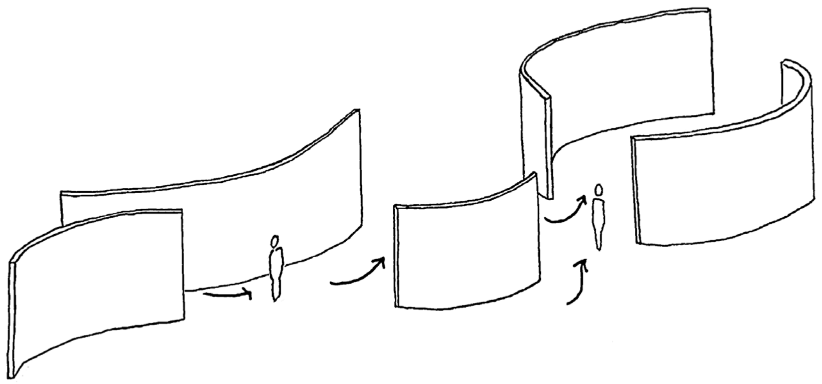
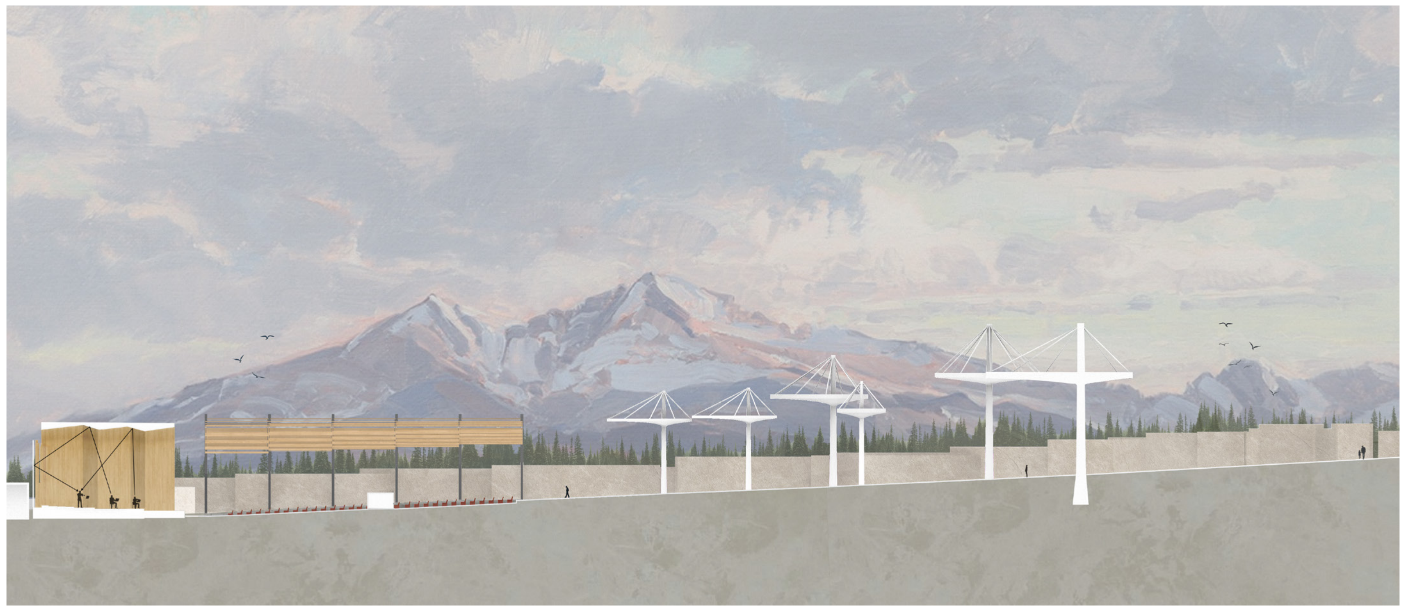
The Wave Auditorium

An Adaptable Venue

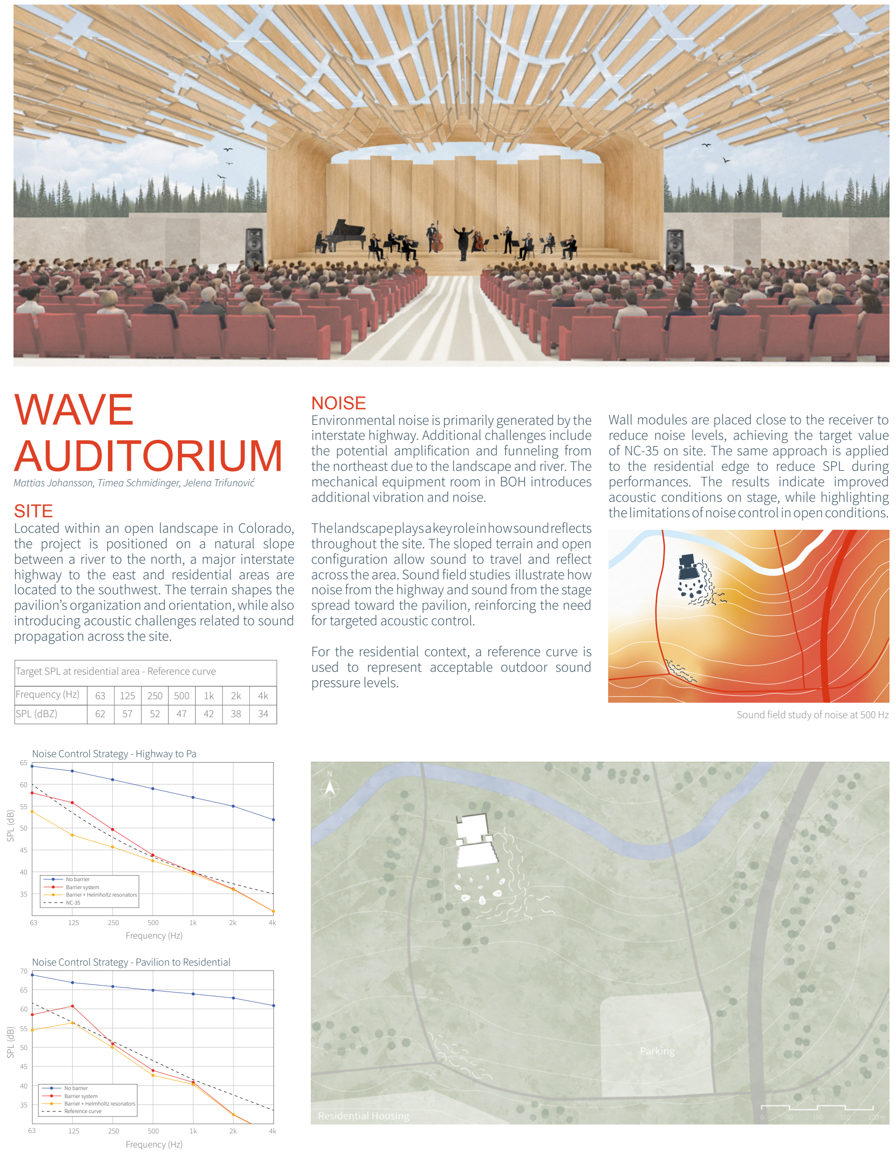
Project Portfolio - ACEX16
Bachelor Thesis in Architecture and Engineering
Mattias Johansson in cooperation with Timea Schmidinger



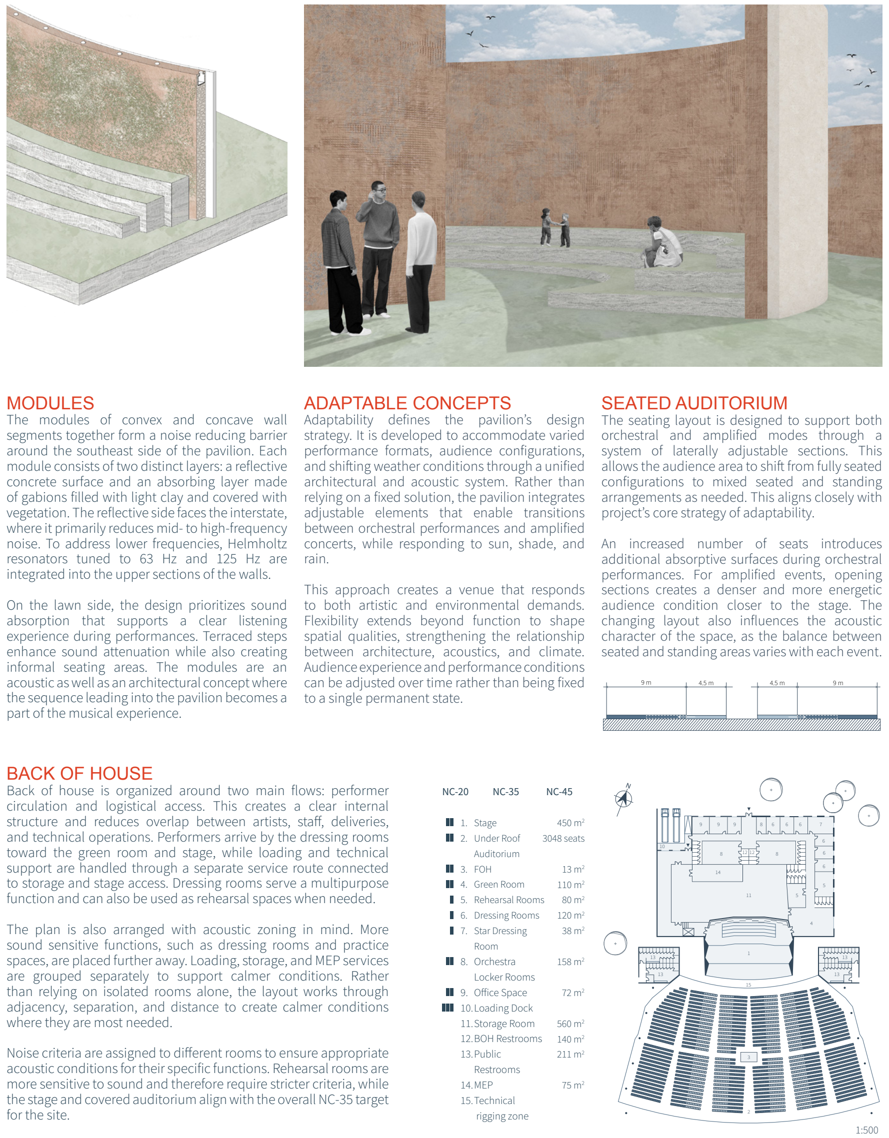


Chalmers University of Technology
Department of Architecture and Civil Engineering
Division of Architectural Theory and Method
Gothenburg, Sweden 2026

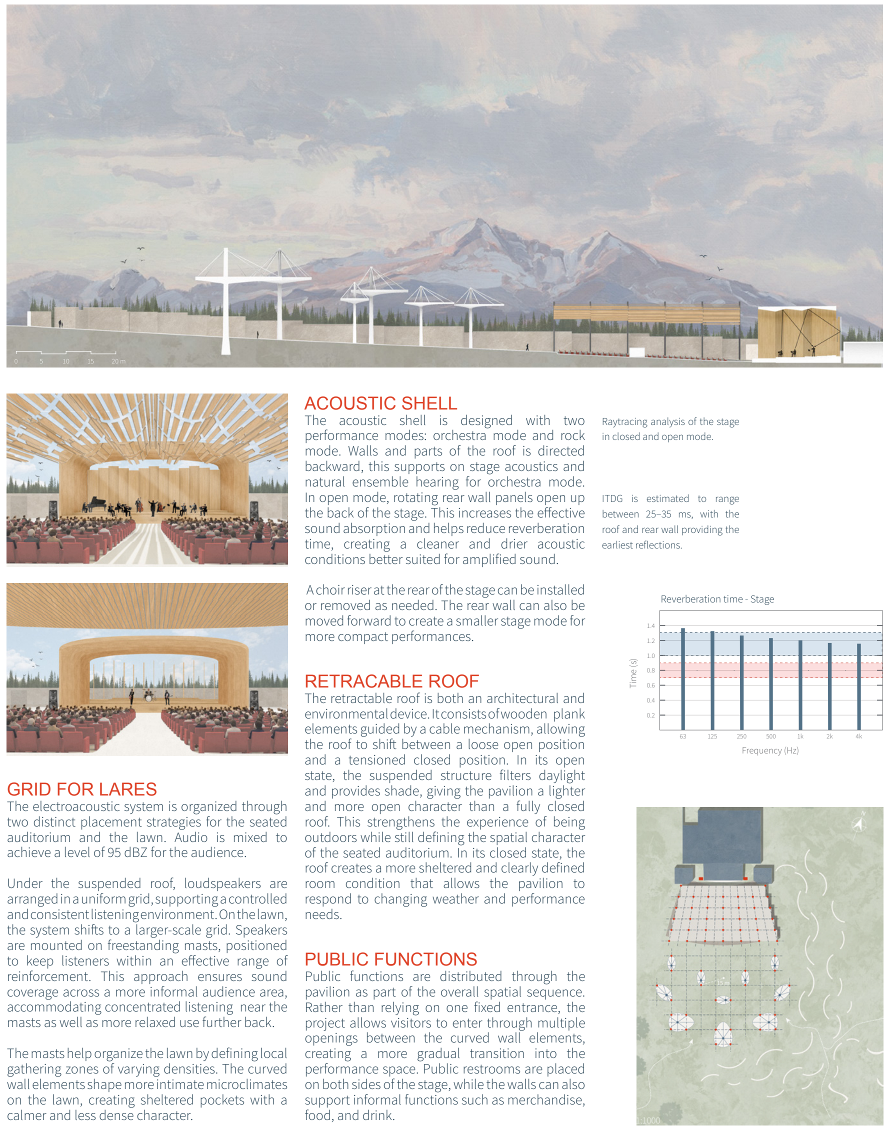
ARCHITECTURAL ACOUSTICS



Competition board, page 1



Competition board, page 2



Competition board, page 3

Competition Brief

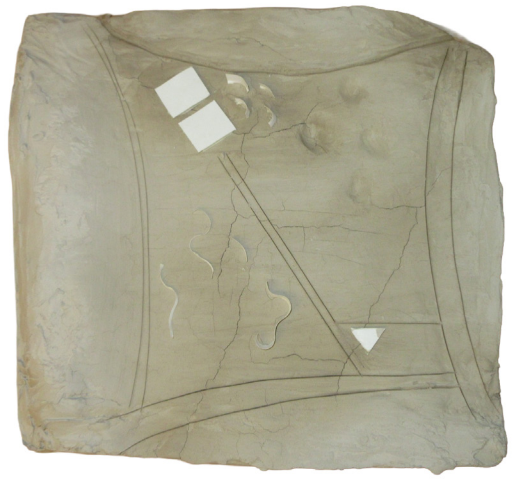
The bachelor project was based on a student design competition for a new 13,000-seat outdoor music pavilion for a city orchestra. The venue was to function as a summer home for orchestral performances, while also supporting touring acts such as pop and rock concerts. The programme included 3,000 covered seats, a 10,000-person lawn, stage areas, back-of-house functions, dressing rooms, storage, loading and technical spaces.

A central part of the task was to integrate architecture with acoustic performance. The design had to address on-stage hearing for musicians, sound reinforcement for large audiences, traffic noise from the surrounding site, and the impact of event sound on nearby residential areas. The brief therefore focused on how spatial organization, structure, landscape and noise control could work together as part of the architectural proposal.

REFLECTION

Context

The music pavilion is placed in an urban park context, similar to Slottsskogen in Gothenburg. It is close to public transport and connected to the city, while still being surrounded by ponds, vegetation and open park spaces that support biodiversity. The landscape creates a gradual transition from the urban surroundings to the pavilion. Sculptural wall elements shape this movement and form smaller social spaces, conversation pits and pauses along the path. These walls also work acoustically by reducing unwanted urban noise and limiting how sound spreads from the stage. Together, the park landscape and wall modules create a more protected and controlled sound environment, while keeping the pavilion open, public and connected to the city.

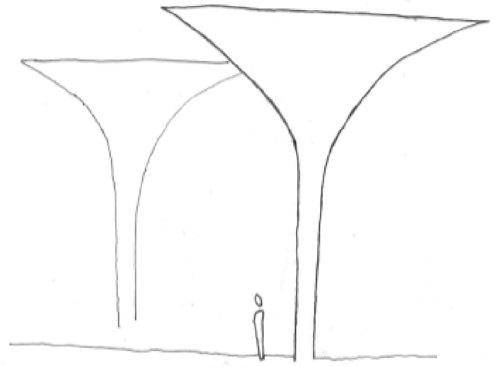


Design Methodology

Our design methodology has been guided by adaptability as the central principle. Rather than designing the pavilion in a fixed state, we have developed it as a system that can shift between different uses, weather conditions and acoustic needs.

The pavilion can support different performance modes, such as rock concerts and orchestral music. This is achieved through modules with built-in flexibility. The roof, stage and auditorium can respond to different spatial and acoustic situations, while the wall modules provide adaptable noise protection through their placement.

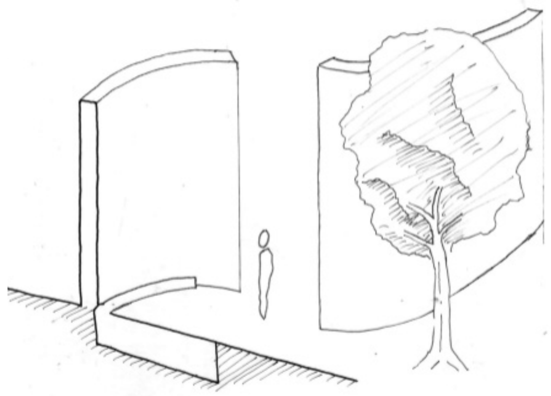
Models and acoustic diagrams have been used as tools to test and communicate how form, structure, climate and sound interact. Sustainability has also shaped the method through minimal ground intervention, lightweight construction and material-efficient systems, including hybrid wall elements.with potential use of local, low-impact materials such as clay.



Architectural Qualities

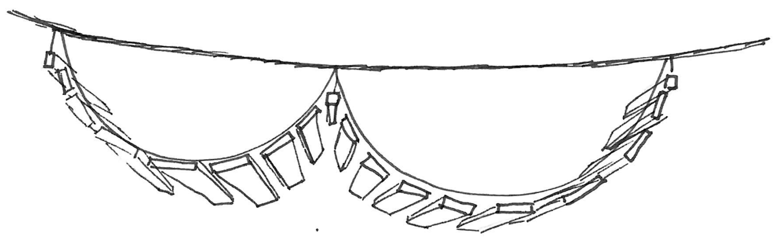
The architectural qualities of the proposal are based on atmosphere, spatial sequence, light, performance-responsive acoustics and the relation to the landscape. The same adaptability that has guided the design methodology also shapes the experience of the pavilion: it can create different spatial characters depending on how it is used, while still maintaining a clear architectural identity.

The landscape is treated as an active part of the proposal. Instead of leaving the remaining site as generic parkland, the project introduces a system of ponds and planting that supports urban biodiversity in Slottsskogen. This creates habitats for birds, insects and varied vegetation, while also strengthening the calm and atmospheric qualities of the pavilion's surroundings.

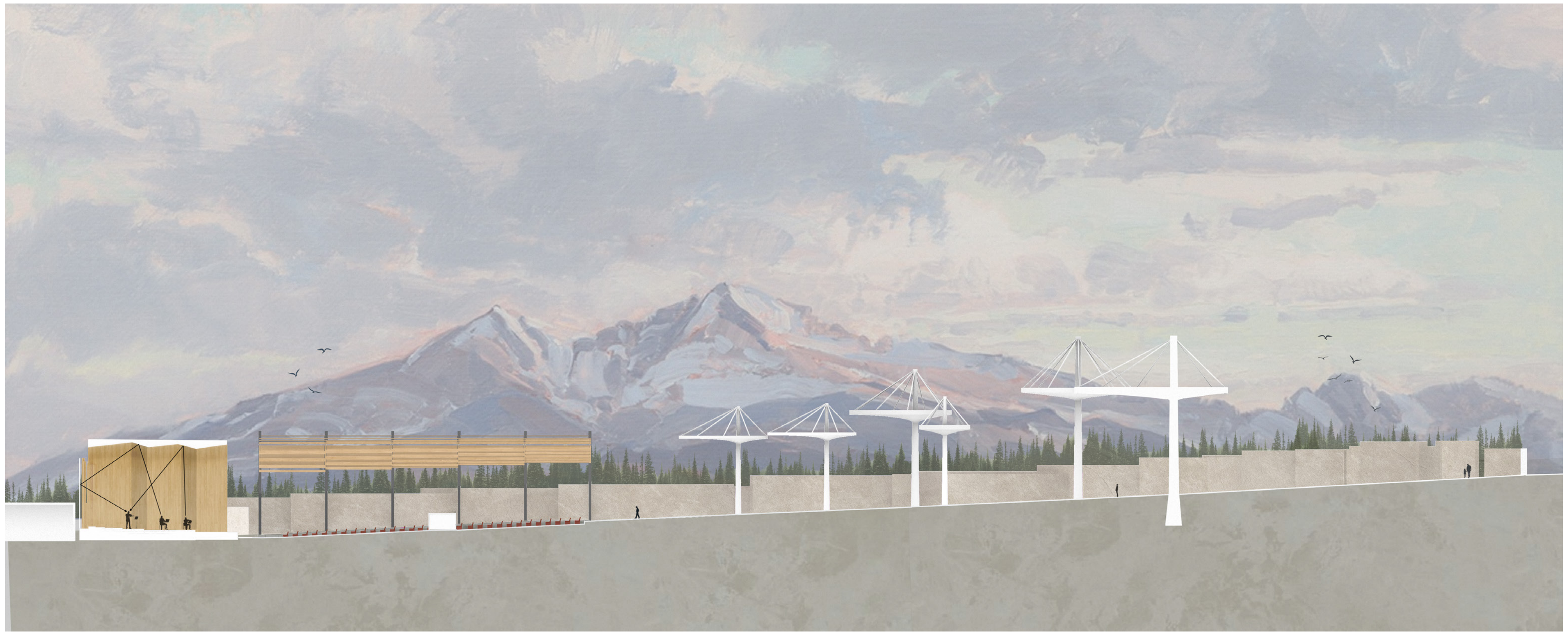


Mattias Johansson
ACEX16

THE MUSIC PAVILION

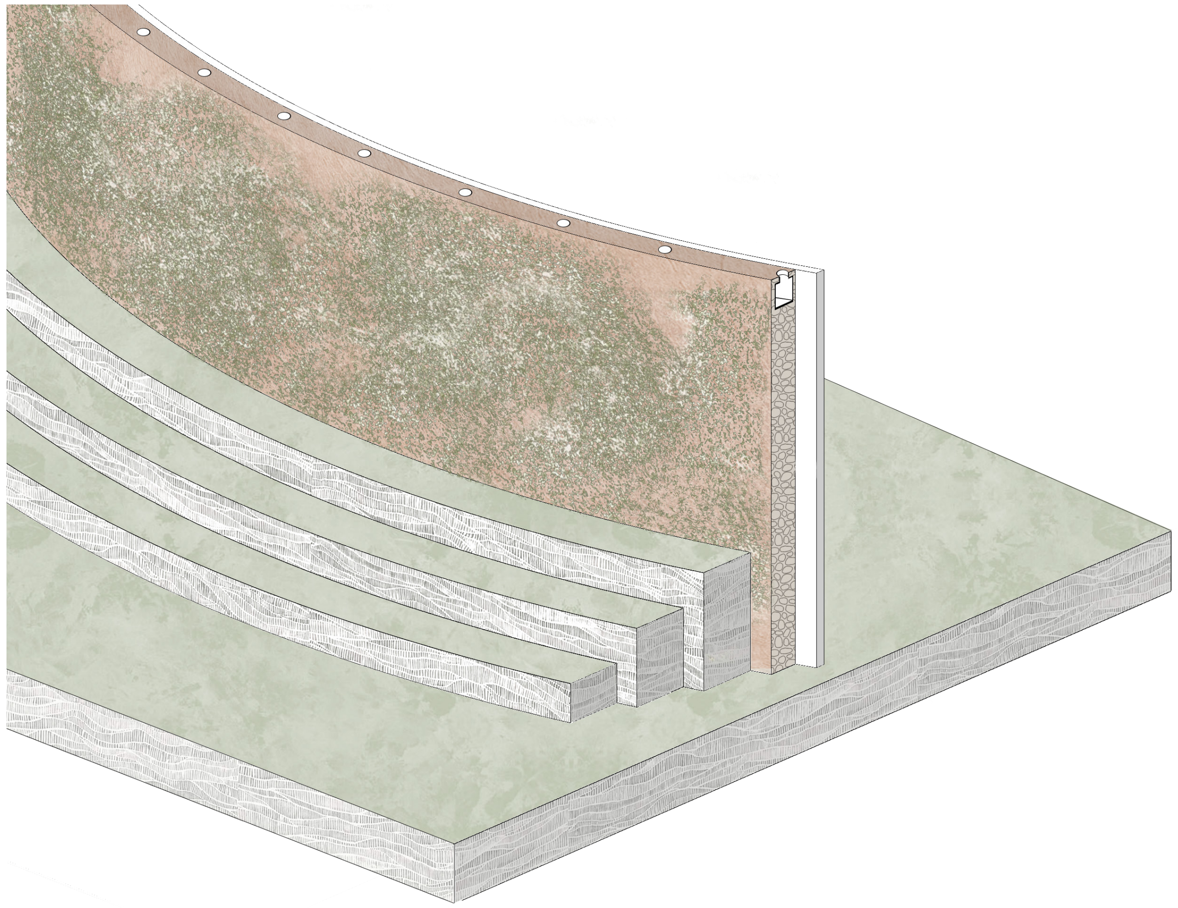


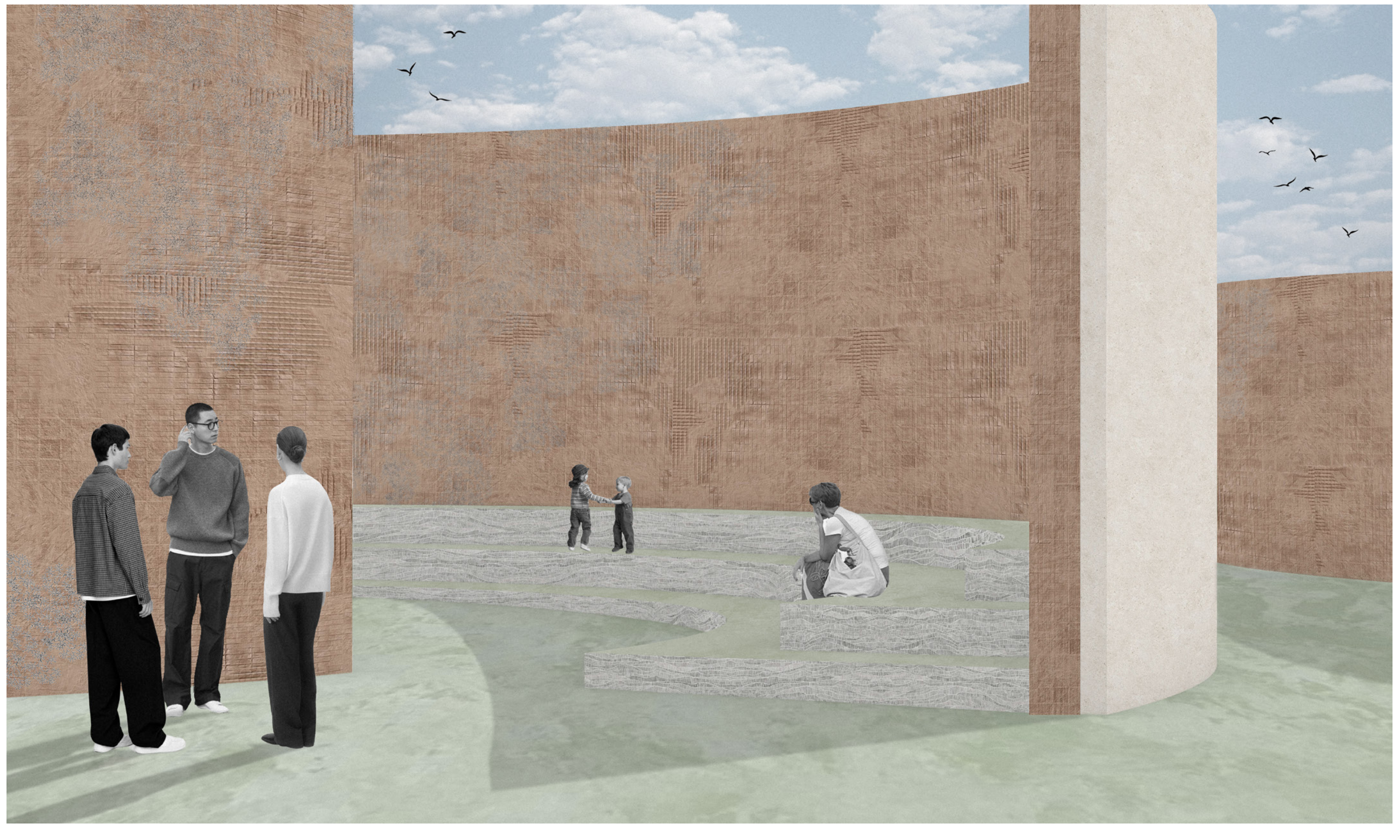
One of the main qualities is the roof and its two modes. In both positions, the roof defines the room, but in different ways. When opened, it creates a lighter and more porous atmosphere, allowing filtered daylight to enter the space. When closed, it becomes more protective and concentrated, strengthening the sense of enclosure. This changing play of light is one of the key architectural gestures of the project. A similar principle is used in the back wall of the stage. It can open up to let in filtered light and frame a view towards the surrounding landscape, connecting the performance to the nature.

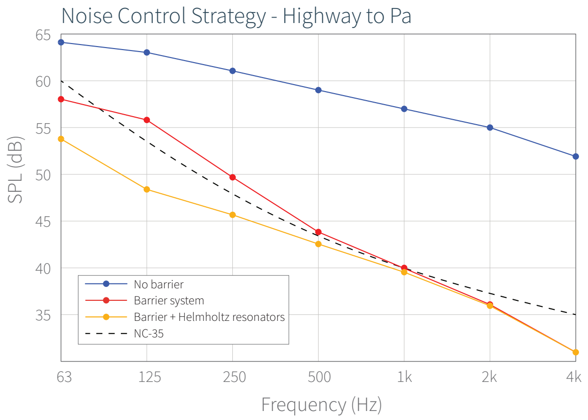


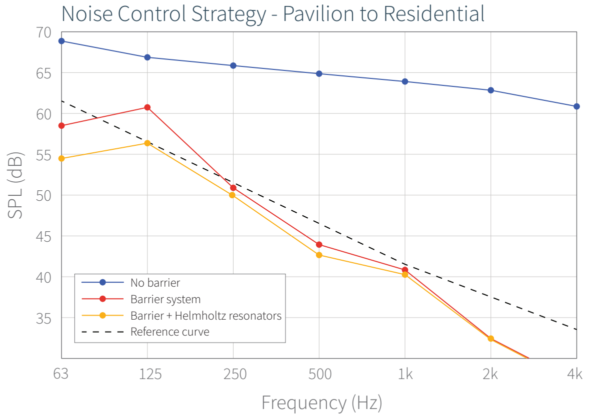
Mattias Johansson
ACEX16

NOISE STRATEGY - BARRIERS AS ARCHITECTURE





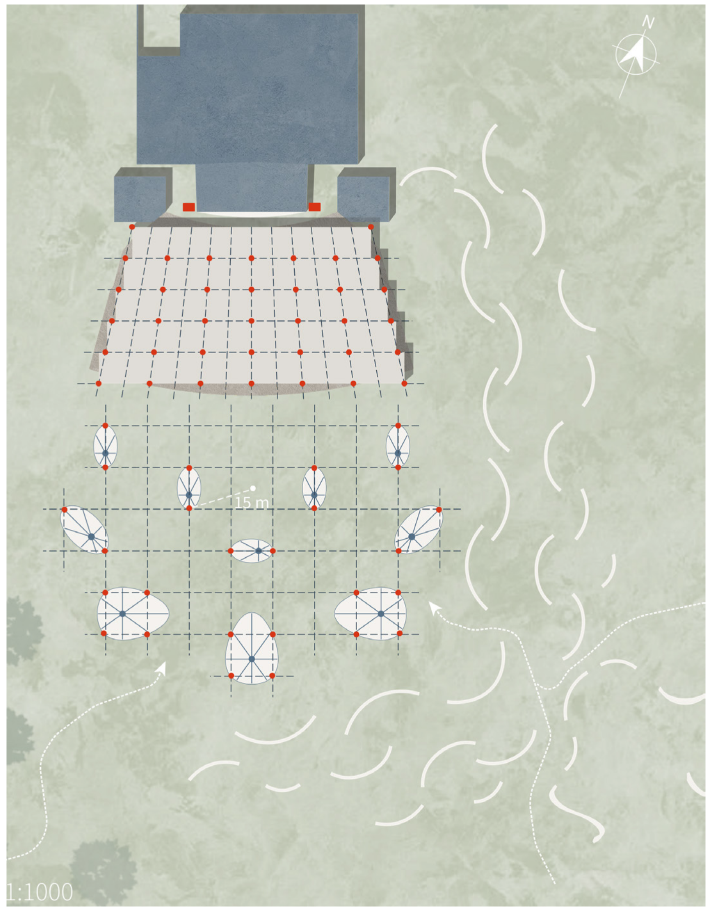




The wall elements contribute to the spatial experience by creating a sequence of rooms, passages and openings. Movement through these openings becomes part of the experience of the pavilion. From certain directions, the project is perceived through diagonal sightlines, creating a gradual approach rather than an immediate reveal. From the south-east, a diagonal axis through the landscape frames the approach to the pavilion and strengthens the sense of arrival. Around the pavilion, tilted and curving wall segments form smaller spaces that support informal meetings, pauses and conversation.

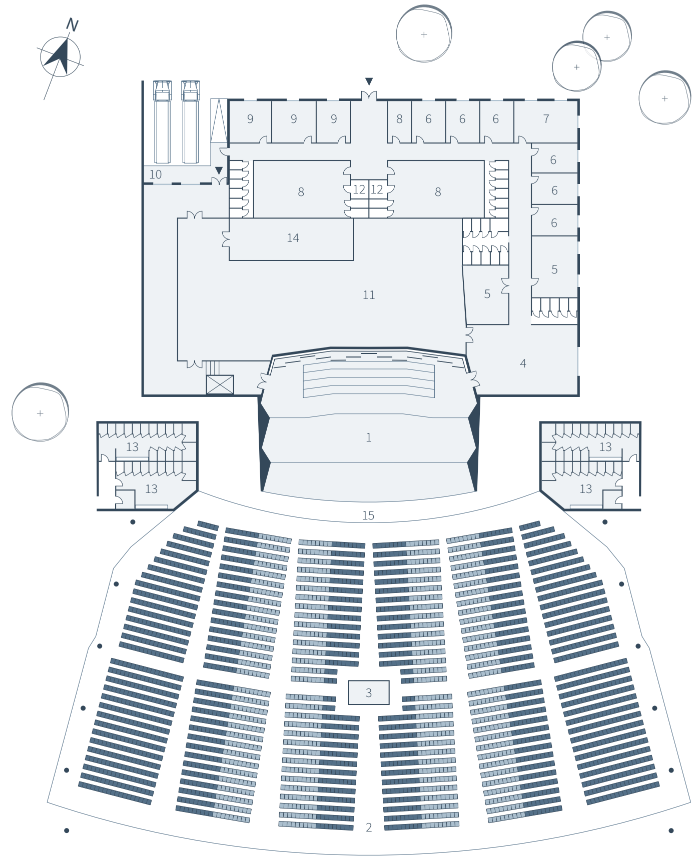
Mattias Johansson
ACEX16

ACOUSTIC PERFORMANCE



NC-20 NC-35 NC-45

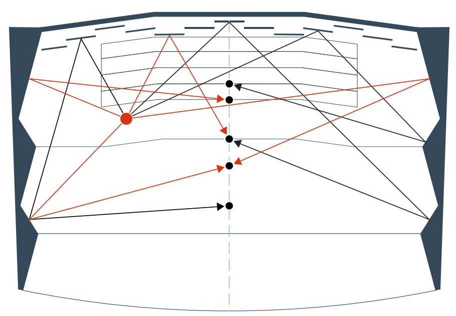
1.	Stage	450 m²
2.	Under Roof Auditorium	3048 seats
3.	FOH	13 m²
4.	Green Room	110 m²
5.	Rehearsal Rooms	80 m²
6.	Dressing Rooms	120 m²
7.	Star Dressing Room	38 m²
8.	Orchestra Locker Rooms	158 m²
9.	Office Space	72 m²
10.	Loading Dock	
11.	Storage Room	560 m²
12.	BOH Restrooms	140 m²
13.	Public Restrooms	211 m²
14.	MEP	75 m²
15.	Technical rigging zone	



1:500

The electroacoustic system is adapted to two audience situations. Under the suspended roof, speakers are placed in a regular grid to create a more controlled listening environment for the seated auditorium. On the lawn, the speakers are instead organized on freestanding masts in a larger grid, giving sound reinforcement to a wider and more informal audience area.

The masts also help structure the lawn by creating smaller gathering points, while the curved wall elements form more sheltered and intimate spaces. Together, the sound system, masts and walls support different ways of listening and using the park during performances.

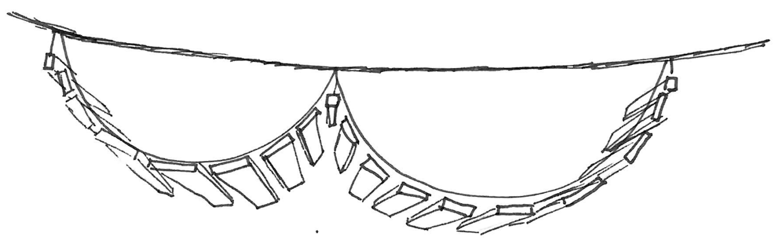


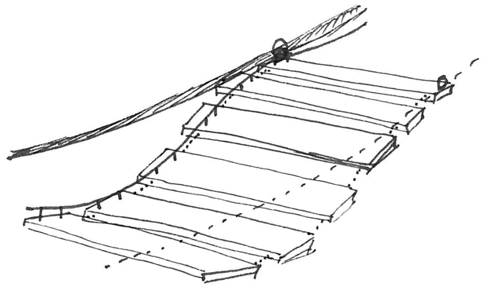
The acoustic shell is designed for two main performance modes: orchestra and rock. In orchestra mode, angled surfaces direct sound back toward the performers, supporting natural ensemble hearing. A removable choir riser can be added at the rear of the stage when needed.

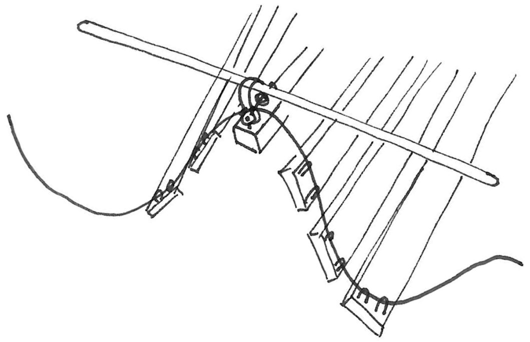
In rock mode, rotating rear wall panels open the back of the stage and increase sound absorption. This creates a drier acoustic condition that works better for amplified music. The rear wall can also move forward to make a smaller and more intimate stage setting.

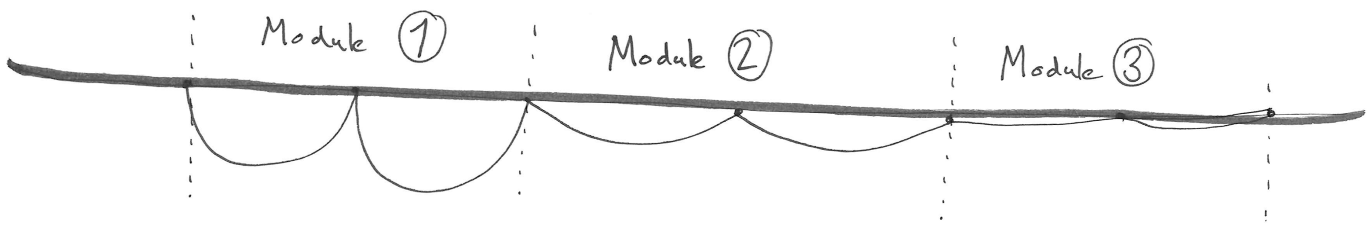
Mattias Johansson
ACEX16

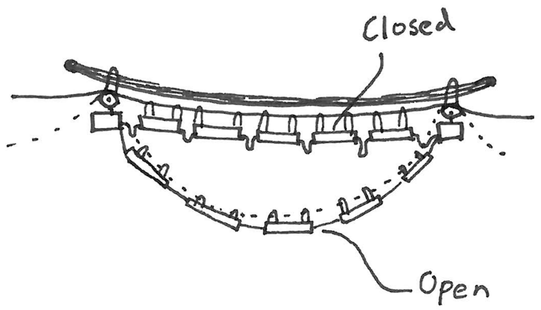
MECHANICAL & STRUCTURAL CONCEPT

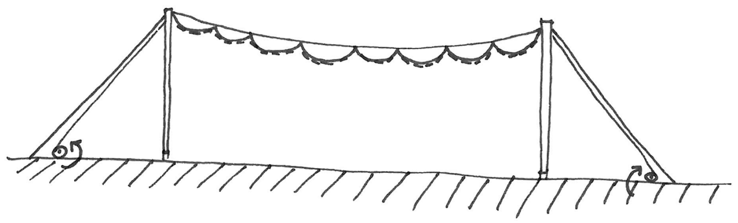


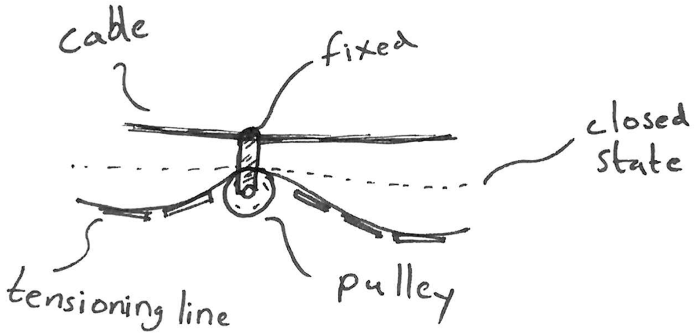













```
%% Simple preliminary model for openable suspended roof
clc; clear;

% ---- Geometry ----
L_global = 48;                  % Horizontal span of global cable [m]
S_global = 48.2;                % Actual cable length of global cable [m]
f_global = 2;                   % Sag of global cable [m]

n_bays = 16;                    % Number of local bays
L_bay_h = L_global/n_bays;      % Horizontal projection per local bay [m]
f_rope = 0.1;                   % Local sag / drop in lower rope [m]
theta_motor = pi/4;             % Angle of motor / pulling rope relative to horizontal [rad]

c_trib = 5;                     % Total tributary width over two global cables [m]
c_trib_per_cable = c_trib/2;

% ---- Plank / rib ----
b_plank = 0.25;                 % Plank width [m]
h_plank = 0.06;                 % Plank height / thickness [m]
I_plank = b_plank*h_plank^3/12;

% ---- Material ----
rho_plank = 440;                % Density of spruce [kg/m^3]
g = 9.82;                       % Gravitational acceleration [m/s^2]
E_parallel = 13700e6;           % Modulus of elasticity GL32c [Pa]
E_steel = 200e9;                % Modulus of elasticity of steel [Pa]

% ---- Load ----
q_h = c_trib_per_cable * h_plank * rho_plank * g;  % [N/m]
q_global = q_h * (S_global/L_global);              % [N/m]
q_rib = b_plank * h_plank * rho_plank * g;         % [N/m]

% ---- Global cable, simplified symmetric model ----
H_global = q_global * L_global^2 / (8*f_global);   % Horizontal force [N]
V_global = q_global * L_global / 2;                % Vertical support reaction [N]
T_cable_support = sqrt(H_global^2 + V_global^2);   % Maximum cable force [N]

% ---- Local lower rope, simplified symmetric model ----
V_rope = q_global * L_bay_h / 2;                   % Vertical reaction [N]
H_rope = q_global * L_bay_h^2 / (8*f_rope);        % Horizontal force [N]
T_rope_support = sqrt(H_rope^2 + V_rope^2);        % Maximum rope force [N]

T_motor = H_rope / cos(theta_motor);               % Motor / pulling force [N]

% ---- Safety factors ----
SF_cable = 5;
SF_rope  = 10;

T_cable_support_SF = T_cable_support * SF_cable;
T_rope_support_SF  = T_rope_support  * SF_rope;
T_motor_SF         = T_motor         * SF_rope;

% ---- Local rib / plank bending ----
L_rib = c_trib;
d_rib = 5*q_rib*L_rib^4 / (384*E_parallel*I_plank); % Deflection [m]
```

----------- GEOMETRY -----------
Global span: 48.0 m
Number of local bays: 16
Local bay, horizontal projection: 3.00 m
Local sag of lower rope: 0.10 m

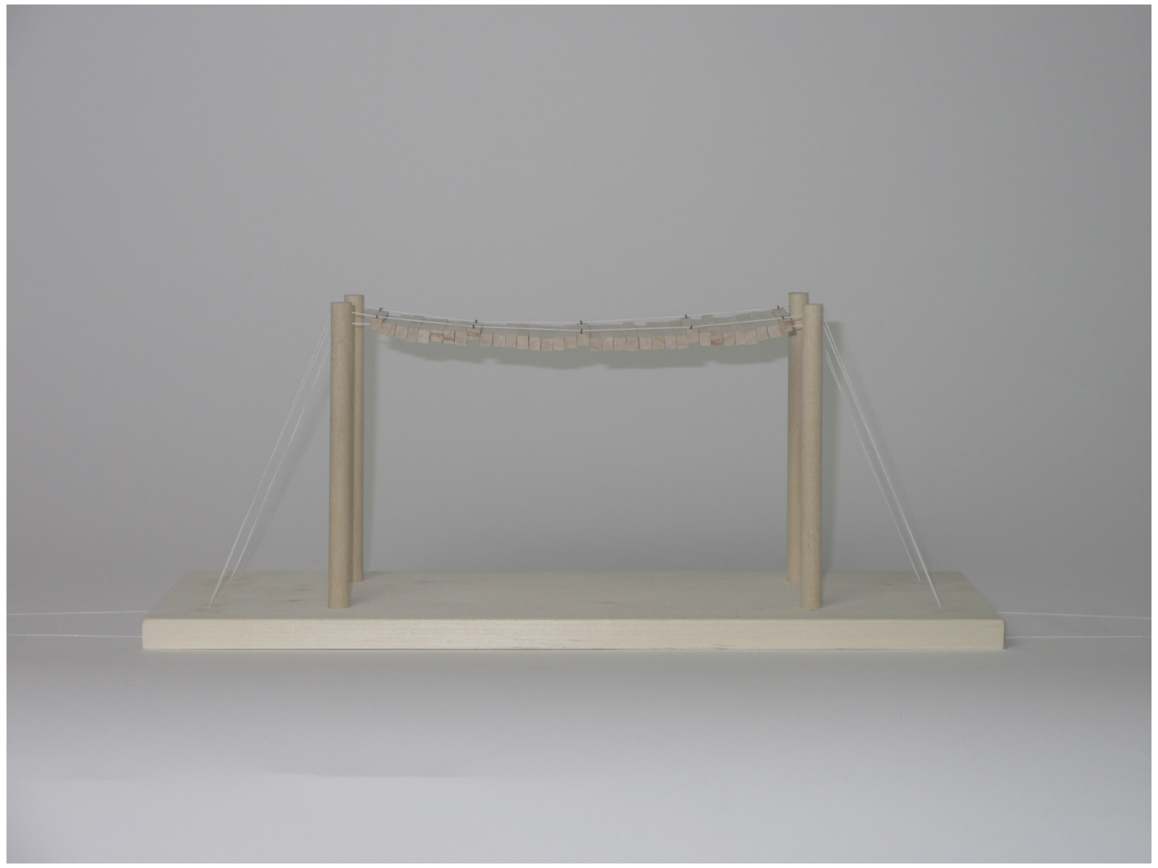
------------- RIB --------------
Rib span = 5.0 m
Rib deflection = 8.6 mm
Deflection ratio L/d = 584

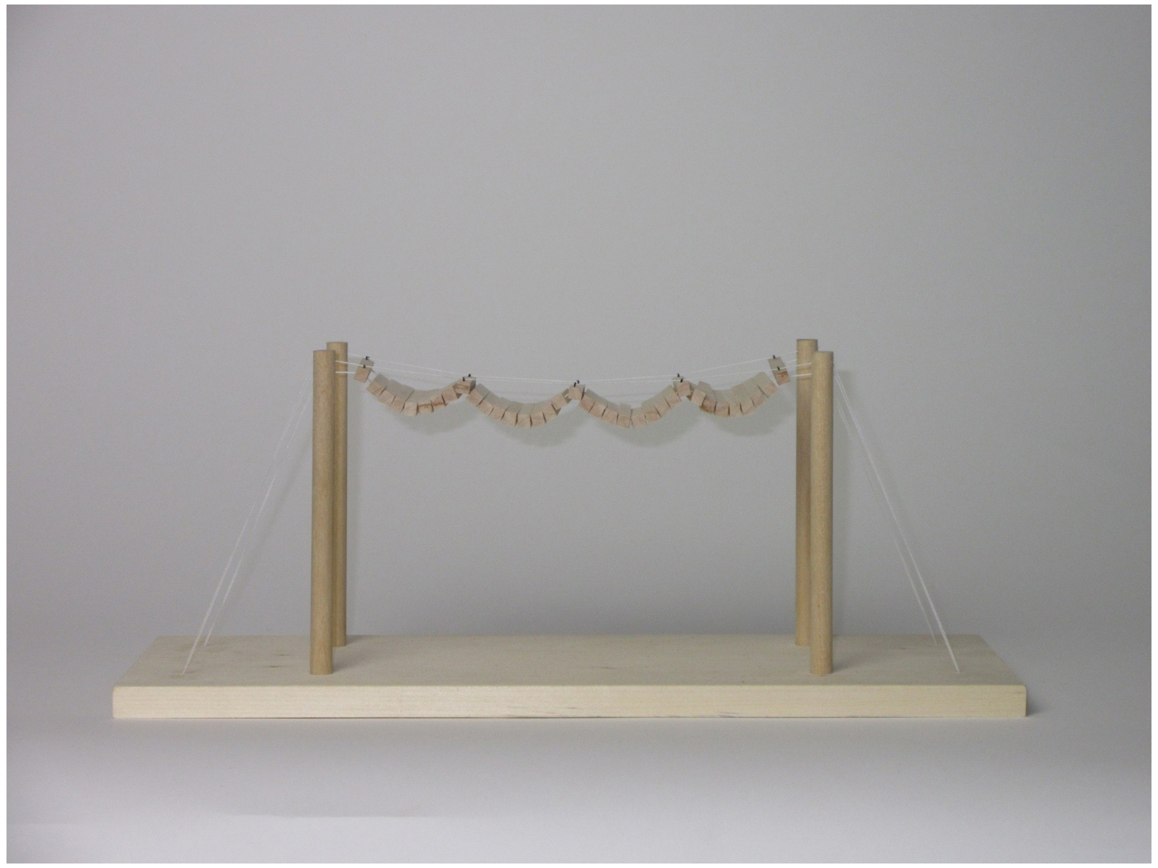
------------------- GLOBAL CABLE ---------------------
Horizontal force H = 93.7 kN
Vertical support reaction V = 15.6 kN
Maximum cable force at support T = 95.0 kN | with SF5 = 475.1 kN

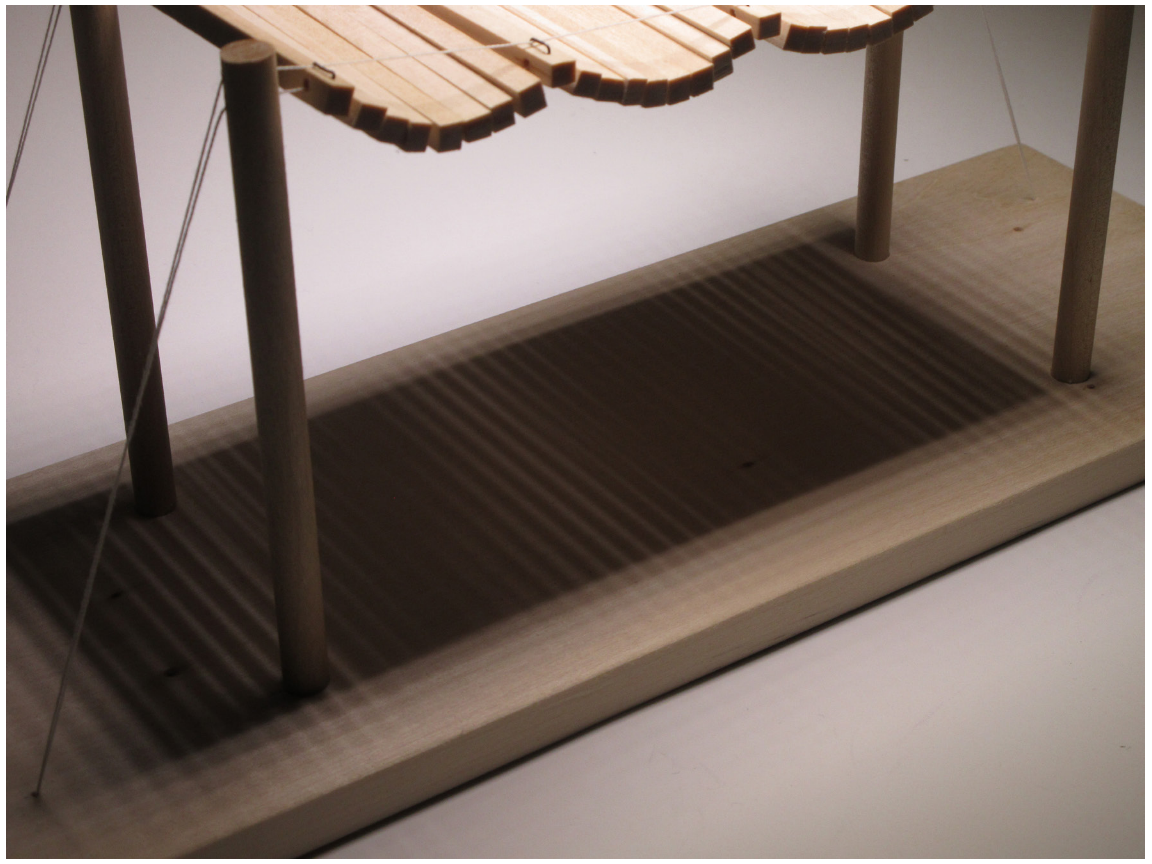
----------- LOWER ROPE ----------
Horizontal force H = 7.3 kN
Vertical reaction in local bay V = 1.0 kN
Maximum rope force in local bay T = 7.4 kN | with SF10 = 73.9 kN
Required motor force = 10.4 kN | with SF10 = 103.5 kN

Mattias Johansson
ACEX16

PHYSICAL MODEL

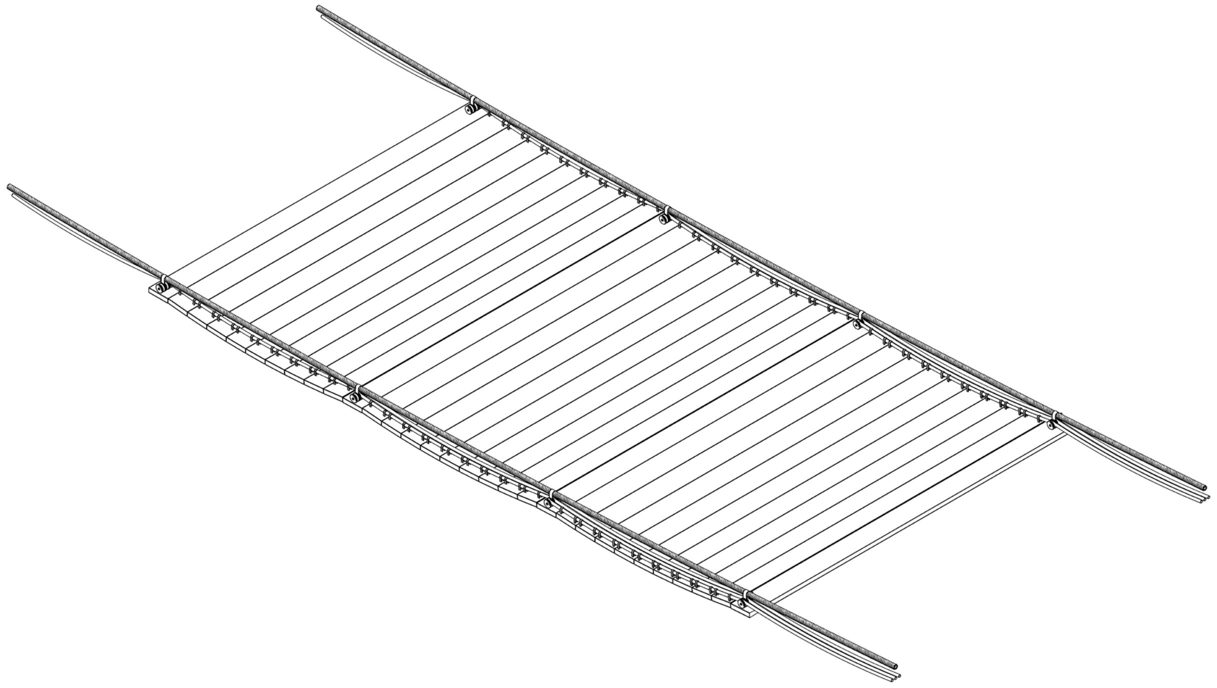


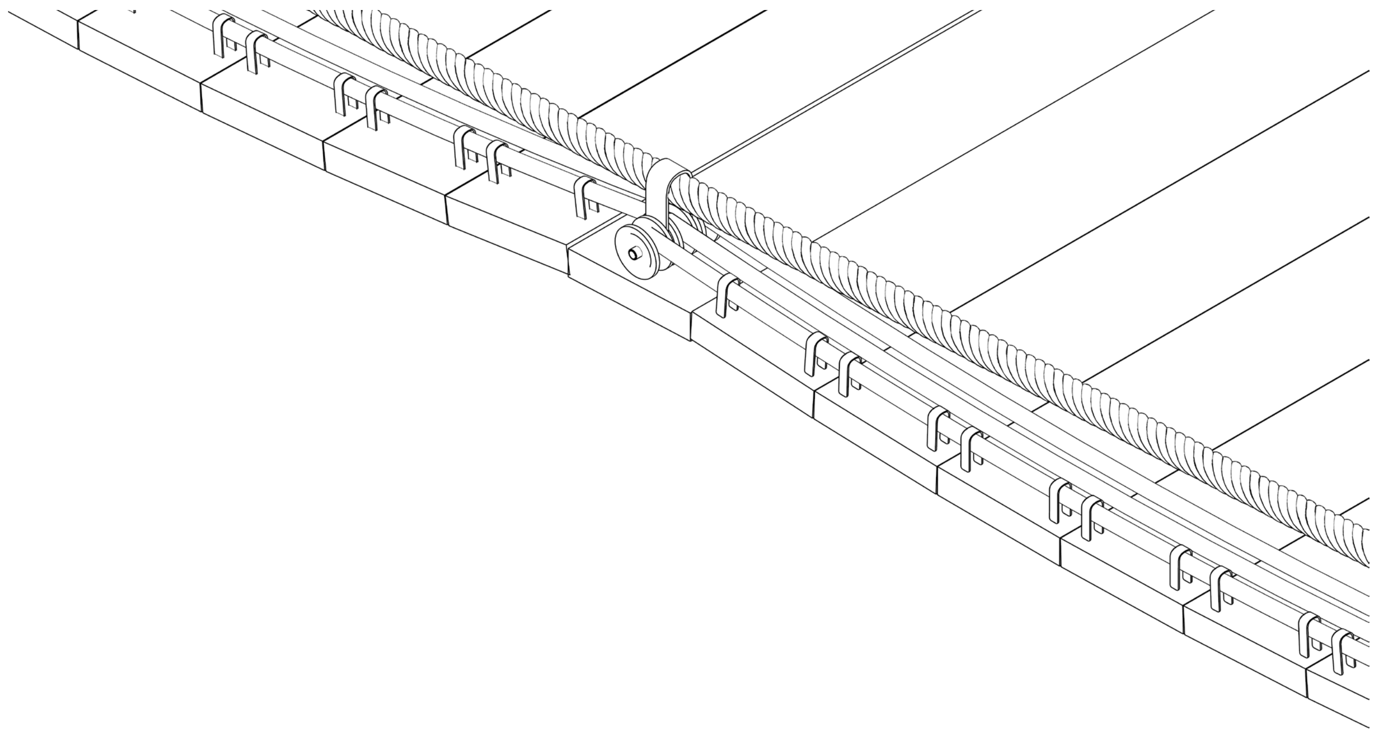


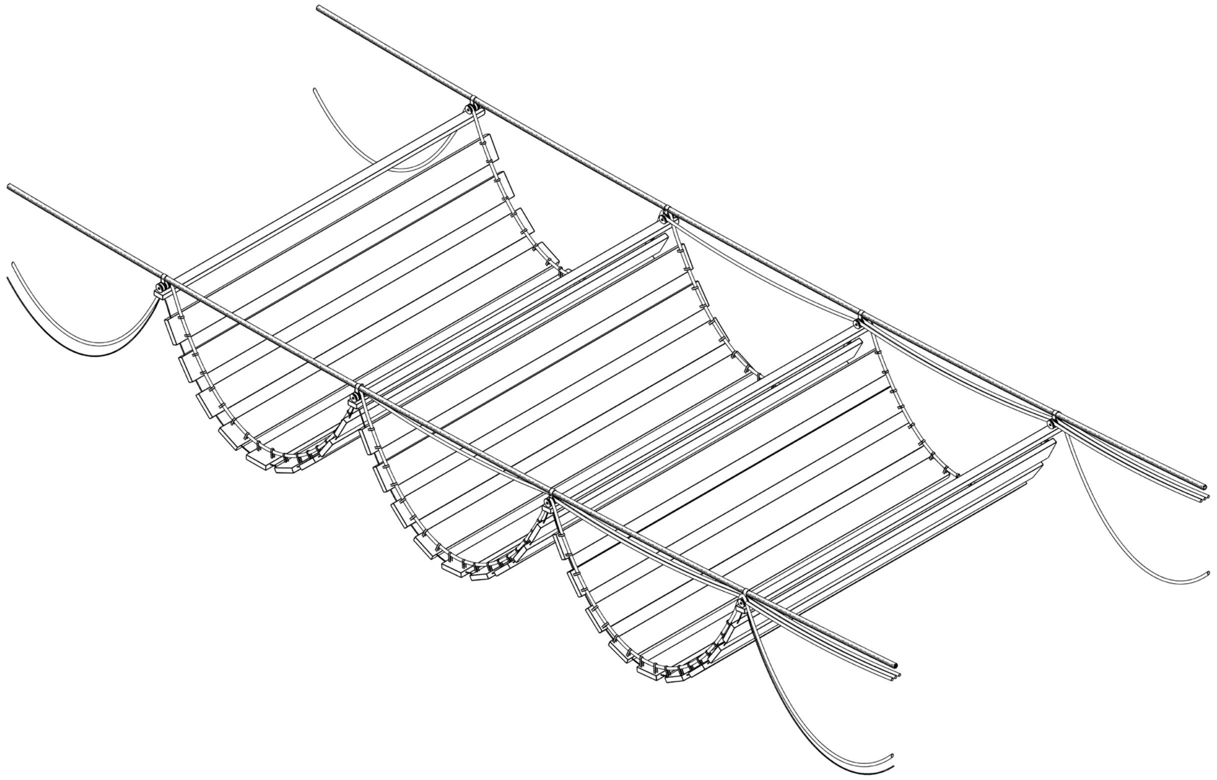


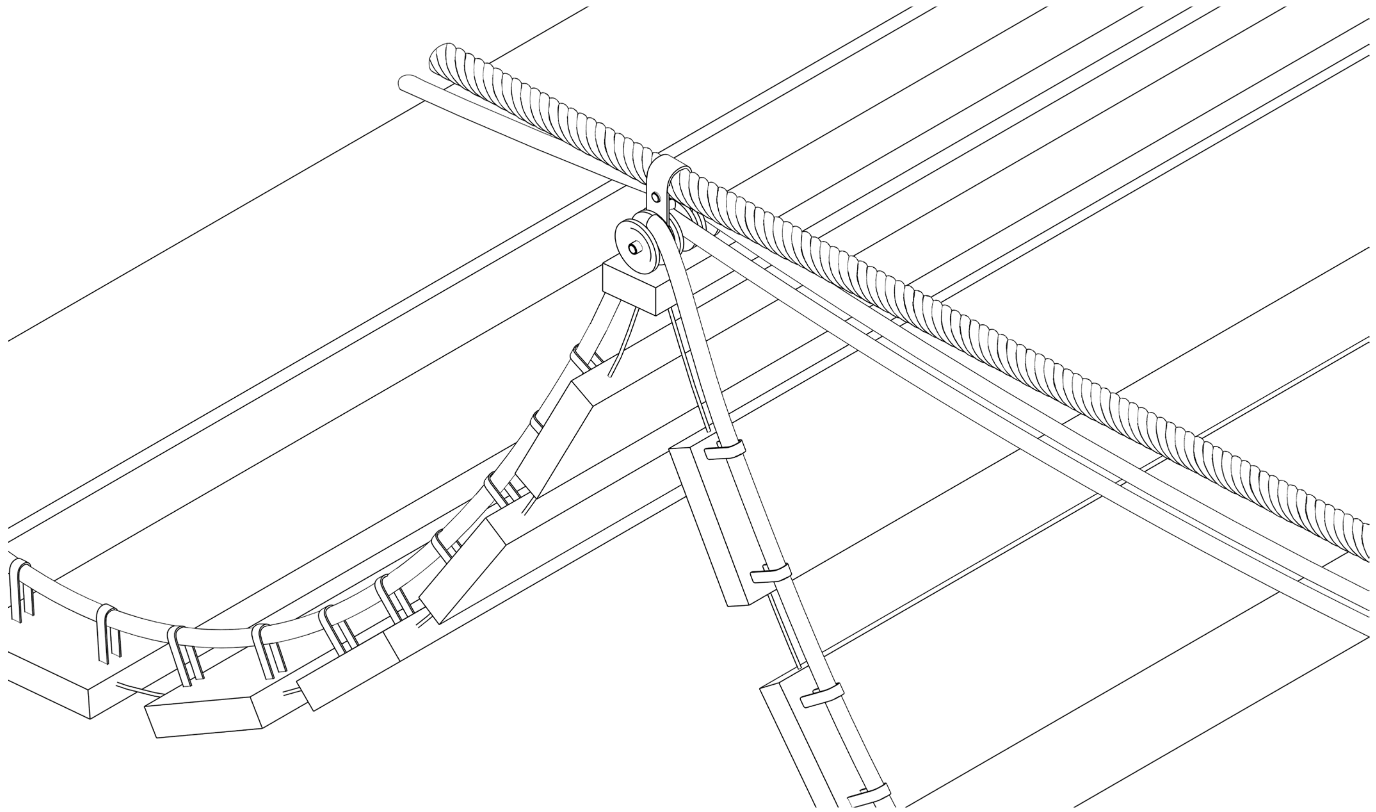
Mattias Johansson
ACEX16

ROOF MODULE









Mattias Johansson
ACEX16

Architecture and Engineering

During three years at Architecture and Engineering, I have developed a broad understanding of both architectural design and technical systems. The programme has introduced me to an interdisciplinary way of working, where architectural ideas are developed together with structural systems, climate, acoustics and other performance-based aspects.

An important part of this has been performance-driven design. For me, this means designing architecture that is not only visually convincing, but also responds to technical demands. Acoustic qualities, indoor climate, structural systems and material efficiency can all influence the design from an early stage, instead of being treated as separate additions later in the process.

Solving complex problem

The education has also taught me how to handle complex projects through an iterative process. Design ideas are rarely solved directly, but need to be tested, adjusted and developed over time. Through drawings, models, calculations and analysis, I have learned to move between architectural ideas and technical reasoning, and to evaluate both the concept and how it performs in practice.

After three years, I take with me both knowledge and a way of working. The programme has shown me the value of combining different disciplines, and how technical understanding can support the design process rather than limit it.