

SOUND GORGE

a cracked landscape for symphonies and rock concerts

SOUND GORGE

Ida Lindbäck, Sofia Löfgren & Yanan Liu

A MEMORABLE EXPERIENCE

A visit at Sound Gorge is both an acoustical and architectural experience. From their very first step, visitors are taken on a journey through a dreamlike landscape where acoustics and architecture work together to amplify each other. Clever use of materials and innovative solutions allows for great acoustic conditions for a wide range of performances.

Being partly underground the venue is well protected from outside noise disturbances. The parts above ground mimics the shape of the surrounding rolling hills, blending in well together with landscape. While the soft exterior is quite invisible, the interior is far more dramatic. Visitors will enjoy an unforgettable experience through a venue that both looks and sounds gorgeous.

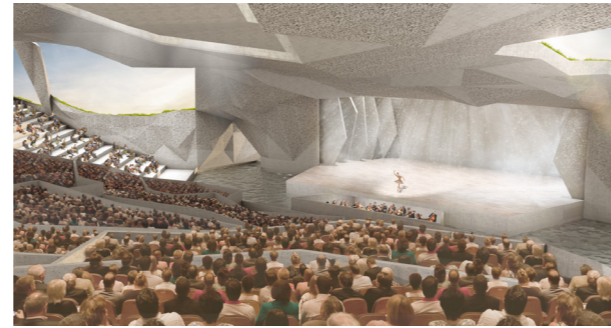
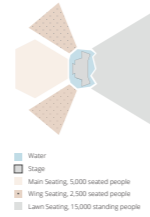
MAIN, WING AND LAWN

The seating in the pavilion is divided into three sections in order to enable maximum flexibility for different performances.

The **main seating** has room for over 5,000 seated people and is covered by a roof that enables a beautiful natural acoustic. By raising or lowering parts of the ceiling the total volume can be adjusted in order to change the reverberation and clarity.

The **wing seating** has in total room for additional 5,000 seated people. They are partly covered by arches and spanning between them is an electro-acoustic grid of loudspeakers. The speakers are tuned to mimic the acoustics of the main seating and provide both a sufficient loudness and a suitable reverberation and clarity.

The **lawn seating** has room for 15,000 standing people and is used mainly for larger pop and rock concerts. The audience can enjoy every beat of the music thanks to a large speaker wall and see every move of the performance from the wide projections beside the stage. The cracks divide the lawn into different audience sections and serve as a transportation route from the garages.



A CHISELED INTERIOR

The pavilion is chiseled out of the rolling landscape. The three types of acoustical tiles are combined on all visible surfaces to finely tune the acoustics.

GAINED REFLECTIONS
The two wings of side sets have a steeper slope than the main seating, resulting in rising walls on the edges of the main seating which allows for more lateral reflections that increases the sense of enclosure.

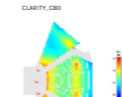
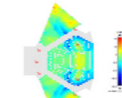
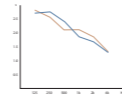
AN ADAPTABLE CEILING

The ceiling adapts to the genre and appurtenant desired clarity and reverberation time by lifting some tiles, opening up the air volume to the reverberation chamber above. Therefore, the pavilion has two different "settings" with two different combinations of clarity and reverberation time.

GROUND WATER
The water in the cracks streams slowly to the lowest point in the venue, the area around the stage. The water has the architectural effect of reflecting light and creating a barrier between the audience and the stage, as well as the acoustic effect of reflecting sound.

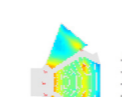
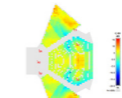
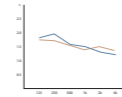
MUSIC MODE

In music mode the ceiling is raised in order to allow sound into the reverberation chamber. Orchestra, opera and ballet performers can enjoy a full and warm sound with a reverberation around 2.



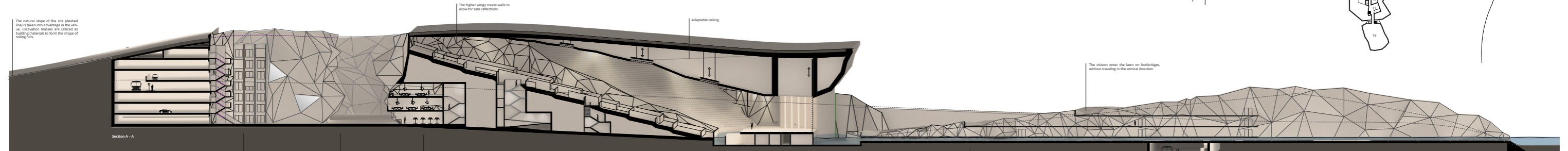
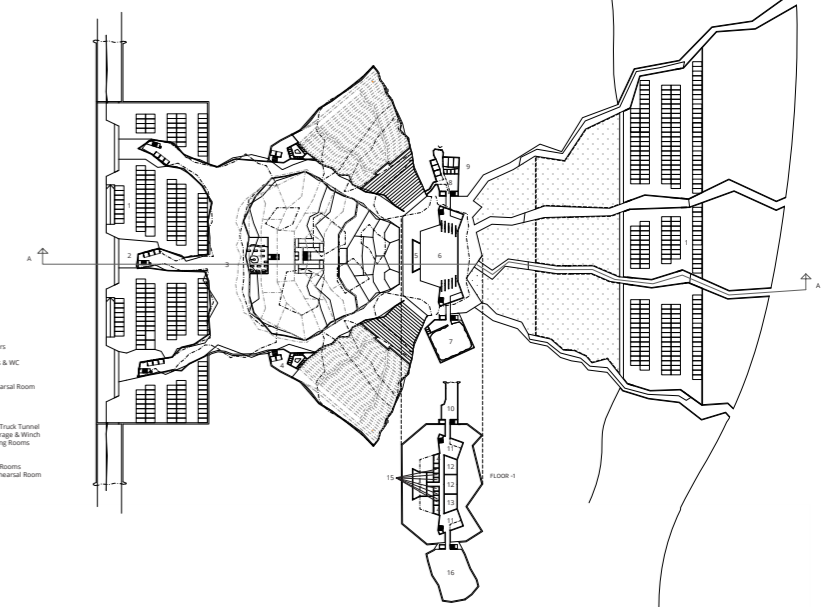
THEATRE MODE

In theatre mode the ceiling is at its lowest setting, creating a smaller volume with and a reverberation around 1.3. The audience can enjoy great speech intelligibility, even in the far wing corners, thanks to electro-acoustic voice amplification.



PLAN 1:100

- FLOOR 0**
- 1 Parking Garage
 - 2 Stairs & Elevators
 - 3 Foyer
 - 4 Stairs, Elevators & WC
 - 5 Orchestra Pit
 - 6 Stage Area
 - 7 Orchestra Rehearsal Room
 - 8 Green Room
 - 9 Offices & WC
- FLOOR 1**
- 10 Underground Truck Tunnel
 - 11 Side Stage Storage & Restroom
 - 12 Change Dressing Rooms
 - 13 MEP Room
 - 14 WC
 - 15 Side Dressing Rooms
 - 16 Movement Rehearsal Room



The natural slope of the site (dashed line) is taken into advantage in the site use. Excavation masses are utilized as building materials to form the shape of rolling hills.

The higher wings create walls to allow for side reflections.

Adaptable ceiling.

Shallow elevators and lightweight steel staircase bring visitors down to the cracks.

Foyer with wardrobe, cafe and restaurant.

Orchestra dock, surmount into the water basin. The solar part can be elevated to the same level as the stage.

The bottom of the crack is covered by water.

The visitors enter the lawn on footbridges, without travelling in the vertical direction.

An underground tunnel connects the three divided lawn areas.

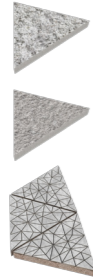
The water is connected to the river on the north side of the site.

ACOUSTICAL TILES

The triangulated inner walls of Sound Gorge are put together by three different acoustical concrete tiles, to create varying acoustical environments filling the purpose of the room.

THE REFLECTIVE TILE

The reflective tiles consist of concrete mixed with larger chunks of rock. After casting the surface is broken with a pneumatic hammer which reveals the stone and creates a very irregular and diffusive surface. The tile is used mostly inside the pavilion where it smoothens out the sound of orchestral early reflection and enabling an excellent fullness of sound.



THE ABSORBENT TILE

The absorbent tiles consist of concrete mixed with expanded perlite, a highly porous volcanic glass that is produced locally in the US. The rough surface offers acoustical properties far superior to ordinary concrete with an absorption coefficient between 0.7-0.8 for mid-high frequencies. The tile is used mostly in the cracks, foyer and other surrounding spaces to achieve a pleasant room loudness and improve speech intelligibility.

THE RESONATING TILE

The resonating tiles work as Helmholtz resonators that consists of four layers: a stucco covered board, a sound transparent cloth, sound insulation wool and a sealed air cavity. The cracks perforating the surface are tuned to absorb mid frequencies while the gap between the tiles absorb lower frequencies. The tiles are used in rooms with high acoustical demands, such as the pavilion and the rehearsal rooms.

THE SOUND WALK

The experience of the Sound Gorge venue begins even before you have left your vehicle. Cars and buses enters through tunnels in the landscape which leads to the underground garages. From here, visitors travel downwards to the bottom of one of the four majestic cracks and into a completely new spatial experience – architecturally as well as acoustically. Guided by water, light and sound visitors are then led deeper in to a large cave like space – a foyer welcoming the audience. Moving on, the walls come closer together to once again form cracks that take the visitors to the final stop at their seat in the marvelous pavilion.



THE LEADING ROLE OF WATER

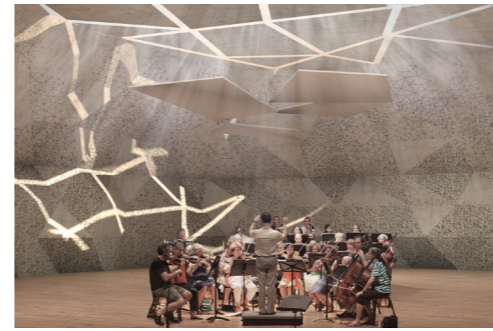
Water plays an important part in the sound walk, both visually and acoustically. The sound of water hitting different surfaces creates an aquatic symphony that both sets the atmosphere and gives a hint of what is to come further in.

BEHIND THE SCENES

THE STAGE AREA

The performers enter the venue by an opening in the ground, on the western side of the stage. Inside, the hall is lit by a crack in the ceiling and surrounded it lies staff office spaces. The hallway opens up into the green room, which is also connected to the audience by a crack hallway.

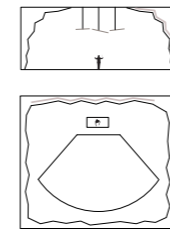
The dressing rooms are located under the stage, to make it easy for performers to access the stage from both directions.



THE REHEARSAL ROOM

The rehearsal room is tuned to create an excellent environment for orchestra practice. Through diffusive reflective tiles at the lower part of the walls and hanging reflectors the orchestra receives sufficient early reflections to hear every tone of their music.

The upper part of the walls are covered by absorbent tiles and Helmholtz resonators in order to control the loudness and lower the reverberation into an appropriate level around 1.3. The wall behind the conductor is completely covered by broad band absorption to avoid a mirrored virtual orchestra.



- Broad Band Absorbent Resonating Tiles
- Diffusive Reflective Tiles

LOUD LAWN

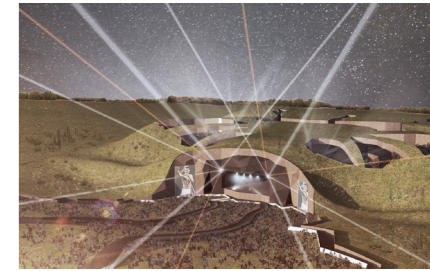
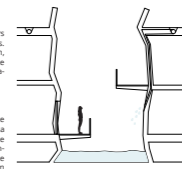
The sloped lawn has room for up to 15,000 audience members and is used when the venue hosts large pop and rock concerts. The performer can choose to only have the audience on the lawn, or to use the main and wing seating as well. The cracks divide the lawn into different audience sections and serve as a transportation route from the garages.

WATER

Drainage water from the lawn and the areas surrounding the cracks is led to the bottom of the cracks where they help create a cooler and fresher environment. In dry seasons the water from the nearby river is utilized instead. The huge thermal mass of the venue absorbs heat during the day and provide warmth during the colder evenings. The open air layout provides natural ventilation for all audience members.

ACOUSTICS

The audience can enjoy every beat of the music thanks to a large speaker wall around the stage and see every move of the performance at the wide projections beside the stage. Touring artists can choose between using their own equipment or utilize the existing electro-acoustics.



ACADEMIC PROJECT

Course Name Bachelor Thesis

Credits 15,0 hp

Form Group project together with Ida Lindbäck and acoustician student Yanan Liu

Place Gothenburg

Year Spring 2020

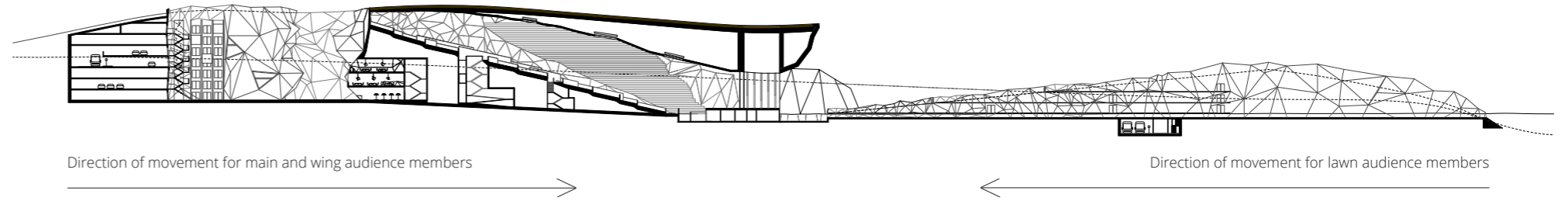
Examinator and teachers Morten Lund, Peter Christensson & Wolfgang Kropp

In short A visit at Sound Gorge is both an acoustical and architectural experience. From their very first step, visitors are taken on a journey through a dreamlike landscape where acoustics and architecture work together to amplify each other. Clever use of materials and innovative solutions allows for great acoustic conditions for a wide range of performances.

Being partly underground the venue is well protected from outside noise disturbances. The parts above ground mimics the shape of the surrounding rolling hills, blending in well together with landscape. While the soft exterior is quite invisible, the interior is far more dramatic. Visitors will enjoy an unforgettable experience through a venue that both looks and sounds gorgeous.

Reflection The strongest qualities of the project Sound Gorge is its coherence and the thought through experience for the visitors, as well as for the performers. The architecture is creating, in interaction with sounds created by water, an experience for all the senses, all the way from outside the site to the final destination, whether it is at one of the seats in the main pavilion, on the open lawn or on the stage. Acoustically, the tiles that are covering all the surfaces within the pavilion are unique in their appearance. Together, they are creating a diffusive surface with an absorbent coefficient depending of the percentage of each type of tile. The three types of flat tiles are easy to produce, yet mesmerizing to look at an acoustically flexible.

The project as it was presented at the final critique 07.05.2020



PART OF THE AUDIENCE

The seating in the pavilion is divided into three sections in order to enable maximum flexibility for different performances. The stage has two directions and consequently two main flows of audience. Disregarding of the seating area stated on your ticket, the experience starts as soon as you enter the site by bus or car.

THE SOUND WALK, GUIDED BY WATER

Cars and buses enters through tunnels in the landscape which leads to the underground garages – one connected to the main and wing seating areas, and one under the lawn seating area.

The visitors to the main and wing travel downwards to the bottom of one of the four majestic cracks and into a completely new spatial experience – architecturally as well as acoustically. The sound of water hitting different surfaces creates an aquatic symphony that both sets the atmosphere and gives a hint of what is to come further in. The visitors are led deeper in to a large cave like space – a foyer welcoming the audience. Moving on, the walls come closer together to once again form cracks that take the visitors to the final stop at their seat in the marvelous pavilion.

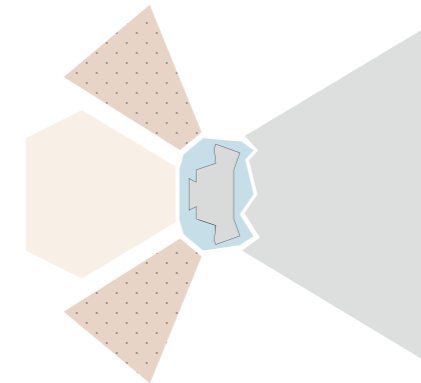
On the other side of the stage, visitors exit the garage onto walk ways in the open air above the water filled crack. Here, drained water is also used to create interesting sounds, preparing for the upcoming concert.

MAIN, WING AND LAWN

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The **wing seating** has in total room for additional 5,000 seated people. They are partly covered by arches and spanning between them is an electro acoustic grid of loudspeakers. The speakers are tuned to mimic the acoustics of the main seating and provide both a sufficient loudness and a suitable reverberation and clarity.

The **lawn seating** has room for 15,000 standing people and is used mainly for larger pop and rock concerts. The audience can enjoy every beat of the music thanks to a large speaker wall and see every move of the performance from the wide projections beside the stage. The cracks divide the lawn into different audience sections and serve as a transportation route from the garages.



- Water
- Stage
- Main Seating, 5,000 seated people
- Wing Seating, 2,500 seated people
- Lawn Seating, 15,000 standing people

PLAN

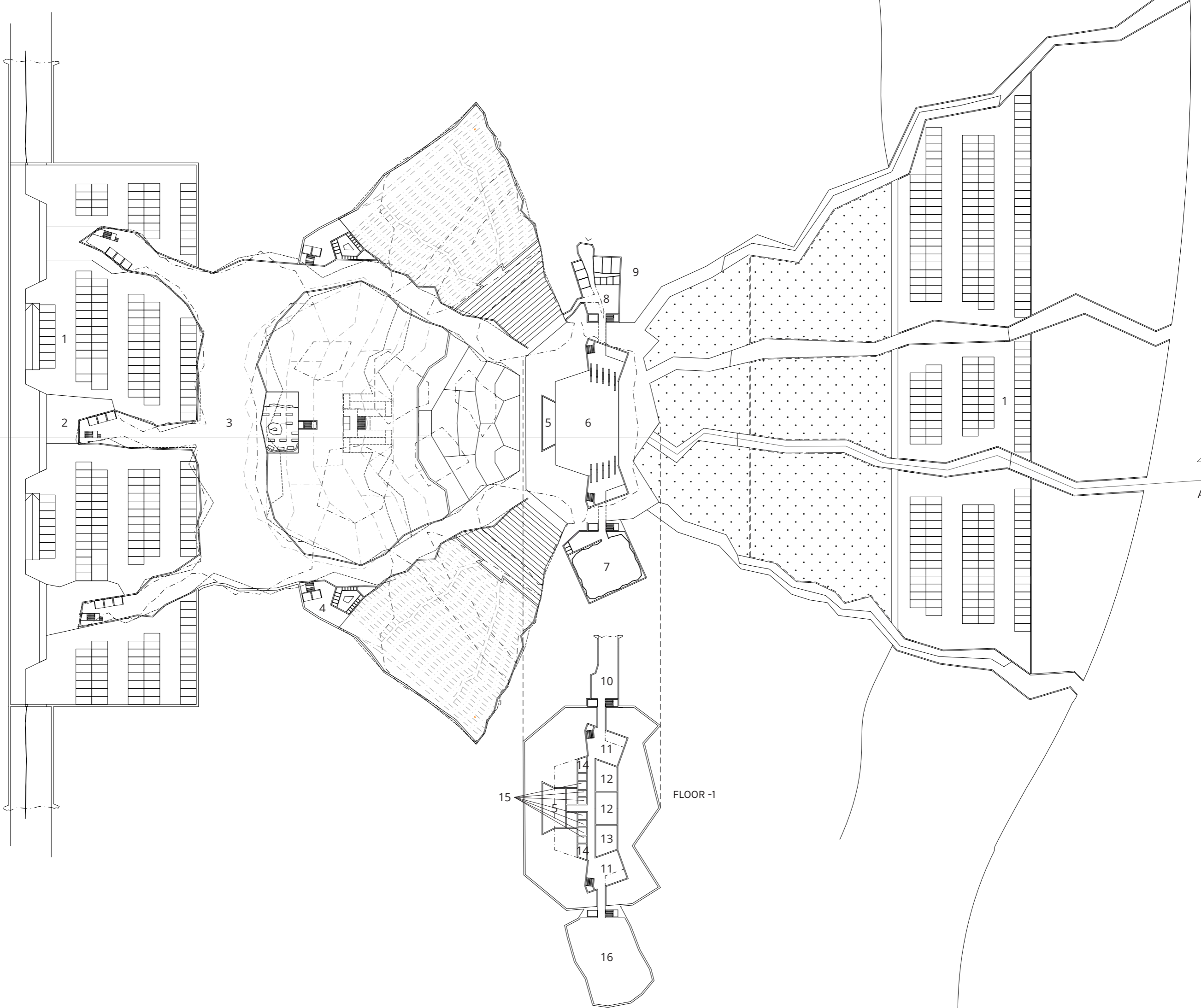
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FLOOR 0

- 1 Parking Garage
- 2 Stairs & Elevators
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- 7 Orchestra Rehearsal Room
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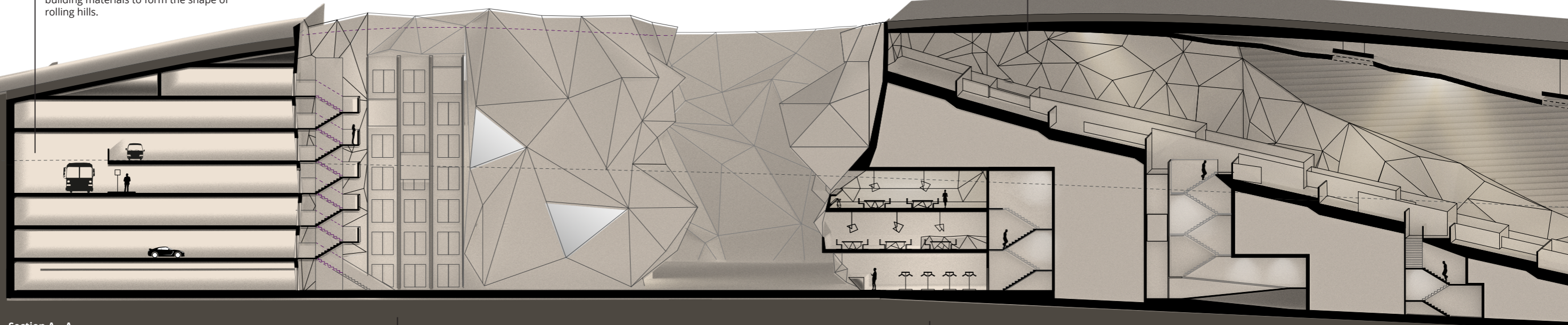
FLOOR -1

- 10 Underground Truck Tunnel
- 11 Side Stage Storage & Winch
- 12 Chorus Dressing Rooms
- 13 MER Room
- 14 WC
- 15 Solo Dressing Rooms
- 16 Movement Rehearsal Room



The natural slope of the site (dashed line) is taken into advantage in the venue. Excavation masses are utilized as building materials to form the shape of rolling hills.

The higher wings create walls to allow for side reflections.



Section A - A

Shaft-less elevators and lightweight steel staircase bring visitors down to the cracks.

Foyer with wardrobe, cafe and restaurant.

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THE REFLECTIVE TILE

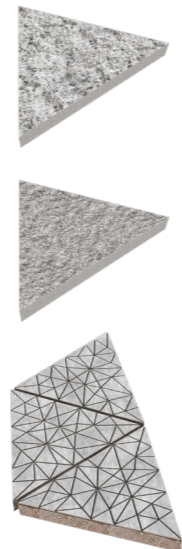
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The dressing rooms are located under the stage, to make it easy for performers to access the stage from both directions.

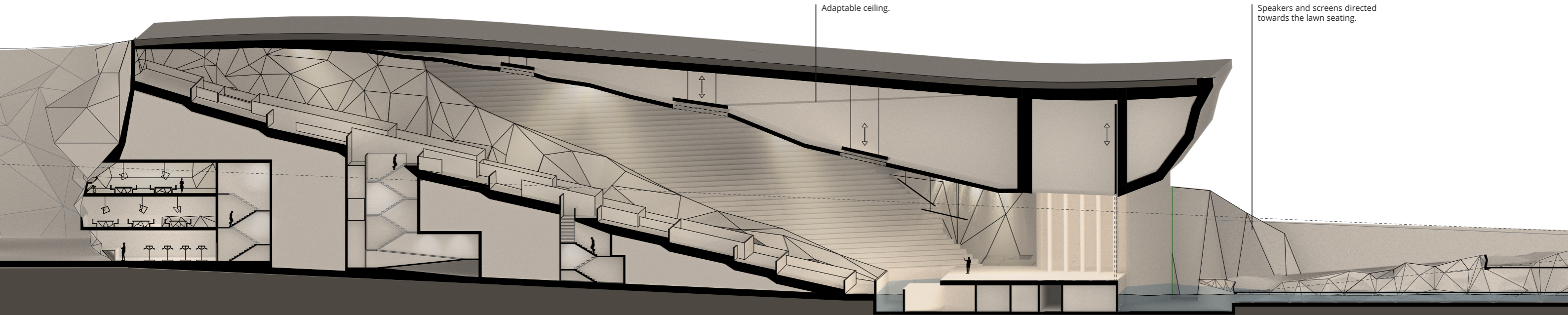
On the eastern side of the stage, the two large rehearsal rooms are located in two levels. The movement rehearsal room has the same measurements as the stage and the roof is covered with absorbent tiles to create a good acoustic climate.

THE REHEARSAL ROOM

The rehearsal room is tuned to create an excellent environment for orchestra practice. Through diffusive reflective tiles at the lower part of the walls and hanging reflectors the orchestra receives sufficient early reflections to hear every tone of their music.

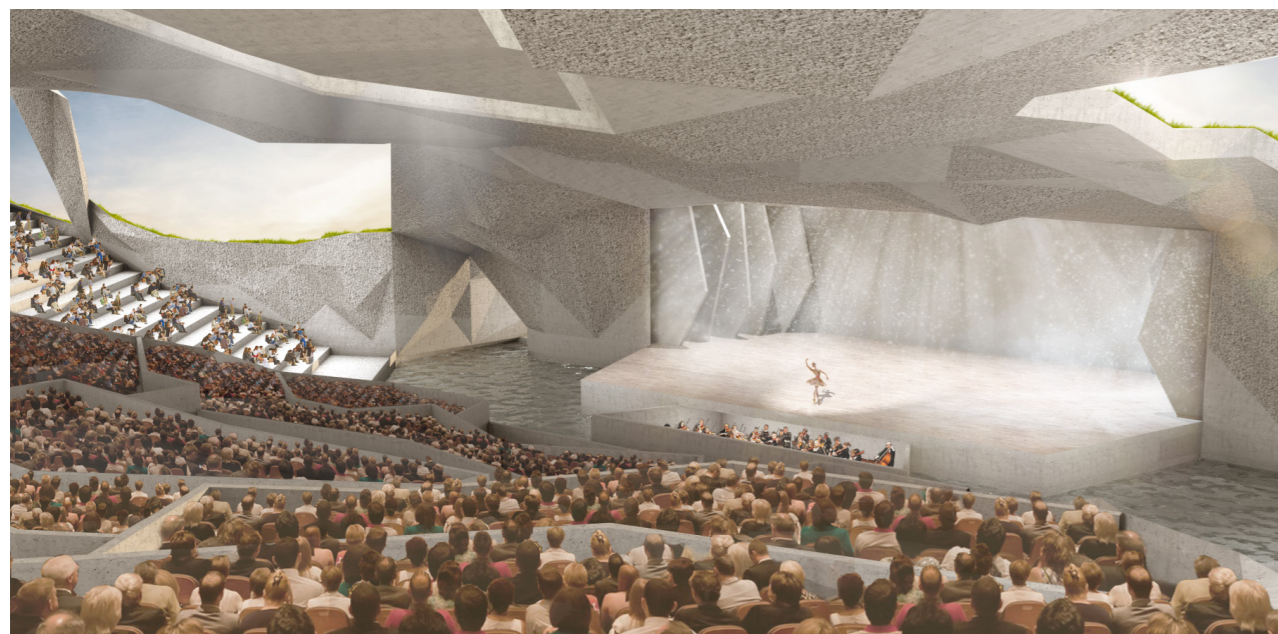
The upper part of the walls are covered by absorbent tiles and Helmholtz resonators in order to control the loudness and lower the reverberation into an appropriate level around 1.1. The wall behind the conductor is completely covered by broad band absorption to avoid a mirrored virtual orchestra.





Orchestra ditch, sunken into the water basin. The outer part can be elevated to the same level as the stage.

The bottom of the crack is covered by water.



A CHISELED INTERIOR

The pavilion is chiseled out of the rolling landscape. The three types of acoustical tiles are combined on all visible surfaces to finely tune the acoustics.

GAINED REFLECTIONS

The two wings of side sets have a steeper slope than the main seating, resulting in rising walls on the edges of the main seating which allows for more lateral reflections that increases the sense of enclosure.

AN ADAPTABLE CEILING

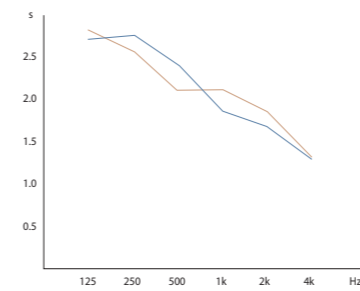
The ceiling adapts to the genre and appurtenant desired clarity and reverberation time by lifting some tiles, opening up the air volume to the reverberation chamber above. Therefore, the pavilion has two different "settings" with two different combinations of clarity and reverberation time.

GROUND WATER

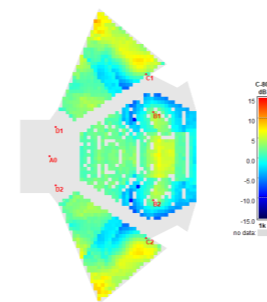
The water in the cracks streams slowly to the lowest point in the venue, the area around the stage. The water has the architectural effect of reflecting light and creating a barrier between the audience and the stage, as well as the acoustic effect of reflecting sound.

MUSIC MODE

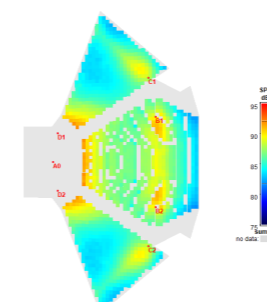
In music mode the ceiling is raised in order allow sound into the reverberation chamber. Orchestra, opera and ballet performers can enjoy a full and warm sound with a reverberation around 2.



REVERBERATION, T30
Main seat, Side seat



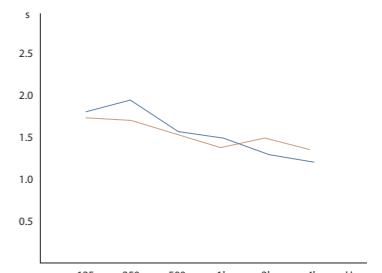
CLARITY, C80



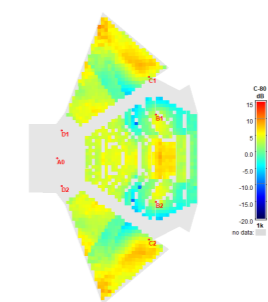
SOUND PRESSURE LEVEL, SPL

THEATRE MODE

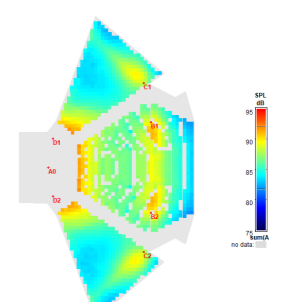
In theatre mode the ceiling is at its lowest setting, creating a smaller volume with and a reverberation around 1.3. The audience can enjoy great speech intelligibility, even in the far wing corners, thanks to electro acoustic voice amplification.



REVERBERATION, T30
Main seat, Side seat

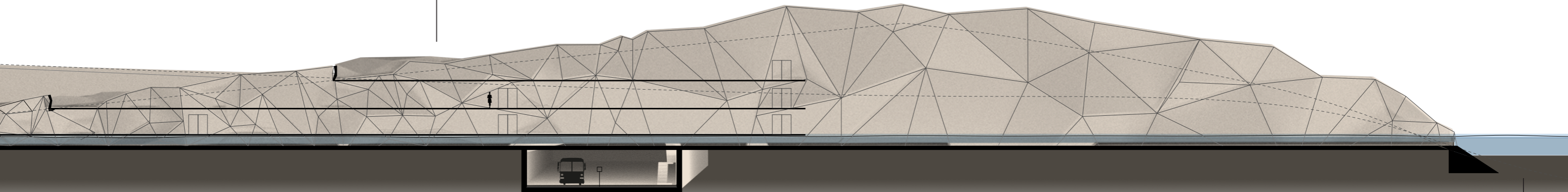


CLARITY, C80



SOUND PRESSURE LEVEL, SPL

The lawn seating area's capacity is 20,000 auditors, but the cracks divide the crowd is into sections.



An underground tunnel connects the three divided lawn areas.

The water is connected to the river on the north side of the site.

LOUD LAWN

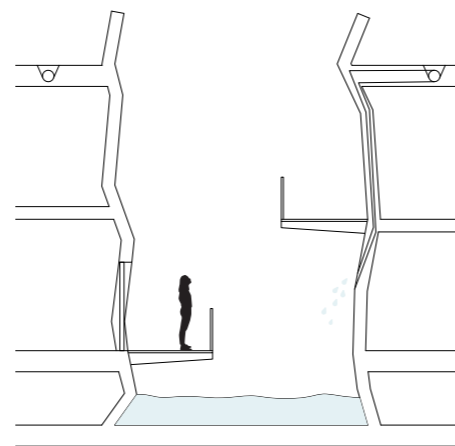
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WATER

Drainage water from the lawn and the areas surrounding the cracks is led to the bottom of the cracks where they help create a cooler and fresher environment. In dry seasons the water from the nearby river is utilized instead. The huge thermal mass of the venue absorbs heat during the day and provide warmth during the colder evenings. The open air layout provides natural ventilation for all audience members.

ACOUSTICS

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SECTION 1:100
LAWN CRACK

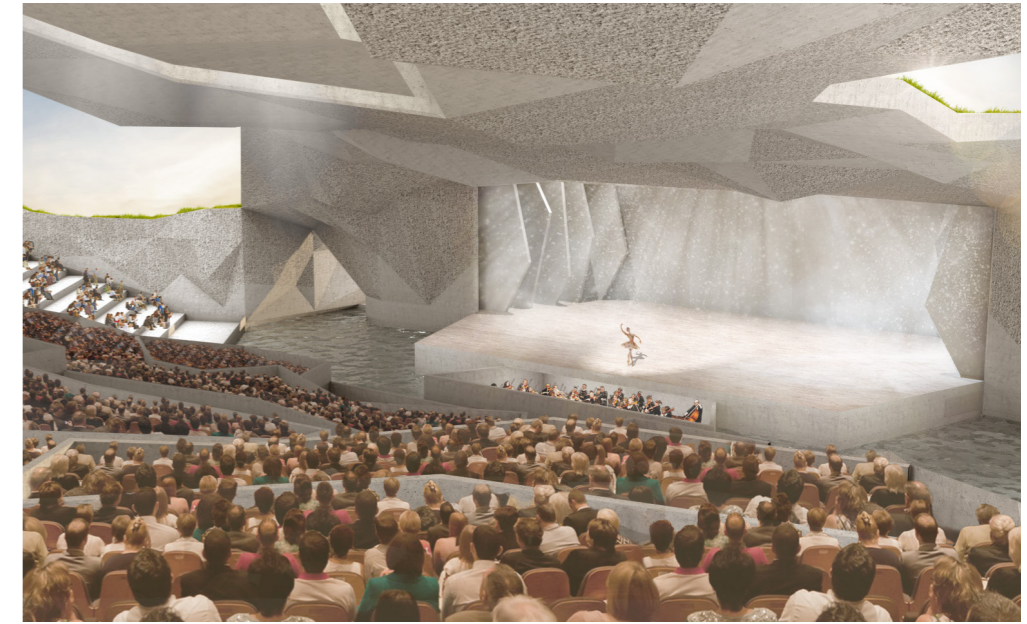


THE ORIGINS OF SOUND GORGE

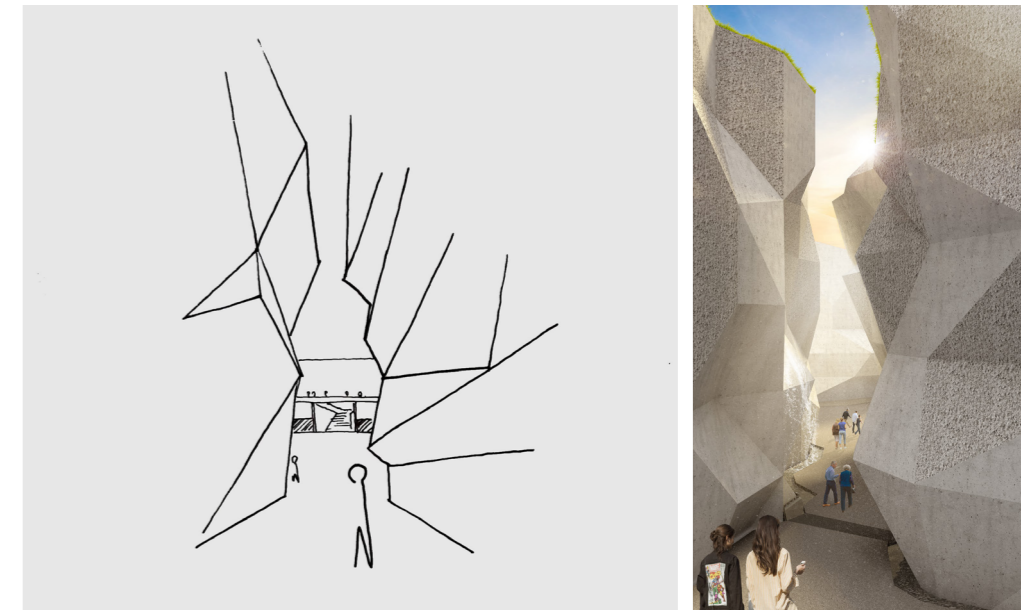
We started off the project by visiting sites around Gothenburg to get a physical experience of the scale and how to integrate the scope of the project on different, unexpected sites.



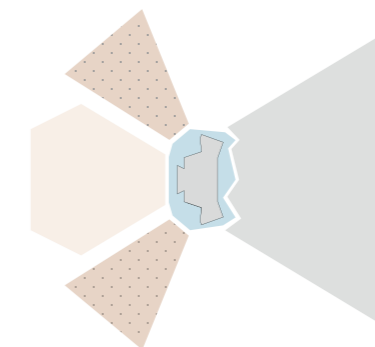
In the old port of Gothenburg, water as an active part of the venue as well as dividing the audience into floes was explored.



At the heart of Gothenburg, inspiration for the long and narrow cracks as well as the grid of speakers was found.



At one of the slopes of the city park Slottsskogen, the idea of having a stage with two directions was born.



- Water
- Stage
- Main Seating, 5,000 seated people
- Wing Seating, 2,500 seated people
- Lawn Seating, 15,000 standing people

AN INTERDISCIPLINARY COLLABORATION METHODOLOGY

This project was my first academic project with an interdisciplinary collaboration. My course mate Ida and I worked together with Yanan, a student at the Sound and Vibration Master at Chalmers. The collaboration was very fruitful and the specific competence allowed for everybody in the team to further refine the concept within their area of knowledge. As the project went on, we found better and better ways of communicating and in the end fulfilling both our architectural and acoustical goals.

To be able to work interdisciplinary and be surrounded by people with expert knowledge within different areas is something that I value highly and hope to be able to do throughout my career.

The overall methodology of the project is based on different iterations. Taking departure in an exploration of different spatial concepts, the later iterations focus on the architectural-acoustical properties of different parts of the building: for example the adaptable ceiling and the surface materials: the acoustical tiles. I think that the exploratory methodology when investigating different architectural concepts in sketch models worked really well. When the spatial concept and the visitor's experience was set, we continued to iterate all the parameters to favour the acoustical properties of the pavilion. During the later part of the project, the iterations was done by using a Rhino-model as well as Grasshopper scripts to control the exterior rolling roof.

ITERATIONS OF THE CRACKS

The final project proposal is the result of several iterations, focusing on different parts of the building and its core concepts. One of which regarded how the vertical transportation should be arranged. At first, we tried to integrate the vertical movement into the cracks - forming a diagonal sort of transportation along the walls of the cracks. However, the proposal was dropped since it would increase the production costs a lot and it wouldn't be able to transport the huge number of audience members that the venue required. Instead, we chose to let the horizontal transportation be done at the bottom of the cracks from the pavilion garage.

The question was then how to make the whole movement from the parking garage to the seats in the pavilion a coherent experience. After sketching and modelling different variations we decided on putting shaft-less elevators and a free standing lightweight steel staircase in the middle of the crack. This put the vertical transportation into the crack, but free standing from the shape of the walls. On the lawn side, there is no vertical transportation, instead the different levels of the parking garage is connected to the lawn area by horizontal walkways following the walls, hanging above the water.

