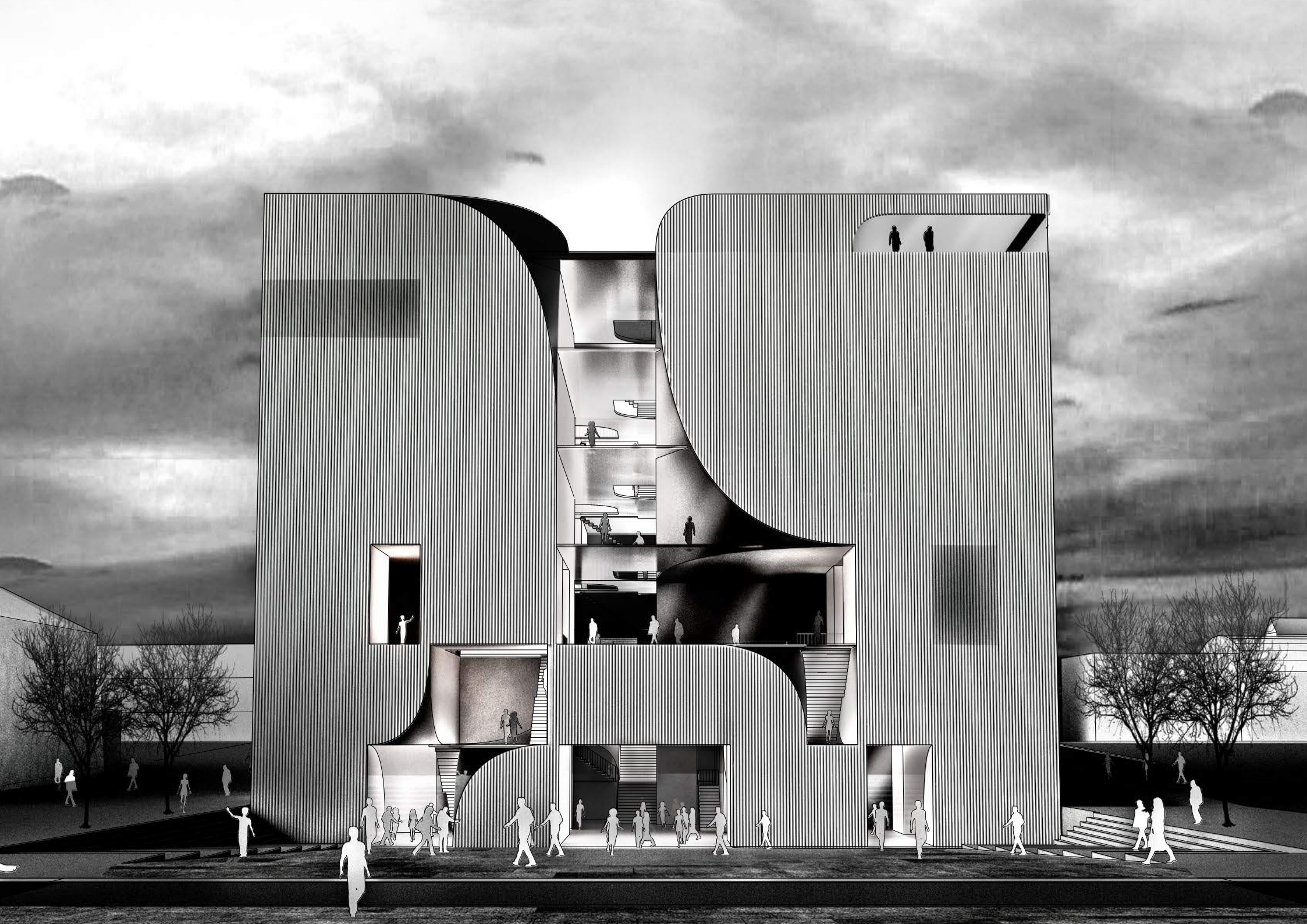
Pendentive Inverted

Performative Arts Center

A Master thesis project in Architecture
At Chalmers University of Technology

By Jens Olsson



Introduction

Skellefteå is a small city in the north of Sweden with around 35000 inhabitants. Despite the small size the city has a rich cultural life, especially in the scene of performative arts. In recent years many of the associations within the category of performative arts have grown out of their current facilities. So when the municipality is proposing to build a new house of culture, I'm proposing one which built around the performative arts scene.

What Skellefteå need is not only a house of culture for the citizens to consume culture. They need facilities where the local talent can find inspiration and develop their skills. Pendentive Inverted is a proposal for a house of culture that celebrates the creativity, the machinery, the handcraft and the practice in the making behind the performance. It is a public building that puts the relationship between the consumer and the producer into the main act.

Culture

Theatre

30 % of the inhabitants in Skellefteå go to the theatre each year, the highest rate of visitors per capita in the whole of in Sweden. The Västebotten theatre travels in the region to perform is based in Skellefteå. Still Skellefteå does not have a theatre that makes it possible to set up or host bigger performances.

Music

Skellefteå has got a considerable music scene with a great music export and a renown music festival called “Trästock”. One of Sweden’s third largest choirs is also based here.

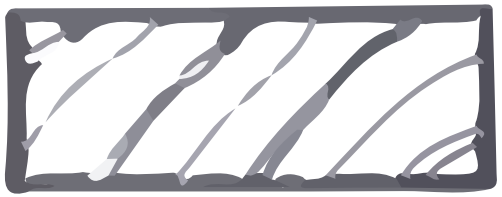
Dance

Skellefteå has also got a popular dance school and the Boliden ballet.

Timber

There is a long history of forestry, timber industries and wood related crafts in Skellefteå. The municipality has recently started a timber engineering research department in collaboration with the universities in Umeå and Luleå, and are keen to brand Skellefteå as the timber city of Sweden. As a material timber is changeable, shapeable with small means and with tools familiar to most people. It can be treated in many ways and people relate to the particular smell touch and texture of the natural material.

Just about 7 miles north of Skellefteå lies the factory for Martinssons CLT production. The proximity to the forest and the contextual heritage together with the low carbon emission for CLT production has lead to the choice of working with CLT as structural material for this house of culture.

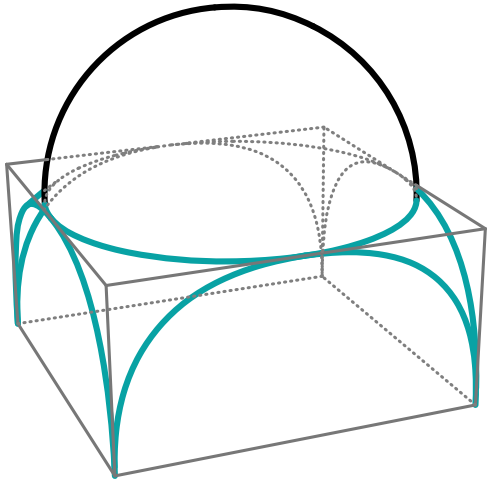


Pendentive

A pendentive is an important component in dome structures allowing the circular base of the dome to come down in a square shaped room. I is regarded as an important structural invention and is a renown characteristic of medieval building from the Byzantine empire.

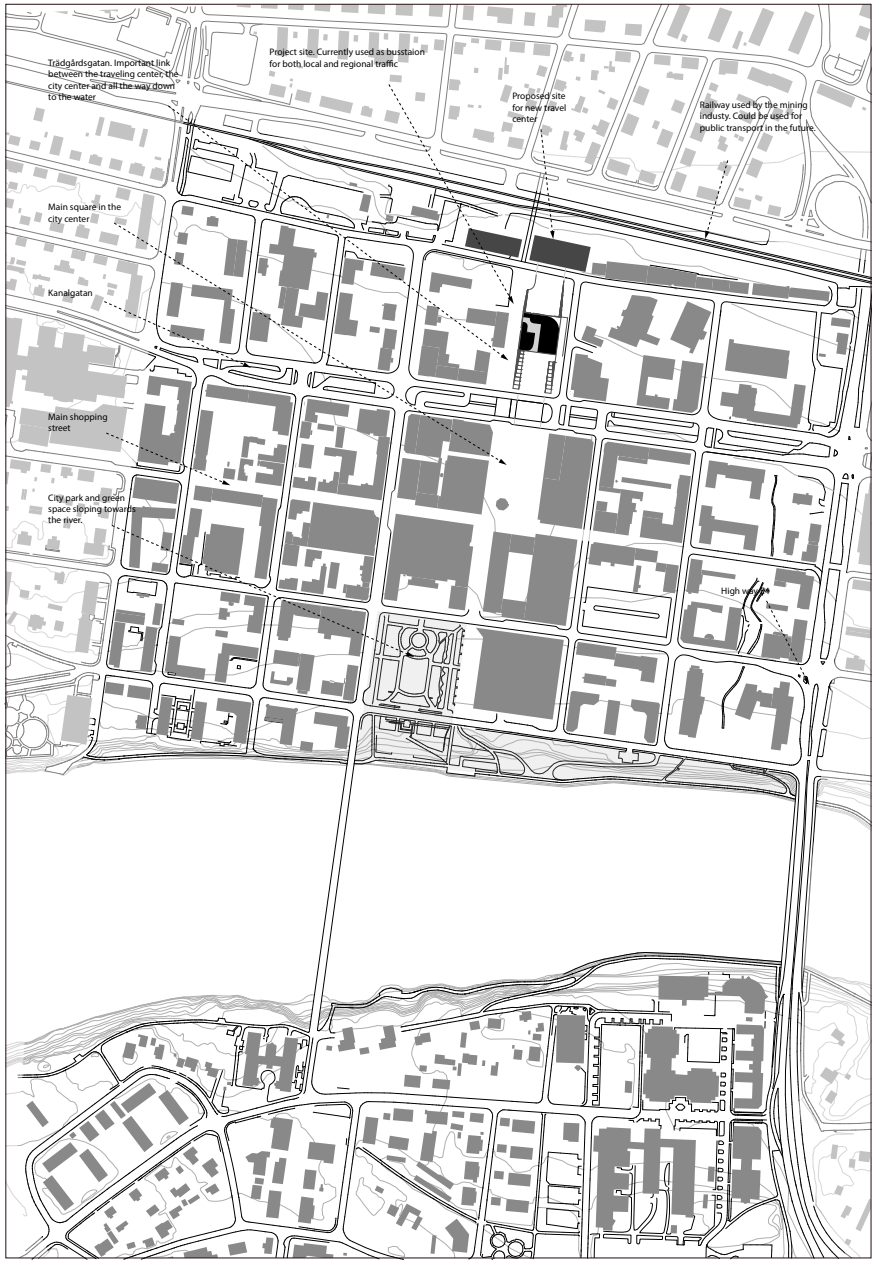
The geometry of a pendentive can be traced back to a part of a sphere or, more applicable for this thesis a convex cut from the corner of a cube defined by three arcs.

The inversed pendentive is derived from the principles of plate structure. It is a non structural component that effectively shapes space and provides a building with a unique character, only through the use of planar cuts in CLT plates.

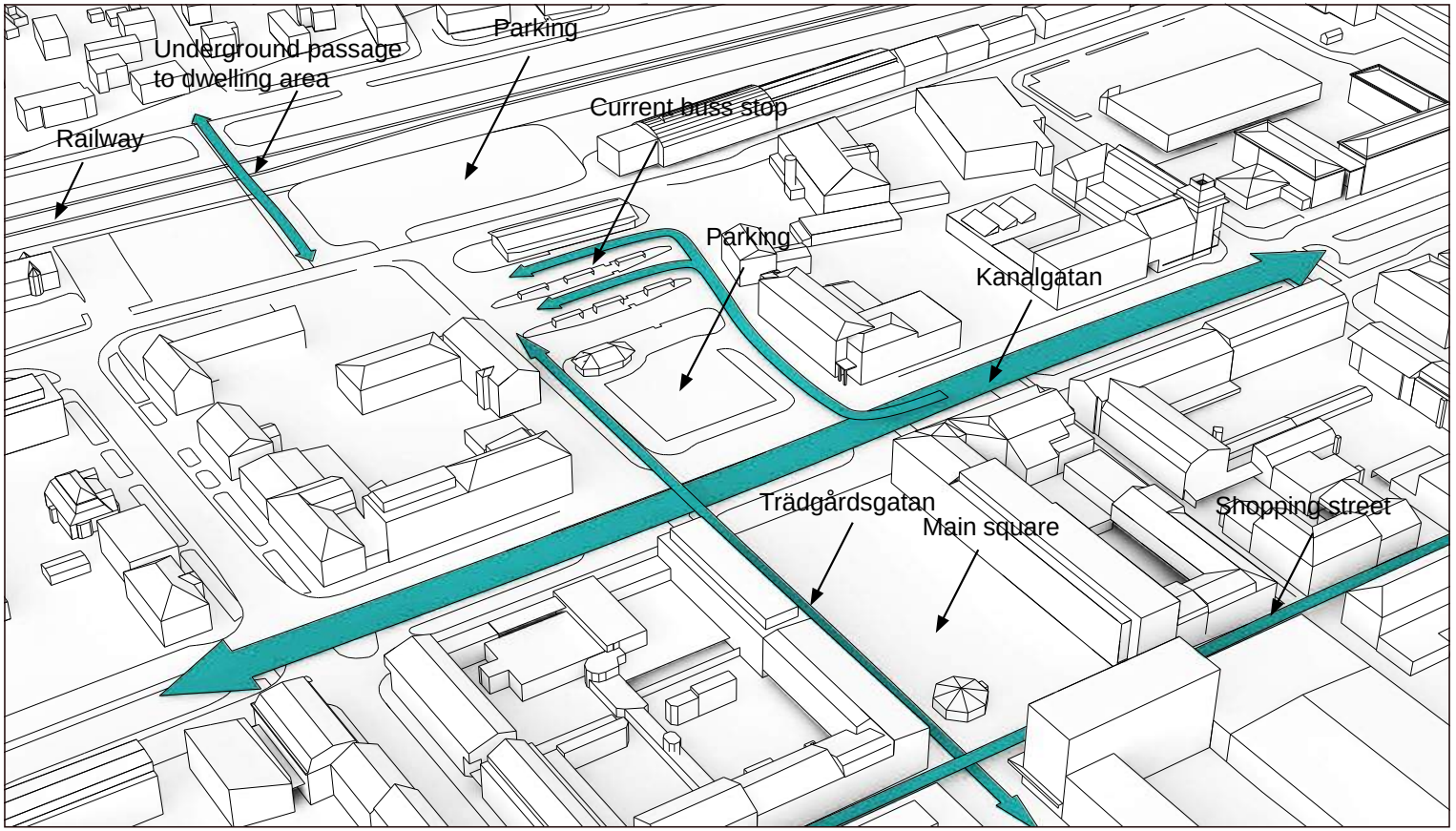


Situation

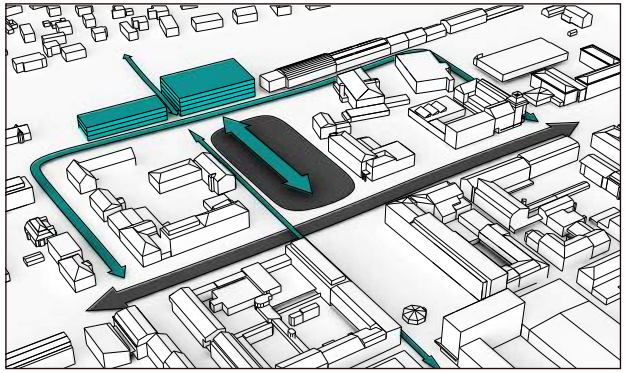
The center of skellefteå is framed by the highway in the east, the river in the south, the train tracks in the north and the street Södra Lassaretgatan in the west. Kanalgatan runs in the east west direction, connecting the center to the highway but also dividing the center into a more industrial part in the north and more commercial part in the south.



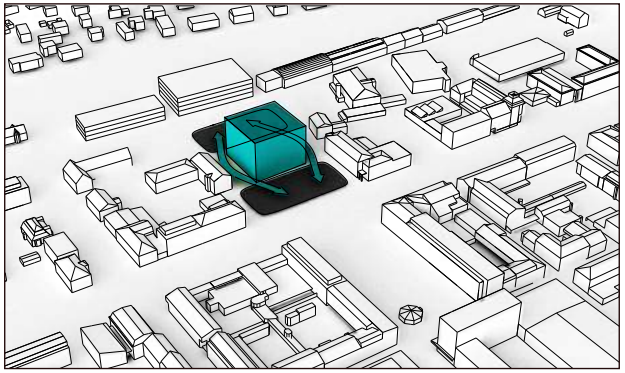
Site plan



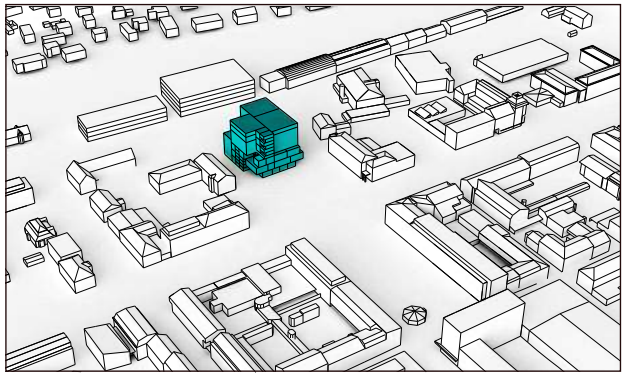
Currently the site is mainly functioning as an out doors bus stations and parking.



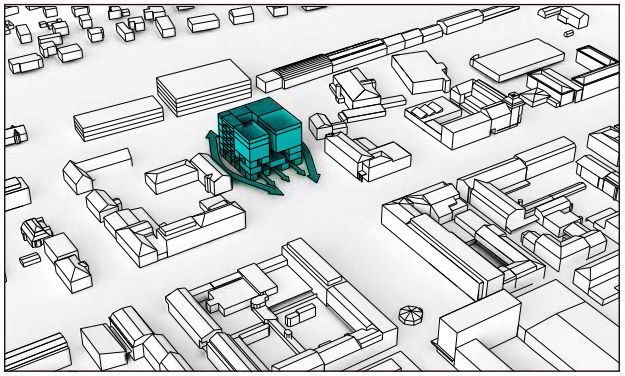
A new traveling center is planed to be built on the parking lot next to the train tracks. Important link between the traveling center and the main square.



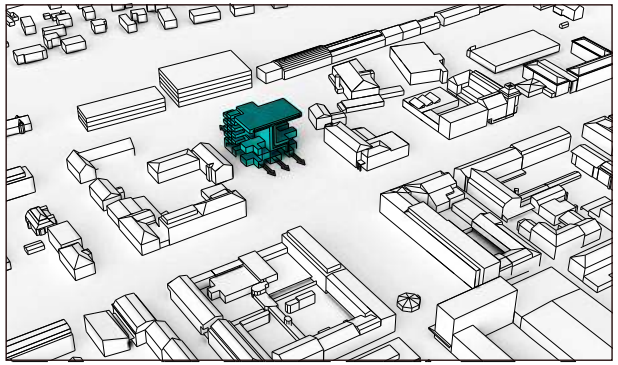
Buy placing a volume in the middle of the site, the vast space is divided into two squares, one in between the culture house and the traveling center, and one facing the city center.



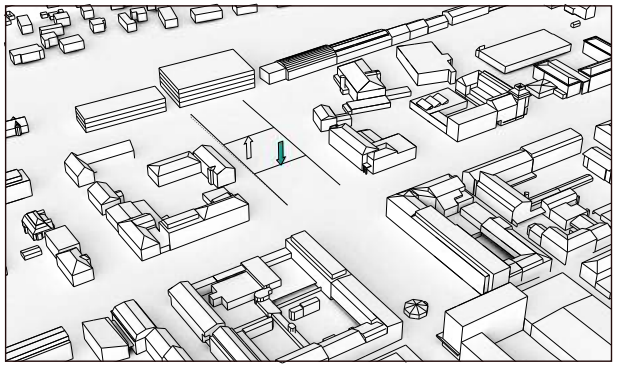
The program of the building arranged as stacked boxes. The largest boxes are elevated to avoid creating a building that becomes a barrier on the site.



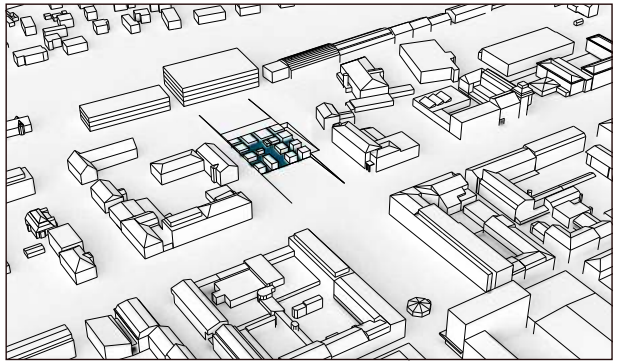
The boxes are separated and the space in between becomes the public space, allowing the link between the two squares to pass through rather than around the building.



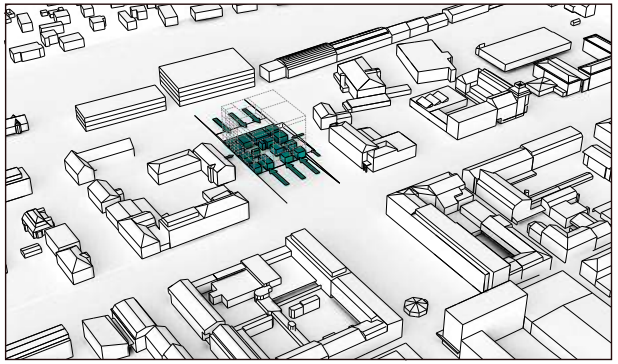
The inverted volume where the void is given mass. Circulation through the building is organized in the void, reaching all the way up to the roof square.



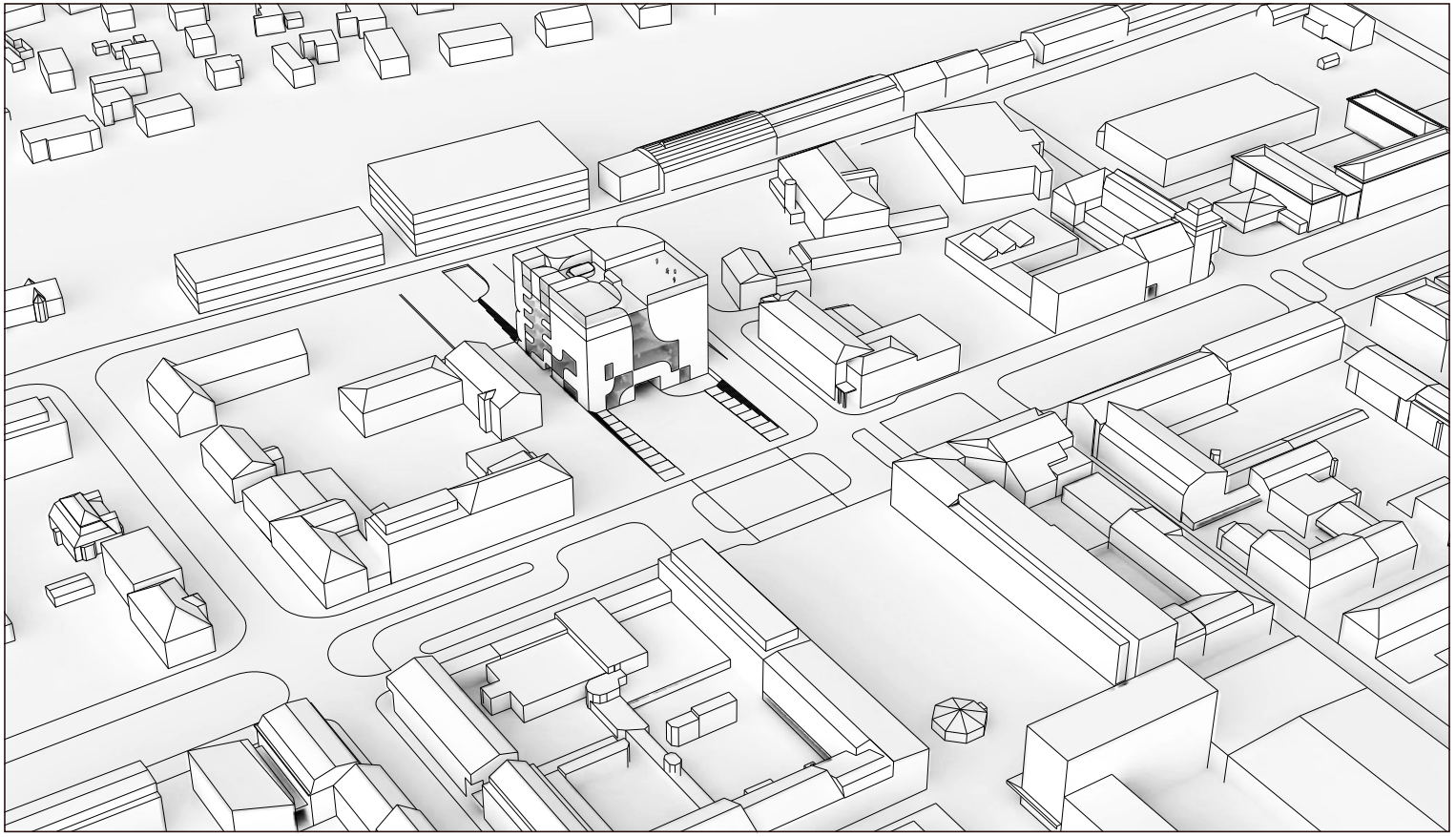
The site has a 3 meter slope. This is utilized to separate the entrances on the front and from the back, to activate the square towards the city center and to accentuate that this is a public building.



A plane that connects the two levels is created to work as a separation between the workers and the visitors.

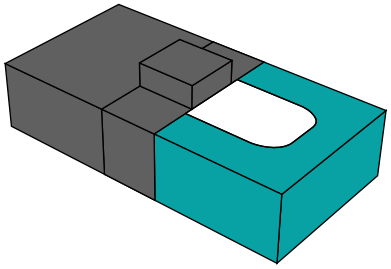


The building is accessible from 8 different entrances, creating a permeable transition between the two squares.

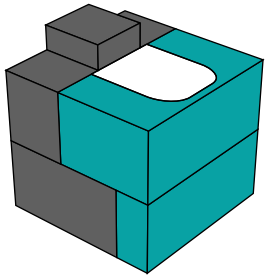


The sloped surface facing the main square in the city is divided into two stairs and a big ramp in the middle. A flat assembly pit is created next to the public workshop.

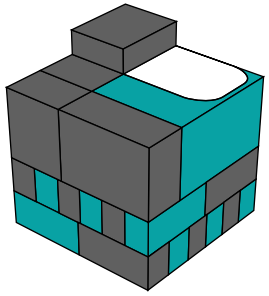
Building organization



Usual organization of performative arts buildings. Clear separation between the consumer (audience) and the producer (artist/worker).



Placing the auditorium on top of the “back stage area” in order to make the building volume more coherent and compact.



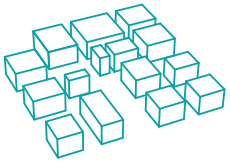
Exposing the machinery behind the scenes buy mixing the public space and the backstage

Space for consumers

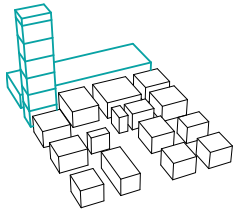
Space for producers

Auditorium

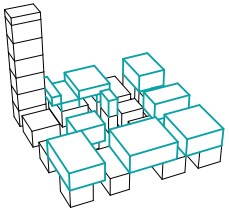
Building organization



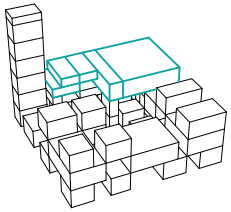
Workshops for the theatre, public workshop and café.



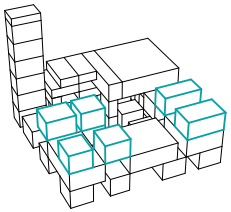
Storage in the back placed with close to demanding workshops. Equipment elevator linking workshops and the side stage.



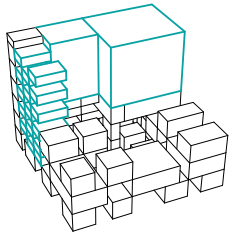
Studios for dance and theatre



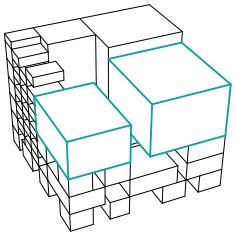
Exercise room to warm up before a performance. Lounge, boxes and tech below stage



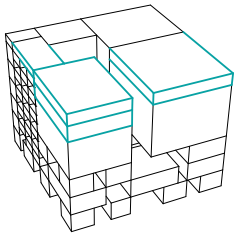
Wardrobe for the audience mixed with music studios



Office space and boxes mixed on the left side. Side stage and stage tower with proximity to equipment elevator.

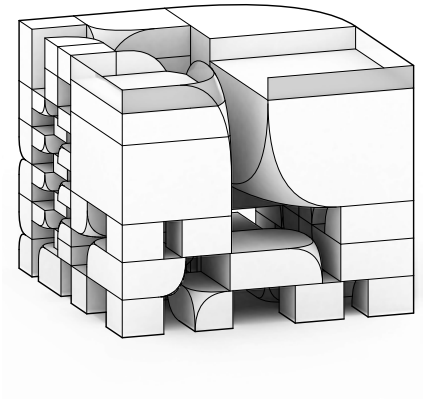


Black box and auditorium.



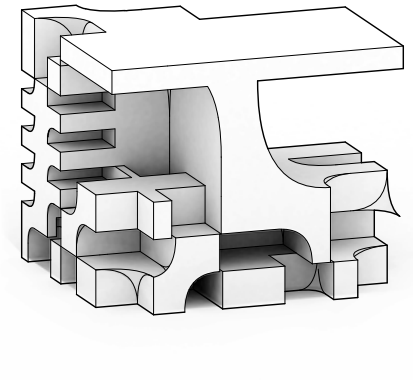
On top of the black box is a bar/restaurant with roof terrace. On top of the auditorium is a public terrace.

Building organization



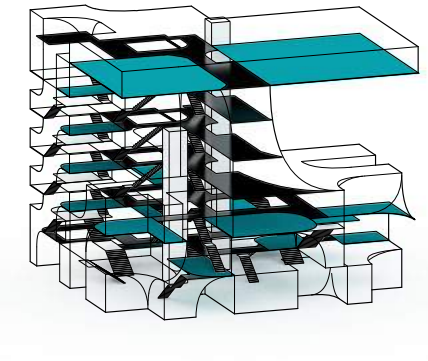
Mass

It is within the “mass” where all the functions such as workshops, studios, restaurant etc are placed. The “mass” is built with boxes made out of CLT plates and the corners of these boxes are cut to shape the space in between boxes.



Void

The void diagram show an inverted volume where the void is shown as mass. This is the public space in the building that climbs up from the square on the ground through narrow alleys passing through the machinery behind the scenes to reach the public square on the roof terrace with views all over the city.

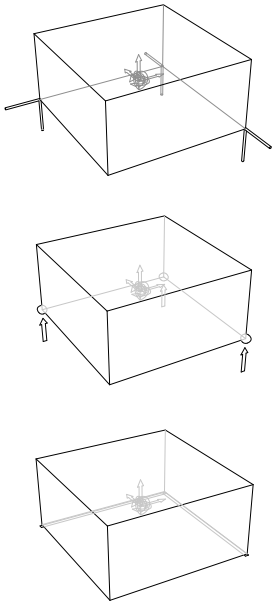


Circulation

The circulation in the building is organized within the void created in between the stacked boxes. A great number of stairs led the visitor through the narrow alleys up the foyer on the third floor, to the black box and the auditorium and finally to the roof terrace.

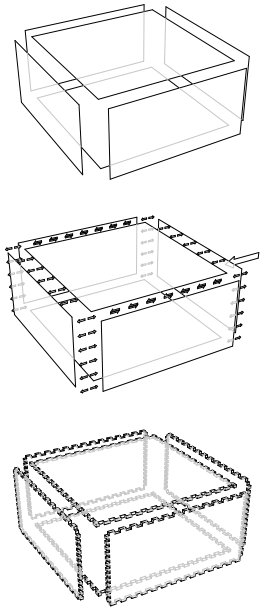
Structural principles

Rigid body stability



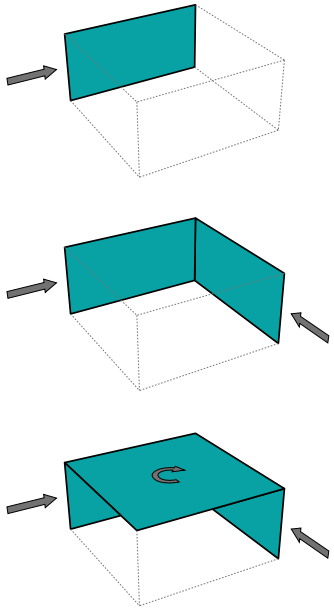
A rigid body can be supported in different ways in order to be stable. A boxes built as a plate structure need a minimum of two lines of support for stability.

Plate Structure



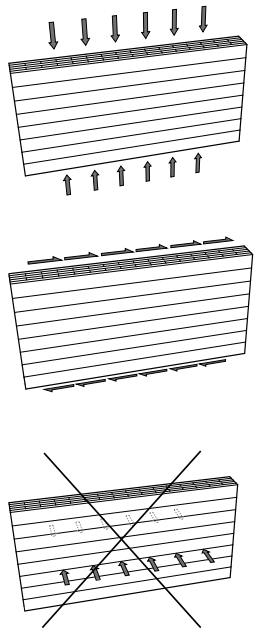
Finger joints inspired from furniture design is used to connect the plates of a box to provide shear capability needed for plate structure.

Box stability



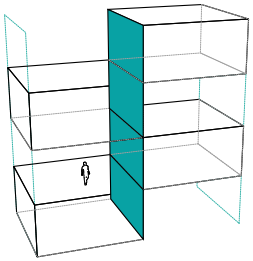
At least 3 plates oriented in different planes are needed to achieve stability for lateral and torsional loading.

Material properties

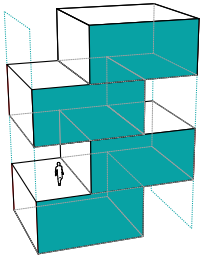


A CLT plate has 1/10 of the structural capacity when loaded perpendicular to the grain. Hence details are designed to avoid this type of loading.

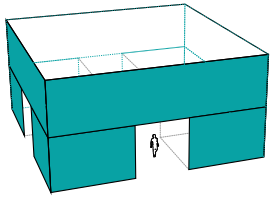
Stacking principles



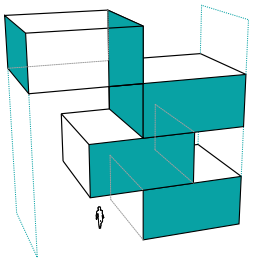
Edge to edge stacking



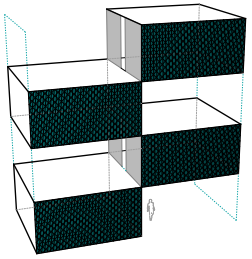
Overlap stacking



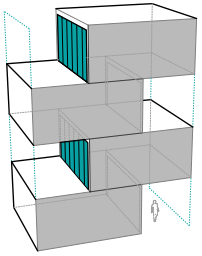
Big box on small boxes stacking



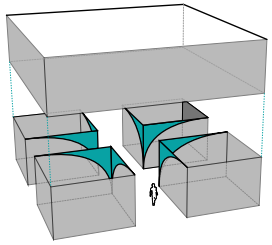
Edge to overlap hybrid



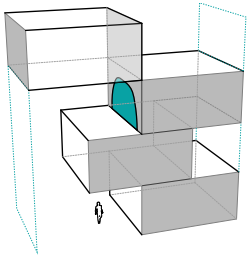
Openings are possible in the verti-
cal load path as well as on the wall
working in bending action.



Non structural wall can be
glassed.

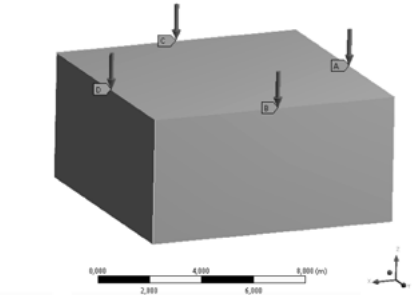


Glassed corner since the loading is
taken on the perimeter walls.

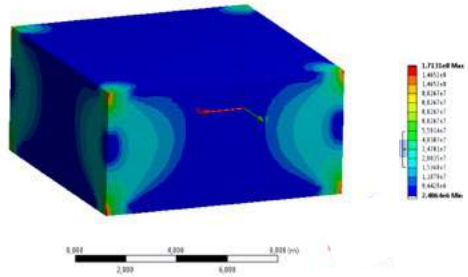


Load is transmitted from a edge
to edge type of stacking to an
overlap stacking and redundant
material in the plat can be cut to
make openings.

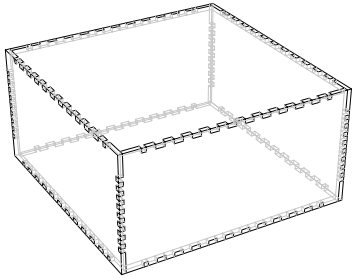
Corner cut



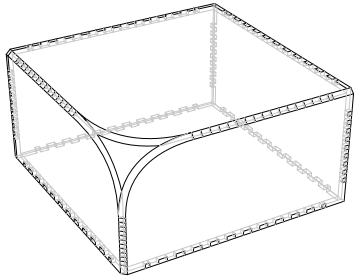
Analysis setup for a box consisting of 6 “welded” plates. Load is applied as line loads and the box is standing on a plane where it is allowed to “float”.



Stress in accumulated to the corners, which are the geometrically stiffest part of the structure. The usual approach for the structural design would be to deal with the stress concentrations by designing strong corners.



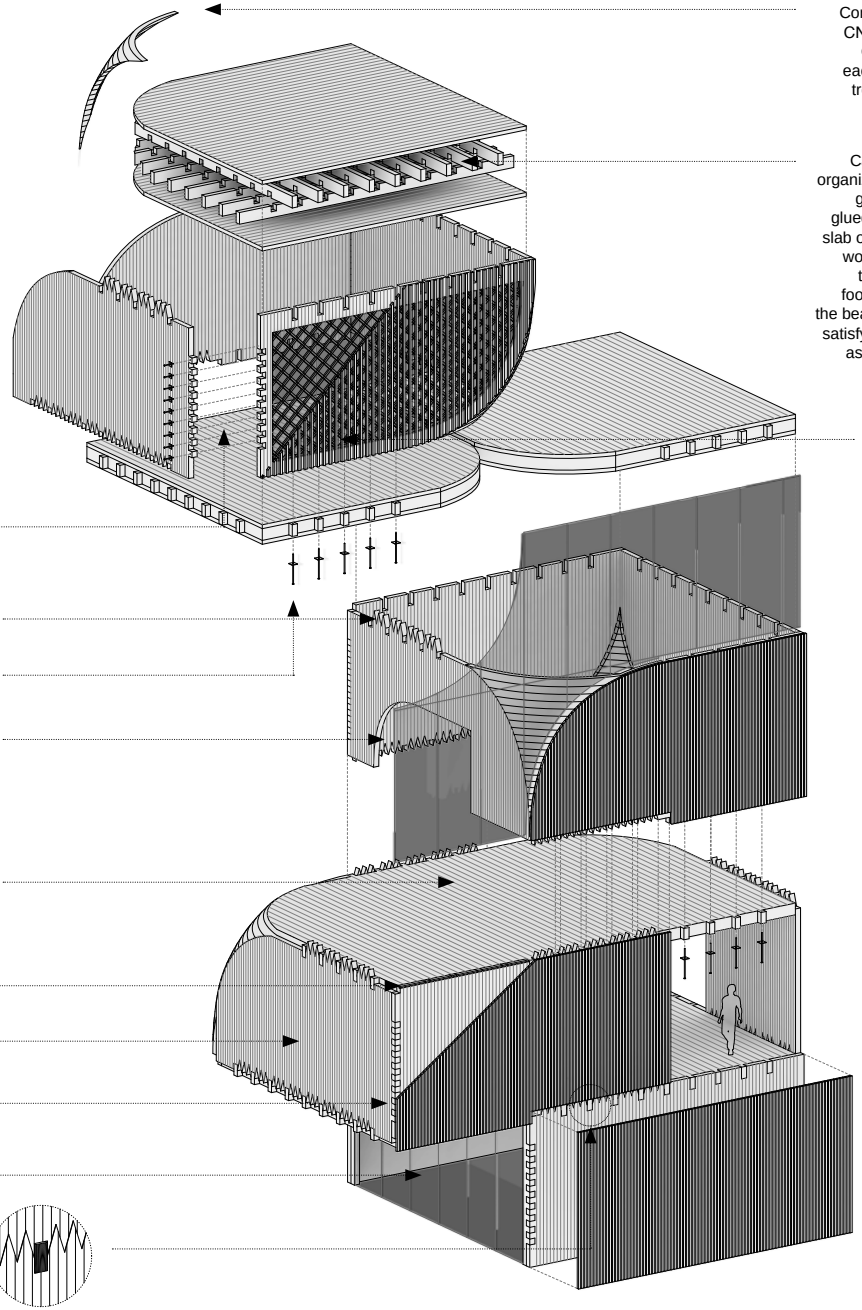
To avoid having to manufacture geometrically complex joints for the corners that can withstand stress concentrations, the corner is made non structural by withdrawing the finger joints.



The corner is then structurally redundant and can be shaped to form the space in between the boxes.

Structural system

The structure is built with CLT plate elements assembled with finger joints, inspired from furniture and product design. The system is created based on the production constraint of 2D cutting with a CNC machine. Principles of stacking, material properties, and openings found on the previous pages can be found in the various detail on the exploded detail drawing to the left.



Corners are built up with CNC milled flat slices of CLT stapled on top of each other and are then treated with sanding to get a better finish.

Cassette slab which is organized in a bi-directional grid of glulamb beams glued together with a CLT slab on each side. Mineral wool is used in between to damp the sound of footsteps. The height of the beams can be varied to satisfy the structural needs as the span of different boxes varies.

Structural plate that lets light through and is strong enough to keep the structural properties for a plate that is exerted to light weight loading.

Square shaped finger joint for pre- assembly at the factory. Each box also has at least one floor of roof slab in order to provide stability for the on site assembly.

The sharp/pointy finger joints show the force transmission from one box to another and have the sharp appearance to simplify assembly on site.

Screws and steel plat that attach the floor plate to the wall for increased tension capability.

Opening in a plate where the force is distributed from the top edge on the plate to the plate in the back.

Two boxes that are stapled on top of each other are charing the same slab

A cut into the CLT plate is made for the glass fitting.

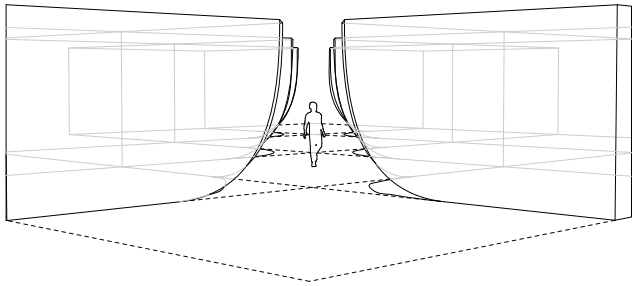
CLT elements cut with a CNC machine.

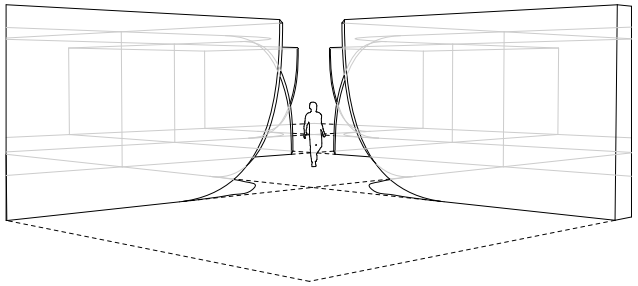
Facade of untreated larch wood, which has a warm color in the begin but changes into a more garish finish as the wood is aging. The gray finish will contrast to the interior boxes.

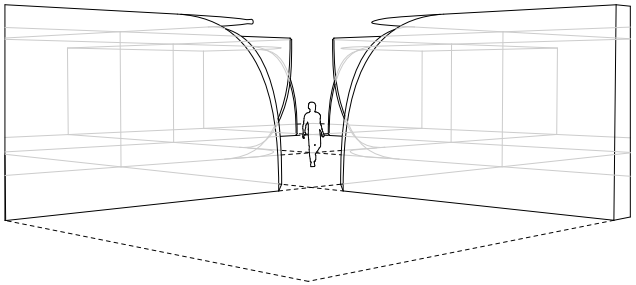
Glass wall where the plate does not have structural function

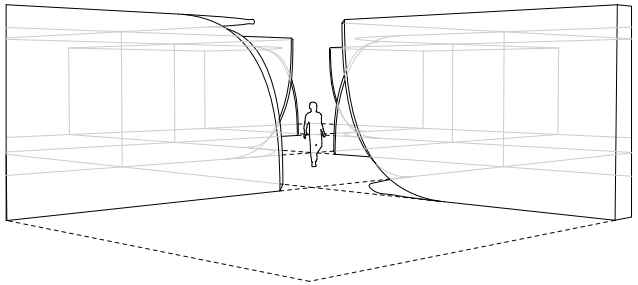
A small gap is left in order to not carry the load through the beam in the slab, perpendicular to the grain. This gap can be closed in order to clamp the beam which would reduce the thickness of the slab.

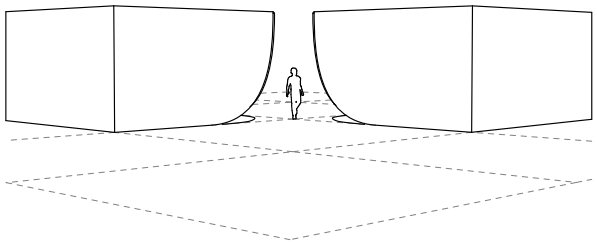
Spacial investigation

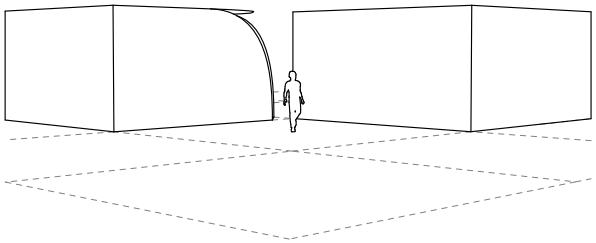


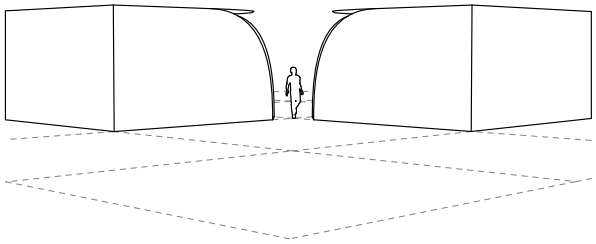


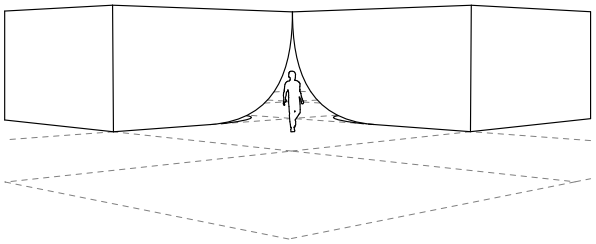


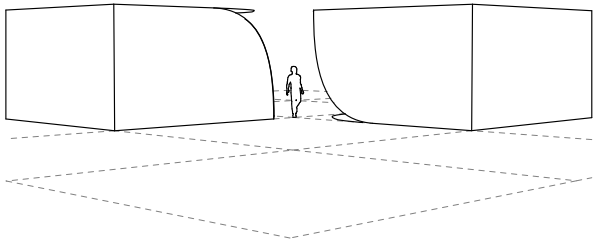


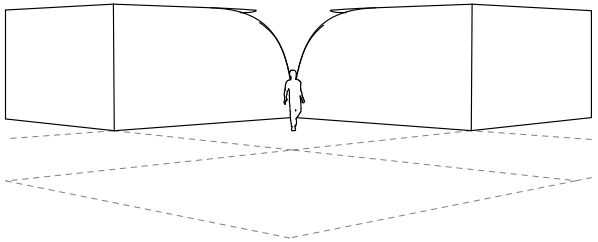


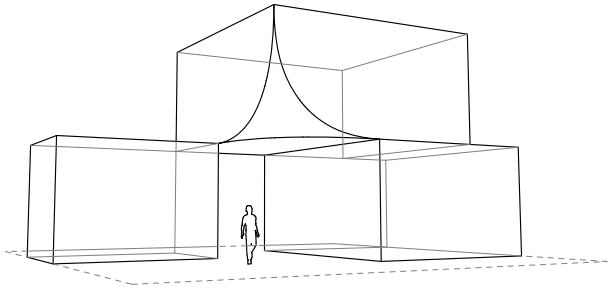


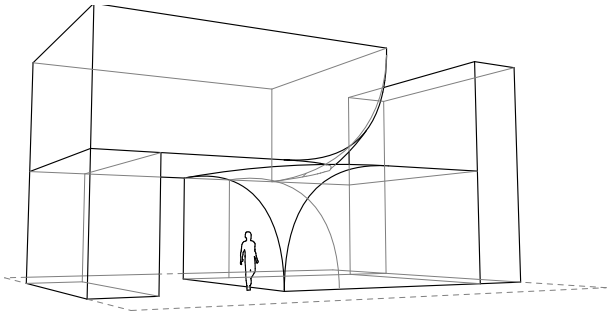


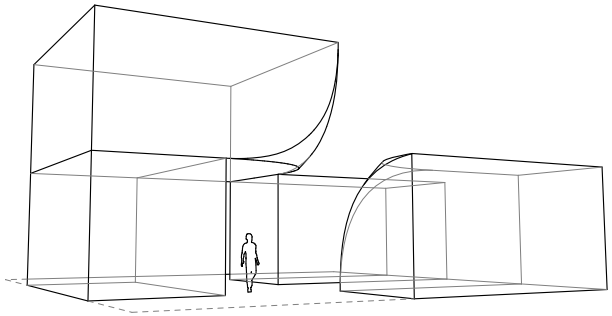


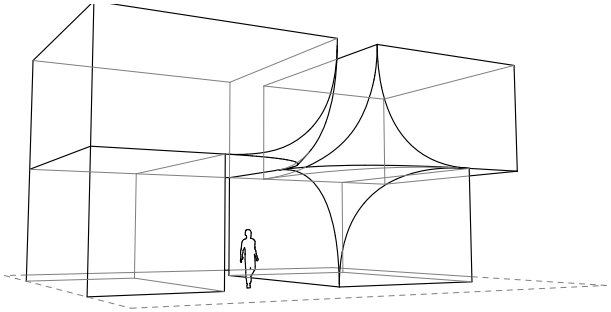


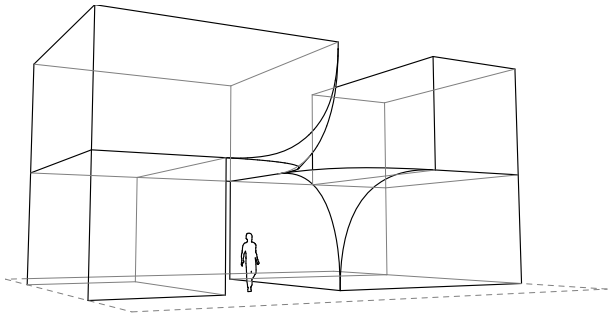


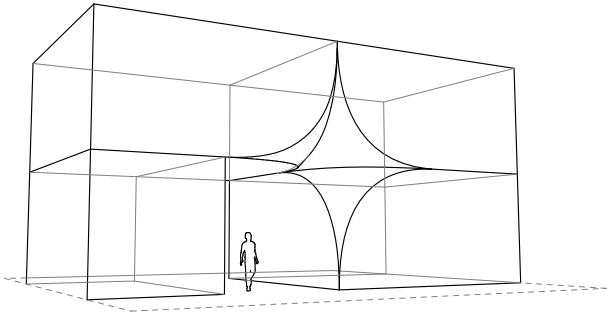










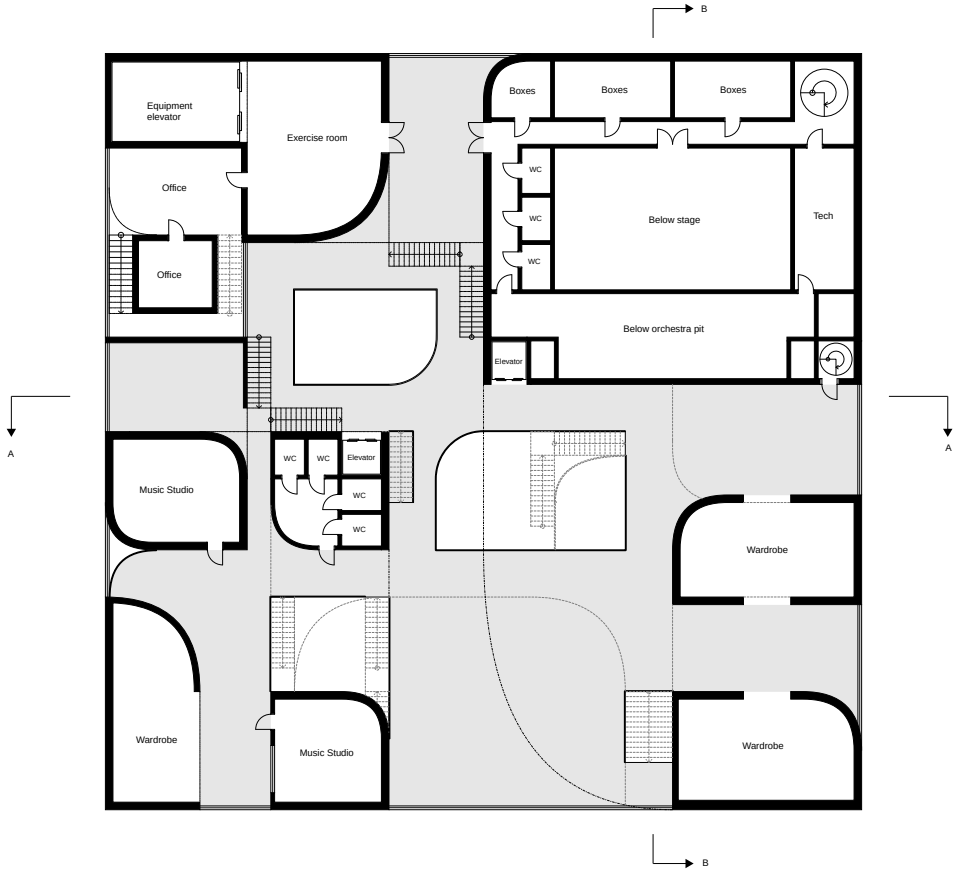



B
Storage
Resturant/Cafe
Storage
Sound/Light
Storage
Requisite
Storage
Material
Storage
Loading
Loading
Equpment
elevator
Paintshop
Carpentry
Sewing studio
Smithy
WC
Elevator
Musician
room
Mask
/Makeup
Side Entrance
A
WC
Elevator
Side Entrance
A
Cafe
Kitchen
Sound/Light
workshop
Material storage
Cafe
Serving
Public workshop
Cafe
Serving
Main Entrance
B
Plan 1
5m
0
10
20
Scale 1:400

Plan 2

5m 0 10 20

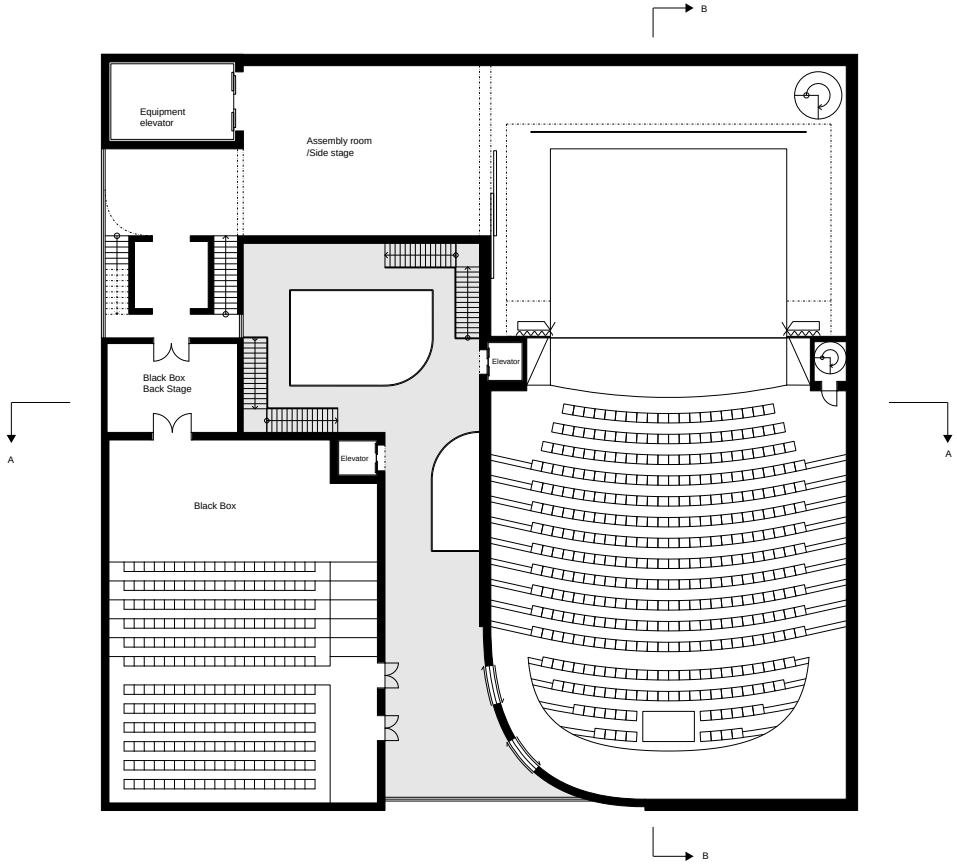
Scale 1:400



Plan 3

5m 0 10 20

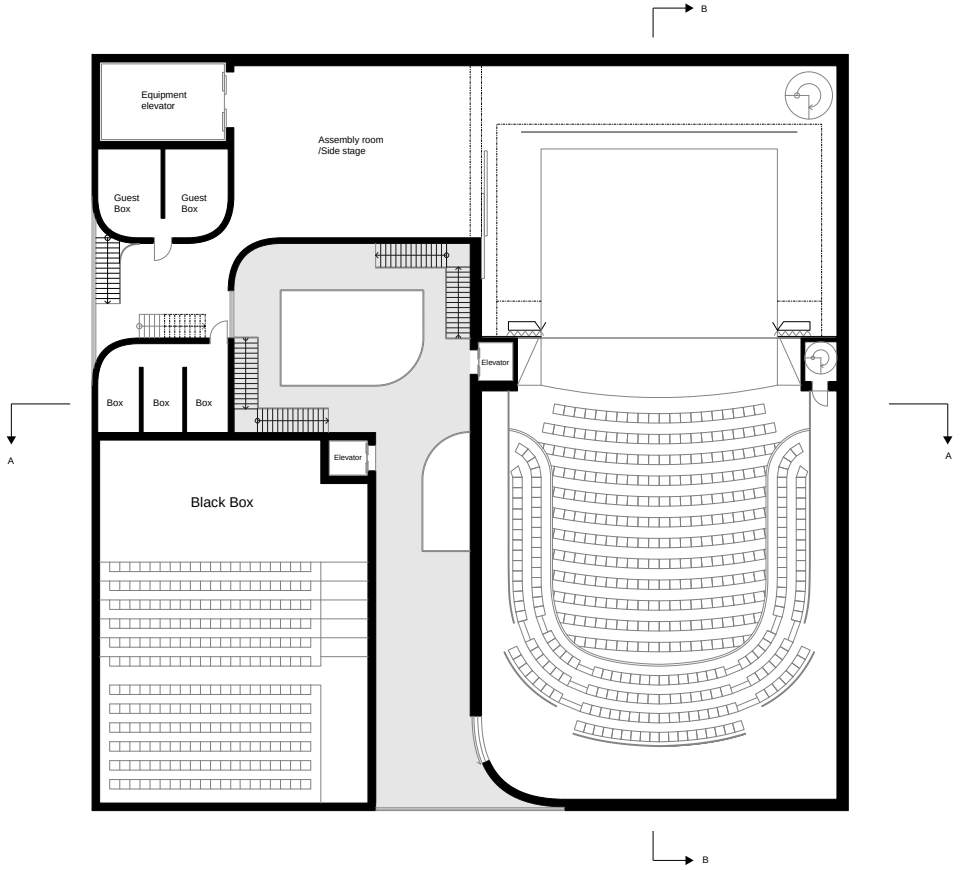
Scale 1:400



Plan 4

5m 0 10 20

Scale 1:400



Plan 5

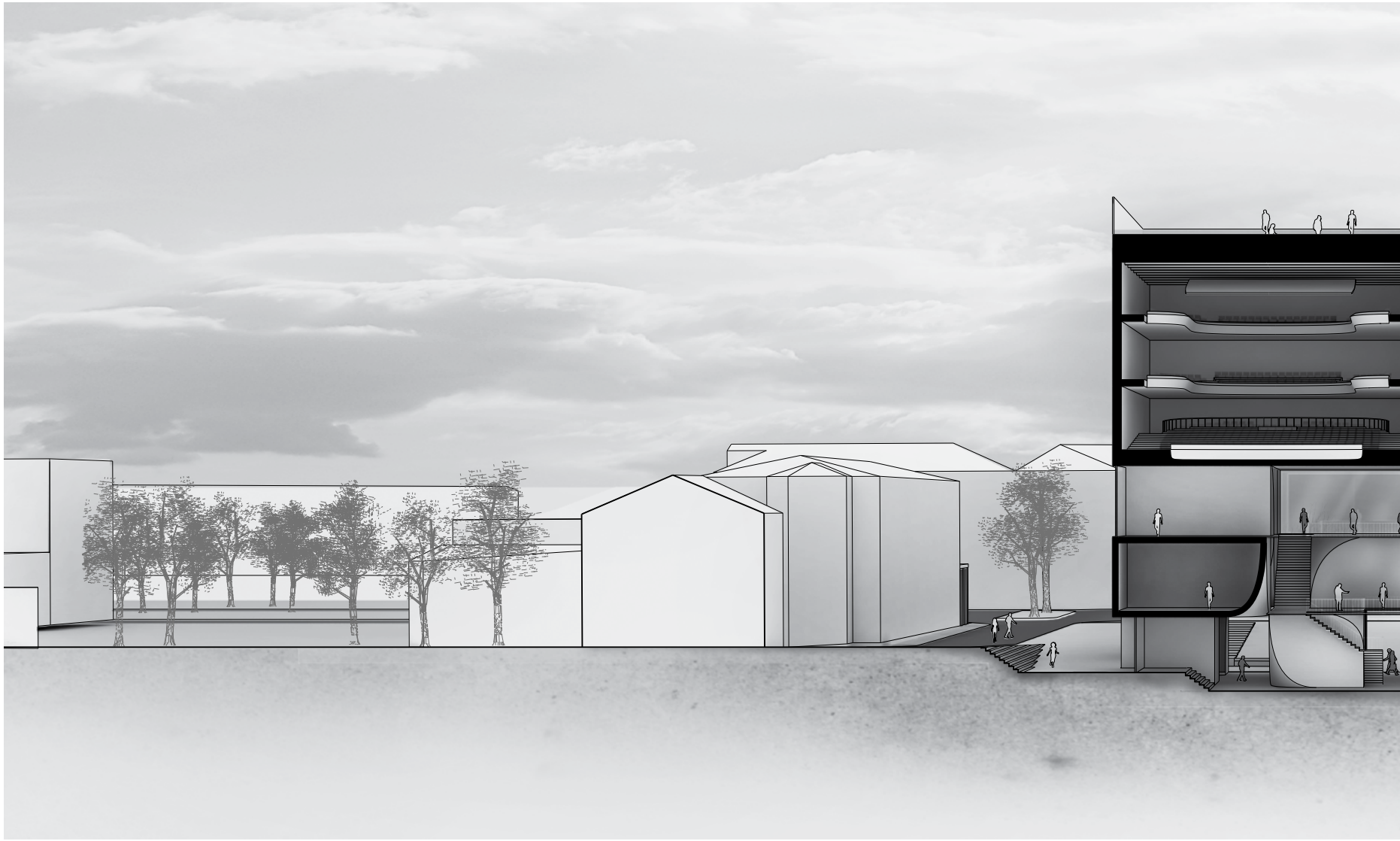
5m 0 10 20

Scale 1:400

Section BB

Scale 1:400

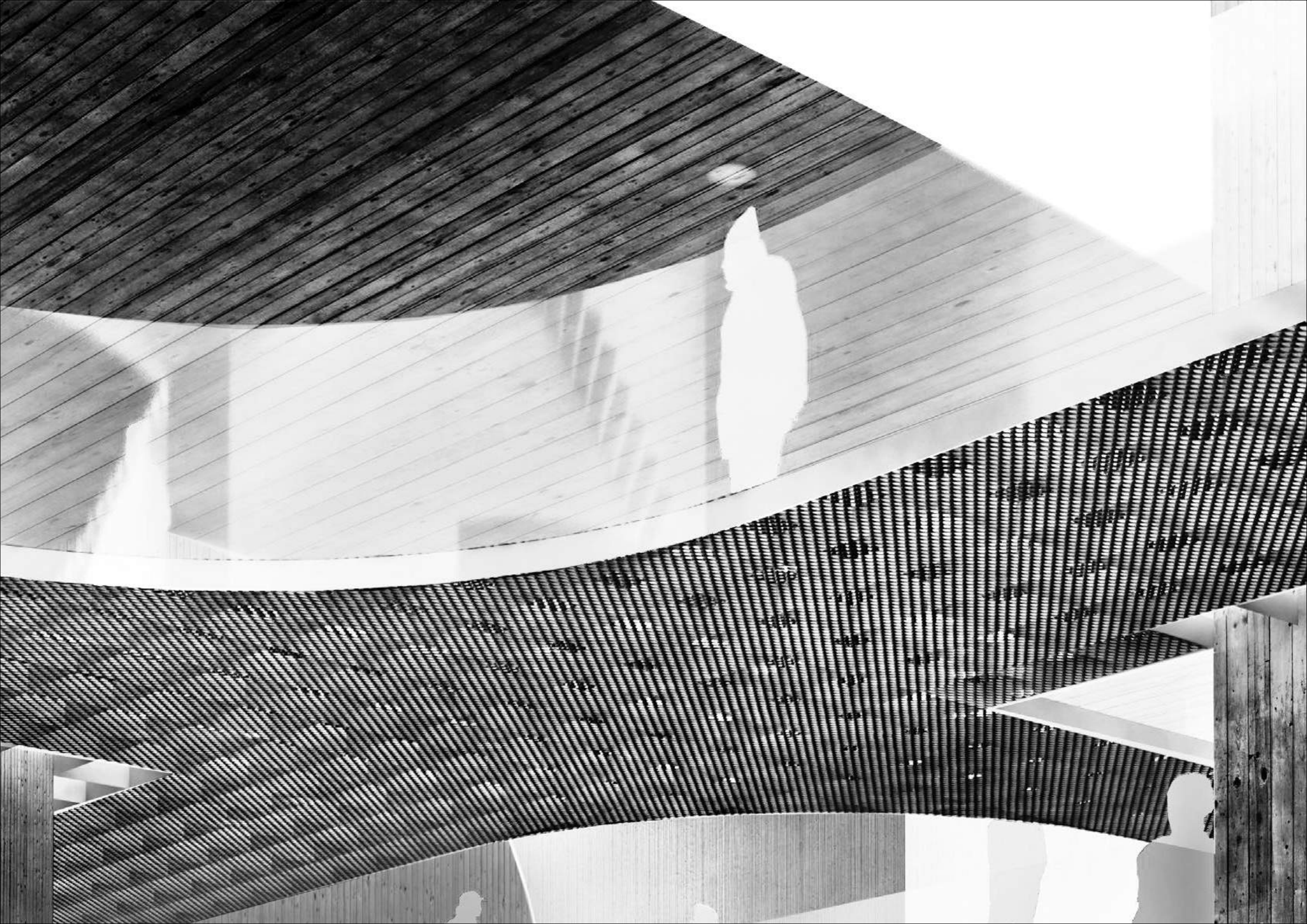
5m 0 10 20

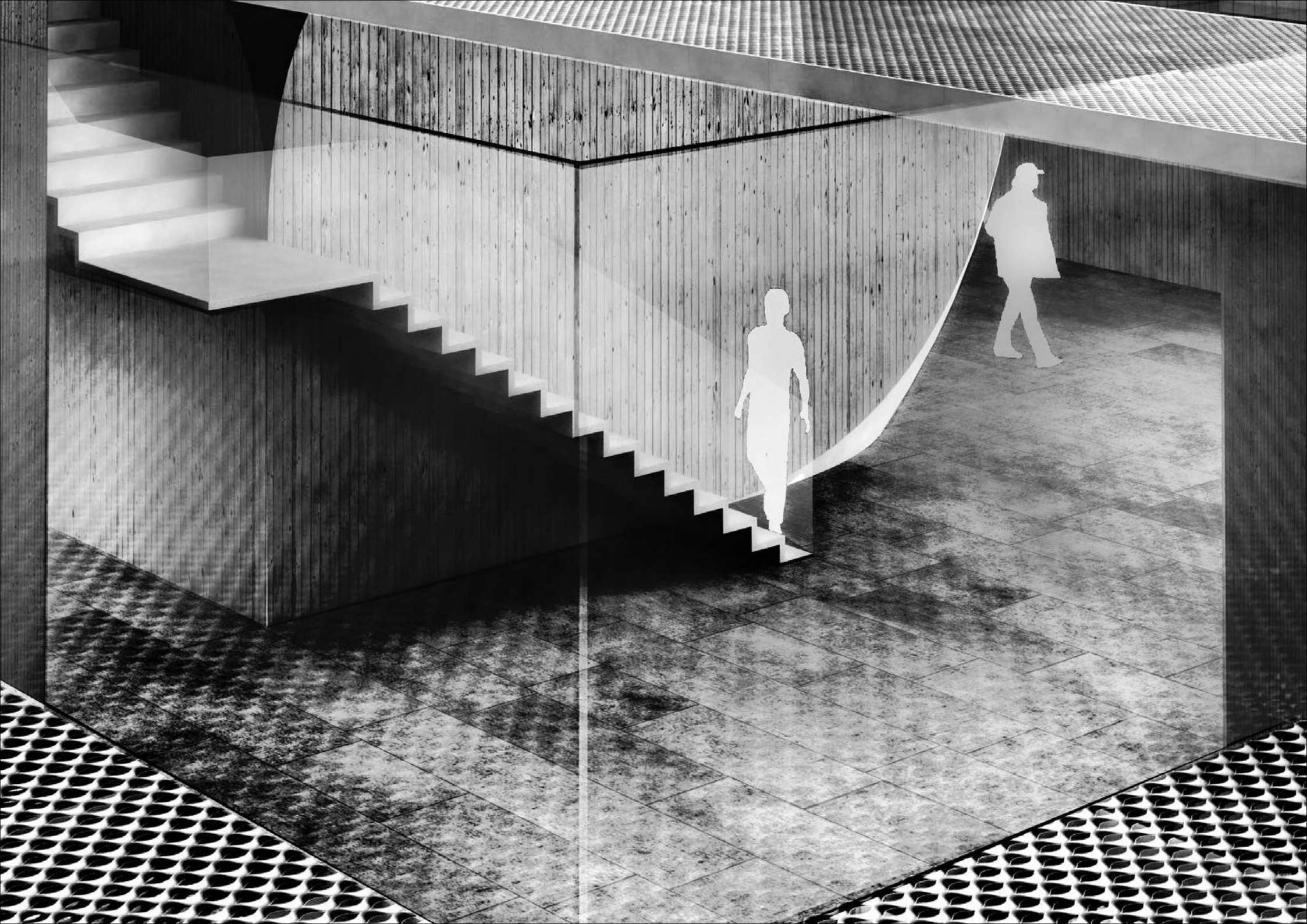


Section AA

Scale 1:400

5m 0 10 20





A Master thesis project in Architecture
At Chalmers University of Technology

By Jens Olsson

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