facilities	1.0	0	2	3	3
Accessibility (2.0)					
- Touristic Sights	0.8	0	3	0	2
- Land	1.0	0	3	1	3
- Water	0.2	0	2	-1	2
Cost-Benefit Indication (2.0)		0	-1	1	2
Complexity (1.4)					
- Social Resistance	1.0	0	-2	2	-2
- Structural Design	0.4	0	-2	-2	-2
Indirect Benefits (1.8)					
- Employment	0.2	0	1	2	3
- Infrastructure	0.4	0	1	3	2
- Liveability	0.6	0	2	2	3
- Growth potential	0.4	0	1	3	3
- Tourism	0.2	0	1	2	3
	10.0	**0.0/30.0**	**10.8/30.0**	**12.8/30.0**	**19.60/30.0**

Figure 6.2: Multi Criteria Analysis, quantitative converted scores

6.1. Attractiveness

Aesthetics Surrounding Area

As discussed before is the 'SMS Pier' part of the historic inner city of Paramaribo. Therefore it scores the highest for the aesthetics of the surrounding area. The Marron Markt is located a bit further where it is nowadays somewhat chaotic, but after the first phase of the Paramaribo Urban Rehabilitation Program it will be connected with the historic inner city of Paramaribo as well as the 'SMS Pier'. It therefore scores a bit less. The Surrounding Area of the 'Nieuwe Haven Zuid' is almost the same as the 'Nieuwe Haven'. There will be space to upgrade the surrounding area a little bit, apart from the cargo and therefore it scores a bit higher.

Sailing Route

The sailing route from the estuary of the Suriname River towards the 'SMS Pier' and the 'Marron Markt' is the same. It shows a beautiful combination of ecological and cultural qualities of Suriname. Towards the 'Nieuwe Haven' and the 'Nieuwe Haven Zuid' the view becomes less attractive. Since their sailing route is the same they both score average.

Facilities

At the 'SMS Pier' the present building will be used to establish the most important facilities. At the 'Marron Markt' and at the 'Nieuwe Haven Zuid' a new building will be placed especially designed for the arrival of cruise ships. These locations have more space and the facilities will have more comfort and will look more luxurious. The last two alternatives will therefore score higher.

6.2. Accessibility

Tourist Sights

The 'SMS Pier' is located closest to most tourist sights, which are located in the historic centre. It scores the highest since other sights, such as the plantations, are on the other side of the river and the bridge to reach that side is further away. The 'Marron Markt' is located only slightly further from the tourist sights in the historic centre. The 'Nieuwe Haven Zuid' is located at almost the same location as the 'Nieuwe Haven', which gives both destinations the same score when it comes to the accessibility of the tourist sights.

Land

The 'SMS Pier' scores the highest in terms of land accessibility because of its central located position. From the 'SMS Pier' many attractions, such as the 'Waterkant boulevard' are walk-able. The in-use bus hub is closely located. The advantages of the position are also applicable to the 'Marron Markt' alternative. However, this location is a little less accessible because of the restrictions imposed with the plans to change the Waterkant street from a two-way street to a one-way street only. The 'Marron Markt' is located further away from bus stations and general touristic attractions, which declares a lower score compared to the 'SMS pier'. Lastly, the 'Nieuwe Haven Zuid' is located further away from the city centre and is now only connected via a heavily congested road. The pavements are not walk friendly. However, when the plans to improve the designated infrastructure are executed, it may come with improvements that prevent congestion. Secondly, this alternative make the development of a bus hub (including direct bus connections with city centre and airport) possible if a cruise vessel is not handled. This will have positive general impact on the terminals accessibility. Although it will never be as accessible as the other locations, this score can be rectified.

Water

The navigability of vessels and the available space for manoeuvring determine the score for the water accessibility. Since all alternatives are located along parts of the river with sufficient depth, all alternatives have enough space for manoeuvring.

the 'Nieuwe Haven Zuid' is positioned near the sailing route of vessels passing the bridge and near the port of Suriname. This alternative will further increase shipping traffic which can lead to routing conflicts. Therefore, the 'Nieuwe Haven Zuid' is scored with a negative value. The 'SMS Pier' and the 'Marron Markt' are positioned further away from the sailing routes, which is an improvement for the navigability compared to the current situation.

6.3. Cost/Benefit Indication

The ’SMS Pier’ will cost a lot since a new quay will have to be built. Also the facilities for the land side will need some investments. The space is limited and therefore only small ships could be handled. The direct cost-benefit ratio is therefore estimated to be less than the cost-benefit ratio of the current mooring location at the ’Nieuwe Haven’. At the ’Nieuwe Haven Zuid’ and the ’Marron Markt’ is much more space and therefore larger cruise ships could be handled, resulting in a higher market share for Suriname. The ’Marron Markt’ is located in the city centre and therefore it will be easier to use the required facilities for different purposes. The gives the possibility to create more economic benefits for this location than for the ’Nieuwe Haven Zuid’ and therefore this location scores highest.

6.4. Complexity

Social Resistance

Most actors are positive about the building of a cruise port in Paramaribo. They are aware of the positive effects that an increase in the tourism industry can bring. The only actors that will create resistance are the property owners of space that will have to be taken over. This is the case for some restaurants at the ’SMS Pier’ and the ’Marron Markt’. This social resistance will make the building of the cruise port more complex. After some negotiations it is assumed that the investors will come to a deal with these actors.

Structural Design

The design should meet the requirements whilst limiting the complexity of the structural design. The level of complexity of the structural design is represented in the costs of the project. Moreover, a complex design brings potential risks and maintenance along. Compared to the temporary facilities located at the Dr. Jules Sedney Terminal, every design alternative result in increasing complexity and therefore is scored negatively.

The designed mooring structures vary between a new jetty of 155 m, an extension of 80 m of the already existing jetty of the ’Nieuwe Haven’ and a quay wall of 200 m, for the ’SMS Pier’, the ’Nieuwe Haven Zuid’ and the ’Marron Markt’ respectively. The ’SMS Pier’ scores quite low, since a new jetty of 155 m long should be constructed. The ’Nieuwe Haven Zuid’ scores also low, since the extension of the jetty is only 80 m long and can be executed in the same way as the already existing jetty. However, the design vessel has a draugth of 5.8 m, resulting in a required water depth of 7.25 m. Therefore, capital and maintenance dredging activities will need to be applied. The ’Marron Markt’ scores also equal, since a quay wall of 200 m will be constructed. The design vessel has a draugth of 5.8 m, resulting in a required water depth of 7.25 m. The water depth of 7.3 m below Chart Datum is therefore sufficient. Since the water depth is sufficient within a short distance of the embankment, an anchored sheet pile wall construction is well executable.

6.5. Indirect Benefits

Employment

The 'SMS Pier' is the smallest location and will attract only smaller cruise ships, so also less cruise ships. Therefore the growth in employment will be the smallest. The 'Nieuwe Haven Zuid' and the 'Marron Markt' will attract also bigger and therefore more cruise ships and will also create more employment. Since the facilities at the 'Marron Markt' will be designed in a way that it can also be used for other purposes, it will probably even create more job opportunities. This location therefore scores the highest.

Infrastructure

The building of a cruise port will increase the priority of the reorganisation of the infrastructure in Paramaribo. Therefore all the alternatives score positive. The 'Marron Markt' is located a bit further from the historic inner centre and a good infrastructure including good pavements is therefore even more necessary and will put more pressure on the Paramaribo Urban Rehabilitation Program. At the 'Nieuwe Haven Zuid' an efficient bus hub could be created outside the city centre, which would even be more beneficial for the infrastructure in the city centre, resulting in less congestion.

Liveability

More tourists will a positive effect on the liveability of Paramaribo. When placing the cruise port in the city centre, more safety measurements en environmental protection measurements will be taken, resulting also in a more liveable city centre for the citizens.

Growth potential

As discussed earlier the space at the 'SMS Pier' is limited and it has not much growth potential. The 'Nieuwe Haven Zuid' and the 'Marron Markt' have much more space, so they have much more growth potential.

Tourism

Cruise tourists can be used as a way to promote Suriname as a single holiday destination. At the 'SMS Pier' less boats can moore per year, since there is only space for the smaller boats. This results in less promotion for Suriname. It also results in the smallest impact for the cruise tourist industry. For a positive promotion of Suriname, the passengers should have a positive experience when visiting Suriname. The arrival should have a certain comfort and the aesthetics should be optimal. The 'Marron Markt' therefore has the biggest potential to have an overall positive effect on the tourist industry.

7 Detailed Design

Detailed design, specifying logistical, structural and financial details.

7.1. Design Specification

In this section, the site specific boundary conditions and starting points are summarised.

7.1.1. Soil Classification

Near 'Waterkant' electric cone penetration tests (CPTs) are done to determine the soil types. Appendix B presents the specific locations and the results, like the measured cone resistance (q_c), the sleeve friction (f_s) and the pore pressure (u) are determined. Instead of the sleeve friction, the friction ratio (R_f) will be used from now one, with:

$$R_f = \frac{f_s}{q_c} \cdot 100\% \tag{7.1}$$

where:

R_f	[%]	: friction ratio
f_s	[MPa]	: sleeve friction
q_c	[MPa]	: cone resistance

According to Robertson (2010), a classification chart is used for the determination of soil (behaviour) types. The chart uses the CPT-values of the cone resistance and the friction ratio. The cone resistance is made dimensionless by dividing it with the atmospheric pressure (p_a = 0,1 MPa), see Table 7.1.

Two conclusions can be derived from the determination of the soil types:

1. The soil consist mostly out of clay and slightly sandy clay mixtures with low bearing capacity.
2. There are some narrow appropriate bearing layers located at depth of NSP - 7.5 m, - 33.5 m and - 38.5 m.

The indicative soil properties are determined using the Eurocode 7 (NEN-ENN9997), see Figure B.8 in Appendix B.1.

Height (+/- NSP)	q_c	q_c/p_a [-]	R_f [%]	Zone	Soil type
- 1.0 / - 2.0	1.0	10	1.0	4	Silt mixtures
- 2.0 / - 2.5	0.1	1	2.0	2	Clay
- 2.5 / - 4.5	1.0	10	1.0	4	Silt mixtures
- 4.5 / - 5.0	0.2	2	3.0	3	Clay
- 5.0 / - 7.0	1.0	10	0.6	4	Silt mixtures
- 7.0 / - 8.0	12.0	120	1.0	6	Sands
- 8.0 / - 9.0	4.0	40	0.6	5	Sand mixtures
- 9.0 / - 13.0	1.0	10	1.0	4	Silt mixtures
- 13.0 / - 33.0	1.0	10	2.0	3/4	Silty clay
- 33.0 / - 33.5	2.0	20	3.0	3/4	Silty clay
- 33.5 / - 34.5	8.0	80	0.4	6	Sands
- 34.5 / - 35.5	3.5	35	2.0	4	Silt mixtures
- 35.5 / - 37.0	4.0	40	2.0	5	Silty sand
- 37.0 / - 38.5	2.0	20	2.0	4	Silt mixtures
- 38.5 / - 39.0	15.0	150	0.4	6	Sands
- 39.0 / - 41.0	2.0	20	1.0	5	Silty sand

Table 7.1: Indicative results CPT 12 executed by MOS Grondmechanica 'Oeververdediging Paramaribo' (2011).

7.1.2. Hydrography

Navigation Channel

In Appendix A the required dimensions of the navigation channel are determined. The main conclusions are:

- The width of the approach channel, after the planned dredging activities, is sufficient.
- A water depth of 7.25 m is required for a 'R-Class' design vessel with a draught of 5.8 m.

Figure 7.1 depicts the draught of the design vessel when applying a tidal window at CD + 1.75 m to guarantee the required water depth of 7.25 m. The schematisation is at the river entrance (defined in Section 3.1.4) after the planned dredging activities (defined in Section 2.3.2). The (dashed) blue lines indicates the Spring and Neap Tidal Cycle from MHWS to MLWS and from MHWN to MLWN respectively, the red line indicates the MSL.

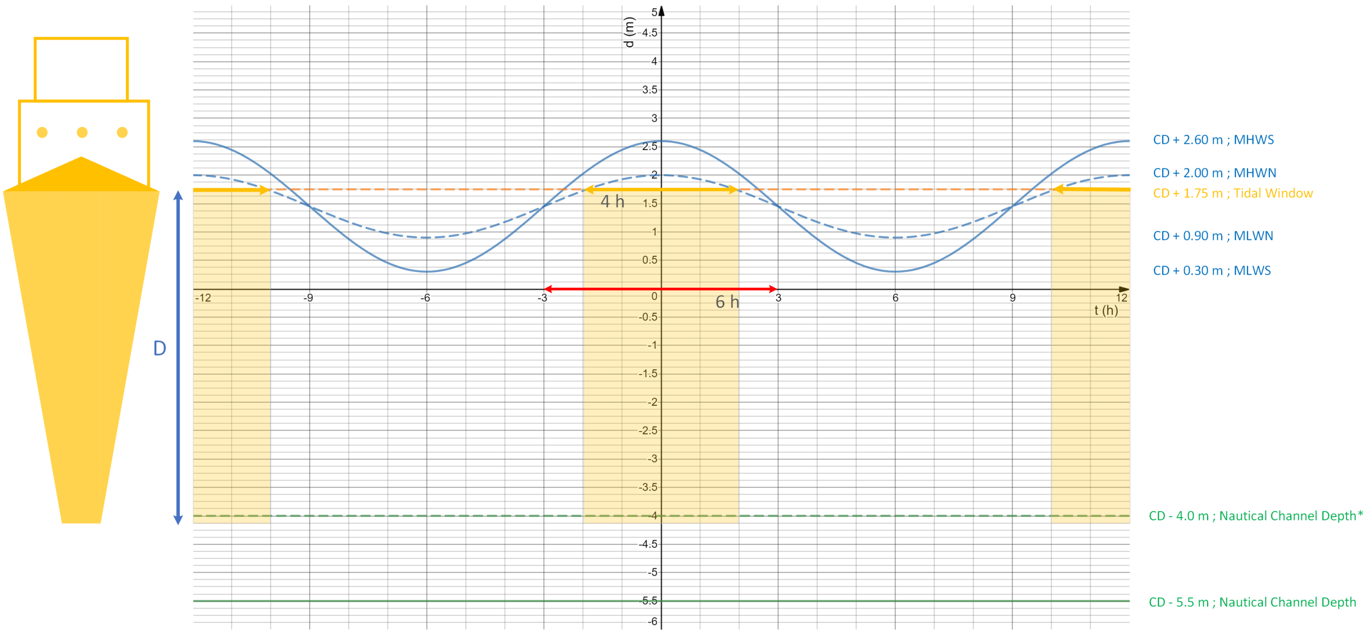


Figure 7.1: Schematisation of the tidal range in the navigation channel with a depth at CD - 5.5 m.

The expected sailing time is below 3 hours to enter the Suriname River to reach the outer bend of the river in front of Paramaribo, see Appendix I.7. The tidal window, indicated with the orange line, is required for the design vessel with a draught of 5.8 m, indicated with the orange transparent shape. The cruise ships are restricted for 4 to 5 hours, in case of neap and spring tide respectively.

Berth

The water depths in the outer bend in front of Paramaribo are sufficient without the application of a tidal window. Moreover, the water depth at the berth is CD - 7.3 m and therefore even agree with required water depth during Lowest Astronomical Tide (LAT).

The height of the quay wall is determined taking into account the qualified range of vessels. According to MarCom (2016), the elevation for the berth facility should exceed the levels below:

- 2.00 m above Mean Lowest Low Water (MLLW) ; 2.0 m + (CD + 0.3 m)
- 1.00 m above Highest Recorded Tide (HRT) ; 1.0 m + (CD + 2.8 m)
- 1.00 m above Mean Highest High Water (MHHW) + SLR ; 1.0 m + (CD + 2.6 m) + (0.20 m)

Therefore, the required height is determined on CD + 3.8 m, hence NSP + 2.5 m for the berth facility.

7.2. Structural Design

7.2.1. Apron Area

MarCom (2016) specifies that the apron area of 12 to 22 m should be enough for a port of call. There is assumed that an apron area with a width of 12 m is sufficient for this design.

7.2.2. Mooring System

Cruise ships are generally moored using 'alongside' type arrangements. The bollards will be placed at the capping beam above the sheet piles in close proximity to the cruise ships. Hereby, higher mooring loads need to be handled, but it makes sure that the apron area is unencumbered by the mooring lines crossing the apron area. High-capacity mooring hardware will be placed at the ends of the berth to accommodate the heavier loads from the bow or stern of the cruise ship. (MarCom, 2016)

Four high-capacity bollards are placed at each side of both bow and stern and an additional four lower-capacity bollards are placed along the primary berth frontage at a spacing of 17.5 m between the bollards. The normative mooring force is 450 kN, see Appendix C.2. The mooring force results in a bollard load normal from the berth of 25 kN/m' berth and a bollard load along the berth of 20 kN/m' berth approximately for a uniform distribution of the mooring load (Thoresen, 2003, p. 137). A more detailed configuration, with corresponding mooring load distribution, should be made in a subsequent study.

7.2.3. Fender System

The fender systems will be provided along the full frontage of the berth area to absorb the energy of an impact during berthing and to provide a soft buffer between the quay and vessel while moored. These systems spreads the loads across a wider section of the berth. (MarCom, 2016).

Appendix C.1 presents the calculation of the energy to be absorbed during berthing. The normal kinetic energy to be absorbed by the fender system is equal to 125 kNm for a approach velocity of 0.15 m/s of the cruise ship. Due to a required abnormal impact factor of 2, the abnormal kinetic energy to is equal to 250 kNm.

The energy capacity of the fenders (E_{RPD}) should be greater than the abnormal energy. Appendix C.1 presents the determination of an appropriate fender type ($E_{RPD} \leq$ 285 kNm). The SPC 900 Cone Fender (G 1.6) of the Shibata Fender Team is selected with an E_{RPD} of 310 kNm and a reaction force (R_{RPD}) of 656 kN. The distance between the fenders will be 8 m. Resulting in a maximum horizontal berthing load of 82 kN/m' berth.

To complete the berthing configuration, more detailed information of the expected location of the vessel baggage and storage shell doors is required. Since a significant tidal range (2.3 m) is governing, the height of these doors can fall below the deck, resulting in a minimum required vessel stand-off. Therefore, the compression of the fenders should be taken into account as well.

7.2.4. Sheet Pile Wall

The determination of the required sheet piles is done in two steps. Firstly, a indicative calculation is done with Blum's schematisation. Secondly, a calculation is done with MSheet (nowadays D-Sheet Piling), a sheet pile design tool according to Stichting CURNET (2008).

Note: Regarding a study assignment, a hand calculation is desired in agreement with supervisor J. Koornaar. The calculation is executed according to Blum's schematisation.

Blum's Schematisation

Appendix D presents a detailed elaboration of the calculation according Blum. Figure D.1 shows the most unfavourable schematisation (water level at LAT) for the sheet pile wall with a retaining height (h) equal to 11.05 m. The sheet piles are single anchored at CD + 1.80 m (2.0 m below ground level). These dimensions are the starting point for the determination of the sheet pile profiles. A required embedded depth of 23.3 m is required, corresponding with a total sheet pile length of 40.0 m. Since a length of 40.0 m is considered quite long, an optimisation with double anchored sheet piles is done with MSheet.

MSheet

In relation to Stichting CURNET (2008), the software tool MSheet is made for the design of sheet pile walls. The critical length for the sheet pile wall will be determined by reducing the length until the structure fails or until unacceptable deformations occur.

Input A simplification of the present surface layers (Table 7.1) is given in Table 7.2. The soil properties are still according to Stichting CURNET (2008), as stated in dr.ir. S. van Baars et al. (2017, Table 31-4). The horizontal modulus of sub grade reactions are also applied according to Stichting CURNET (2008), as stated in dr.ir. S. van Baars et al. (2017, Table 33-1).

Layer name	Level h [m]	Unsat. weight γ_d [kN/m^3]	Sat. weight γ_s [kN/m^3]	Cohesion c [kN/m^2]	Internal friction ϕ [deg]	External friction δ [deg]
Sand - SSC	3.80	18.00	20.00	0.00	27.00	9.00
Clay - SSS	0.30	20.00	20.00	13.00	22.50	7.50
Clay - SSM$_1$	-7.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM$_2$	-11.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM$_3$	-29.70	18.00	18.00	5.00	22.50	7.50
Sand - CL	-31.70	17.00	19.00	0.00	30.00	10.00
Clay - SSM$_4$	-33.70	18.00	18.00	5.00	22.50	7.50

Table 7.2: Input - Simplified surface layers. SSC: slightly sandy clayey, SSS: slightly sandy solid, SSM: slightly sandy moderate, CL: clean loose.

The two applied anchors are of the type GEWI-50T. They are mounted at CD + 1.80 m and CD - 1.20 m with a wall height of 3 m and with a length of 23.0 m.

Three stages are set:

1. Constant loads plus the berthing loads, see Section 7.2.3.
2. Constant loads.
3. Constant loads plus the mooring loads, see Section 7.2.2.

Stage 1 and 3 are depicted in Figure 7.2 and 7.3. Stage 2 has been disregarded, due to the non-normative results.

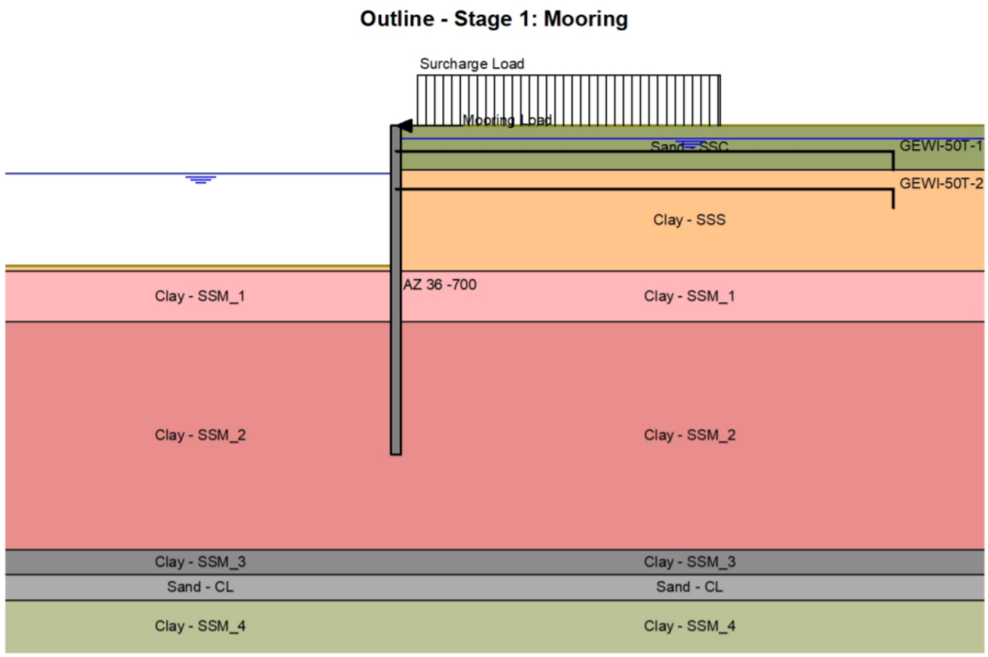


Figure 7.2: MSheet Input - Stage 1

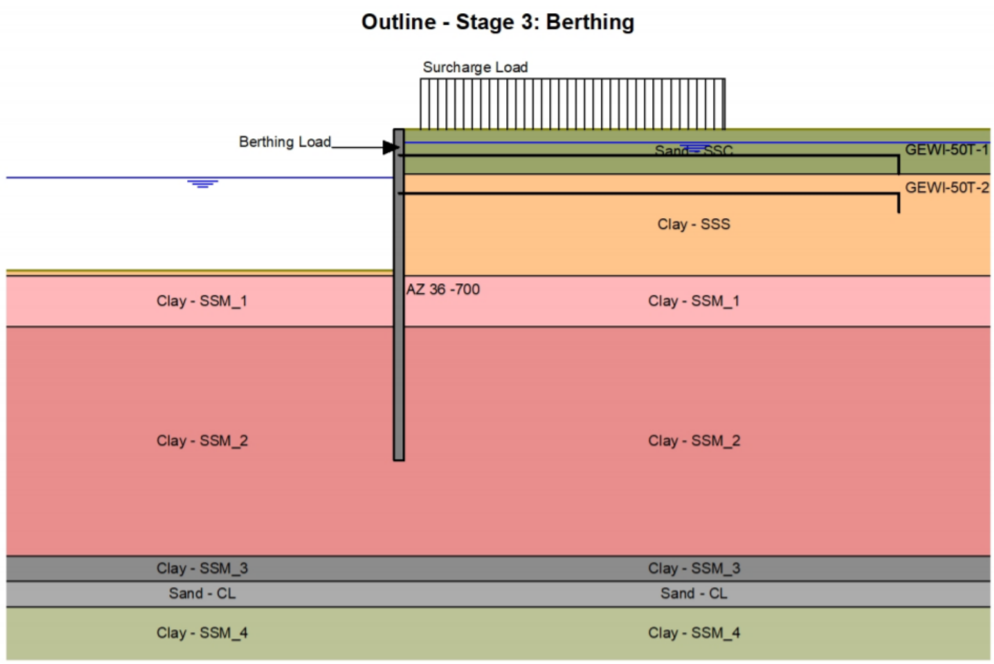


Figure 7.3: MSheet Input - Stage 3

Results The partial factor set II is applied. The results of the calculations are depicted in Figure 7.4, 7.6, 7.5 and 7.7. Due to the double anchoring, the sheet pile length can be reduced until a length of 26.0 m. The MSheet Report is presented in the Appendix.

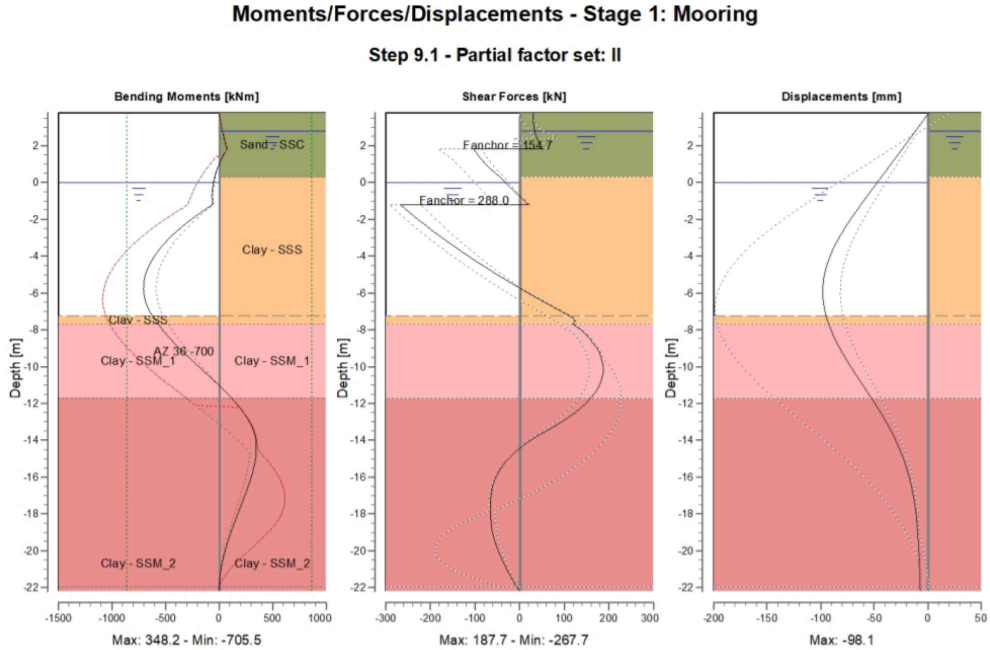


Figure 7.4: MSheet Results - Stage 1

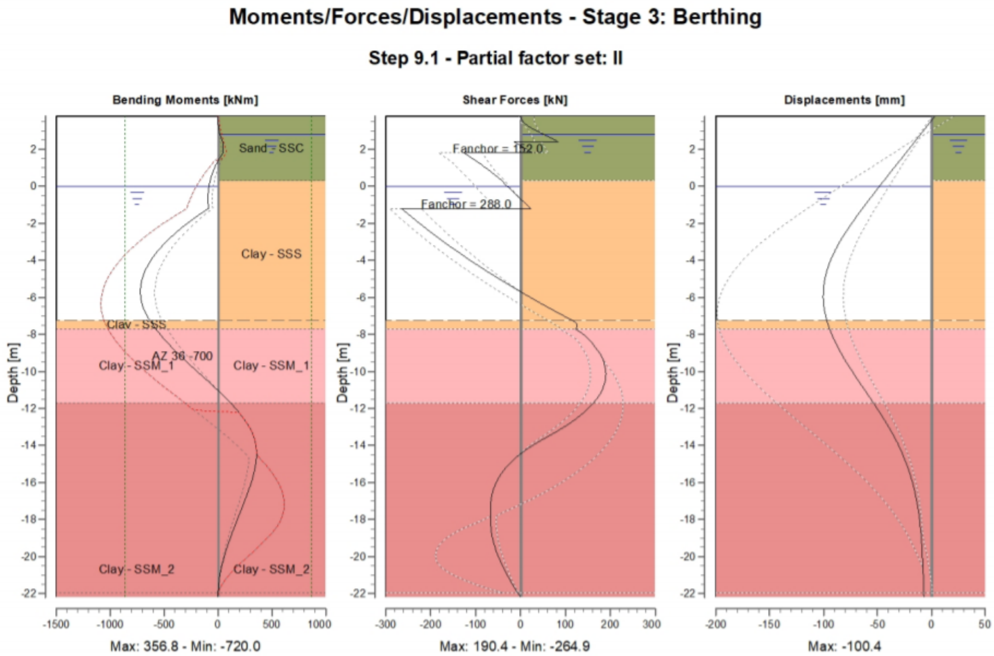


Figure 7.5: MSheet Results - Stage 3

MSheet is unable to determine the allowable anchor force for a double anchored sheet pile wall. An elaboration of the influence of the anchor on the total stability and a calculation of the required anchor length and type are given in Appendix E.

Figure 7.8 presents the final dimensions of the sheet pile wall.

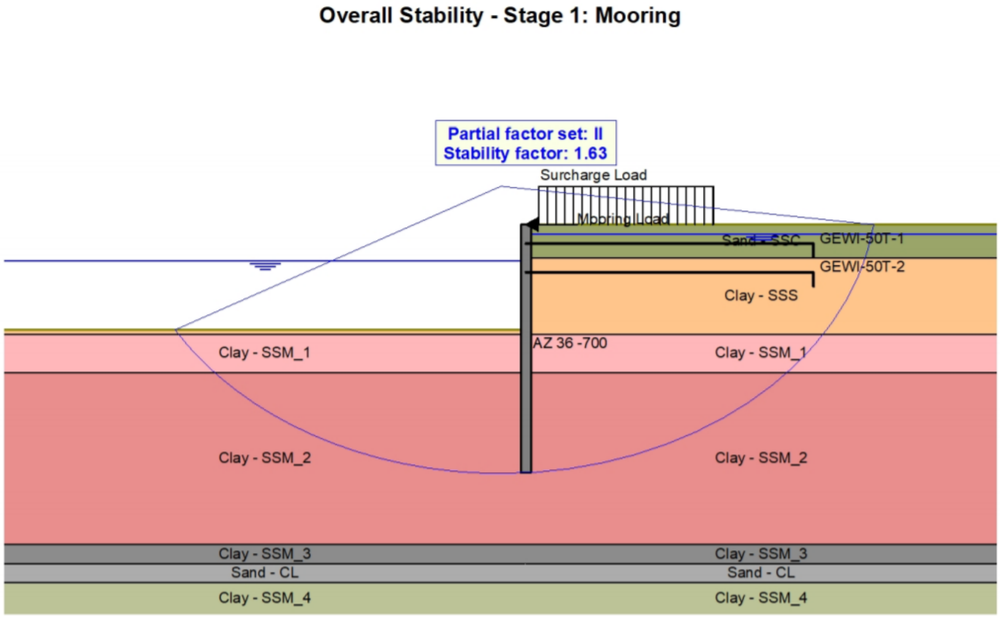


Figure 7.6: MSheet Stability - Stage 1

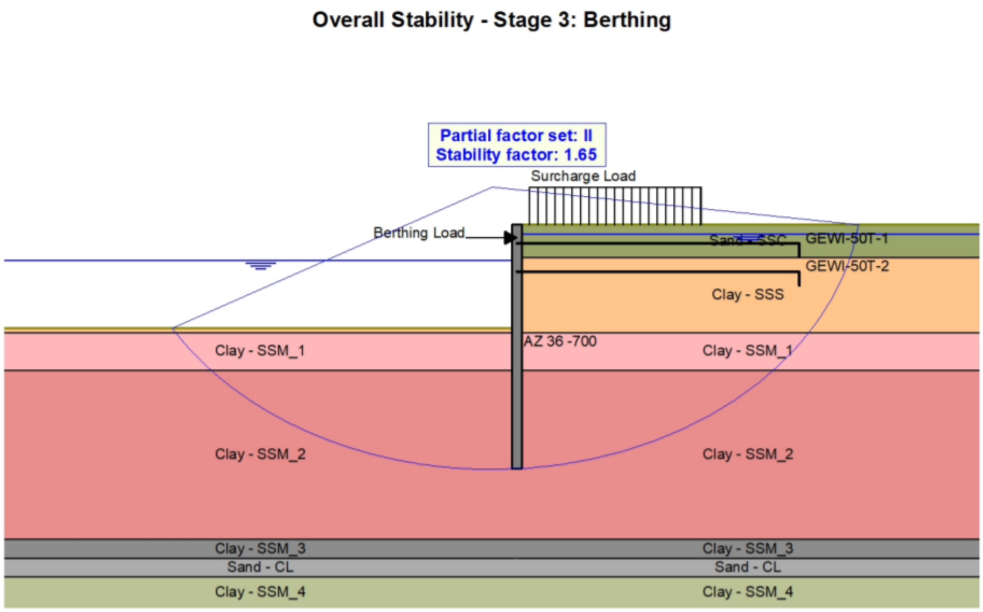


Figure 7.7: MSheet Stability - Stage 3

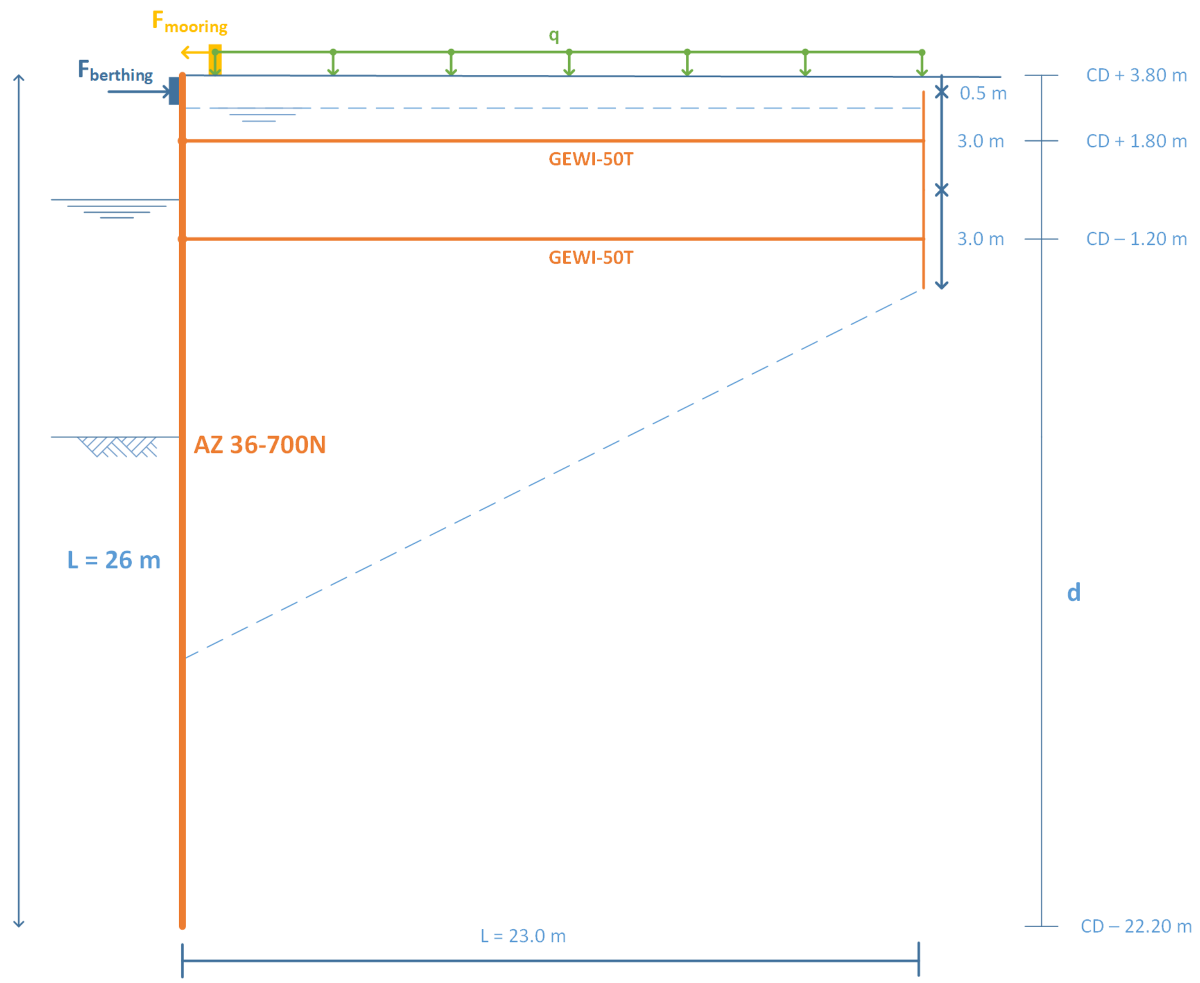


Figure 7.8: Final design of the sheet pile wall

7.3. Cruise Terminal

According to the PIANC-guidelines, terminals lay-outs could be divided into four different user categories which are described in this chapter. A specific design for the Paramaribo port is suggested.

7.3.1. Terminal usage

Firstly, a temporary terminal is managed only on those days where a cruise vessel needs to be handled. Depending on the characteristics of the placement a tent or another temporary construction could be used in case of a vessel handling. Secondly, purpose-built terminals are completely designed to accommodate and handle the needs of cruise passengers, including the optimisation of flow, maximise passenger satisfaction and maintaining security. If there is no vessel in the port, the terminal is not used. A mixed-use terminal adds other functionalities rather than only handling cruise passengers, such as commercial areas, theatres, hub-functionality of other transport modes etc. The multiple uses of the terminal increase the financial rate of return since the investments can be divided into several parties.

The best option for Suriname is the fourth and last option which is the so-to-call convertible building. The convertible building allows for flexible interior arrangements and facilities, so that the lay-out can be designed dependent on the needs and capacity of the cruise ship. Baggage lay-down and passenger check can be done in the same area that will later serve as waiting space or customer facilities. The building could normally be used for other functions, such as a congress centre or a warehouse. This category could be the most beneficial for the Paramaribo port since its cost efficiency could be very high if this building is used for other purposes than only handing cruise passengers during times that there is no present vessel. It also reduces the risk of investment in case of a stable or declining number of incoming cruise ships because the building could be used for other purposes and it's revenue is not only dependent on the cruise market.

7.3.2. Programme

The terminal design should have sufficient space for passengers before or after embarking or disembarking. In the planning process the internal lay-out of the terminal includes sizes, types and location of spaces and is referred as the 'programme' of the terminal. The particular design of the terminal is mostly dependent on the expected number of passengers that needs to be handled. In this study it is assumed that a cruise ship will have a capacity of 450 PAX. Several cruise ships may have a higher capacity, but in those cases it is assumed that only 75% will de-board the vessel. For this design, there is no possibility to handle more than one ship at the same time. Passengers disembark first before the embarking procedure can start.

The following table 7.9 summarises the surfaces of the areas for a 600, 450 and 250-pax terminal. The designed terminal is single-story and only has a ground level. This prevents higher investments.

Required surface m^2	600 pax	450 pax	250 pax
Baggage area	571	428	238
Baggage screening	47	35	20
Overall lounge	484	363	202
Provisions	21	16	9
Check-in	107	80	44
Immigration	22	17	9
Police/security	15	15	15
Crew	50	50	50
Wc	50	50	50

Figure 7.9: Table of required surfaces

In figure 7.9 possible design is given. This design could be interpreted as highly flexible and all facilities can be expended dependent on special cases or needs, such as in cases where more security capacity is needed, or in cases where passengers will not have baggage with them. In this design the walking distances are minimised so that the total passenger flows are optimised. Also important is the separation of waiting passengers and moving passengers as much as possible.

7.3.3. Internal spaces

Passengers are entering the building in the main entrance where they can immediately check-in at the check-in desks to the right. There are (at least) 5 check-in desks needed in order to prevent queues.

It is necessary that information (such as way-finding) is shown clearly in the entrance and the rest of the building so that passengers are able to find their way through. The entrance needs to be clearly visible from the outside and it is advised that there are no steps or angles so that it is highly accessible for wheelchairs and trolleys. Queuing should be prevented in the entrance but there may be some places to sit or wait. An overhead protecting shelter may protect passengers from hot sun or rain.

After the passenger check-in, the baggage can be screened with luggage scanners and security systems. The screening area is strategically positioned next to the check-in so that passengers do not have to walk around with their luggage. In case that further investigation is needed, the police could use their office which is located next to the baggage screening area. The tpilets are located in the corners of the building, so that passengers don't have to walk through the building, preventing unnecessary movements. The baggage could be stored in the baggage area if checked a passenger could wait in the waiting area. In that area passengers could wait until they are called for the actual boarding.

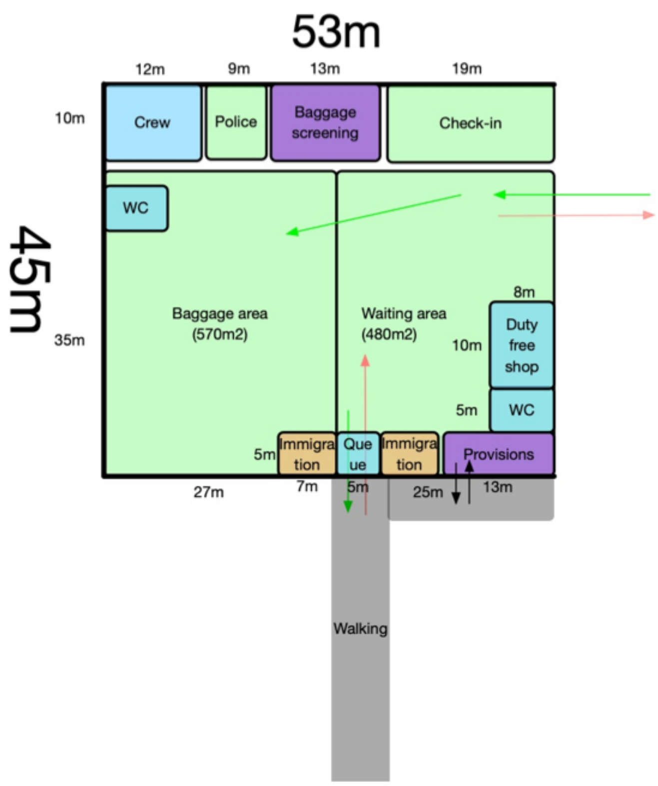


Figure 7.10: Design terminal

The provisions flow is separated from the passenger flow so that no provisions have to get through the terminal but could be loaded and unloaded immediately from the parking area outside the terminal. The immigration desks are located next to the apron entrance so that incoming passengers immediately can show their necessary passports when they enter the building. For crew it could be satisfaction to have a private area where they could rest or could use as an office separated from the passengers.

The baggage lay-down is the largest area of the building. Luggage could be brought there by passengers themselves or with help of crew on land. A special ordering process should be designed in order to easily track luggage such as colour coding. The space required for baggage is about 0,75 m2 per passenger and is therefore for a capacity of 600 pax about 450 square metres. This area can be either used for boarding or de-boarding. Passengers could walk through the rows to select their bags.

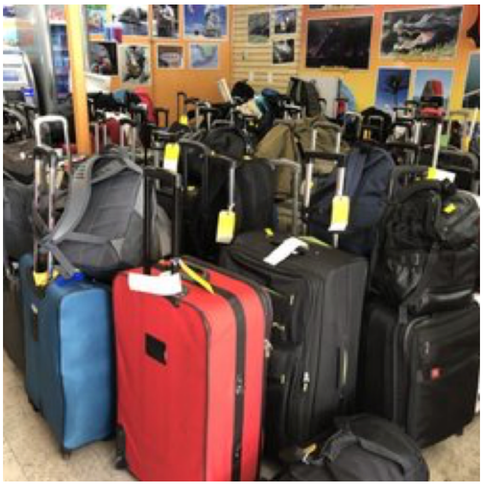


Figure 7.11: Example of baggage lay-down

7.3.4. Ground transportation area

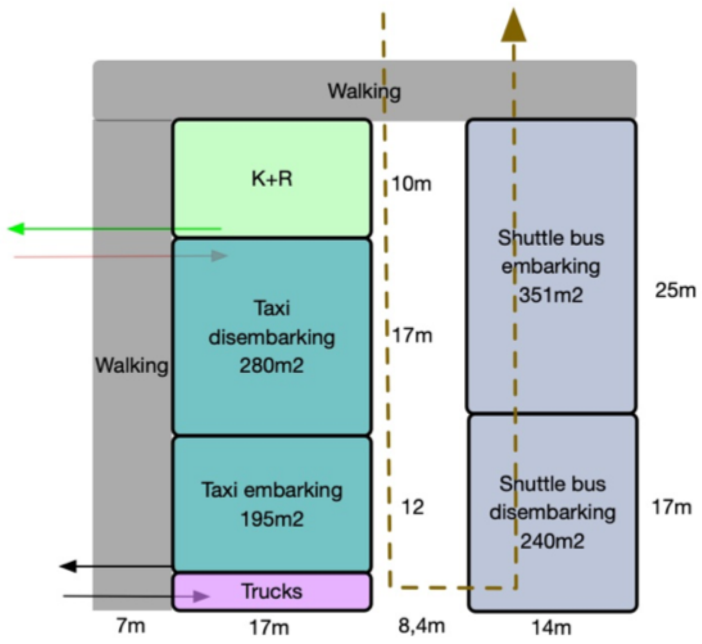


Figure 7.12: Ground transportation area design

The outside area of the port has to be designed so that all passengers can reach the terminal easily and efficient and should therefore be linked to local infrastructure networks. The area provides space for passengers to go on busses, taxi's or be dropped off and picked up. Traffic around the terminal has to be able to circulate and park for short times. Passengers and traffic should be separated if possible to guarantee safety. The design of the outside area consists of a platform for taxis, busses and private vehicles.

The taxi area must be free for taxis to stand for a short time or to queue waiting for passengers. A fair system (such as a first-in-first-out) should be designed in order to create a fair market so that passengers' step into the taxi that waited there the longest. Other space is required for passengers and vehicles to move. A buffer area could be incorporated where vehicles could be parked.

It is expected that there are 3 different kind of bus services to be exploited in Paramaribo – the shuttle bus, which is planned by a local tour operator and offers passengers a possibility to directly travel to certain activities or central places. The airport bus connects passengers directly to the airport and the public bus is also used by travellers who are not related to the cruise. All vehicles are assumed to have a capacity as described in figure 7.13.

Private vehicles are mostly having the same requirements as taxi vehicles, since they are picking up or dropping off passengers and then continue to leave the area. Some space may be required to park personal vehicles in the rare case that a cruise passenger wants to park their vehicle during their travel.

Vehicle capacities	Persons/vehicle	Space required/vehicle (m^2)
Taxi	2,5	25
Shuttlebus	30	100
Airport bus	4	40
Public bus	30	100
Private vehicle	4	25
Walking	-	0

Figure 7.13: Required space and vehicle capacities

To define the required area of each transportation mode it has to be known at what time the space is used at its maximum. The other times the same space could be used as a buffer or just open area where people could walk. Therefore, an embarking and disembarking pattern for any cruise ship is given in the figure below. The numbers are related to the passenger flows of a 600 PAX cruise ship. The pattern is based on a study in San Francisco ((EDAW/AECOM, 2008)) in which boarding patterns of a 4400-passenger cruise ship are described. With the activity patterns the modal shift could be used in order to define the required area per transport mode. The expected modal shifts per alternative are given in the figures below.

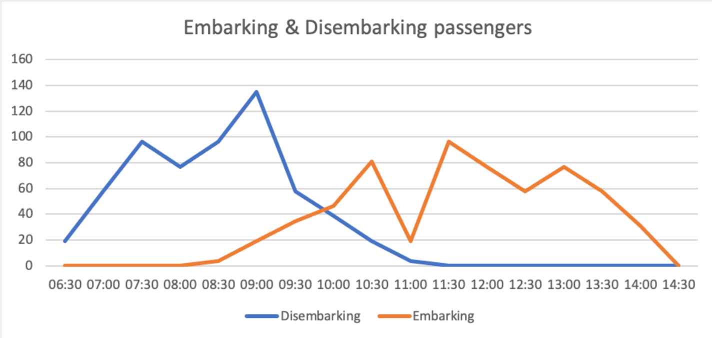


Figure 7.14: Embarking and disembarking pattern

With the activity patterns the modal shift could be used in order to define the required area per transport mode. The expected modal shifts per alternative are given in the figures below (7.15)

Modal shift	**Marron market**	**SMS-pier**	**Nieuwe Haven**
Taxi	20%	20%	25%
Shuttlebus	40%	40%	75%
Airport bus	0%	0%	0%
Public bus	0%	0%	0%
Private vehicle	0%	0%	0%
Walking	40%	40%	0%

Figure 7.15: Modal shift per alternative

With this information the required surfaces for each alternative and each transport mode could be determined. The required surfaces for the Marron Market are given below. For the taxis the required area is 275 m^2 and for the busses 200 m^2. It is assumed that the embarking and disembarking passengers roulate so the vehicles don't have to be summed up. However, there is a 10% marge added to the total area for manoeuvring and walking which leads to a total required surface of 962.5 m^2 for the Marron Market alternative. The calculations for the other alternatives are given in Appendix G.

In this figure it becomes clear how surface each transport mode needs at a certain time. Before 10:00 the area is mostly used by disembarking passengers using the shuttle bus or taxi. Since walking is not using any space it is zero during all hours. After 10:00 the area is more used for embarking passengers using taxi and shuttle busses which require almost the same area. The area usage is at its maximum around 9:00 o'clock.

Now that the required surface areas are known, a first design could be made. However some assumptions done for this calculation could differ per individual ship. It is recommended to use this design as an example but to build a square area in which the lay-out could be changed easily depending on the need for several modes. This way, changes could be done easily by just moving lanes and spaces. In all cases the lay-out must be aesthetically attractive, safe for walking passengers and easy for wayfinding by giving clear direction and information. This can be done by placing correct signs, light the area during night times and the placement of (digital) information boards.

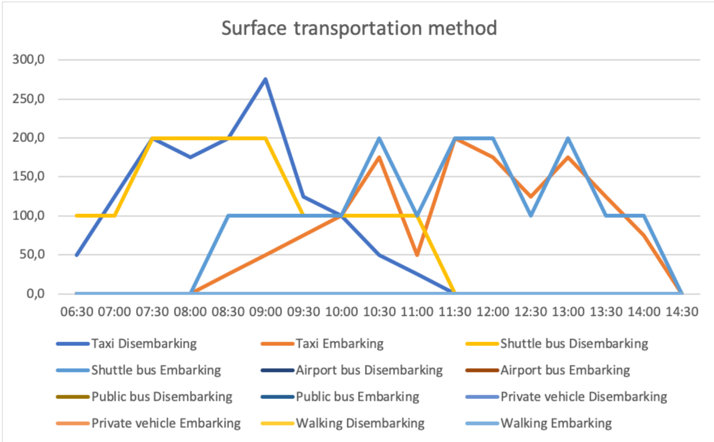


Figure 7.16: Required surface during time

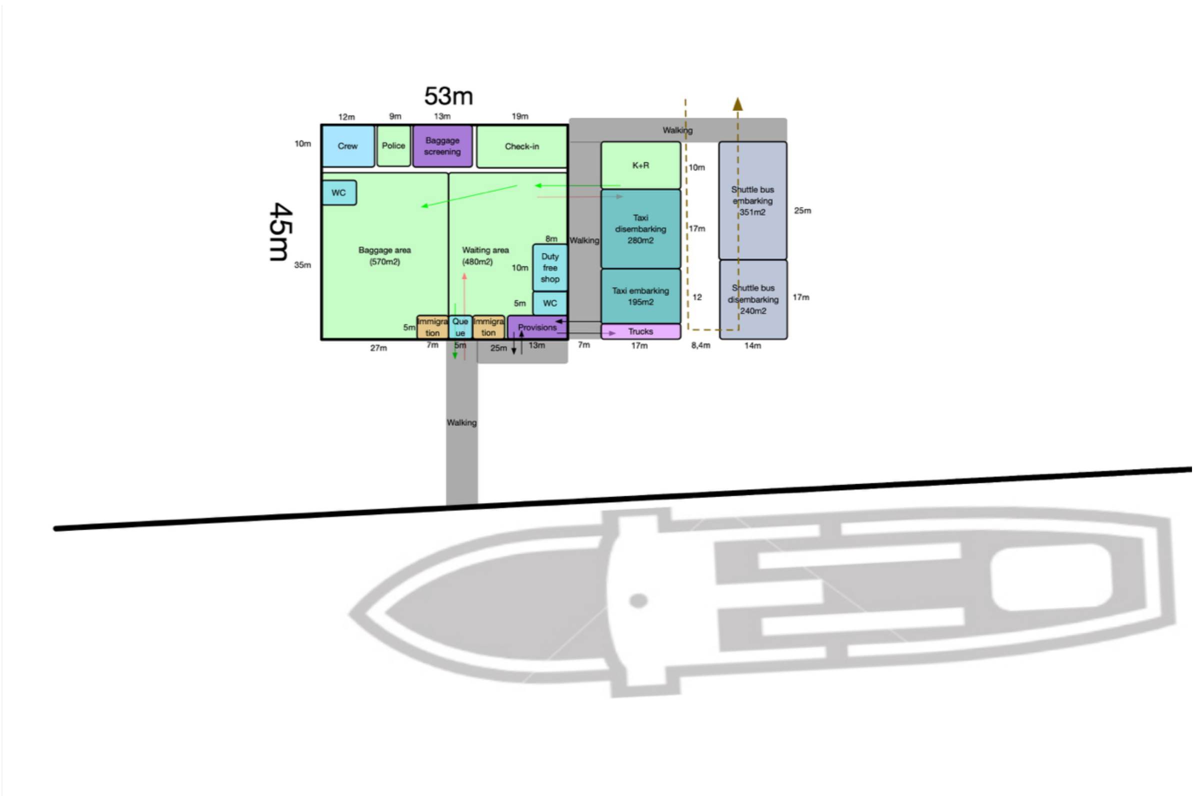


Figure 7.17: Overview of design

7.4. Design Impression

An impression of a final design is presented in the figures below. The top view, in Figure 7.18, shows four areas; the square, the terminal building, the ground transportation area and the quay with a cruise ship.

The second figure shows a impression of the ground transportation area, with kiss & ride, taxis and tour busses. There is an opening in the fence for trucks which can drive to the apron area and resupply the vessel.

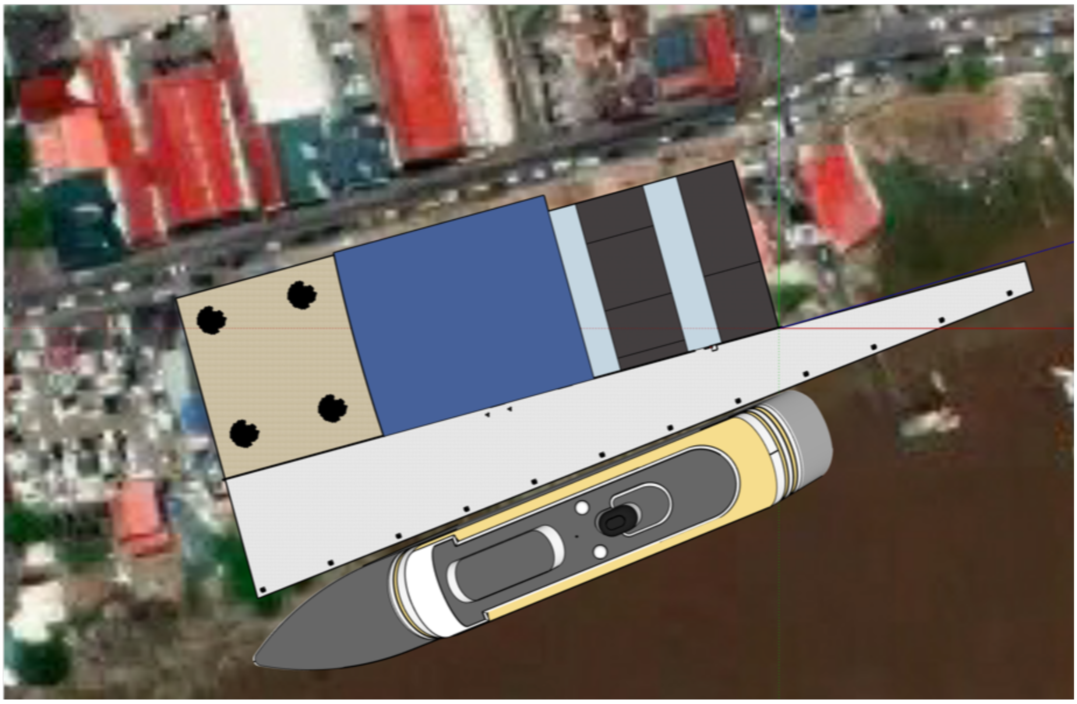


Figure 7.18: Top-view impression of the final design

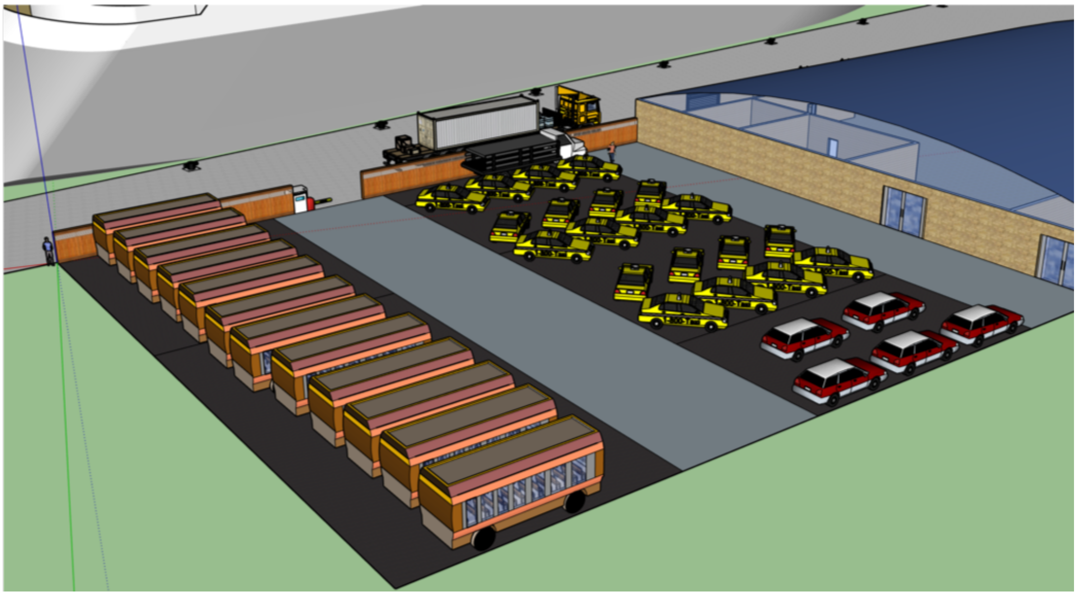


Figure 7.19: Impression of the ground transportation area

The terminal building is shown in Figure 7.20, in which the large open area and the different rooms can be seen. This makes the building suitable for multiple purposes. When there is a cruise ship, a queue can be created near the entrance for customs.

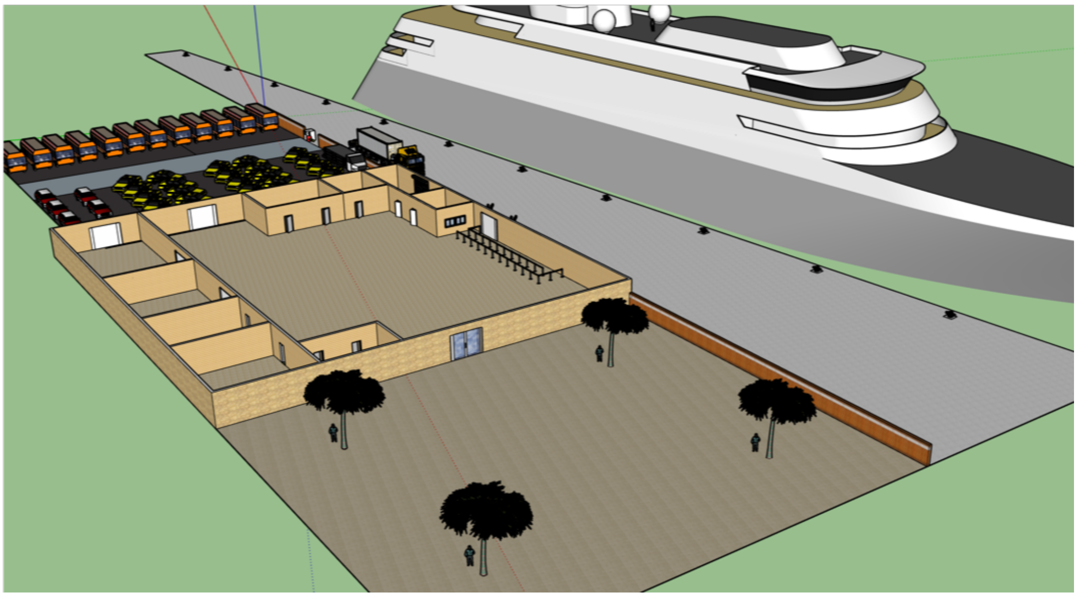


Figure 7.20: Impression of the final design

7.5. Finance

7.5.1. Costs

An estimation of the total costs, consisting of the land facilities and the quay wall construction amongst others, results in a estimated total construction costs of EUR 8.4 million.

Land facilities

The construction costs of the land facilities are estimated using the cost guidelines written by (RIAI, 2016), see Table 7.3. The terminal building is considered as commercial office development with an low cost level, since the facilities in the terminal are limited. The costs of the park and parking area are seen as site development business parks with an average price level, since the design requires an aesthetic environment.

Item	Costs per unit	Dimensions	Total costs
Building	€ 1550 per m^2	2250 m^2	€ 3,487,500.00
Parking area	€ 300,000 per hectare	2025 m^2	€ 60,750.00
Park	€ 300,000 per hectare	1800 m^2	€ 54,000.00
	Total		**€ 3.602,250.00**

Table 7.3: Construction costs of land facilities

Quay Wall

The construction costs of the quay wall are estimated with the assistance of ILACO Suriname NV, a local consultancy and engineering firm. Table 7.4 presents the costs of the main components of the anchored sheet piles, the required sand for the land reclamation and the pavement of the apron area.

Item		Costs per unit	Dimensions	Tons	Total costs
Sheet Piles	i.e. *AZ 36-700N*	€ 2,500 per ton	5200 m^2	878.8	€ 2,197,000.00
Capping Beam	(reinforced)	€ 2,000 per m	-	-	€ 400,000.00
Tie Rod	i.e. *GEWI-50T*	€ 1,500 per ton	4600 m	70.8	€ 106,260.00
Sheet Pile Screen	i.e. *AZ 18-700* (incl. coating, etc.)	€ 2,500 per ton	1200 m^2	121.4	€ 303,000.00
Sand (supply by barge)	(incl. compacting & vertical drainage)	€ 50 per m^3	17500 m^3	-	€ 875,000.00
Pavement	(incl. rainwater system)	€ 50 per m^2	5000 m^2	-	€ 250,000.00
Others	(mobilisation, etc.)	+ 5%	-	-	€ 208,310.00
	(unforseen costs)	+ 10%	-	-	€ 437,460.30
		Total			**€ 4,812,030.00**

Table 7.4: Construction costs of the quay wall, based on estimations of ILACO Suriname NV

7.5.2. Revenues

This section contains a rough estimation of market potential and gives a possible value of revenue potential gained from cruise tourism in Suriname. The analysis consists of three steps.

- Estimation of potential volume of annual passengers based on cruise ships analysis earlier in this study.
- Expected value generated by passenger expenditures on land based on earlier studies of the FCAA.
- Expected value generated by cruise operators, also based on earlier studies of the FCAA.

Since the maximum draught for the ships in Paramaribo is set to be 5.8 m, only a few ships are able to sail to the port. This selection is already done earlier in this study and the capacity of each ship is used to estimate the passengers volume.

Next, an estimation is done considering the expected annual number of calls. This estimation is based on the frequency of which the ship currently sails near Suriname. Some cruise vessels include oversea itineraries from Europe to the Caribbean. It is assumed that, if cruise handling facilities are realised in Paramaribo, it will be likely that the popularity of the usage of the Paramaribo cruise port will be high. This is because of the few alternative ports in the area. Georgetown (Guyana) is not attractive because of the high crime rates and Devil's Island (French-Guiana) is not seen as a very interesting stop, except for French cruise operators which will probably prefer handling with national resources. The French cruise vessels have a lower chance of putting off in Paramaribo. For that reason, it is to be expected that ships other than 'Le Champlain' will only visit Paramaribo once per year. 'Le Champlain' is already visiting four times per year and it is reasonable to say that this number doubles because of the successful expertise. Furthermore, some ships (like the Marina and Road Amundsen) do not operate in the near seas so they have a low probability of being handled at all.

The total number of expected cruise passengers in the year of realisation (YOR) of cruise handling facilities is given in Figure 7.21. The total number of passengers at YOR is to be 8992 pax per year. Cruise operators determine destinations two years ahead, so it is assumed that if the plans are revealed that the number of visits has increased compared to the current number of visits.

Furthermore, it is expected that after the year of completion the number of visits will grow definitely at least 150% to 13488 pax per year in the low scenario based on the global growth of the cruise market, 200% in the middle scenario to 17894 pax per year and up to 300% which is 26976 pax per year in the maximum scenario. These scenario's are based on a time span of 5 years after completion. It has to be said that for some vessel's itineraries differ highly from year to year and are season dependent. Therefore, it may be possible that some cruise vessels are less likely to visit Suriname at all but some may visit Suriname more often than stated. In these calculations the expenditures from crew are excluded.

The output of the tourism industry can now be estimated. The FCCA (FCCA, 2018) executed an aggregate analysis of the economic contribution of cruise tourism to 35 destinations which were located in the Caribbean, Mexico and Central and South America (see Appendix J).

Suriname is not included in this research because of the very low visiting number of passengers. Data from this study could be a basis for the estimation of economic benefits related to cruise tourism. Most destinations are highly advanced in the handling of cruise tourism compared to Suriname and are therefore not directly comparable. Therefore, an average of expenditure rates of destinations with low visiting rates is calculated and chosen as reference for the estimation of potential expenditure rates in Paramaribo. This is to be Tobago (30.9 thousand visits, $74.18 average expenditure per passenger), Trinidad (10.8 thousand, $42,58), Nicaragua (43 thousand, $54,94) and Guatemala (73.4 thousand, $63,62). The average expenditure per passenger for Paramaribo should be about $59.

Operator	Ship	Capacity (Pax)	Annual number of calls	**Total YOR (Pax)**	High scenario +5Y (+300%) (Pax}	Middle scenario +5Y (+200%)	Low scenario +5Y (+150%)
Azamara	Pursuit	690	1	690	2070	1380	1035
Azamara	Quest	690	1	690	2070	1380	1035
Hurtigruten	Fram	318	1	690	2070	1380	1035
Hurtigruten	Road Amundsen	530	0	0	0	0	0
Oceania	Marina	1250	0	0	0	0	0
Oceania	Sirena	684	1	684	2052	1368	1026
Ponant	L'Austral	264	1	264	792	528	396
Ponant	Le Boreal	264	1	264	792	528	396
Ponant	Le Champlain	184	8*	1472	4416	2944	2208
Ponant	Le Dumont d'Urville	184	1	184	552	368	276
Ponant	Le Lyrial	264	0	0	0	0	0
Ponant	Le Soleal	264	0	0	0	0	0
Pacific	Princess	670	2	1340	4020	2680	2010
Silversea	Cloud	254	4	1016	3048	2032	1524
Silversea	Explorer	144	4	576	1728	1152	864
Silversea	Galapagos	100	4	400	1200	800	600
Silversea	Wind	298	1	298	894	596	447
Windstar	Star Pride	212	2	424	1272	848	636
Total			**24**	**8992**	**26976**	**17984**	**13488**

* Le Champlain is already handled at Paramaribo four times/year.

Figure 7.21: Potential annual passengers

This average multiplied by the expected number of passengers gives the following on shore expenditures presented in the Figure 7.22. Categories with the highest expenditure rates, such as shore excursions, restaurants, local crafts, clothing and expenditures on watches & jewellery are included in this calculation (see Appendix J for a detailed analysis of expenditures per category). It is expected that Paramaribo invests in facilities so that these expenditures could be made, that means for example the attraction of stores that sell jewellery and expand current catering facilities.

	Total YOR	High scenario +5Y (+300%)	Middle scenario +5Y (+200%)	Low scenario +5Y (+150%)
Total expenditures per year	$ 530.528	$ 1.591.584	$ 1.061.056	$ 795.792

Figure 7.22: Potential expenditures per year

With an annual revenue between $0.5 and $1.5 million, as a result of the passenger expenditures, the total revenue will be more than $10 million in 20 years.

A third and last component of revenue created is the expenditure of cruise operators themselves. These are for example:

- Oil
- Water
- Local produced commodities (like vegetables, fruit, fish)
- Garbage disposal fees
- Pilotage per ship
- Berthing costs per ship

It is highly difficult to estimate the expected revenues coming from the cruise operators themselves since it relies heavily on the height of wages, local currencies, market values etc. In each of the 27 destinations expenditures by cruise lines during 2014/2015 in the FLAA study the lowest range of expenditures was $100,000 in Trinidad to a height of $14.1 million in Belize (exclusion the destinations with exceptional high expenditures which are not relevant for this study).

7.6. SWOT

Different influences are identified which can be considered as strengths, weaknesses, opportunities and threats regarding the proposed design of the new cruise port in Paramaribo. These influences are summarised in a SWOT analysis shown in Figure 7.23. The SWOT analysis can be used as a guidance to recognise that the changes in these influences can affect the impact of the port.

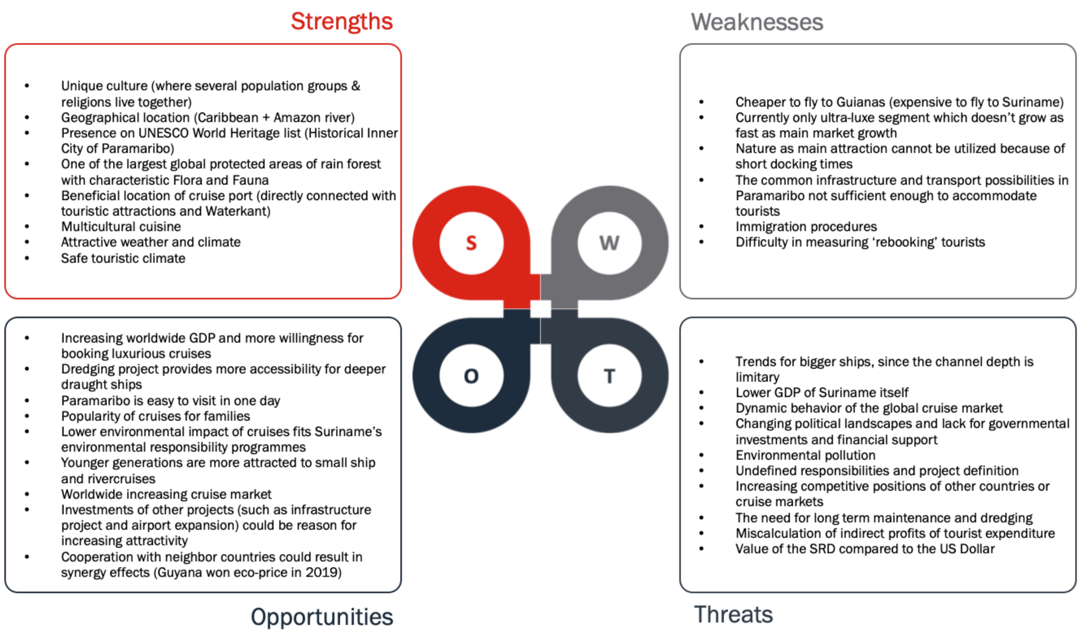


Figure 7.23: SWOT-analysis

7.7. Implementation

For the success of the cruise terminal it is important to include the realisation of other projects as well. In Figure 7.24 an implementation timeline for the port is suggested in parallel with the implementation timeline of these other relevant projects. It is a starting point that the projects schedules and deadlines as they are presented now are met.

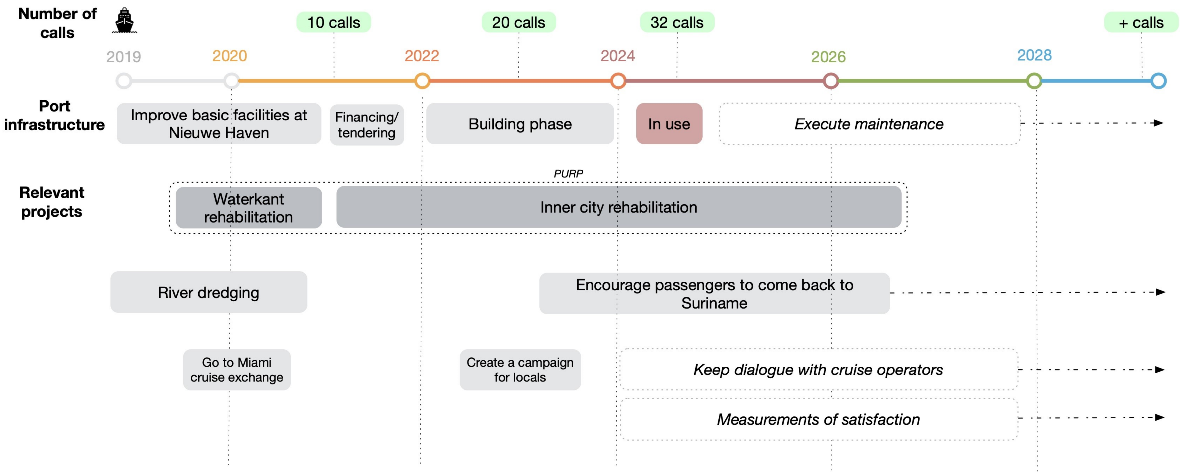


Figure 7.24: Proposed measures for implementation timeline

During further investigation on the realisation of the cruise port, it is important to improve the facilities at the 'Nieuwe Haven'. This to already attract more cruise ships to Suriname. This will increase the priority of the other projects and will help to promote Suriname as a cruise ship destination to the cruise passengers. The river dredging projects will start in 2019 and will take two years. The projects of the PURP involving the 'Waterkant rehabilitation' are planned on 2020 until 2021. It is also important to go to the 'Seatrade Cruise Glabal' in Miami, which is the largest cruise industry gathering in the world in 2019, to further promote the Suriname as a cruise destination to the cruise operators. It is assumed that in 2021 the amount of calls at the 'Nieuwe Haven' will approximately be 10.

At that time the financing and tendering of the building of the cruise terminal can start, together with the rehabilitation of the inner city. The building phase will then start in 2022. During the building phase it is important to involve the locals, so they are informed about the possible arrival of more tourists and they can prepare themselves to benefit from that. It is assumed that from the promotion in Miami the amount of calls will double and 20 ships will come to Suriname in 2023. At that moment Suriname should really invest in promoting the country as a single holiday destination. In 2024 the completion of the terminal is expected.

8 Conclusion

In this chapter, the research questions are answered.

What is the expected impact of a cruise port on Suriname?

Based on the background information it can be concluded that Suriname could benefit from the potential related to the cruise industry by developing a cruise port. The current economic situation in Suriname is based on the export of soil materials which is considered as highly dynamic and unsustainable. Developing the tourism industry may contribute to the differentiation and the growth of the national economy. Next to the economic benefits, tourism also has the potential to enhance social and cultural development, which is important for Suriname. This includes the creation of jobs, the urge for cultural preservation and environment protection and the need for peace and security. The cruise market is the fastest growing sector in the tourism industry and is therefore interesting for Suriname to invest in.

Cruise operators offer itineraries as products to passengers. This is an opportunity for Suriname to attract passengers that do not know Suriname as a holiday destination. Research has shown that 70% of the cruise passengers book a holiday returning to the country they visited during their cruise trip. Suriname can profit from its cultural strength to attract cruises to sail to Suriname. In the meantime, Suriname could get the opportunity to promote its eco-tourism potential to the visiting cruise passengers to attract them to book a holiday back to Suriname as a single destination.

The observation that the largest passenger amount comes from the USA, is interesting for Suriname since it is nearby. Also, inhabitants from the neighbouring country Brazil show a growing preference for local cruise travel. The greater interest in Brazilian cruises is again beneficial for Suriname. The Caribbean has the highest share in the cruise market. One of the most popular itineraries in South America is through the Amazon up to the Caribbean. This would be the most interesting itinerary for Suriname to be included in. Also intercontinental itineraries are promising. Both itineraries offer Suriname the possibility to facilitate provisions for the cruise ships such as fuel, water and food.

Which aspects should be considered when designing a cruise ship terminal in Paramaribo?

From the analysis of the physical environment and the land and infrastructure different critical aspects arise which should be taken into account to determine the best location of the cruise port. This includes the location of the tourist sights, from which most are concentrated in the inner city centre, and the fort and some plantations are located on the other side of the river, to the north. It also includes the infrastructure facilities on land. All the roads in Suriname are connected in Paramaribo. This causes congestion especially at the roundabout close to the 'Nieuwe Haven'. The project 'Dr. Jules Sidney Terminal and access roads' should alleviate this situation. On the waterside the depth is an important factor for the location of the port. The water is deeper in the outer bends of the river.

Another limiting factor for the cruise port location is the sailing time in combination with the Suriname River depth and the tidal behaviour. The navigation channel at the outer bank shows a minimum depth of 4.0 m. After the river dredging project the minimum depth will be 5.5 m during low water. The mean tidal range is 1.8 m. Since a cruise ship is only on shore for a part of the day, the touristic sights that can be reached will be limited to buildings, parks and recreational areas. Nature tours cannot be offered to cruise tourists, since transport would take too much time.

Based on a capacity of 450-1200 passengers, which is a passenger number that can be handled in Suriname, 33 ships sail near the coast of Suriname. 18 ships have a draught of 5.8 m or less, which seem most interesting for Suriname.

From the actor analysis other criteria arise which are important from their point of view. Actor willingness is essential for the success of the project. From the power interest matrix the key actors are determined. The criteria important for these key actors get a higher weighting factor in the multi criteria analysis. The government, IDB, cruise operators, STF and private property owners are the most influential actors.

What is the most optimal design for a cruise ship terminal in Paramaribo and how can this design be implemented?

From the multi-criteria analysis it is concluded that from the possible options, the Marron Markt is the most optimal. The design includes a multi functional terminal building suited for 600 pax, a new quay wall of 200 meters and a ground transportation area. This design allows ships with a draught of 5.8 m to sail the Suriname River at a tidal window above CD + 1.75 m. This allows a sailing time of 4 to 5 hours regarding neap or spring tide. There are 18 potential cruise ships that could enter the Suriname river with capacities between 200 and 1250 passengers.

The tourists can choose how to spend their time in Suriname. The terminal is close to the old city centre and there is enough time to visit plantations. The large ground transportation area ensures an effective logistic operation, with enough space for busses, taxis and kiss & ride.

Since the number of cruise ships visiting Suriname will be limited in the first years after construction, the terminal building is designed to be multi functional. The building has large open space, which makes it suitable for other events. The cruise port can also be used for smaller ship handling and the design contains a square which can be used for markets and improves the living environment in this way. This integral approach makes the design an optimal design, because it has a large positive impact on the surroundings.

What is the most feasible and socially desirable way to develop a cruise port in Paramaribo?

The main finding of this research is that a cruise port in Suriname requires an integral approach. A cruise port does not guarantee that many cruise ships will visit Suriname in the future and the area is not yet suited for many cruise tourists. On the other hand, the combination of developing cruise tourism together with many ongoing projects, like improving the infrastructure in the city centre and port, stimulating tourism in Suriname and creating a more durable economy will strengthen the positive effects of these projects. An integral approach has great potential and is necessary because the cruise port is only feasible when other projects are also carried out. An integral approach is also required to create willingness among involved actors. If the implementation plan as provided in this research is followed, the port can be constructed between 2022 and 2024 and taken into use from 2024.

The most optimal design for a cruise port requires a large investment of more than $9.5 million. With an annual revenue between $0.5 and $1.5 million, as a result of the passenger expenditures, the total revenue will be more than $10 million in 20 years. Considering a lifetime of more than 20 years, the revenues will exceed the considered construction costs. Moreover, expenditures of cruise operators for on-board provisions and other indirect or induced benefits are not yet considered. However, besides the rough estimation of these construction costs, multiple type of costs are not yet taken into account. Even more important is that the revenues will not directly be earned by the government or by an investor. Therefore, the feasibility will mainly depend on the type of financing. The willingness from cruise operators and residents, investments and governmental participation is crucial, in which fund raising and further specification of a project plan timeline and a more detailed analysis of costs estimations are considered as the next step after this research.

9 Discussion

Suriname can greatly benefit from the development of a cruise port, as shown in this report. It is, however, not guaranteed that a cruise port will be a success. There must be noted that this report is a feasibility study and not a final design, so the level of detail of the proposed design is limited. This research shows that it is very interesting to do a subsequent study.

The financial assessment of the proposed design shows that a cruise port can be very lucrative for Suriname. The financial success will depend on the financing structure, because the investment cost cannot be earned back by direct benefits only. This means that the project must be partly financed by the government. Further research is necessary to explore how the project can be financed and which parties should be involved. Moreover, the operational costs and deprivation should be included in the cost overview.

The success of the cruise port will heavily depend on the development of the tourism industry in Suriname and the fulfilment of relevant projects. This will increase the attractiveness of Suriname as destination for cruise ships. Furthermore, to fully profit from the benefits of cruise tourism, luxury segment stores should be developed near the cruise port. There is no certainty that these projects will be implemented, since it depends on the political decision making.

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A
Navigation channel

The navigation channel of the Suriname River is described in Section 2.3.2. To verify the required dimensions for the design cruise ship, a comparison to an approach channel is made. The International Navigation Association for Waterborne Transport (PIANC) has published a report, 'Harbour Approach Channels Design Guidelines', that will be referred to several times as Maritime Navigation Commission (MarCom) (2014).

Table A.1 presents the relevant dimensions of the design cruise ship as defined in Chapter 5.

Table A.1: Maximum dimensions of the cruise ships

	L [m]	W [m]	D [m]
R-Class	180	25.5	5.8

A.1. Width

In this section, the required width of the navigation channel is calculated, according to the PIANC guidelines. Since a ship makes a sinusoidal track, a 'basic width' (W_{bm}) of 1.5 times the width of the design vessel will be applied. Additional widths ($\sum W_a$) are required for the effects of wind, current and waves and the lack of visibility and the type of cargo. Furthermore, an additional width is needed depending on the type of channel bank (W_b). Equation A.1 describes the channel width for a concept design for one-way traffic. (Maritime Navigation Commission (MarCom), 2014).

$$W = W_{bm} + 2 \cdot W_b + \sum W_a \tag{A.1}$$

Table 3.5 p-87 of the PIANC-guidelines will be used applying moderate manoeuvrability and slow vessel speed.

The additional widths ($\sum W_a$) are:

- **Prevailing cross-winds**
  The wind speed of less than 15 knots most of the time near the coast as described in section 3.1.6 is classified as mild, resulting in an additional with of 0.3 B_s. The wind speed near the coast may be higher, which does not require additional width since the speed of the vessel can also be higher near the coast.
- **Prevailing cross-current**
  The maximum cross-current, as described in section 3.1.8 is equal to 0.4 m/s = 0.77 knots. This current only exists at sea, leading to an additional width of 1.0 B_s at sea and 0.3 B_s inside the Suriname River.
- **Prevailing long-current**
  The longitudinal current is maximum 0.7 m/s = 1.36 knots, resulting in an additional with of 0.0 B_s.

- **Prevailing wave-height**
  The wave height (H_s) is 2.5 m at maximum, resulting in an additional with of 0.5 B_s at sea and 0.0 B_s inside the Suriname River.
- **Aids to navigation**
  The channel is equipped with paired lighted buoys with radar reflectors and lighted leading lines and with the availability of pilots, resulting in an additional with of 0.0 B_s.
- **Seabed characteristics**
  Sand, soft, resulting in an additional with of 0.1 B_s.
- **Bottom surface**
  Since the depth of the channel is less than 1.5 times the draft of the design vessel and the bottom surface is soft, an additional width of 0.1 B_s is required.
- **Depth of waterway**
  For the same reason as above, an additional width is required of 0.2 B_s at sea and 0.4 B_s in the Suriname River.

The additional width depending on the type of channel bank (W_b) is:

- **Bank clearance**
  Gentle underwater channel slope, resulting in no additional width.

The total width of the one-way approach channel inside the Suriname River, see eq. A.2.

$$W_1 = W_{bm} + 2 \cdot W_b + \sum W_a = 66.3\ m \tag{A.2}$$

The total width of the one-way approach channel at sea, see eq. A.3.

$$W_1 = W_{bm} + 2 \cdot W_b + \sum W_a = 91.8\ m \tag{A.3}$$

A.2. Depth

The depth of approach channels depends on:

1. Draught of the design ship.
2. Ship-related factors.
3. Water level.
4. Channel bottom factors.

The various factors are represented in the equation for the guaranteed depth, see eq. A.4.

$$h_{gd} = D - h_T + s_{max} + a + h_{net} \tag{A.4}$$

where:

D : draught design vessel
h_T : tidal elevation above reference level
s_{max} : maximum sinkage due to squad and trim
a : vertical motion due to wave response
h_{net} : net keel clearance

The draught of design vessel is 5.8 m and there is assumed that the depth of the river is 5,5 m CD, when the dredging work is finished. This means that a tidal window is necessary, because the depth of the river is not sufficient.

The gross under keel clearance consists of the maximum sinkage (s_{max}), due to squat and trim, the vertical motion due to wave response (a) and the remaining safety margin (h_{net}).

The maximum sinkage is determined with the formula of Barrass for shallow water (Barrass, 2004). However, the sinkage depends on the guaranteed depth (h_{gd}). An iteration starting with a value of 0.5 m for s will result in a value of 7,35 m for h_{gd}. Various other factors (a, h_{net} and d_{tol}) are already used in this iteration and will be mentioned below.

The requirements that a vessel should have minimum speed regarding to the surrounding water for sufficient rudder control determines the entrance speed. In example an entrance speed of 4 kn and a drift angle that should not exceed a tangent of 1:4. The minimum entrance speed, with a vessel speed of (for slow vessel speed 4 kn = 2.06 m/s):

$$v_s = v_{min} + 4 \cdot v_{cross} = 3.66\ m/s$$

and:

$$v_{min} = 2.06\ m/s$$

The second iteration starting with a value of 7.55 m for h_{gd} is showed, see eq. A.5. A slope of the channel of 1:3 is used.

$$s = 3.98 \cdot \frac{C_B}{30} \cdot k^{0.81} \cdot v_s^{2.08} [m] = 0.37\ m \tag{A.5}$$

in which:

v_s = 3,66	$[m/s]$	: vessel speed
C_B = 0.8	[-]	: block coefficient
k = 0.16	[-]	: blockage coefficient

where:

$$k = \frac{A_s}{A_{ch}} = 0.16$$

for:

$$A_s = W_s \cdot D_s = 148\ m^2$$
$$A_{ch} = W_{ch} \cdot h_{gd} + 3 \cdot h_{gd}^2 = 900\ m^2$$

with:

W_s = 25,5	$[m]$	: width cruise vessel
D_s = 5,8	$[m]$	: draught design vessel
W_{ch} = 100	$[m]$	: width channel
h_{gd} = 7,35	$[m]$	: guaranteed depth

The vertical motion (a) is equal to 0.75 m, which is the wave height divided by 2. The net under keel clearance (h_{net}) is equal to 0.3 m, for a soft bottom.

s is 0.37 and the guaranteed depth h_{gd} is 7.22 m, calculated as in eq. A.6. A guaranteed water depth of 7.25 m will be applied in the design, see Chapter 5 and 7.

$$h_{gd} = D - h_T + s_{max} + a + h_{net} = 7.22\ m \tag{A.6}$$

where:

$$
\begin{aligned}
D &= 5.8 && [m]: \text{draught design container vessel}\\
h_T &= 0 && [m]: \text{tidal elevation above reference level}\\
s_{max} &= 0.37 && [m]: \text{maximum sinkage due to squad and trim}\\
a &= 0.75 && [m]: \text{vertical motion due to wave response}\\
h_{net} &= 0.3 && [m]: \text{net keel clearance}
\end{aligned}
$$

A.3. Turning circle

The turning circle is located at the end of the approach channel and at the begin of the port. A minimum diameter is required to guarantee enough space for the manoeuvres, see eq. A.7.

$$D = 2 \cdot L_s = 360\ m \tag{A.7}$$

with:

$$L_s = 180\ m$$

B
Environmental Data

B.1. Cone Penetration Tests

Figures B.2 - B.7 depicts the Cone Penetration Tests, executed by MOS Grondmechanica.

Figure B.1: Overview CPTs executed by MOS Grondmechanica 'Oeververdediging Paramaribo' (2011)

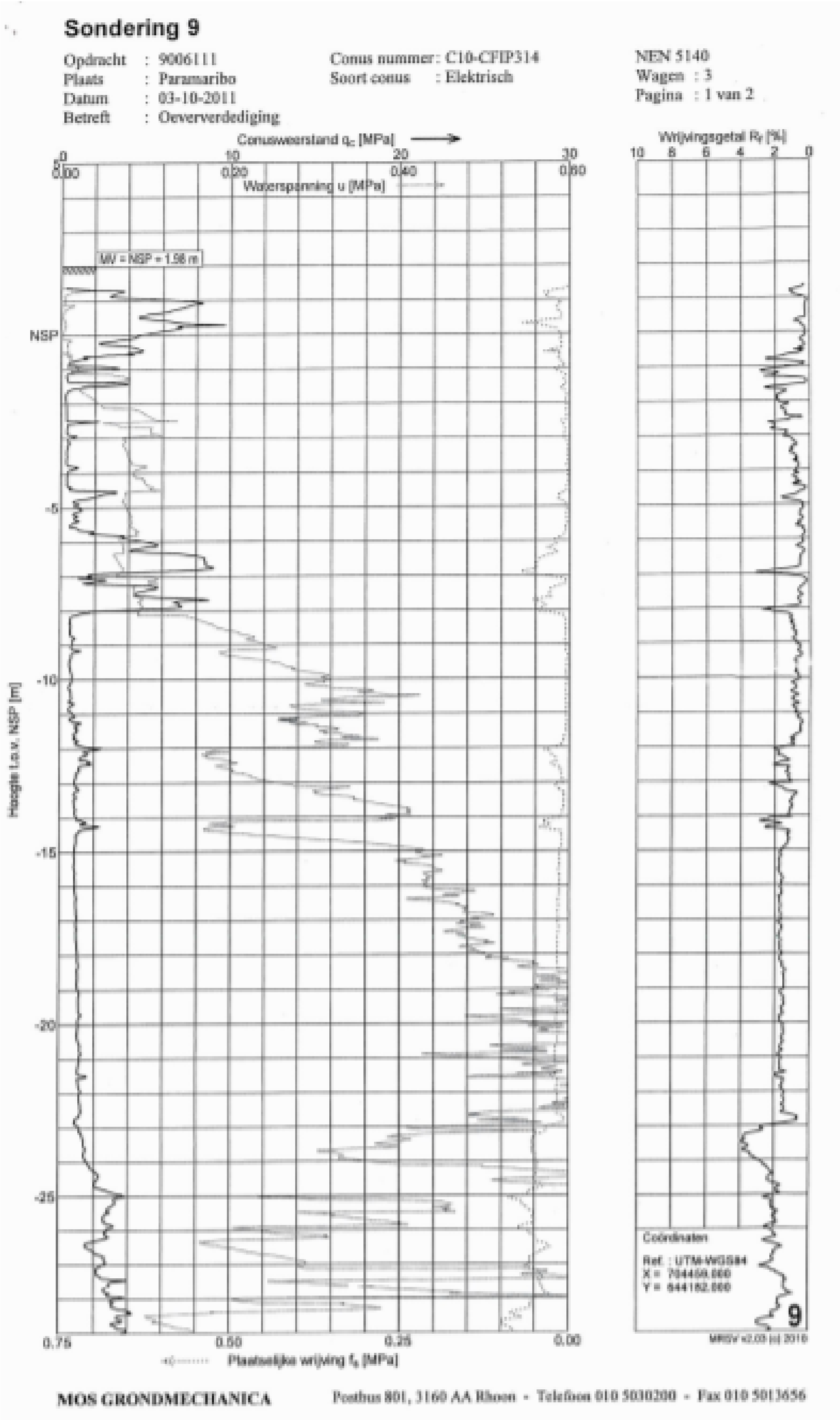

Figure B.2: CPT Paramaribo 9 1/2 (MOS Grondmechanica, 2011)

TU Delft SUNECON Royal HaskoningDHV Enhancing Society Together

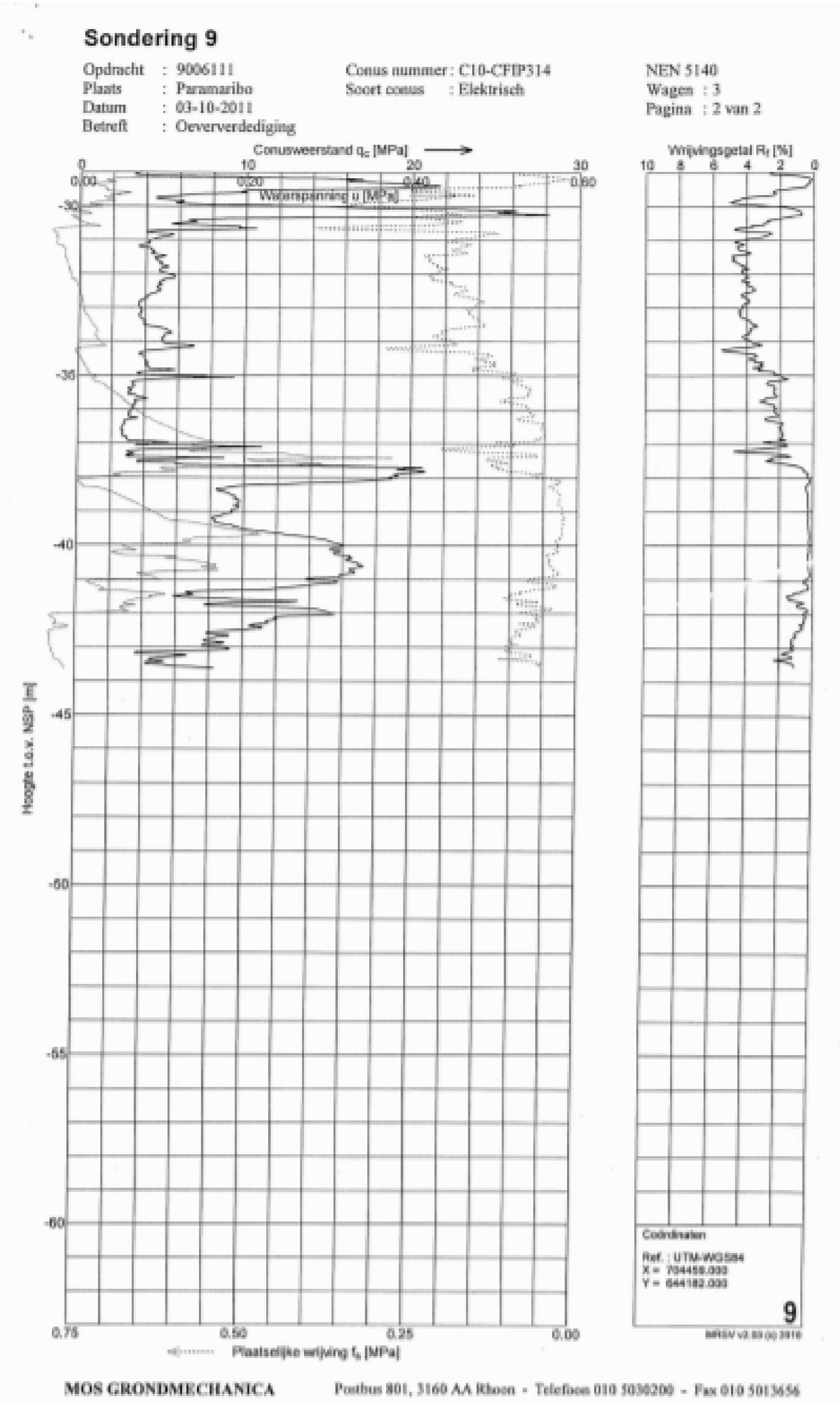

Figure B.3: CPT Paramaribo 9 2/2 (MOS Grondmechanica, 2011)

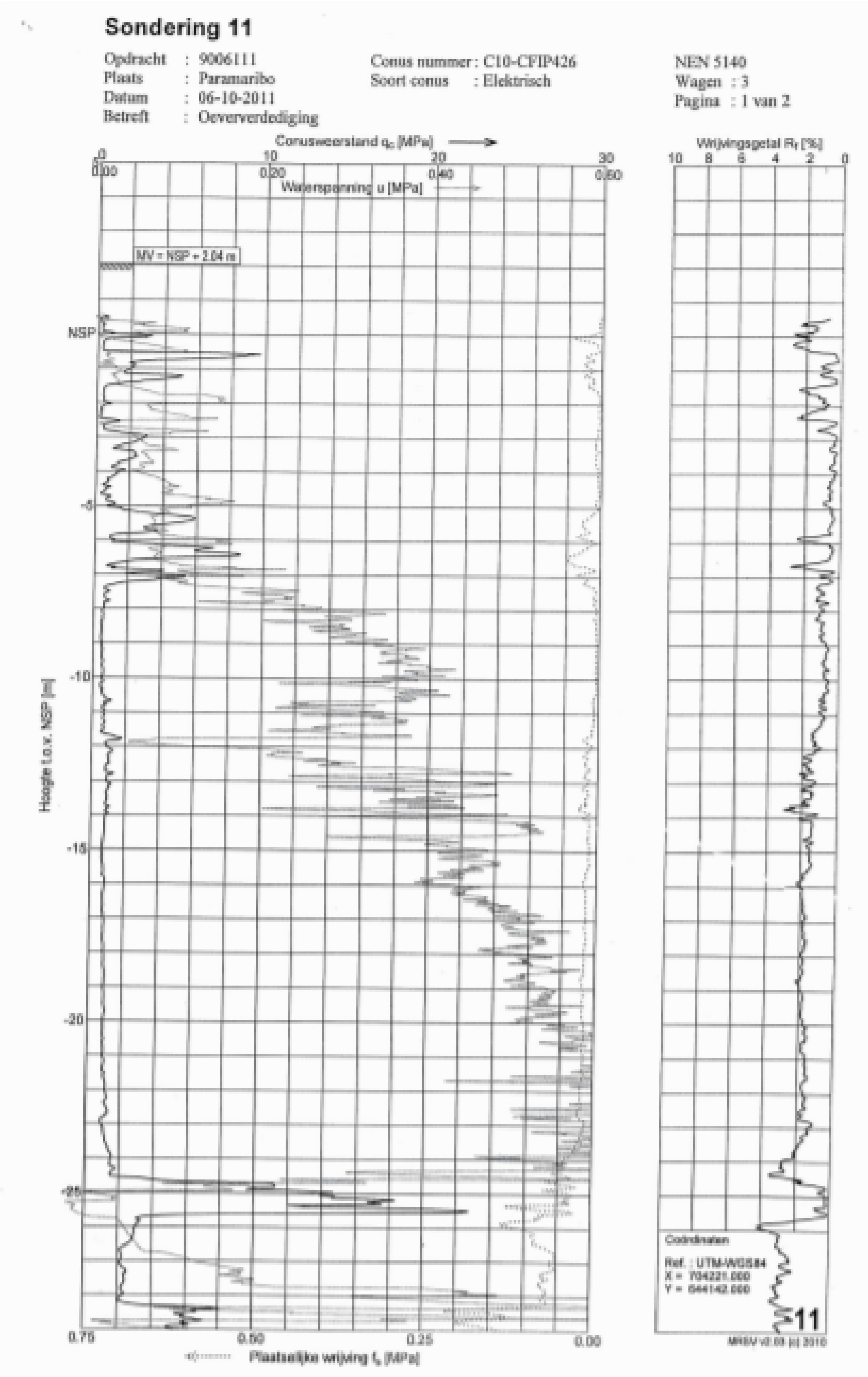

Figure B.4: CPT Paramaribo 11 1/2 (MOS Grondmechanica, 2011)

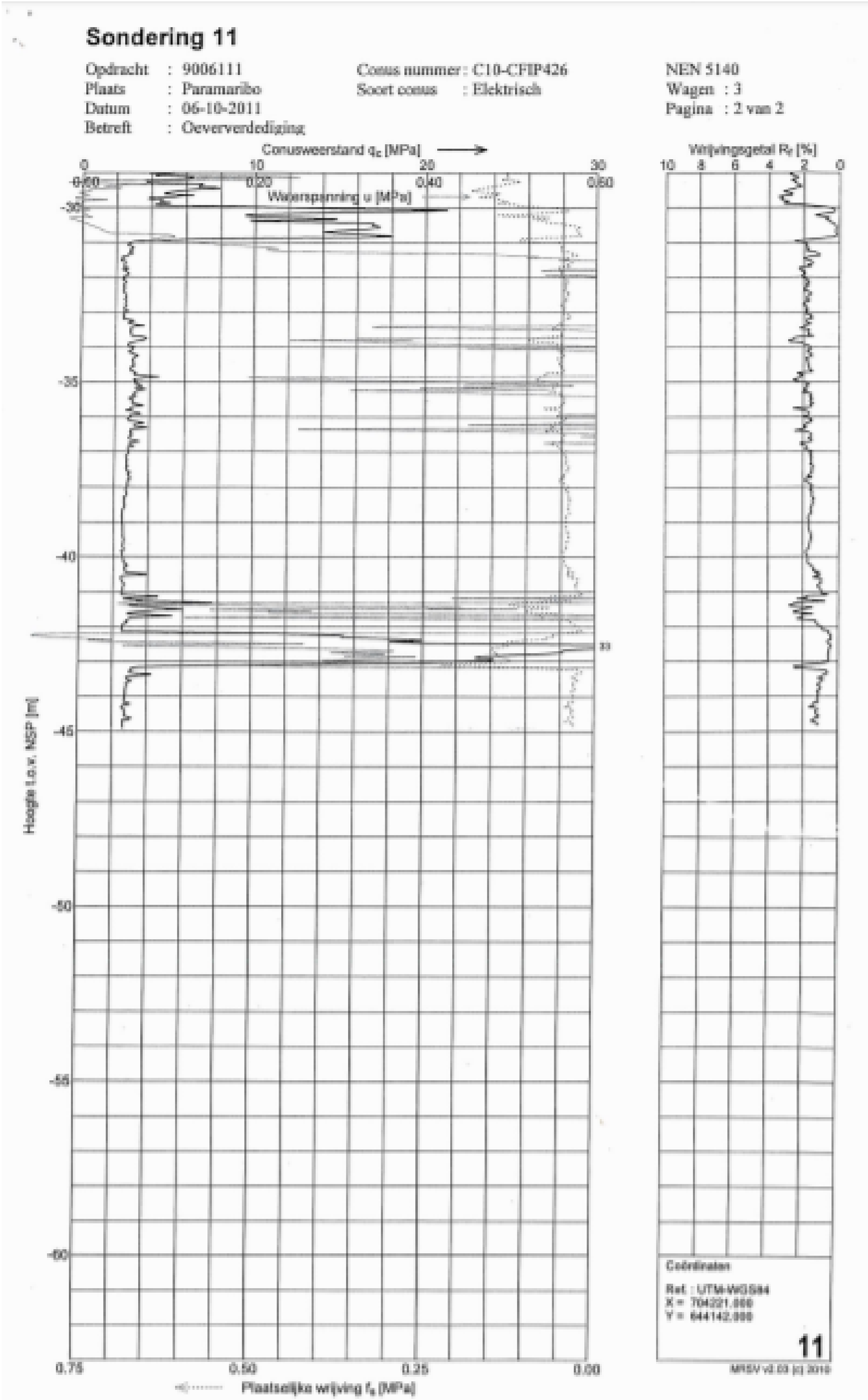

Figure B.5: CPT Paramaribo 11 2/2 (MOS Grondmechanica, 2011)

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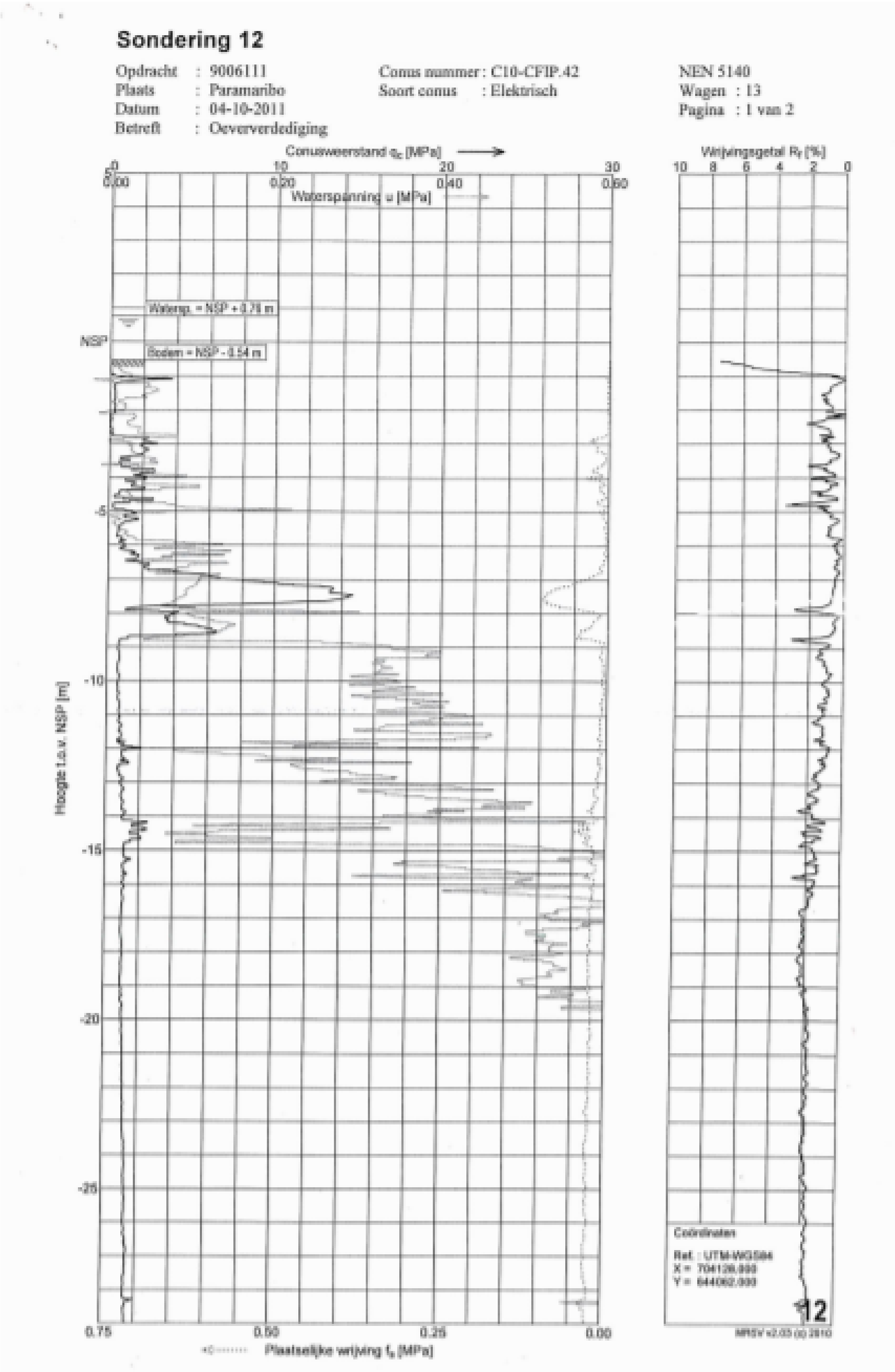


Figure B.6: CPT Paramaribo 12 1/2 (MOS Grondmechanica, 2011)

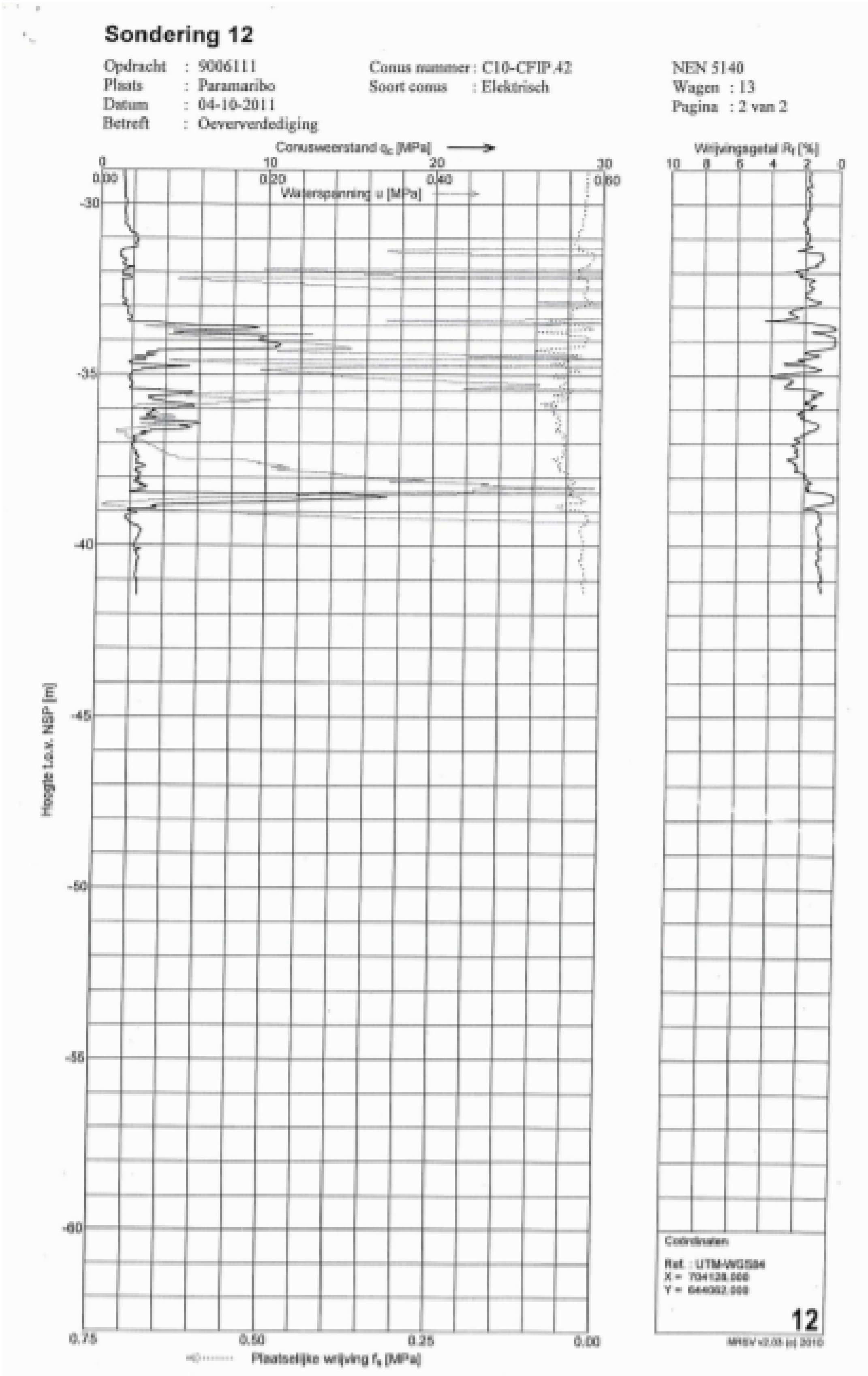


Figure B.7: CPT Paramaribo 12 2/2 (MOS Grondmechanica, 2011)

Soil type			Representative value a) of the soil property											
Main type	mix	consis-tency b)	γ c) kN/m³	γ_{sat} kN/m³	q_c d, g) Mpa	C'_p -	C'_s -	$C_c/(1+e_0)$ g)	C_α f) -	$C_{sw}/(1+e_0)$ g) -	E_{100} g,h) Mpa	φ' g) °	c' kPa	c_u (= f_{undr}) kPa
gravel	slightly silty	loose	17	19	15	500	∞	0,0046	0	0,0015	45	32,5	0	-
		moderate	18	20	25	1000	∞	0,0023	0	0,0008	75	35	0	-
		solid	19 20	21 22	30	1200 1400	∞	0,0019 0,0016	0	0,0006 0,0005	90	37,5 40	0	-
	greatly silty	loose	18	20	10	400	∞	0,0058	0	0,0019	30	30	0	-
		moderate	19	21	15	600	∞	0,0038	0	0,0013	45	32,5	0	-
		solid	20 21	22 22.5	25	1000 1500	∞	0,0023 0,0015	0	0,0008 0,0005	75 110	35 40	0	-
sand	clean	loose	17	19	5	200	∞	0,0115	0	0,0038	15	30	0	-
		moderate	18	20	15	600	∞	0,0038	0	0,0013	45	32,5	0	-
		solid	19 20	21 22	25	1000 1500	∞	0,0023 0,0015	0	0,0008 0,0005	75 110	35 40	0	-
	slightly silty clayey		18 19	20 21	12	450 650	∞	0,0051 0,0035	0	0,0017 0,0012	35 50	27 32,5	0	-
	greatly silty clayey		18 19	20 21	8	200 400	∞	0,0115 0,0058	0	0,0038 0,0019	15 30	25 30	0	-
loam e)	slightly sandy	weak	19	19	1	25	650	0,0920	0,0037	0,0307	2	27,5 30	0	50
		moderate	20	20	2	45	1300	0,0511	0,0020	0,0170	3	27,5 32,5	1	100
		solid	21 22	21 22	3	70 100	1900 2500	0,0329 0,0230	0,0013 0,0009	0,0110 0,0077	5 7	27,5 35	2,5 3,8	200 300
	greatly sandy	-	19 20	19 20	2	45 70	1300 2000	0,0511 0,0329	0,0020 0,0013	0,0170 0,0110	3 5	27,5 35	0 1	50 100
clay	clean	weak	14	14	0.5	7	80	0,3286	0,0131	0,1095	1	17,5	0	25
		moderate	17	17	1	15	160	0,1533	0,0061	0,0511	2	17,5	5	50
		solid	19 20	19 20	2	25 30	320 500	0,0920 0,0767	0,0037 0,0031	0,0307 0,0256	4 10	17,5 25	13 15	100 200
	slightly sandy	weak	15	15	0.7	10	110	0,2300	0,0092	0,0767	1,5	22,5	0	40
		moderate	18	18	1.5	20	240	0,1150	0,0046	0,0383	3	22,5	5	80
		solid	20 21	20 21	2.5	30 50	400 600	0,0767 0,0460	0,0031 0,0018	0,0256 0,0153	5 10	22,5 27,5	13 15	120 170
	greatly sandy		18 20	18 20	1	25 50	320 1680	0,0920 0,0164	0,0037 0,0007	0,0307 0,0055	2 5	27,5 32,5	0 1	0 10
	organic	weak	13	13	0.2	7.5	30	0,3067	0,0153	0,1022	0,5	15	0 1	10
		moderate	15 16	15 16	0.5	10 15	40 60	0,2300 0,1533	0,0115 0,0077	0,0767 0,0511	1 2	15	0 1	25 30
peat	not preloaded	weak	10 12	10 12	0.1	5 7.5	20 30	0,4600 0,3067	0,0230 0,0153	0,1533 0,1022	0,2 0,5	15	1 2,5	10 20
	moderately preloaded	moderate	12 13	12 13	0.2	7.5 10	30 40	0,3067 0,2300	0,0153 0,0115	0,1022 0,0767	0,5 1,0	15	2,5 5	20 30
variation coefficient			0,05		-	0,25						0,10	0,20	

a) The table gives the low and the high characteristic value of the average of the soil type concerned. If an increase of the characteristic value of a soil property would lead to a situation that is more unfavourable than the given low value for that property, the value on the right should be used. If there is no value mentioned on the right side of a cell, then the value just below it should be used. This is, for example, the case for negative friction on a pile where a higher value for φ', c' and c_u also results in a high value of the negative friction. The table gives the high characteristic average values for $C_c/(1+e_0)$, C_α and $C_{sw}/(1+e_0)$.
b) Loose: $0 < R_n < 0{,}33$; moderate: $0{,}33 < R_n < 0{,}67$; solid: $0{,}67 < R_n < 1{,}00$.
c) The γ-values are applicable to a natural moisture content
d) The values for q_c (cone resistance) given in this table should be considered as entry values for use of the table and should not be used in calculations.
e) The values concern saturated loam
f) The C_α-values are valid for a trajectory of stress increase of at least 100%.
g) For gravel, sand and to a lesser extent also for loam and sandy clay, q_c, E_{100}, φ' and the compressibility coefficients C'_p, $C_c/(1+e_0)$ and $C_{sw}/(1+e_0)$ are normalised for an effective soil stress σ'_v of 100 kPa. In that sense the equation $q_{c,table} = q_{c,measured} \cdot C_{qc}$ should be used, where $C_{qc} = (100/\sigma'_v)^{0{,}67}$. For an angle of internal friction φ' and cohesion c' it applies that these are dependent on the consistency of the soil. This implies that this conversion is also needed for φ' and c'. If $q_{c,table}$ would become larger than the value given in the table, the value given in the lowest row of the concerning soil type should be used.
h) The Youngs' modulus in case of recurrent stress can be considered to be three times the given value.

Example: In clean sand at a depth of 5 m below water it is measured that: $q_{c,field} = 9$ MPa and $\sigma'_v = 50$ kPa. C_{qc} then is $2^{0.67} \approx 1{,}6$ and $q_{c,table} = 9 \cdot 1{,}6 = 14.4$ MPa. This means that $E = 45$ MPa, $\varphi' = 32{,}5°$, $C'_p = 600$, $C_c/(1+e_0) = 0{,}0038$ and $C_{sw}/(1+e_0) = 0{,}0013$.

Figure B.8: Indicative soil properties according to Eurocode 7 NEN-EN9997

B.2. Climatological Data

Figure B.9 depicts the location of the Intertropical Convergence Zone (ITCZ).

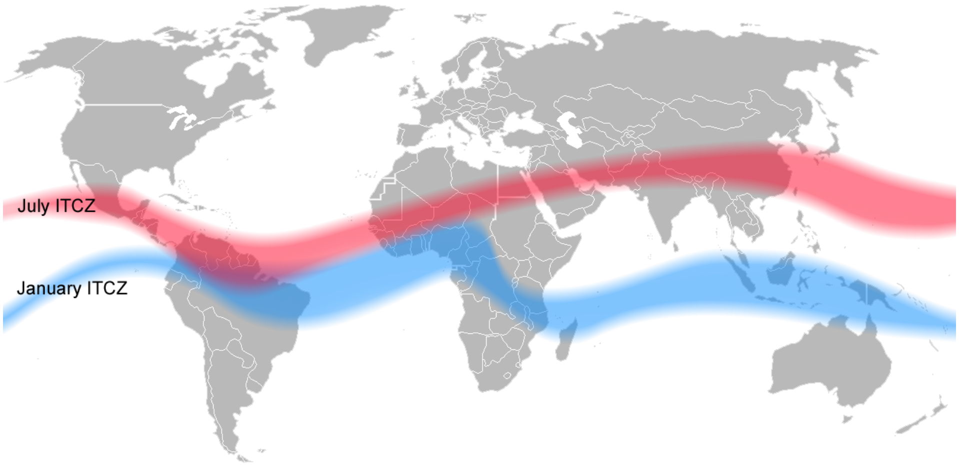


Figure B.9: Location of the Intertropical Convergence Zone (ITCZ) in January (blue) and July (red)

Figures B.10 - B.12 depicts the Wind Roses (July – December 2017), executed by Environmental Sciences Limited (ESL).

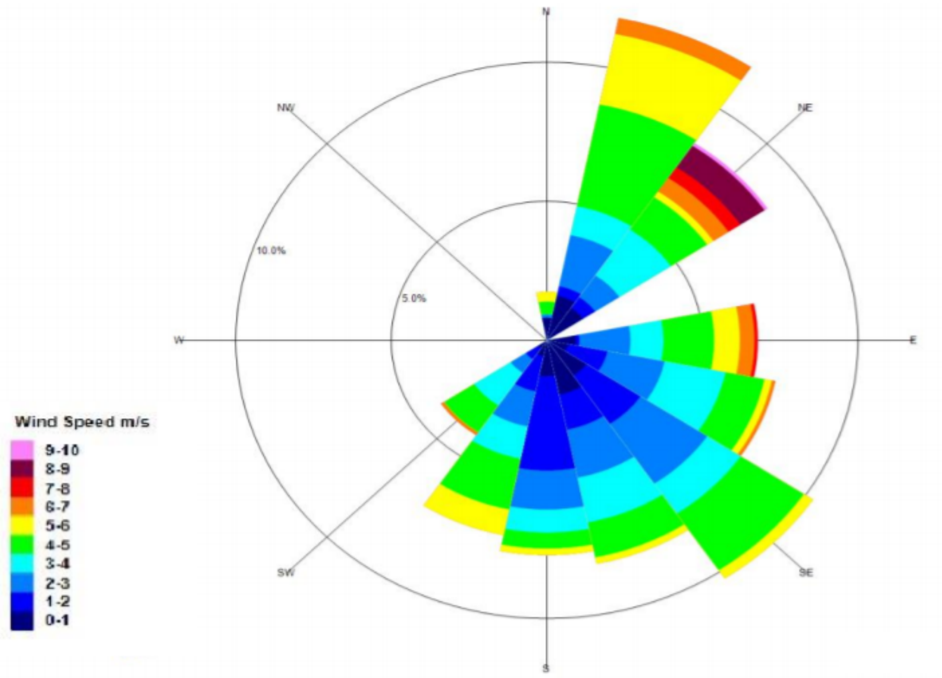


Figure B.10: Wind Rose for the Long Wet Season (ESL Meteorological Station; Weg naar Zee; July 2017).

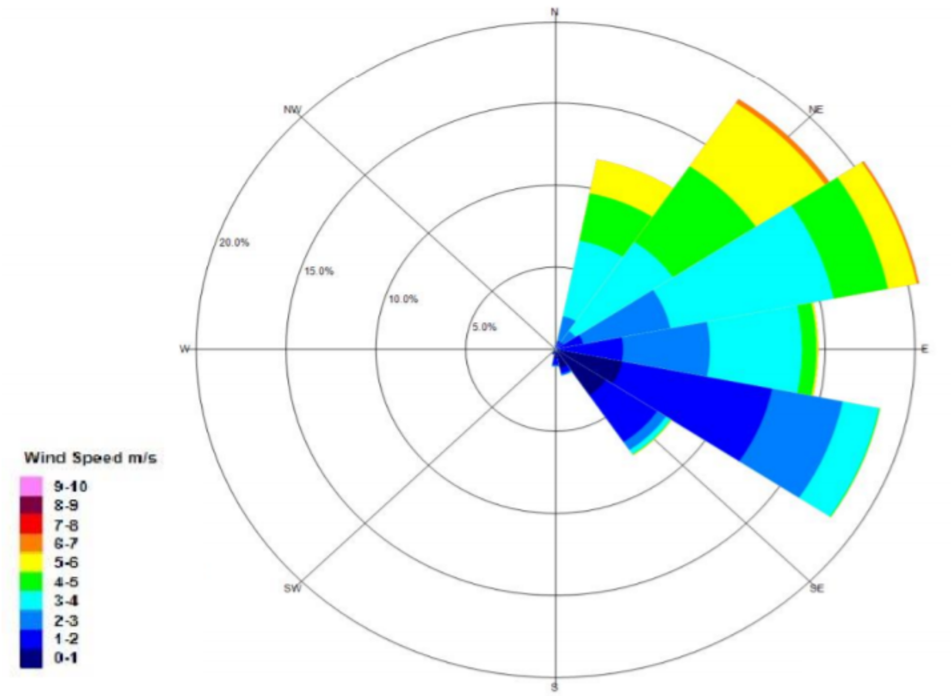


Figure B.11: Wind Rose for the Long Dry Season (ESL Meteorological Station; Weg naar Zee; August – November 2017).

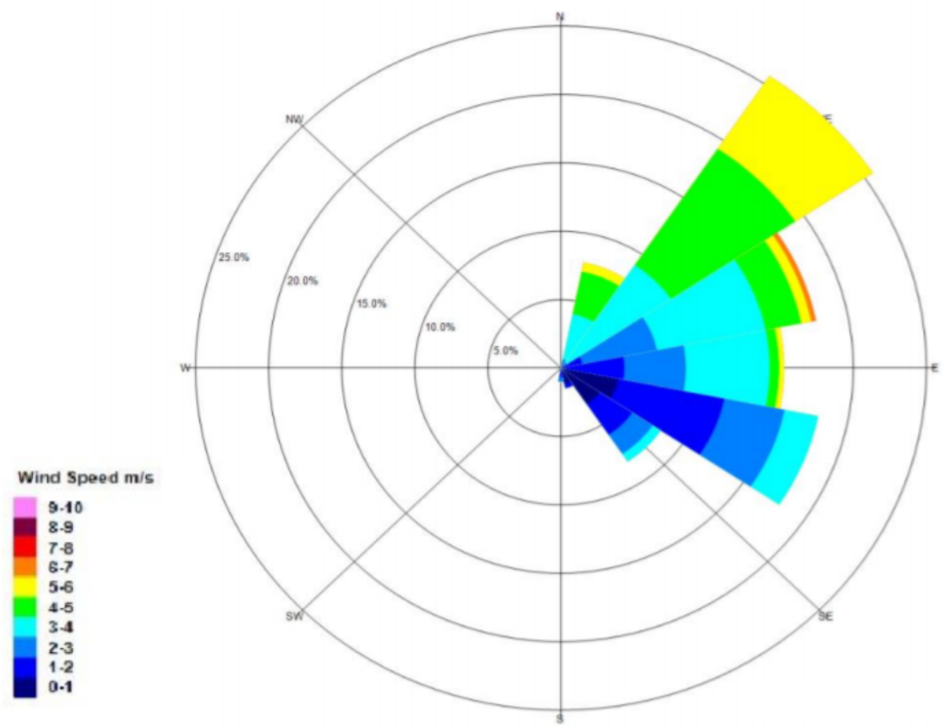


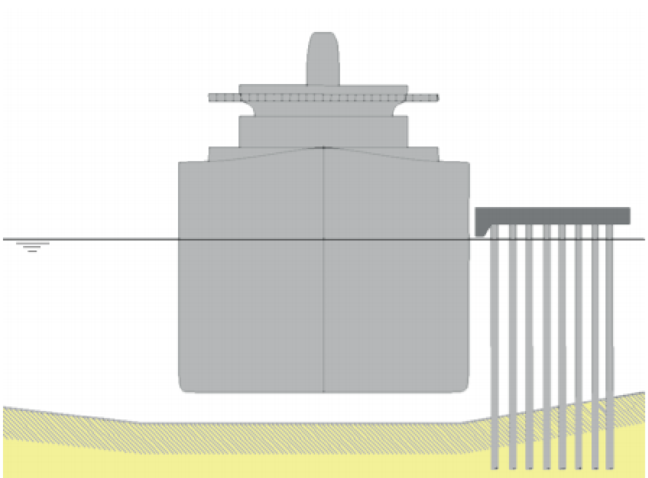
Figure B.12: Wind Rose for the Short Wet Season (ESL Meteorological Station; Weg naar Zee; December 2017).

C
Loads

C.1. Berthing

C.1.1. Berthing Energy

Berthing a ship to a structure result in a certain berthing impact. Figure C.1 depicts a schematic representation of a berthing vessel including the main parameters relevant to calculating the berthing impact. The applied method is retrieved from dr.ir. S. van Baars et al. (2017).



k_{ship} = stiffness of the ship's hull
k_{water} = hydrodynamic stiffness
$k_{structure}$ = stiffness of the structure

m_{ship} = mass of the ship
m_{water} = hydrodynamic-, added mass
$m_{structure}$ = mass of the structure

c_{ship} = damping of the ship's hull
c_{water} = hydrodynamic damping
$c_{structure}$ = damping of the structure

Figure C.1: Schematization of a berthing vessel and main parameters related to berthing impact (dr.ir. S. van Baars et al., 2017).

Together with the water that moves along, the ship to be moored has the following amount of kinetic energy:

$$E_{kin} = \frac{1}{2}(m_s + m_w) \cdot v_s^2 \tag{C.1}$$

with:

m_s [kg] : mass of the ship
m_w [kg] : mass of the water moving with the ship; additional mass
v_s [m/s] : velocity of the ship and water (⊥ structure)

The kinetic energy has to be absorbed by the berthing structure and it is a measure of the load on a structure. The maximum force that develops between the ship and the berthing structure largely depends on the stiffness of the whole ship-water-structure system. This system can be schematized as a mass-spring-dashpot system, see Figure C.2.

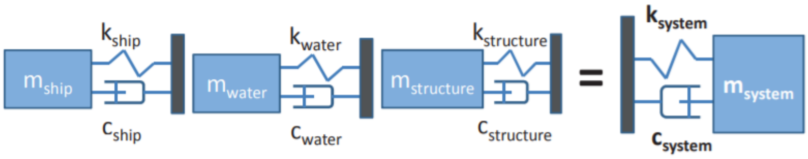


Figure C.2: Schematisation of a berthing vessel as a mass-spring-dashpot system (dr.ir. S. van Baars et al., 2017).

In a preliminary design damping will be neglected, which results in a conservative calculation of the berthing load on the structure. Without damping, which dissipates energy, all of the kinetic energy is transformed into potential energy.

Compared to the mass of the ship plus added water mass, the mass of the (moving) structure is negligible. Hence, the maximum potential energy in the spring equals the maximum kinetic energy of the ship and the water. For a linear elastic structure, equating potential and kinetic energy the relation is given by C.2. Where Δx is the displacement of the spring, and k is the spring stiffness of the total system, the water stiffness has been neglected.

$$E_{pot,max} = E_{kin,max} \Leftrightarrow \frac{1}{2} k \Delta x^2 = E_{kin,max} \Leftrightarrow \Delta x = \sqrt{\frac{2E_{kin,max}}{k}} \tag{C.2}$$

The total amount of kinetic energy to be absorbed by the structure is equal to:

$$E_{kin} = \frac{1}{2} \cdot m_s \cdot v_s^2 \cdot C_H \cdot C_E \cdot C_S \cdot C_C \tag{C.3}$$

where:

m_s	[kg]	: mass of the ship (displacement of the ship M_D)
v_s	[m/s]	: velocity of the ship (component ⊥ structure)
C_H	[-]	: hydrodynamic coefficient
C_E	[-]	: eccentricity coefficient
C_S	[-]	: softness coefficient
C_C	[-]	: configuration coefficient

The coefficients are explained in the subsections below. Besides the amount of kinetic energy to be absorbed during mooring, other forces on the ship must also be taken into account, such as wind and current. These forces are transferred to the structure via the ship.

The stiffness of the structure depends both on the structure (including the foundation) and on the used fenders. In very stiff structures the fenders are normative. (dr.ir. S. van Baars et al., 2017, p.165-167)

Hydrodynamic coefficient

The hydrodynamic coefficient is the ratio between the mass of the ship plus the water moving with the ship and the mass of the ship, see eq. C.4. (dr.ir. S. van Baars et al., 2017, p. 167)

$$C_H = \frac{m_s + m_w}{m_s} \tag{C.4}$$

with a simple approximation for a preliminary design (Stelson Mavils' equation):

$$m_w = \rho \cdot L \cdot \frac{1}{4} \cdot \pi \cdot D^2 \tag{C.5}$$

and:

$$m_s = \rho \cdot L \cdot B \cdot D \cdot C_b$$

where:

ρ =	1025.0	$[kg/m^3]$	: density of (sea)water
L =	181.0	$[m]$	: length of the ship
D =	5.8	$[m]$	: draught of the ship
B =	25.5	$[m]$	: width of the ship

Resulting in a simplified equation for the hydrodynamic coefficient with an assumption for the block coefficient ($C_b \approx \pi/4$):

$$C_H = \frac{m_s + m_w}{m_s} \approx 1 + \frac{D}{B} = 1.22$$

Coefficient of eccentricity

When a ship moors eccentrically against a structure, energy is dissipated by the *yawing* of the ship. The coefficient of eccentricity takes this energy dissipation into account and is determined by eq. C.6. Typical values are $0.4 \leq C_E \leq 0.7$. Figure C.3 depicts the symbols. (dr.ir. S. van Baars et al., 2017, p. 168).

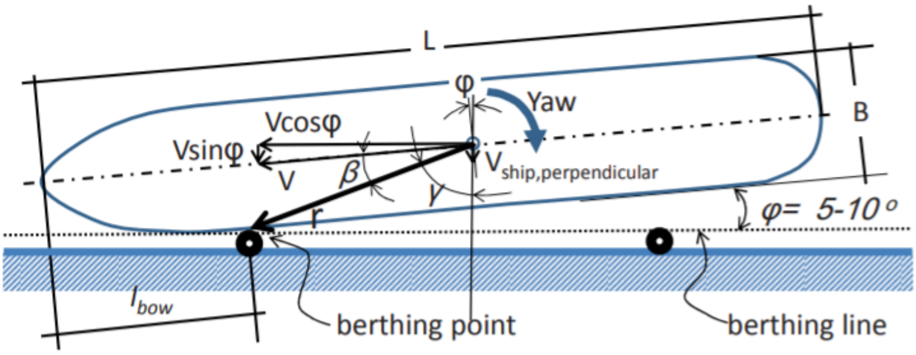


Figure C.3: Coefficient of eccentricity (C_E)

$$C_E = \frac{k^2 + r^2 \cdot cos^2(\gamma)}{k^2 + r^2} = 0.60 \tag{C.6}$$

with:

$$\gamma = 90° - \beta - \phi = 65° \tag{C.7}$$

and:

$$r = \sqrt{(1/2 \cdot L - l_{bow})^2 + 1/4 \cdot B^2} = 73.5\ m \tag{C.8}$$

where:

k	$[m]$	: radius of gyration of the ship
r	$[m]$	: radius between the gravity centre of the ship and the berthing point
β	$[°]$	: angle between radius r and the ship's velocity along the axis of the ship, approximately 15°
γ	$[°]$	: angle between radius r and the ship's velocity perpendicular to the berthing line
ϕ	$[°]$	: the berthing angle, approximately 10°
l_{bow}	$[m]$	: distance between the bow tip and the point,
		: where the straight part of the hull starts to curve to the bow, appr. 1/10 · L

The radius of gyration can be approximated by:

$$k = (0,19 \cdot C_b + 0,11) \cdot L = 45.7\ m$$

where:

C_b	[-]	: block coefficient, approximately 0.75 for cruise ships
L	[m]	: length of the ship

Soft coefficient

The softness coefficient takes into account the elasticity of the ship's side, depending on the stiffness of the fender and that of the hull of the ship. C_S is in the range of 0.9 to 1.0, for weak to stiff structures respectively. When the hull of the ship deflects elastically, a small amount of energy will be absorbed. For safety reasons, C_S = 1.0 is used (dr.ir. S. van Baars et al., 2017, p.168).

Configuration coefficient

The fact that water has to be squeezed away from the space between the ship and quay structure dissipates energy. The berth configuration coefficient takes this energy dissipation into account.

If the structure is closed, i.e. a straight vertical sheet pile wall, a cushion of water between the structure and ship will slow the ship down. For a closed quay and parallel mooring ($\theta = 0°$) this can lead to a 20% reduction of the amount of energy to be absorbed. If there is a small angle between the ship and the quay ($\theta = 5°$) this reduction can disappear almost entirely because the water can simply flow away. Since berth angles are likely, C_C = 1.0 will be used. (dr.ir. S. van Baars et al., 2017, p.169)

Conclusion

The normal kinetic energy to be absorbed by the fender system is equal to 125 kNm, see eq. C.9. A fender which can transmit an acceptable horizontal force against the berth-structure front will be selected. Each fender unit must be capable of absorbing the full impact energy since ships almost always contact only one fender on the first impact. (Thoresen, 2003)

$$E_{kin,n} = \frac{1}{2} \cdot m_s \cdot v_s^2 \cdot C_H \cdot C_E \cdot C_S \cdot C_C = 125\ kNm \tag{C.9}$$

where:

m_s :	15,100	[t]	: mass of the ship (displacement of the ship M_D)
v_s :	0.15	[m/s]	: velocity of the ship (component ⊥ structure) for moderate conditions with tug assistance
C_H :	1.22	[-]	: hydrodynamic coefficient
C_E :	0.60	[-]	: eccentricity coefficient
C_S :	1.0	[-]	: softness coefficient
C_C :	1.0	[-]	: configuration coefficient

According to MarCom (2002, Table 4.2.5), an Abnormal Impact factor of 2.0 should be taken into account due to abnormal impacts like mishandling, malfunction or exceptionally adverse wind or current or a combination of them.

$$E_{kin,a} = 2 \cdot E_{kin,n} = 250\ kNm \tag{C.10}$$

C.1.2. Fender Selection

According to MarCom (2002), the Rated Performance Data (RPD) should be considered, see eq. C.11. The energy capacity of the fender (E_{RPD}) should be greater than the abnormal energy. Manufacturing tolerance, compression angle, operating temperatures, and compression speeds should also be considered. (ShibataFenderTeamAG, 2015)

$$E_{RPD} \leq \frac{E_{kin,a}}{f_{tol} \cdot f_{vel} \cdot f_{temp} \cdot f_{ang}} = 285 \; kNm \tag{C.11}$$

where:

$E_{kin,a}$:	250	[kNm]	: kinetic energy to be absorbed by the fender system
f_{tol} :	0.9	[-]	: manufacturing tolerance for moulded rubber fenders
f_{vel} :	1.0	[-]	: velocity factor for an initial berthing velocity of 0.15 m/s, datum velocity is 0.15 m/s
f_{temp} :	0.98	[-]	: temperature factor at 30 $\pm$ 5°C, datum temperature is 23°C
f_{ang} :	1.0	[-]	: angle factor for $<$ 10°, datum compression angle is 0°

Retrieved from Shibata Fender Team (2019), the SPC 900 Cone Fender (G 1.6) is chosen with E_{RPD} = 310 kNm and R_{RPD} = 656 kN. Table C.1 and Figure C.4 present the dimensions of the cell fender SPC 900. (Shibata Fender Team, 2019)

	H	⌀ D	⌀ d	t	E	⌀ PD	⌀ Pd	Anchors/Bolts	Weight
SPC 900	900	1450 mm	785 mm	36 mm	72 mm	1313 mm	630	6 x M30	850 kg

Table C.1: SPC Cone Fenders Dimensions (Shibata Fender Team, 2019).

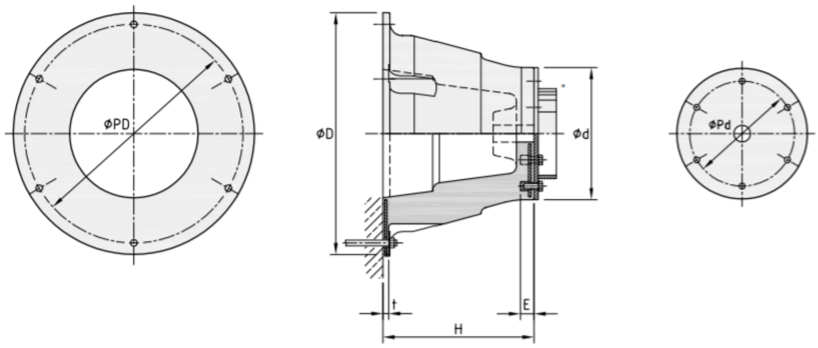


Figure C.4: SPC Cone Fenders Dimensions (Shibata Fender Team, 2019).

The distance between the fenders is set at 7 m. Abnormal berthing impacts ($E_{kin,a}$ = 250 kNm) on a SPC 900 Cone Fender (E_{RPD} = 310 kNm), with a corresponding berthing reaction force R_f of 656 kN, will result in a maximum horizontal load of 82 kN/m' berth.

C.2. Mooring Forces

Forces in the mooring ropes caused by a cruise ship can be a result of loads on the ship, such as wind and current, and movements of the ship.

For a preliminary design the mooring forces of seagoing vessels, like cruise ships, can be assumed as stated in Table C.2. (dr.ir. S. van Baars et al., 2017)

Water displacement of ship [ton]	Mooring force [kN]
< 2,000	0 - 100
2,000 - 10,000	100 - 300
10,000 - 20,000	300 - 600
20,000 - 50,000	600 - 800
50,000 - 100,000	800 - 1,000
100,000 - 200,000	1,000 - 1,500
> 200,000	1,500 - 2,000

Table C.2: Mooring forces per bolder

A normative mooring force of 450 kN is set, since the displacement of the design vessel is equal to 15,100 tons. The mooring force results in a bollard load normal from the berth of 25 kN/m' berth and a bollard load along the berth of 20 kN/m' berth approximately for a spacing of 17.5 m between the bollards (Thoresen, 2003, p. 137). The bollards are situated 1 m from the quay wall.

C.3. Surcharge

In order to meet the service requirements of typical cruise ship loading, the structure should be designed for each of the following load conditions in general:

- Uniform loading
- Truck loads
- Point loads from cranes and/or mobile gangways

The load capacities are low compared to other types of terminals. As stated in Stichting CURNET (2008), in case of uncertain and varying surcharges a distributed load (q_{sur}) of 10 kN/m' is required. The uniformly assumed distributed load will start 1.0 m from the quay wall.

D

Sheet Piles - Blum

Figure D.1 shows a schematisation of the sheet pile wall from ground level (CD + 3.80 m)) until the bottom of the construction dock (CD - 7.25 m) plus the embedded depth d. Therefore, the retaining height (h) is equal to 11.05 m. The sheet piles will be single anchored at CD + 1.80 m (2.0 m below ground level). The LAT, equal to CD, is depicted on the left and represents the most unfavourable situation for the stability of the sheet piles. The ground water level (CD + 2.80 m) is depicted on the right. These dimensions are the starting point for the determination of the sheet pile profiles.

Based on the CPTs, as mentioned in 7, a uniform soil of slightly sandy clay (weak/moderate) is assumed. The soil properties ($\gamma_s = \gamma_d = 18kN/m^3$, $\phi = 22.5°$ and $c' = 0kPa$) are according to dr.ir. S. van Baars et al. (2017, Table 31-4).

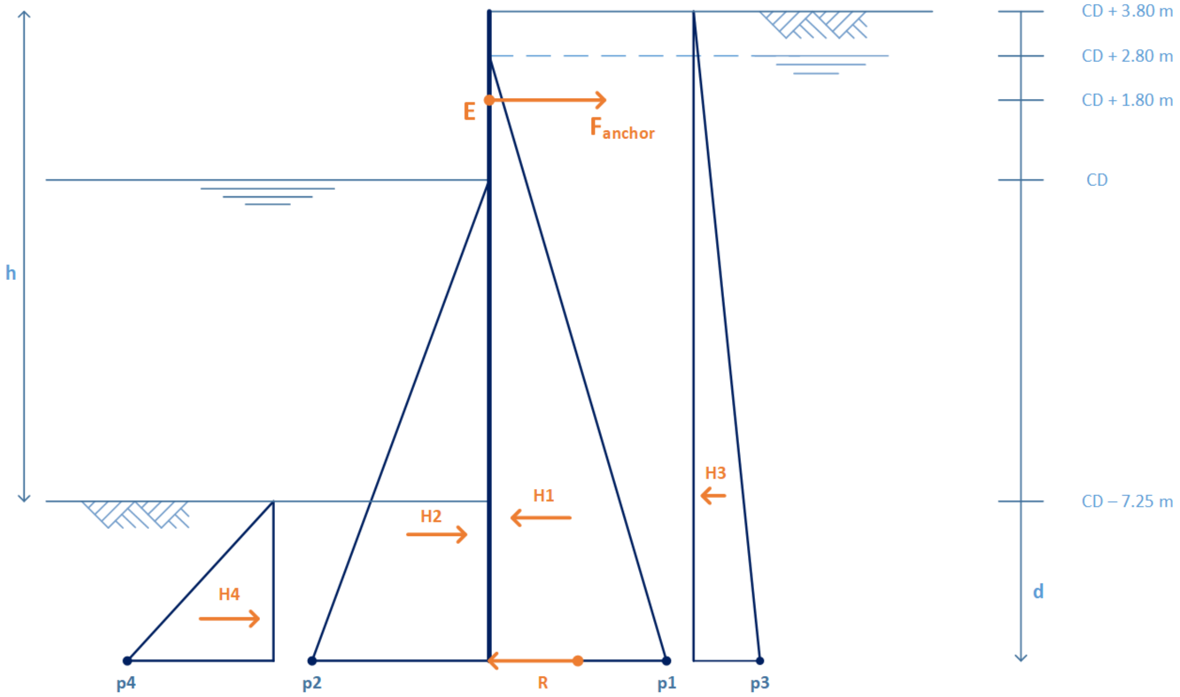


Figure D.1: Horizontal loads with a variable embedded depth (d)

Active and passive soil pressure coefficients

The horizontal pressures governing on the sheets pile walls are due to the effective horizontal soil stress and the pore pressures. A distinction is made between the effective horizontal soil stresses, since there is a difference between an active and passive side. The effective horizontal soil stress will have a greater influence on the passive side, the side to which the sheet pile walls will tend to tilt. See Figure D.2 for the active and passive slip plane.

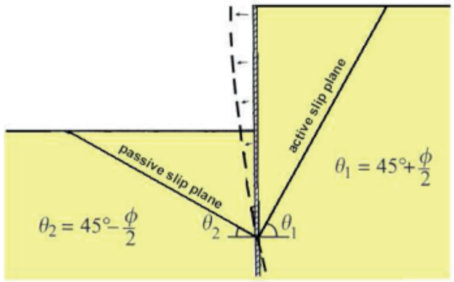


Figure D.2: Active and passive slip planes (dr.ir. S. van Baars et al., 2017).

The distinction is made by different coefficients for the influence of the vertical soil stress on the horizontal soil stress, determined by the internal friction angle (ϕ) and the angle of wall friction (δ), as shown in eq. D.1 and D.2. The coefficients are determined in eq. D.3 and D.4.

$$\sigma'_{h,min} = K_a \cdot \sigma'_v \tag{D.1}$$

$$\sigma'_{h,max} = K_p \cdot \sigma'_v \tag{D.2}$$

where:

$$K_a = \left(\frac{cos(\phi)}{1 + \sqrt{\frac{\sin(\phi+\delta) \cdot sin(\phi)}{cos(\delta)}}} \right)^2 = 0.41 \tag{D.3}$$

$$K_p = \left(\frac{cos(\phi)}{1 - \sqrt{\frac{\sin(\phi-\delta) \cdot sin(\phi)}{cos(\delta)}}} \right)^2 = 1.82 \tag{D.4}$$

and, according to Stichting CURNET (2008, Table-3.2):

$$\delta = 1/3 \cdot \phi = 7.5°$$

with:

ϕ = 22.5 [°] : internal friction angle

Blum's schematisation

Blum's schematisation will be applied to determine the required embedded depth of the sheet piles. Figure D.3 depicts the schematisation of Blum. Due to the prevailing forces and the assumption that the sheet piles are infinitely rigid, the sheet pile wall inclines to turn around point D, see Figure D.3A. Accordingly a clamping load will develop under point D, resisting the turning of the wall, see Figure D.3B. Since the length of a sheet pile wall should be longer than strictly necessary to ensure equilibrium, the passive soil pressure does not need to develop over the entire length of the embedded part of the wall. Because of this extra length the toe will act as a clamped edge, where the lowest part has the tendency to move to the right resulting in a pressure to the left. In combination with the passive soil pressure that is directed to the right this will constitute a clamping moment.

In order to calculate the required embedded depth, the real pressure diagram is replaced by a schematised diagram, see Figure D.3C. The clamping load below point D is replaced by a concentrated load (Q and in Figure D.1 noted as R) acting through point D. The theoretical embedded depth is calculated considering an equilibrium of forces around point D. (dr.ir. S. van Baars et al., 2017)

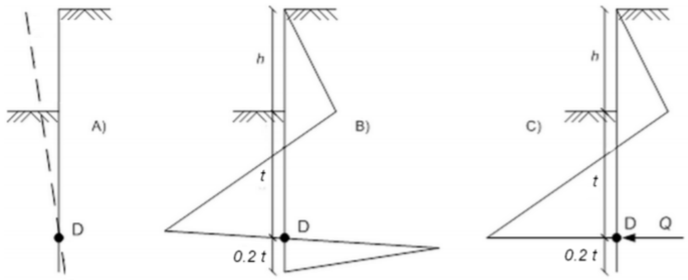


Figure D.3: Sheet pile with rotation point (A), ground pressure diagram (B) and schematised pressure diagram (C) (dr.ir. S. van Baars et al., 2017).

In case of a water head, the effect of the difference in pore pressures ($p1$ and $p2$) is considerable. The influence of the effective vertical soil stress on the effective horizontal soil stresses ($p3$ and $p4$) results in the horizontal forces H1, H2, H3 and H4, presented in Figure D.1. The forces depend on depth d. The values of the active and the passive soil pressure coefficients apply as determined in eq. D.3 and D.4.

The theoretical embedded depth (d) is determined using the condition that the horizontal displacement at the level of the anchor (point E) must be zero. This theoretical depth will be multiplied by 1.2 to compensate for the schematisation. (dr.ir. S. van Baars et al., 2017)

A first combination of 5 constantly governing loads is set. These loads are depicted in Figure D.4. The loading results in horizontal displacements (u_1, u_2, u_3, u_4 and u_5) and should be zero together. As stated in Appendix C.3, a distributed surcharge load of 10 kN/m' (according to Stichting CURNET (2008)) is assumed. Since the surcharge load (Figure D.7) is favourable for the stability of the sheet piles and the actual value of the load is unknown, the load is not taken into account. The variable berthing and mooring load are considered hereafter.

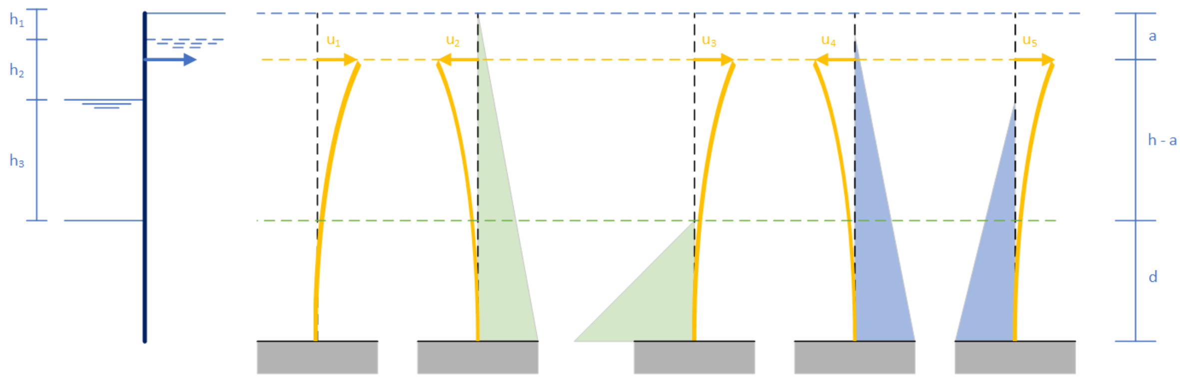


Figure D.4: Horizontal displacement at the level of the anchor (E)

The horizontal displacements are determined in eq. D.5 - D.9.

(i) Loading case due to the anchor force:

$$u_1 = \frac{T \cdot (h+d-a)^3}{3 \cdot EI} = \frac{T \cdot (h+d-a) \cdot (h+d-a)^2}{3 \cdot EI} \tag{D.5}$$

where, following from an equilibrium of moments about the toe of the sheet pile:

$$T \cdot (h+d-a) = 1/6 \cdot K_a \cdot \gamma_s \cdot (h+d)^3 - 1/6 \cdot K_p \cdot \gamma_s \cdot d^3 + 1/6 \cdot \gamma_w \cdot (h_2+h_3+d)^3 - 1/6 \cdot \gamma_w \cdot (h_3+d)^3$$

(ii) Loading case as a result of the active soil pressure, by approximation:

$$u_2 = -\frac{q_a \cdot (h+d-a)^4}{30 \cdot EI} \tag{D.6}$$

with:

$$q_a = K_a \cdot \gamma_s \cdot (h+d-a)$$

(iii) Loading case as a result of the passive soil pressure:

$$u_3 = \frac{q_p \cdot d^4}{30 \cdot EI} + \frac{q_p \cdot d^3}{24 \cdot EI} \cdot (h-a) \tag{D.7}$$

with:

$$q_p = K_p \cdot \gamma_s \cdot d$$

(iv) Loading case as a result of the right pore pressure, by approximation:

$$u_4 = -\frac{q_{w,1} \cdot (h_2+h_3+d-a)^4}{30 \cdot EI} \tag{D.8}$$

with:

$$q_{w,1} = \gamma_w \cdot (h_2+h_3+d-a)$$

(v) Loading case as a result of the left pore pressure:

$$u_5 = \frac{q_{w,2} \cdot (h_3+d)^4}{30 \cdot EI} + \frac{q_{w,2} \cdot (h_3+d)^3}{24 \cdot EI} \cdot (h_1+h_2-a) \tag{D.9}$$

with:

$$q_{w,2} = \gamma_w \cdot (h_3+d)$$

and:

$$\begin{aligned} \gamma_s &= 18\ kN/m^3 \\ \gamma_w &= 10\ kN/m^3 \end{aligned} \tag{D.10}$$

The sum of the horizontal displacements should be equal to zero, see eq. D.11 and D.12.

$$u_1 - u_2 + u_3 + u_4 + u_5 = 0 \tag{D.11}$$

and:

$$(u_1 - u_2 + u_3 + u_4 + u_5) \cdot \frac{EI}{K_p \cdot \gamma_s} = 0 \tag{D.12}$$

gives:

$$d = 22.6\ m$$

Additional loads The influence of the berthing and mooring forces (App. C.2 and App. C.1) are depicted in D.5 and D.6.

(vi) Loading case as a result of the berthing force:

$$u_6 = \frac{F_b \cdot l^3}{3 \cdot EI} + \frac{M \cdot l^2}{2 \cdot EI} = \frac{F_b \cdot (h + d - a)^3}{3 \cdot EI} + \frac{F_b \cdot a \cdot (h + d - a)^2}{2 \cdot EI} \tag{D.13}$$

where:

F_b = 82 kN/m' berth : Berthing force

(vii) Loading case as a result of the mooring force:

$$u_7 = \frac{F_m \cdot l^3}{3 \cdot EI} + \frac{M \cdot l^2}{2 \cdot EI} = \frac{F_m \cdot (h + d - a)^3}{3 \cdot EI} + \frac{F_m \cdot a \cdot (h + d - a)^2}{2 \cdot EI} \tag{D.14}$$

where:

F_m = 25 kN/m' berth : Mooring force

The sum of the horizontal displacements needs to be equal to zero, see eq. D.15 and D.16. The loading case as a result of the berthing force appears to be normative.

$$u_1 + u_2 + u_3 + u_4 + u_5 + u_6 = 0 \tag{D.15}$$

and:

$$(u_1 + u_2 + u_3 + u_4 + u_5 + u_6) \cdot \frac{EI}{K_p \cdot \gamma_s} = 0 \tag{D.16}$$

gives:

$$d = 24.25\ m$$

The length of a sheet pile wall is determined in eq. D.17.

$$L = h + 1.2 \cdot d = 40.0\ m \tag{D.17}$$

with:

h = 11.05 m

The length of 40.0 m is quite long, due to the conservative design with no surcharges and unfavourable soil properties.

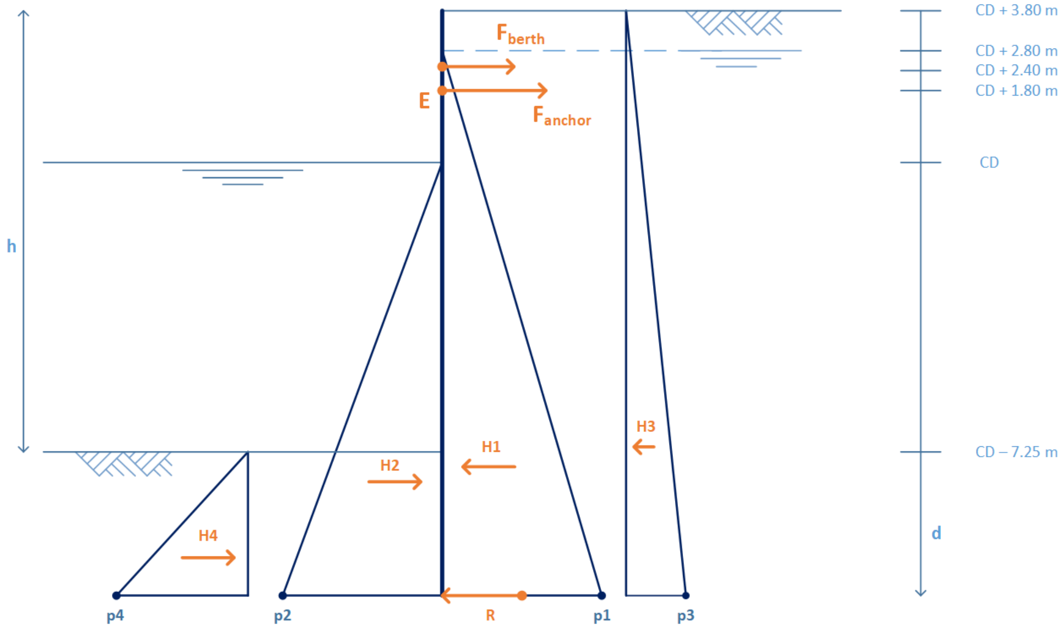


Figure D.5: Berthing load

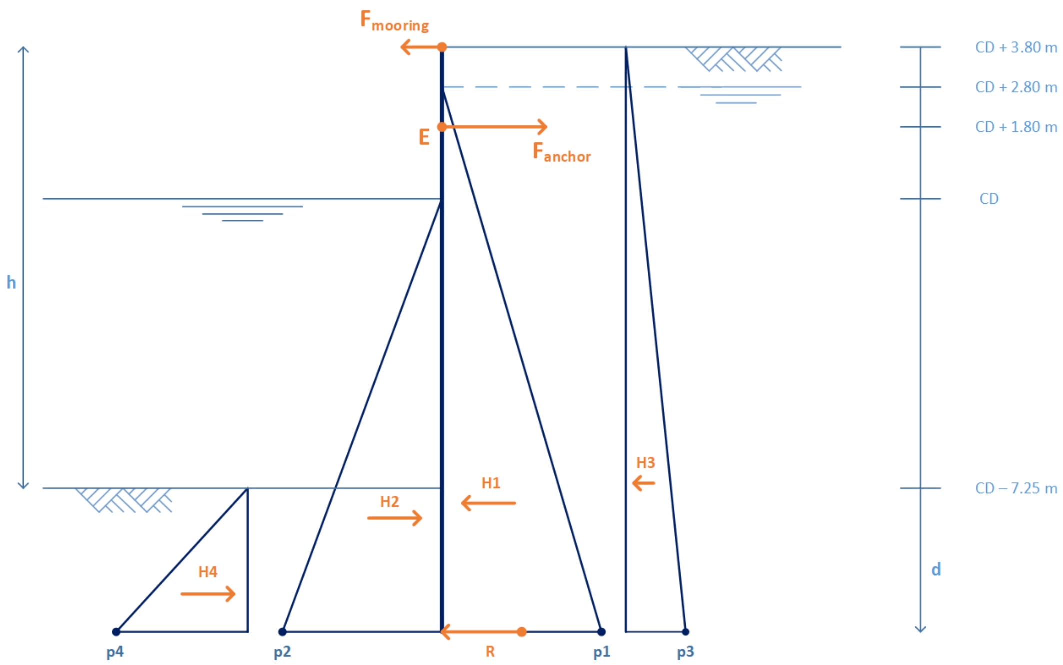


Figure D.6: Mooring load

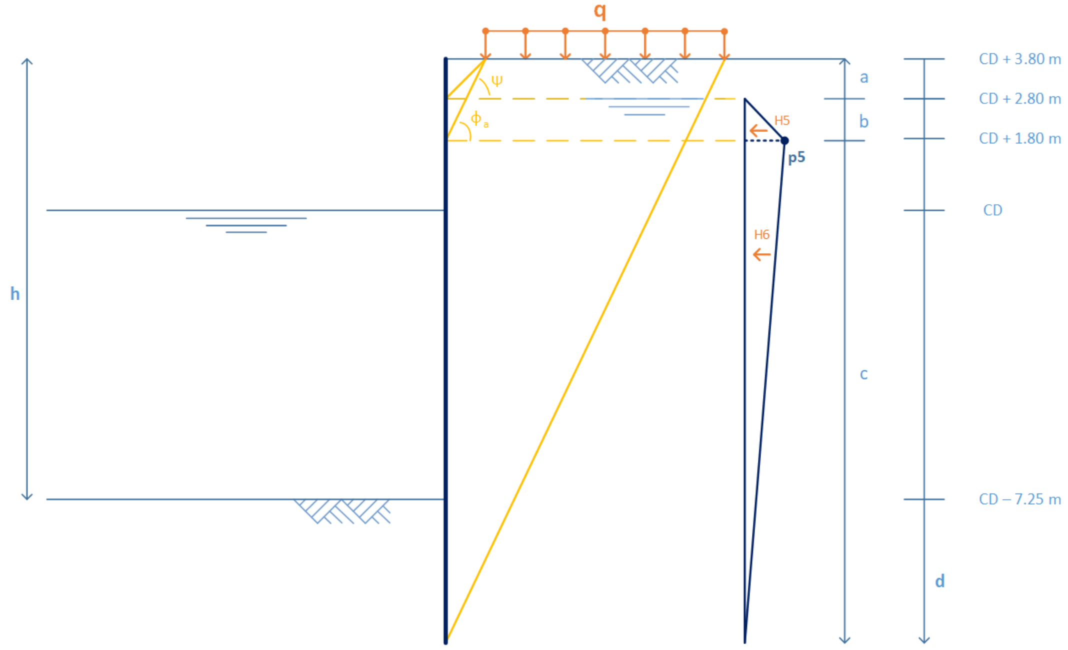


Figure D.7: Vertical load

E
Stability Quay Wall

Figure E.1 presents the straight slip planes according to Coulomb.

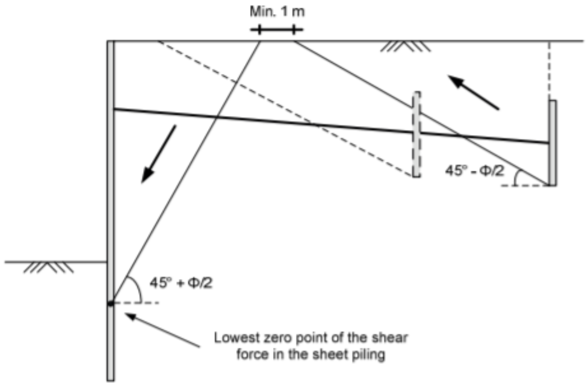


Figure E.1: Areas of influence using straight slip planes in case of a single anchor (dr.ir. S. van Baars et al., 2017, p.328)

The required minimum distance between the anchor and the sheet pile wall is equal to 22.6 m, since the lowest zero point of the shear force in the sheet piles is at CD - 14.0 m. The enclosed soil body is depicted in Figure E.2. All forces on the soil body are taken into account. Forces working directly onto the sheet piles, i.e. the berthing force, are already taken into account for the maximum anchor force.

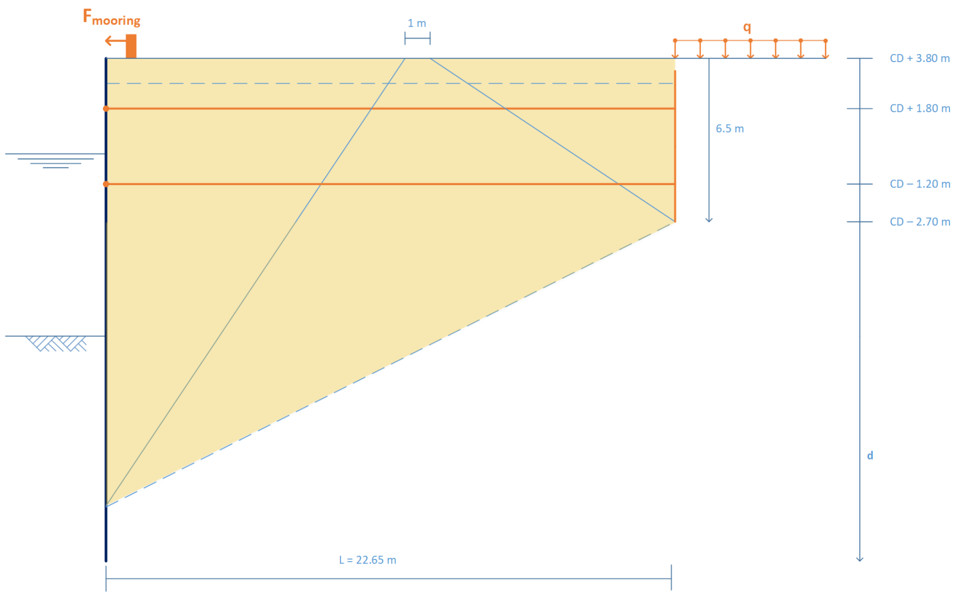


Figure E.2: Enclosed soil body by double anchor structure (ϕ = 56.25 °)

The total stability is approved as the design value of the maximum anchor force is supported by the soil retained between the sheet pile wall and the double anchored structure. The calculation in MSheet is done according to Kranz. Figure E.3 depicts the computational scheme according to Kranz.

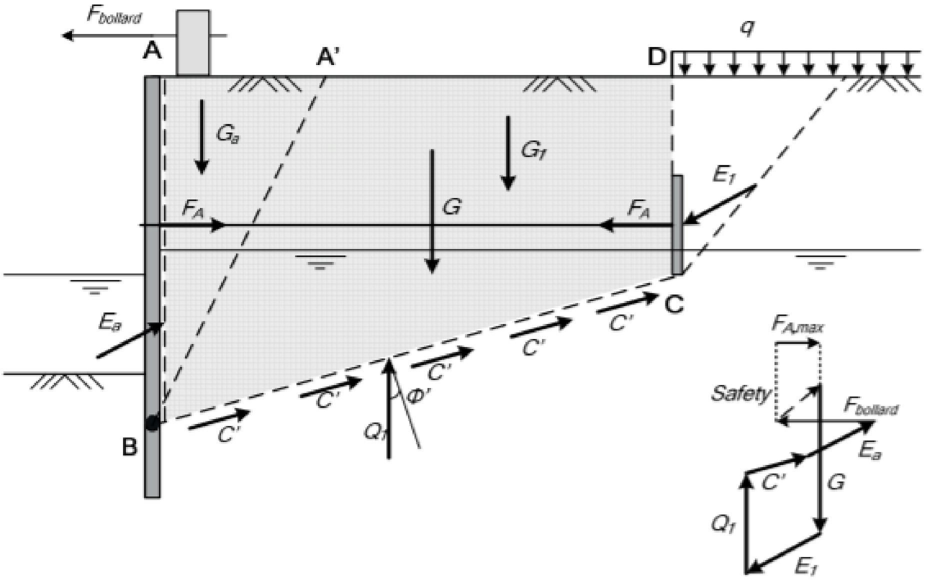


Figure E.3: Computational scheme according to Kranz (dr.ir. S. van Baars et al., 2017, p. 328)

Figure 7.4 and 7.5 present both a maximum force in the anchor of 288 kN/m' berth. However, MSheet is unable to verify the allowable anchor force for a double anchored sheet pile wall. A centre-to-centre distance (a) between the tie rods of 2 m will be applied and results in an anchor force of 576 kN per tie rod. The type GEWI-50T with a diameter of 50 mm is sufficient, see Appendix F.3.

F
Maple Sheets

F.1. Maple - Loads

> *restart*;

Coefficients

> $\mathrm{D} := 5.8 : L := 181 : B := 25.5 :$

$C_H := 1 + \frac{\mathrm{D}}{B};$

$$C_H := 1.227450980 \quad (1)$$

> $\phi := 10 : \beta := 15 : \gamma_r := 90 - \beta - \phi;$

$l_{bow} := \frac{L}{10} :$

$r := \mathrm{sqrt}\left(\left(\frac{1}{2}L - l_{bow}\right)^2 + \frac{1}{4} \cdot B^2\right);$

$C_b := 0.75 :$

$k := (0.19 \cdot C_b + 0.11) \cdot L;$

$C_E := evalf\left(\frac{k^2 + r^2 \cdot \cos^2(\gamma_r)}{k^2 + \gamma_r^2}\right)$

$$\gamma_r := 65$$
$$r := 73.51409729$$
$$k := 45.7025$$
$$C_E := 0.6016105014 \quad (2)$$

> $C_S := 1.0 : C_C := 1.0 :$

> $m_s := 15100000 : m_{s,\,ton} := \frac{m_s}{1000};$

$v := 0.15;$

$$m_{s,ton} := 15100$$
$$v := 0.15 \quad (3)$$

Kinetic energy (normal/abnormal)

> $E_{kin} := \frac{m_s}{2} \cdot v^2 \cdot C_H \cdot C_E \cdot C_S \cdot C_C$:
$E_{normal,\ kNm} := \frac{E_{kin}}{1000}$;
$E_{abnormal,\ kNm} := E_{normal,\ kNm} \cdot 2$;

$$E_{normal,kNm} := 125.4437520$$
$$E_{abnormal,kNm} := 250.8875040 \quad \textbf{(4)}$$

> $E_a := 250$;

$$E_a := 250 \quad \textbf{(5)}$$

> $E_{RPD} := \frac{E_a}{1.0 \cdot 0.9 \cdot 0.98 \cdot 1.0}$;

$$E_{RPD} := 283.4467120 \quad \textbf{(6)}$$

Berthing load

> $R_f := 656$; $R_{f,\ m} := evalf\left(\frac{R_f}{8}\right)$;

$$R_f := 656$$
$$R_{f,m} := 82. \quad \textbf{(7)}$$

Mooring load

> $F_m := 450$; $F_{m,\ m} := evalf\left(\frac{F_m}{17.5}\right)$;

$$F_m := 450$$
$$F_{m,m} := 25.71428571 \quad \textbf{(8)}$$

>

F.2. Maple - Sheet Piles

> *restart*;
Digits := 5 :
interface(*displayprecision* = 2) :

Active en passive coefficient

> $\phi := 22.50;\ \delta := evalf[3]\left(\frac{1}{3}\cdot\phi\right);$

$\theta_1 := evalf[4]\left(45+\frac{\phi}{2}\right);\ \theta_2 := evalf[4]\left(45-\frac{\phi}{2}\right);$

$$\phi := 22.50$$
$$\delta := 7.50$$
$$\theta_1 := 56.25$$
$$\theta_2 := 33.75 \quad \textbf{(1)}$$

Compute the embedded depth (d) and the total length of the sheet piles (L)

> $u_{1a} := \frac{\left(\frac{1}{6}\cdot K_a\cdot\gamma_s\cdot(h+d)^3-\frac{1}{6}\cdot K_p\cdot\gamma_s\cdot d^3\right)\cdot(h+d-a)^2}{3\cdot EI};$

$u_{1b} := \frac{1}{3\cdot EI}\left(\left(\frac{1}{6}\cdot K_a\cdot\gamma_s\cdot(h+d)^3-\frac{1}{6}\cdot K_p\cdot\gamma_s\cdot d^3+\frac{1}{6}\cdot\gamma_w\cdot(h2+h3+d)^3-\frac{1}{6}\cdot\gamma_w\cdot(h3+d)^3\right)\cdot(h+d-a)^2\right);$

$u_2 := -\frac{K_a\cdot\gamma_s\cdot(h+d-a)^5}{30\cdot EI};$

$u_3 := \frac{K_p\cdot\gamma_s\cdot d^5}{30\cdot EI}+\frac{K_p\cdot\gamma_s\cdot d^4}{24\cdot EI}\cdot(h-a);$

$u_4 := -\frac{\gamma_w\cdot(h2+h3+d-a)^5}{30\cdot EI};$

$u_5 := \frac{\gamma_w\cdot(h3+d)^5}{30\cdot EI}+\frac{\gamma_w\cdot(h3+d)^4}{24\cdot EI}\cdot(h1+h2-a);$

$F_1 := \left(\frac{656}{8}\right);\ M_1 := F_1\cdot a:$

$u_6 := \frac{F_1\cdot(h+d-a)^3}{3\cdot EI}+\frac{M_1\cdot(h+d-a)^2}{2\cdot EI};$

$F_2 := evalf[3]\left(\frac{450}{17.5}\right);\ M_2 := F_2\cdot a:$

$u_7 := -\frac{F_2\cdot(h+d-a)^3}{3\cdot EI}-\frac{M_2\cdot(h+d-a)^2}{2\cdot EI};$

$$u_{1a} := \frac{\left(\frac{K_a \gamma_s (h+d)^3}{6} - \frac{K_p \gamma_s d^3}{6}\right)(h+d-a)^2}{3\,EI}$$

$$u_{1b} := \frac{\left(\frac{K_a \gamma_s (h+d)^3}{6} - \frac{K_p \gamma_s d^3}{6} + \frac{\gamma_w (h2+h3+d)^3}{6} - \frac{\gamma_w (h3+d)^3}{6}\right)(h+d-a)^2}{3\,EI}$$

$$u_2 := -\frac{K_a \gamma_s (h+d-a)^5}{30\,EI}$$

$$u_3 := \frac{K_p \gamma_s d^5}{30\,EI} + \frac{K_p \gamma_s d^4 (h-a)}{24\,EI}$$

$$u_4 := -\frac{\gamma_w (h2+h3+d-a)^5}{30\,EI}$$

$$u_5 := \frac{\gamma_w (h3+d)^5}{30\,EI} + \frac{\gamma_w (h3+d)^4 (h1+h2-a)}{24\,EI}$$

$$F_1 := 82$$

$$u_6 := \frac{82\,(h+d-a)^3}{3\,EI} + \frac{41\,a\,(h+d-a)^2}{EI}$$

$$F_2 := 25.7$$

$$u_7 := -\frac{8.5667\,(h+d-a)^3}{EI} - \frac{12.850\,a\,(h+d-a)^2}{EI} \qquad \textbf{(2)}$$

Soil properties

> phi := *convert*(22.5 *degrees*, *radians*) : delta := *convert*(7.5 *degrees*, *radians*) :

$$K_a := evalf[2]\left(\left(\frac{\cos(\text{phi})}{\left(1+\text{sqrt}\left(\frac{\sin(\text{phi}+\text{delta})\cdot\sin(\text{phi})}{\cos(\text{delta})}\right)\right)}\right)^2\right);$$

$$K_p := evalf[3]\left(\left(\frac{\cos(\text{phi})}{\left(1-\text{sqrt}\left(\frac{\sin(\text{phi}-\text{delta})\cdot\sin(\text{phi})}{\cos(-\text{delta})}\right)\right)}\right)^2\right);$$

$\gamma_s := 18 : \gamma_d := 18 : \gamma_w := 10 :$

$h1 := 1.0 : h2 := 2.8 : h3 := 7.25 : h := h1 + h2 + h3 :$
$a := 1.5 : EI := 80 \cdot 10^3 :$

$$K_a := 0.44$$

$$K_p := 1.82 \qquad \textbf{(3)}$$

Horizontal displacement

$$eq1 := (u_{1a} + u_2 + u_3) = 0 :$$

$$eq2 := (u_{1a} + u_2 + u_3) \cdot \frac{EI}{K_p \cdot \gamma_s} = 0 :$$

$d1 := solve(\{eq1, d > 0\}, d);$
$solve(\{eq2, d > 0\}, d) :$

$$eq3 := (u_{1b} + u_2 + u_3 + u_4 + u_5) = 0 :$$

$$eq4 := (u_{1b} + u_2 + u_3 + u_4 + u_5) \cdot \frac{EI}{K_p \cdot \gamma_s} = 0 :$$

$d2 := solve(\{eq3, d > 0\}, d);$
$solve(\{eq4, d > 0\}, d) :$

$$eq5 := (u_{1b} + u_2 + u_3 + u_4 + u_5 + u_6) = 0 :$$

$$eq6 := (u_{1b} + u_2 + u_3 + u_4 + u_5 + u_6) \cdot \frac{EI}{K_p \cdot \gamma_s} = 0 :$$

$d3 := solve(\{eq5, d > 0\}, d);$
$solve(\{eq6, d > 0\}, d) :$

$$eq7 := (u_{1b} + u_2 + u_3 + u_4 + u_5 + u_7) = 0 :$$

$$eq8 := (u_{1b} + u_2 + u_3 + u_4 + u_5 + u_7) \cdot \frac{EI}{K_p \cdot \gamma_s} = 0 :$$

$d4 := solve(\{eq7, d > 0\}, d);$
$solve(\{eq8, d > 0\}, d) :$

$$d1 := \{d = 15.717\}$$
$$d2 := \{d = 22.568\}$$
$$d3 := \{d = 24.259\}$$
$$d4 := \{d = 21.993\} \tag{4}$$

Multiply with a factor of 1.2

$d := 24.25;$
$L := evalf[3](h + 1.2 \cdot d);$

$$d := 24.25$$
$$L := 40.0 \tag{5}$$

>

F.3. Maple - Anchors

> $restart;$
$Digits := 5:$
$interface(displayprecision = 2):$

Anchor length.

> $\phi := convert(56.25\ degrees, radians):$

$L_1 := evalf[3]\left(\frac{17.8}{\tan(\phi)}\right);$
$L_2 := 1.0;$
$L_3 := evalf[3](\tan(\phi)\cdot(2.70 + 3.80));$
$L := evalf[3](L_1 + L_2 + L_3);$

$$L_1 := 11.9$$
$$L_2 := 1.0$$
$$L_3 := 9.75$$
$$L := 22.6 \tag{1}$$

Steel quality (f_u = 550 N/mm2).

> $F_{anchor} := 288;\ a := 2:$
$\gamma_{m,a} := 1.4 : f_u := 550\cdot 10^3:$

$$F_{anchor} := 288 \tag{2}$$

Minimum profile (As) and diameter (d).

> $A_s := 1.1 \cdot F_{anchor} \cdot a \cdot \frac{\gamma_{m,a}}{f_u};$
$d := evalf[2]\left(\mathrm{sqrt}\left(\frac{A_s\cdot 4}{3.14}\right)\right);$

$$A_s := 0.0016128$$
$$d := 0.045 \tag{3}$$

>

G
Ground area calculations

		Taxi			Shuttle bus	
		Disembarking	Embarking		Disembarking	Embarking
Space required	06:30	50,0	0,0		100,0	0,0
	07:00	150,0	0,0		200,0	0,0
	07:30	250,0	0,0		300,0	0,0
	08:00	200,0	0,0		200,0	0,0
	08:30	250,0	25,0		300,0	100,0
	09:00	350,0	50,0		400,0	100,0
	09:30	150,0	100,0		200,0	100,0
	10:00	100,0	125,0		100,0	200,0
	10:30	50,0	225,0		100,0	300,0
	11:00	25,0	50,0		100,0	100,0
	11:30	0,0	250,0		0,0	300,0
	12:00	0,0	200,0		0,0	200,0
	12:30	0,0	150,0		0,0	200,0
	13:00	0,0	200,0		0,0	200,0
	13:30	0,0	150,0		0,0	200,0
	14:00	0,0	100,0		0,0	100,0
	14:30	0,0	0,0		0,0	0,0

Figure G.1: Space required for the Nieuwe Haven per mode

		Taxi			Shuttle bus	
		Disembarking	Embarking		Disembarking	Embarking
Space required	06:30	50,0	0,0		100,0	0,0
	07:00	125,0	0,0		100,0	0,0
	07:30	200,0	0,0		200,0	0,0
	08:00	175,0	0,0		200,0	0,0
	08:30	200,0	25,0		200,0	100,0
	09:00	275,0	50,0		200,0	100,0
	09:30	125,0	75,0		100,0	100,0
	10:00	100,0	100,0		100,0	100,0
	10:30	50,0	175,0		100,0	200,0
	11:00	25,0	50,0		100,0	100,0
	11:30	0,0	200,0		0,0	200,0
	12:00	0,0	175,0		0,0	200,0
	12:30	0,0	125,0		0,0	100,0
	13:00	0,0	175,0		0,0	200,0
	13:30	0,0	125,0		0,0	100,0
	14:00	0,0	75,0		0,0	100,0
	14:30	0,0	0,0		0,0	0,0
	MAX M2	275,0	200,0		200,0	200,0
	Length	16,583124	14,14213562	0	14,14213562	14,14213562

Figure G.2: Space required for the Marron Market per mode

		Taxi			Shuttle bus	
		Disembarking	Embarking		Disembarking	Embarking
Space required	06:30	25,0	0,0		100,0	0,0
	07:00	50,0	0,0		100,0	0,0
	07:30	100,0	0,0		100,0	0,0
	08:00	75,0	0,0		100,0	0,0
	08:30	100,0	25,0		100,0	100,0
	09:00	125,0	25,0		100,0	100,0
	09:30	50,0	50,0		100,0	100,0
	10:00	50,0	50,0		100,0	100,0
	10:30	25,0	75,0		100,0	100,0
	11:00	25,0	25,0		100,0	100,0
	11:30	0,0	100,0		0,0	100,0
	12:00	0,0	75,0		0,0	100,0
	12:30	0,0	50,0		0,0	100,0
	13:00	0,0	75,0		0,0	100,0
	13:30	0,0	50,0		0,0	100,0
	14:00	0,0	50,0		0,0	100,0
	14:30	0,0	0,0		0,0	0,0
	MAX M2	125,0	100,0		100,0	100,0
	Length	11,1803399	10	0	10	10

Figure G.3: Space required for the SMS-pier per mode

H
Tourist Highlights

H.1. Mapping of tourist highlights

A list of the most popular tourist highlights, relevant for cruise tourists is shown in Table H.1. The mapping of these highlights together with the three possible locations for the cruise ports are shown in Figure H.1 and H.2

Table H.1: List of popular tourist highlights relevant for cruise tourists.

tourist sights	number on map
Landmarks	
Waterkant Boulevard	4
Fort Zeelandia	5
Onafhankelijkheidsplein	6
Presidential Palace	7
Historic innercity of Paramaribo	8
Saint Peter and Paul Cathedral	9
Neveh Shalom Synagogue	10
Mosque Keizerstraat	11
Centrumkerk	12
Martin Luther Kerk	13
Centrale Markt	14
Arya Dewaker Hindu Temple	20
Hermitage Mall	21
Marienburg suikerfabriek	22
Musea	
Numismatisch Museum	15
Surinaamsch Rumhuis	16
Het Koto Museum	17
Ready Tex Art Gallery	18
Fort Nieuw Amsterdam	23
Lalla Rookh Museum	24
Nature and Parks	
Palmentuin	19
Paramaribo Zoo	25
Peperpot	26
Neotropical Butterfly Park	27
White Beach	28

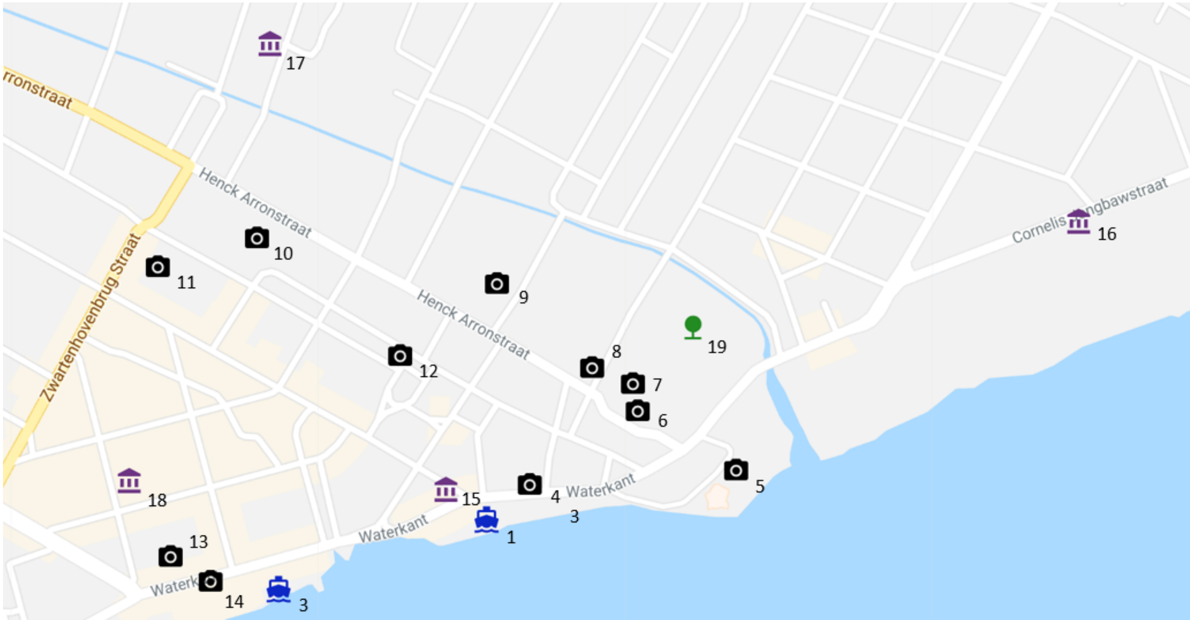


Figure H.1: Tourist sights in the historic inner city of Paramaribo.

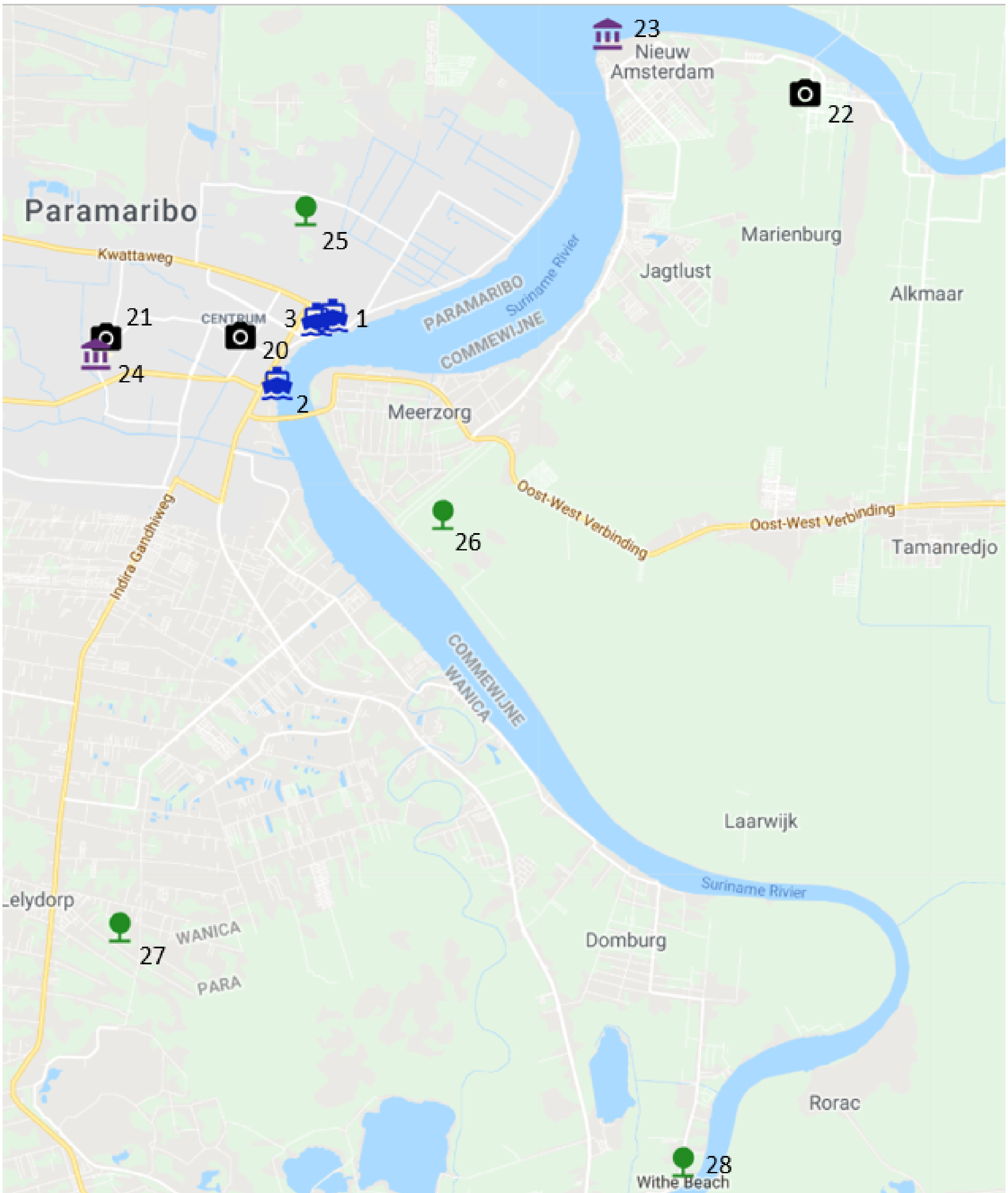


Figure H.2: Touristic sights, relevant for cruise tourists, in the rest of city and its surrounding.

H.2. UNESCO Heritage Sites Paramaribo

The Current Historic inner centre with its corresponding bufferzones is shown in Figure H.3, obtained from the Stichting Gebouwd Erfgoed Suriname.

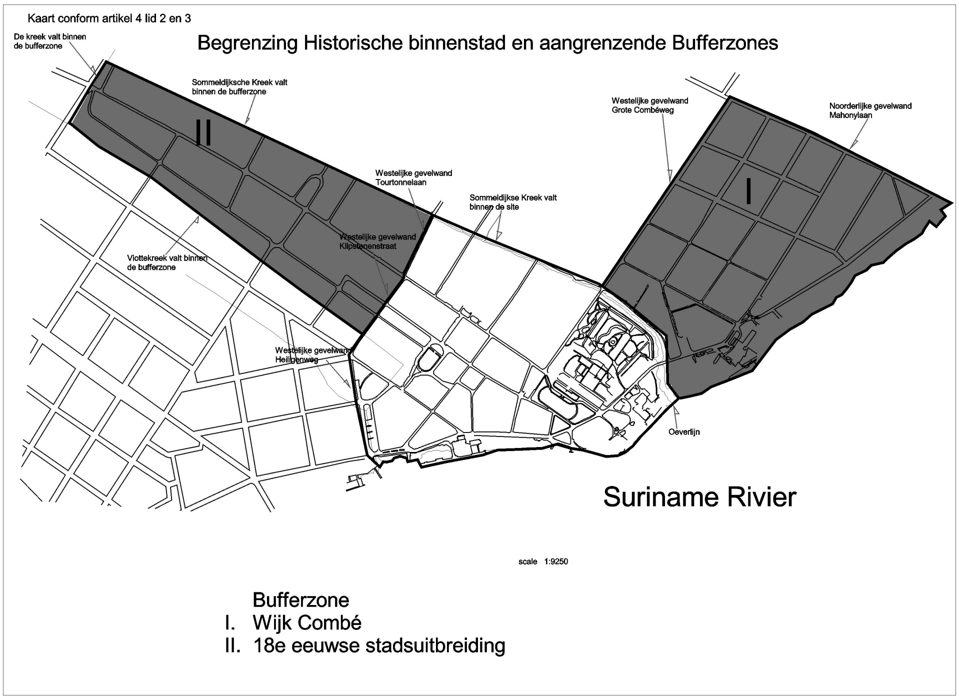


Figure H.3: Historic inner centre of Paramaribo on the UNESCO World Heritage List.

There are plans to expand the bufferzones as shown in Figure H.4, also obtained from the Stichting Gebouwd Erfgoed Suriname.

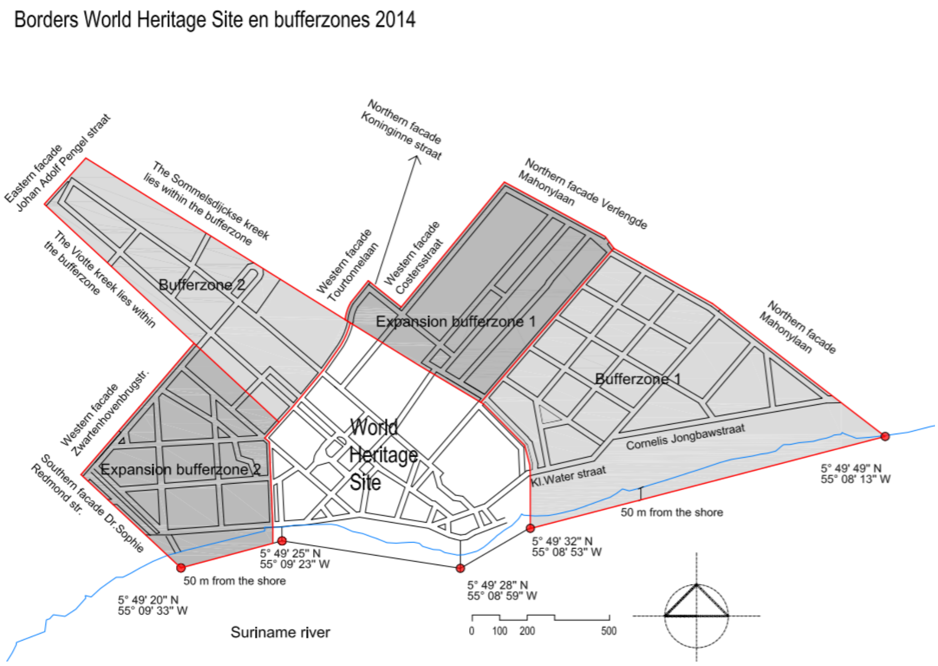


Figure H.4: Expansion of the bufferzones of the historic inner centre of Paramaribo on the UNESCO World Heritage List.

I
Interviews

I.1. Sun Kishoen Misier (Anton de Kom Universiteit)

Aanwezig: Sun Kishoen Misier, Maxime, Luke
Datum: 13/02/2019
Tijd: 16:15 – 17:30

Staff
Sun Kishoen Misier -> Civiele Projecten
Martinus -> Bouwkundige projecten
Brian Delprado -> design cruise terminal + lecturer AdeK
Professor Naipal -> Sediment trapping unit (STU)

Cruise terminal in Suriname

- Waar komen toeristen voor? Suriname moet iets te bieden hebben voor toeristen
- Op schip al kiezen wat toeristen in Suriname willen doen, logistiek klaar voor zijn in Suriname
- Kun je paspoorten al afhandelen op schepen zelf?
- Nu is al het "avond vermaak" bij Torarica in de buurt, niet bij waterkant

Projecten Waterkant

- Kade is verstevigd in 2010 omdat er sediment wegspoelde
- IDB: Miljoenen USD voor herinrichting Waterkant (PURP)
  - Drukke verkeersader omleiden
  - Waterkant inrichten als recreatieomgeving (fietspaden, voetpaden etc)
  - Instantie waar huiseigenaren geld kunnen lenen voor onderhoud huis
- Stichting Gebouw Erfgoed Suriname (SGES)
  - Stephan Fokke (Fort Zeelandia)

Suriname rivier

- Vroeger werd de vaargeul opengehouden door de bauxiet schepen, sinds een jaar is dat minder. Daardoor slibt de vaargeul dicht
- De bauxiet schepen voeren naar de Paranam
- Als een cruiseschip ergens ligt mag de vaargeul niet geblokkeerd worden
- Een deel van de schepen komt alleen binnen bij hoogwater

Mogelijke locaties

- Nieuwe haven
- Kade waterkant met te bouwen steiger
- Maron Markt
  - Was vroeger vismarkt met grote steiger

Documenten

- Stephan -> groeiplan toerisme tot 2050
- EDOM(?) van IDB
- Brian -> waterkant inrichting

I.2. Prof. Augustinus (Utrecht University, Department of Physical Geography)

Meeting Prof. Augustinus
Datum: 18 februari
Aanwezig: Prof. Augustinus, Hugo, Luke

Prof. Augustinus heeft veel kennis over de kust en rivieren van Suriname.

Relevante projecten

- Augustinus en Pieter Teunissen 2004
  - Rapport over morfologie en invloed begroeiing op rivier t.b.v. de aan te brengen bescherming van de rechteroever van de Suriname Rivier en de linkeroever van de Commewijne. Gekozen voor een bescherming die doorloopt tot in de vaargeul.
- Uitvoering van het oeverbeschermingsproject, waarbij tussen Jagtlust en Voorburg een dijk aangelegd is en aan de kant van Nieuw Amsterdam een damwand geslagen is.
  - Uitgevoerd omdat de plantages steeds onder water liepen bij bv springtij. Die plantages zijn allang buiten gebruik, maar vormen sinds de 'Bosjebrug' aantrekkelijke woongebieden.
  - Mogelijk beschikbaar:
    - Gegevens over stroming
    - Hoogteprofielen
- Op bovenstaand project is een vervolgstudie geweest waarin bepaald is hoe dicht de vaargeul langs de oever lag, dit omdat de vaargeul zou worden uitgediept.
  - Dit was relevant geworden door bovengenoemd project

Doorsnede Suriname rivier

- In 1964 was de vaargeul in de rivier behoorlijk diep
- Door de komst van het stuwmeer:
  - Was de vaargeul in het estuarium 2 jaar later enkele meters opgeslibd, onder meer omdat er bijvoorbeeld in de natte tijd geen goede doorspoeling van de vaargeul meer is
  - Is de vaargeul veranderd
    - Tot jaren 80 werd de vaargeul vooral minder diep (aanpassing aan de nieuwe situatie)
    - In jaren 90 is de vaargeul verschoven naar de buitenbocht
- Bauxiet schepen zorgden voor diepgang in de vaargeul
  - Baggeren in de vaargeul gebeurd door modder op te zuigen, los te laten en mee te laten stromen met het water
  - Conclusie: schepen met voldoende diepgang moeten de vaargeul diep genoeg houden

Cruise Toerisme in Suriname

- Achterstallig onderhoud kan problematisch zijn
  - Nieuw Amsterdam is niet aantrekkelijk voor cruise toeristen
- Met busjes vervoeren is een extra hobbel
  - Waar komen deze bussen vandaan in Suriname?

Mangroves

- Mangroves worden van nature opgehoogd door slibsedimentatie

  - Het bouwen van dammen of dijken verstoort dit proces
  - Hierdoor kan het land juist dalen (geen sediment aanvoer meer)
  - Door het weghalen van zand bij Braamspunt kan zich bij Weg-naar-Zee geen nieuwe rits vormen
- Bij Guyana zijn grote stukken mangrove verdwenen voor de aanleg van plantages. Daarom veel erosie. Over grote afstanden is een zeedijk gebouwd. Zeewaarts daarvan door verhoogde erosie geen mangrove meer.

Meer informatie Suriname rivier / vaargeul / schepen die Suriname aandoen

- MAS -> Bernice (Hoofd Hydrologie)
- Waterloopkundig Laboratorium (openbare werken) -> Armand Amatali (directeur) – tel 490963

I.3. Vereniging Surinaams Bedrijfsleven

Datum: 20 februari 2019
11:00 uur ' t Vat eerste verdieping
Aanwezig: Jan van Charante, Tijn Bartelings, Maxime Penning

- We hebben twee afspraken met de VSB omdat Jan van Charante's visie kan verschillen met de rest van de VSB.
  - Charante ziet de haven van Paramaribo als 'tool' voor de hele Surinaamse economie in plaats van als losstaand project.
- Inleiding carriere Jan van Charante
  - Suriname geboren, 1960-1965 kostschool Nederland gezeten. Geneeskunde gestudeerd in Amsterdam. Later gespecialiseerd als bedrijfsarts. Vader is 40 jaar loods geweest: 'Pilot'.
  - Op vakantie in Suriname en nooit meer terug gegaan naar NL.
  - Consultant geweest op het gebied van milieu en toerisme bij meerdere bedrijven. Veel ervaring in kustgebieden als arts en als consultant.
  - Bij NS gespecialiseerd op milieu vlakken (hij heeft oa. de onderhoudsplaatsen 'gezien' waar NS treinen werden gespoten).
  - Met milieu visie heeft hij een veranderende kijk gekregen op plekken waar hij gewerkt heeft.
  - Momenteel eigenaar van 't Vat (grote horeca locatie).
  - Concluderend: veel kennis en vakspecifieke bagage omtrent toerisme, milieukundige materie, Surinaamse en Nederlanse bevolking en politiek en verloop van rivier (kennis van vader).

Cruise

- Veel cruise operators zitten in Miami. Hij is daar met moeite aan tafel gekomen om Suriname als cruise locatie te promoten.
  - Er werd aangegeven dat probleem met cruise ontvangst zijn de beperkte geschikte getijden voor de haven. Haven kan maar beperkt operationeel zijn waardoor operators hun hele itineraryschedule zouden moeten aanpassen op getijden Paramaribo. Bovendien duurt het minimaal 4 uur voordat het schip vanuit het lichtschip naar de haven en weer terug is gevaren. De vraag: is Suriname worth it en wat zou dat het wel maken?
  - Operators varen 's nachts. Ze willen elke passagier weer op tijd aan boord hebben voor casino's eten etcetera.
  - Immigratie- en douanefaciliteiten weinig flexibel (wil te ver van tevoren weten welke passagiers mee gaan, is vanuit operator niet mogelijk ivm bijv. last-minute boekingen).
- In Paramaribo erg veel congestie vanwege een rotonde (aansluitend aan de Grote Brug) die voor elk type verkeer wordt gebruikt (woon-werk/airport) en bovendien in elke richting aansluit.
  - De rotonde wordt te intensief gebruikt en er wordt onvoldoende gekeken naar andere oplossingen om de rotonde te ontlasten.
  - Wegenstructuur Paramaribo ontoereikend (geen ontsluitingswegen zoals in NL).
- Twijfel over de value van een passagier, op cruise ship wordt ontmoedigd om te eten aan land. Tweezijdig: ze willen voorkomen dat er foodborne diseases aan boord uitbreken en om commerciële redenen (eigen eten aan boord verkopen).

Baggeren

- Lost case. Rivier is nooit gebaggerd geweest, gaat veel kosten. Bovendien onderschat men de onderhoudskosten.

- Alles slibt dicht in de buurt van de Amazone
- Vroeger voeren er veel bauxiet schepen die een speciaal schroefontwerp hadden waardoor ze ook voorkomen dat de rivier dicht zou slippen. Deze industrie bestaat niet meer.
- Er is sowieso minder verkeer over de Suriname Rivier
- Havenproject Frans Guyana, des Grades des Cannes, is mislukt.

Conclusies

- Cruise terminal in rivier gaat niet werken.
  - Argumenten: politiek niet aan boord, baggeren te duur, korte termijn instelling van Surinaamse investeerders (regering gebrek aan visie, integriteit, eerlijkheid en intelect killers).
  - Bedrijven worden niet betrokken bij beleid van de overheid.
  - peratie is slecht - er moet uren worden gewacht op een loods, dan op getij en vervolgens toerist onvriendelijke infrastructuur en inefficiënte immigratiediensten.
  - Te weinig belang voor cruisetoerisme (inkomstencijfers erg laag in vergelijking met totaal toeristen).
  - Cruise schip november 2018 is bijna gecancelled (terwijl het al richting suriname voer) omdat er te veel problemen waren
  - Cruise Toerisme is niet interessant: geven te weinig geld uit, zijn niet interessant voor lokale horeca omdat ze 'alleen maar gebruik maken van de wc's'. Ze boeken geen overnachtingen of diners.
  - De inkomsten van cruise toerisme moeten worden verdeeld onder zes (of meer) cruise operators in Paramaribo, spoeling erg dun.
- Alternatief: diepzee terminal met goede olie leiding en waterleiding en betrouwbare wegverbinding (waarmee huidige infrastructuur wordt ontlast).
  - 24 uur beschikking tot haven.
  - Focus op voorzieningen (zoals beladingen, tanken, inkoop van voedselvoorraden aan schip) van cruise schepen die toch al langs varen in plaats van toerisme.
  - Potentiële samenwerking met Frankrijk (in verband met EU subsidie), Frans-Guyana en Guyana en Brazilië.
  - Er was eerder al een werkgroep ingericht om opties te bekijken.
- Ander alternatief: locatie Waterkant. Bij de Waag werden vroeger ook grote schepen ontvangen met producten van de plantages omdat de waterdiepte daar het grootst is.
  - Echter is er bij aanleg van damwanden onderschat wat de rivierstromingen doen.
  - De douane is mogelijk niet bereid om vanuit de Nieuwe Haven te reizen naar locatie Waterkant.
- Er moet stevig geïnvesteerd worden in achterliggende infrastructuur. Momenteel te veel congestie om passagiers te ontvangen. Bovendien mengt cargo-personen verkeer slecht en dat levert onveiligheid op.
- Alternatieven op grotere schaal bedenken (in plaats van enkel focus op toerisme). Voorbeelden zijn treinverbindingen voor goederenvervoer of short-sea om haven aantrekkelijker te maken.
- Maatschappelijk: iedereen staat open voor toerisme. Echter mist servicegerichtheid van Surinamers. Dat kun je terugzien in bureaucratie rondom visum en overige onderwerpen (mensen zijn toerisme niet gewend).
- Politiek: overheid moet het land marketen om vraag te genereren.

  - Vliegtickets zijn bijvoorbeeld te duur, zeker ook met doorverbindingen binnenlands zijn er veel alternatieven (zoals autorit naar Brazilië).
- Toerisme trend: juli augustus en december januari veel toerisme. Hij merkt dat aan verkoop van dure 'luxe' producten. In het dal is er weinig koopkracht.
  - Cruisetoerisme zou daarentegen kunnen zorgen voor stabieler toerisme
- Toeristen geven geld uit aan souvenirs. Probleem is dat verkopers geen vermogen hebben om grondstoffen in te kopen en voorraden aan te leggen, waardoor er bij piekvraag te weinig verkocht kan worden (opportunity costs zijn erg hoog).
  - Advies: toon craftsmanship aan - laat zien dat Surinamers producten zelf maken. Toeristen komen hier niet om 'kraaltjes' uit China te kopen.
- Nationaal toerismeplan geschreven door overheid is amateuristisch (geen rekening gehouden met bedrijven/commercie en op vrijwillige basis geschreven).
- Nodig om toerisme succesvol te maken: luchtvaartmaatschappijen en politiek (ministeries).

Overige contacten

- Marcel Meyer: boek geschreven over het beheer van de kuststrook.
- Dickland: gespecialiseerd in historische architectuur en koffieplantages.
  - Bij de plantages werden getijwisselingen gebruikt om stroom op te wekken.
- CTO (Caribbean TourismOrganisation): heeft onderzocht wat ze voor Suriname kunnen betekenen. Hierin de combinatie beach (ABC-eilanden) en jungle, maar vooralsnog weinig synergie combinaties mogelijk geweest.
- METS: vragen om twijfel/onzekerheid in cruise toerisme.
- Renee van Essen: Oud Directeur VSB geweest.
- Stichting toerisme suriname (STS) = Suriname Tourism Foundation (FTS), benaderen via de Kamer van Koophandel en Fabrieken.

I.4. VSB

Datum: 26-02-2019
Aanwezigen: Paul Torilal, Steven Mac Andrew, Tijn Bartelings, Luke Boers, Maxime Penning

Steven Mac Andrew: directeur VSB
Paul Torilal: beleidsadviseur (vroeger groepsvertegenwoordiger van transport met 20 jaar maritieme ervaring)

Toerisme

- De natuur maakt het hier uniek (ondanks milieurampen in het binnenland door gebruik van kwik en de enorme export van hout).
  - schone rivieren
  - stroomversnellingen
  - ongerepte natuur
- Toerisme staat hoog in het vaandel van de regering
  - Dit komt naar voren in alle beleidsplannen van de overheid.
  - Er lopen verschillende projecten die gestimuleerd worden door de idb.
  - Innovatieve bedrijven op het gebied van toerisme worden beloond.

Cruisetoerisme

- Grootste schip was 850 man (Minerva). Deze boot deed beide Guyana's aan en het Caribisch gebied.
- Er komen nu meer Franse schepen die de Franse eilanden bezichtigen, Frans Guyana, Suriname en Brazilië.
- Limitatie zit in diepgang van de vaargeul (afgelopen jaren verslechterd en versmald) en gebrekkige accommodatie.
- Activiteiten om te doen zijn belemmerd door de korte verblijfsduur (ongeveer 6 uur).
- Problemen in de infrastructuur:
  - het duurt lang om ergens te komen
  - er zijn geen trottoirs
  - onveilig
- Faciliteiten die de immigratiedienst heeft zijn beperkt.
  - passagiers moeten persoonlijk betalen voor visum (ipv het afhandelen van de kosten met de cruise lijn door middel van een passagiers manifest)
- Faciliteiten en de cruise terminal moet voldoen aan de Caribische normen
  - toeristvriendelijk
  - klantgericht
  - faciliteiten voor minder mobiele mensen (cruisetoerisme wordt geassocieerd met bejaarden).
- Integraal project: ergonomische zaken, maritieme zaken, verbetering verblijf facilitering, groei activiteiten in de binnenstad.

Inkomsten van cruisetoeristen

- Er zijn geen echte cijfers hiervan

- Mets biedt pakketten aan aan de cruise toeristen zoals naar de Peperpot plantage of met een bus naar de Hermitage malls
- Horecagelegenheden
- Craftsman (goud)
- Duty free shops zouden ontwikkeld kunnen worden
- Ander soort toeristen geven wel meer uit dan cruisetoeristen.

Projecten

- Baggeren: er moet nu wel echt gebaggerd worden en dat gaat dus ook wel gebeuren.
  - Er is eerder over gepraat, maar er is een stagnatie gekomen omdat er geen aparte ministerie van transport meer is. Deze is nu ondergebracht in het ministerie van openbare werken. Hierdoor zijn de prioriteiten (geld) verplaatst.
  - Er zijn wel offertes gemaakt door de Boer van 15 miljoen, waarin een onderhoudsplan zou zijn toegevoegd.
  - Hierbij zou het gebruik van de vaargeul belast worden. Dit naast alle andere kosten die een schip moet betalen aan de MAS en de haven. Ook zijn de vrachtkosten per bij de rederijen omhoog gegaan omdat de capaciteit per schip, dat over de Suriname rivier vaart, omlaag is gegaan (welke gegroeid zijn doordat de capaciteit per schip gedaald is).
- Verbetering infrastructuur
  - Er is wel een verbetering van de wegen richting Paramaribo.
  - Er wordt weinig gemerkt van verbetering van de infrastructuur in Paramaribo zelf.
    - Veel congestie

Haalbaarheidsstudie

- Er is eerder een haalbaarheidsstudie gedaan naar een cruise terminal in Paramaribo. Dit was een samenwerking tussen NV Havenbeheer of MAS en Jan Sierhuis (vanuit de Caribbean Shipping Association). Rapport zou online moeten staan.
- Locatie: aan de waterkant naast de oude veersteiger.
- Het gebied ten noorden hiervan zou aangepakt worden tot de assemblee. Dit is deels gebeurd. Het andere deel zou geëxploiteerd worden door loyalisten van de overheid, maar dat is nog niet gebeurd.

Bedrijfsleven

- Overheid zou faciliterende functie moeten hebben en uitvoerende/beleidsvormende functies zouden moeten worden opgepakt door deskundige. Deze scheiding is in Suriname slecht.
- De economie trekt nog niet aan, ze zijn nog steeds herstellende van de crisis.
- Het gros van de bedrijven zitten nog steeds in een overlevingsstrijd.
- Olie gaat wat beter.
  - Staatsolie gaat beginnen met wat boringen aan de kust.
- Multinationals gaan ook wat beter (de overheid heeft ze gefaciliteerd).
- Er zijn op zich goede banden met de buurlanden Frans Guyana en Guyana.
  - Frans Guyana zou een goede potentiële markt zijn om producten vanuit Suriname af te zetten.
  - Geen speciale relatie voor het oppakken van cruisetoerisme.
- Voor bedrijven is kapitaal de grootste bottleneck

  - Leningen zijn duur met een rente van 8 tot 10
  - Er is nog maar weinig overheidsgrond in de industriegebieden beschikbaar. Dit is daarom erg duur.
  - Het krijgen van energie in een nieuw bedrijf is erg lastig. De aansluiting is al een probleem.
  - Er is veel corruptie.
- Regelgeving is nog erg soepel
  - Veel bedrijven zijn niet vergunning plichtig.
  - Het oprichten van een naamloze vennootschap verloopt erg soepel.
- Doing Business in Suriname: interessant rapport te vinden op de website van de World Bank Group.
- Verder is er wel communicatie tussen de vsb en de overheid.
  - Als ze ergens over willen praten worden ze ontvangen.
  - Via de ingangen die ze hebben proberen ze hun punten te maken.

Transport

- Bussen
  - Overheidstransport: nationaal vervoer bedrijf en de particuliere lijnbus organisatie.
  - Er zijn teveel vergunningen verleend op verschillende trajecten.
  - De bussen worden gesubsidieerd om kunstmatig lage prijzen te houden.
  - Ze rijden hier niet op bepaalde tijdstippen maar als ze vol zijn.
  - Als het druk is worden ongepland andere trajecten gereden.
  - Er zijn wel bushaltes, maar in principe kunnen bussen overal stoppen.
  - Er is voldoende capaciteit om mensen, dat mensen niet meer met het eigen vervoer zouden hoeven te rijden, alleen de indeling hiervan is nog niet goed genoeg.
  - Studenten van de universiteit hebben een plan ontwikkeld voor de herinrichting van het bus transport. Hierbij zou men werken met hubs vanuit alle randgebieden van Paramaribo.
- Goederentransport
  - Grotere bedrijven hebben hun eigen expeditie afdelingen
  - Voor passagiers (zoals voor nachtdiensten/mijnbouwbedrijven) worden contracten met particulieren lijnbus organisaties opgesteld.
- Eigen vervoer
  - Het centrum slibt dicht.
  - Er is nu in principe nog voldoende fatsoen om elkaar ruimte te geven om in te voegen.
  - het zou minder aantrekkelijk moeten worden om naar de stad te komen met de auto, met bijvoorbeeld parkeermeters.
- Als er fondsen vanuit een bepaald land komen, moet de infrastructurele uitvoering voldoen aan de normen van dat land.
  - Zo is er een rotonde met fietspaden die nergens op aangesloten zijn.
- Voor een infrastructurele herinrichting van de waterkant zouden er terreinen onteigend moeten worden.

I.5. PIU (PURP, SGES)

Datum: 06-03-2019
Aanwezigen: Lilian Krishnadath (Operations specialist), Anushka Dewansingh (Procurement specialist), Armand Moredjo (Environmental, Health and Safety specialist), Stephen Fokké (Directeur SGES), Tijn Bartelings, Maxime Penning

PIU (program implementation unit) voor het PURP (Paramaribo Urban Rehabilitation Program), gevestigd op het kantoor van SGES (Stichting Gebouwd Erfgoed Suriname).

SGES

- Overheidsinstantie die valt onder het ministerie van Onderwijs, Wetenschap en Cultuur.
- Bescherming van de historische binnenstad, die staat op de Unesco Werelderfgoedlijst.
- Als er gebouwd wordt in de binnenstad moet dit worden goedgekeurd door de bouwcommissie van Openbare Werken Transport en Communicatie of de Monunmentencommissie als het een monumentaal pand betreft. Unesco / ICOMOS evalueert en brengt advies uit.

PURP

- TAG (Technical Advisory Group) is een werkgroep tbv PURP, die bestaat uit vertegenwoordigers van verschillende ministeries.
- De implementatie van PURP is gedelegeerd naar SGES middels een aangetrokken PIU.
- Doel: Versterken van de sociaal economische functie van de binnenstad
- Gefinancierd met een lening van de IDB
- Bestaat uit de volgende onderdelen
  - Urban interventions: herinrichting van straten en renovatie van gebouwen
  - Business/Commercial en woonfunctie versterken: Historische woningen renoveren en inkomsten genereren voor onderhoud, levendigheid terug in het centrum
  - Versterken van het institutionele kader, SGES management
- In dit component zit o.a. toerisme.

Volgend jaar willen ze starten met baggeren (dit staat los van PURP).

Toerisme

- Het toerisme plan: gaat vooral over branding en marketing van het land
- Er moet weer een fijne ambiance gecreëerd worden.
  - Opknappen van gebouwen is heel duur
  - Sommige gebouwen worden gerestaureerd als pilot, 'goede voorbeeld', met hopelijk als spin-off effect dat andere het ook gaan doen.
- Sfeerlichten op de historische gebouwen om kenmerkende indruk van de stad te promoten.
- De vele en bruisende feesten in Suriname moeten meer gepromoot worden. Cruise planning kan inspelen tijdens deze populaire hoogtij dagen.
- Toerisme kan zorgen voor een diversiteit in de economie
- Het land moet erop inspelen. Cruisetoerisme is een potentiele inkomstenbron.
- Suriname moet zich onderscheiden van de buurlanden
- Denk aan de aantrekkelijkheid van de route. Verder dan de centrale markt wordt het minder fraai.
- De stad is verlaten na kantoortijden - geen goede indruk.

Ministerie van openbare werken

- De kade bij de Waterkant gaat verlengd worden
- Directeur civieltechnische werken: dhr. Soman
- Herinrichting van de nieuwe haven
- De herinrichting van de wegen gaat alleen door als openbare werken mee werkt

Op verschillende plannen zit veel vertraging door de snelle wisselingen van beleidmakers op de ministeries.

Andere belangrijke actoren

- Ilaco is een ingenieursbureau die veel projecten heeft uitgevoerd voor de idb
- Stichting United Tour Guides Suriname
- Ingenieursburea Sunecon heeft veel data.

I.6. SUNECON Director M. A. Meyer

Meeting andere vestiging SUNECON
Datum: 12 maart 2019
Tijd: 13:00 – 14:10
Aanwezig: mr. Meyer, mr. Delprado, Hugo Stam, Tijn Bartelings, Maxime Penning en Luke Boers

Sunecon heeft altijd een internationale mindset gehad.

- De samenwerking is gezocht met andere ingenieursbureaus om te blijven ontwikkelen en leren
- Er zijn altijd veel stagairs uit andere landen geweest vanaf de jaren ’60
- Met veel van deze stagairs is later nog goed contact

Sunecon is niet politiek gekleurd.

- Daarom wordt het bureau gezien als betrouwbaar en no-nonsense
- Als de overheid iets doet worden mensen vaak vervangen op de paar jaar
  - Daarom is het beter de overheid geen meerderheidsbelang te geven

Toerisme

- Er komt steeds meer begraafplaatstourisme uit het buiteland naar de oranjetuin waar 1500 mensen begraven liggen
- Genealogie is ook booming

Potentieel interessant

- Suriname Road Federation
- FIDDIK(?) Engineering
- Vroeger was er een samenwerkingsverband tussen universiteiten uit omringende landen
- Amazone cruise belem – manaus -> bekijk aanlegplaatsen cruise schepen
- Zusters uit Suriname

I.7. Maritieme Autoriteit Suriname

Datum: 5 maart 2019
Tijd: 9:55 – 10:35
Aanwezig: Bernice Mahabier, Nancy Yang, Hugo Stam, Luke Boers

Bevaarbaarheid vaargeul

- Obstructies vaarroutes: wrak Goslar en Jules Wijdenboschbrug
  - Schepen mogen niet te dicht bij pijlers van de brug in de buurt komen
- Schepen nemen 2 routes
  - Via de binnenbocht als ze aanleggen bij de Nieuwe Haven
  - Via de buitenbocht om de opening van de brug te als ze daar onderdoor gaan
    - De doorvaart van de brug is gebouwd op een vaarroute via de buitenbocht
- Een cruiseschip of een terminal mag de vaarroutes niet te veel in de weg zitten
  - Bij de SMS-pier of ten noorden hiervan is waarschijnlijk geen probleem
- De bevaarbaarheid van de vaargeul neemt af door sedimentatie van de vaargeul door oa. de modderbanken.
- Bij laagwater is de diepgang 4 meter door een ondiepte in de vaargeul rondom tidal bank, eventueel beïnvloedt door migratie modderbanken.
- Er zijn plannen om de vaargeul te baggeren tot 5,5 m diepgang bij LLWS

Schepen beloodsen

- Schepen worden beloodsd vanaf de outer buoy, waar een schip eerst voor anker gaat
- Het afleggen van de afstand naar de Nieuwe Haven duurt ongeveer 3 uur
- De MAS heeft ook een charter dienst

Getijden

- De MAS geeft een shipping notice met informatie over de toegankelijkheid van de vaargeul
- Er staat een getijdestation bij de MAS
  - Voor het getij bij de monding wordt een tijdscorrectie uitgevoerd, geen hoogtecorrectie
- Tot iets voorbij Domburg dringt het (zoute) zee water binnen tijdens vloed

Graag ontvangen wij nog van de MAS

- Archiefkaarten van de Suriname Rivier
- Sedimental flows
- AutoCAD files van de vaargeul met XYZ metingen van buitenbocht Suriname Rivier rondom gebied Waterkant – Nieuwe Haven
- Kaart van de vaargeul
- Gegevens over wat voor typen schepen en aantallen Suriname per jaar aandoen

Andere informatiebronnen

- Prof. Augustinus met zijn report over de vaargeul
- Er is een cruise schip geweest in ongeveer 2015 die voor anker is gegaan in de buurt van de marinetrappen waarna toeristen met bootjes en bussen vervoerd zijn naar toeristische bestemmingen voor in totaal 6 uur

I.8. Mets / SHATA

Aanwezig: Armand Bhagwandas, Tijn Bartelings, Maxime Penning
Datum: 21-02-2019

SHATA: Overkoepelende vertegenwoordiger van vooral grotere bedrijven (40 leden uit de private sector). Ze proberen namens hen te praten met de overheid van Suriname over hoe het toerisme hier verder ontwikkeld kan worden. De minister is van plan om 1 onderdirecteur aan te wijzen die het toerisme op kan pakken, maar SHATA wil liever een board, die onafhankelijker is. Zo'n board zou dan bijvoorbeeld de taak van marketing en branding op zich kunnen nemen.

Toerisme groei in Suriname

- Tot 2015 een mooie groei.
- Vanaf 2005 een verdubbeling van hotelkamers en tour operator.
- Na 1015 een devaluatie een USD was eerst 3.25 SRD waard en nu 7.50 SRD.
- Afname in het toerisme vanuit het buitenland en ook vanuit Nederland
- Het gaat weer beter maar er is geen stabiele groei om op te bouwen.
- Suriname is een dure destinatie: De doelgroep moet dat geld hebben.

Cruises

- Doelgroep: kleinere luxere schepen (met veel geld aan boord)
  - Suriname kan nu een grotere capaciteit niet aan.
  - Het grootste schip kwam van de UK, met 1200 passagiers (Minerva).
- 8 maart en 1 april komt Le Champlain (160 passagiers/140 crew)
- Er hebben zich nu 3 schepen aangekondigd voor 2019
- Algemeen komen er meer oudere.
- Jeugd toerisme is een opkomende markt, maar voor hen is een cruise naar Suriname te duur.

Route Le Champlain komt vanuit het Caribisch gebied, zou dan langs Orinoco en dan naar Paramaribo (niet langs de amazone). Door de onveilige situatie in Venezuela is de route gewijzigd. Hij gaat niet meer langs Orinoco en komt dus eerder aan in Paramaribo.

Wat biedt METS 8 maart bijvoorbeeld: 160 man is perfect voor een cruise naar Suriname dan heb je ongeveer 8 tot 10 bussen nodig. De mensen blijven maximaal 1 dag (tussen 7:00 uur 's ochtends en 16:00 uur).

- Paramaribo City Tour
- Commewijne Tour langs Peperpot en Nieuw Amsterdam
- Ambachtelijke chocolade maken van Surinaams cacao
- Rumfabriek
- Naar het binnenland vliegen

Afhandeling

- Pilots brengen de schepen naar binnen, MAS heeft hier een goede controle over.
- CMA CGM handelt de schepen op de haven af. Dit gaat ook keurig.
- Toelating van de passagiers is het grootste probleem.

Complicaties

- Een Cruise komt nu aan bij de Nieuwe Haven: dit is een Cargo haven en niet ingericht op personen.
- Problemen met de planning om de Suriname rivier in en uit de varen door getijden zijn niet heel groot (vooral als er gebaggerd gaat worden). In Frans Guyana geeft dit een grotere uitdaging.
- Infrastructuur is een bottleneck om grotere schepen aan te kunnen.
- Bij de marketing van Suriname op beurzen met cruise operators duurt het weer 2 jaar voordat er een schip komt. Daarom is afstemming tussen de marketing van Suriname en de plannen voor de aanleg van een cruiseterminal heel belangrijk.
- Toelating: visum aanvraag
  - Geen speciale wetgeving voor cruise passengers
  - Het ministerie consulaire zaken wil 2 weken van tevoren een kopie van je paspoort en een foto, voor de mensen die een visum nodig hebben moeten ook alle overige papier ingediend worden. Voor 300 man is hier niet eens de verwerkingscapaciteit voor.
  - Andere landen sturen een ambtenaar die stempelt en halen cruise toerisme met een rode loper binnen.
  - Oplossing hiervoor
    - head tax voorstel is nu ingevoerd
    - dan komt er een transit visum voor 3 dagen (over bijvoorbeeld verkeerde namen zal dan soepeler gehandeld worden.)

Plannen Er is een haalbaarheidsstudie gedaan naar het bouwen van een cruiseterminal aan de waterkant naast de centrale markt. Dit zou 4 miljoen dollars kosten. Het toenmalige TCT ministerie bestaat niet meer (nu is toerisme onderverdeeld bij het HI&T ministerie). Maar er schijnt met de IDB bank gesproken te zijn over de financiering ervan en blijkbaar heeft de president gezegd dat er een cruise terminal komt. Dit kunnen we navragen bij buitenlandse zaken.

De buurlanden

- Frans Guyana krijgt jaarlijks ongeveer 30 schepen, die vanuit Cayenne naar de amazone rivier varen.
- Het schip dat langs Paramaribo vaart begint by Cayenne en gaat dan via Paramaribo naar het Caribisch gebied.
- De product manager op de boot van december (le champlain) was heel enthousiast over Suriname. Naast de route van het caribische gebied langs Orinoco en Paramaribo hebben zou ook een route van Cayenne naar het Amazonegebied. Paramaribo zou heel goed als home port in deze tweede route kunnen worden opgenomen.
- Als schepen naar Guyana gaan worden daar city tours aangeboden en een bezoek aan de Kaieteur falls, dit zijn de tweede hoogste watervallen ter wereld.
- Toerisme autoriteit is enthousiast om met de 3 Guyana's (waaronder Suriname) dat gebied te gaan promoten.
- In het Caribisch gebied is alles hetzelfde. Hier is het uniek.

Inkomsten van cruisetoeristen

- Overheid verdient aan de toelating gelden.
- Tours bij METS worden geboekt door het schip zelf, waarbij het schip een marge pakt.
- Andere Tour operators (Access Suriname travels/Travel the Guianas)
- Souvenirs.
- Het schip doet inkopen voor bevoorrading:

  - water wordt gebunkerd
  - olie getankt
- Horeca verdient weinig omdat de mensen eten en drinken aan boord.
- Bushouders
- Gidsen
- CMA CGM
- Paramaribo kan optioneel een homeport zijn
  - De mooiste route: Paramaribo, Cayenne, Amazone
  - Dan zouden er meer vliegtickets verkocht worden.
  - Er zouden meer overnachtingen geboekt worden.
  - De bevoorrading zou geleverd kunnen worden door Suriname.

I.9. N.V. Havenbeheer

Aanwezig:Marougja Sordam, Venessa Aman, Charle Getrouw, Hugo Stam, Luke Boers, Tijn Bartelings, Maxime Penning
Datum: 20-02-2019

Marougja Sordam: Public relations Venessa Aman: commercial services Charle Getrouw?: manager operations

NV. Havenbeheer: beheer van de kade en daarbij het faciliteren van offshore activiteiten bij:

- de Nieuwe Haven in Paramaribo
- de Algemene Haven van Nieuw Nickerie

Andere terminals of gedeelten van de kade aan de Suriname rivier zijn ingenomen en uitgegeven aan derden. Andere partijen zijn verantwoordelijk zijn voor het laden en lossen van schepen. Douane is verantwoordelijk voor visitatie. De MAS is verantwoordelijke en direct aansprakelijk voor de ontwikkeling van de waterwegen, the port health en de port security.

Er is een samenwerking met de IDB die projecten heeft voor:

- verbetering van de transport logistiek en infrastructuur in Paramaribo
- baggerwerk in de Suriname rivier (klopt dit?)

Actuele situatie van de nieuwe haven

- Ongeveer 600 schepen per jaar.
- Dit aantal is sterk verminderd de afgelopen jaren vanwege de verslechterde diepgang.
- 5 scheepslijnen verloren (ze komen nog steeds maar zijn geconsolideerd op 1 lijn)
- de kade is 600 meter in totaal wat ruimte geeft voor 2 a 3 schepen max
- er is import en export, nauwelijks transshipment

Plannen van de Nieuwe Haven

- Het aanleggen van een off-shore jetty, waar supply schepen kunnen aanmeren voor de bunkering: vuilverwerking, brandstof, water en bevoorrading.
- Ontwikkeling van een short sea line richting o.a. (frans)guyana en brazilië

Cruiseschepen Nu Het is niet ideaal om mensen verkeer en goederenverkeer samen te brengen, toch verloopt het tot nu toe soepel door het volgende beleid:

- Er worden goede afspraken gemaakt met verschillende ministeries.
- Er is goede begeleiding van de toeristen.
- Het gebied wordt afgeschermd.
- Toeristen worden in een bus naar buiten gebracht (er wordt niet gewandeld op de terminal)
- Paspoort controle wordt gedaan door de immigratiedienst.

De winst voor het NV Havenbeheer is minimaal omdat er geen heffing is per passagier. Het doel was voorgaand niet om te verdienen maar om te ontwikkelen en de spin-off in de creatieve werkgelegenheid te identificeren.

In 2007 kwamen er 1000 toeristen van 1 cruiseschip. Hier zat 2 maanden voorbereiding in. De stad was toen schoner en veiliger dan ooit tevoren. De surinamers zeiden: kwamen er maar wekelijks cruiseschepen. Er hebben zich voor aankomend jaar 4 schepen aangekondigd van de CMA.

Plannen: Er is eerder een haalbaarheidsstudie gedaan naar een cruise terminal vanuit een macro benadering. Combinatie van de steden ontwikkeling en de ontwikkeling van de cruise terminal. Ze keken naar het gebied achter de centrale markt. Die zou geschikt zijn door:

- Centrale markt zou geaccommodeerd kunnen worden in de terminal.
- Er is een redelijke diepgang van 8 meter.
- Toeristen zouden direct in de stad zijn.
- Historische binnenstad is om de hoek. De samenleving (onder andere crafters) werd ook betrokken bij het project. Via de Mets kunnen we waarschijnlijk een overzicht krijgen van de betrokken partijen vanuit de samenleving. Of via de consultant die dit project uitvoerde (Wellicht hebben jullie hier het juiste contact persoon nog voor vanuit NV. Havenbeheer?)

Het leek heel haalbaar maar ging niet door, door politieke redenen. Het traject moet lang zijn maar in de politiek is veel kortzichtig. Er wordt gedacht wat de politiek in 5 jaar kan doen, zodat ze nog 5 jaar kunnen blijven zitten.

Als hier een cruise terminal komt zou het NV Havenbeheer graag meedoen, maar ze bemoeien zich er verder niet mee omdat het niet hun core business is.

Nu verder Ontwikkeling, daar moet je gewoon mee beginnen. Wat je hiervoor nodig hebt is lef, finance en de politiek moet zich erin terug kunnen vinden.

Suriname promoten om:

- veiligheid (natuurrampen terrorisme)
- cultuur/natuur
- vredige samenleving van verschillende religies

Partijen die betrokken moeten worden bij het project:

- ministerie van transport
- ministerie van ontwikkeling, onderwijs en wetenschap
- ministerie van HI&T
- toeristische organisaties
- port health commissie:
  - Loyd Gemerts (vanuit de MAS) (597 8855611)

In het beste geval ontvangt havenbeheer 52 cruiseschepen per jaar

- Elke zaterdag eentje: dit is een rustige dag op de haven, er is minder stadsdrukte maar alles is open. Er moet gefocust worden op de veiligheid.
- Technische volgorde van controle aan boord van schepen moet veranderen van; eerst de douanecontrole en dan de rest naar; eerste immigration en health controle (bij de ankerplaats bij de monding van de rivier) en dan pas de andere autoriteiten waaronder de douane.
- De overheid heeft gepland dit jaar te baggeren, hopelijk zijn ze al bezig met dit project en wordt de rivier 8 meter diep.
- Naast het verbeteren van de waterwegen en de infrastructuur van de waterkant moet ook de lucht infrastructuur aangepakt worden. Een ticket moet geen 1200 euro kosten.

15 maart komt er weer een cruise schip, dan mogen we komen kijken!

Laatste Advies:

- Probeer niet het wiel opnieuw uit te vinden en kijk naar andere studies.

Te ontvangen documenten:

- eerder uitgevoerd haalbaarheidsonderzoek van een cruiseterminal
- indeling van de haven nu met toekomstige plannen

J

Economic contribution of cruise tourism

This Appendix contains some tables from the cruise passenger expenditures research conducted for the Florida-Caribbean Cruise Association in October 2018. (FCCA, 2018)

Destinations	Total Cruise Tourism Expenditures ($US Millions)	Total Employment	Total Employee Wage Income ($US Millions)
Antigua & Barbuda	$ 43.9	1,170	$ 11.10
Aruba	$ 71.9	1,716	$ 29.20
Bahamas	$ 373.1	7,954	$ 138.50
Barbados	$ 57.3	1,845	$ 19.50
Belize	$ 86.3	2,492	$ 26.50
Bonaire	$ 9.4	191	$ 3.20
British Virgin Islands	$ 26.2	465	$ 8.70
Cabo San Lucas	$ 22.4	587	$ 3.90
Cayman Islands	$ 207.6	4,454	$ 87.00
Colombia	$ 48.4	1,089	$ 6.90
Costa Maya	$ 27.6	726	$ 4.50
Costa Rica	$ 20.0	557	$ 3.20
Cozumel	$ 365.5	9,727	$ 61.00
Curacao	$ 51.0	903	$ 16.70
Dominica	$ 14.2	373	$ 2.90
Dominican Republic	$ 61.0	1,914	$ 8.00
Ensenada	$ 52.7	1,370	$ 9.50
Grenada	$ 12.2	342	$ 2.30
Guadeloupe	$ 38.2	724	$ 6.10
Guatemala	$ 5.6	183	$ 0.80
Honduras	$ 73.0	1,585	$ 7.80
Jamaica	$ 198.6	7,067	$ 46.10
Martinique	$ 22.7	453	$ 3.70
Mazatlan	$ 9.4	268	$ 1.50
Nicaragua	$ 2.9	141	$ 0.40
Progreso	$ 23.9	609	$ 3.60
Puerto Rico (San Juan)	$ 198.2	5,209	$ 75.00
Puerto Vallarta	$ 27.1	757	$ 4.90
St. Kitts & Nevis	$ 84.3	1,293	$ 11.20
St. Lucia	$ 57.2	1,422	$ 11.70
St. Maarten	$ 422.9	9,259	$ 189.10
Tobago	$ 2.7	124	$ 1.50
Trinidad	$ 0.6	30	$ 0.40
Turks and Caicos	$ 95.0	1,654	$ 29.10
U. S. Virgin Islands	$ 344.3	6,397	$ 141.00
All Destinations	**$3,157.5**	**75,050**	**$ 976.5**

[1] The economic contribution of cruise tourism to the 35 destinations was estimated for the 12-month period from May, 2014 through April, 2015 which is referred to as the 2014/2015 cruise year throughout this report.

[2] All monetary figures are in U.S. dollars.

Figure J.1: Expenditures

Purchase Categories	Average Spend per Passenger ($US)	Share of All Onshore Visits①	Weighted Average Spend per Passenger	Total Passenger Expenditures ($US Millions)
Shore Excursions②	$ 43.99	53.0%	$ 23.33	$ 551.2
F&B at Restaurants & Bars	$ 15.90	50.4%	$ 8.01	$ 189.3
Clothing	$ 23.24	43.4%	$ 10.08	$ 238.0
Local Crafts & Souvenirs	$ 16.07	44.4%	$ 7.13	$ 168.4
Taxis/Ground Transportation	$ 15.36	23.7%	$ 3.64	$ 85.9
Watches & Jewelry	$ 187.64	19.8%	$ 37.11	$ 876.6
Other Purchases	$ 41.27	20.5%	$ 8.44	$ 199.4
Retail Purchases of Liquor	$ 20.78	10.8%	$ 2.25	$ 53.1
Perfumes & Cosmetics	$ 30.09	3.4%	$ 1.02	$ 24.2
Entertainment/Night Clubs	$ 33.92	1.5%	$ 0.51	$ 12.0
Lodging③	$ 139.98	1.3%	$ 1.79	$ 42.4
Telephone & Internet	$ 10.48	1.4%	$ 0.15	$ 3.4
Electronics	$ 69.87	0.5%	$ 0.38	$ 9.1
Total			**$103.83**	**$2,452.8**

① For the purposes of this table we have combined the expenditure data for both transit and homeport passengers. The expenditures of each group are analyzed separately elsewhere in this report.

② This is the effective average onshore expenditure and is a weighted average of the onshore purchases and the portion of the onboard and travel agent purchases paid to local tour operators. Actual reported average spending for shore excursions by source is as follows: cruise lines - $66.36 per passenger; travel agents/other - $57.71; and onshore tour operators - $28.85. The weighted average actual spend across all sources was $60.07.

③ Lodging expenditures only apply to those passengers who embarked on cruises in San Juan, Barbados, the Dominican Republic, Guadeloupe, Martinique and Cartagena. For purposes of this table the weighted average has been calculated across all passengers.

Figure J.2: Expenditures per category

K

Strategic Urban Mobility Plan for Paramaribo Historic Centre

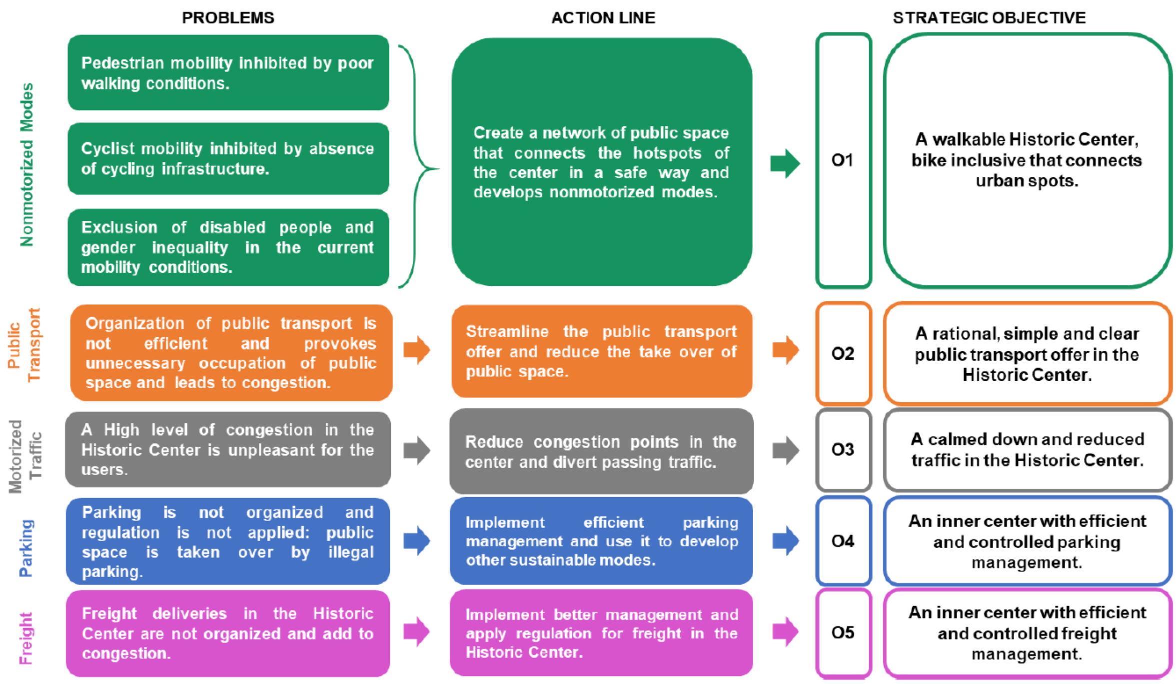


Figure K.1: Strategic objectives of the Sustainable Urban Mobility Plan of Paramaribo (Sinaí Lòpez Santos, 2018)

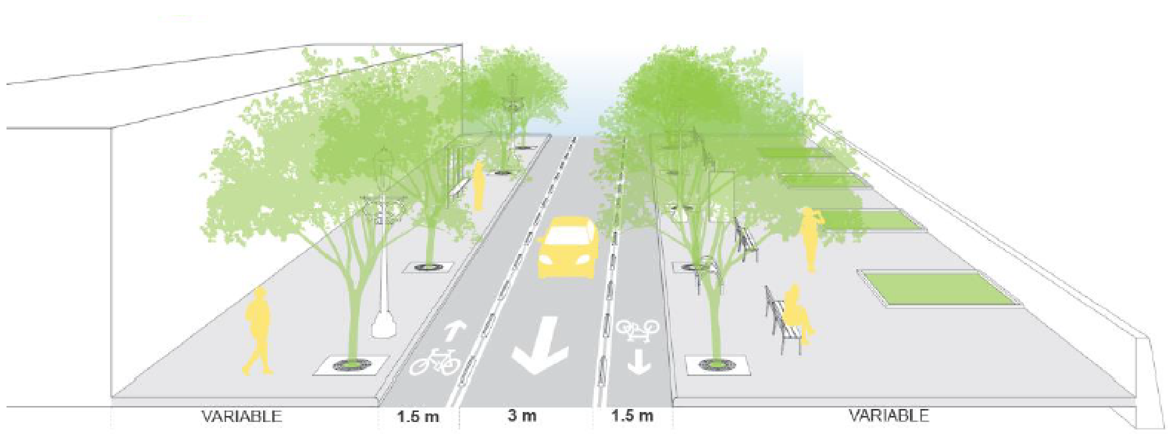


Figure K.2: Proposal for section Waterkant design(Sinaí Lòpez Santos, 2018).

Report for MSheet 7.7

Design of Sheet Pilings
Developed by GeoDelft

Company:	<Not Registered> <Not Registered>
Date of report:	01/04/2019
Time of report:	13:28:41
Date of calculation:	01/04/2019
Time of calculation:	13:26:16
Filename:	C:\Users\Hugo Stam\Desktop\Tutorial-1
Project identification:	Tutorial-1 Excavation using Ka, Ko and Kp

Verification according to CUR 166

1 Summary

1.1 Overview per Stage and Test

Stage no.	Verification type	Displace-ment [mm]	Moment [kNm]	Shear force [kN]	Mob. perc. moment [%]	Mob. perc. resistance [%]	Vertical balance
1	Step 6.3		-1062.0	**-292.2**	**0.0**	75.2	---
1	Step 6.4		-1022.2	-286.0	**0.0**	76.3	---
1	Step 6.5	-81.8	-588.0	-223.1	**0.0**	57.3	---
1	Step 6.5 * 1.20		-705.5	-267.7			
1	Step 9.1		-588.0	-223.1	**0.0**	57.3	---
2	Step 6.3		-1074.4	-290.6	**0.0**	75.3	---
2	Step 6.4		-1032.1	-284.7	**0.0**	76.4	---
2	Step 6.5	-82.9	-594.1	-221.8	**0.0**	57.4	---
2	Step 6.5 * 1.20		-712.9	-266.2			
2	Step 9.1		-594.1	-221.8	**0.0**	57.4	---
3	Step 6.3		**-1085.8**	-289.2	**0.0**	75.4	---
3	Step 6.4		-1041.0	-283.6	**0.0**	**76.5**	---
3	Step 6.5	**-83.7**	-600.0	-220.8	**0.0**	57.5	---
3	Step 6.5 * 1.20		-720.0	-264.9			
3	Step 9.1		-600.0	-220.8	**0.0**	57.5	---
Max		**-83.7**	**-1085.8**	**-292.2**	**0.0**	**76.5**	---

1.2 Anchors and Struts

Stage	Verification type	Anchor/strut GEWI-50T-1		Anchor/strut GEWI-50T-2	
		Force [kN]	State	Force [kN]	State
1	Step 6.3	222.85	Elastic	240.00	Yielding
2	Step 6.3	223.45	Elastic	240.00	Yielding
3	Step 6.3	218.73	Elastic	240.00	Yielding
1	Step 6.4	209.97	Elastic	240.00	Yielding
2	Step 6.4	211.97	Elastic	240.00	Yielding
3	Step 6.4	209.93	Elastic	240.00	Yielding
1	Step 6.5	128.88	Elastic	240.00	Yielding
2	Step 6.5	129.55	Elastic	240.00	Yielding
3	Step 6.5	126.66	Elastic	240.00	Yielding
1	Step 9.1	154.65	Elastic	288.00	Yielding
2	Step 9.1	155.46	Elastic	288.00	Yielding
3	Step 9.1	151.99	Elastic	288.00	Yielding

2 Input Data for all Stages

2.1 General Input Data

Verification according to CUR 166

Model	Sheet piling
Check vertical balance	No
Number of construction stages	3
Unit weight of water	9.81 kN/m³
Number of curves on spring characteristic	1
Unloading curve on spring characteristic	No

2.2 Sheet Piling Properties

Length	26.00 m
Level top side	3.80 m
Number of sections	1

Section name	From [m]	To [m]	Stiffness EI [kNm²/m']	Acting width [m]	Maximum moment [kNm/m']
AZ 36 -700	-22.20	3.80	1.8845E+05	1.00	864.00

Section name	From [m]	To [m]	Red. factor EI [-]	Red. factor max. moment [-]	Note to reduction factor
AZ 36 -700	-22.20	3.80	1.00	1.00	

Section name	From [m]	To [m]	Corrected stiffness EI [kNm²]	Corrected max. moment [kNm]
AZ 36 -700	-22.20	3.80	1.8850E+05	864.00

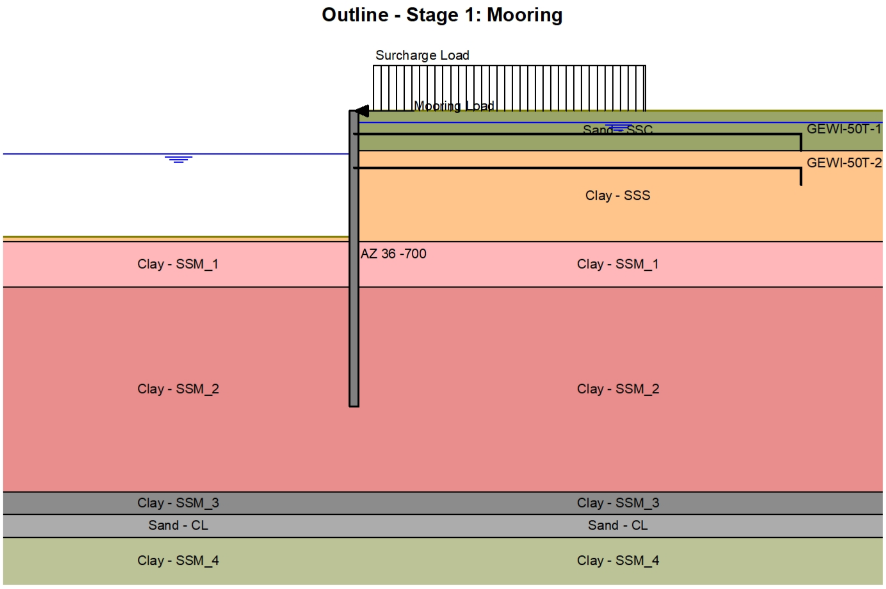
2.3 Calculation Options

First stage represents initial situation	No
Calculation refinement	Coarse
Reduce delta(s) according to CUR	Yes
Verification	CUR method I: Partial factors (design values) in all stages
Multiplication factor for anchor stiffness	1.000
Used partial factor set	II
Factors on surface loads	
- Permanent load, unfavourable	1.00
- Permanent load, favourable	1.00
- Variable load, unfavourable	1.00
- Variable load, favourable	0.00
Material factors	
- Cohesion	1.00
- Tangent phi	1.15
- Delta (wall friction angle)	1.15
- Modulus of subgrade reactions	1.30
Geometry modification	
- Reduction in surface level on passive side	- 0.30 m
- Reduction in phreatic line on passive side	- 0.20 m
- Raise in phreatic line on passive side	- 0.20 m
- Raise in phreatic line on active side	0.05 m

Overall stability factors

- Driving moment	1.00
- Cohesion	1.50
- Phi	1.20

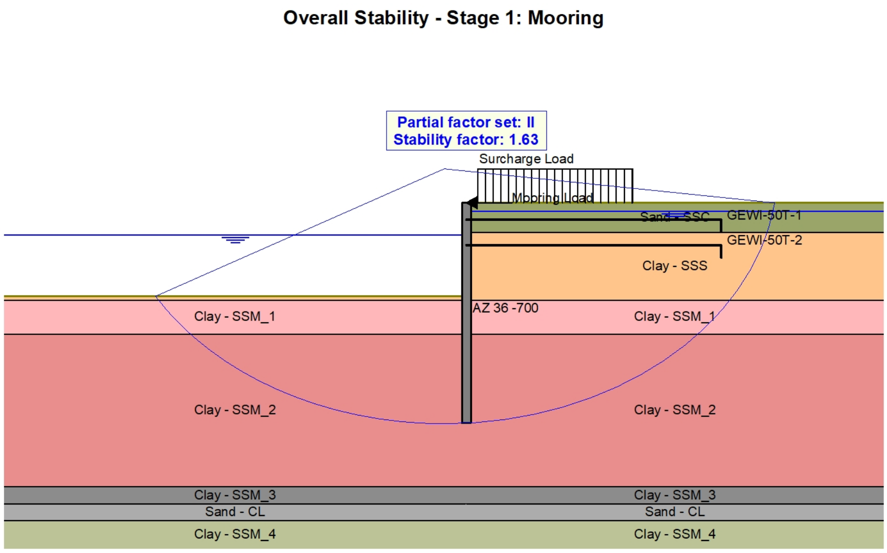
3 Outline Stage 1: Mooring



4 Overall Stability Stage 1: Mooring

Stability factor : 1.63

4.1 Overall Stability



5 Step 6.5 Stage 1: Mooring

5.1 General Input Data

5.1.1 Horizontal Loads

Name	Level [m]	Load [kN/m']
Mooring Load	3.80	-25.00

5.2 Input Data Left

5.2.1 Calculation Method

Calculation method: C, phi, delta

5.2.2 Water Level

Water level: 0.00 [m]

5.2.3 Surface

X [m]	Y [m]
0.00	-7.25

5.2.4 Soil Layer Properties in Profile: right

Layer name	Level	Unit weight		Cohesion	Friction angle phi	Delta friction angle
		Unsat	Sat			
	[m]	[kN/m³]	[kN/m³]	[kN/m²]	[deg]	[deg]
Sand - SSC	3.80	18.00	20.00	0.00	27.00	9.00
Clay - SSS	0.30	20.00	20.00	13.00	22.50	7.50
Clay - SSM_1	-7.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_2	-11.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_3	-29.70	18.00	18.00	5.00	22.50	7.50
Sand - CL	-31.70	17.00	19.00	0.00	30.00	10.00
Clay - SSM_4	-33.70	18.00	18.00	5.00	22.50	7.50

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Sand - SSC	3.80	1.00	1.00	Fine
Clay - SSS	0.30	1.00	1.00	Fine
Clay - SSM_1	-7.70	1.00	1.00	Fine
Clay - SSM_2	-11.70	1.00	1.00	Fine
Clay - SSM_3	-29.70	1.00	1.00	Fine
Sand - CL	-31.70	1.00	1.00	Fine
Clay - SSM_4	-33.70	1.00	1.00	Fine

Layer name	Level	Earth pressure coefficients			Additional pore pressure	
		Active	Neutral	Passive	Top	Bottom
	[m]	[-]	[-]	[-]	[kN/m²]	[kN/m²]
Sand - SSC	3.80	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSS	0.30	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_1	-7.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_2	-11.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_3	-29.70	n.a.	n.a.	n.a.	0.00	0.00
Sand - CL	-31.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_4	-33.70	n.a.	n.a.	n.a.	0.00	0.00

5.2.5 Modulus of Subgrade Reaction (Tangent MSheet Classic)

Layer name	Level [m]	Branch 1	
		Top [kN/m³]	Bottom [kN/m³]
Sand - SSC	3.80	40000.00	90000.00
Clay - SSS	0.30	6000.00	13500.00
Clay - SSM_1	-7.70	4000.00	9000.00
Clay - SSM_2	-11.70	4000.00	9000.00
Clay - SSM_3	-29.70	4000.00	9000.00
Sand - CL	-31.70	12000.00	27000.00
Clay - SSM_4	-33.70	4000.00	9000.00

5.3 Calculated Earth Pressure Coefficients Left

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m²]	Passive [kN/m²]	Ka [-]	Ko [-]	Kp [-]
1	-7.47	0.0	53.9	0.00	0.62	23.50
2	-8.20	0.0	41.9	0.00	0.62	4.83
3	-9.20	0.0	64.2	0.00	0.62	3.81
4	-10.20	0.0	86.4	0.00	0.62	3.45
5	-11.20	3.1	108.7	0.09	0.62	3.27
6	-12.03	10.3	127.0	0.26	0.62	3.18
7	-12.68	12.5	141.5	0.28	0.62	3.12
8	-13.57	15.5	161.5	0.29	0.62	3.06
9	-14.72	19.4	187.1	0.31	0.62	3.01
10	-15.88	23.3	212.7	0.33	0.62	2.97
11	-17.02	27.2	238.2	0.34	0.62	2.94
12	-18.18	31.0	263.8	0.34	0.62	2.92
13	-19.32	34.9	289.4	0.35	0.62	2.90
14	-20.48	38.8	314.9	0.36	0.62	2.88
15	-21.63	42.7	340.5	0.36	0.62	2.87

5.4 Input Data Right

5.4.1 Calculation Method

Calculation method: C, phi, delta

5.4.2 Water Level

Water level: 2.80 [m]

5.4.3 Surface

X [m]	Y [m]
0.00	3.80

5.4.4 Soil Layer Properties in Profile: right

Layer name	Level [m]	Unit weight		Cohesion [kN/m²]	Friction angle phi [deg]	Delta friction angle [deg]
		Unsat [kN/m³]	Sat [kN/m³]			
Sand - SSC	3.80	18.00	20.00	0.00	27.00	9.00
Clay - SSS	0.30	20.00	20.00	13.00	22.50	7.50
Clay - SSM_1	-7.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_2	-11.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_3	-29.70	18.00	18.00	5.00	22.50	7.50
Sand - CL	-31.70	17.00	19.00	0.00	30.00	10.00
Clay - SSM_4	-33.70	18.00	18.00	5.00	22.50	7.50

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Sand - SSC	3.80	1.00	1.00	Fine
Clay - SSS	0.30	1.00	1.00	Fine
Clay - SSM_1	-7.70	1.00	1.00	Fine
Clay - SSM_2	-11.70	1.00	1.00	Fine
Clay - SSM_3	-29.70	1.00	1.00	Fine
Sand - CL	-31.70	1.00	1.00	Fine
Clay - SSM_4	-33.70	1.00	1.00	Fine

Layer name	Level	Earth pressure coefficients			Additional pore pressure	
		Active	Neutral	Passive	Top	Bottom
	[m]	[-]	[-]	[-]	[kN/m²]	[kN/m²]
Sand - SSC	3.80	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSS	0.30	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_1	-7.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_2	-11.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_3	-29.70	n.a.	n.a.	n.a.	0.00	0.00
Sand - CL	-31.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_4	-33.70	n.a.	n.a.	n.a.	0.00	0.00

5.4.5 Modulus of Subgrade Reaction (Tangent MSheet Classic)

Layer name	Level	Branch 1	
		Top	Bottom
	[m]	[kN/m³]	[kN/m³]
Sand - SSC	3.80	40000.00	90000.00
Clay - SSS	0.30	6000.00	13500.00
Clay - SSM_1	-7.70	4000.00	9000.00
Clay - SSM_2	-11.70	4000.00	9000.00
Clay - SSM_3	-29.70	4000.00	9000.00
Sand - CL	-31.70	12000.00	27000.00
Clay - SSM_4	-33.70	4000.00	9000.00

5.4.6 Anchors

Name	Level [m]	E-Modulus [kN/m²]	Cross section [m²/m']	Length [m]	Angle [deg]	Yield force [kN/m']	Pre-tension. force [kN/m']
GEWI-50T-1	1.80	2.100E+08	7.009E-04	23.00	0.00	240.00	n.a.
GEWI-50T-2	-1.20	2.100E+08	7.009E-04	23.00	0.00	240.00	n.a.

5.4.7 Surcharge Loads

Name	Distance [m]	Load [kN/m²]
Surcharge Load	1.00	10.00
	15.00	10.00

5.5 Calculated Earth Pressure Coefficients Right

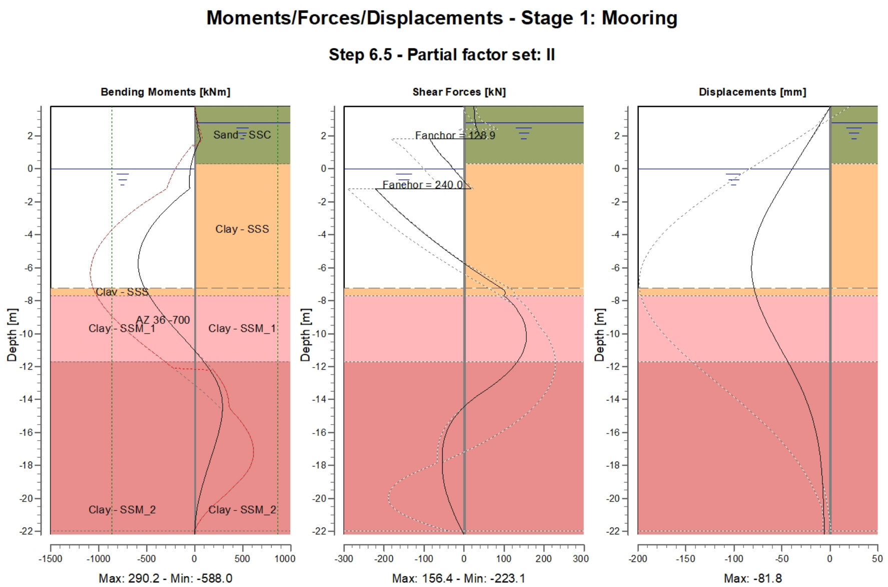
Segment number	Level	Horizontal pressure		Fictive earth pressure coefficients		
		Active	Passive	Ka	Ko	Kp
	[m]	[kN/m²]	[kN/m²]	[-]	[-]	[-]
1	3.30	3.1	45.9	0.33	1.03	4.87
2	2.60	8.6	107.8	0.38	0.80	4.79
3	2.10	11.5	122.2	0.40	0.72	4.22
4	1.43	14.1	145.1	0.38	0.66	3.90
5	0.68	16.9	171.1	0.37	0.61	3.74
6	0.15	5.8	205.4	0.11	0.66	3.98
7	-0.60	9.1	219.8	0.15	0.64	3.68
8	-1.67	14.2	247.8	0.20	0.62	3.49
9	-2.60	18.1	273.5	0.22	0.61	3.38
10	-3.53	22.0	277.8	0.24	0.61	3.07
11	-4.50	26.1	296.1	0.26	0.60	2.95
12	-5.50	30.3	322.7	0.27	0.60	2.92

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m²]	Passive [kN/m²]	Ka [-]	Ko [-]	Kp [-]
13	-6.63	35.0	354.5	0.29	0.60	2.91
14	-7.47	38.6	382.4	0.30	0.60	2.93
15	-8.20	51.1	369.8	0.37	0.60	2.70
16	-9.20	54.5	391.9	0.38	0.60	2.70
17	-10.20	57.8	414.0	0.38	0.60	2.71
18	-11.20	61.2	436.1	0.38	0.60	2.71
19	-12.03	64.0	454.4	0.38	0.60	2.71
20	-12.68	66.2	468.8	0.38	0.60	2.71
21	-13.57	69.2	488.8	0.38	0.60	2.71
22	-14.72	73.1	514.3	0.39	0.60	2.72
23	-15.88	77.0	539.8	0.39	0.60	2.72
24	-17.02	80.6	565.4	0.39	0.60	2.72
25	-18.18	82.1	590.9	0.38	0.60	2.72
26	-19.32	84.9	616.5	0.38	0.60	2.73
27	-20.48	88.9	642.0	0.38	0.60	2.73
28	-21.63	92.5	667.6	0.38	0.60	2.73

5.6 Calculation Results

Number of iterations: 4

5.6.1 Charts of Moments, Forces and Displacements



5.6.2 Moments, Forces and Displacements

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
1	3.80	0.0	25.0	0.8
1	2.80	26.0	28.2	-9.6
2	2.80	26.0	28.2	-9.6
2	2.40	38.1	32.4	-13.8
3	2.40	38.1	32.4	-13.8
3	1.80	60.5	43.4	-20.1
4	1.80	60.5	-85.5	-20.1
4	1.05	3.6	-64.8	-28.2

Segment number	Level [m]	Moment [kNm]	Shear force [kN]	Displacement [mm]
5	1.05	4.4	-77.7	-33.8
5	0.30	-41.8	-43.8	-43.5
6	0.30	-41.8	-43.8	-43.5
6	0.00	-53.2	-32.3	-47.3
7	0.00	-53.2	-32.3	-47.3
7	-1.20	-60.7	20.3	-62.4
8	-1.20	-60.7	**-267.7**	-62.4
8	-2.13	-289.0	-221.0	-73.7
9	-2.13	-289.0	-221.0	-73.7
9	-3.07	-471.6	-170.0	-83.6
10	-3.07	-471.6	-170.0	-83.6
10	-4.00	-604.6	-114.5	-91.3
11	-4.00	-604.6	-114.5	-91.3
11	-5.00	-687.3	-50.3	-96.5
12	-5.00	-687.3	-50.3	-96.5
12	-6.00	**-703.2**	19.1	**-98.1**
13	-6.00	**-703.2**	19.1	**-98.1**
13	-7.25	-621.3	112.8	-94.9
14	-7.25	-621.3	112.8	-94.9
14	-7.70	-566.9	119.4	-92.5
15	-7.70	-566.9	119.4	-92.5
15	-8.70	-422.0	163.3	-84.9
16	-8.70	-422.0	163.3	-84.9
16	-9.70	-245.2	184.6	-75.2
17	-9.70	-245.2	184.6	-75.2
17	-10.70	-58.8	183.2	-64.1
18	-10.70	-58.8	183.2	-64.1
18	-11.70	114.8	159.2	-52.7
19	-11.70	114.8	159.2	-52.7
19	-12.35	209.8	131.5	-45.6
20	-12.35	209.8	131.5	-45.6
20	-13.00	283.8	94.1	-39.0
21	-13.00	283.8	94.0	-39.0
21	-14.15	346.2	15.5	-28.8
22	-14.15	346.2	15.4	-28.8
22	-15.30	331.3	-36.0	-21.0
23	-15.30	331.3	-36.0	-21.0
23	-16.45	274.0	-59.9	-15.5
24	-16.45	274.0	-59.9	-15.5
24	-17.60	200.7	-65.3	-11.9
25	-17.60	200.7	-65.3	-11.9
25	-18.75	126.3	-62.7	-9.8
26	-18.75	126.3	-62.7	-9.8
26	-19.90	60.9	-49.2	-8.5
27	-19.90	60.9	-49.2	-8.5
27	-21.05	16.3	-27.4	-7.7
28	-21.05	16.3	-27.4	-7.7
28	-22.20	0.0	0.0	-7.0
Max		**-703.2**	**-267.7**	**-98.1**
Max, minor nodes incl.		-705.5	-267.7	-98.1

6.6.3 Stresses

Node number	Level	Left				Right			
	[m]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]	Effective stress [kN/m²]	Water stress [kN/m²]	Stat*	Mob* [%]
1	3.80	0.00	0.00			0.00	0.00		
1	2.80	0.00	0.00			6.52	0.00		
2	2.80	0.00	0.00			7.54	0.00		
2	2.40	0.00	0.00			9.56	3.92		
3	2.40	0.00	0.00			9.97	3.92		
3	1.80	0.00	0.00			12.96	9.81		
4	1.80	0.00	0.00			12.44	9.81		
4	1.05	0.00	0.00			15.81	17.17		
5	1.05	0.00	0.00			15.34	17.17		

Node number	Level [m]	Left Effective stress [kN/m²]	Left Water stress [kN/m²]	Left Stat*	Left Mob* [%]	Right Effective stress [kN/m²]	Right Water stress [kN/m²]	Right Stat*	Right Mob* [%]
5	0.30	0.00	0.00			18.45	24.52		
6	0.30	0.00	0.00			5.61	24.52		
6	0.00	0.00	0.00			5.98	27.47		
7	0.00	0.00	0.00			8.09	27.47		
7	-1.20	0.00	11.77			10.04	39.24		
8	-1.20	0.00	11.77			13.21	39.24		
8	-2.13	0.00	20.93			15.17	48.40		
9	-2.13	0.00	20.93			17.03	48.40		
9	-3.07	0.00	30.08			19.21	57.55		
10	-3.07	0.00	30.08			20.87	57.55		
10	-4.00	0.00	39.24			23.21	66.71		
11	-4.00	0.00	39.24			24.77	66.71		
11	-5.00	0.00	49.05			27.42	76.52		
12	-5.00	0.00	49.05			28.90	76.52		
12	-6.00	0.00	58.86			31.68	86.33		
13	-6.00	0.00	58.86			33.20	86.33		
13	-7.25	0.00	71.12			36.83	98.59		
14	-7.25	0.00	71.12			37.91	98.59		
14	-7.70	107.75	75.54			39.25	103.00		
15	-7.70	22.16	75.54			49.58	103.00		
15	-8.70	61.73	85.35			52.60	112.81		
16	-8.70	48.62	85.35			52.95	112.81		
16	-9.70	79.79	95.16			55.98	122.63		
17	-9.70	72.32	95.16			56.32	122.63		
17	-10.70	100.57	104.97			59.36	132.44		
18	-10.70	95.30	104.97			59.69	132.44		
18	-11.70	122.07	114.78			62.74	142.25		
19	-11.70	118.58	114.78			63.01	142.25		
19	-12.35	135.49	121.15			65.00	148.62		
20	-12.35	133.18	121.15			65.20	148.62		
20	-13.00	149.80	127.53			67.19	155.00		
21	-13.00	147.07	127.53			67.46	155.00		
21	-14.15	147.73	138.81		84	71.01	166.28		
22	-14.15	147.73	138.81		85	71.33	166.28		
22	-15.30	128.76	150.09		64	74.90	177.56		
23	-15.30	128.76	150.09		65	75.21	177.56		
23	-16.45	115.85	161.37		51	78.79	188.84		
24	-16.45	115.85	161.37		52	78.79	188.84		
24	-17.60	109.01	172.66		43	82.37	200.12		
25	-17.60	109.01	172.66		44	80.34	200.12		
25	-18.75	107.25	183.94		39	85.02	211.41		
26	-18.75	107.25	183.94		39	85.19	211.41		
26	-19.90	109.01	195.22		36	94.82	222.69		
27	-19.90	109.01	195.22		36	94.99	222.69		
27	-21.05	112.51	206.50		34	102.89	233.97		
28	-21.05	112.51	206.50		34	103.06	233.97		
28	-22.20	116.33	217.78		33	110.66	245.25		

*
Stat Status (A=active, P=passive, Number is branche, 0 is unloading)
Mob Percentage passive mobilized

6.6.4 Soil Collapse

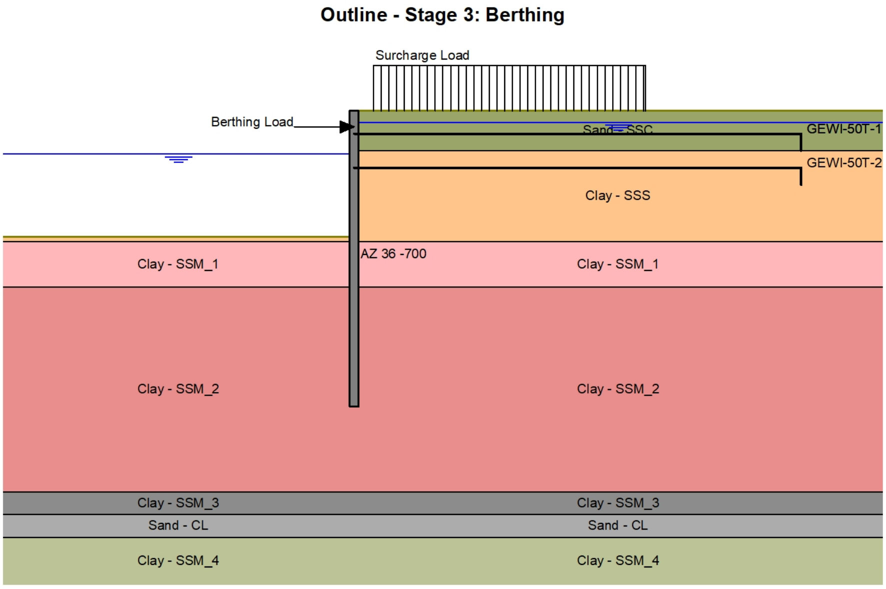
Horizontal soil pressure	Left [kN]	Right [kN]
Effective	1610.9	1306.8
Water	2417.4	3065.6
Total	4028.3	4372.4

Considered as passive side	Left
Maximum passive effective resistance	2809.38 kN
Mobilized passive effective resistance	1610.92 kN
Percentage mobilized resistance	57.3 %

6.6.5 Anchors/Struts

Anchor/strut name	Level [m]	E-Modulus [kN/m²]	Force [kN]	State	Side	Type
GEWI-50T-1	1.80	2.100E+08	154.65	Elastic	Right	Anchor
GEWI-50T-2	-1.20	2.100E+08	288.00	Yielding	Right	Anchor

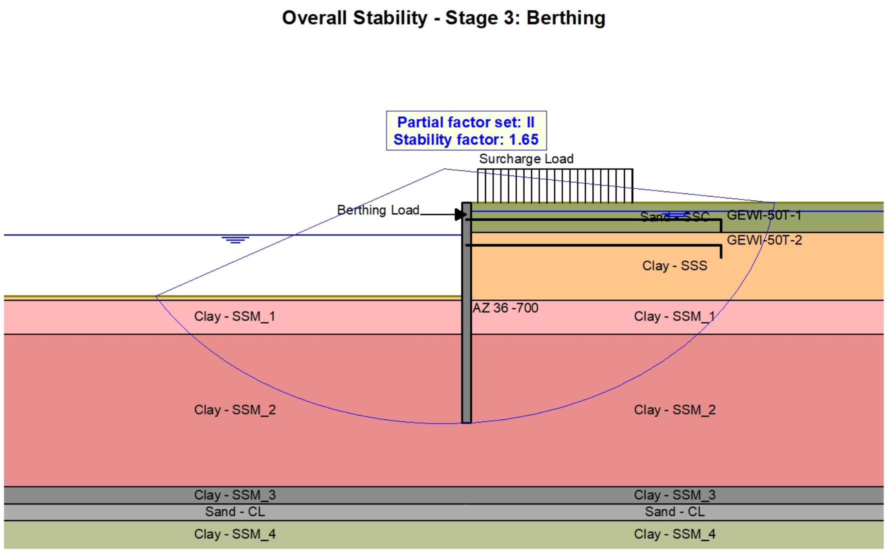
7 Outline Stage 3: Berthing



8 Overall Stability Stage 3: Berthing

Stability factor : 1.65

8.1 Overall Stability



9 Step 6.5 Stage 3: Berthing

9.1 General Input Data

9.1.1 Horizontal Loads

Name	Level [m]	Load [kN/m']
Berthing Load	2.40	82.00

9.2 Input Data Left

9.2.1 Calculation Method

Calculation method: C, phi, delta

9.2.2 Water Level

Water level: 0.00 [m]

9.2.3 Surface

X [m]	Y [m]
0.00	-7.25

9.2.4 Soil Layer Properties in Profile: right

Layer name	Level [m]	Unit weight		Cohesion [kN/m²]	Friction angle phi [deg]	Delta friction angle [deg]
		Unsat [kN/m³]	Sat [kN/m³]			
Sand - SSC	3.80	18.00	20.00	0.00	27.00	9.00
Clay - SSS	0.30	20.00	20.00	13.00	22.50	7.50
Clay - SSM_1	-7.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_2	-11.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_3	-29.70	18.00	18.00	5.00	22.50	7.50
Sand - CL	-31.70	17.00	19.00	0.00	30.00	10.00
Clay - SSM_4	-33.70	18.00	18.00	5.00	22.50	7.50

Layer name	Level [m]	Shell factor [-]	OCR [-]	Grain type
Sand - SSC	3.80	1.00	1.00	Fine
Clay - SSS	0.30	1.00	1.00	Fine
Clay - SSM_1	-7.70	1.00	1.00	Fine
Clay - SSM_2	-11.70	1.00	1.00	Fine
Clay - SSM_3	-29.70	1.00	1.00	Fine
Sand - CL	-31.70	1.00	1.00	Fine
Clay - SSM_4	-33.70	1.00	1.00	Fine

Layer name	Level [m]	Earth pressure coefficients			Additional pore pressure	
		Active [-]	Neutral [-]	Passive [-]	Top [kN/m²]	Bottom [kN/m²]
Sand - SSC	3.80	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSS	0.30	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_1	-7.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_2	-11.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_3	-29.70	n.a.	n.a.	n.a.	0.00	0.00
Sand - CL	-31.70	n.a.	n.a.	n.a.	0.00	0.00
Clay - SSM_4	-33.70	n.a.	n.a.	n.a.	0.00	0.00

9.2.5 Modulus of Subgrade Reaction (Tangent MSheet Classic)

Layer name	Level [m]	Branch 1	
		Top [kN/m³]	Bottom [kN/m³]
Sand - SSC	3.80	40000.00	90000.00
Clay - SSS	0.30	6000.00	13500.00
Clay - SSM_1	-7.70	4000.00	9000.00
Clay - SSM_2	-11.70	4000.00	9000.00
Clay - SSM_3	-29.70	4000.00	9000.00
Sand - CL	-31.70	12000.00	27000.00
Clay - SSM_4	-33.70	4000.00	9000.00

9.3 Calculated Earth Pressure Coefficients Left

Segment number	Level [m]	Horizontal pressure		Fictive earth pressure coefficients		
		Active [kN/m²]	Passive [kN/m²]	Ka [-]	Ko [-]	Kp [-]
1	-7.47	0.0	53.9	0.00	0.62	23.50
2	-8.20	0.0	41.9	0.00	0.62	4.83
3	-9.20	0.0	64.2	0.00	0.62	3.81
4	-10.20	0.0	86.4	0.00	0.62	3.45
5	-11.20	3.1	108.7	0.09	0.62	3.27
6	-12.03	10.3	127.0	0.26	0.62	3.18
7	-12.68	12.5	141.5	0.28	0.62	3.12
8	-13.57	15.5	161.5	0.29	0.62	3.06
9	-14.72	19.4	187.1	0.31	0.62	3.01
10	-15.88	23.3	212.7	0.33	0.62	2.97
11	-17.02	27.2	238.2	0.34	0.62	2.94
12	-18.18	31.0	263.8	0.34	0.62	2.92
13	-19.32	34.9	289.4	0.35	0.62	2.90
14	-20.48	38.8	314.9	0.36	0.62	2.88
15	-21.63	42.7	340.5	0.36	0.62	2.87

9.4 Input Data Right

9.4.1 Calculation Method

Calculation method: C, phi, delta

9.4.2 Water Level

Water level: 2.80 [m]

9.4.3 Surface

X [m]	Y [m]
0.00	3.80

9.4.4 Soil Layer Properties in Profile: right

Layer name	Level [m]	Unit weight		Cohesion [kN/m²]	Friction angle phi [deg]	Delta friction angle [deg]
		Unsat [kN/m³]	Sat [kN/m³]			
Sand - SSC	3.80	18.00	20.00	0.00	27.00	9.00
Clay - SSS	0.30	20.00	20.00	13.00	22.50	7.50
Clay - SSM_1	-7.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_2	-11.70	18.00	18.00	5.00	22.50	7.50
Clay - SSM_3	-29.70	18.00	18.00	5.00	22.50	7.50
Sand - CL	-31.70	17.00	19.00	0.00	30.00	10.00
Clay - SSM_4	-33.70	18.00	18.00	5.00	22.50	7.50