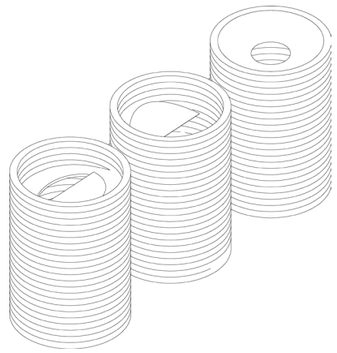
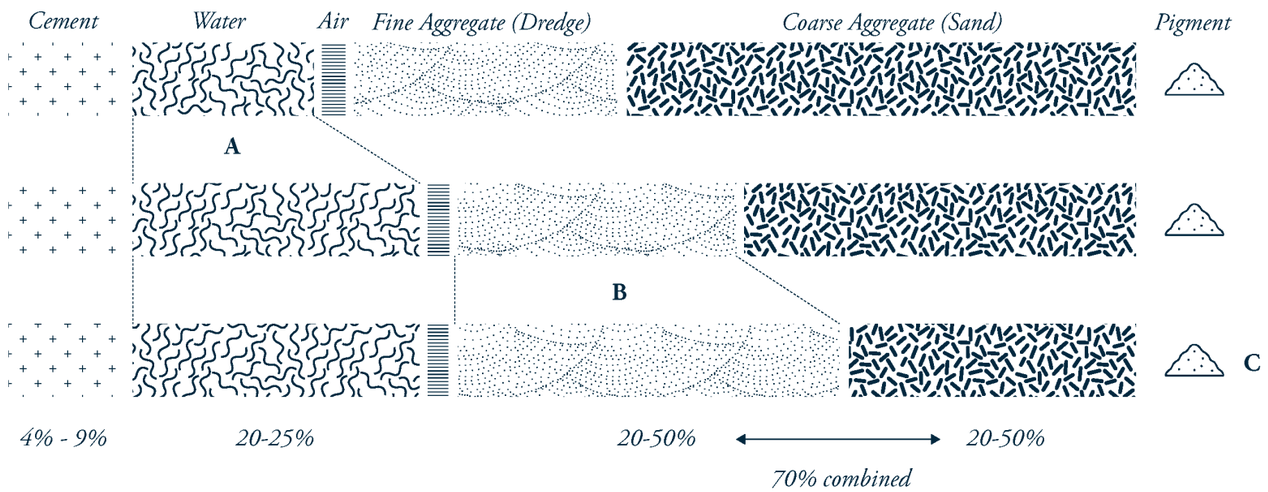


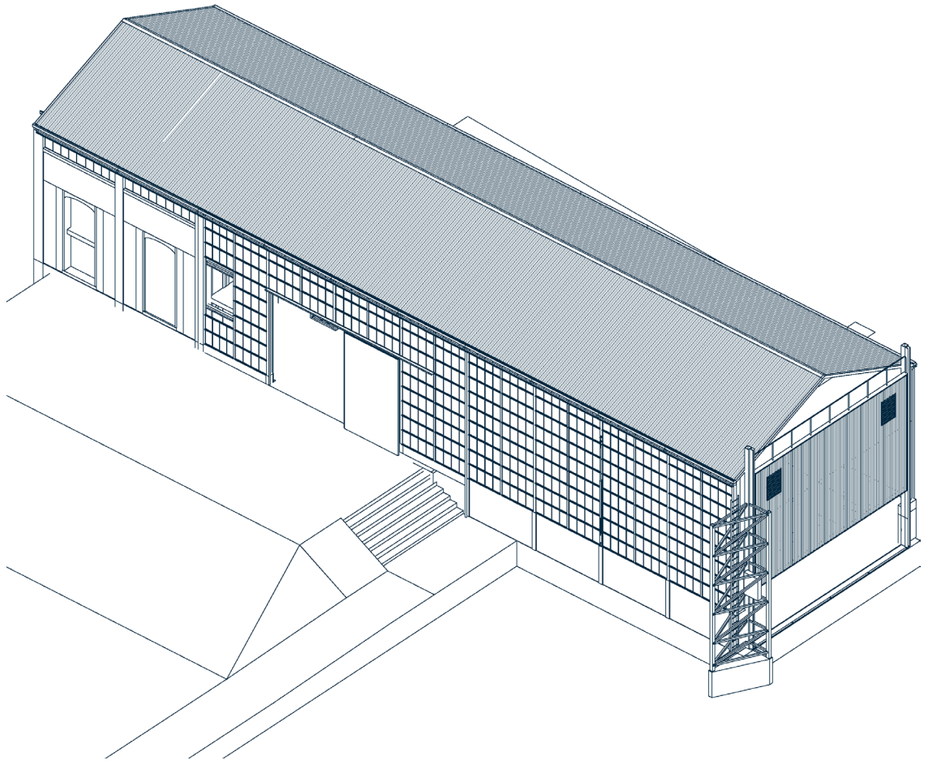
DREDGING SPECIE SILOS

‘Dredging Specie’ is commonly seen as a waste material in the dredging business. This experiment is a first exploration into building with dredging specie. Concrete works in a combination of cement, water and aggregate, in this experiment the aggregate used is dredged up from local rivers. The building becomes part of the Volker museums exhibition.

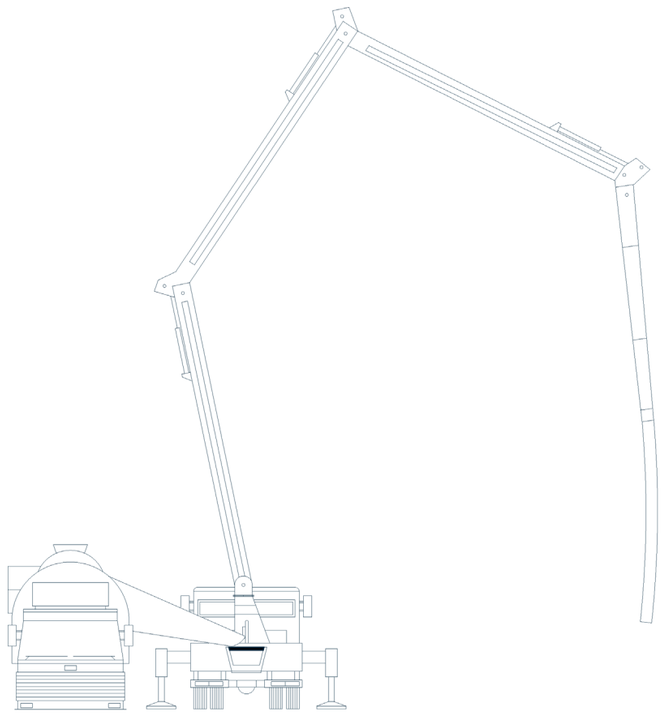


(Gallery of Stratum House / Stpmj - 24, n.d.)

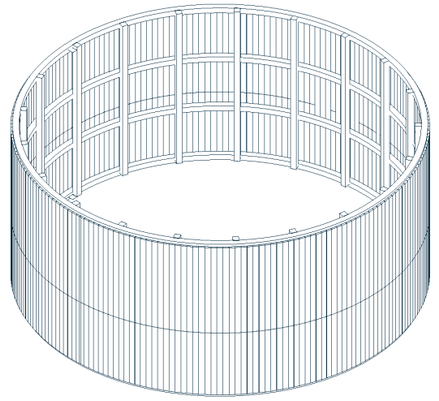
Three constraints are applied; water-cement ratio, use of diverse aggregates and different amount of pigment. The change of concrete shape according to the slump value is the first. When the water ratio is increased, the slump value is increased. The concrete forms a shape close to the horizontal. On the other case, the slump value is reduced and the mound is formed with a mass. The second is the variety of texture on exposed concrete surface depending on the ratio of fine to coarse aggregate. The last is the color changes of the surface. With the combinations of these three variables; shape, texture and color, the concrete of each different quality is cast on-site everyday. It allows to have delicately designed divisions of stacked concrete layers showing time differences.



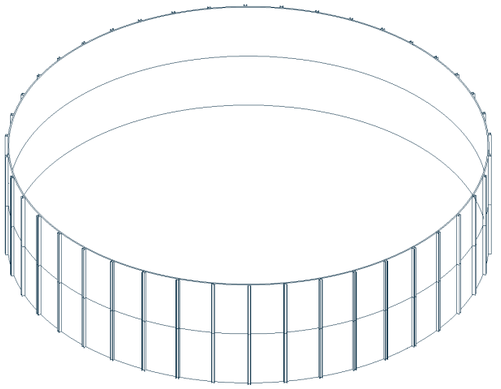
On-site minifactory in Shipyard



Concrete pouring tube



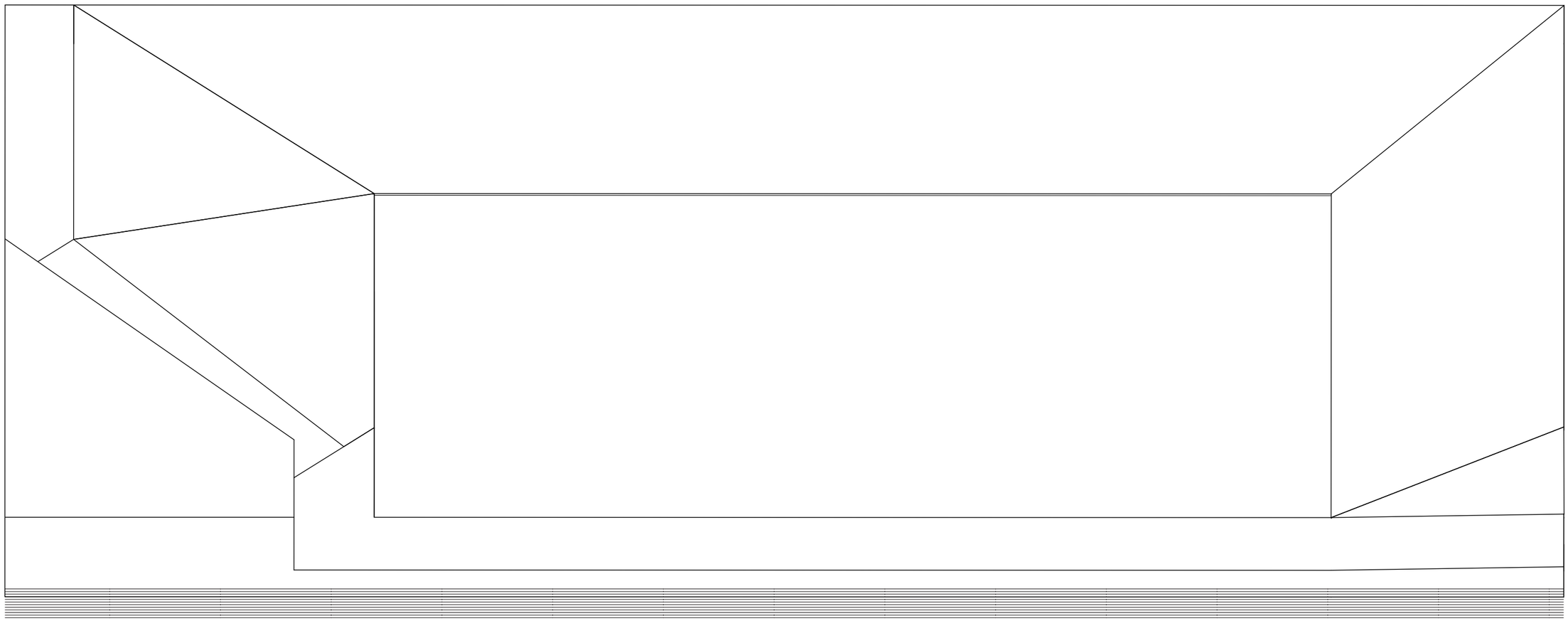
Textured inner mould



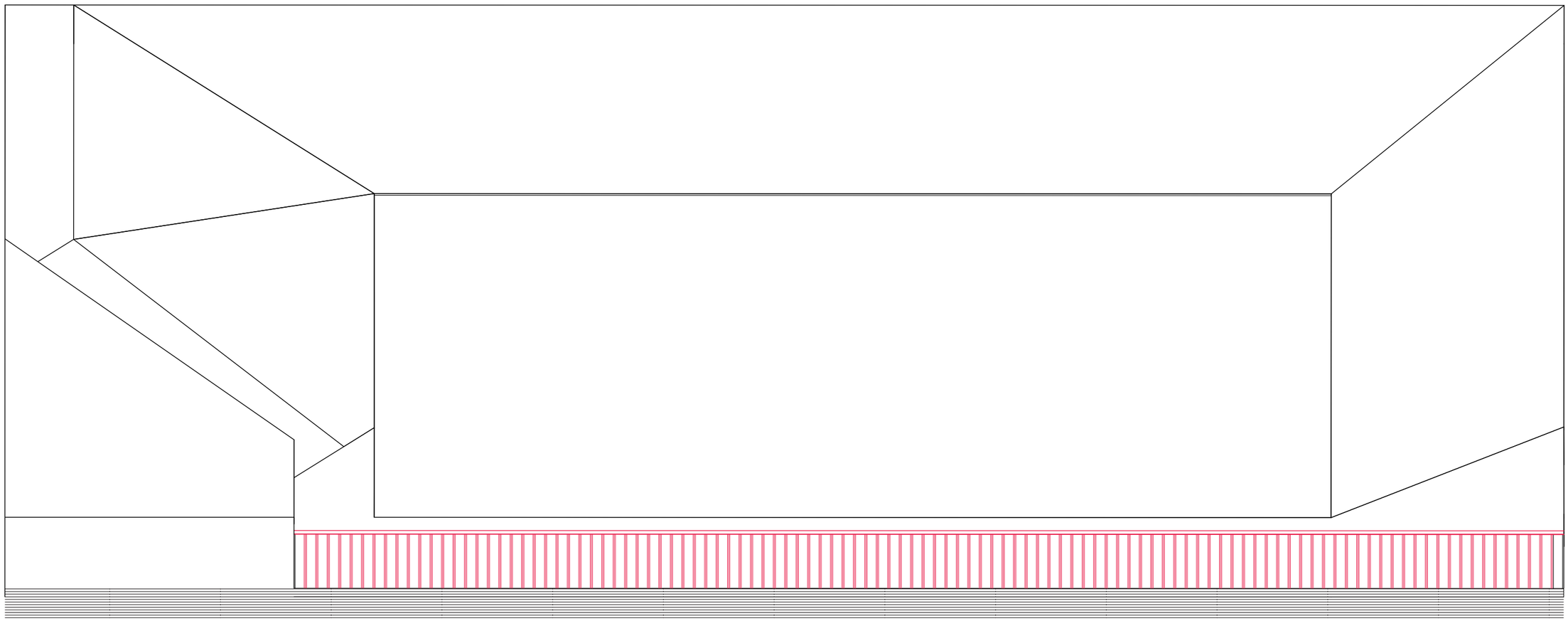
Smooth outer mould

The casting process is relatively long and therefore I have opted to build a temporary mini factory inside of the shipyard. That way the material is safely stored and allows the mix to be made on-site. The equipment is fairly similar to standard concrete casting. The difference is that the mixer is on-site and the moulds are stackable. In this project the inner and outer mould have a different surfaces causing the finish of the outside and the interior to differ. Whilst the outside is smooth and seamless the interior has a rougher texture that provokes people to touch the concrete walls.

02_The Equipment

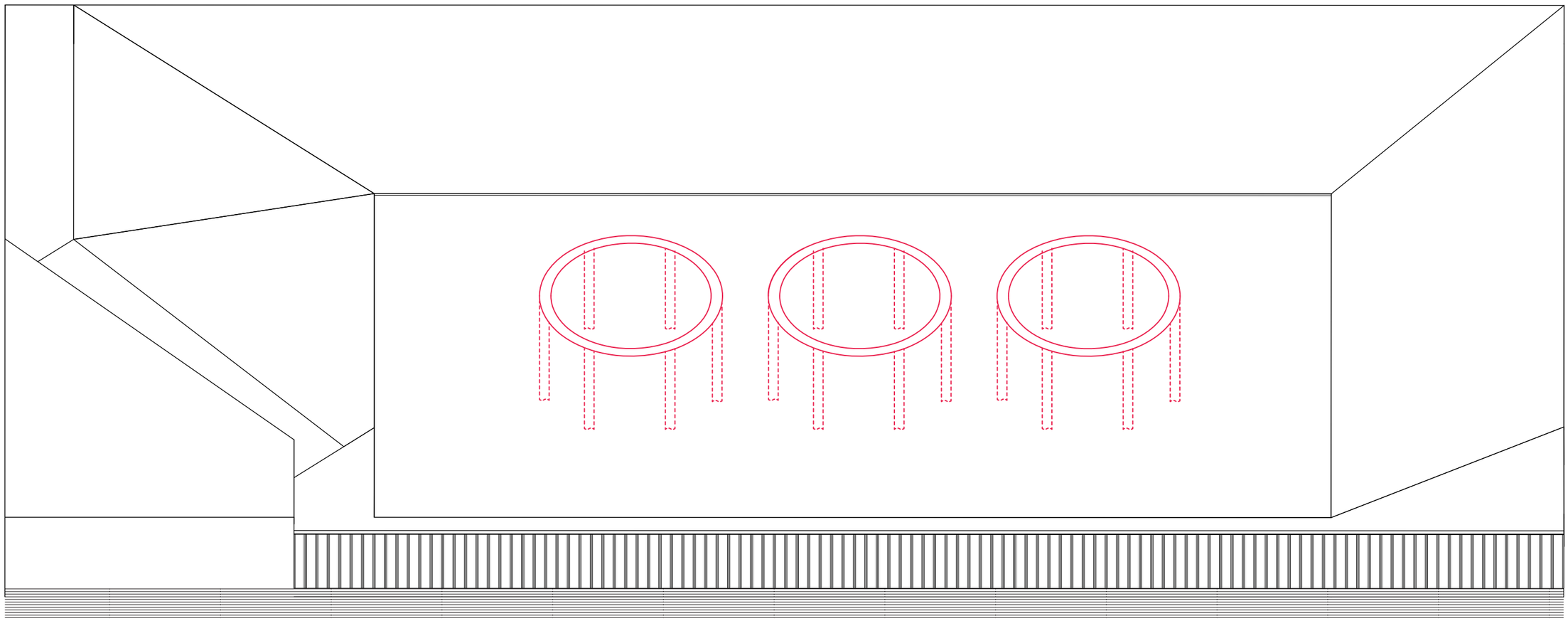


After the quay has been restructured the construction of the silo's can begin.



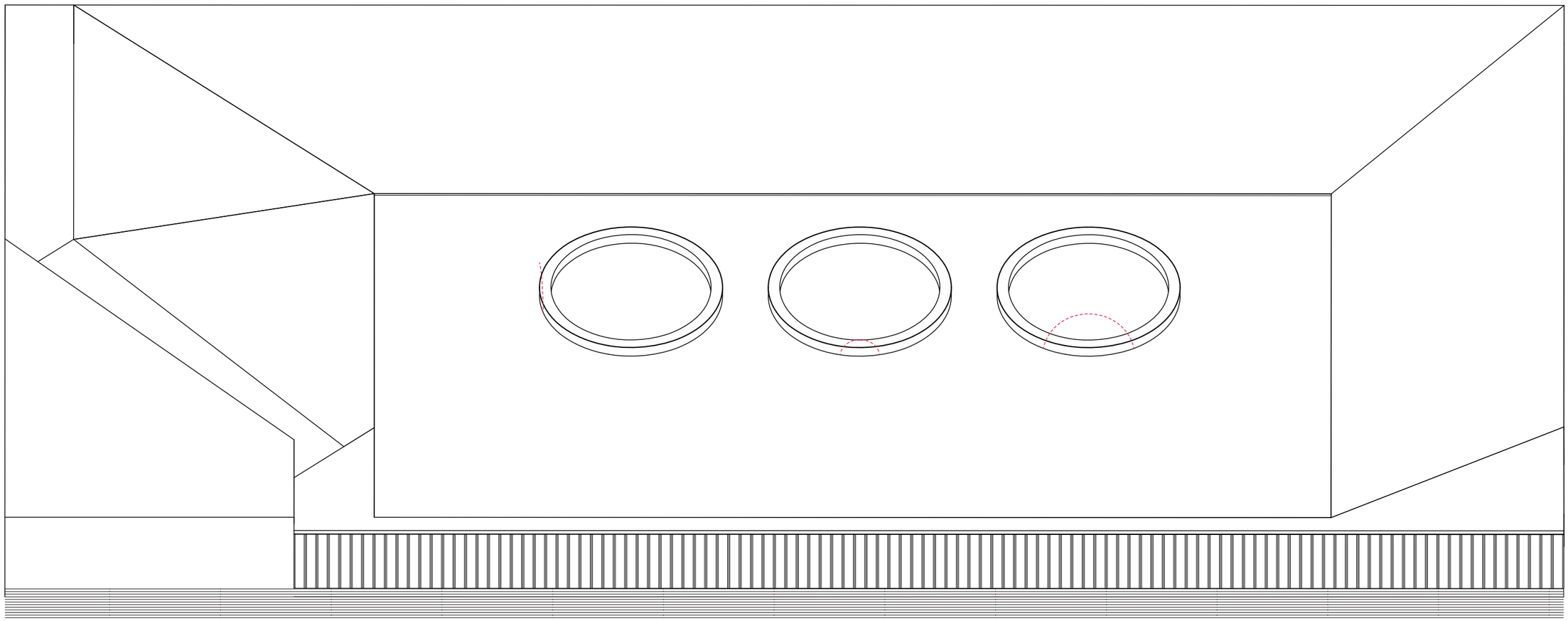
A temporary waterbarrier is placed to keep out the water during the construction process. The steel plates for the old quay are being reused.

04_Temporary Waterbarrier



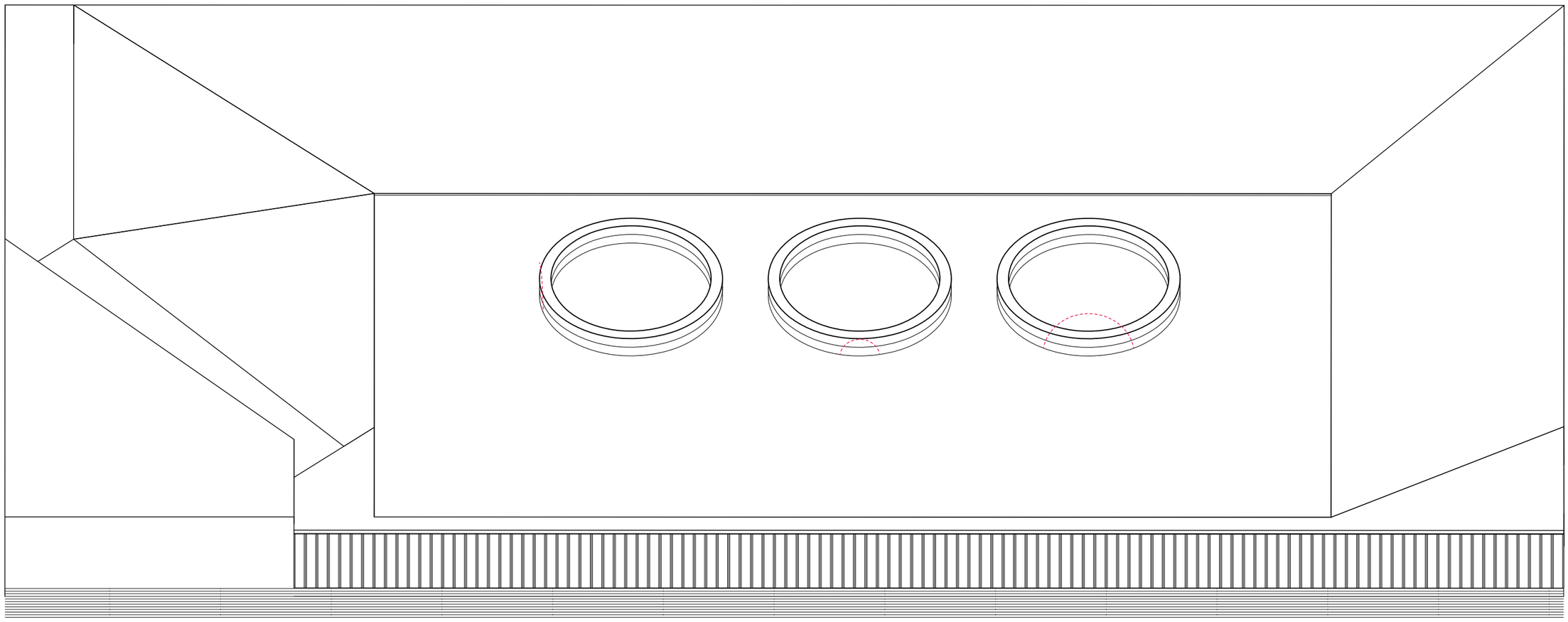
Concrete pile foundations support the silos, regular concrete is used to guarantee strenght requirements.

05_Foundations

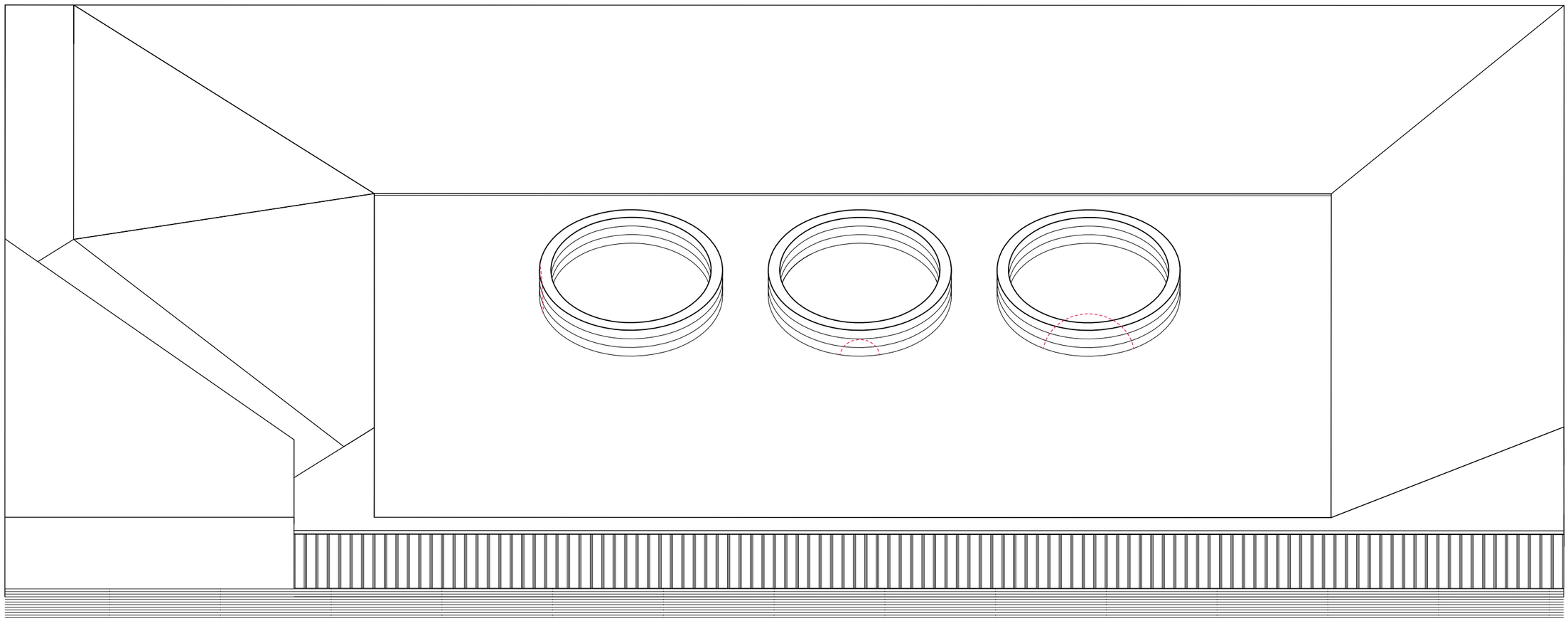


Mix day 1

The base of the inner and outer mould is assembled, in the beginning of the casting process a higher concentration cement is present in the mix to enhance water resistance.

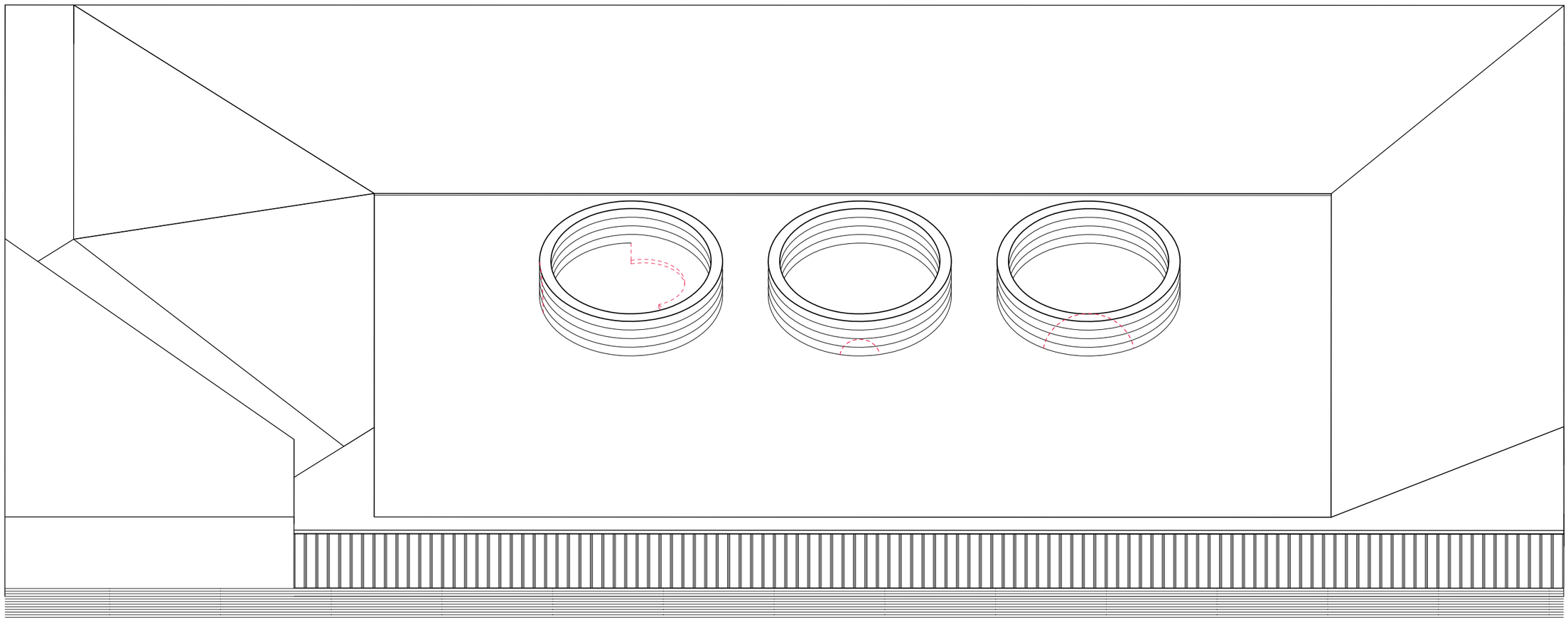


Mix day 2 With each day passing a different dredgingspecie mix is added into the mould. creating a rammed earth like layering.



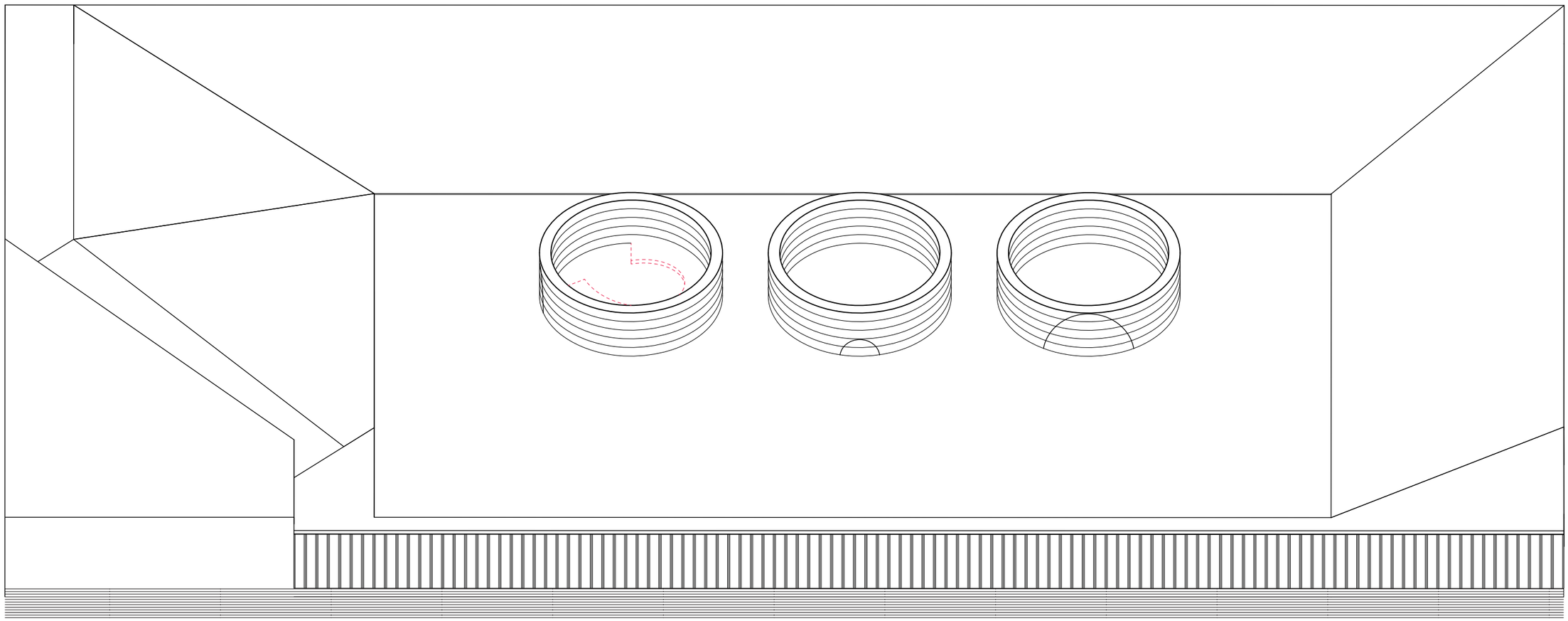
Mix day 3

Where there are openings at the base of the silo, reinforcement is placed into the mould to ensure the arches can take the pressure.



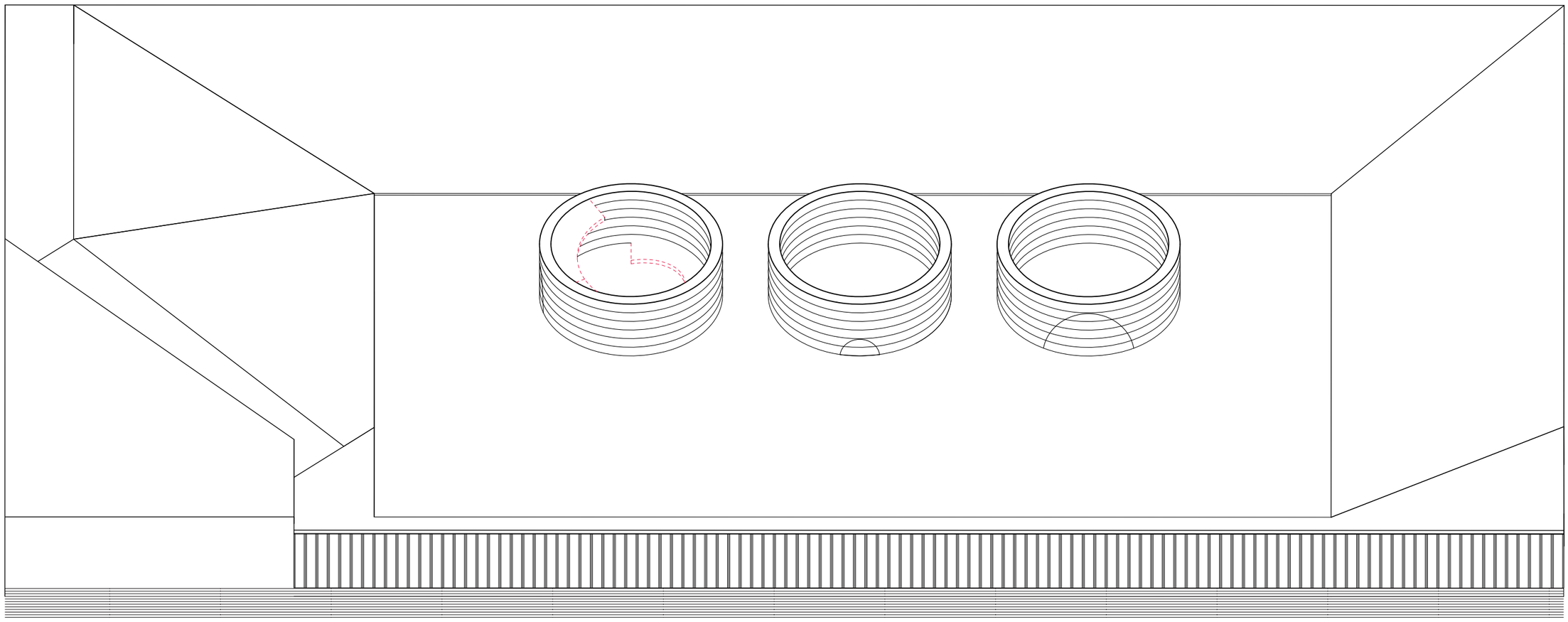
Mix day 4

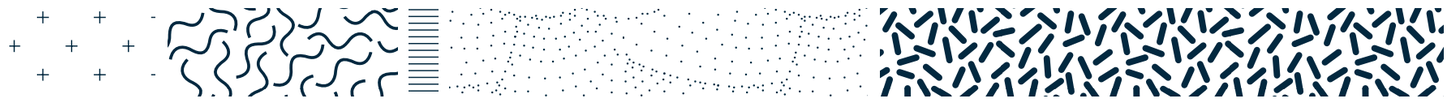
The silo on the left has a ramp spiraling up, the ramp is divided in 1/4 of a circle and precast. The ramp will be added later when the casting process has finished.



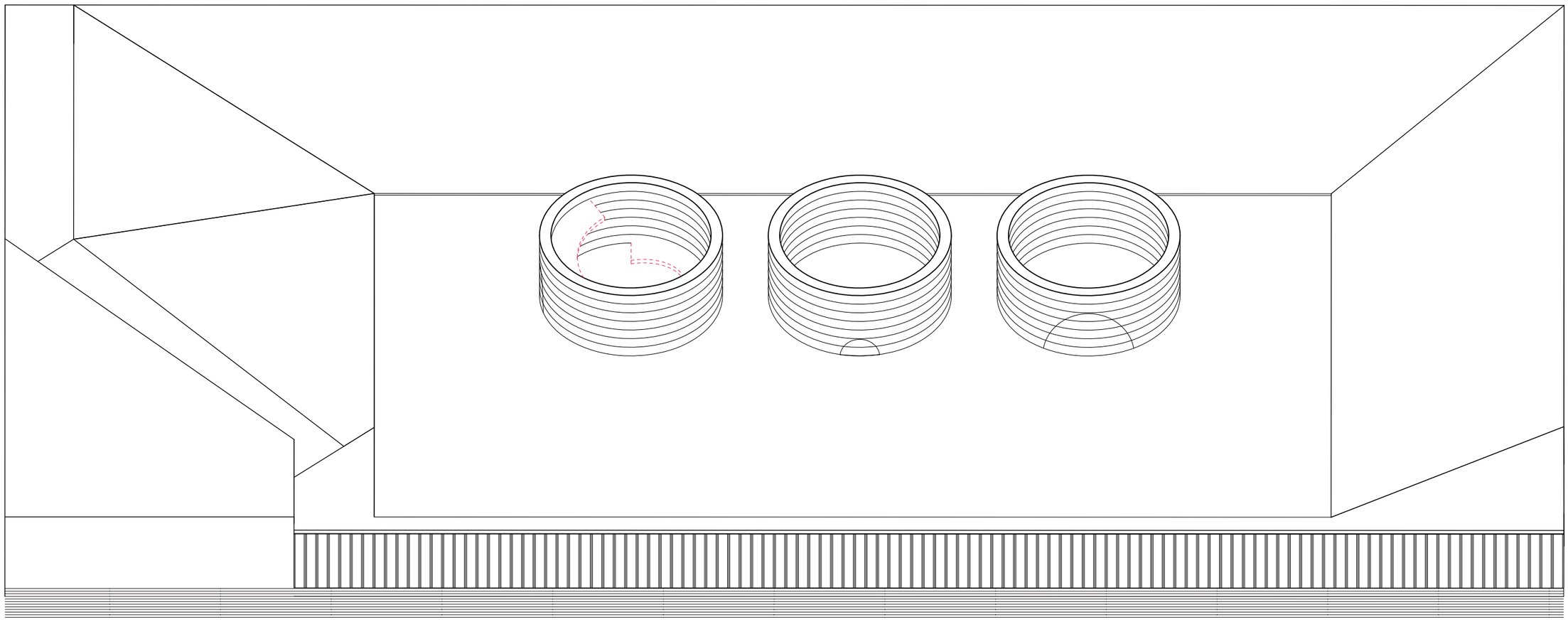
Mix day 5

The openings in the silo's are of different height, allowing people to enter the outer two. The middle silo has a smaller gap that allows animals and water to enter.



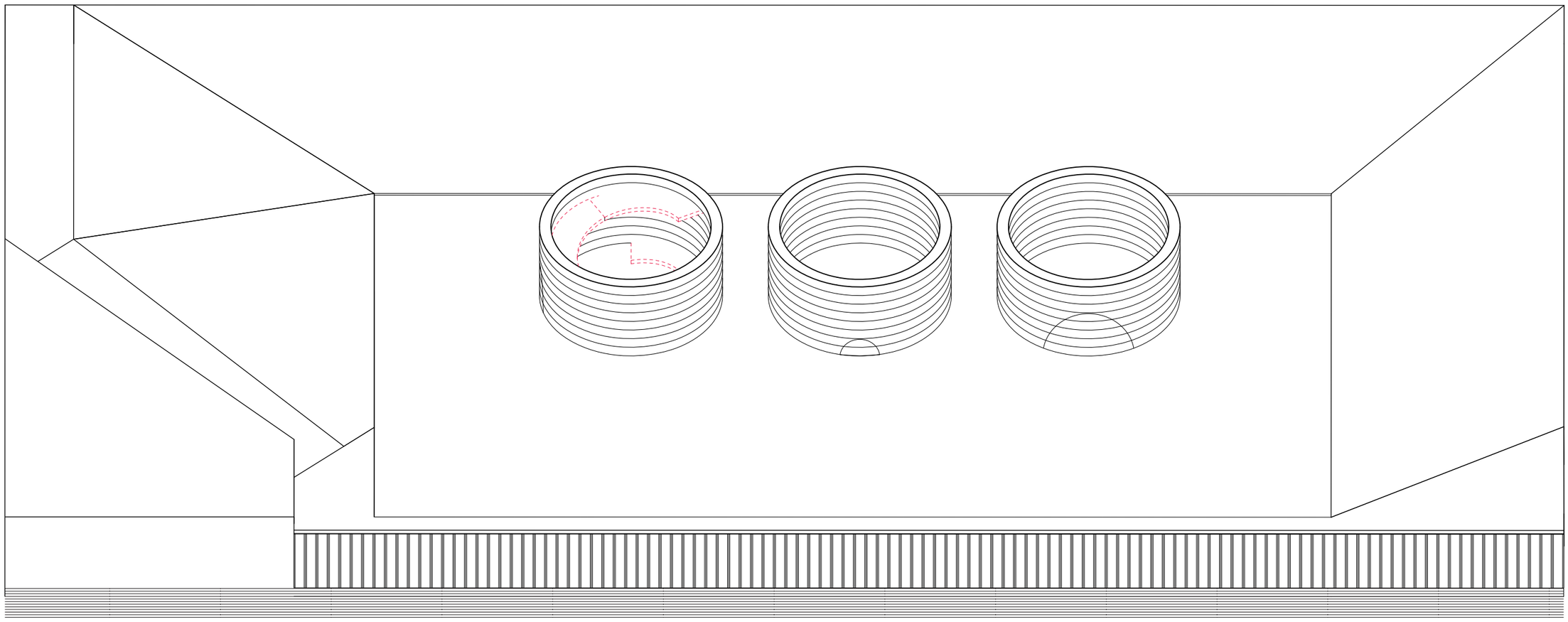


Mix day 6 With each day another layer is added to the mould to, making the casting process more accurate and measureable.

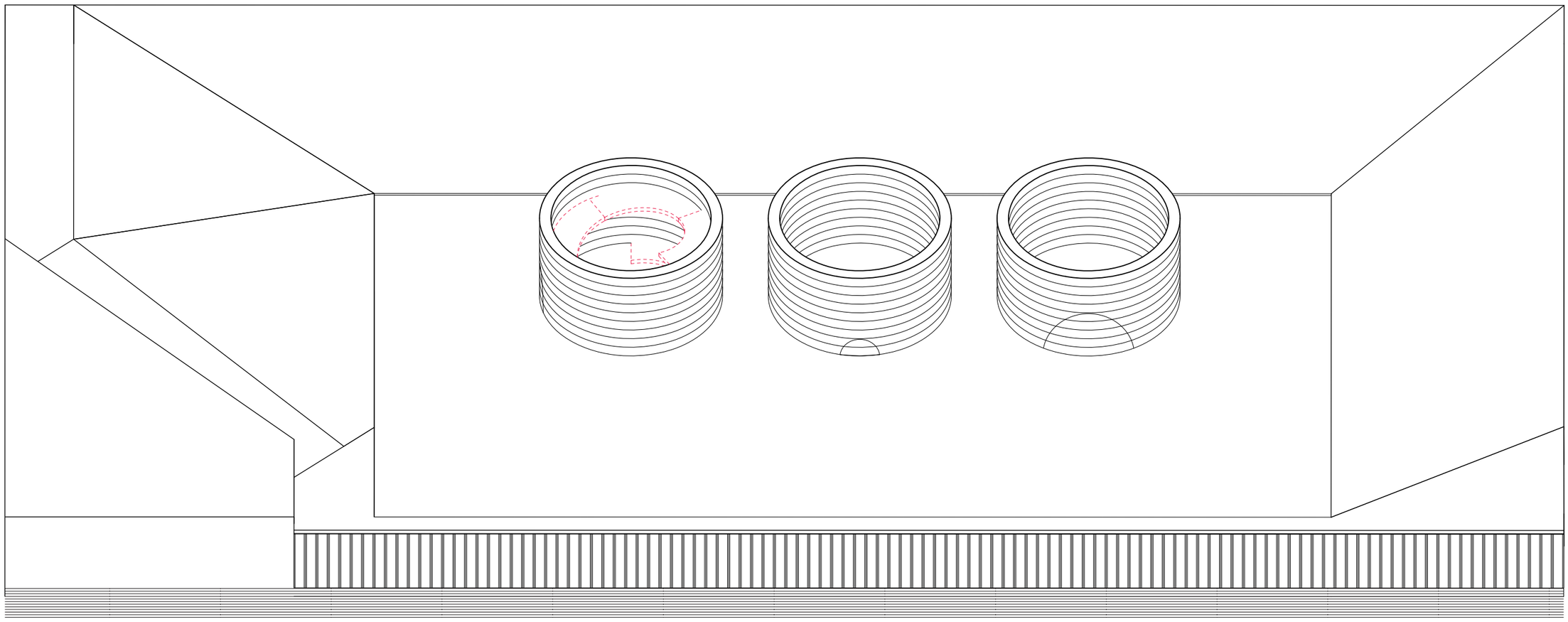


Mix day 7

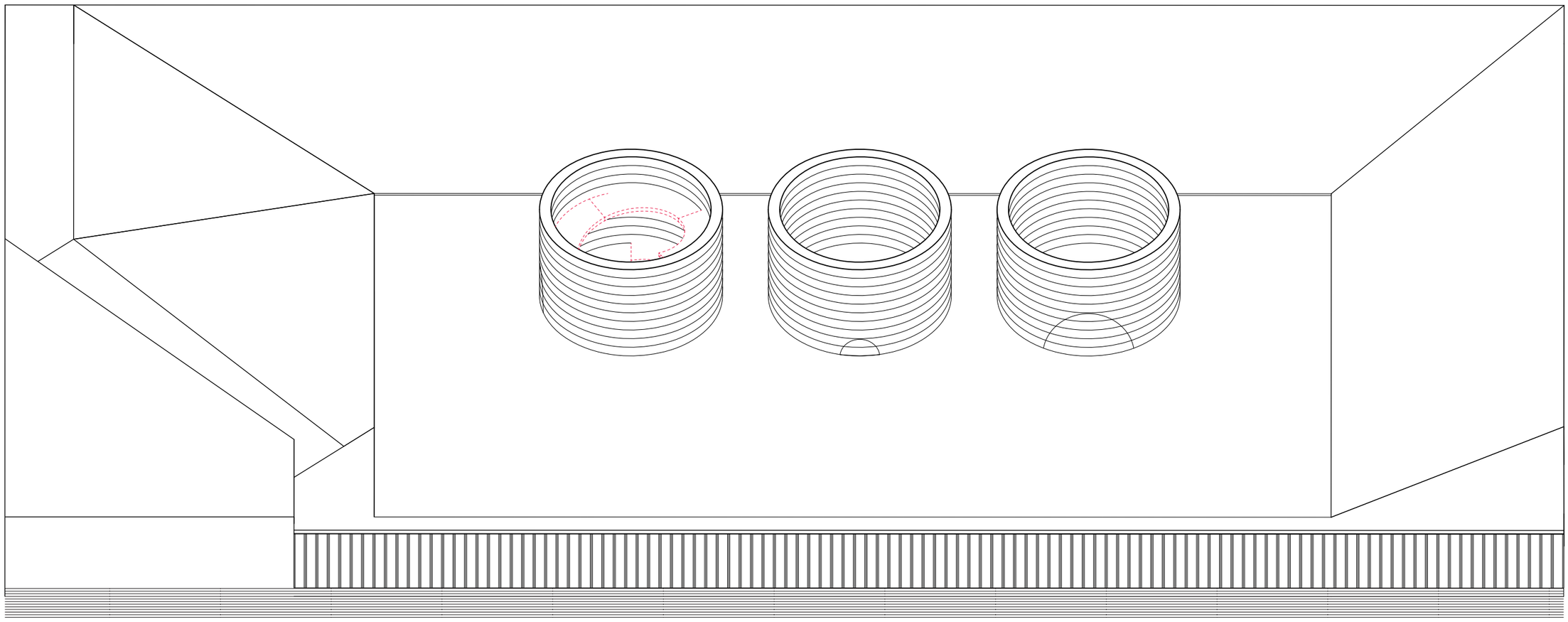
The casting process is planned for the summer period when there is less chance of rain. In events of sudden rain, a plastic tarp is on-site to temporary cover the moulds.



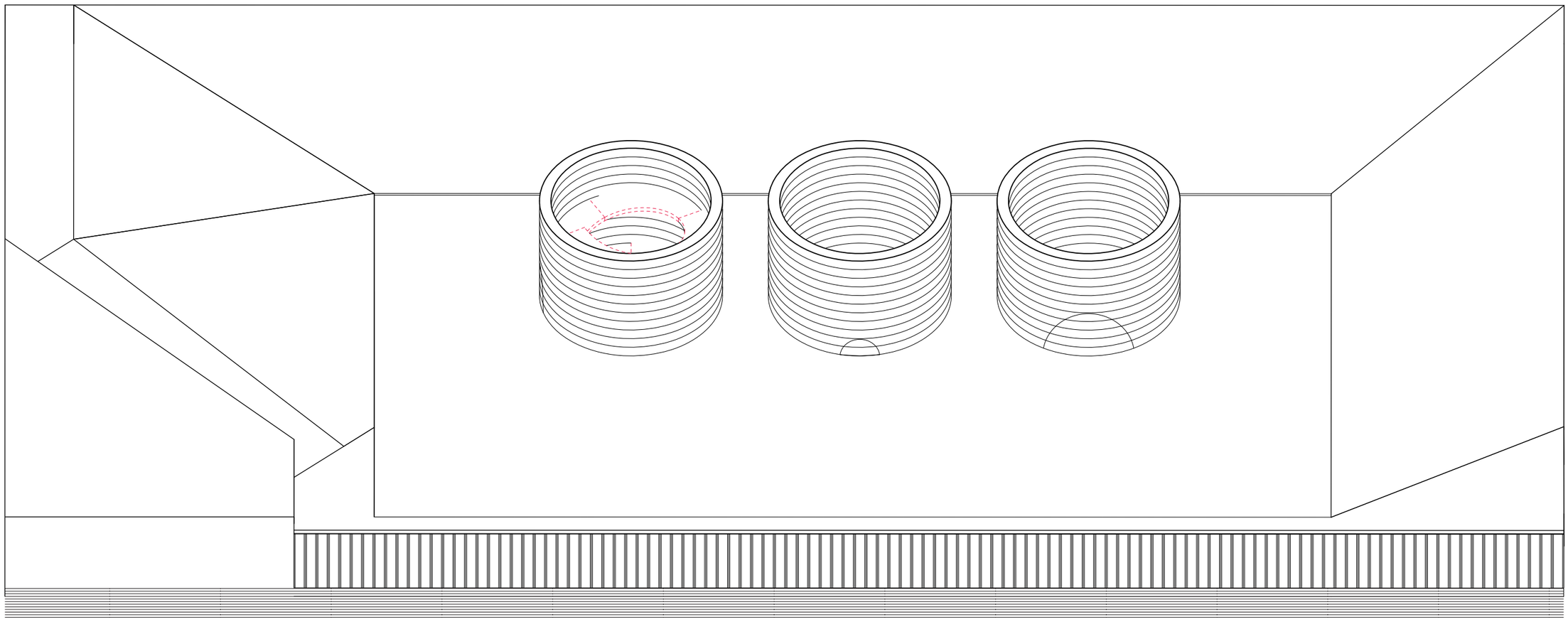
Mix day 8



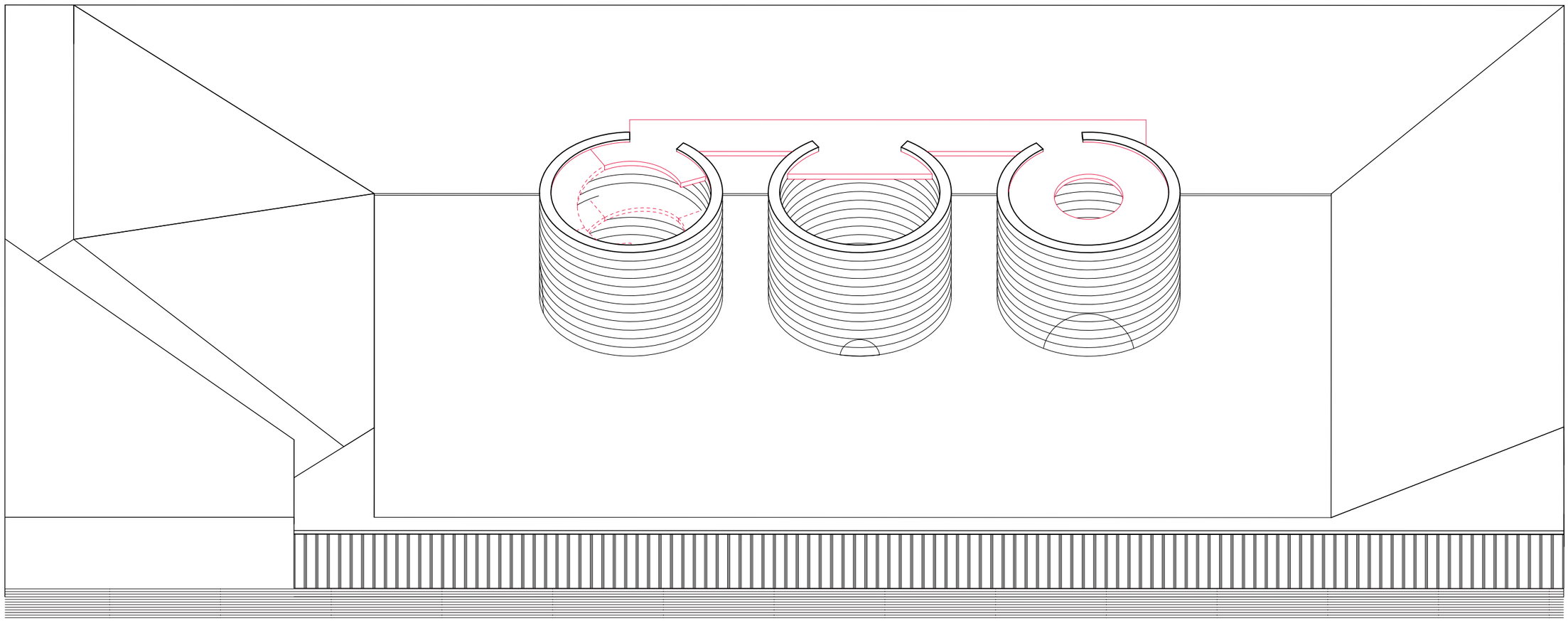
Mix day 9



Mix day 10

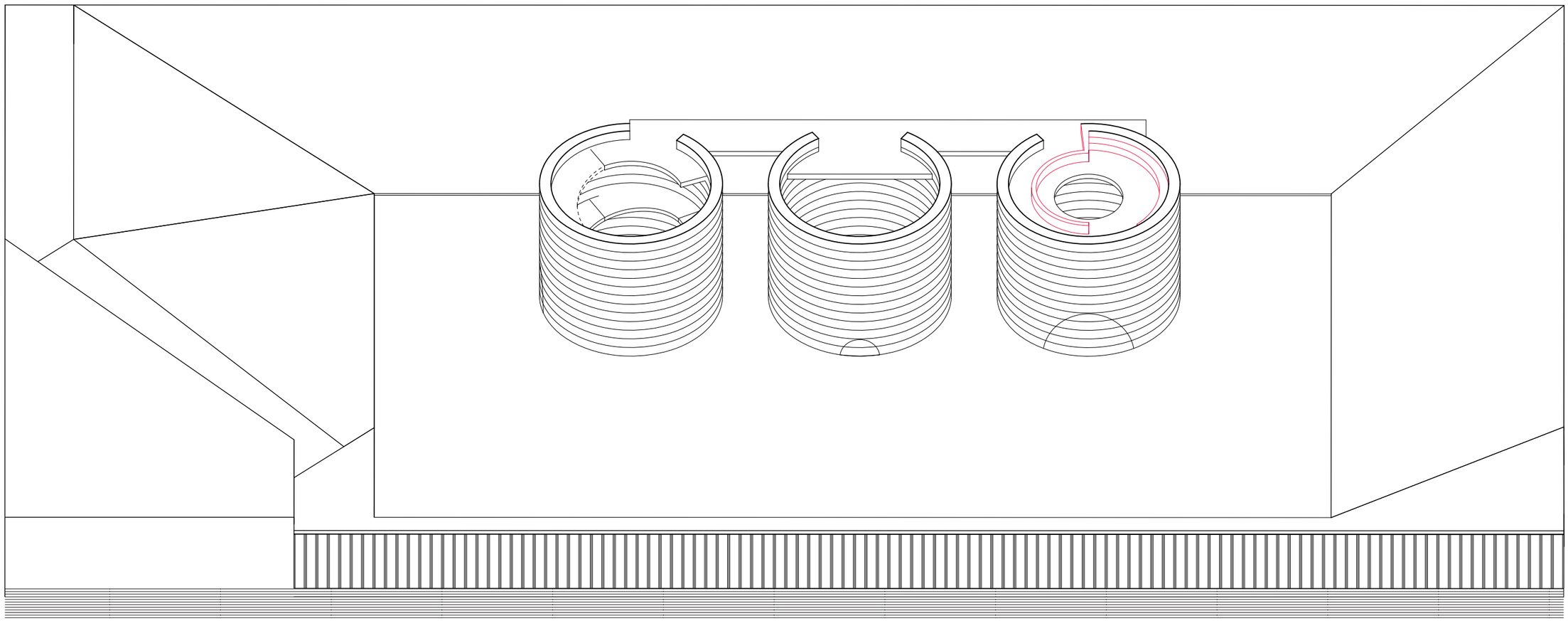


Mix day 11

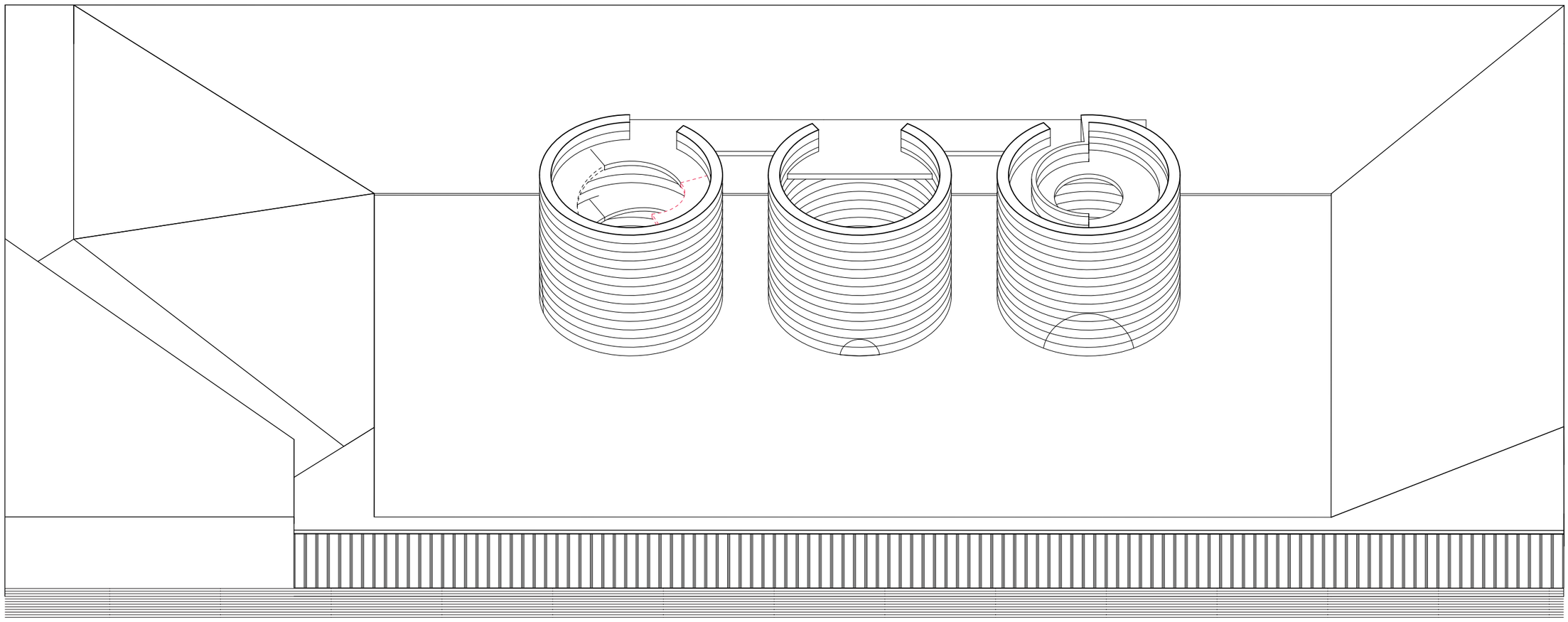


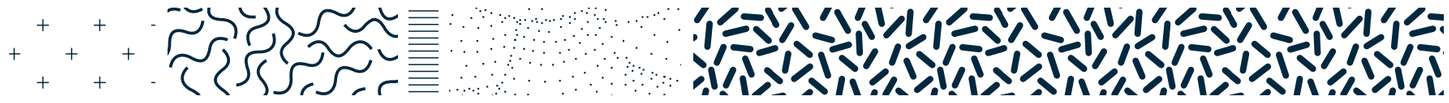
Mix day 12

The walking bridge is divided into two sections. One section is cast in-situ along with the floors of the silo's the other one is assembled later. Several steel columns are cast inside for loadbearing capabilities.

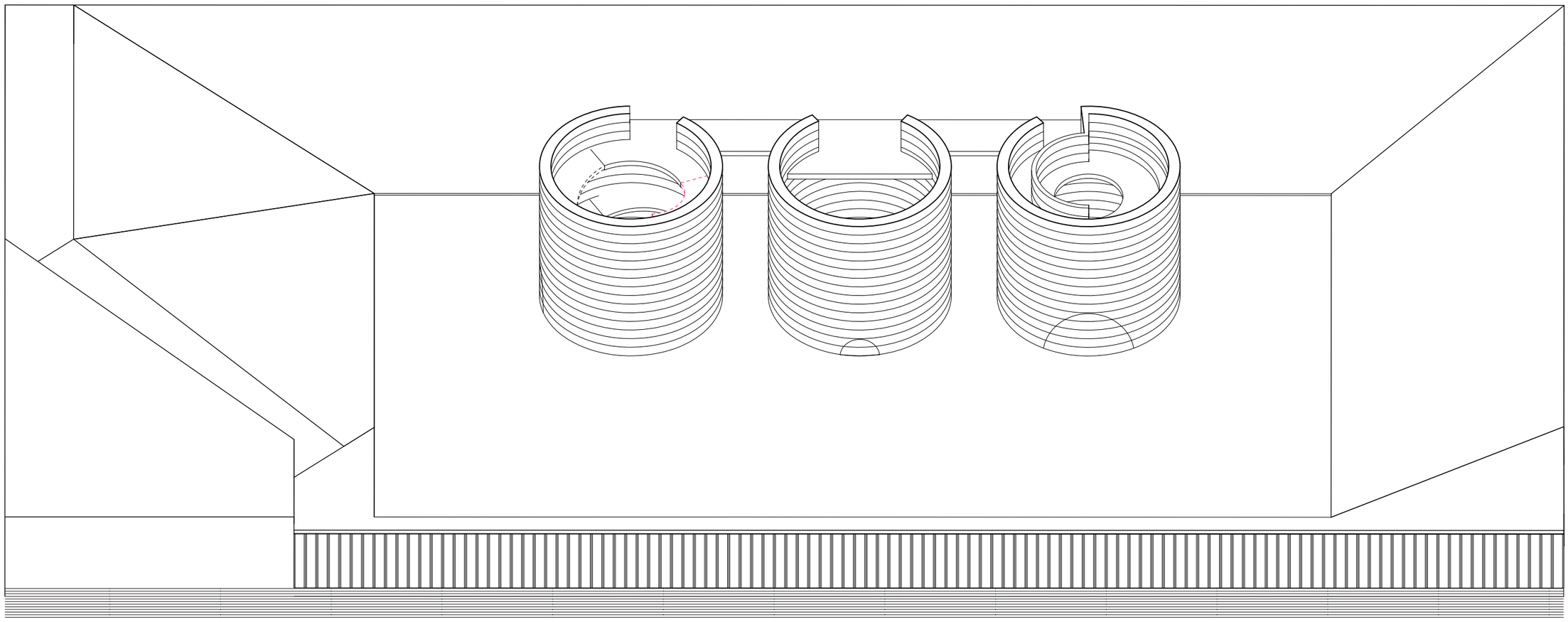


Mix day 13 The bench and inner walls of the right silo are cast together with the main structure, creating seamless connections.

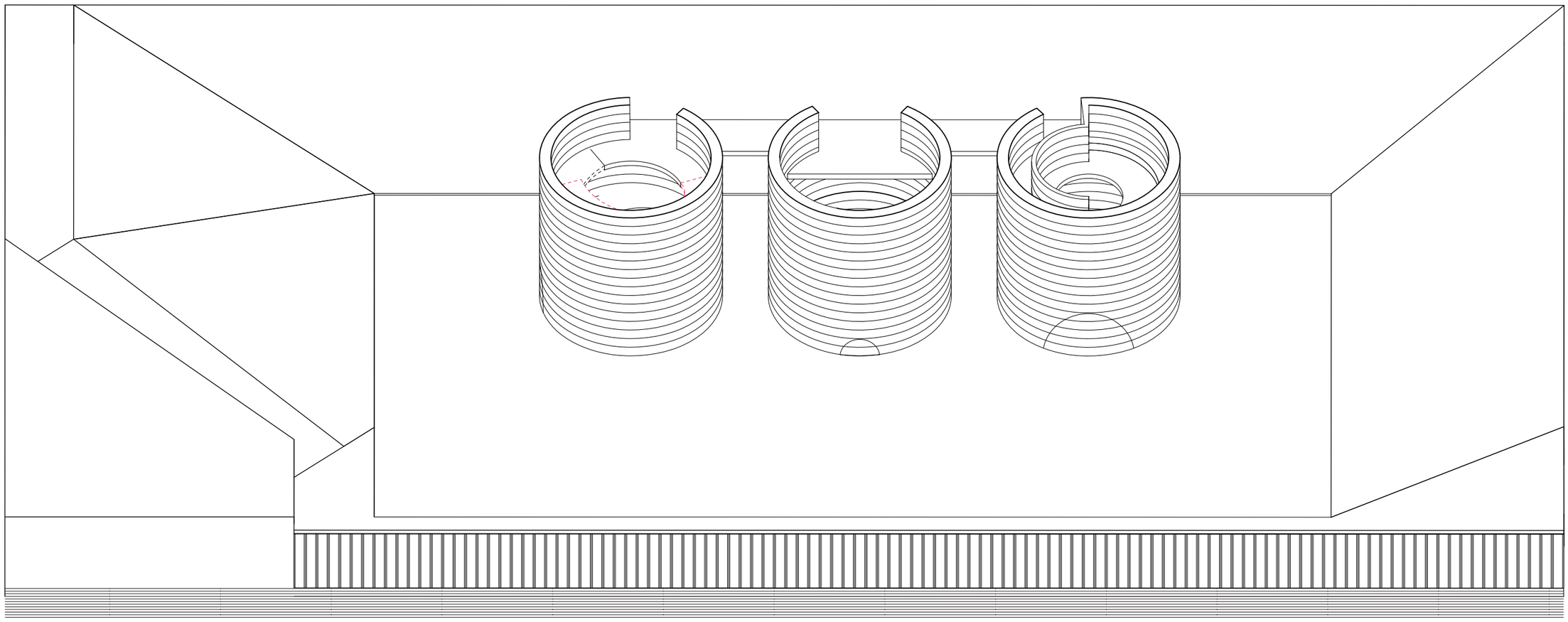




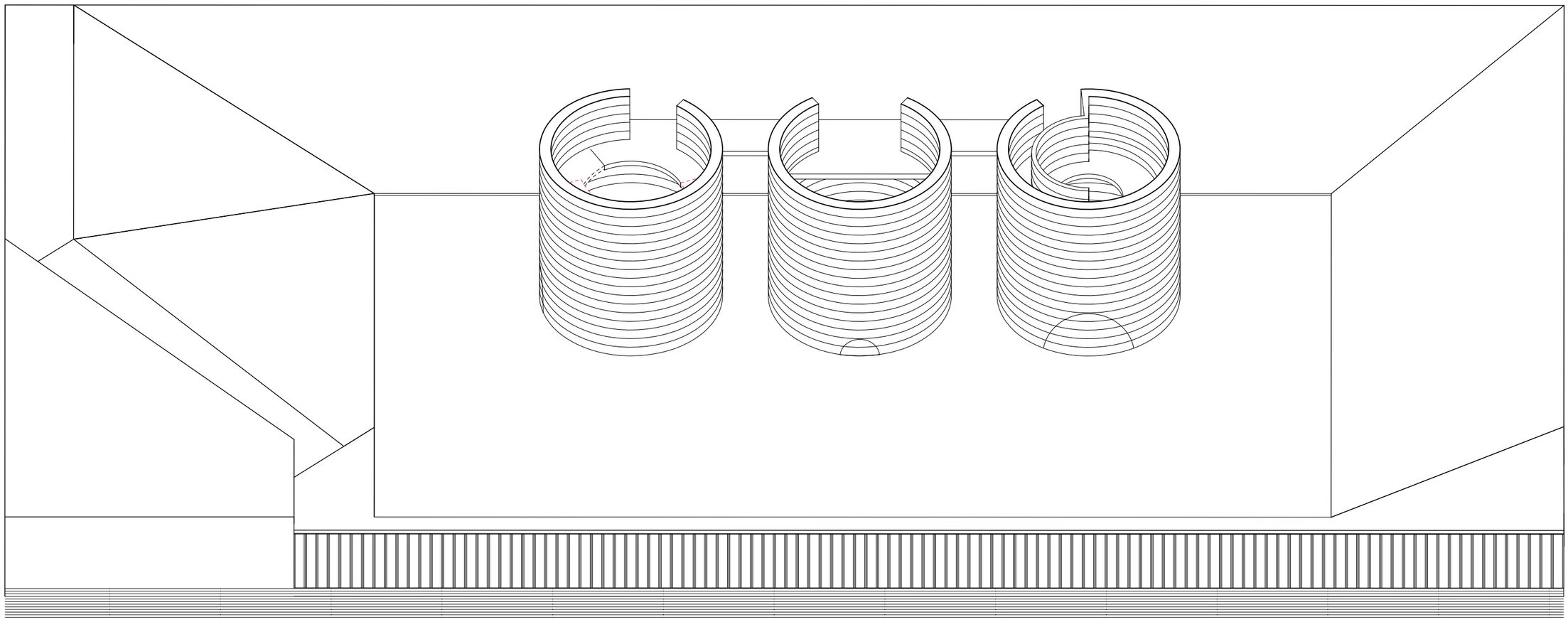
Mix day 14 After two weeks the first layers of concrete are at 90% of the strenght capabilities.

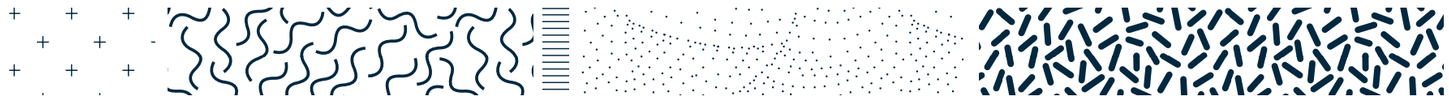


Mix day 15

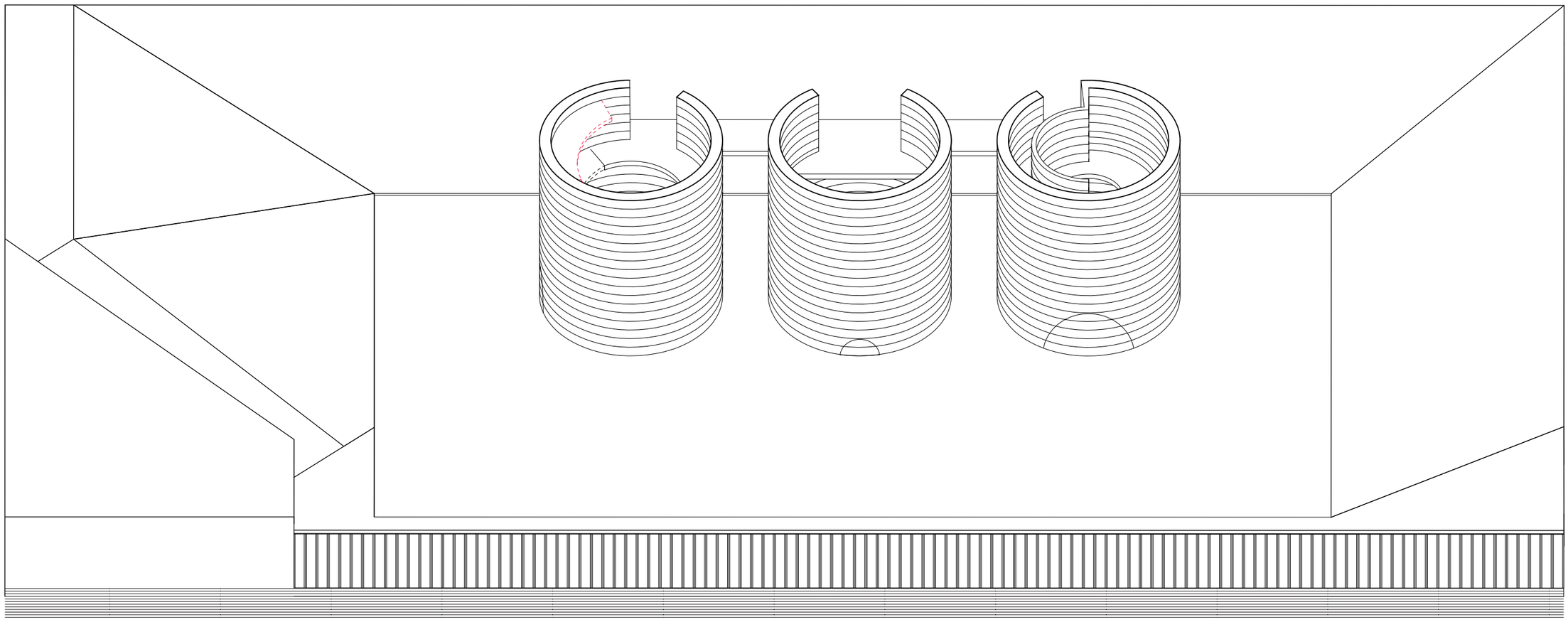


Mix day 16

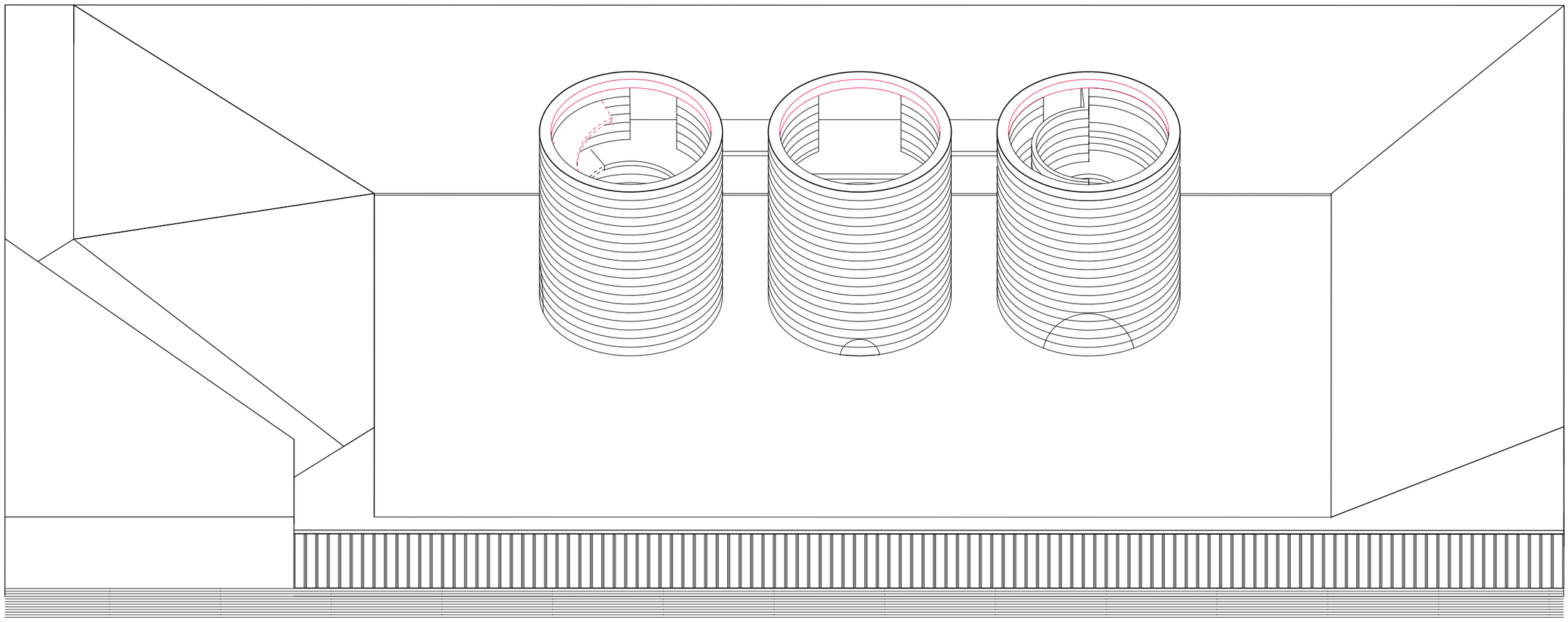




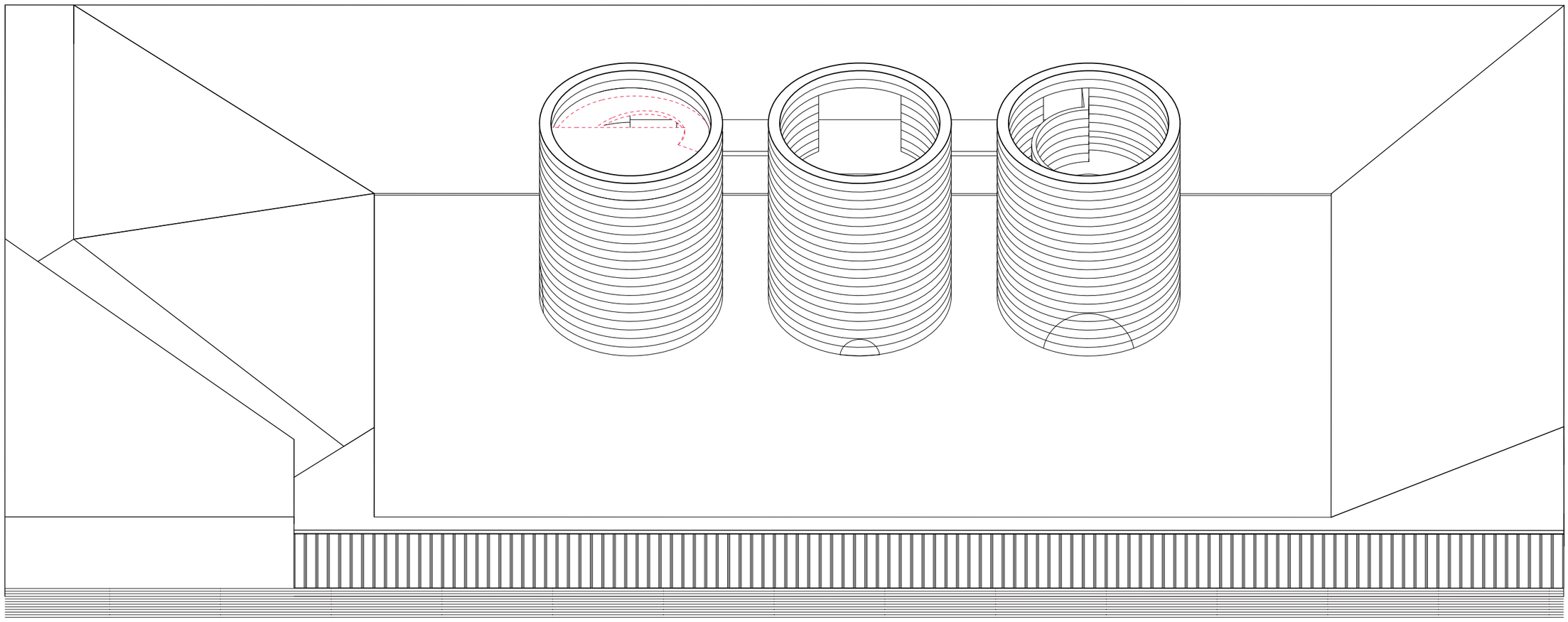
Mix day 17



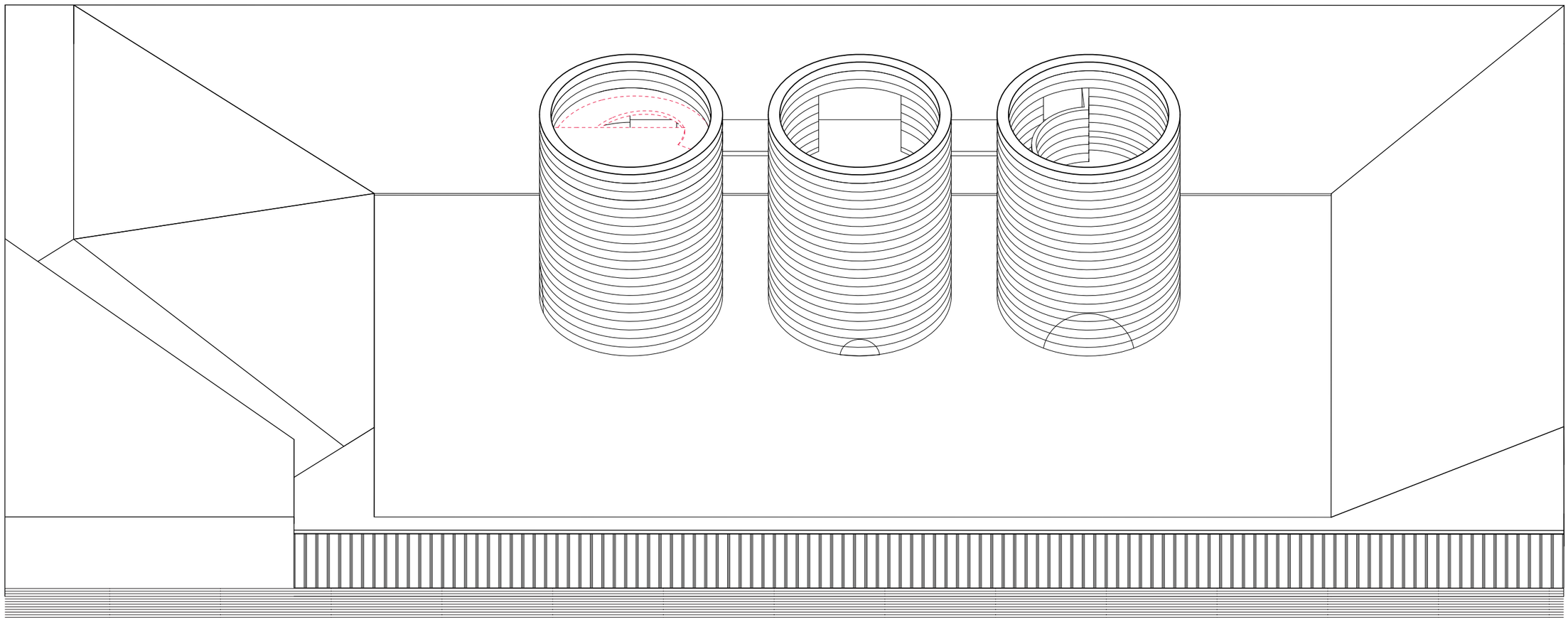
Mix day 18



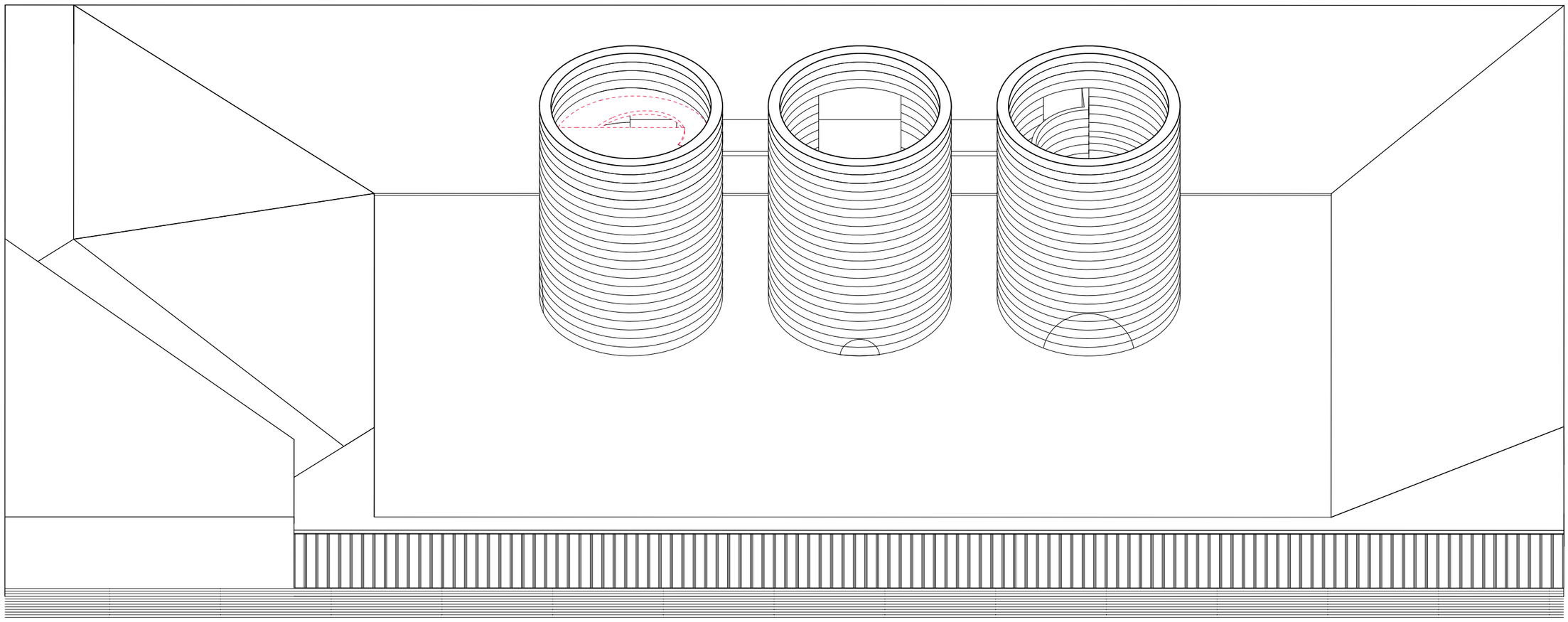
Mix day 19 above the openings a concrete lintel is placed.



Mix day 20 The dotted line indicates where the viewing platform is going to be cast.

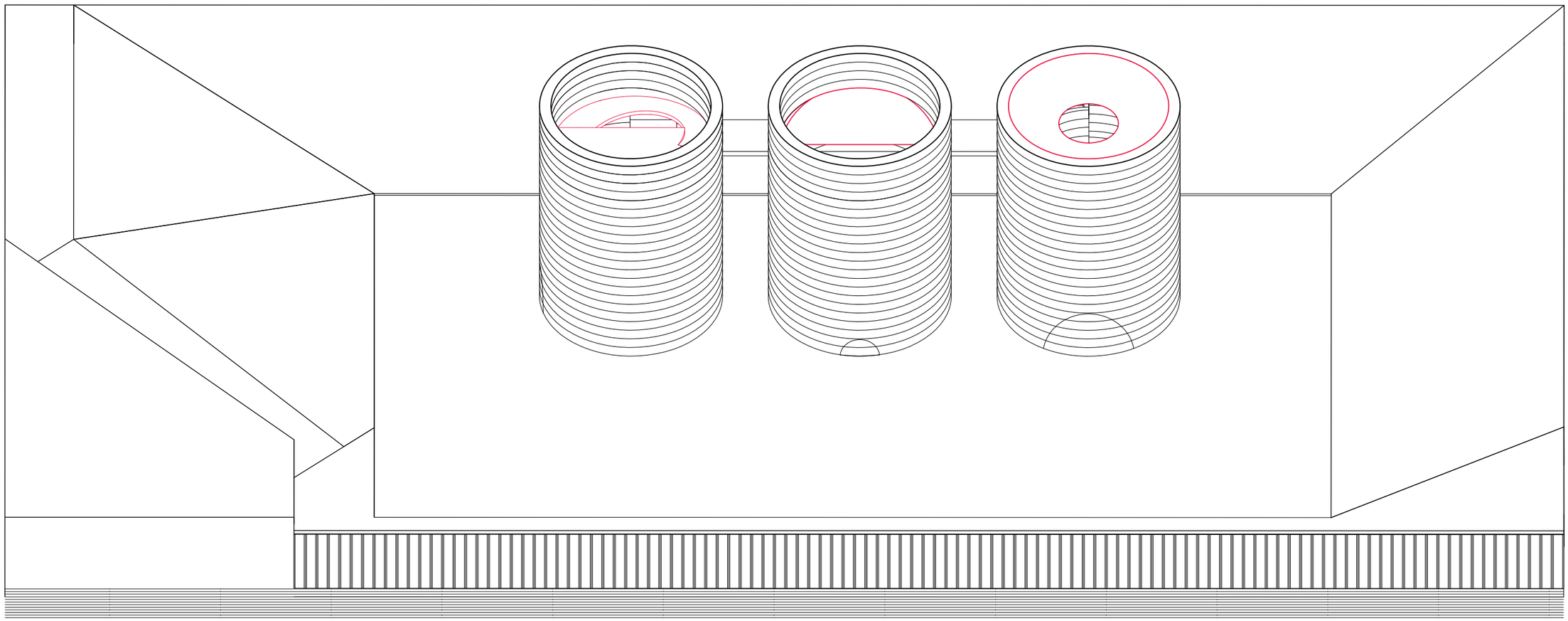


Mix day 21



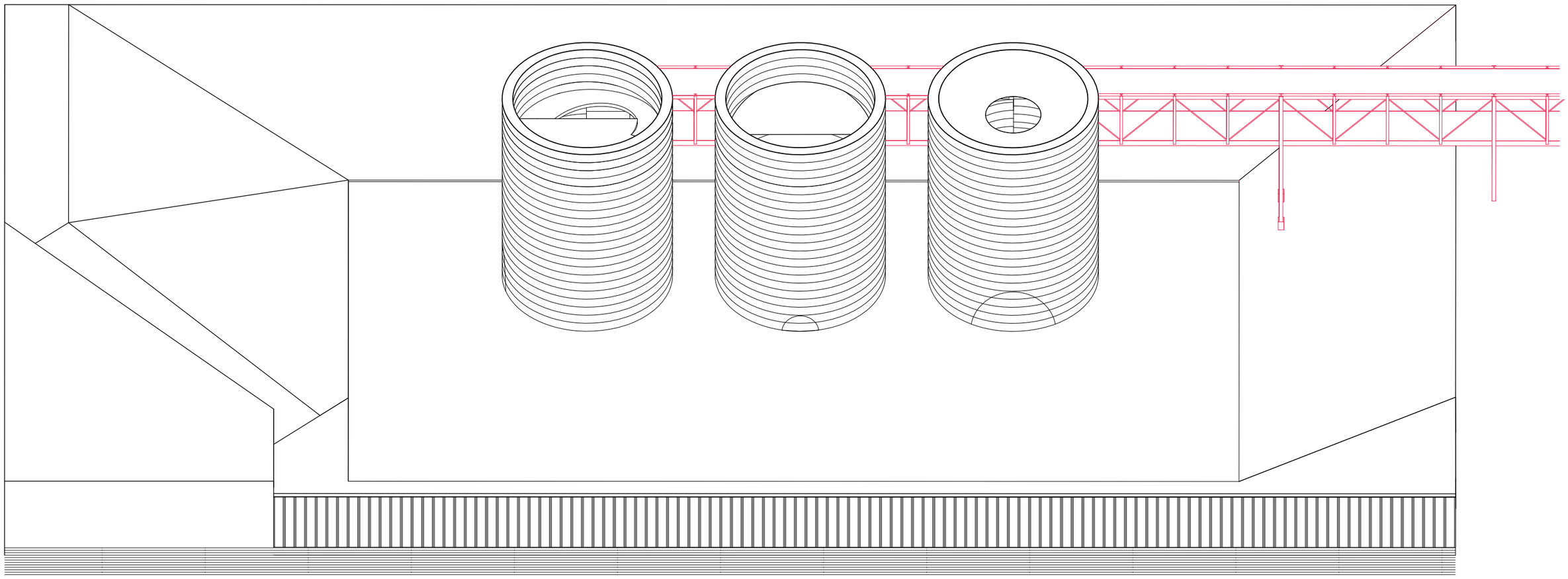
Mix day 22

Day 22 markes the end of the casting process. After this day a waiting period of two weaks is issued to let the silo's harden. On day 36 the moulds are disassembled.

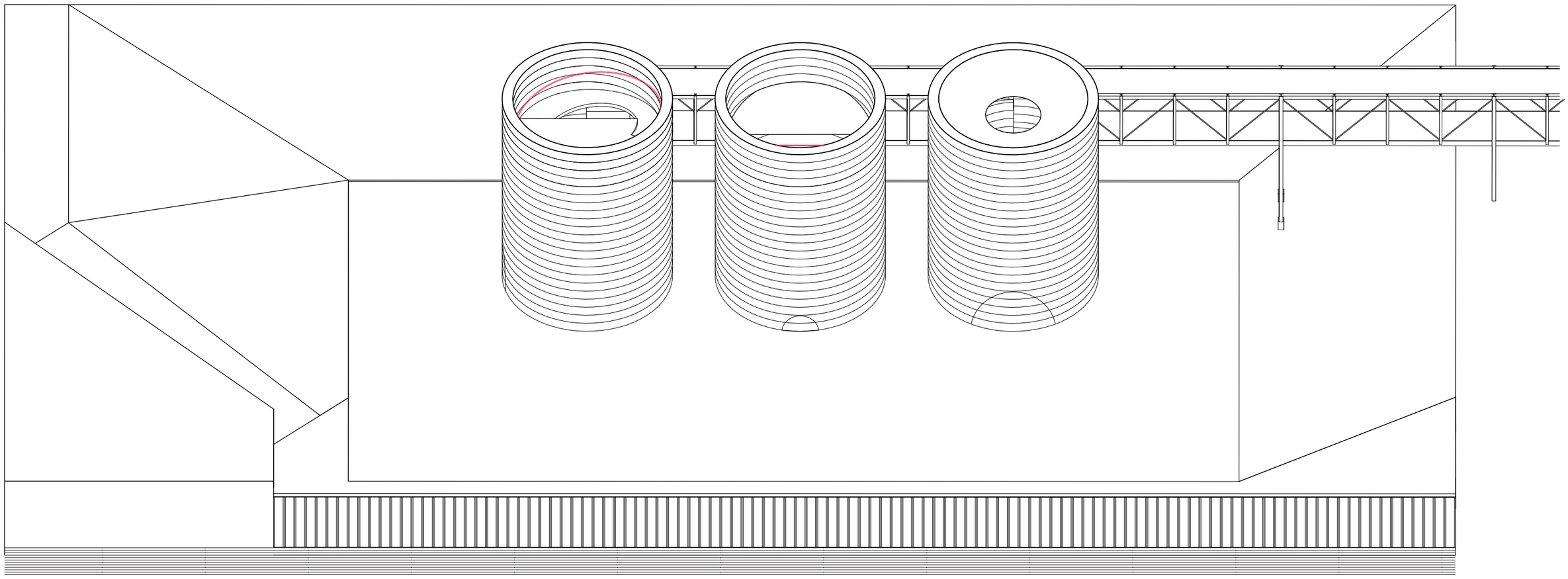


precast elements such as the ramps, platform and roofs are assembled. Chemical anchors are used to attach the elements.

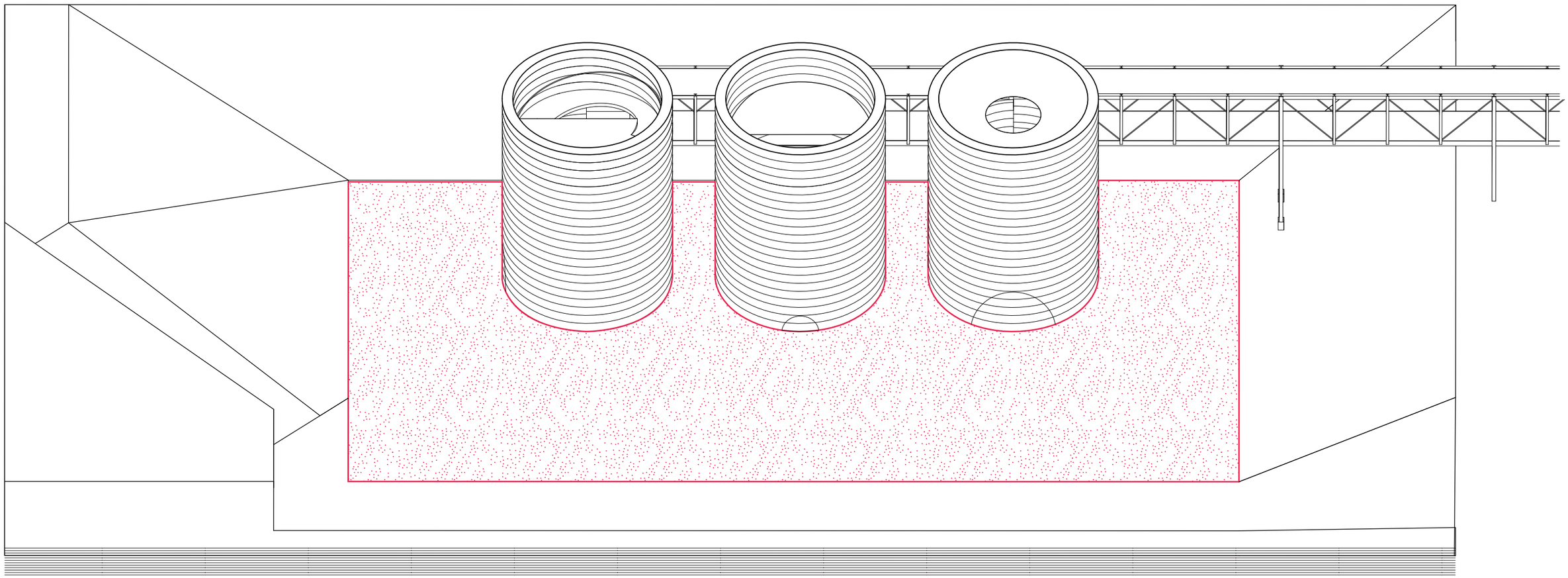
07_Assembly



The walking bridge is assembled and connected to the silo's.

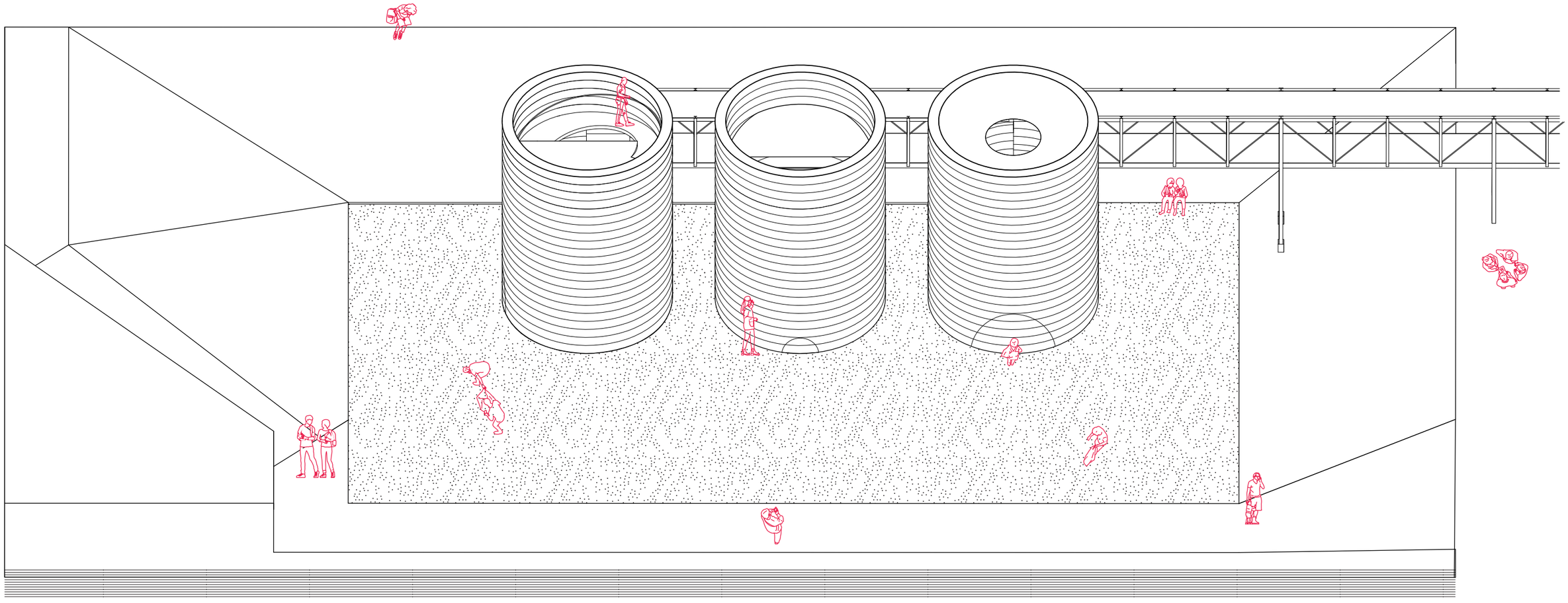


Railings, the mesh and other steel details are assembled, marking the end of the construction period.



The pit is filled with sand and the temporary waterbarrier is removed. The water is now able to enter. This marks the beginning of the weathering proces. Imbedding the silo's into the landscape.

08_Landscaping



From both inside and outside the silo's are part of the exhibition. Touching the material, feeling the water and mud is part of the experience.

09_Museum

Grondbank Dordrecht (locally sourced)

Dredging specie Pit

Filtering machine

Sundrying

The dredging specie is sourced locally from a ‘Grondbank‘ in Dordrecht. Here the specie slowly dries for 6 months to a year. The dredging specie I could acquire is industrial grade, this means unfiltered and usually used for infrastructure projects when dried (just as increment). For higher quality dredging specie they filter out organic matter and small stones. In this testing process, I accomplished this by hand. The dredging specie is a very wet material. To establish a good starting product, I decided to sundry and crush up the dredging specie. The final product was similar to clay/loam. Different to my initial theory this material is better used in a combination of concrete and rammed earth, Rammed concrete. With this in mind I decided to divert from my initial approach. Together with a consultant we decided a few starting mix ratios.

10_Dredging specie

These were the tools I initially used to do the tests. Later I found out that using **clamps** to hold the mould in place is preffered, rather than using **screws**. For the drying process I also used an **old canvas** to sundry the dredging specie. Furthermore, I used a **wine bottle** to further crush the dredging specie into smaller bits.

11_Supplies

Step 1 / Choose your mix ratio. To start I used 70% sand 20% dredging specie and 10% cement, recommended by expert. Later I experiment with replacing sand with dredgingspecie and cement.

Step 2 / Mix the dry elements well before adding water.

Step 3 / The water content has a direct impact on the strength of the finished wall. Too little water causes the wall to not be as compacted and become brittle. Too much water and the mix will be too wet and the water itself resists compaction. The mix should have a moist, rained upon consistency. This is easiest achieved by spraying the water in a fine mist instead of pouring it as you would in a normal concrete wall mix.

Step 4 / For full-scale projects lab tests should be conducted. for smaller samples like this - a few do it yourself tests can be used to determine if the mix is good or not.

Step 5 / The ball should then be dropped from about a meter's height and break into a few larger and smaller pieces. If it doesn't break into pieces or the particles are the same size or to small, it is probably a sign that the water content isn't right. Too much water and the ball stay together when dropped, too little and it just result in sand on the floor.

Step 6 / The formwork/mould is made from non stick wooden panels, held together by clamps. First I used screws, but to enable easy demoulding clamps work better, also not damaging the formwork.

Here are the steps I followed when creating all the samples, including mixing and conducting a few simple tests to determine the ideal water-to-aggregate ratio. These same steps would apply to the full-scale project, but instead of mixing by hand, you would use equipment such as a cement mixer. While these on-site tests are useful for estimating water content, conducting proper lab tests before beginning any large-scale production is highly recommended. Different types of sand have varying water content, so investing additional time in testing the mix thoroughly can help prevent potential issues.

12_Testing process

Step 7 / The soil should be built up in layers within the formwork. This is very important, my first test I compacted everything at once, making it very brittle and non-compacted.

Step 8 / Ramming should be carried out systematically, ramming along the sides first, constantly crossing from side to side to obtain an even result, then ramming the centre until the entire layer is dense and hard.

Step 9 / This is how a compacted portion of a layer should look like. Make sure you start at the edges, they are the hardest part to compact.

Step 10 / Gradually add and compact Repeat the ramming steps until you have reached the desired height.

Step 11 / Remove the formwork The positives about a sample of this size is that you can also remove the formwork immediately, this allows it to harden faster and when making a lot of samples you could start with another one right after.

Step 12 / The next week or two is when the wall is at its most fragile stage. It will also change colour and by how much, depends on your mix, choice of cement and the dredging specie ratio.

The ramming process can be physically demanding, especially when done manually, even on a smaller scale like this. For the execution of a full-scale project, electrically or pneumatically powered tampers would be a more ideal tools to use. Investing in good ramming equipment will increase quality of the final product greatly.

Basic Starters Mix: 70% Sand, 20% Dredging specie, 10% Cement

Dredging specie: Dried and pulverized by hand

Sand: Riversand, approximately 0-3 mm

Cement: Enci, portland cement (CEM1)

1 / In my first sample I did not use the right ramming technique. This resulted in a less compacted block. I also think the water content was on the high side.

2 / In my second sample I used the correct ramming technique. The block is very compacted. Also the water content is better. I believe that the river sand did already contain more water than expected.

3 / For the third sample i wanted to see what happend if I lowered the water content even more since I had the feeling I was pushing a lot of water out of the mould during the ramming stage ast sample 2.

Stabilized Starter Mix: 60% Sand, 30% White Cement, 10% Dredging specie

Dredging specie: Dried and pulverized by hand

Sand: Mortar sand, 0-3 mm

Cement: Beamix, portland cement, White (CEM1)

4 / In the first three samples my focus was on water ratio. For the second series of samples I decided to focus on color and aesthetics. The new ratio already made the mix lighter, since dredging specie makes the block very dark and white cement makes the mix a lot lighter.

5 / My fourth and fifth sample of this series are stable and have the color I want to aqquire. But the dredging specie forms black spots where it is not crushed completely beforehand.

6 / In the last sample of this serie I did not do the water content correctly. The mix was too wet and was sticking to the formwork when demoulding. Upon drying this did give me a good look on the inside of the block.

Increased Dredging Specie Mix:

50% Sand
40% Dredging specie
10% Cement

Dredging specie: Dried and pulverized by hand
Sand: Riversand, approximately 0-3 mm
Cement: Enci, portland cement (CEM1)

7 / For this sample series I decided to increase the dredging specie content. Whilst the mix itself was ok, the formwork reached its limit. From this point on I decided to use clamps instead of screws. The color became darker and with this in mind I decided to make three different color mixes and use my experience to make three new mixes. (8,9,10)

Increased Dredging Specie Mix:

60% Sand
25% White Cement
15% Dredging specie

Dredging specie: Dried and pulverized by hand
Sand: Mortar sand, 0-3 mm
Cement: Beamix, portland cement, White (CEM I)

8 / With the new formwork the edges of the blocks already become sharper. This proves the importance of a well constructed formwork. I tried to reduce the amount of cement needed without losing too much of the lighter shade. The color, consistency and strenght of this mix will be used in the mockup.

Increased Dredging Specie Mix:

45% Sand
45% Dredging specie
10% Cement

Dredging specie: Dried and pulverized by hand
Sand: Riversand, approximately 0-3 mm
Cement: Enci, portland cement (CEM1)

9 / In this sample I increased the amount of dredging material to equal the amount of sand. To my surprise the block came out really smooth with a darker shade of color. This will create a well enough contrast in the mockup to show the difference in layers.

Increased Dredging Specie Mix:

60% Sand
30% Dredging specie
10% White Cement

Dredging specie: Dried and pulverized by hand
Sand: Riversand, approximately 0-3 mm
Cement: Beamix, portland cement, White (CEM I)

10 / For the last sample I used the basic mix recipe again because of its strenght and consistency. However, I used white cement to create a shade of grey inbetween the shades of test 8 and 9.

Learn by doing. The testing, and finally making the mockup let me better understand the material and how to handle it. As opposed to the theory of poured concrete formulated at P4, the final result seems to be a combination of concrete and rammed earth. Rammed concrete. During the initial tests it seems that the dredging specie functions as a loam, rather than sand or clay. The dredging specie also seems to be the pigment to darken the material, with the possibility to equal the amount of sand from these first series of tests. White cement functions as its counterpart, making the mix lighter. The final mockup displays a gradient of different shades of grey. Although I would have liked for the layers to be more visible, in a fullscale project the distance would be greater, showing the difference in layers more. Looking back at the process and projecting this on a full scale project, I would strongly advise to start with smaller projects. Building the formwork and ramming the concrete are just as important as formulating the mix, making the process time consuming and requiring a lot of effort and manpower. When taking these aspects into account, I do believe that using dredging specie as a building material could be a nice addition to locally sourced and inspired building techniques of the Waterdriehoek region, and possibly other delta areas.

14_Conclusion