CAMANCHACA

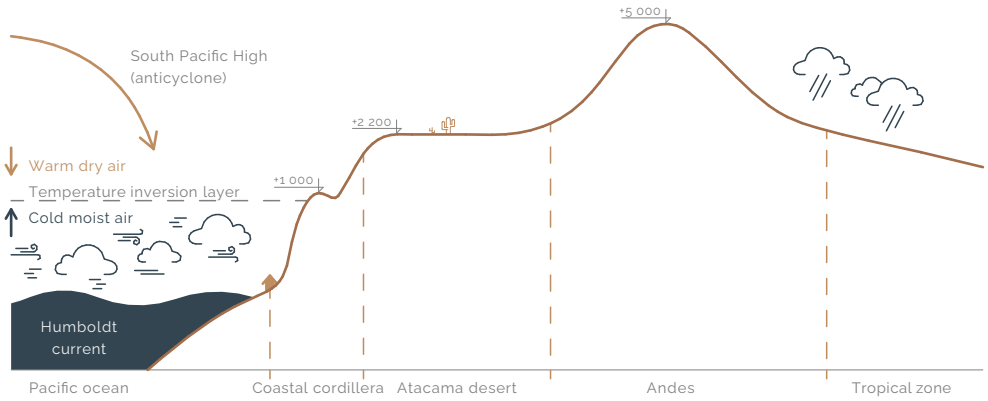
WATER TECHNOLOGY CENTE
AND A REPLICABLE FOG HARVESTING MODULE FOR COMMUNITIES IN THE ATACAMA DESERT

Anastasia Balašova

supervisor
Jaan Kuusemets

Camanchaca

A special type of dense coastal fog that forms along the Pacific coast of South America under the influence of the cold Humboldt Current and the South Pacific High (anticyclone).



Camanchaca

Fog composed of ultra-fine droplets that are too light to fall as rain. A temperature inversion layer prevents them from rising, while the coastal mountains block them from moving inland. As a result, this vast mass of stratocumulus clouds becomes trapped right along the coast, suspended in the air as an ideal source for harvesting moisture.

Chile's problem

The Atacama Desert is the driest place on Earth, but due to climate change, extreme drought is rapidly spreading southward across the country. Natural freshwater sources are disappearing, turning water scarcity into a chronic threat to the livelihoods of entire regions. This crisis is being exacerbated by a complex combination of factors...

Mining industry

Lack of construction and
land ownership control

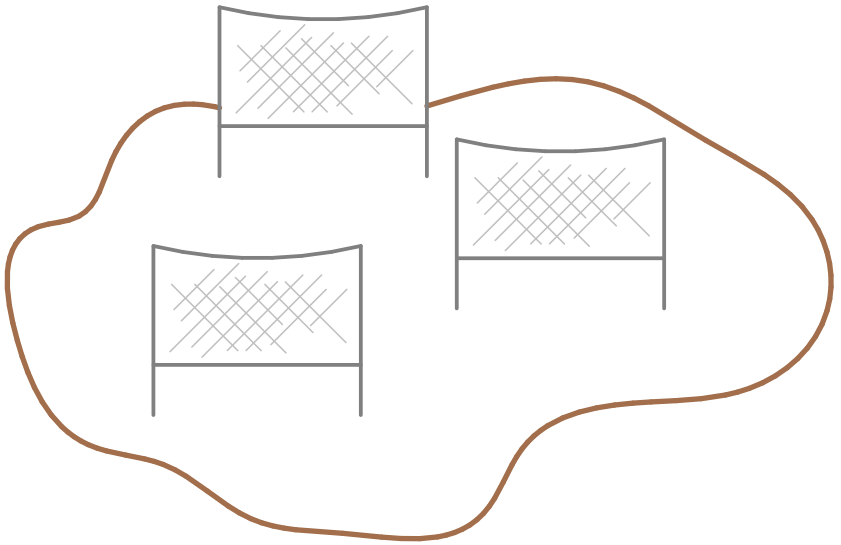
Freshwater scarcity
(natural and geographical causes and human activity)

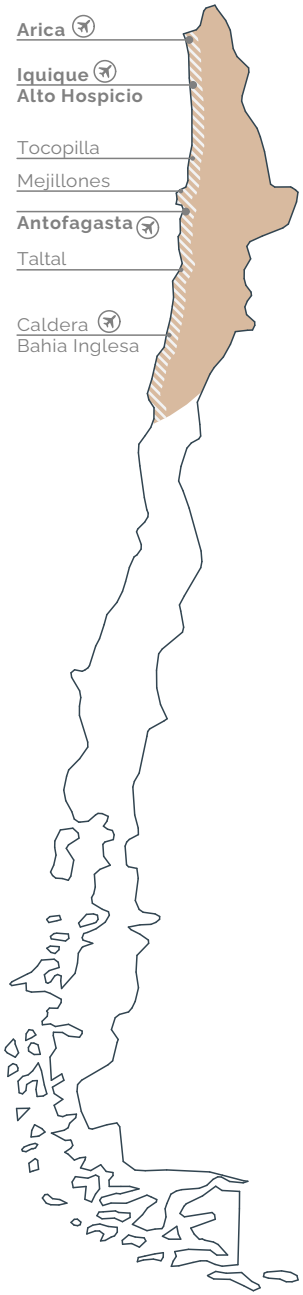
“Convenience migration”

Desalination of ocean water
and its transport by tankers

Architectural response

The solution emerges at the intersection of nature and technology. Using special mesh structures, architecture captures camanchaca, transforming the elusive coastal fog into a tangible and clean source of freshwater, restoring life and independence to the arid lands of Chile.

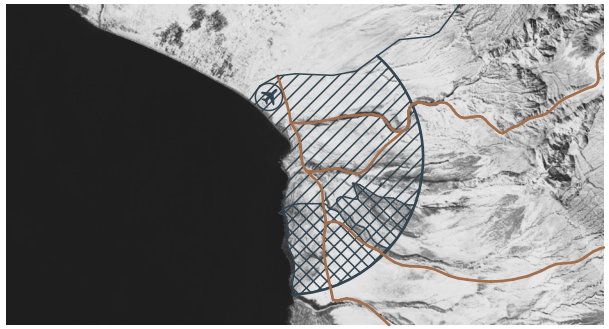




Site selection

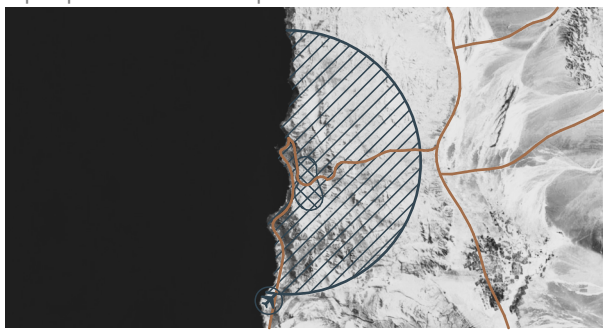
The search for a location was based on an analysis of climate and logistics. Among all coastal regions, Iquique offers the ideal potential: unlike the steep cliffs of other areas, here the vast Alto Hospicio plateau extends directly to the ocean while remaining within walking distance of major transport corridors.

Arica



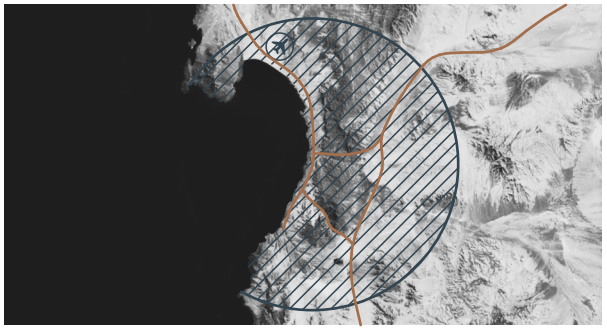
Peamaanteed

Iquique / Alto Hospicio



30 km tsoon linna keskusest

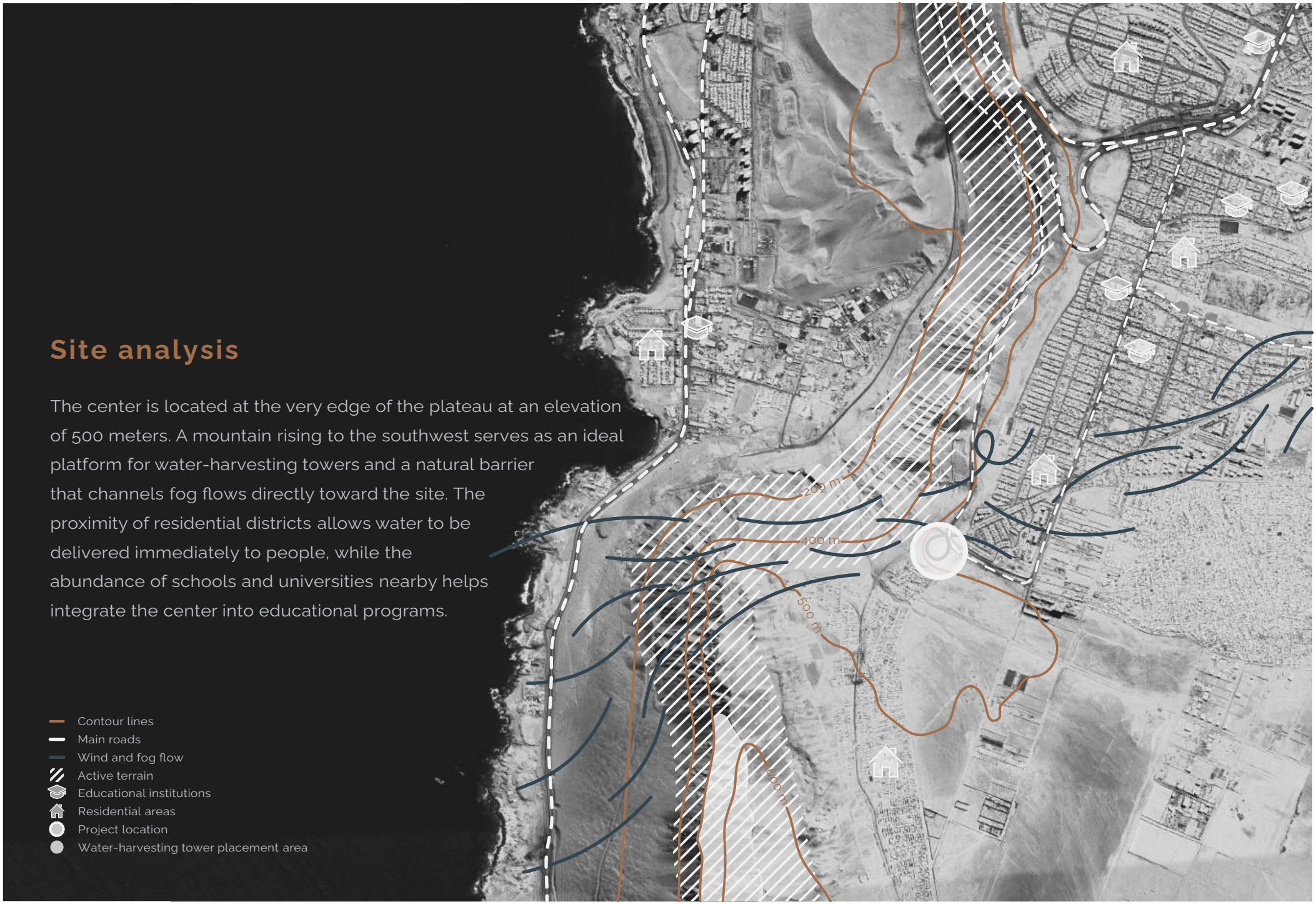
Antofagasta



Platoo 400–900 m üle merepinna

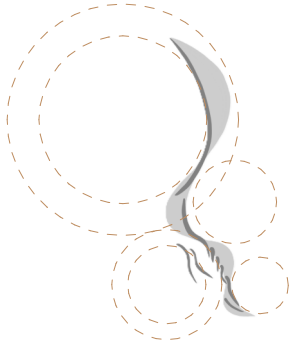
Site analysis

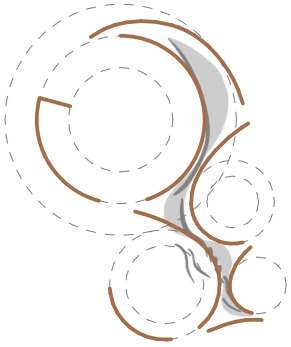
The center is located at the very edge of the plateau at an elevation of 500 meters. A mountain rising to the southwest serves as an ideal platform for water-harvesting towers and a natural barrier that channels fog flows directly toward the site. The proximity of residential districts allows water to be delivered immediately to people, while the abundance of schools and universities nearby helps integrate the center into educational programs.

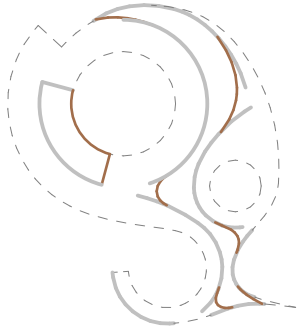


Concept

The image of the center is born from a dialogue between two forces of the Atacama: the plasticity of sand dunes and the semi-transparency of fog. To find this balance, seven exploratory models were developed, from which the two most successful forms were combined into the final geometry of the building. The smooth lines of the building's massive base echo the geometry of the foothill sand dunes.







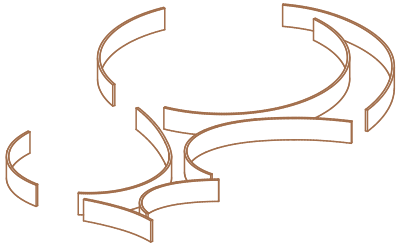
1 - main entrance, 2 - researchers' entrance, 3 - entrance to the underground level,
4 - tourist trail to the mountain viewing and water-harvesting tower, 5 - waste collection building

Site plan solution

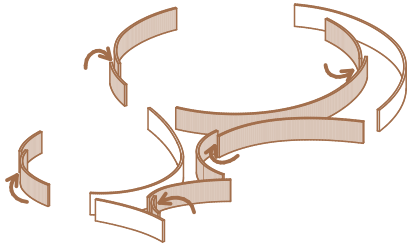
The complex is located at the very edge of the plateau, using the change in terrain to create a subtle separation of functions. The building itself dominates the upper level, while parking and technical areas are hidden further down the slope. From the main entrance to the center, a scenic pedestrian route begins, leading directly into the mountains toward the water-harvesting towers and the viewing platform.

Shape

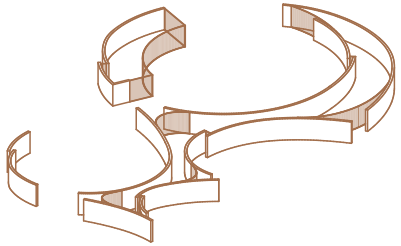
The design evolves from the basic geometry of the walls toward the creation of functional recessed niches for entrances and glazing. The division of the roof into segments of varying heights emphasizes the functional zones and creates a dynamic silhouette that echoes the rolling terrain. The final touch is the integration of multilayered “fog harps” on the terraces.



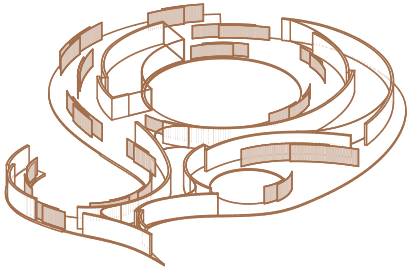
Main wall geometry



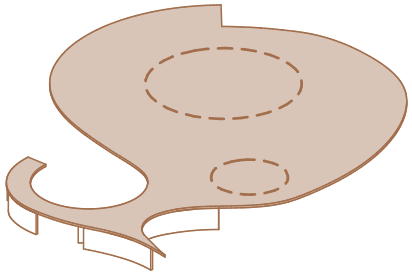
Design of additional
“pocket” openings



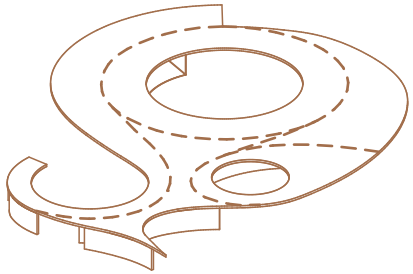
Glazing



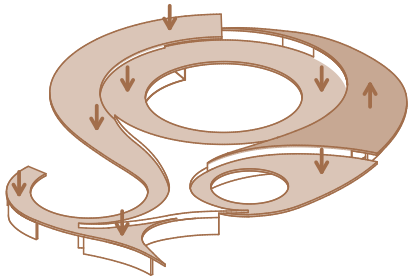
Integration of fog-capture
systems



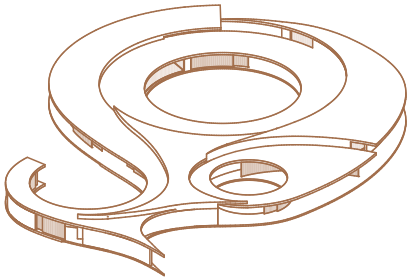
Unified roof volume.
Atriums for inner gardens



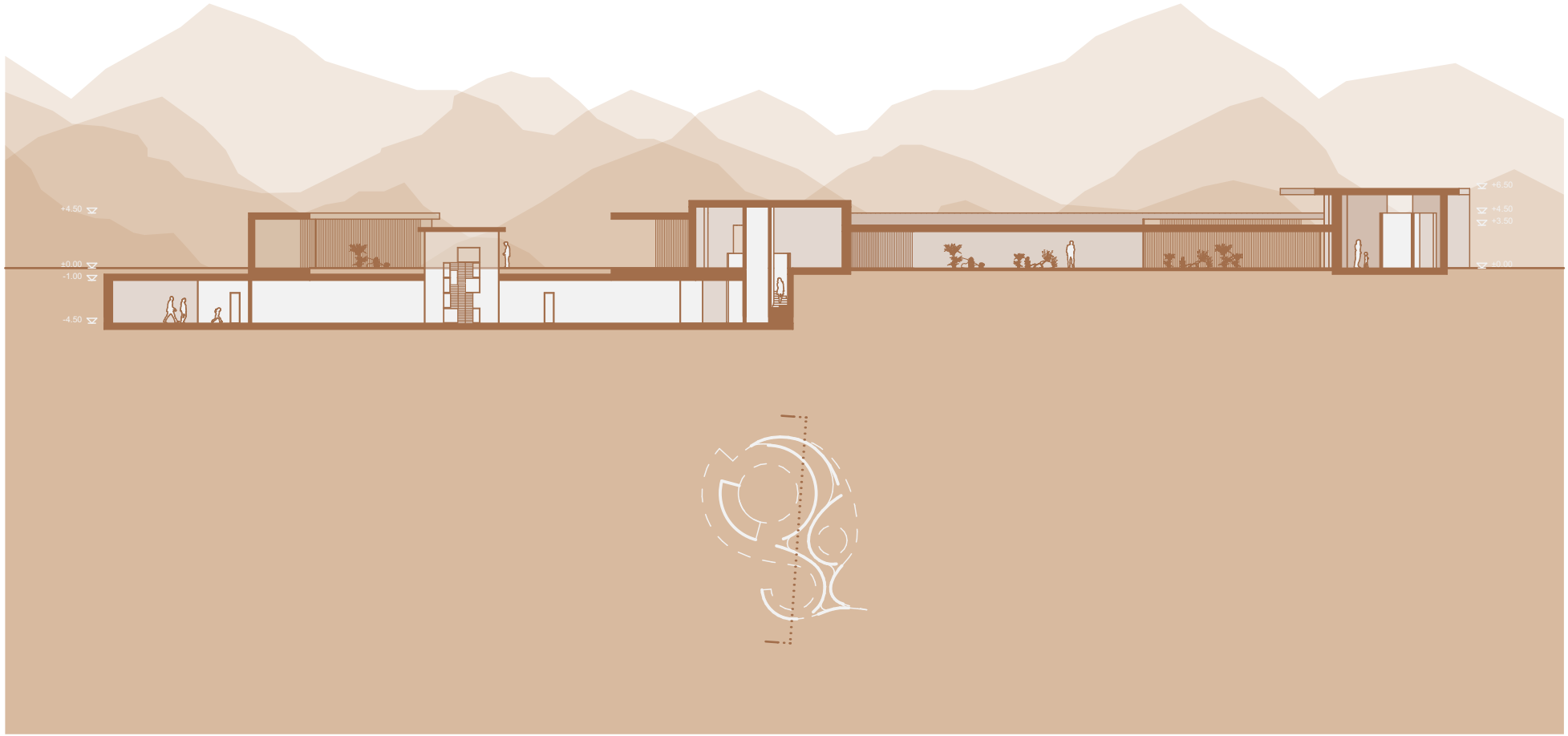
Roof soning



Roof height solution



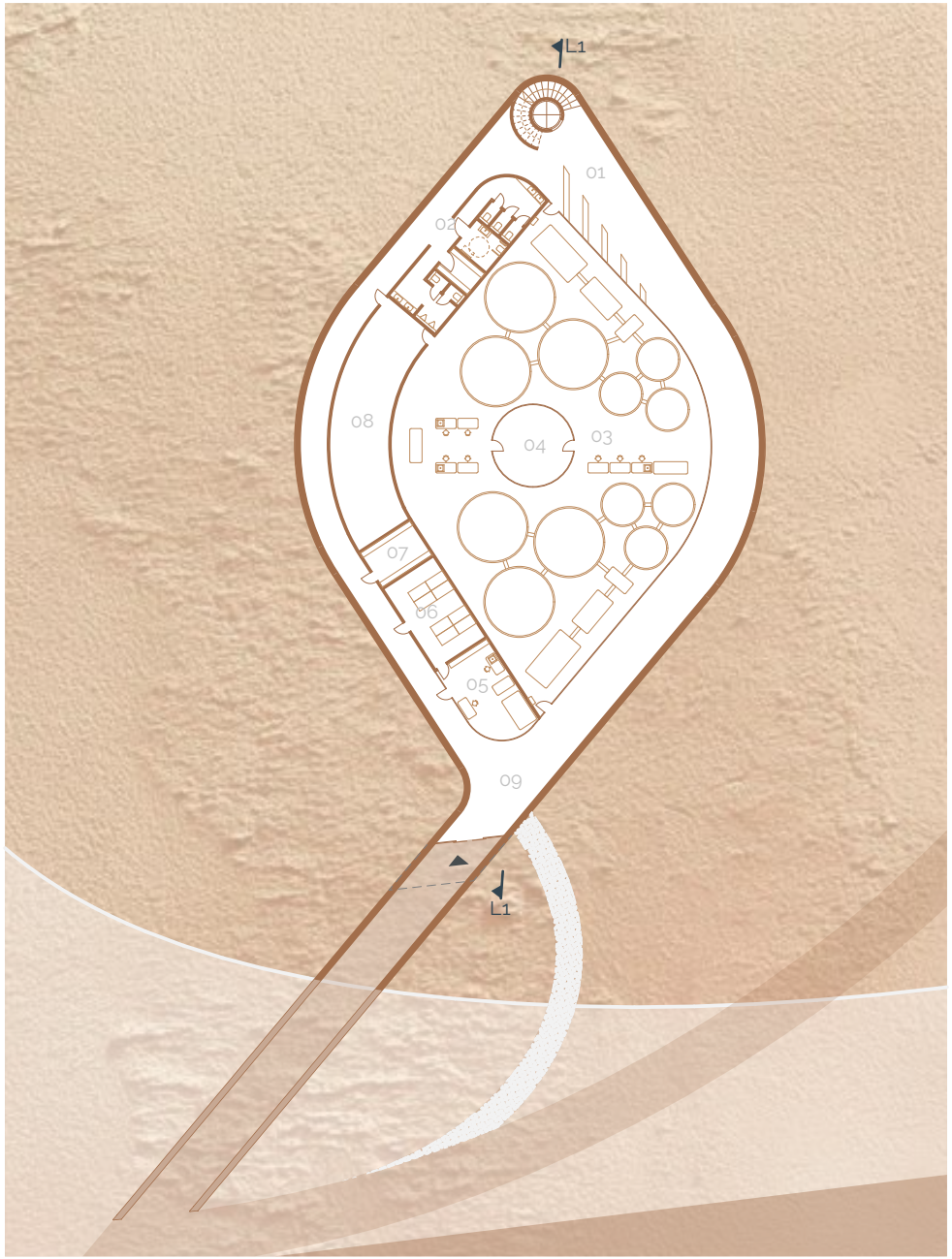
Final volume


+4.50
±0.00
-1.00
-4.50
+6.50
+4.50
+3.50
±0.00

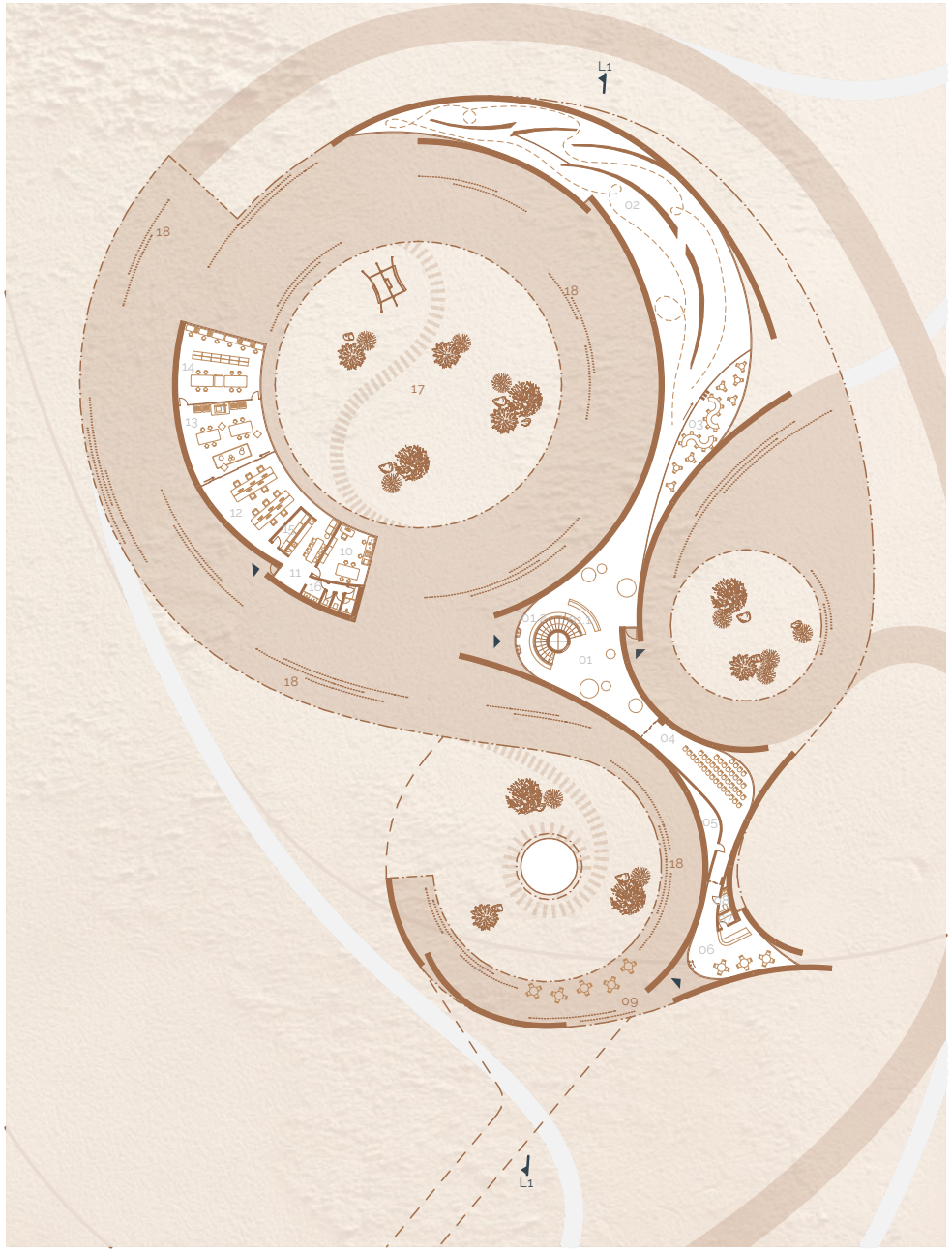
Floor Plans

The underground level is entirely dedicated to engineering and logistics. In the main hall, behind transparent glass walls, visitors can closely observe the entire process of purification and treatment of the harvested moisture.

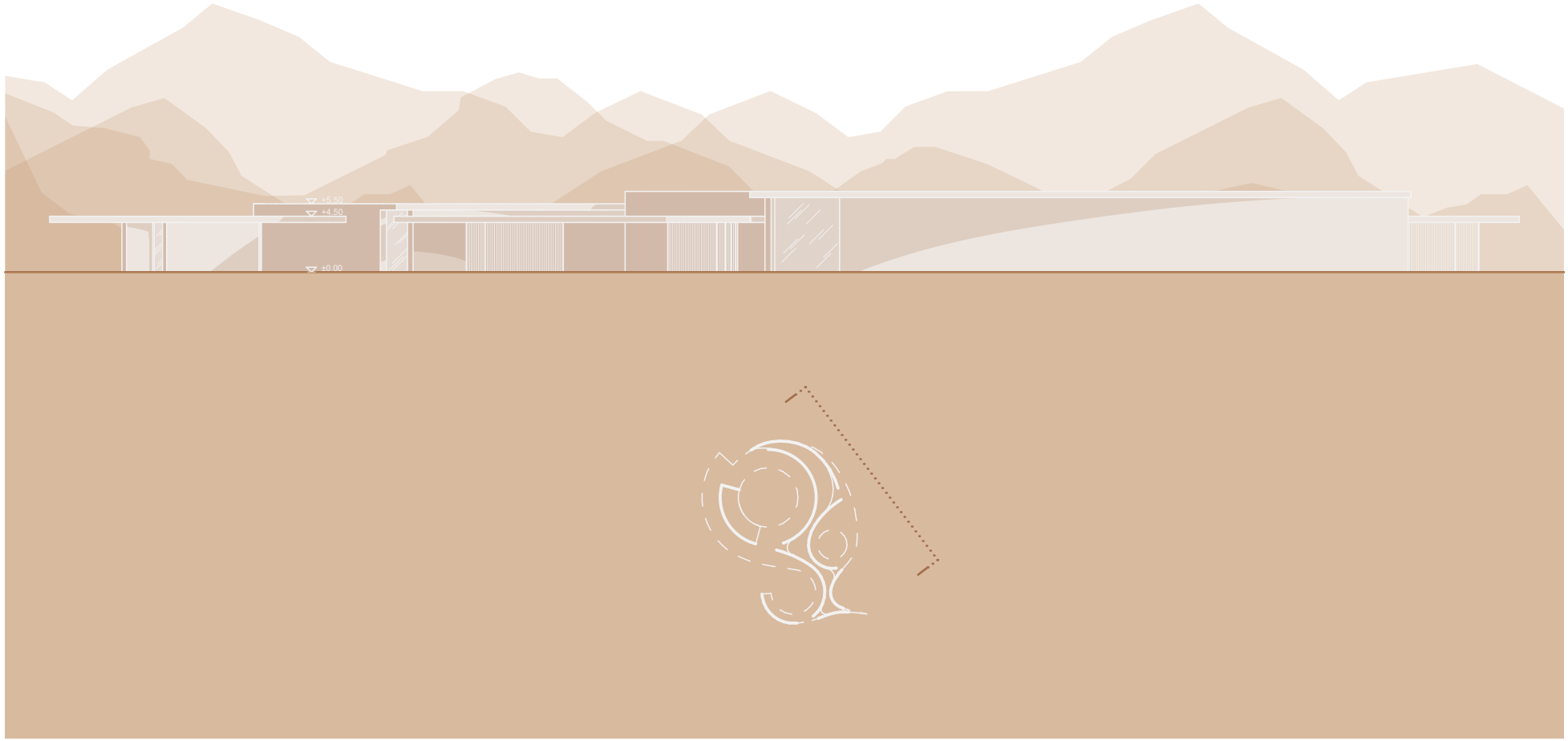
The concept of three internal courtyards and surrounding “fog terraces” blurs the boundary between the interior and the desert, transforming the galleries with integrated fog-harvesting modules into part of the scientific and educational visitor route.



01 - cloakroom, 02 - restrooms, 03 - “water journey” hall, 04 - testing area, 05 - coating application workshop, 06 - raw materials storage, 07 - utility room, 08 - technical room, 09 - corridor

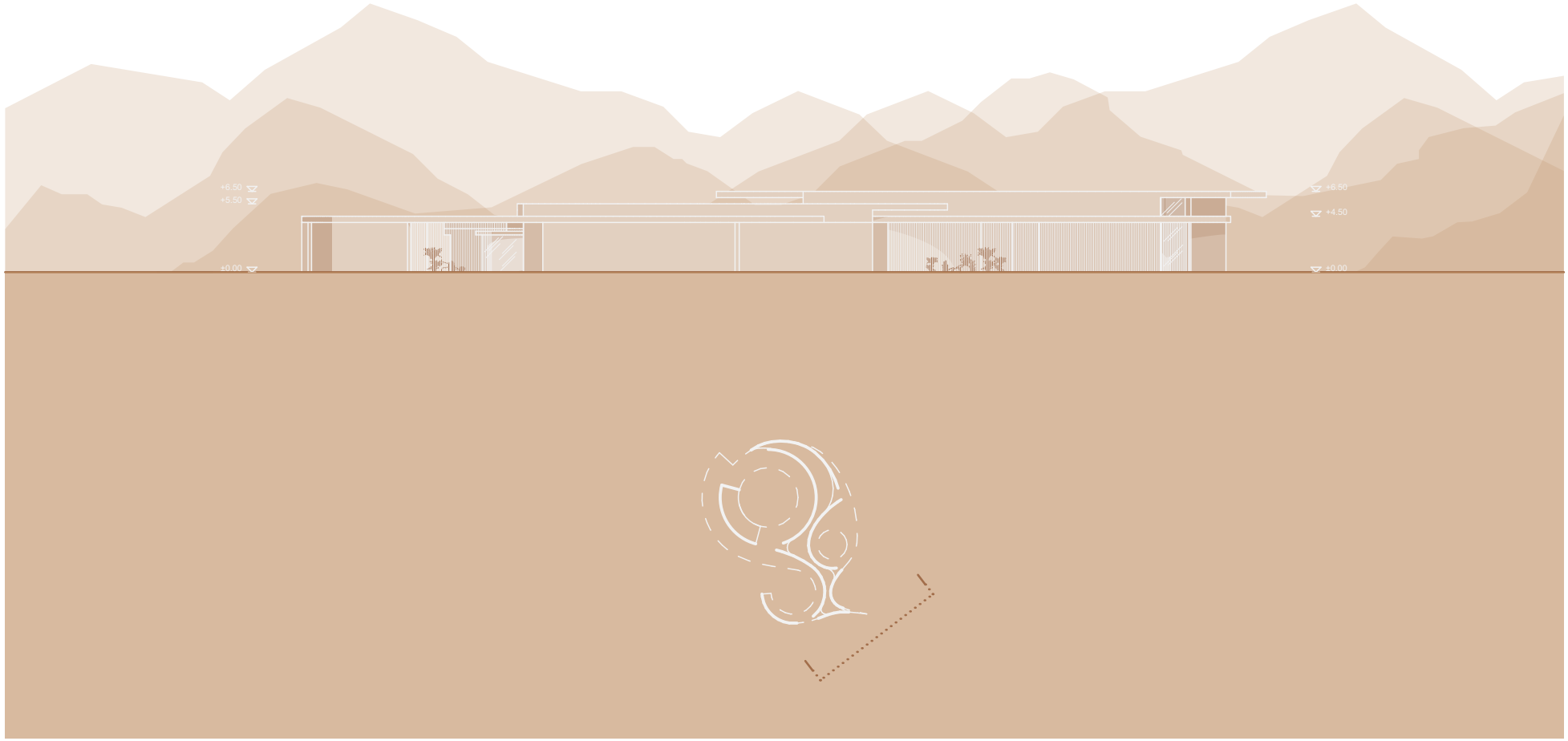


01 - lobby, 01.1 - information desk, 01.2 - souvenir shop, 02 - exhibition hall, 03 - workshop, 04 - seminar room, 05 - storage room, 06 - café, 07 - storage room, 08 - wc, 09 - café terrace, 10 - hydrometeorology laboratory, 11 - staff lounge with kitchen, 12 - researchers' office, 13 - prototyping area, 14 - materials science laboratory, 15 - archive, 16 - wc, 17 - testing area, 18 - fog collection systems.


+5.50
+4.50
±0.00

Materials

The architectural image of the center is based on a monolithic unity with the landscape of the Atacama. The exterior walls are covered with rough sand-colored shotcrete that imitates the texture of rocks and desert dunes. The interior plays on contrasts, where the coolness of polished concrete floors is complemented by warm accents of copper and nylon, referencing the materials of the water-harvesting towers and creating a tactile and harmonious space.

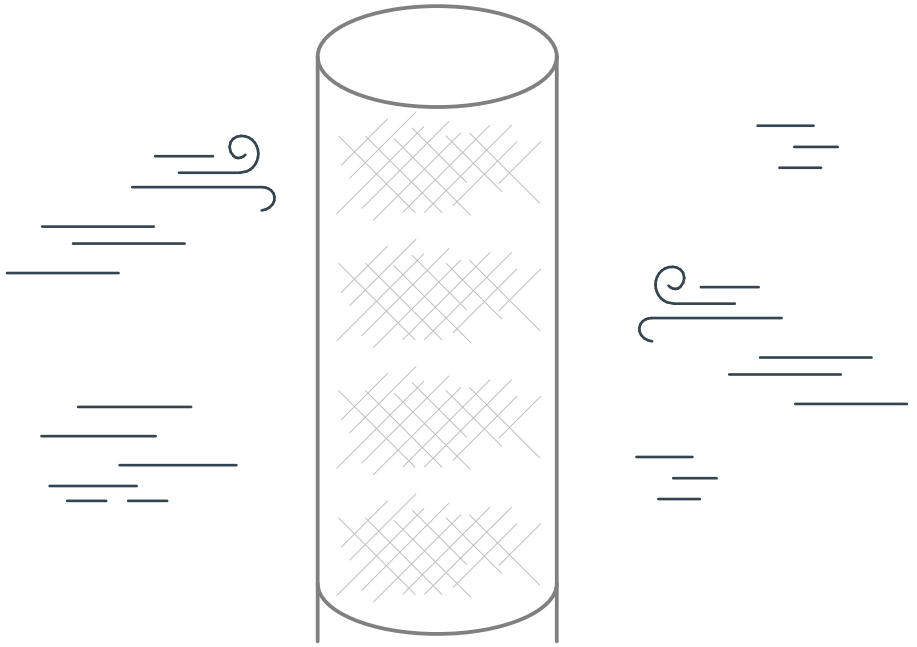

+6.50
+5.50
±0.00
+6.50
+4.50
±0.00

Fog collection towers

Monumental engineering structures located on the mountain peak serve as the main fog collectors. Like sails unfurled against the wind, they intercept drifting clouds to transform the fleeting mist into tangible streams of clean water.

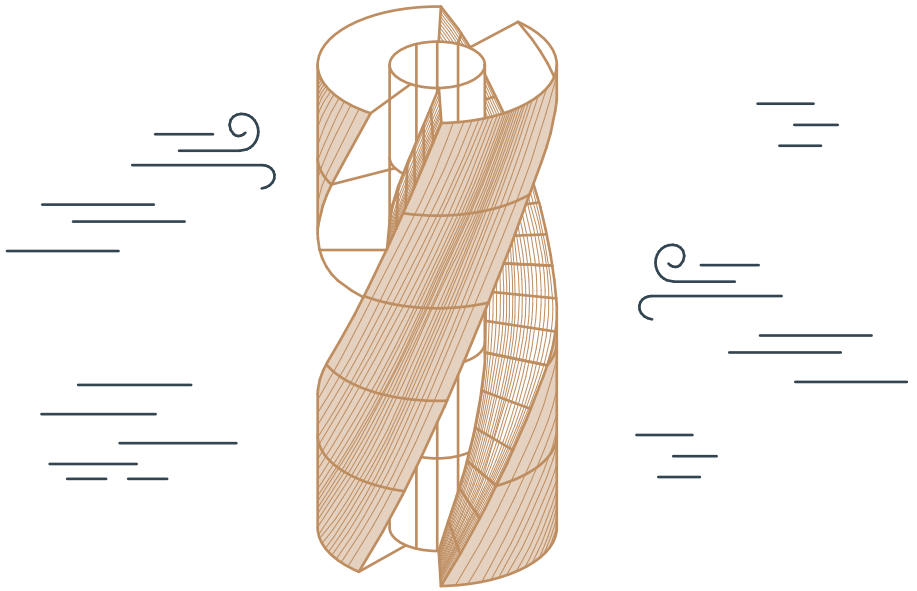
Module form development concept

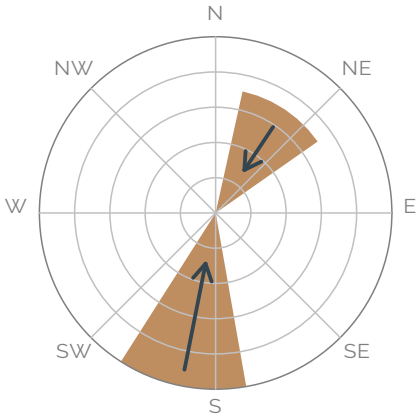
The search for the ideal geometry of the collection towers was based on a delicate balance between aerodynamics and maximum moisture-harvesting efficiency. During the research process, three fundamentally different tower forms were developed and tested in detail. In addition to the overall shape, both the structure of the mesh itself and the design of each individual thread were carefully studied and refined.



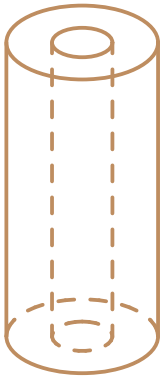
Concept № 1

The first form is a spiral structure that, through its geometry, creates a pressure difference—a high-pressure zone on the outside and a low-pressure zone within. This pressure gradient drives the wind into the structure, where additional internal surfaces are positioned to capture fog.

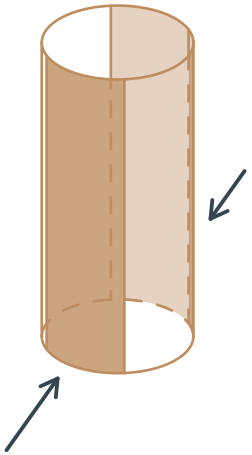




Prevailing wind directions



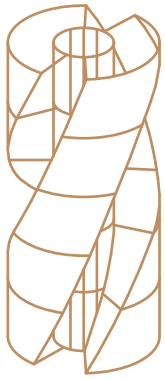
Double contour



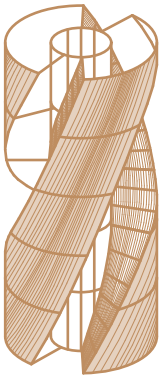
Separation of working sectors

Facade twisting into a spiral

Formation of vortex niches



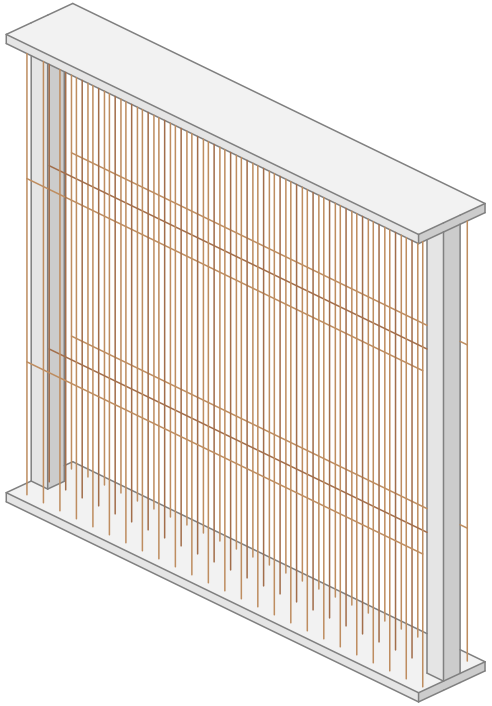
Structural frame



Harp with variable spacing

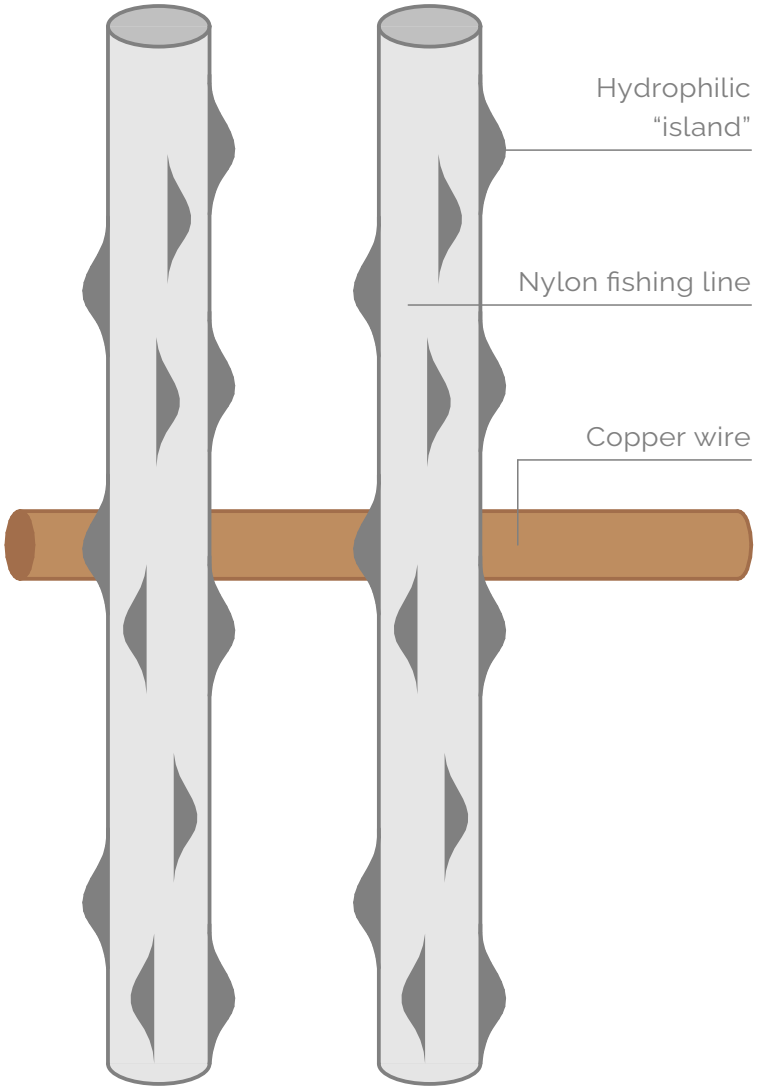
Concept Nº 1

For the first spiral tower, a system of vertical threads was developed. This solution was driven by the need to maximize droplet transport speed. The minimal number of horizontal connections allows water droplets to slide downward almost instantly, quickly clearing the mesh surface for the collection of new fog particles.



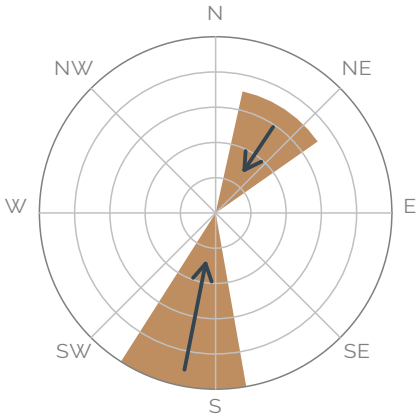
Concept Nº 1

To maximize efficiency, the hydrophobic base threads of the mesh are selectively coated with a hydrophilic solution that forms microscopic “islands.” This combination of materials causes moisture from the fog to condense instantly at these points and accelerates the formation of larger water droplets.

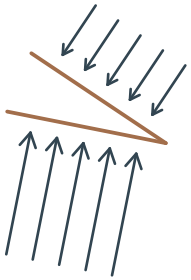


Concept № 2

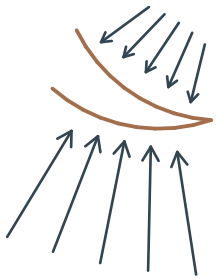
The second concept is based on the use of two surfaces, one of which features an S-shaped curvature. This geometry creates an injection (suction) effect, in which the airflow moving around the convex surface accelerates sharply and is directed into the enclosed inner part of the structure.



Prevailing wind directions

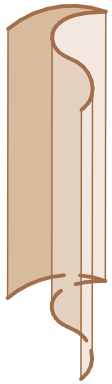


Primary capture fronts



Form adaptation for variable wind conditions and reduced resistance

Creation of a suction effect

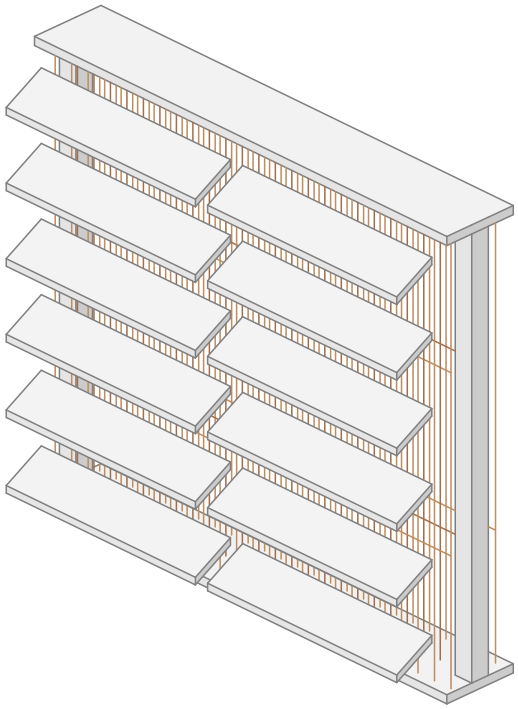


Spatial volume

Form refinement

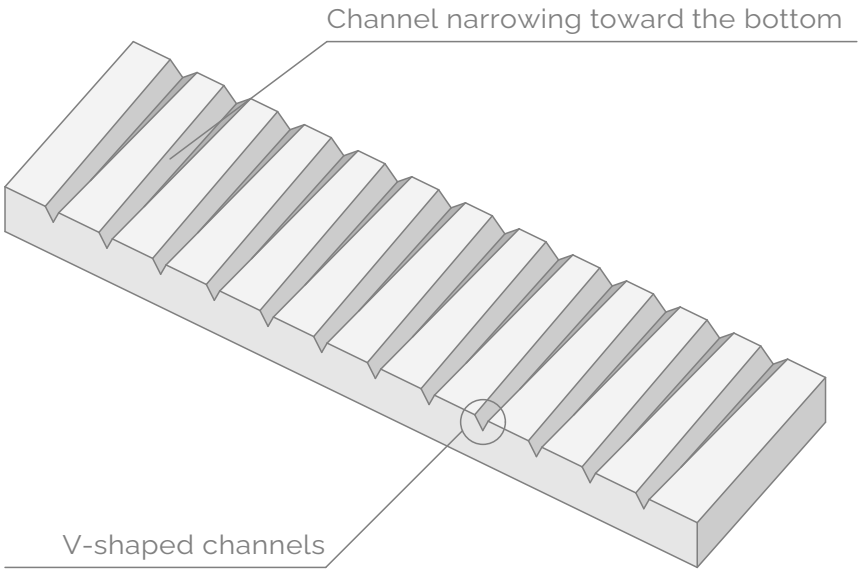
Segmentation

Integration of deflector panels



Concept № 2

Instead of a conventional mesh, inclined panels are used to generate vortices and transform the smooth movement of fog into turbulent flow. Within this chaotic environment, microscopic water droplets begin to collide, merge into larger droplets, and settle much more efficiently onto the collecting surfaces.

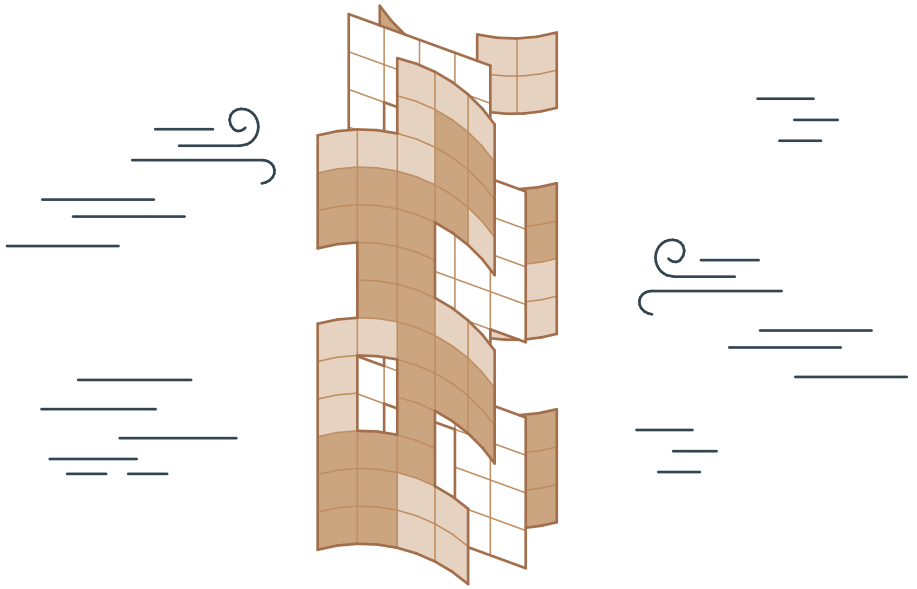


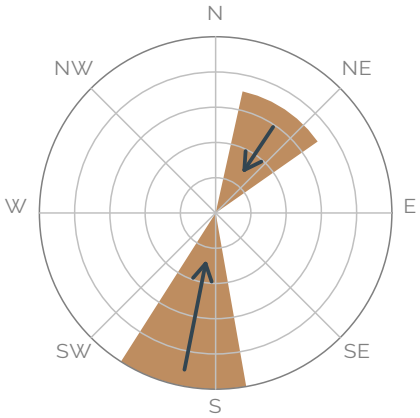
Concept № 2

The surfaces of the inclined panels are not smooth but are covered with a network of miniature V-shaped channels. These micro-grooves act as guiding capillaries, instantly capturing droplets and rapidly directing them into the integrated drainage system.

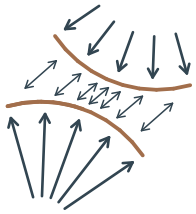
Concept № 3

The third concept employs a three-layer, lens-shaped tower form. Due to the narrowing of the volume in its central section, the airflow passing through the tower accelerates significantly, greatly increasing the likelihood of microscopic fog droplets colliding with the collection elements. To reduce wind resistance, each tier of the tower is composed of three different surface types—meshes, inclined panels, and open passages—which allow storm winds to pass safely through the structure.

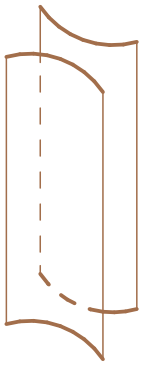




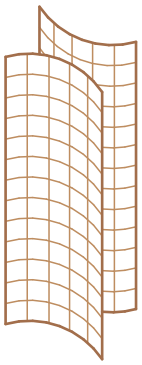
Prevailing wind directions



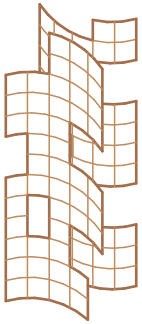
Form adaptation for variable winds and flow compression



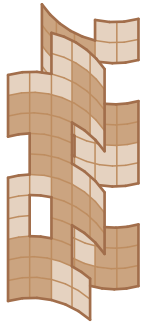
Spatial volume



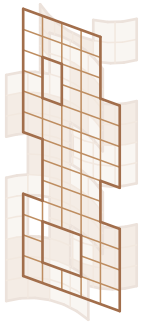
Structural mesh



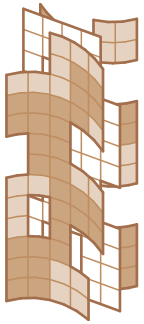
Opening system



Arrangement of standard panels and louvered panels



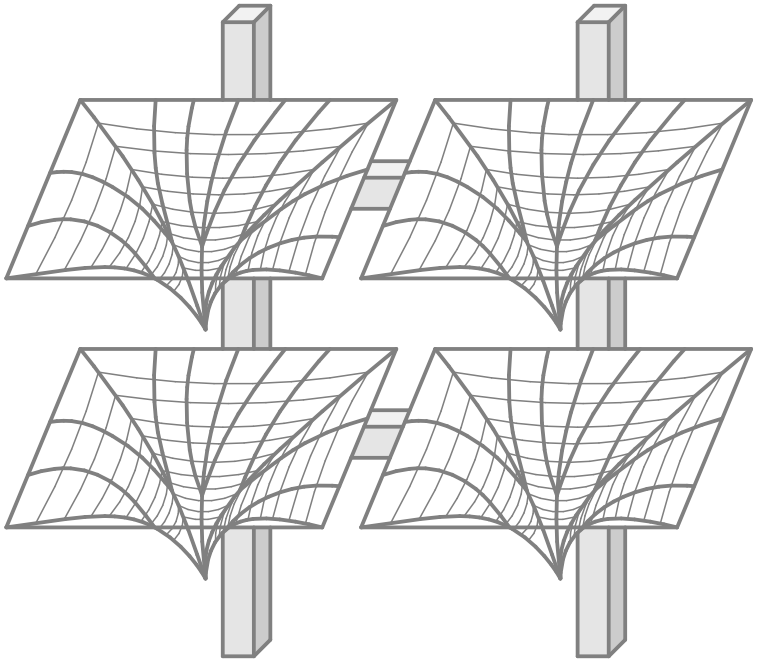
Internal collection panel



Final result

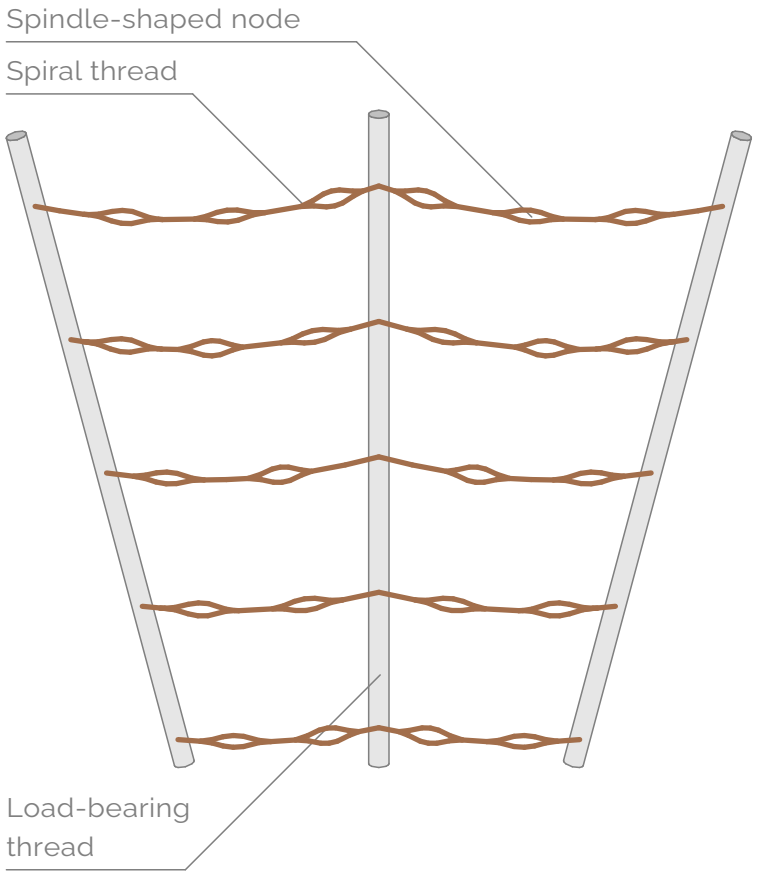
Concept № 3

The collection mesh in this concept fully imitates the structure and operating logic of a natural spider web.



Concept № 3

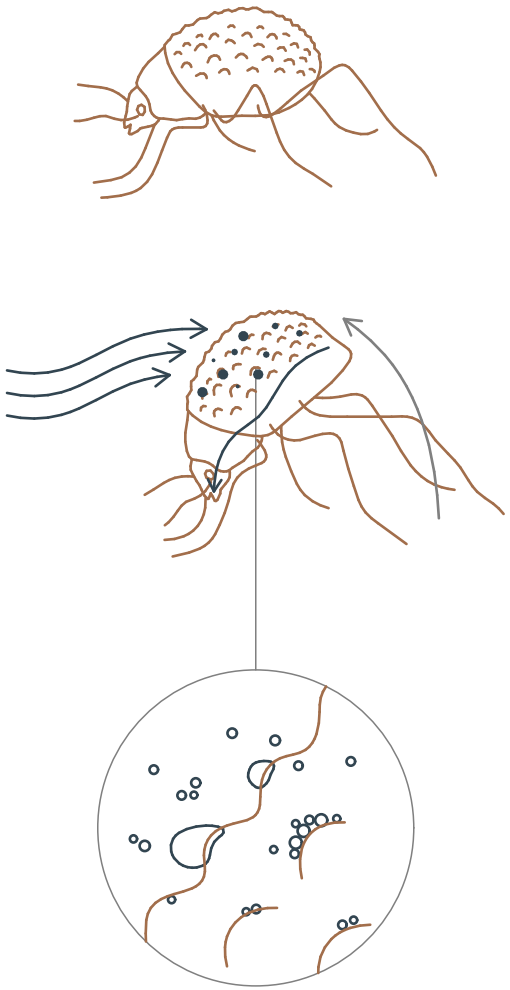
A special coating is applied to the threads, forming microscopic nodules that attract moisture and cause droplets to grow and merge many times faster than on conventional surfaces.



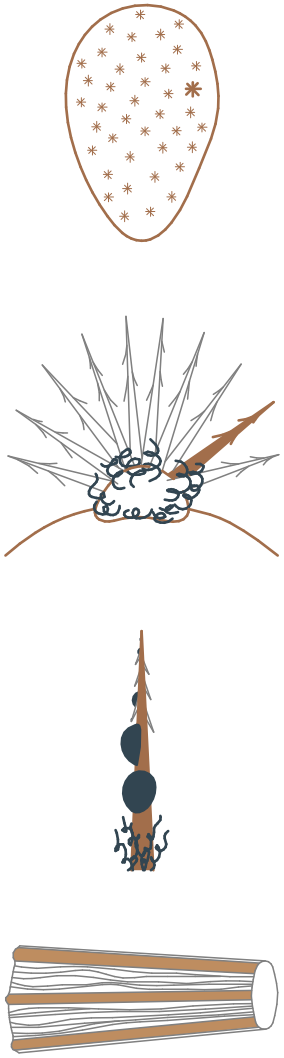
Biomimetic basis

All technological solutions related to the structure of the threads and the design of the collection meshes are based on the principles of biomimetics. The design relies on the unique survival mechanisms of insects, plants, and animals that have evolutionarily learned to efficiently collect moisture.

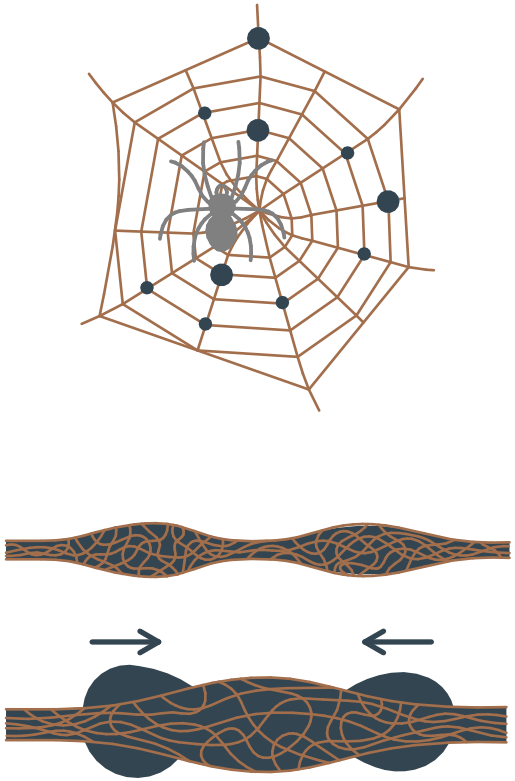
Concept Nº 1



Concept Nº 2

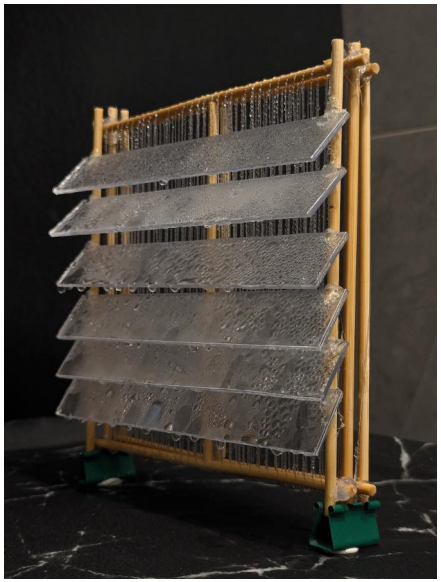


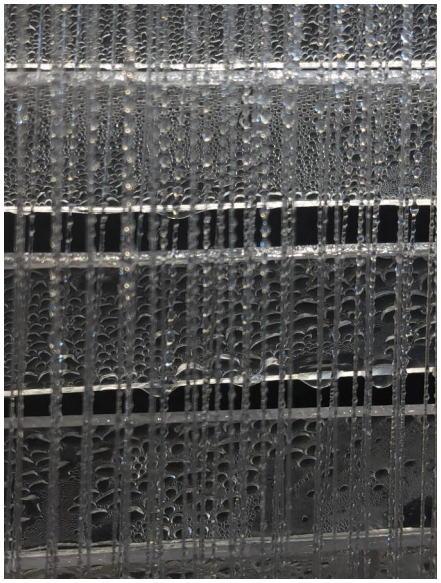
Concept Nº 3

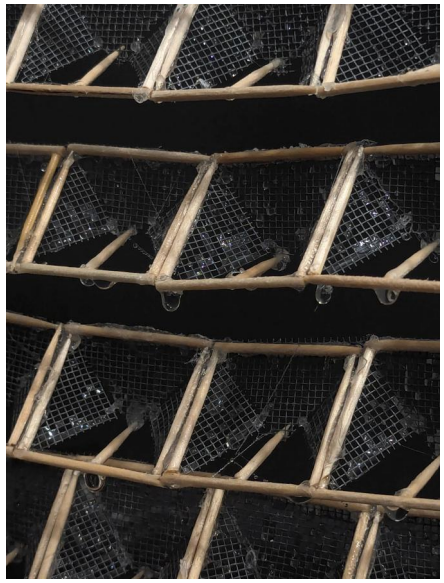


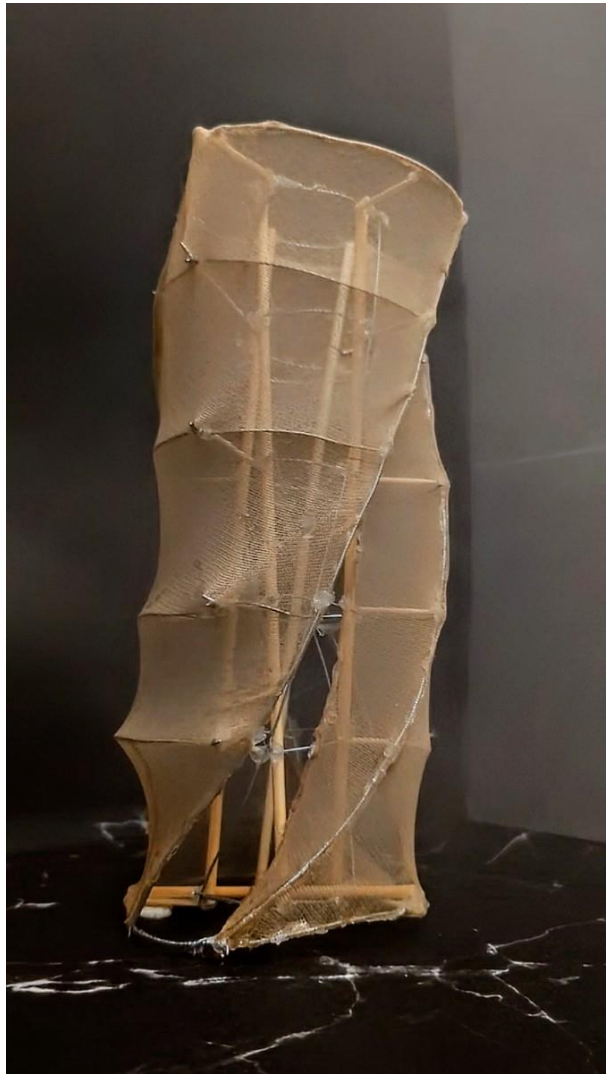
Testing

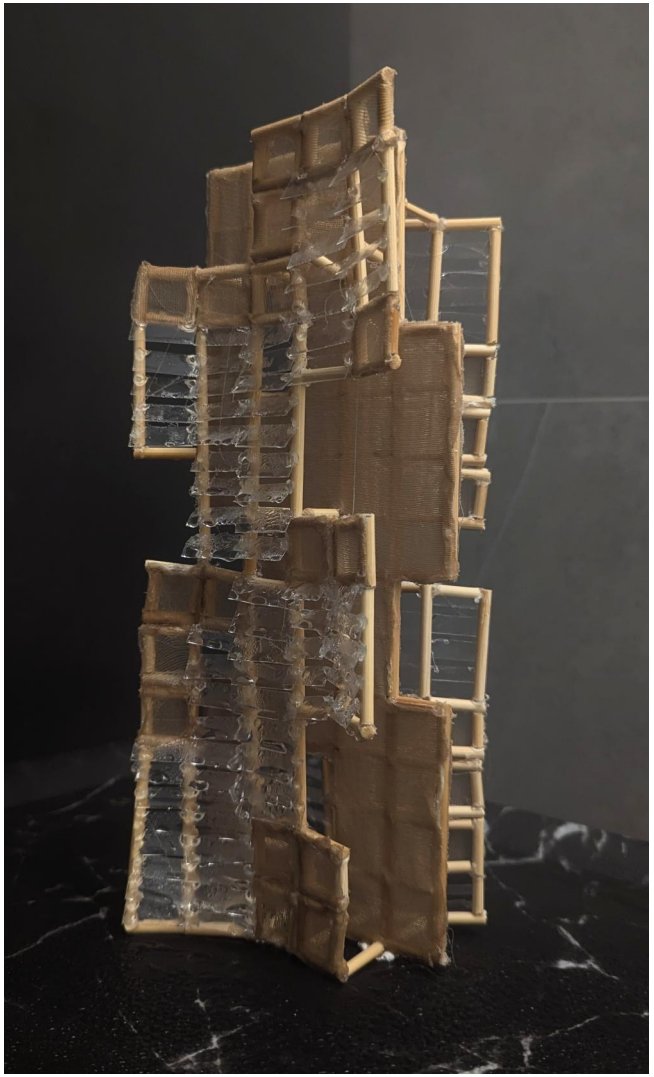
To verify the functionality of each concept, experimental testing was conducted under conditions as close as possible to those of the Atacama Desert. For this purpose, physical prototypes were created: three façade system models and three tower models. Each sample was continuously tested for one hour.

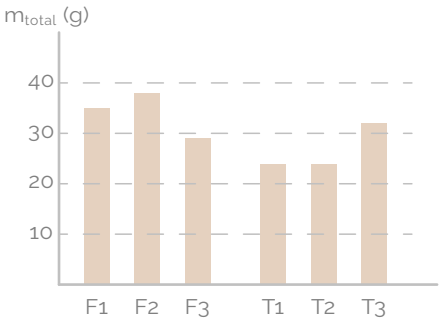












	m_{dry} (g)	m_{wet} (g)	m_{free} (g)	m_{total} (g)	n (g/m²)	K_{ret} (%)
F1 (“harp”)	23	26	32	**35**	**1556**	8.6
F2 (“harp”+panels)	80	86	32	**38**	**1689**	15.8
F3 (spider web)	19	25	23	**29**	**1289**	20.7
T1 (cylinder)	48	51	21	**24**	**379**	12.5
T2 (sail)	23	26	21	**24**	**494**	12.5
T3 (“lens”)	89	98	23	**32**	**523**	28.1

m_{dry} - dry model mass

m_{wet} - wet model mass

m_{free} - free condensate mass

m_{total} - total condensate mass

n - specific efficiency

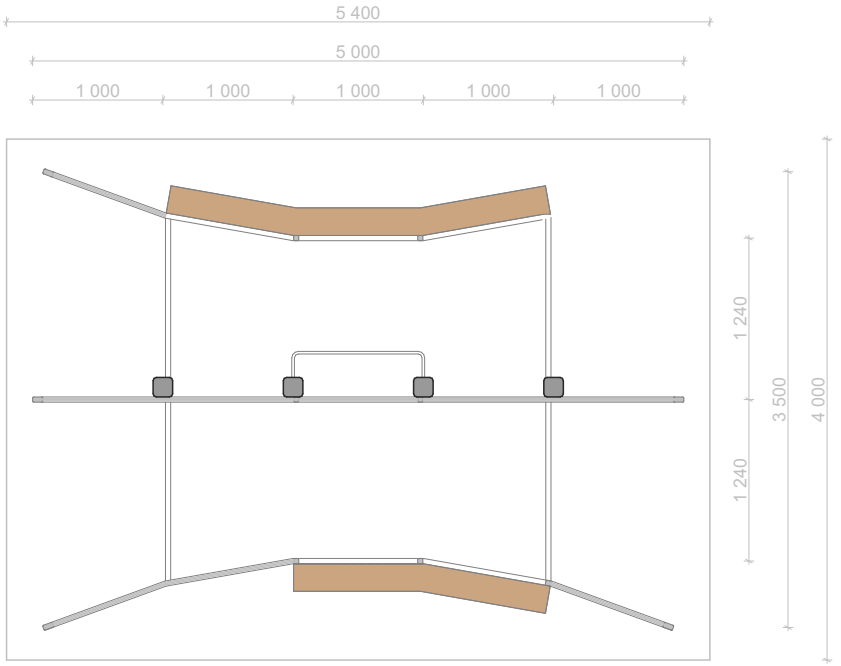
K_{ret} - moisture binding coefficient

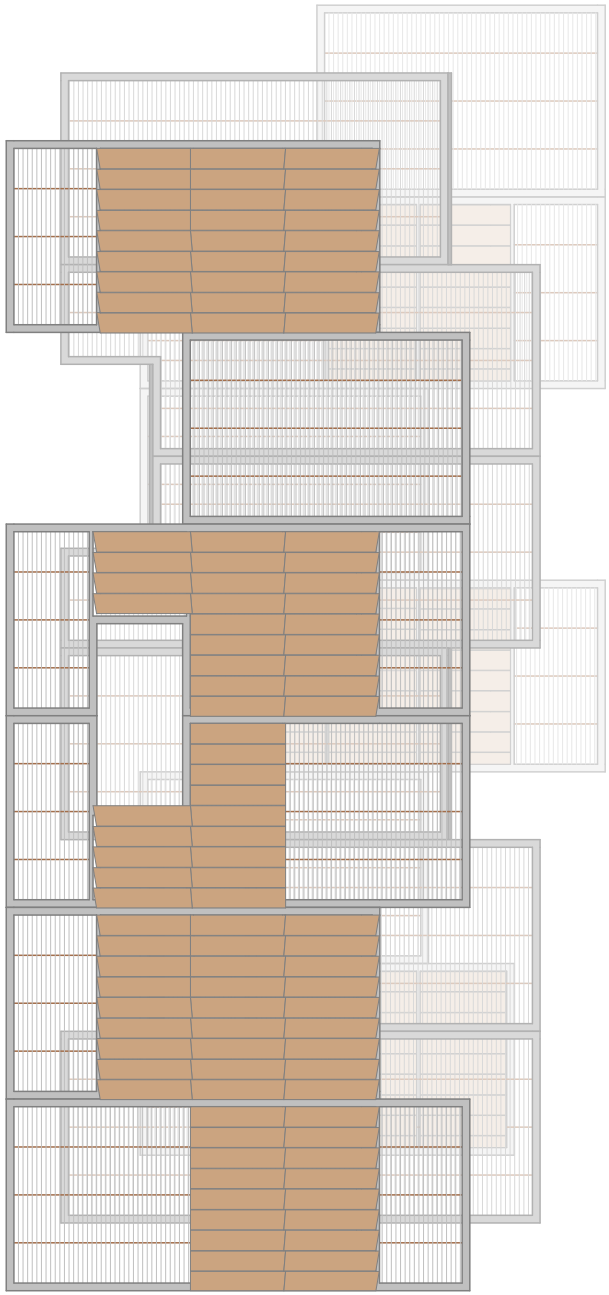
Results

Among the façade systems, the best performance was demonstrated by the combination of mesh with inclined panels that generate airflow vortices, while among the tower concepts the leading solution was the three-layer lens-shaped model, which outperformed traditional cylindrical forms commonly used in similar projects. Therefore, it was decided to adopt the multilayer lens-shaped tower concept as the basis, but adapt it for the use of vertical threads.

Final tower solution

The final design is based on a three-layer lens-shaped tower, in which the collection mesh is made of interwoven vertical threads. Reflecting the identity of the region, where fishing and copper mining are prominent industries, the mesh is constructed from sustainable local materials—recycled fishing line and copper wire sourced from mining waste.

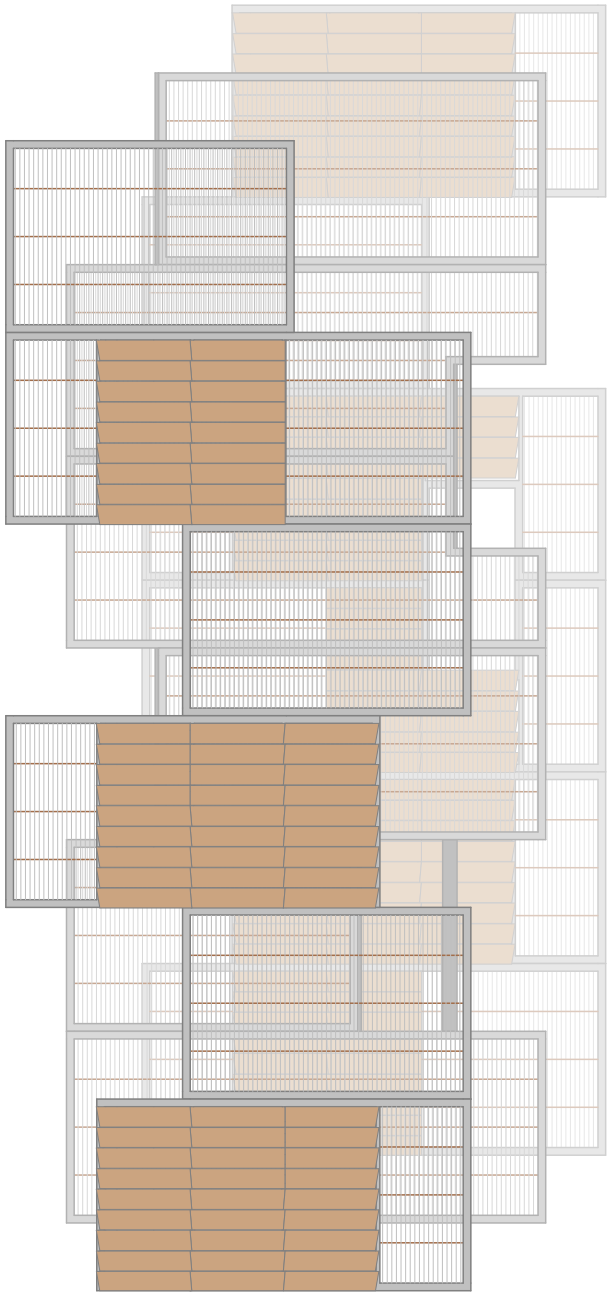




Nylon rope with copper wire

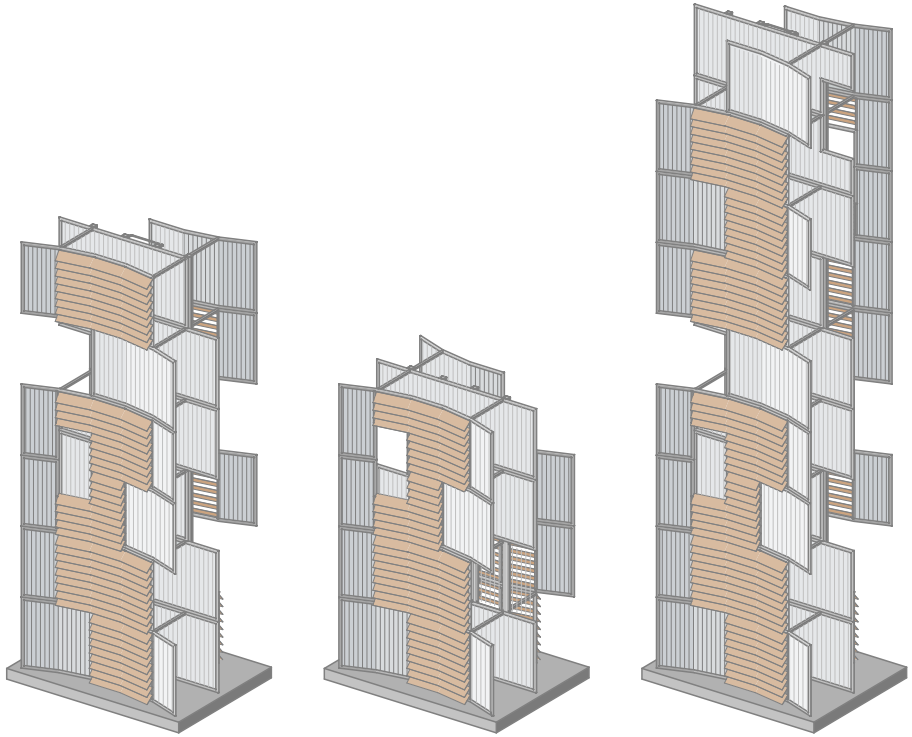
Anodized aluminum

Corten steel terrace

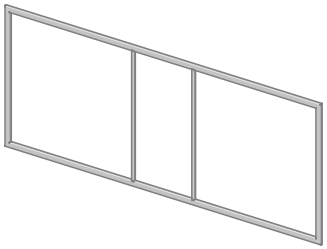


Modularity

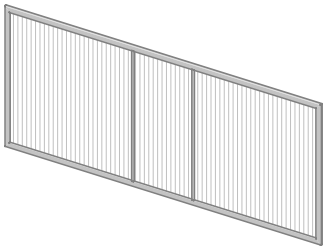
The architectural framework of the towers is based on a flexible modular system, in which the standard structure is assembled from six two-meter modules. This approach allows the project to be easily scaled according to the needs of the region.



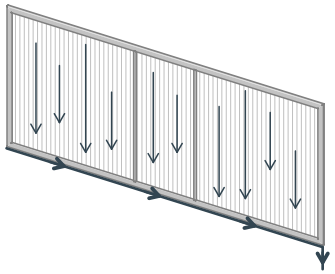
Flat panels



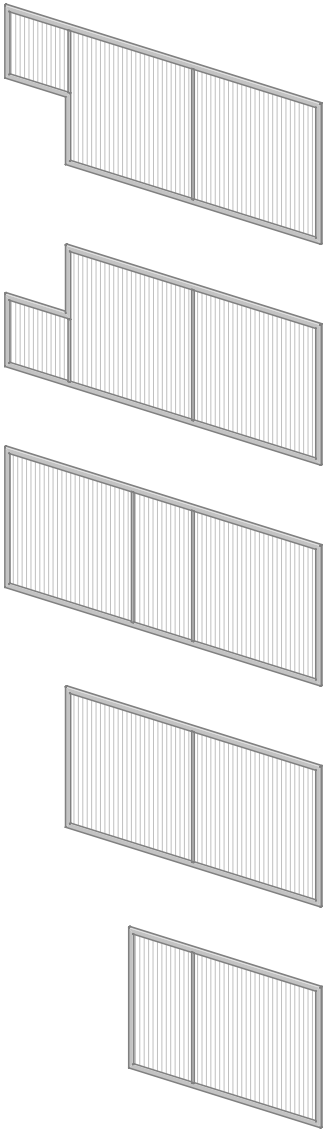
Frame



“Harp”

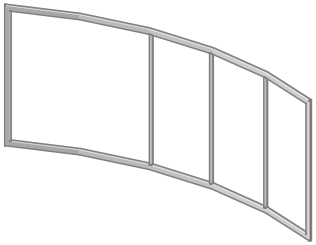


Water drainage

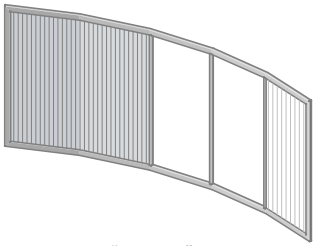


Types

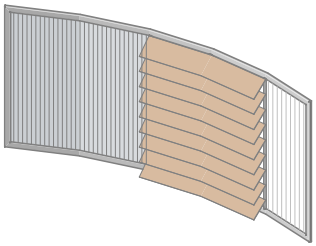
Concave panels



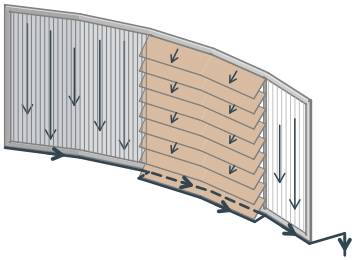
Frame



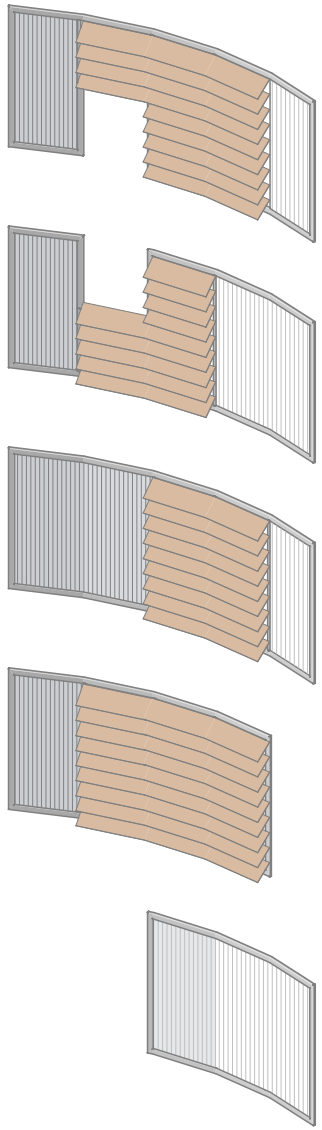
“Harp”



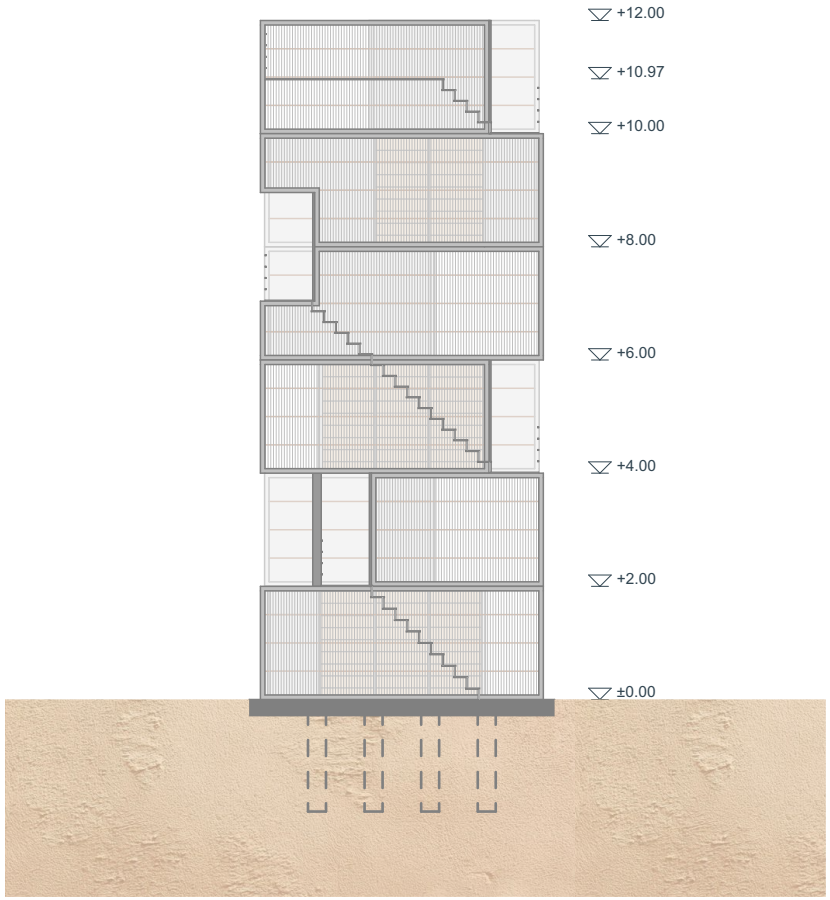
Inclined panels



Water drainage

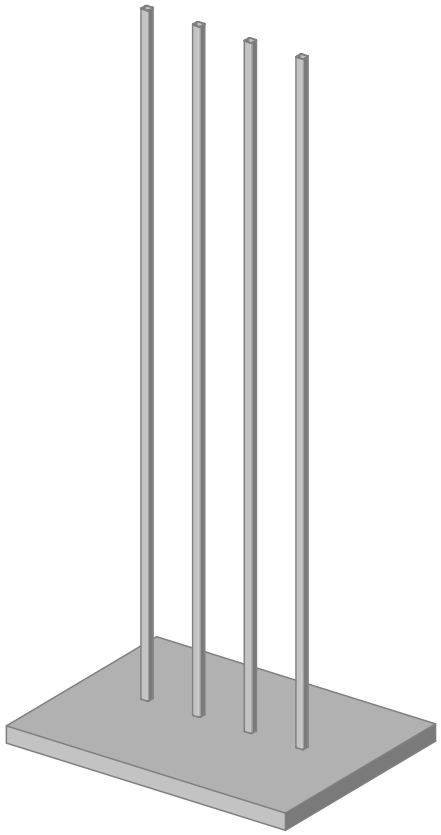


Types



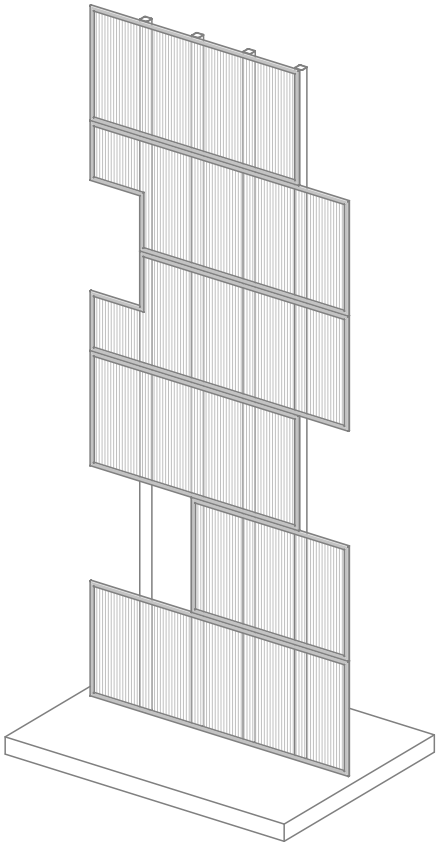
Structure

The structural stability of the tower is ensured by a rigid frame supported by a monolithic and column foundation system with four load-bearing columns, onto which three layers of modules are mounted in a cascading arrangement. The tower located near the research center is additionally equipped with an integrated staircase and an open viewing platform at a height of 11 meters.



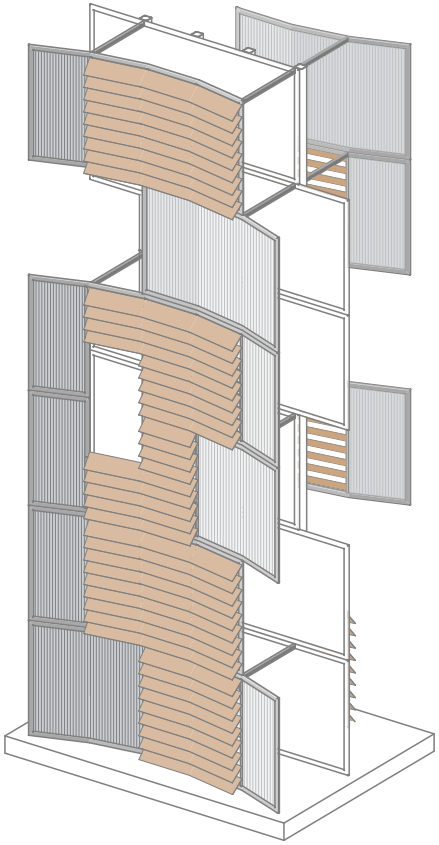
Load-bearing structure

Monolithic foundation
and vertical columns



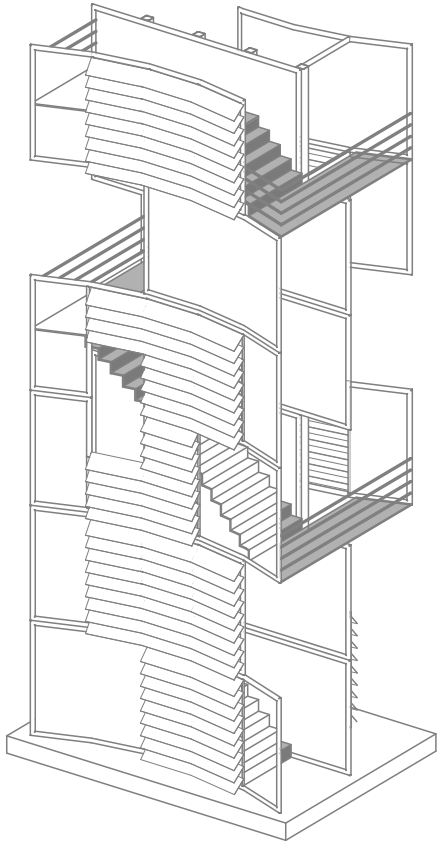
Rigid core

Installation of the central
modular collection system



Functional envelope

Assembly of exterior facades
from collection modules



Viewing platform function
(not included in all towers)

Integration of stairs

THANK YOU