INDUSTRIAL NATURE

A Visitor Centre in Limhamn Limestone Quarry

Master Thesis
Henrik Hagejärd

Chalmers School of Architecture
Examiner: Mikael Ekegren
Tutor: Björn Gross

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Chalmers School of Architecture
Department of Architecture and Civil Engineering
412 96 Göteborg
Sweden

Cover: Visualization of the entrance

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ABSTRACT

Transformation of post-industrial areas into public recreational areas can make our cities more sustainable with more space for both nature and people. The city of Malmö is one of the densest cities in Sweden and has one of the smallest amounts of green space. A large former limestone quarry, located in Limhamn close to Malmö, has the potential of becoming an important contribution to the city as a public recreational area.

The industry closed in 1994 and the quarry is a nature reserve since 2011. The nature reserve is not yet open to the public and the municipality is considering building a visitor centre.

The purpose of the project has been to investigate how the quarry's values and layers of nature, geology and history can be communicated, through and in architecture. The aim has been to design a detailed proposal of an entrance and exhibition space, which will enrich the visitor's experience of the quarry.

The project has been made in an iterative design process where different design solutions have been tested in models and drawings. Analyses on site with focus on the industrial remnants as well as literature studies about the quarry's qualities and history has made the design adapted to its purpose.

The final design proposal is a transformation of an existing silo battery. On the way down to the quarry, descending through the silos, the visitors will experience the space inside in relation to the quarry outside; they will also pass through and learn from exhibitions about the quarry. By proposing an adaptive reuse of the existing silos the industrial heritage will be preserved and at same time the visitors will get a unique and authentic spatial experience.

Figure 1. View of the quarry and the only remnant building from the industrial era.

INTRODUCTION

ME & MY SUBJECT

I have always enjoyed to spend time outdoors, free time and weekends are preferably spend on small excursions to interesting spots in nature. I also have a fascination for industrial landscapes and buildings, preferably with interesting history and atmosphere.

When deciding topic for my thesis I knew that I wanted to explore the topic how architecture can be used as a tool to communicate a place with relation to nature. I was searching for a scenic or somewhat special place and came to think about the limestone quarry in Limhamn, located in my hometown Malmö. When I started to do research about it I found it really interesting and immediately felt that this was the perfect site for me.

The quarry is a huge man made hole in the surrounding flat landscape that I felt would be really interesting to visit, but even if the industry has been closed for many years it is still not accessible to the public. My intention and hope is that the quarry will become accessible and I think that a visitor centre here would make perfect sense, it would of course be possible to just open the gates but I believe that both the visitors and the nature would gain if the people entering the area would have knowledge and awareness about it.

BACKGROUND

Malmö is one of the densest cities in Sweden and at the same time it has one of the smallest amounts of green space (SCB, 2015).

Limhamn limestone quarry is located close to Malmö, the quarry was in use for 130 years but was finally closed down in 1994 and has since then been left unused. Since 2011 the quarry is protected as nature reserve because of its special life environment that has become a habitat for many rare and endangered species (Gatukontoret & Fastighetskontoret, 2010). I think that the quarry has the potential to become a unique place for education as well as recreation.

PURPOSE

The reason to build a visitor centre is to support the visitors when they come to the quarry by highlighting the different layers of information in a way that enriches the visitors experience of the area. I believe that if the visitors gain knowledge of the industrial heritage, the geology and the existing biological values they will experience the grand space with a deeper meaning and understanding, it will also raise their awareness about the sensitive nature as well about their own personal safety.

RESEARCH QUESTION

How can the qualities and values of a place be communicated, in and through architecture, in a way that enriches the visitor's experience?

The explorations in this thesis project have been about finding out how the quarry's interesting layers of biology, geology and history can be communicated, through and in architecture. The focus has been to explore how the visitor centre itself can be a part of creating an authentic experience by emphasizing the post-industrial atmosphere of this very special and scenic area and building.

METHODS

Analysis of the last remnant industrial building has been made on site by evaluating the current condition of the different parts of building. Existing original drawings have been compared to the built reality by both control measurements in accessible parts and visual methods in unreachable parts of the building. Literature studies about the quarry's different values and layers has contextualized the project and has influenced the layout for the exhibition. The design project has been made in an iterative design process where different design solutions have been tested in models and drawings.

RESULTS

The final design proposal is a re-use and adaptation of an existing silo battery into a visitor centre. In the proposed visitor centre the visitors will be able to experience the unusual spaces inside the silos and the preserved industrial atmosphere. The main function in the program is the exhibition about the quarry, located in the former vertical storage spaces. The visitors will follow a continuous path with exhibitions and descending ramps in between. In the adapted floors at the top and bottom of the silos there will be other supporting functions that the visitors can use if they need or want. The additions needed for the adaptation are carefully designed in detail with the intention to keep the industrial feeling. Elements of wood make the spaces warmer and more adapted to their new content of people instead of limestone.

FOCUS & DELIMITATIONS

The project has been delimited to the design of the visitor centre. Before the quarry can be visited without a guide the safety in the area need to be improved and areas of sensitive nature need to be secured. The largest risks for visitors today are; fall risk from 20 meter limestone-walls, stones falling from the eroding walls, the stone crusher building and the silos - the last risk will be solved in this project.

SITE & CONTEXT

Figure 2. Air photo of Limhamn limestone quarry, view towards west (Kärppä, P. 2011).

MALMÖ

Malmö is the third largest city in Sweden. It's known to be the city of the parks, but statistics shows that it is the second least green city and has the smallest amount of green space per inhabitant of all Swedish cities with more than 30000 inhabitants (SCB, 2015).

Since Malmö is located by the sea and is surrounded by agricultural landscape there is a lack of alternative natural recreational areas close to the city (Malmö Stad, 2003).

Limhamn limestone quarry is a nature reserve located just outside the city, it is closed but can be developed into a new recreational area.

The municipality is planning to build a visitor centre as the first step to make the quarry accessible to the public (Grundén).

Diagram 1. Grönytans andel av tätorternas landareal år 2010, procent

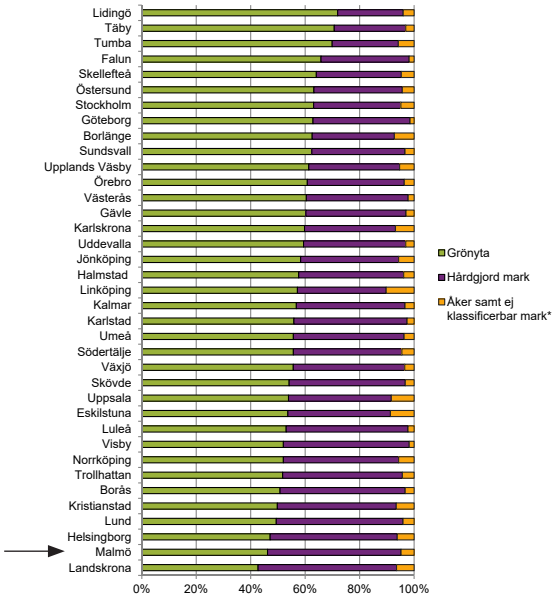


Figure 3. Proportion of green area in swedish cities (SCB 2015).

Diagram 3. Tillgänglig respektive ej allmänt tillgänglig grönyta per tätortsinvånare 2010, kvadratmeter

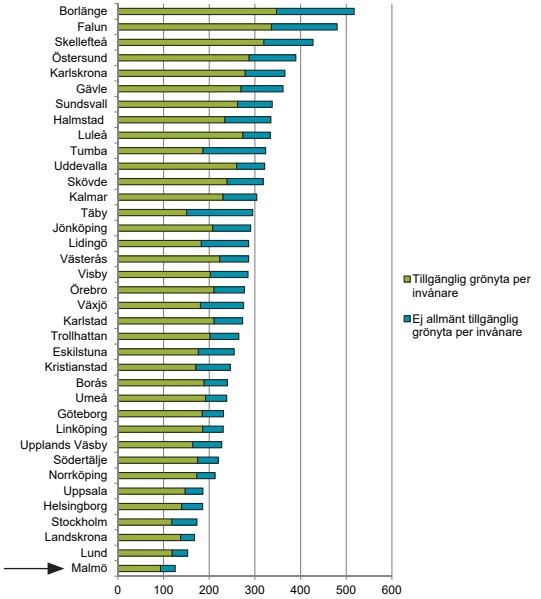


Figure 4. Accessible green space per inhabitant (SCB 2015).

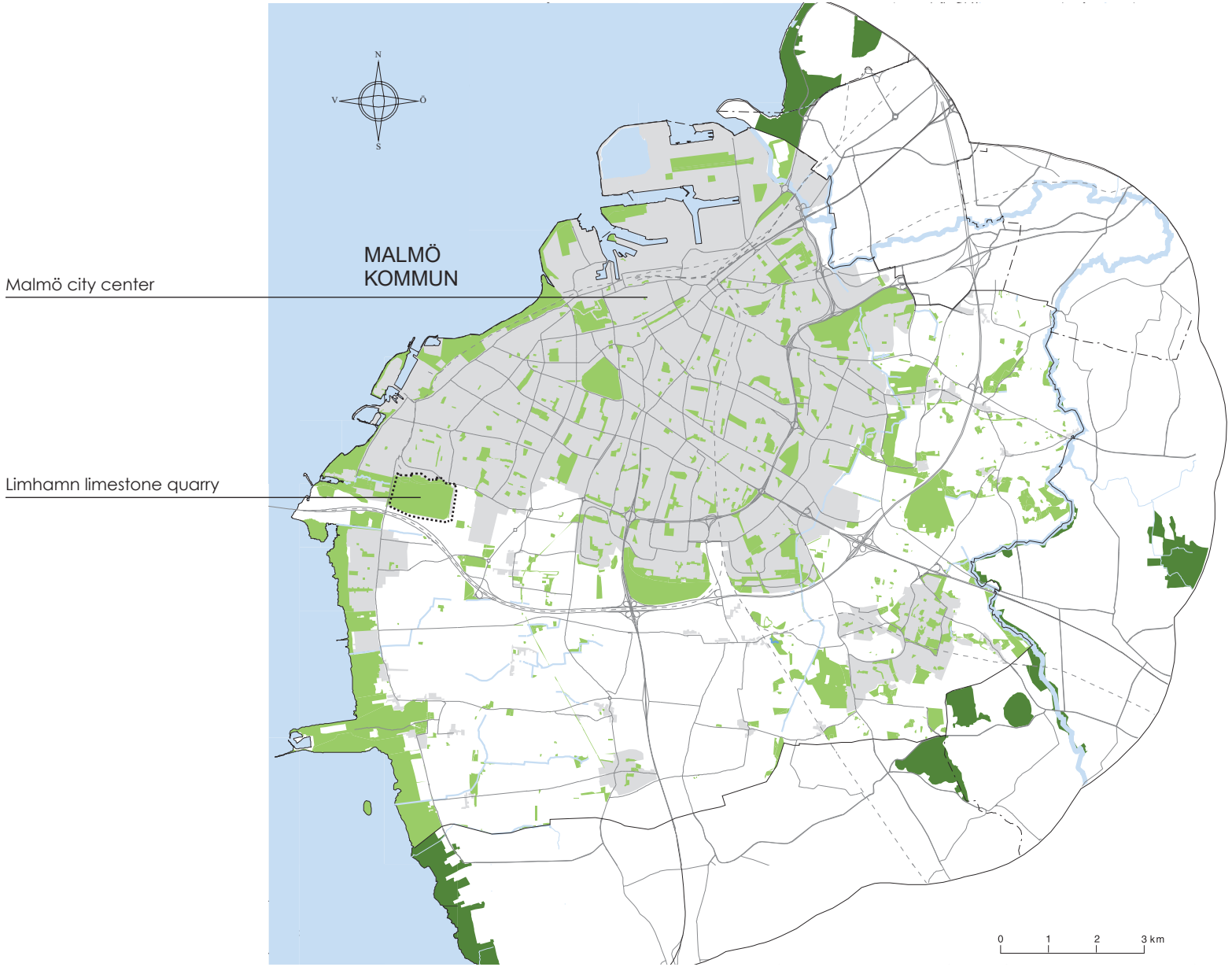


Figure 5. Map of Malmö showing green areas (Malmö Stad, 2003).

LIMHAMN LIMESTONE QUARRY

The quarry is a large man made pit in the surrounding flat landscape, it covers an area of about 100 hectares with the size of approximately 1350 × 750 m and a depth of 65 m below ground level and 58 m below sea level, it is one of northern Europe's largest open pit mines (Gatukontoret & Fastighetskontoret, 2010).

The quarry is a grand space with a unique atmosphere. In the eastern part three characteristic plateaus, each with 20 m high and vertical limestone walls, show the result of the mining method with dynamite that was used during many years (Henkov, 2012). The surface of the limestone walls also clearly shows 64-52 million old geological layers and formations (Vajda, 2014). The limestone walls are constantly eroding, especially when the winter frost-breaks depending on water and weather conditions (Gatukontoret & Fastighetskontoret, 2010).

The quarry is closed and fenced off to public access. To make it possible to experience it a 4 kilometer long walkway has been built around the quarry, close to the edge with many viewpoints. A few times a year guided tours down to the quarry takes place and the tours attract many people. The quarry is impressive from above but when entering the quarry it feels almost like entering another world, it is very different from the surrounding flat and fertile landscape. The most noticeable is the size and scale of the enormous man-made pit, reflecting upon the 130 years of active limestone industry where large amounts of stone have been excavated in the human strive for raw-materials.

Except from the quarry itself, there is not much preserved from the industrial era in the quarry but in the north-western part there is a stone crusher building with three connected silos. Close to the building is the remnants of the entrance to a conveyor tunnel built between the quarry and the northern factory and the harbor, the tunnel is now under water and all other entrances have been demolished. In the western part by the two ponds is a short part of the railway "brottets bana" and two small railway limestone wagons left (Schlyter, 2010).

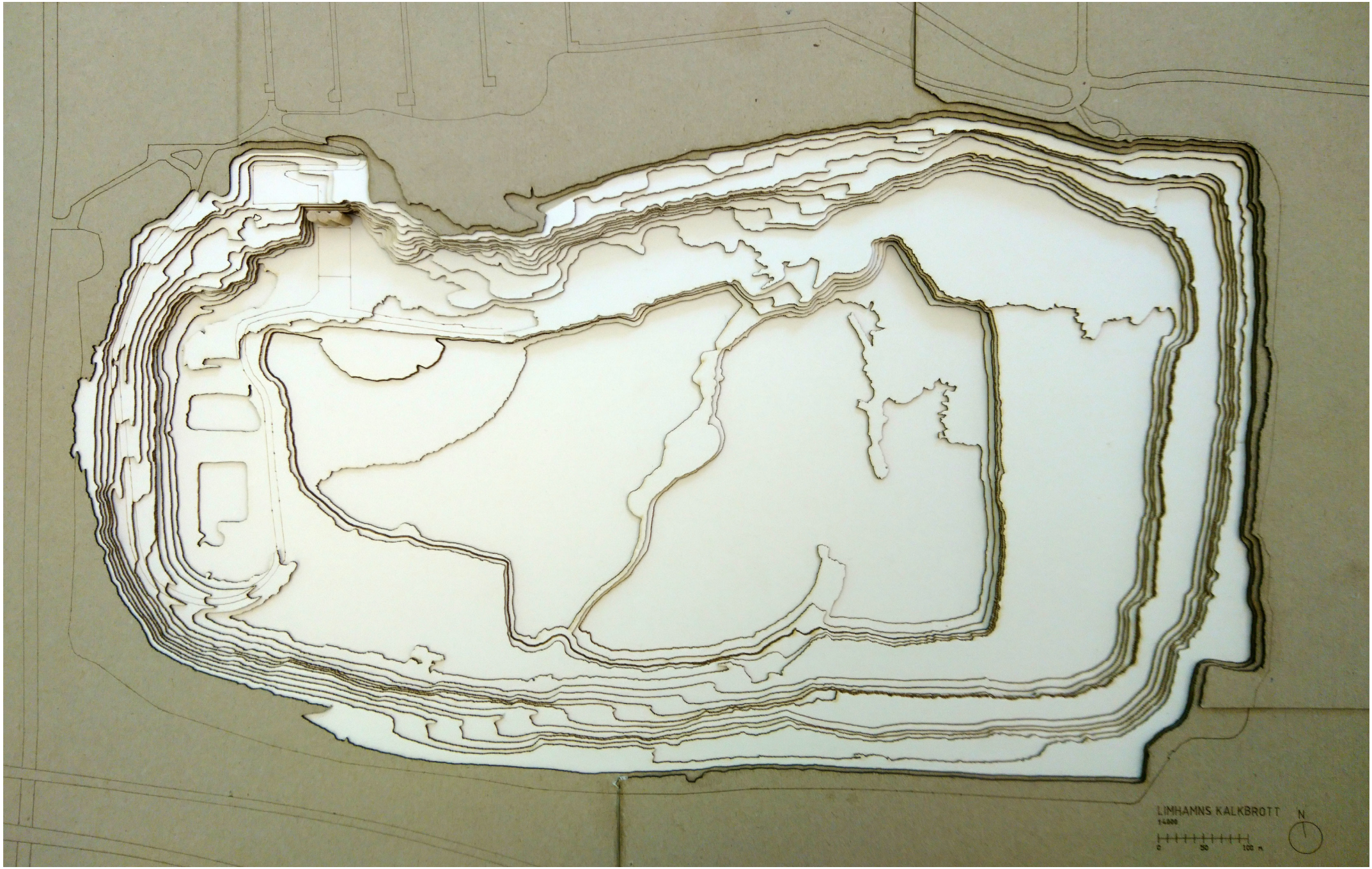


Figure 6. Site model.

NATURE RESERVE

Limhamn limestone quarry became a nature reserve in 2011 and is also a Natura 2000 area. Natura 2000 is a European network of core breeding and resting sites for rare and threatened species, and some rare natural habitat types which are protected in their own right. The aim of the network is to ensure the long-term survival of Europe's most valuable and threatened species and habitats, listed under both the Birds Directive and the Habitats Directive (Länstyrelsen 2016).

The nature reserve has a management plan and due to the Natura 2000 area there also is a preservation plan. The management plan and preservation plan have been coordinated and do not contradict each other. Both plans include guidelines and policies for planning, developing, managing the nature reserve, and also have suggested activities how to further develop the quarry for visitors, outdoor life and tourism.

One important purpose of the reserve is to preserve the atmosphere of the area and to develop it and make it possible to experience it in pedagogical ways. Another important purpose is to protect the many rare and special plant and animal species living in the quarry. The plan for the quarry also aims to preserve and illustrate interesting geological formations and phenomenas like the layer formations along the limestone walls, the inflow of groundwater and the erosion processes, preserve and illustrate remnants and traces from the industrial activity, which has been a basis for the areas entire origin and existence (Gatukontoret, 2010).

Furthermore, the plans for the quarry points out the importance of informing the public and visitors about its **Biology, History and Geology** and aims to make the quarry accessible to the public. But it needs to be used and managed in a way that minimizes the interference and damages upon the quarry's qualities. The quarry must become safe for visitors and transports within the area (Gatukontoret & Fastighetskontoret, 2010).

According to the management plan one possible way to obtain the purposes of the nature reserve is to found a visitor centre. The municipalities has now decided to build a visitor centre and a team is working on evaluating different possible options (Grundén).

Figure 7. View from the bottom of the quarry.

Figure 8. Signs at the fence surrounding the quarry.

Figure 9. View towards east.

BIOLOGY

The quarry has harsh life conditions with almost no soil which makes it a demanding environment to biological life. The local climate in the mine is different from the surrounding coastal climate; the mine offers a more continental climate with higher moisture and temperature levels. The depth of the mine also makes it more silent and less exposed to artificial light. The different sun exposure of the steep limestone walls and terraces makes micro climate conditions varied. The inflow of both sweet and broken water also makes the conditions special and demanding for the biological life. Natural streams and waterfalls brings the water to the lowest point, where it has to be pumped out.

The quarry has three dominating nature types:

-Open areas with rocky ground
-Vegetation-poor wetlands
-Reed meadows

The biotope structure of the quarry is unique because of the rocky ground of vegetation-poor lime gravity, without soil layers and with a field substrate of lime with varying fractions, vegetation-poor wetlands and surrounding limestone walls. Areas of large trees and shrubs has grown freely in the western part of the quarry since the 1940s and today have high biological values.

The quarry host a large amount of animal and plant species despite its closeness to the city and its harsh conditions. The biodiversity can be explained by the special life environment, the calmness, the size and the climate of the quarry. There are around 2000 species of animal, plants and fungus living in the area. Many of these species are nationally red-listed, rare or somewhat special. Most noticed is the presence of the acute endangered Green Speckled Toad and the plant Limestone Karst Sing. The pit also holds a lot of birds of prey. In 2009 an Eagle Owl couple arrived to the area but now it is only the male, called Bernard, left. Mammals living in the pit are for example Roe Deers, Rabbits, Foxes and Badgers.

The immigration of plants and animals has almost exclusively taken place naturally or through unplanned diffusion by humans (soil and lime from machines, boots and car tires, dumping of building and garden waste etc.).

The knowledge about when different species were established in the quarry is limited. Several of the quarry's existing species were established during active limestone industry and may have existed for over a century, others have established later and the biodiversity will continue to evolve in a natural way (Gatukontoret, 2010).

Figure 10. The endangered Green speckled toad (Wirén, M., 2011).

Figure 11. The rare Lime karst sing (Wirén, M., 2011).

Figure 12. View towards east, from the edge of the quarry.

INDUSTRIAL & CULTURAL HISTORY

Since the late Middle Ages, limestone mining has been an important binary for the local farmers. Limestone was excavated and burned in primitive kilns. The burned lime was used for mortar and grout.

1522 The name Limhamn, which means just "lime harbor" first occurs in text. That means that limestone has been excavated and shipped from the area for at least almost 500 years.

1860 At the time there were more than 50 limestone quarries in Limhamn.

1866 The two brothers Anders and Joseph Larsson starts Annetorps limestone quarry, later called Limhamn limestone quarry. Eventually, all mining in Limhamn was concentrated to Annetorp.

1874 A narrow-track railway "Brottets bana" with horse-drawn carriages is built to transport the limestone to the harbor.

1883 Skånska Cement receives permission to use steam locomotives instead of horses.

1889 The cement plant in the port of Limhamn is completed.

1940s During the Second World War two ponds were located in the western part of the quarry with the purpose of creating a water reservoir.

1968 The largest expansion in history of Limhamn limestone quarry. New factories, silos, stone-crusher and conveyor belts makes the complex top modern. The railway is replaced by a 2 km long conveyor tunnel to the north factory and the harbor.

1978 The cement production ends due to high energy costs during the oil crises.

1994 The quarry is closed down and the industrial era ends.

2011 The quarry becomes a municipal nature reserve (Malmö Stad, 2016).

Figure 13. Letter paper of Förenade kalkbrotten in 1882 (Sydsvenskan).

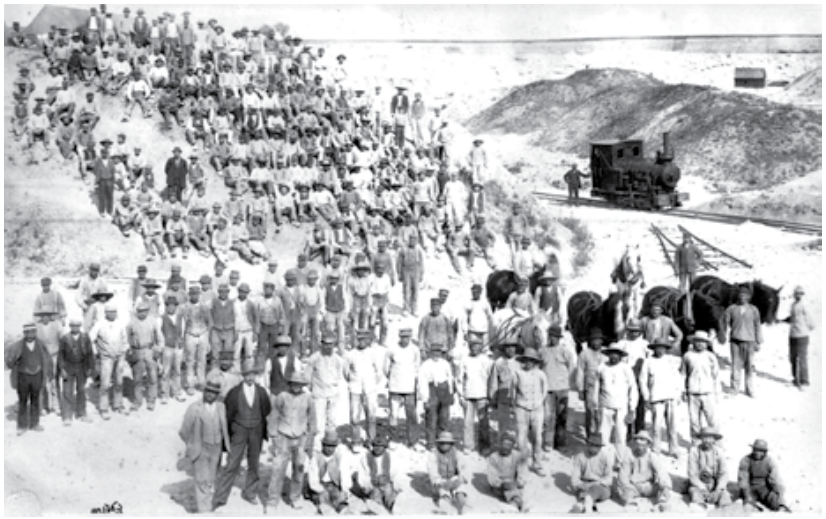


Figure 14. The quarry in 1898 (Limhamns museiförening).

Figure 15. The quarry in the 1970s (Andersson, Limhamns museiförening).

GEOLOGY

The visible geological layers in the quarry were created about 62-64 million years ago during the latter part of the Cretaceous period and the early Paleogene period in a subtropical ocean.

Geologically Sweden belongs to the Fennoscandic shield which is part of the Eurasian tectonic plate, at the time it was located further south at the same latitude as the Mediterranean countries are today. The global climate was generally warmer during this period and the planet had no polar ices and a higher sea level. The coastal areas of today were below water and most of Scania was the ocean floor of a shallow and warm sea. The climate is proved to have been warmer by fossil fruitful forests around the poles and in this case by the fossil fauna in the quarry (Vajda, 2014).

Three different types of limestone dominate the quarry, they were accumulated, during different time periods due the variating ocean level, by deposits from the biological marine life;

-Bryozoan limestone consists of sediments from microscopic marine moss organisms that lived in large colonies. These organisms built reef-like structures on the ocean floor which today are visible in the clear wavy structure of the layers of the exposed limestone walls.

-Coccolit limestone consists of compressed skeletons of the microscopic Coccolit alges.

-Coral limestone consists of the calcareous skeletons of corals (Björk, Bergman, Stridsberg 2003).

A rich marine life developed during the Paleogene period and the quarry contains many fossils from both flora and fauna. The quarry is especially known for two crocodile fossils and thousands of shark teeth (Henkov, 2012).

Figure 16. Visible layers showing how the sea bed once was. The limestone is rich of 62-64 million year old fossils from both flora and fauna.

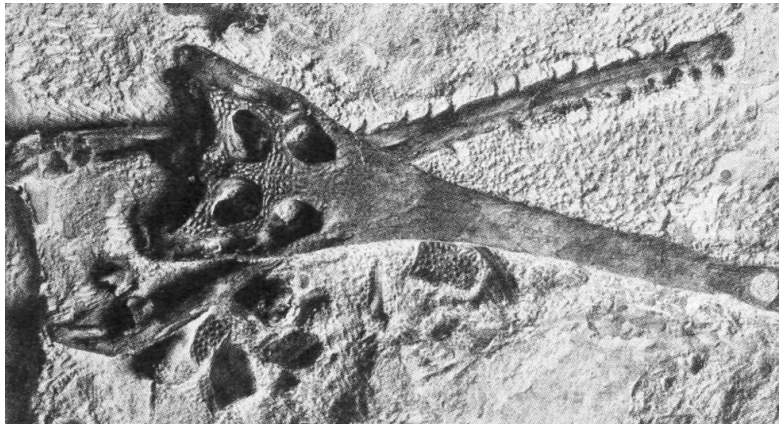


Figure 17. Fossil from the quarry, a cranium from a 4m long crocodile, Thoracosaurus scanicus "Skånekrokodilen". (Dalin, Liliengren & Håkanson, 1994).

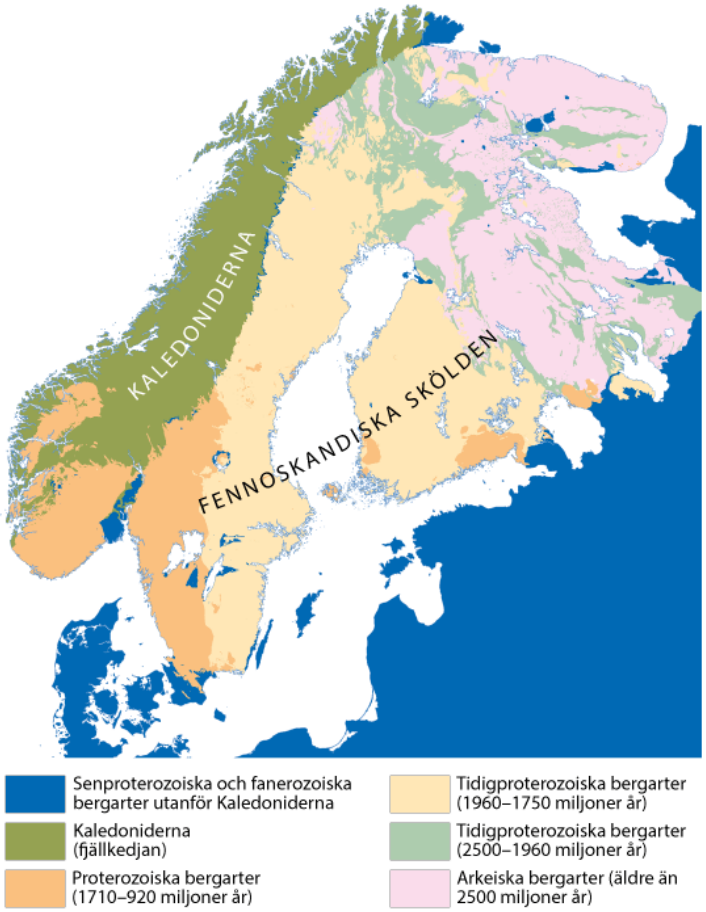


Figure 18. Sedimentary bed rock represented in blue (SGU, 2017).

EXISTING BUILDING

Figure 19. View from the quarry towards the existing building.

CONTEXT

My first visit at the site in the beginning of the project confirmed my expectations of the quarry, it is a place worth experiencing, I was looking for a location for the visitor centre when the last remnant building in the quarry caught my attention, it is a large almost empty building where they used to crush limestone and a silo battery standing behind. What interested me was the unique and strategic position of the silos close to the limestone wall with the top of stretching just above the upper plateau, I saw the potential of integrating them into my project and how they could be used as a way down to the quarry.

The silos was built in 1967 and was part of a larger investment in new factories and new connections between the north factory with the harbor and the south factory by the quarry (Åberg, 1972).

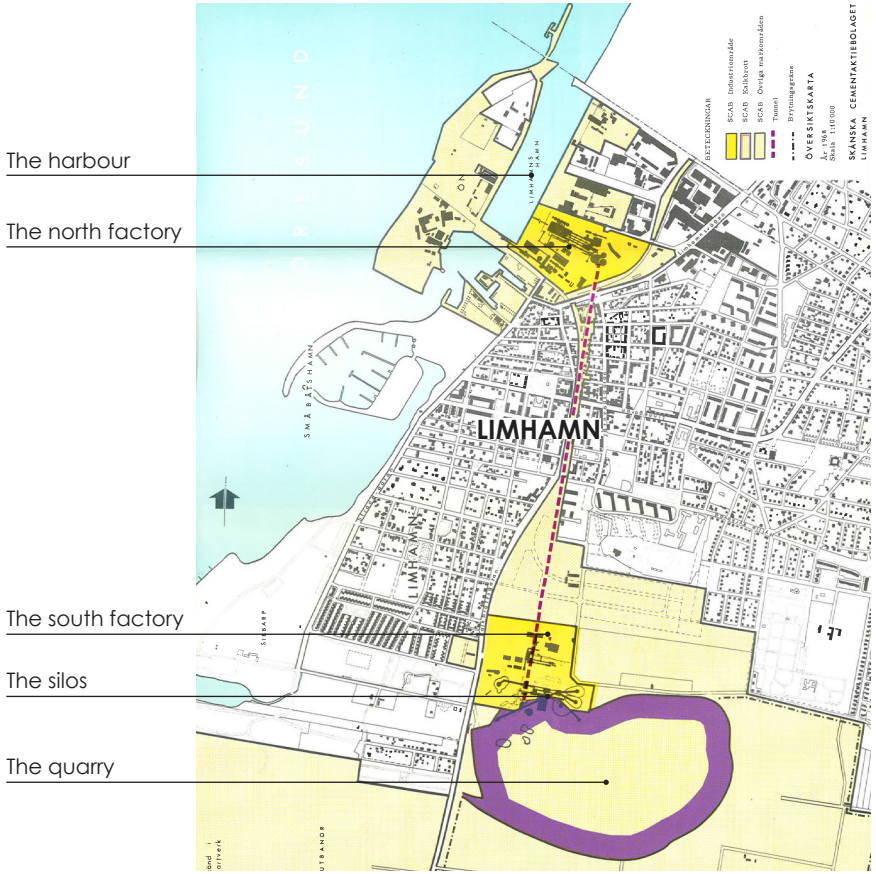


Figure 20. Overview of the industry in 1968 (Skånska cementaktiebolaget, 1968).

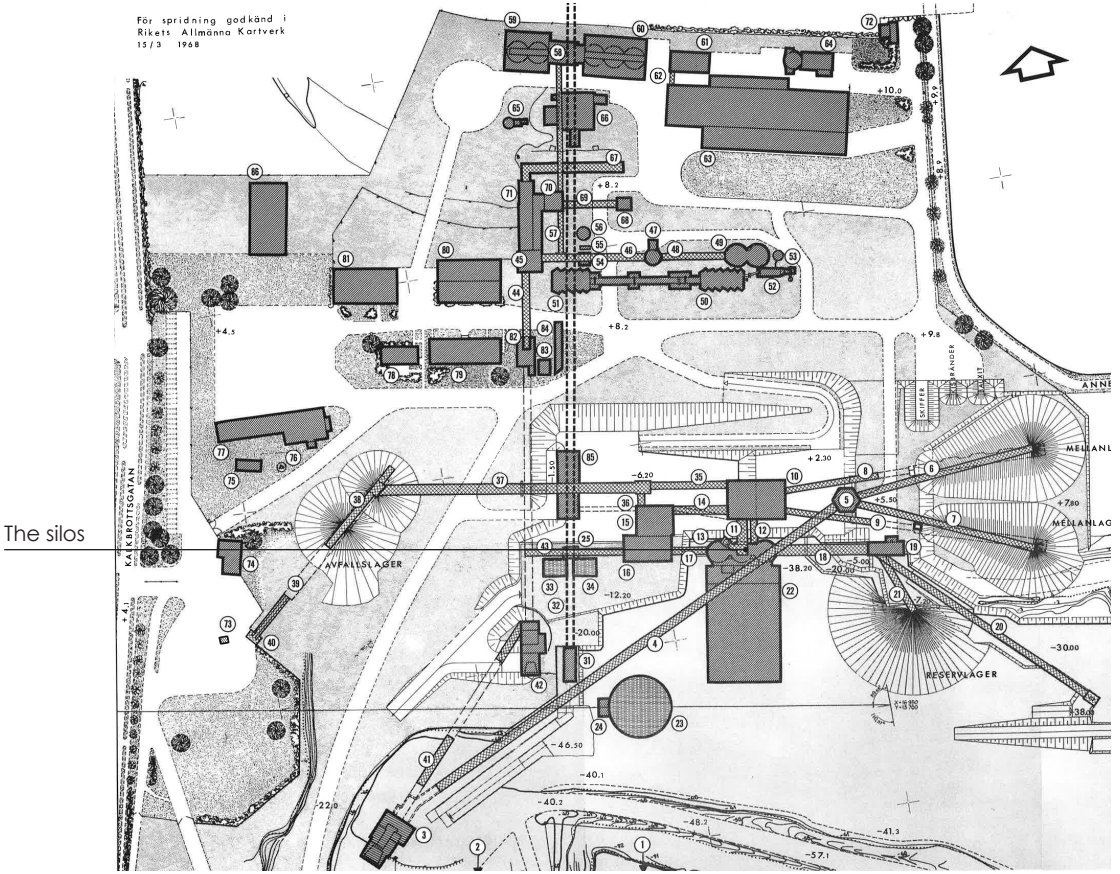
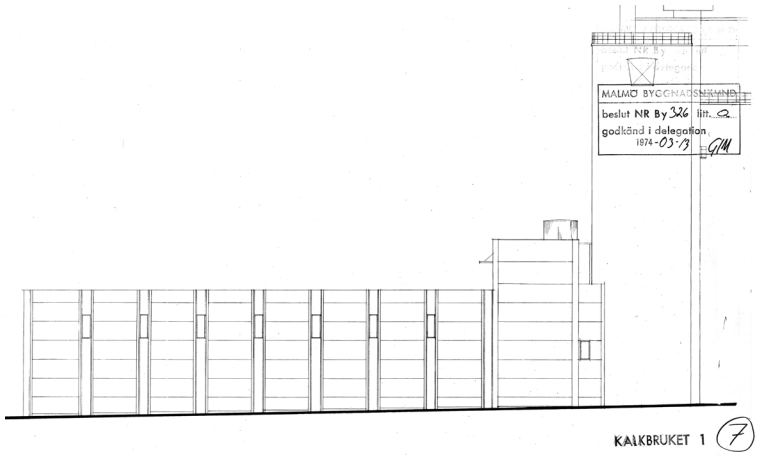
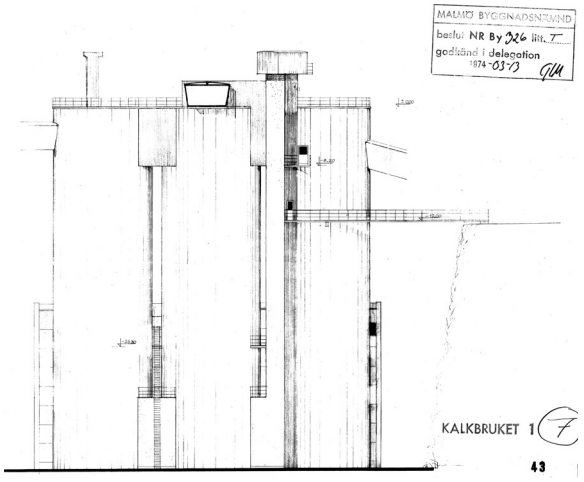


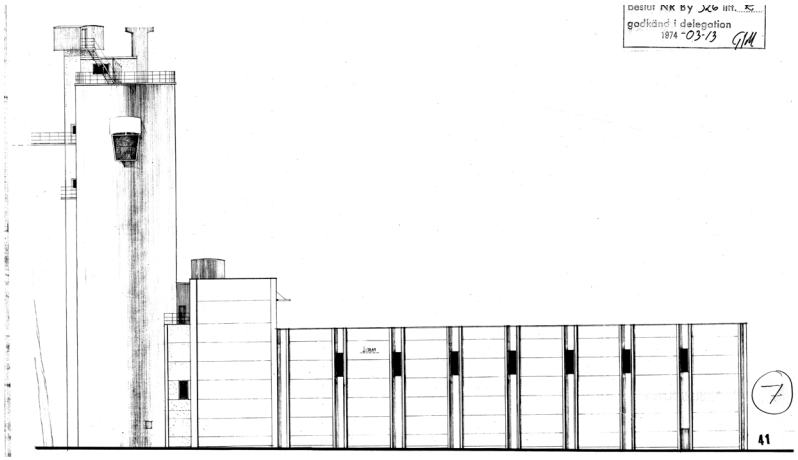
Figure 21. Overview of parts of the quarry in 1968 (Skånska cementaktiebolaget, 1968).

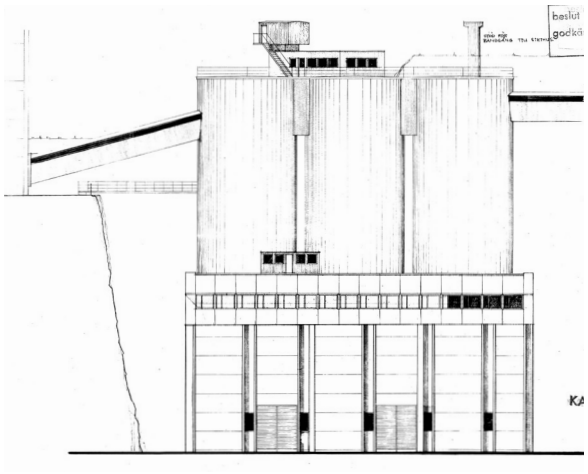
Figure 22. View ot the construction of the new factory in 1968 (Berenhult, 1967).

EXTERIOR ANALYSIS









0 5 10 15 20 40m

Figure 23. Original drawings (Stadsbyggnadskontorets arkiv).

Figure 24. The building in front of the silos was used for crushing limestone, it has a partly demolished operator room on the roof. The load-bearing structure of the stone crusher building has major frost damages. The gap between the silos and the limestone wall is covered with metal sheets.

Figure 25. The silo roof is at sea level +-0 and reaches up above the plateau at -6m. Remnants of conveyor belts and structures covering the gap in-between the silos and the limestone wall are in poor condition.

Figure 26. View of the space in-between the silos and the limestone wall. The silos appears to be i good condition. The structures around the silos are falling apart.

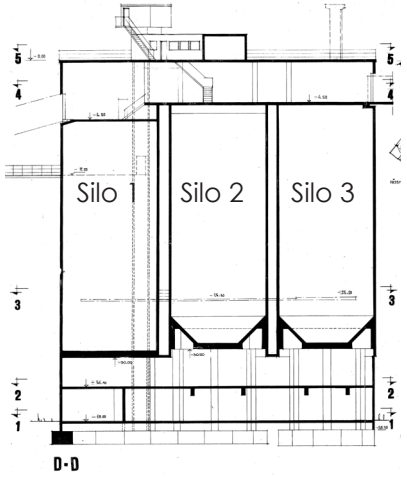
INTERIOR ANALYSIS

Service floor, raw-materials entering the building

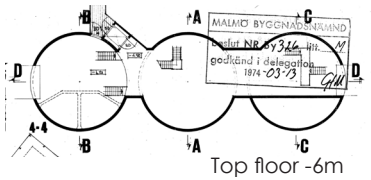
Main function of the building;
Storage of raw-materials

Service floors, raw-materials moving on to the stone crusher building

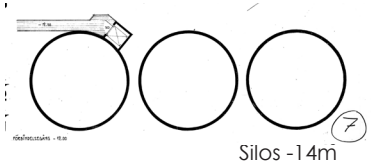
Raw-material was carried to the top floor of the silos by three conveyerbelts from three different directions.



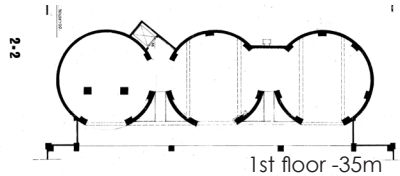
Silo 1 was used as storage for bauxite and silo 2 and 3 are identical and was used for limestone.



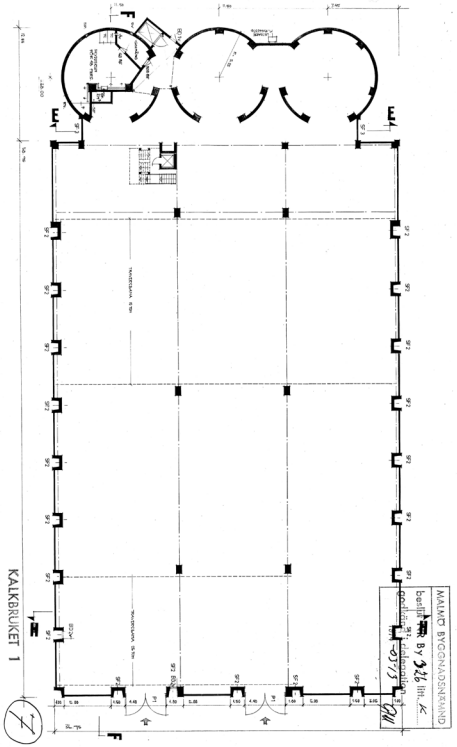
Top floor -6m



Silos -14m



1st floor -35m



Ground floor -38m

0 5 10 15 20 40m

Figure 27. Original drawings (Stadsbyggnadskontorets arkiv).

Figure 28. View towards silo 2, a balcony of concrete runs in front of the silos at the 1st floor. The openings in the front are about 4x7 meters.

Figure 29. View of the 1st floor of the silos.

Figure 30. View from the balcony in front of the silos, the floor in the former stone crusher building is covered with large concrete bases.

DESIGN PROPOSAL

Figure 31. View towards the entrance.

VISITOR CENTRE

Nature related visitor centres in Sweden are often called "Naturum" which is a concept and trademark by the Swedish Environmental Protection Agency.

In a Naturum the visitors will learn more about the animals, plants, geology and cultural history of the specific area. The national guidelines for the concept states that;

"Naturum leads the way into nature. Visitors will, in an enjoyable way, learn about nature, obtain an understanding and a feeling for its values, as well as being inspired to go there, spend time there and to enrich their contact with nature".

"A naturum must be an attraction in itself through its design and content, at the same time as it should reinforce the attraction and identity of the site or the area" (Naturvårdsverket, 2015).

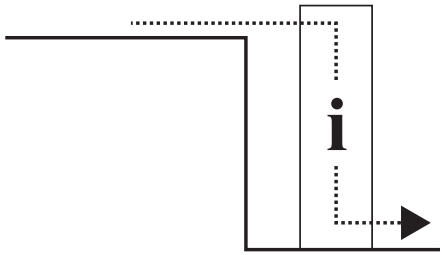
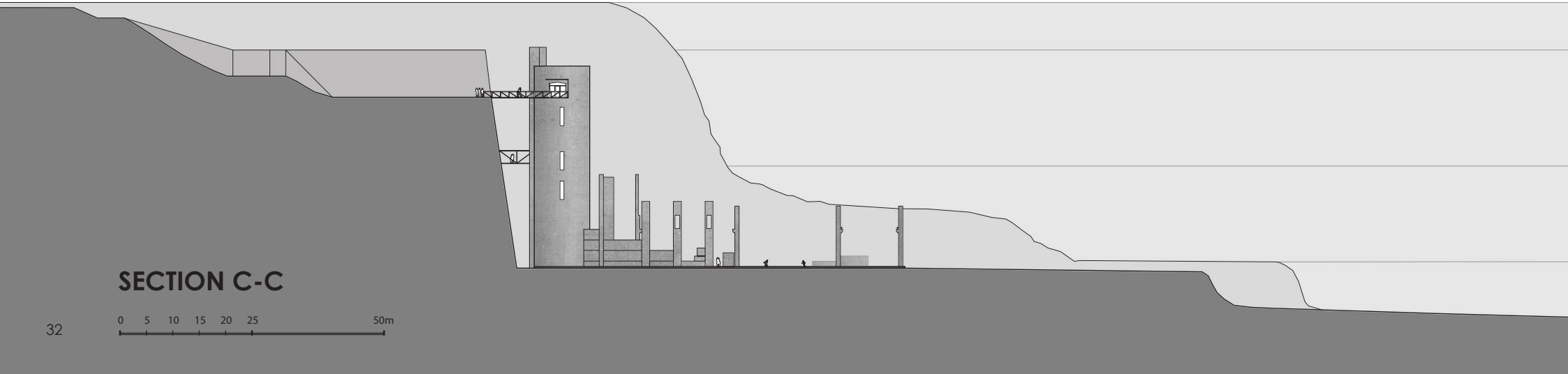


Figure 32. Site model.

The design proposal suggests that the visitor centre in the quarry will be placed inside the existing silos from the industrial era. By transforming the silos the interior space will be accessible to the visitors and be an intresting and authentic part of their experience of the quarry.

The strategic location of the silos, close to the limestone wall, will be used to create a vertical connection from the upper plateau to the bottom of the quarry. During the descent the visitors will get unique spatial experiences in combination with exhibitions about the biology, industrial & cultural history and geology.

The visitor centre will also have additional services and functions supporting the visitors and the staff like reception, auditoriums, restrooms and a café.



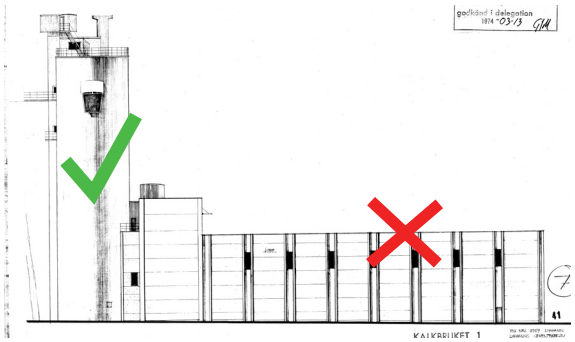
SITE PLAN


+9
C
Parking
-6
+2
Entrance
B
A
A
-12
-38
Ruin-park
B
C
NORTH
0 5 10 15 20 25 50m

DESIGN STRATEGY

REDUCE

Remove all additions and covering structures around the silos. The stone crusher building in front of the silos is in bad condition and will be demolished.



The silos will stand free from the limestone wall behind and their strong shape will be clear and clean like in the picture below when they where constructed in 1967.

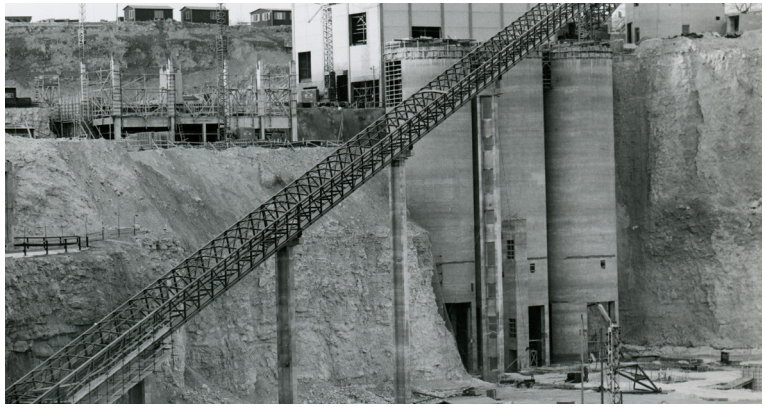


Figure 33. Silos and conveyor belt under construction (Skånska Cement AB, 1967).

REUSE

Reuse the existing structure, spaces and openings and make the most out of them to preserve the industrial history and to emphasize their strong character.

Reuse the flow through the building in a similar way like during the industrial era to obtain a natural and authentic flow and experience.

Reuse parts of the stone crusher building to create a ruin-park with concrete floor, bases and pillars.

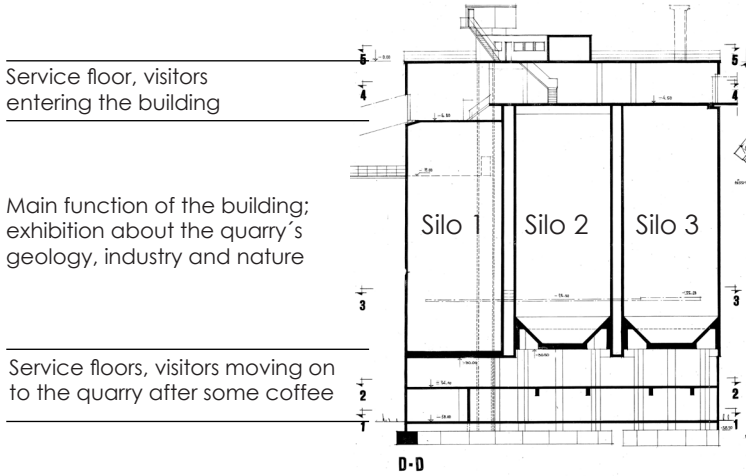


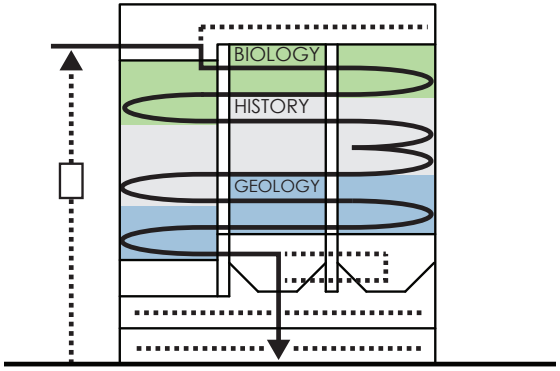
Figure 34. Existing opening towards east.

Figure 35. Existing opening towards west.

ADAPT

Adapt the structure where it´s needed.

The existing horizontal floors at the top and at the bottom will have many architectural qualities after the surrounding structure has been reduced, there will be enough openings for daylight and entrances and only smaller adaptations need to be done.



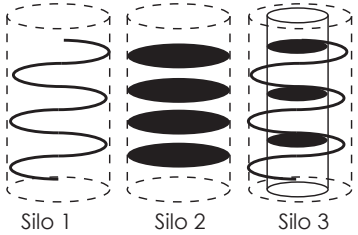
The high vertical storage spaces are not built to be accessed by people and therefore they need to be adapted more before they can be experienced. New openings need to be cut; in the floors to get in and out, in between the silos in order to move around and in the walls to let natural light in and enable contact with the quarry.

ADD

Add new structures in order to create movement, spatial experiences and space for functions.

The service-floors needs enclosed spaces for necessary functions, they will be added by placing new volumes of wood in a radial floor-plan.

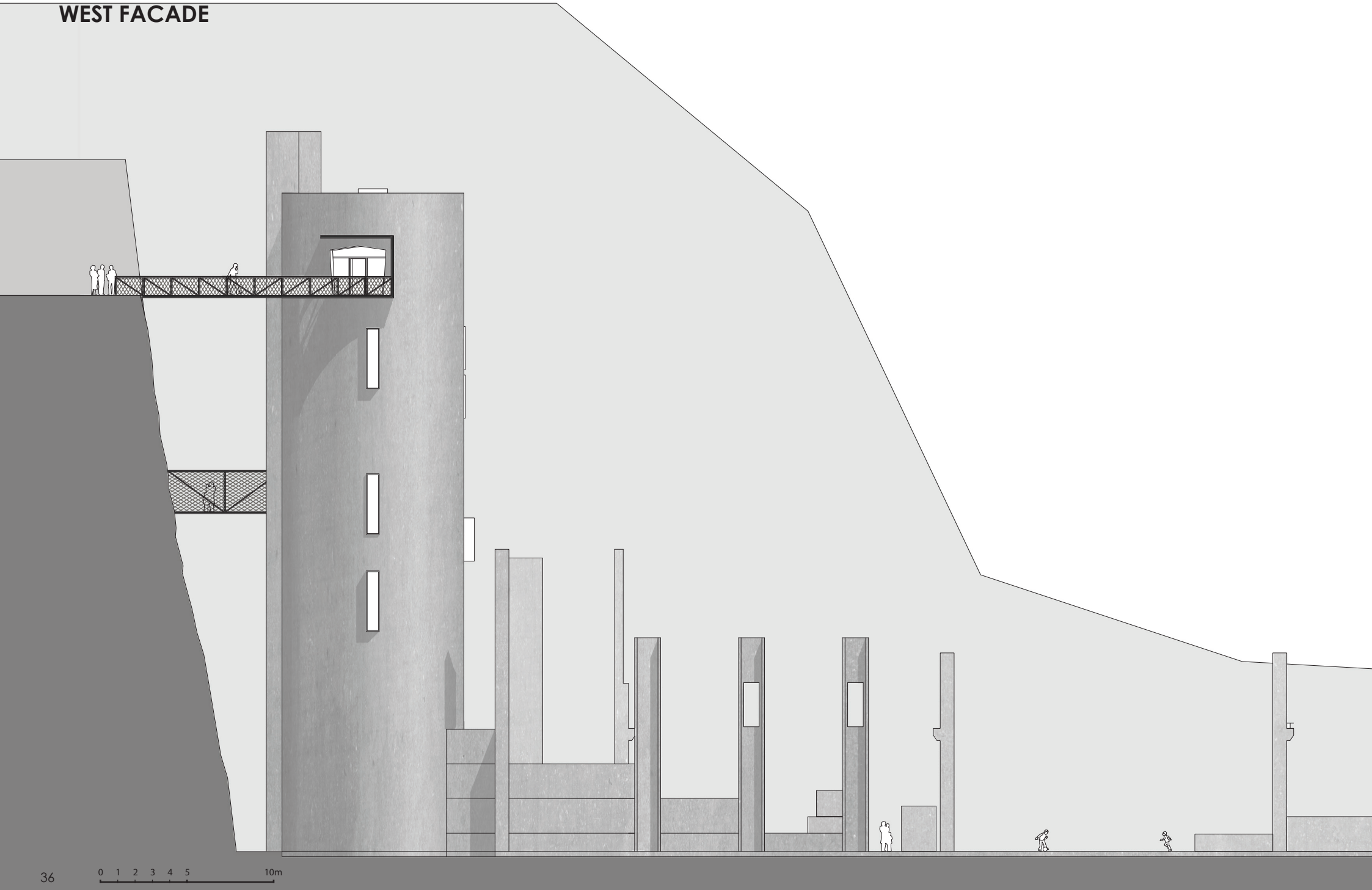
In the vertical storage spaces new floors for exhibitions will be added, they will be connected by descending ramps in order to create a continuous path down.



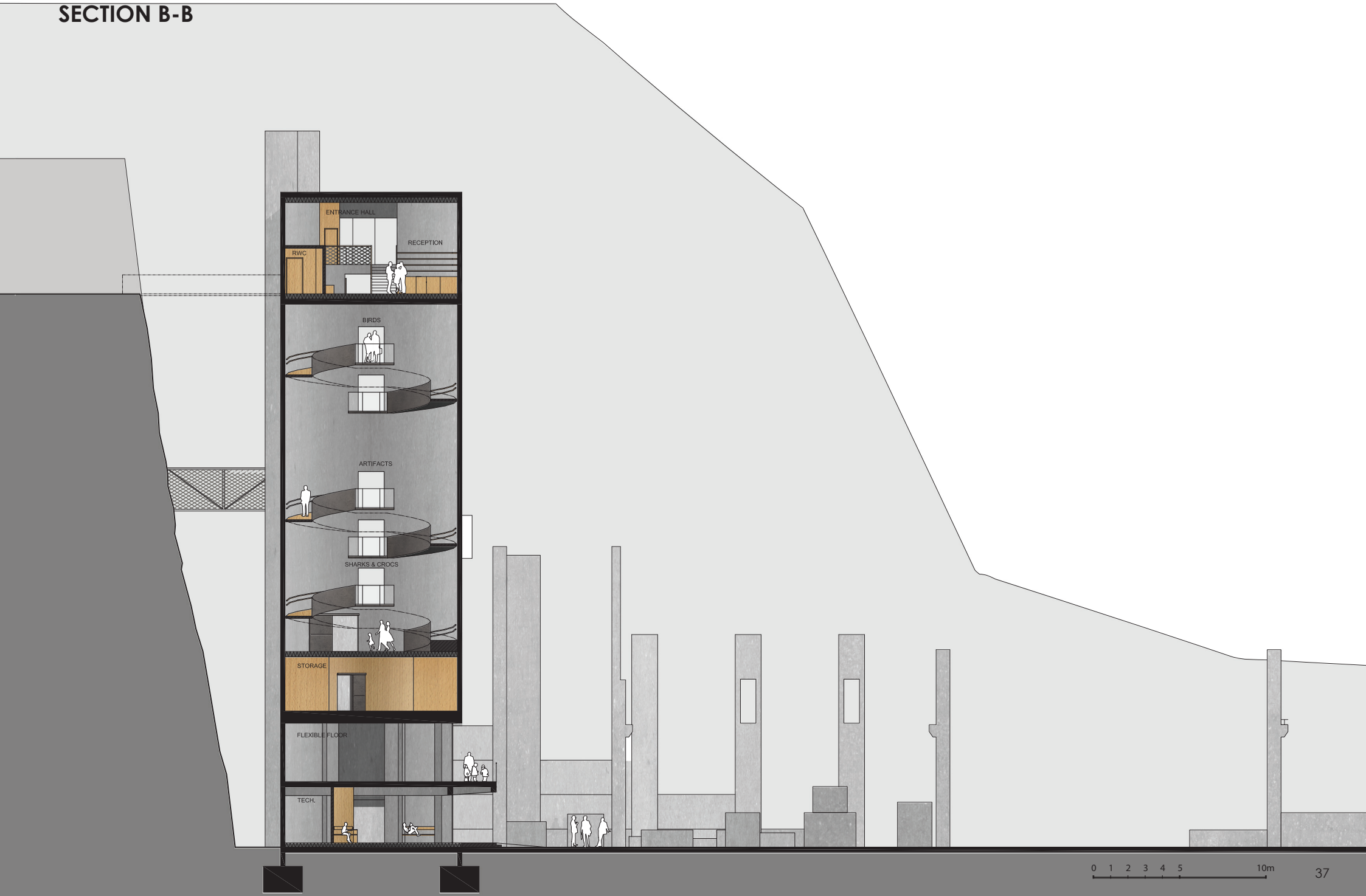
Each of the three cylinders will offer the visitors its own architectural experience within the same architectural language.

Silo 1; Helix ramp descending around open space and hanging exhibitions.
Silo 2; Horzontal exhibition floors with a central vertical sigthline from the ground-floor to the roof.
Silo 3; Helix ramp descending around a mesh tube with smaller exhibition floors inside.

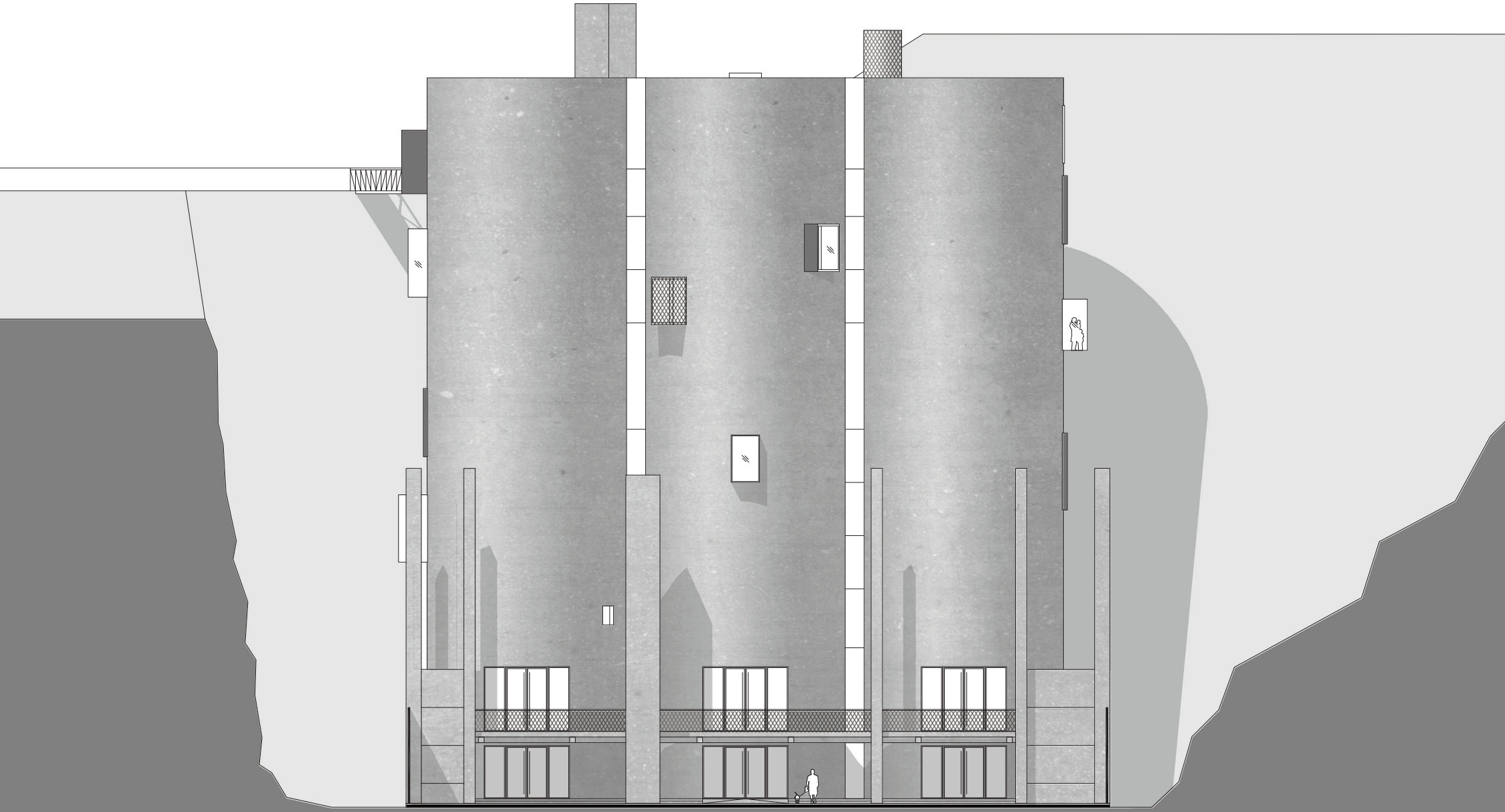
WEST FACADE



SECTION B-B

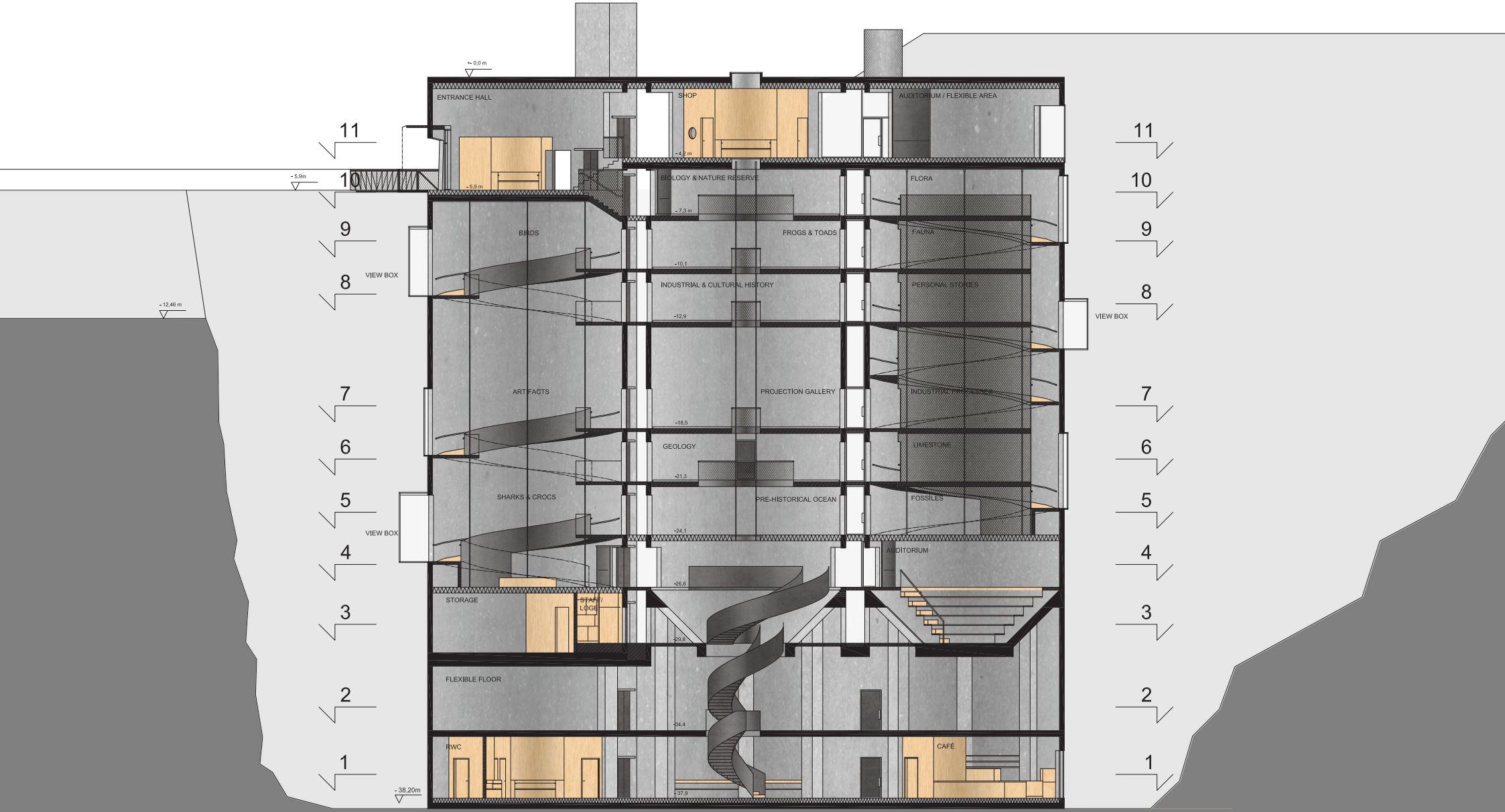

ENTRANCE HALL
RECEPTION
RWC
BIRDS
ARTIFACTS
SHARKS & CROCS
STORAGE
FLEXIBLE FLOOR
TECH.
0 1 2 3 4 5 10m

SOUTH FACADE



0 1 2 3 4 5 10m

SECTION A-A


+- 0.0 m
ENTRANCE HALL
SHOP
AUDITORIUM / FLEXIBLE AREA
-4.2 m
-5.9m
-5.9 m
BIOLOGY & NATURE RESERVE
FLORA
-7.3 m
BIRDS
FROGS & TOADS
FAUNA
-10.1
VIEW BOX
INDUSTRIAL & CULTURAL HISTORY
PERSONAL STORIES
-12.46 m
-12.9
ART FACTS
PROJECTION GALLERY
INDUSTRIAL EVOLUTION
-18.5
GEOLOGY
LIMESTONE
-21.3
SHARKS & CROCS
PRE-HISTORICAL OCEAN
FOSSILES
VIEW BOX
-24.1
AUDITORIUM
-26.8
STORAGE
STAFF / LOGE
-29.8
FLEXIBLE FLOOR
-34.4
RWC
CAFÉ
-38,20m
-37.9
11
10
9
8
7
6
5
4
3
2
1
0 1 2 3 4 5 10m

FLOOR PLANS

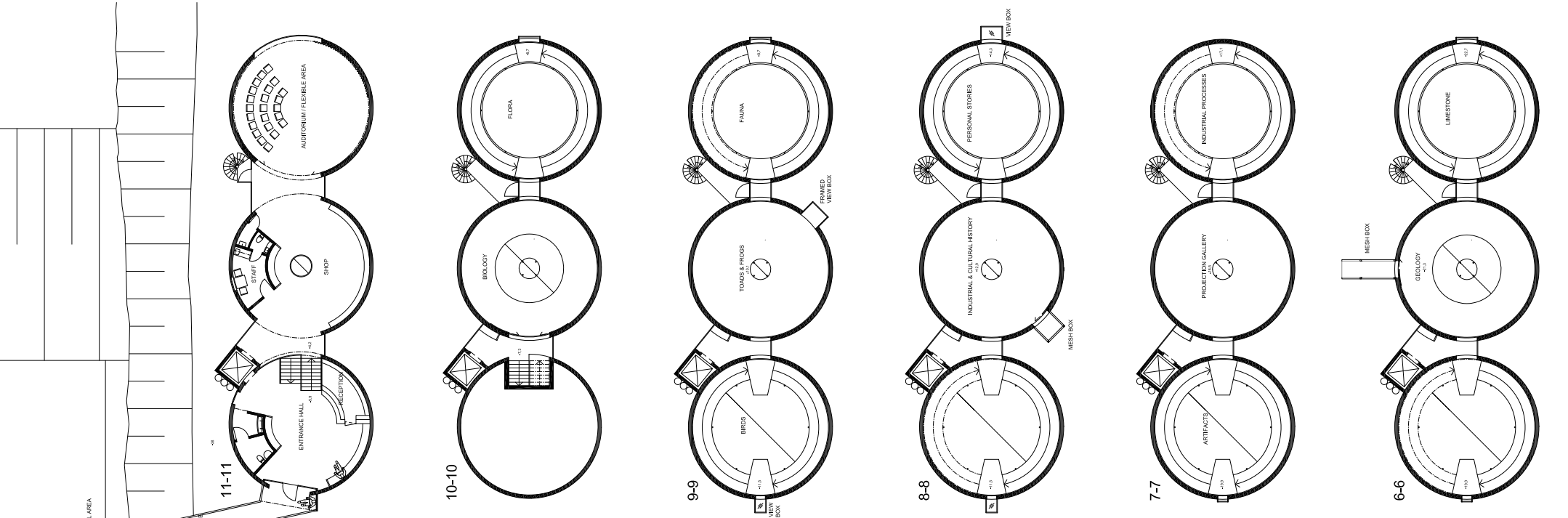


Figure 36. Bridge to the entrance.

Figure 37. Entrance. View throughout the building at two levels.

Figure 38. Entrance hall.

Figure 39. Exhibition space.

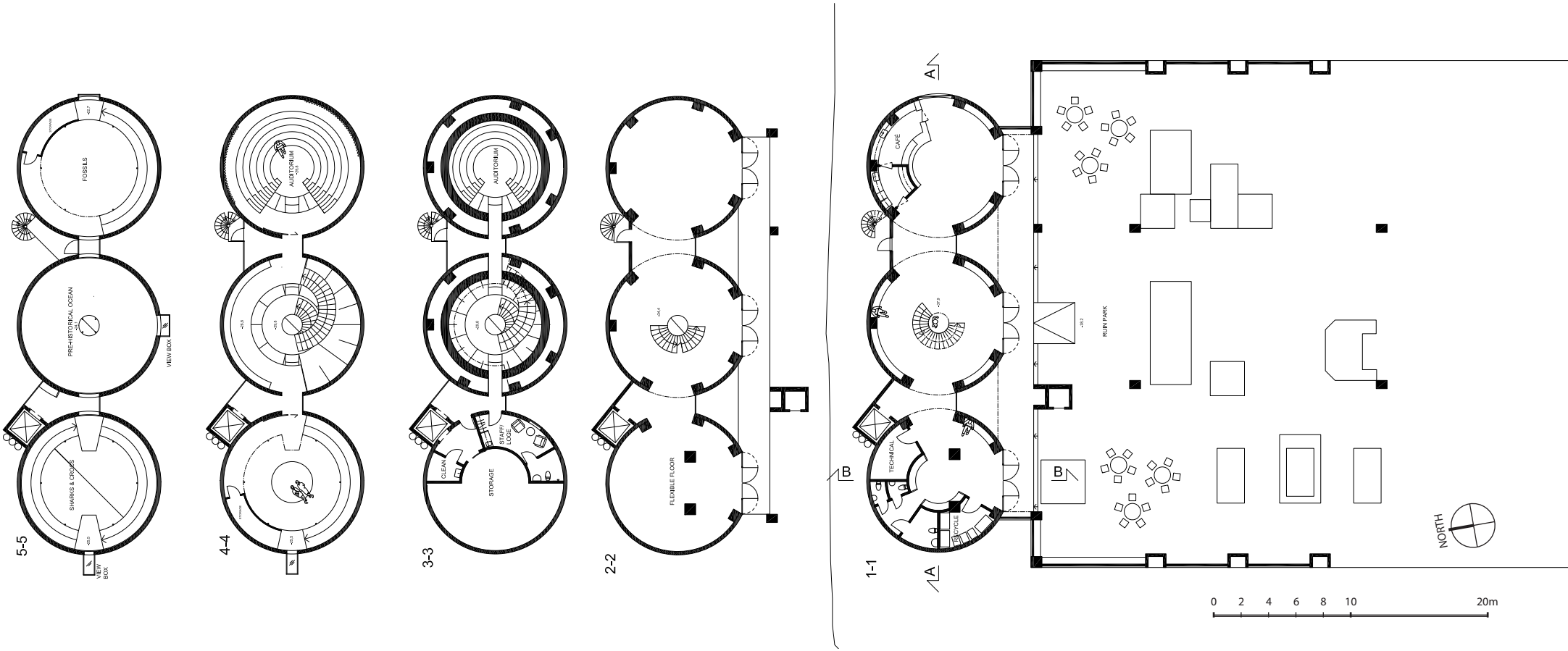


Figure 40. Auditorium in funnel.

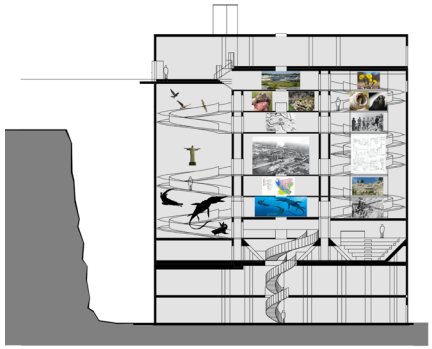
Figure 41. Staircase through funnel.

Figure 42. Staircase at basefloor.

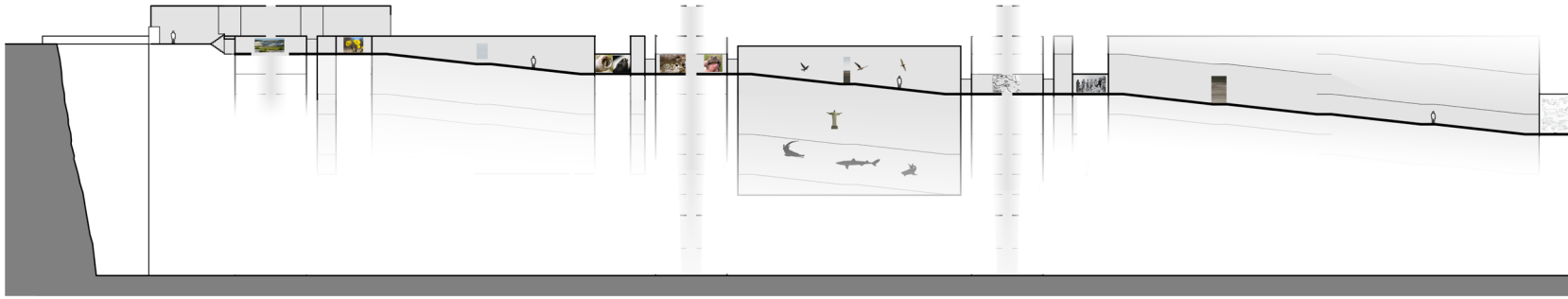
Figure 43. Ruin park below the silos.

STRETCHED SECTION

THE QUARRY VISITOR CENTRE, MALMÖ

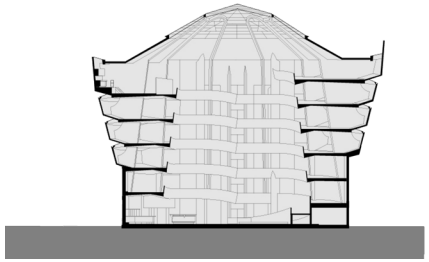


Section A-A, straight cut.

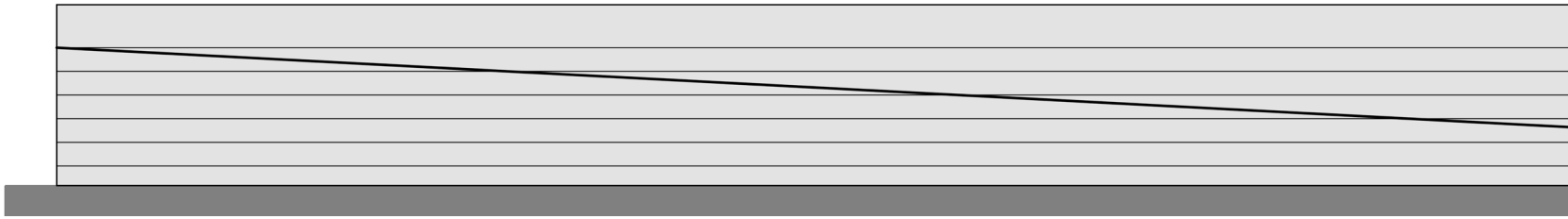


Section, cut along the descending path.

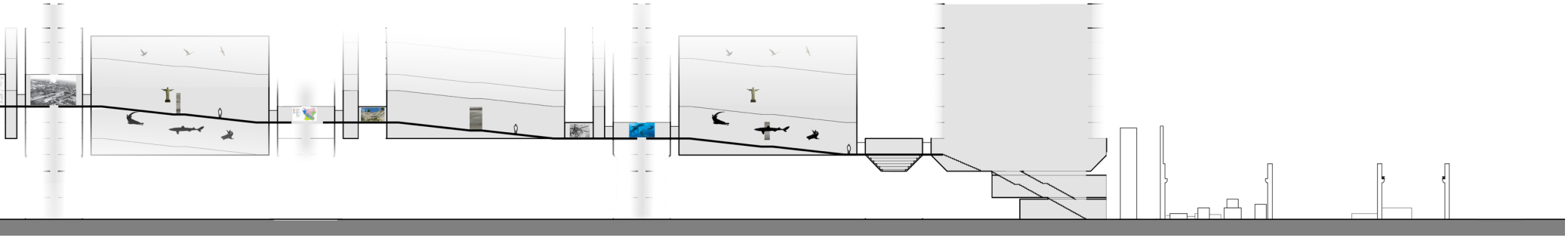
REFERENCE PROJECT; THE GUGGENHEIM MUSEUM, NEW YORK

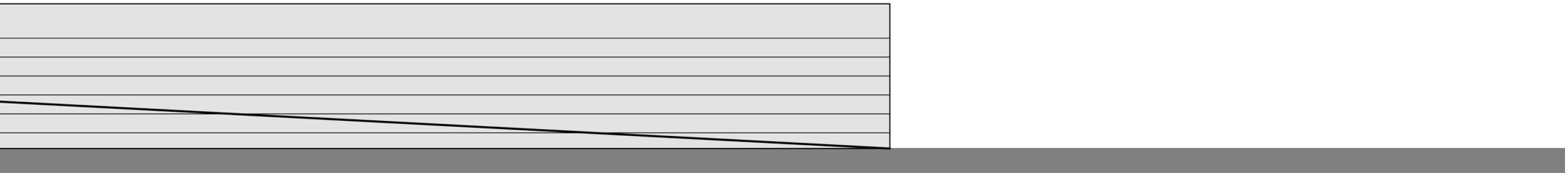


Section, straight cut.



Section, cut along the descending path.





0 5 10 15 20 25 50m

SILO 1

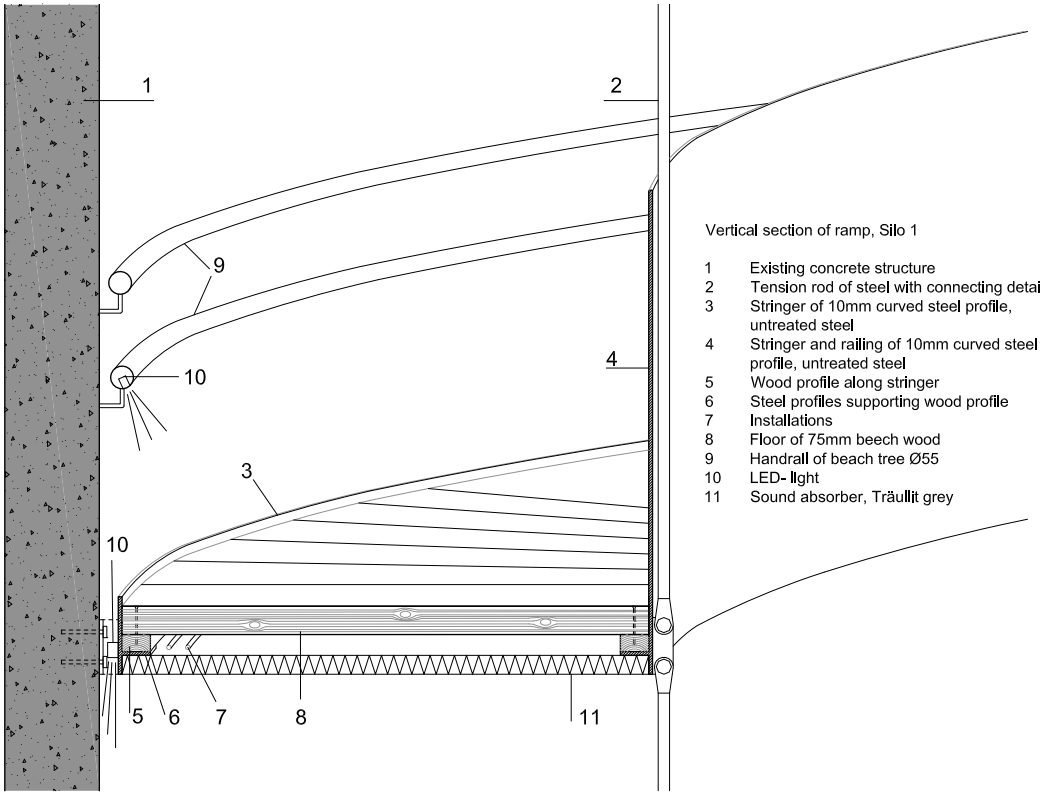
INTERIOR

Figure 44. Experience of space.

Figure 45. Loops and interior view-balconies.

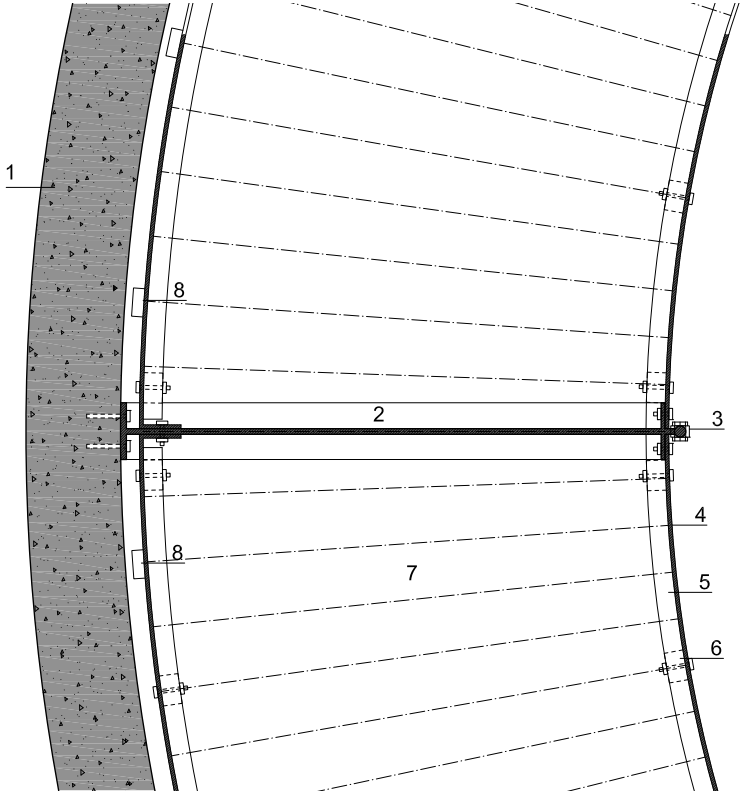
SILO 1

DETAILS



Vertical section of ramp, Silo 1

1 Existing concrete structure
2 Tension rod of steel with connecting details
3 Stringer of 10mm curved steel profile, untreated steel
4 Stringer and railing of 10mm curved steel profile, untreated steel
5 Wood profile along stringer
6 Steel profiles supporting wood profile
7 Installations
8 Floor of 75mm beech wood
9 Handrail of beach tree Ø55
10 LED- light
11 Sound absorber, Träullit grey



Horizontal section of ramp, Silo 1
(Silo 3 + floors)

1 Existing concrete structure
2 Beam, Steel section T, 150mm
3 Tension rod of steel with connecting details
4 Stringer of 10mm curved steel profile, untreated steel
5 Wood profile along stringer
6 Steel profiles supporting and connecting wood profile
7 Floor of 75mm beech wood
8 LED- light

0 10 20 30 40 50 100cm

SILO 2

INTERIOR

Figure 46. Exhibition space with central vertical sight-line from base-floor to roof-level.

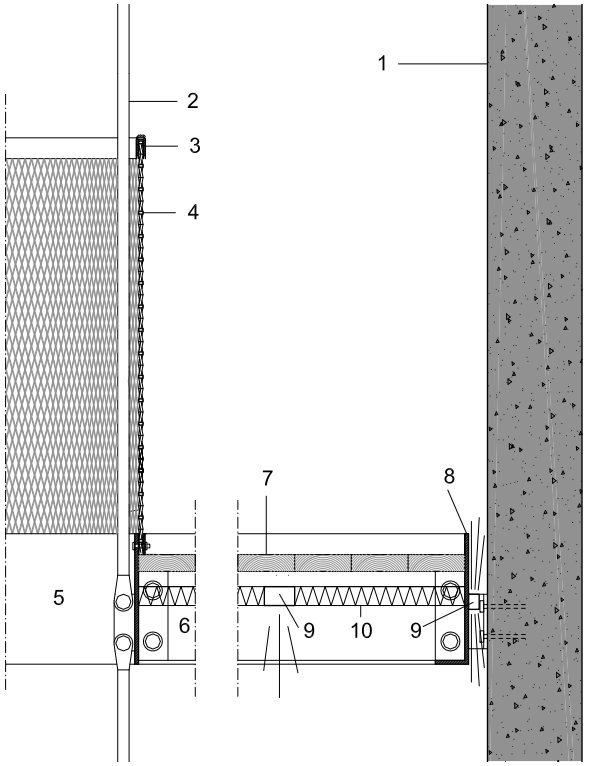
Figure 47. A swirling and winding staircase through the funnel at the base of the cylinders.

SILO 2

DETAIL

Detail of floor, Silo 2

1 Existing concrete structure, raw surface
2 Tension rod of steel with connecting details
3 Handrail of steel
4 Expanded metal, raised, untreated metal, standing mesh 28x62mm, open area 57%, untreated steel
5 Circular steel profile Ø 1500, untreated steel
6 Floor of 75mm beech wood
7 Beams of beech wood
8 Steel profile, 50mm distance from wall
9 LED- light
10 Sound absorber, Träullit white colour



0 10 20 30 40 50 100cm

SILO 3

INTERIOR

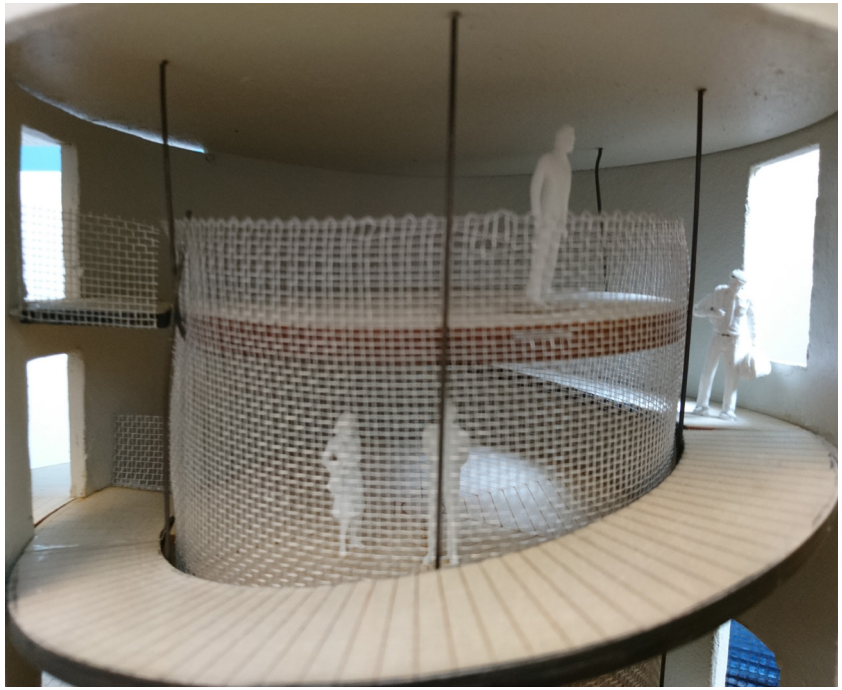


Figure 48. A hanging mesh exhibition-space with the ramp descending around.

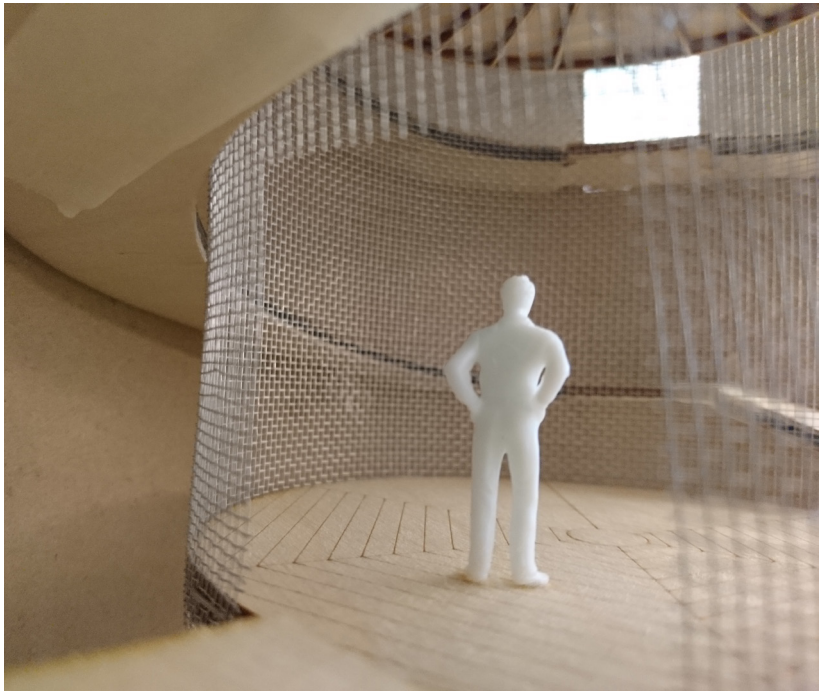


Figure 49. The double-heigth exhibition-space inside the mesh tube.

SILO 3

DETAIL

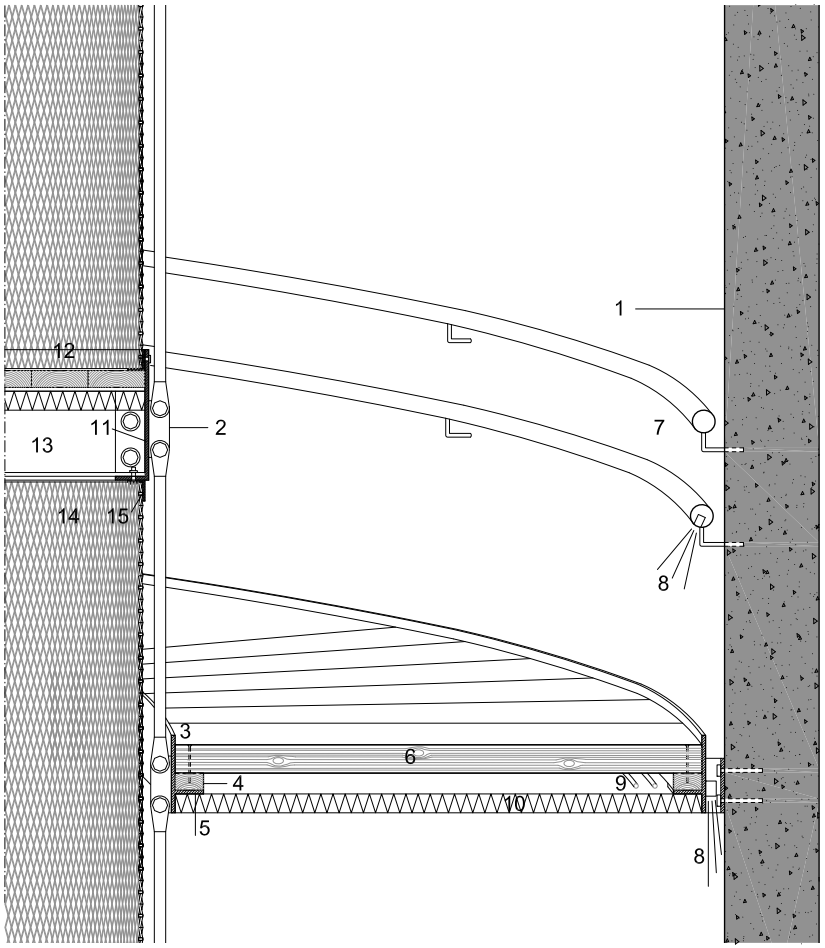
Vertical section of ramp and internal exhibition floor, Sllo 3

Ramp

1 Existing concrete structure
2 Tension rod of steel with connecting details
3 Stringer and railing of 10mm curved steel profile, untreated steel
4 Wood profile along stringer
5 Steel profiles supporting wood profile
6 Floor of 75mm beech wood
7 Handrail of beach tree Ø55
8 LED- light
9 Installations
10 Sound absorber, Träullit natural colour

Exhibition floor

11 Steel profile curved around floor
12 Floor of 45mm beech wood
13 Beams of wood / steel
14 Expanded metal, raised, untreated metal, standing mesh 28x62mm, open area 57%. Mesh panels joined by bolts and flat steel on exterior and interior sides.
15 Steel profile welded to mesh, bolted to construction



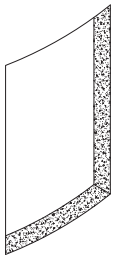
0 10 20 30 40 50 100cm

Figure 50. View from the quarry towards the silos and the ruin park in front.

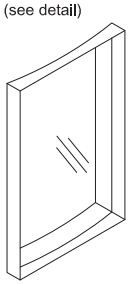
EXTERIOR ADDITIONS

AXONOMETRIC VIEW

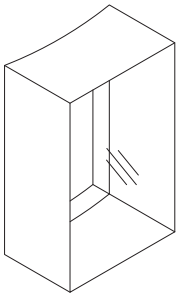
Cut opening in existing concrete structure to let light in and views out



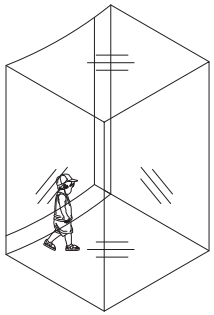
WIndow frame, vlews of the quarry and protection for personal safety and weather
(see detail)



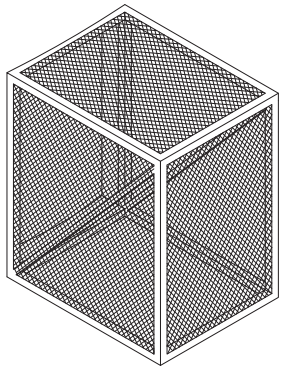
Framed view box, highlights the view of a certain area in the quarry



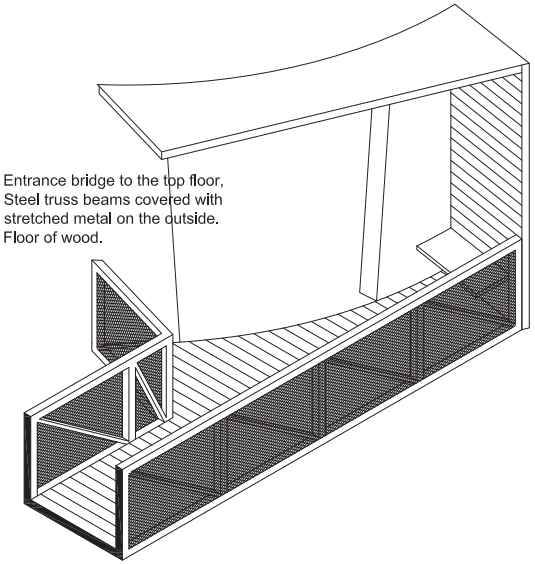
Vlew box, experlence of space - unlimited views in all directions
(see detall)



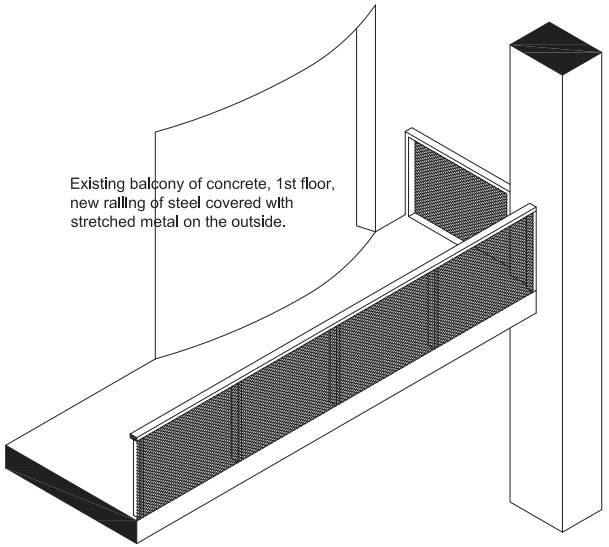
Mesh box, experlence of space, alr and views through expanded metal in all directions



Entrance bridge to the top floor,
Steel truss beams covered with stretched metal on the outside.
Floor of wood.

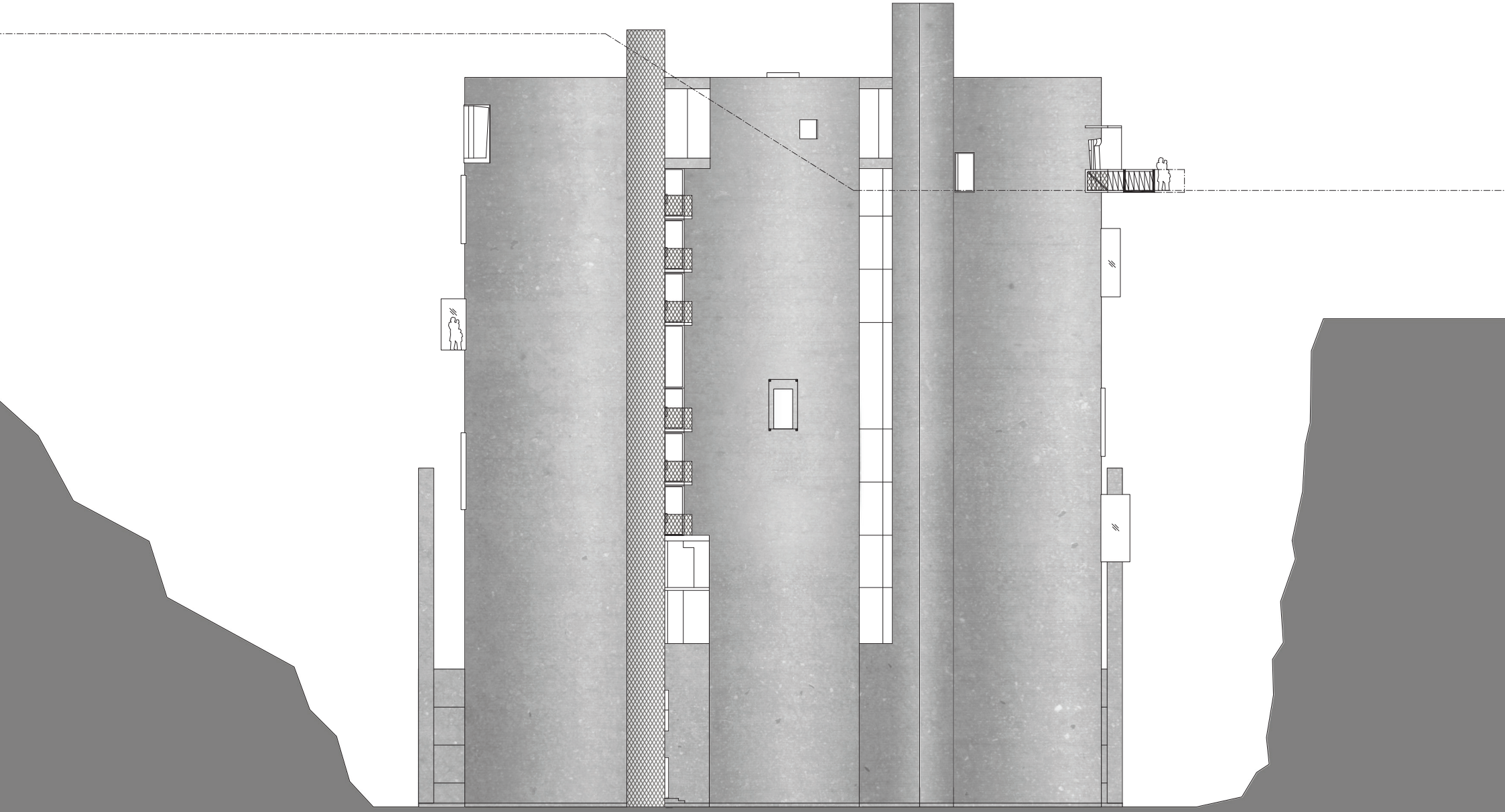


Existing balcony of concrete, 1st floor, new ralling of steel covered wlth stretched metal on the outside.



0 1 2 3 4 5m

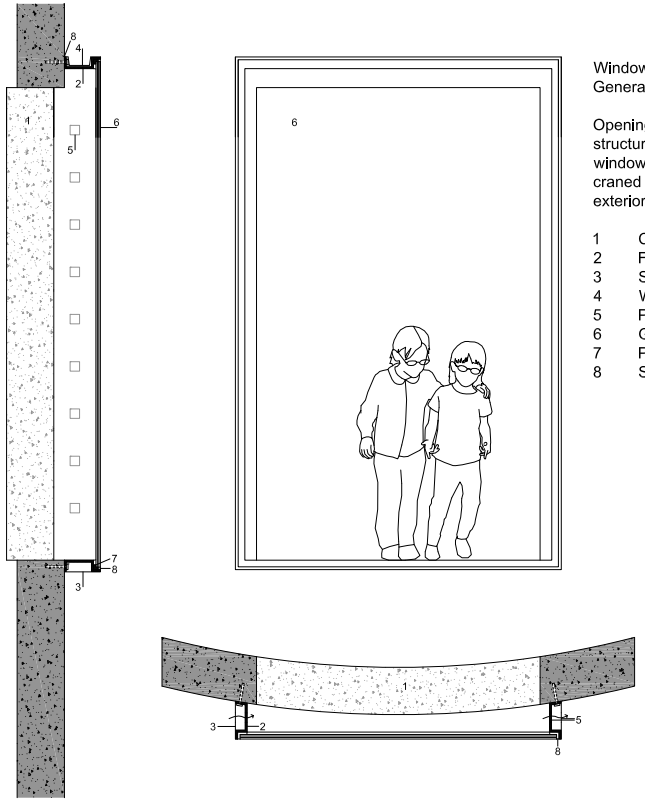
NORTH FACADE



0 1 2 3 4 5 10m

EXTERIOR ADDITIONS

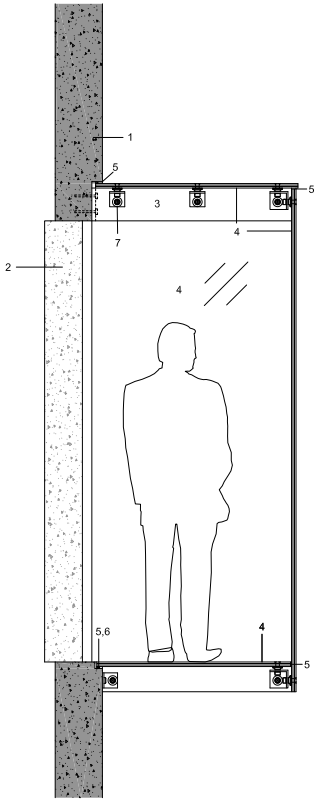
DETAILS



Window frame
General Detail

Openings are cut in the concrete structure. The openings are covered by window frames that arrives in one piece, craned in position and bolted to the exterior side of the wall.

1 Cut opening, raw concrete surface
2 Frame of steel
3 Sheet of 2mm aluminum, black,
4 Water drainage
5 Perforation for natural ventilation
6 Glass, laminated and hardened
7 Plastic distance
8 Silicone sealant, black

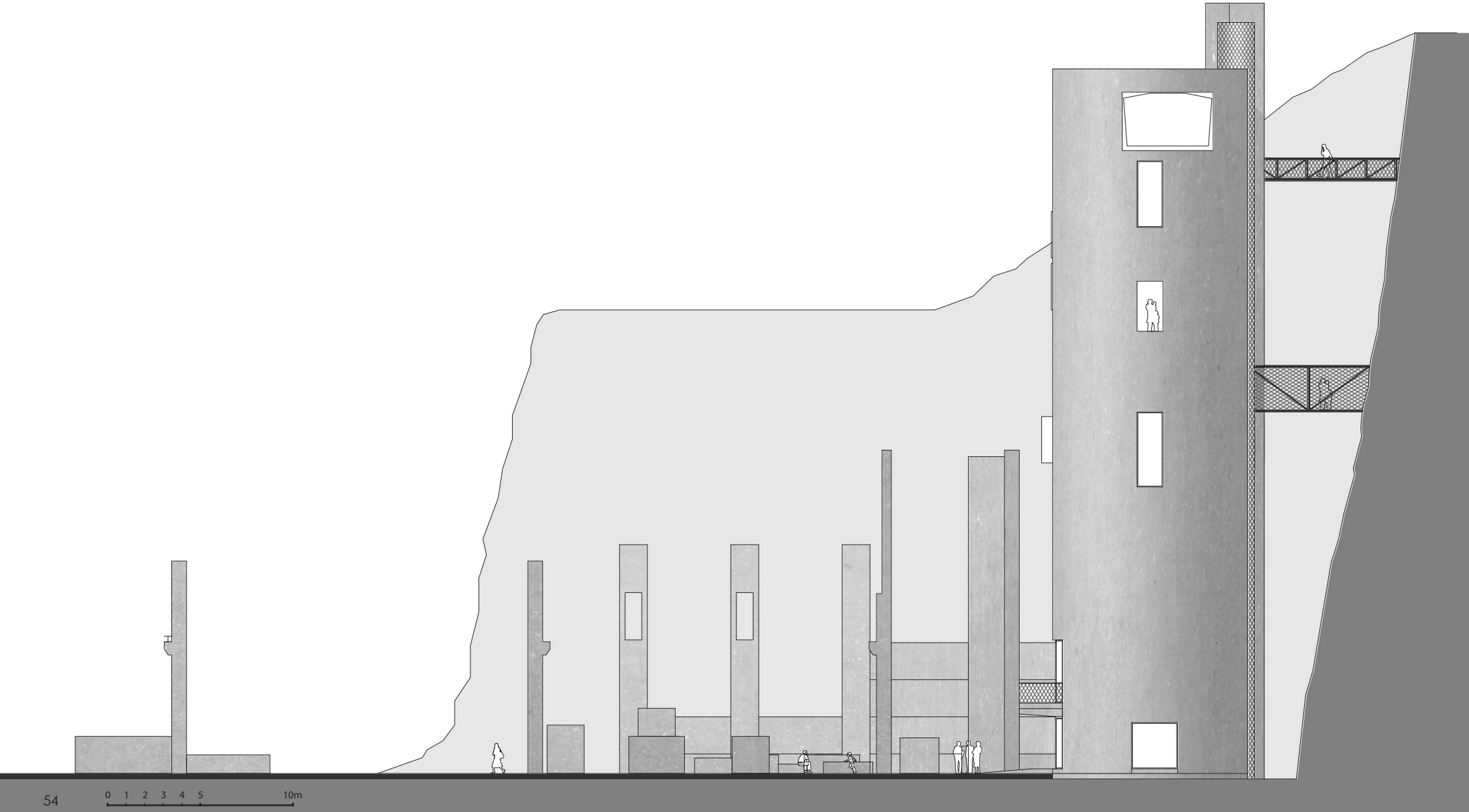


View box
General detail

1 Existing concrete structure
2 Cut opening, raw surface
3 Steel profile, on exterior side
4 Safety glass, laminated and hardened
5 Silicone sealants
6 Plastic distance
5 Brackets

0 20 40 60 80 100 200cm

EAST FACADE



DETAIL TOP FLOOR

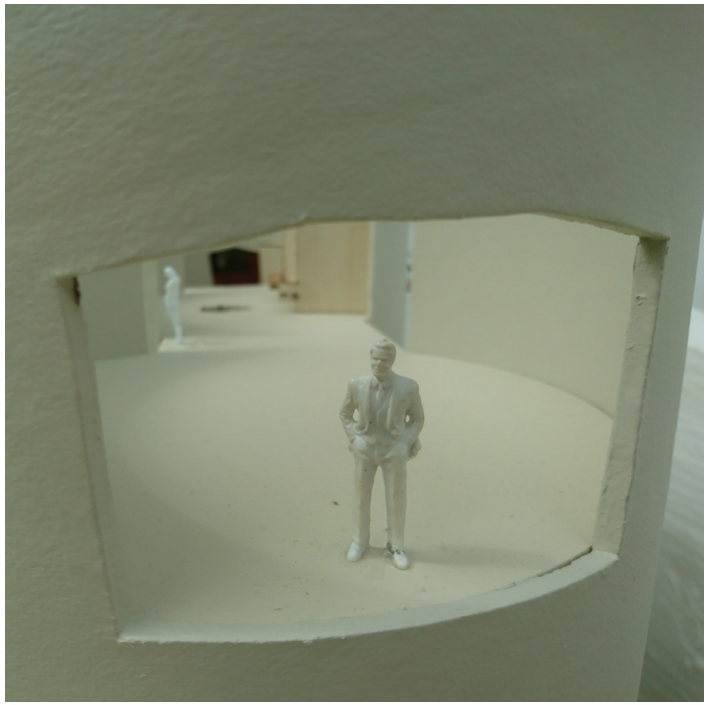
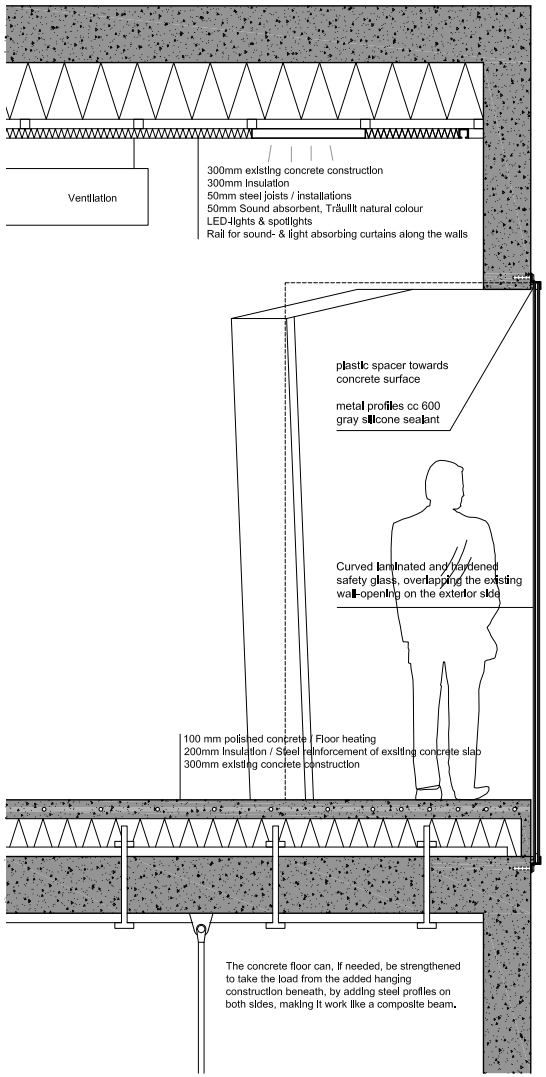


Figure 51. Top floor, existing opening towards east.



0 20 40 60 80 100 200cm

REFLECTION

Looking back at my master thesis I find that it has been an enjoyable and interesting period of hard work, the inspiration and progress of the work has of course fluctuated but in general I have managed to keep the mood up and the project running. Since I have family and two small children it has been natural to limit the work to a maximum of normal office hours. I think the fact that the time and attention dedicated to the project has been limited has kept me focused but also helped me avoiding being totally absorbed by the project.

The thesis topic, about how to communicate the quarry by adapting the existing silos into a visitor centre, has been fun to explore. After evaluating the work I would say that the topic suited me well, I have had the chance to explore the relationship between architecture, industrial remnants and nature which I all find very interesting.

Working with an existing structure has been interesting but also challenging. The static structure of the silos has been helpful giving the project clear constrains but at the same time it has been a tough challenge to change their content from limestone to people. I have spent weeks and months trying to find the perfect movement from top to bottom and to find a working sectional layout for the exhibition and the other functions.

Looking from another angle, the three silos are connected at the top floor and at the bottom floors, the linked round shapes create quite interesting floor plans but almost everything you put in these floors will unbalance the space, the process of finding a satisfying floor plan solution spanned the full project time.

The work of finding materials and designing details that can co-exist with the old concrete structure and atmosphere has been done in parallel and has evolved during the process. I think that the balance between the cold industrial details and warm materials for humans has come relatively naturally into the work of the design.

The strategy of my work has been to sketch and evaluate the results in different ways. The method has worked well, sketches by hand have been more detailed and evaluated in CAD or Sketch Up and the space has been tested in physical models and vice versa. The round shapes and the ramps have been challenging and time consuming in especially in physical model.

To sum up, this has been a fun and challenging project that I have managed to keep together by disciplined work and a good mood with great support by my family, colleges at Chalmers and constructive tutoring from Björn Gross. A special thank to Jessica Grundén at Gatukontoret, Malmö for sharing ideas and information.

CONCLUSION

The inhabitants in Malmö would benefit of having more accessible green space and the quarry is one of few alternatives of creating new recreational areas close to the city. In my thesis work I have had the opportunity to experience the unique atmosphere in the quarry and I can imagine that it will attract many interested visitors. My own experience of my visits at the site is that it gets more and more interesting to spend time there the more I learn about it and its different layers of history. With these insights my conclusion is that a visitor centre would add value to the future visitors in the quarry.

In my thesis I propose that the abandoned silos at the site can be re-used and adapted into a visitor centre. The position of the silos, close to the limestone wall, stretching from the base of the quarry to a plateau accessible from above, is quite unique and is the key factor in making the space inside usable and able to experience in a natural way. The unique position makes it possible to enter the silos from above and use the interior space for descending to the quarry while learning about it. It is a simple idea that has been complicated to solve.

In the design proposal I found it natural to reuse the original industrial flow through the building, service floors at the top and at the bottom and the main function in the storage spaces in-between. To adapt it for people I have added a continuous path down which will tie the exhibition space and the building together. The detailed solutions of the additions are made simple, with for example steel and bolts, which I think emphasize the industrial atmosphere. The details are reused and adapted into several variants in order to create different spatial experiences within the same architectural language.

To conclude I think that, when creating a visitor centre at this site, using the silos would be the most interesting and authentic way to do it. The spaces and the movement pattern that the visitor will experience inside the silos will be an attraction in itself complementing the experience of the quarry. The silos and the quarry will in a natural way work together to create a cohesive holistic experience that I hope will encourage the visitors to come back and discover more.

APPENDIX

SUMMARY IN NUMBERS

FLOORS

Level	m^2	Status	Climate	Main function
11	252	Adapted	Controlled	Entrance, shop, auditorium
10	110	Added	Natural	Exhibition - biology
9	133	Added	Natural	Exhibition - biology
8	133	Added	Natural	Exhibition - industry
7	133	Added	Natural	Exhibition - industry
6	115	Added	Natural	Exhibition - geology
5	139	Added	Natural	Exhibition - geology
4	119	Added	Controlled	Auditorium
3	114	Adapted	Controlled	Staircase
2	242	Adapted	Controlled	Flexible function
1	248	Adapted	Controlled	Café and restroom

Total: 1738 m^2

FUNCTIONS

Function	q.	Level
Reception	x1	11
Auditorium	x2	11, 4
RWC	x2	11, 1
WC	x4	11, 3, 1
Staff	x2	11, 3
Exhibition	x3	10-4
Storage	x1	3
Café	x1	1
Recycle	x1	1
Technical	x1	1
Elevator	x1	11-1

RAMPS

Loops	1	7 (all)
Height	2,8m	19,6m
Length	28m	196m
Area	35 m^2	245 m^2
Downgrade	1:9 in-between landings, all floors are accessible by elevator.	

DESIGN PROCESS

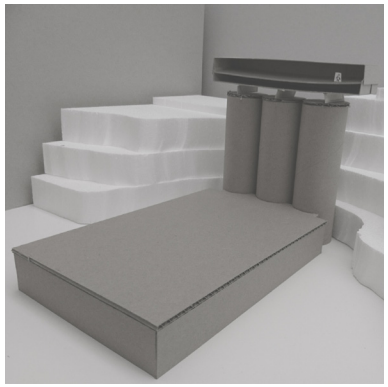


Figure 52. Model 1:200. New volume on top of the silos, staircase descending inside one silo.

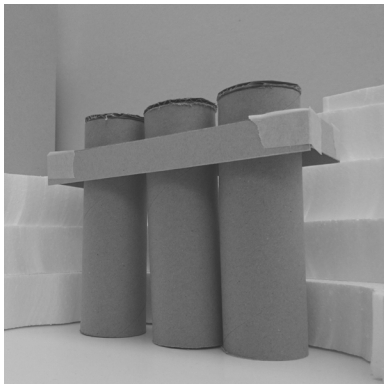


Figure 53. Model 1:200. New volume embracing the silos. The building in front has been discarded.

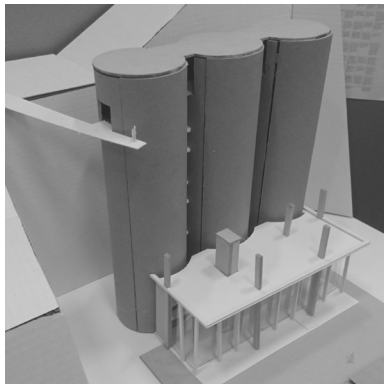


Figure 54. Model 1:100 Mid-critique; exhibition space inside the silos. The path ends in a new volume at the base floor.

Figure 55. Model 1:100. The movement and the spatial experience becomes concentrated to the interior of the silos in order to keep the design and the experience clear and simple.

Figure 56. Model 1:50. The movement developes and the different spaces has got their own character to enrich and vary the spatial experience of the silos.

Figure 57. Model 1:50. Final presentation. The movement and the spaces has been fine-tuned and designed in detail. A selection of drawings, models and visualizations are shown at the public exhibition.

VERTICAL MOVEMENT

Spiraling helix ramps and winding staircases

Figure 58. The Bramante Staircase, 1505, Rome.

Figure 59. The Round Tower, 1642, Copenhagen.

Figure 60. Pio-Clementine Museum double helix staircase, 1932, Rome.

Figure 61. Guggenheim Museum, 1959, New York (www.guggenheim.org).

LIGHTHOUSE, RUDBJERG, DENMARK
Retrofitting inside an existing static structure

A scenographic stairway gives access to the tower and makes the ascent a sequence of architectural experiences. The cliff is rapidly eroding and the lighthouse is estimated to be taken by the sea within 15 years. The projects is mainly made from rusted steel that has been bent, perforated, welded and finally assembled inside the tower and can easily be dissembled and reused before the lighthouse disappears.

Figure 62. Existing exterior.

Figure 63. Added interior.

The conditions are quite similar to the project in the quarry, an existing static structure thats challenging to adapt without destroying. Its also similar in how natural forces can overtake the structure, the silos can eventually be flooded if the pump are shut off. It has inspired me to design in a way that can be built inside the silos with the existing structure intact.

UNIVERSEUM, GOTHENBURG, SWEDEN
Hanged communication construction

Universeum has several similarities with the quarry silo project, it has an exhibition about nature where the visitors start at a higher level and then stroll down trough a variety of spaces and exhibitions with different but still connected themes.

Figure 64. Hanged bridges.

Figure 65. Tension rod detail.

The communication space in between the nature exhibitions and the experimental workshops has a hanging construction of bridges of steel and floors of wood hanging in tension rods from the roof trusses.

The project has been helpful when designing the hanging structures inside the silos, how the parts are joined and as an evaluator of the dimensions of my proposed structure.

CURIOSITY

Figure 66. The luxurous Waldorf-Astoria Hptel in New York is built of 20000 barrels of Limhamn cement from Cementa. The classical Art déco hotel was completed in 1931.

Figure 67. The Exchange-court in New York is partly built from cement from Limhamn.

Figure 68. Monoment Cristo Redentor in Rio de Janeiro alleges to be made of cement from Limhamn and is therefore called "Limhamns-Jesus". However, only the statue's base is built out of concrete from Limhamn.

(Malmö Stad, 2016).

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LIST OF FIGURES

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CONTACT

Henrik Hagejärd

+46701322687

henrik.hagejard@gmail.com