

ALGATECTURE

HYPERBODY GRADUATION STUDIO 08112016

LESLIE CHE

NIMISH BILORIA | KAREL VOLLERS | HENRIETTE BIER

01 | ASSIGNMENT
AND CONCEPT

02 | OBJECTIVES
DESIGN REQUIREMENTS + LIMITATIONS

03 | URBAN ANALYSIS
APPROACH + DESIGN STRATEGY

04 | DESIGN
PROGRAM + PRINCIPLES

05 | TECHNOLOGY
DETAILS + CALCULATIONS

The image features a dark blue background with a cityscape at night, including a prominent cable-stayed bridge. The text is overlaid in white and blue boxes. The logo 'WORLD EXPO ROTTERDAM 2025' is in the top left. The main message is in the center, and the subtitle is at the bottom.

WORLD
EXPO
ROTTERDAM
2025

World Expo 2025 where ambition turns
environmental challenges into economic opportunities

Changing currents / Deltas in transition



CARBON DIOXIDE IN OUR ATMOSPHERE

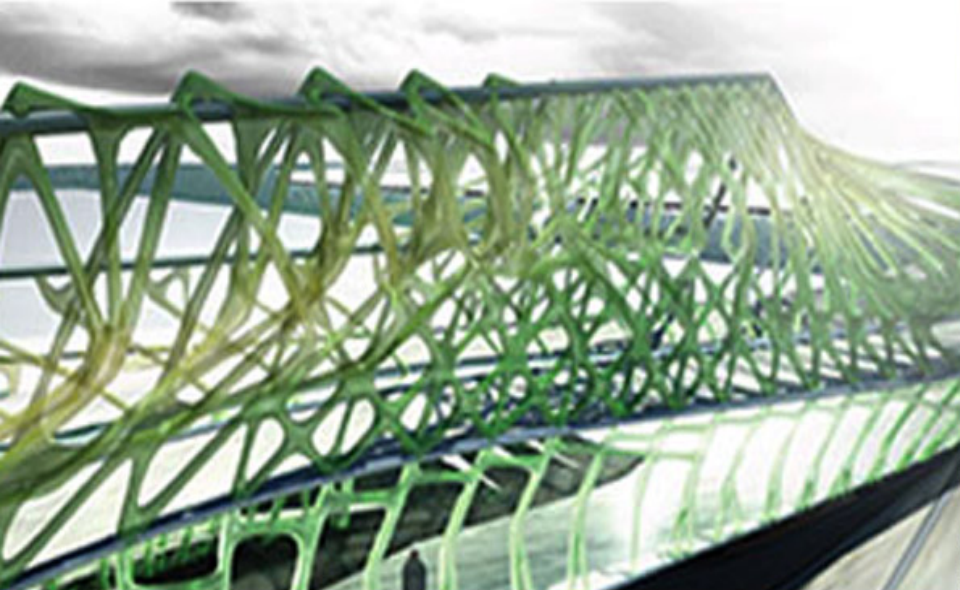
2020-2030 EUROPEAN UNIONS CLIMATE POLICY - CO2 EMISSIONS
CUT GREENHOUSE GAS EMISSIONS BY 40%

2025 GOAL REDUCE BY 100% OF CO2 EMISSIONS

- USING NEW/CLEANER ENERGY RESOURCES
- CO-SITING, FACTORIES USING EACH OTHERS HEAT
- STORING CO2 UNDER THE SEA

2030 ROTTERDAM CITY TO BECOME THE MOST IMPORTANT AND
INNOVATIVE HAVEN OF EUROPE (SUSTAINABLE)

PROGRESS IN MILIEU AND SPACE DEVELOPMENT - CREATIVE WAY



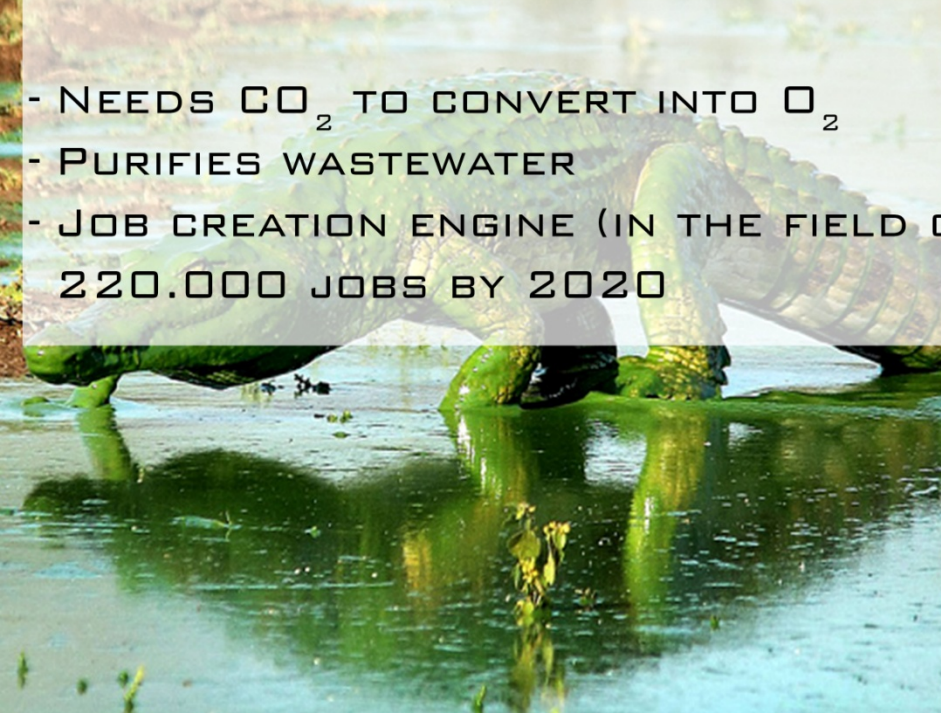
ALGACULTURE





- MORE THEN 72.500 ALGAL SPECIES
- SINGLE- & MULTICELLULAR EUKARYOTES
- SALT- & FRESHWATER BASED SPECIES
- LIVES IN DIFFERENT WEATHER CONDITIONS
- CAN BE FOUND IN ANIMALS, LAKES, SWAMPS, RIVERS, RESERVOIRS, ROCKS, SOIL, ETC

- NEEDS CO_2 TO CONVERT INTO O_2
- PURIFIES WASTEWATER
- JOB CREATION ENGINE (IN THE FIELD OF ALGAE FARMING) POTENTIAL 220.000 JOBS BY 2020



ALGAE - CHOSEN SPECIES

CHLORELLA VULGARIS

- SINGLE-CELL GREEN ALGAE BELONGING TO THE PHYLUM CHLOROPHYTA.
- CHLORELLA HAS A TOUGH, RIGID CELL WALL, AND THUS DISRUPTION OF THE CELL WALL IS REQUIRED FOR THE FACILITATION OF OIL EXTRACTION.
- IS KNOWN AS ONE OF THE FASTEST GROWING GREEN MICROALGAE.
- CAN ADAPT TO DIFFERENT TYPES OF WASTEWATERS, WITH NO LAG PHASES OBSERVED.

DISRUPTION METHODS

MECHANICAL CRUSHING, ULTRASONIC TREATMENT AND ENZYMATIC DEGRADATION, CAN BE EMPLOYED FOR CELL-WALL DISRUPTION.

REQUIREMENTS

LIGHTING: 60 MMOL/M²/S PPF ~ 3250 LUX

CO₂ FIXATION: 15% -> 624 MG/L.DAY

GROWTH TEMPERATURE: 25 - 30 DEGREES CELCIUS

LIQUID CIRCULATION VELOCITY: 0,55 M/S

EXISTING ALGAE SYSTEMS



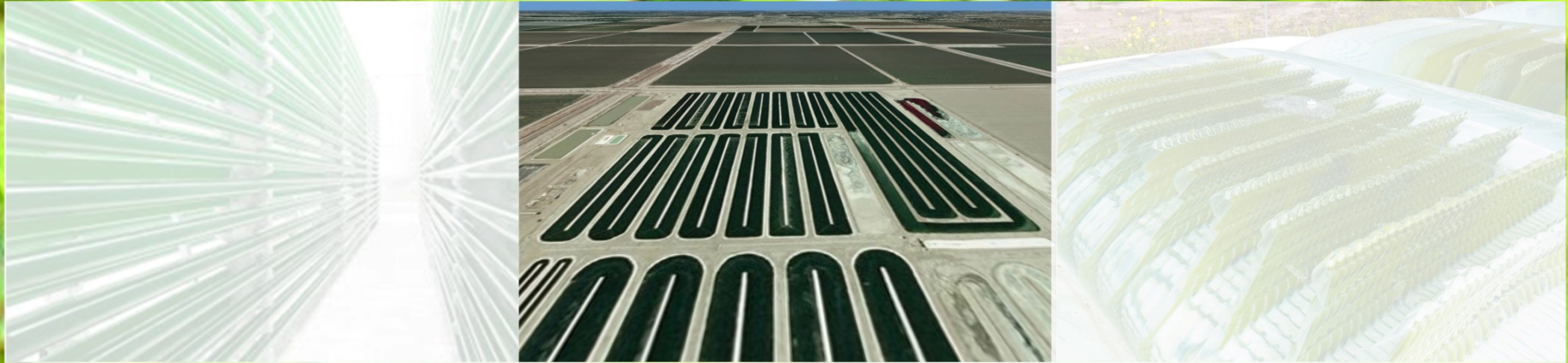
PHOTOBIOREACTORS

FLAT PLATES

RACE PONDS

GREEN BAGS





RACE/OPEN PONDS

PROSPECTS

- SIMPLE AND EFFICIENT TREATMENT
- CHEAP AND EASY TO MAINTAIN

LIMITATIONS

- HIGH RISK OF CONTAMINATION, EASY ACCESS FOR INSECTS
- HIGH WATER EVAPORATION, RESULTING IN SALT PRECIPITATION HAZARD
- SEASONAL, ESPECIALLY FOR THE NETHERLANDS



HORIZONTAL PHOTOBIOREACTOR (PBR)

GREEN BAGS

PROSPECTS

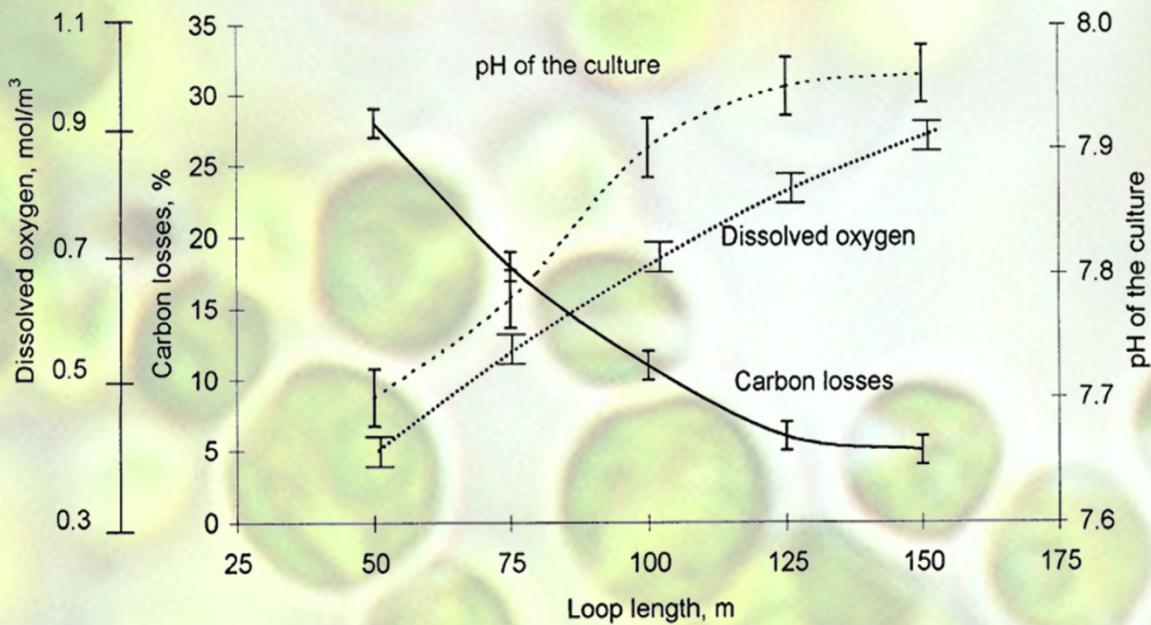
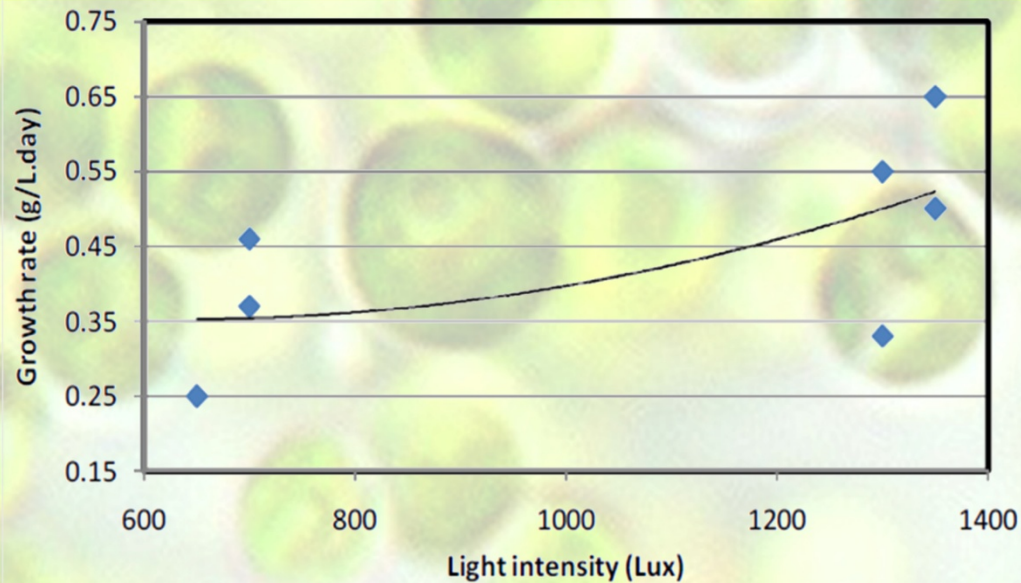
- LARGE ILLUMINATION SURFACE AREA, SUITABLE FOR OUTDOOR CULTURES
- HIGHER BIOMASS PRODUCTIVITY MASS PER AREA AND DAY (COMPARED TO OPEN PONDS)
- HIGHER QUALITY BIOMASS
- VERY LOW RISK OF CONTAMINATION
- RELATIVELY CHEAP
- NO EVAPORATION

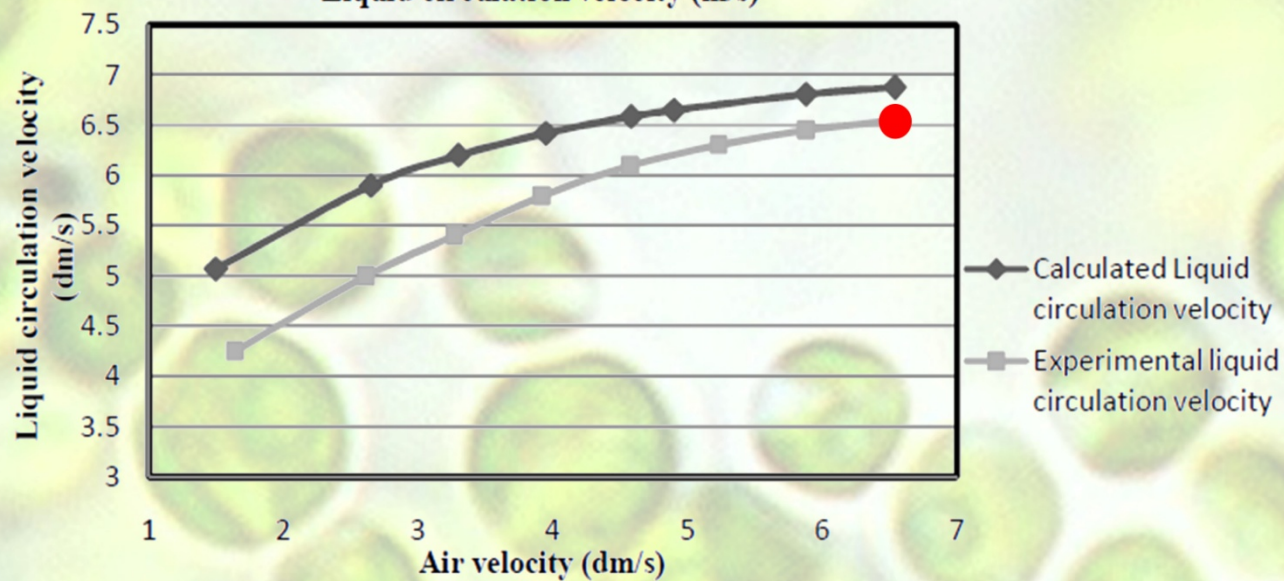
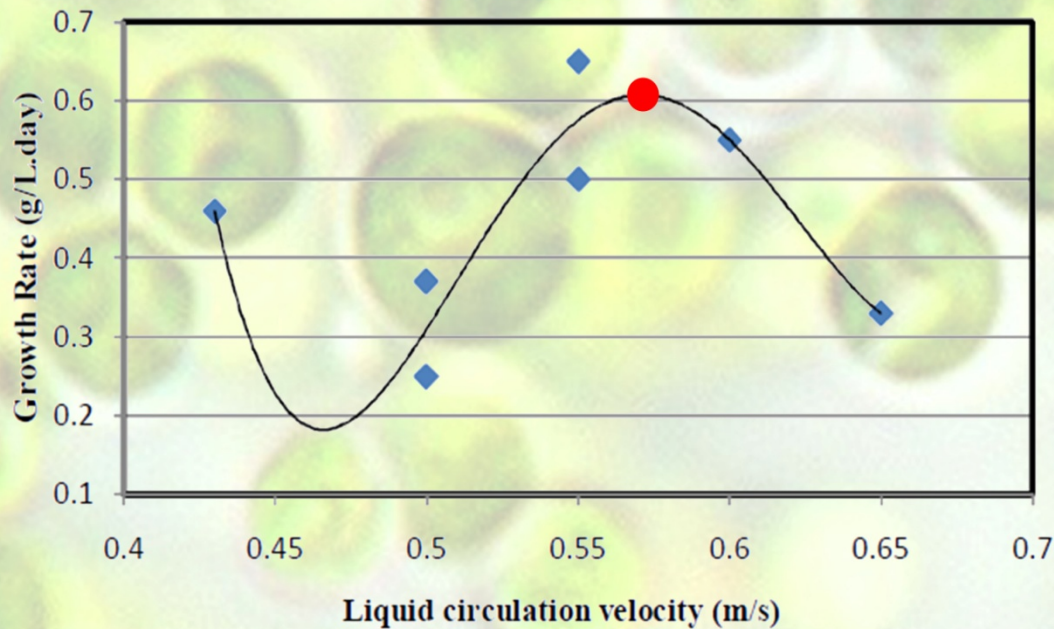
LIMITATIONS

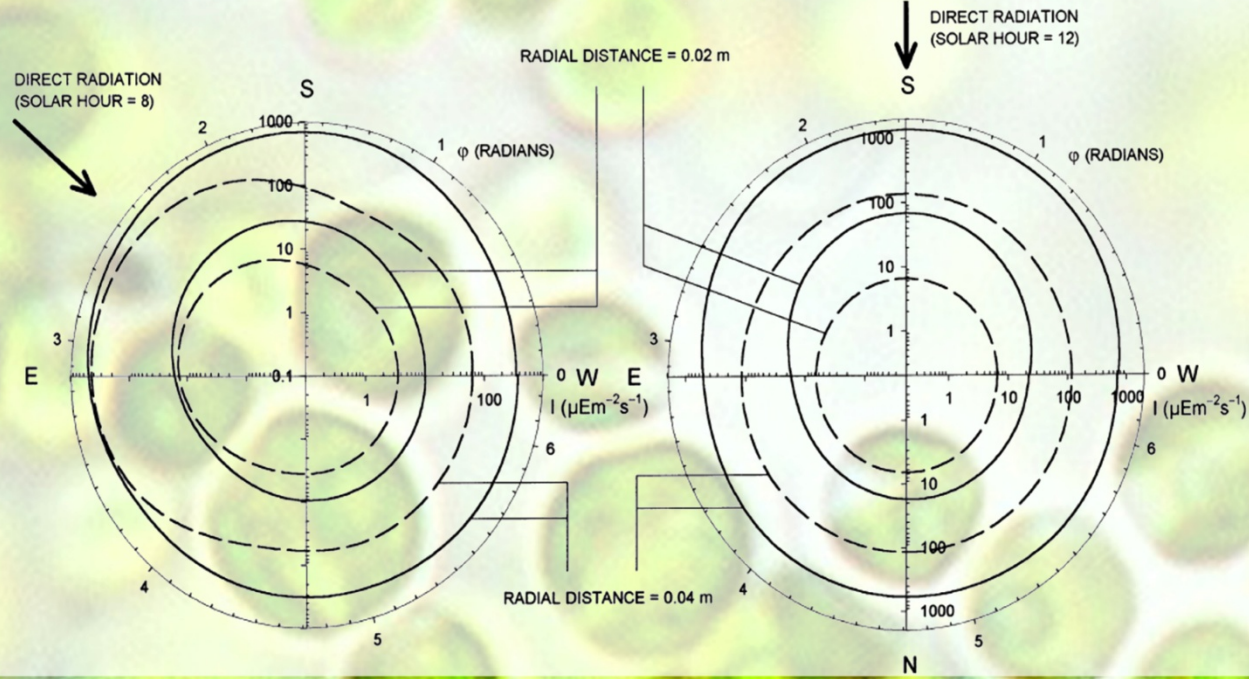
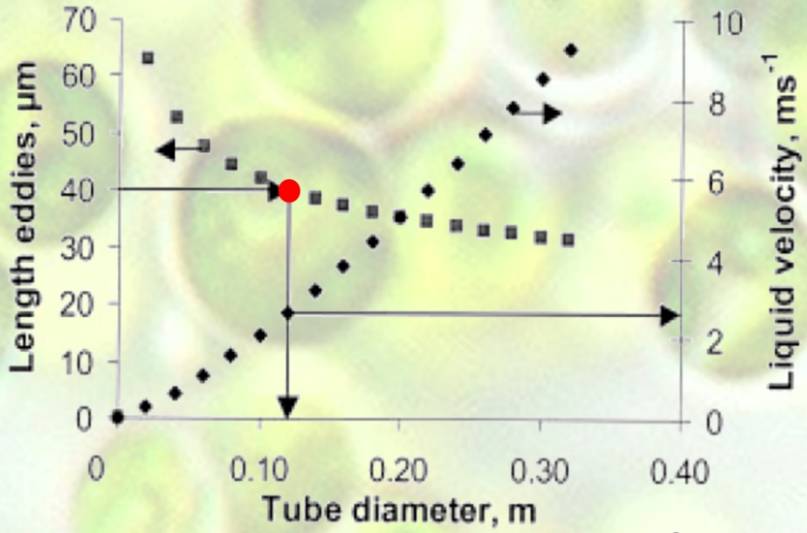
- GRADIENTS OF PH
- DISSOLVED OXYGEN AND CO₂ ALONG THE TUBES
- FOULING
- SOME DEGREE OF WALL GROWTH
- REQUIRES LARGE LAND SPACE

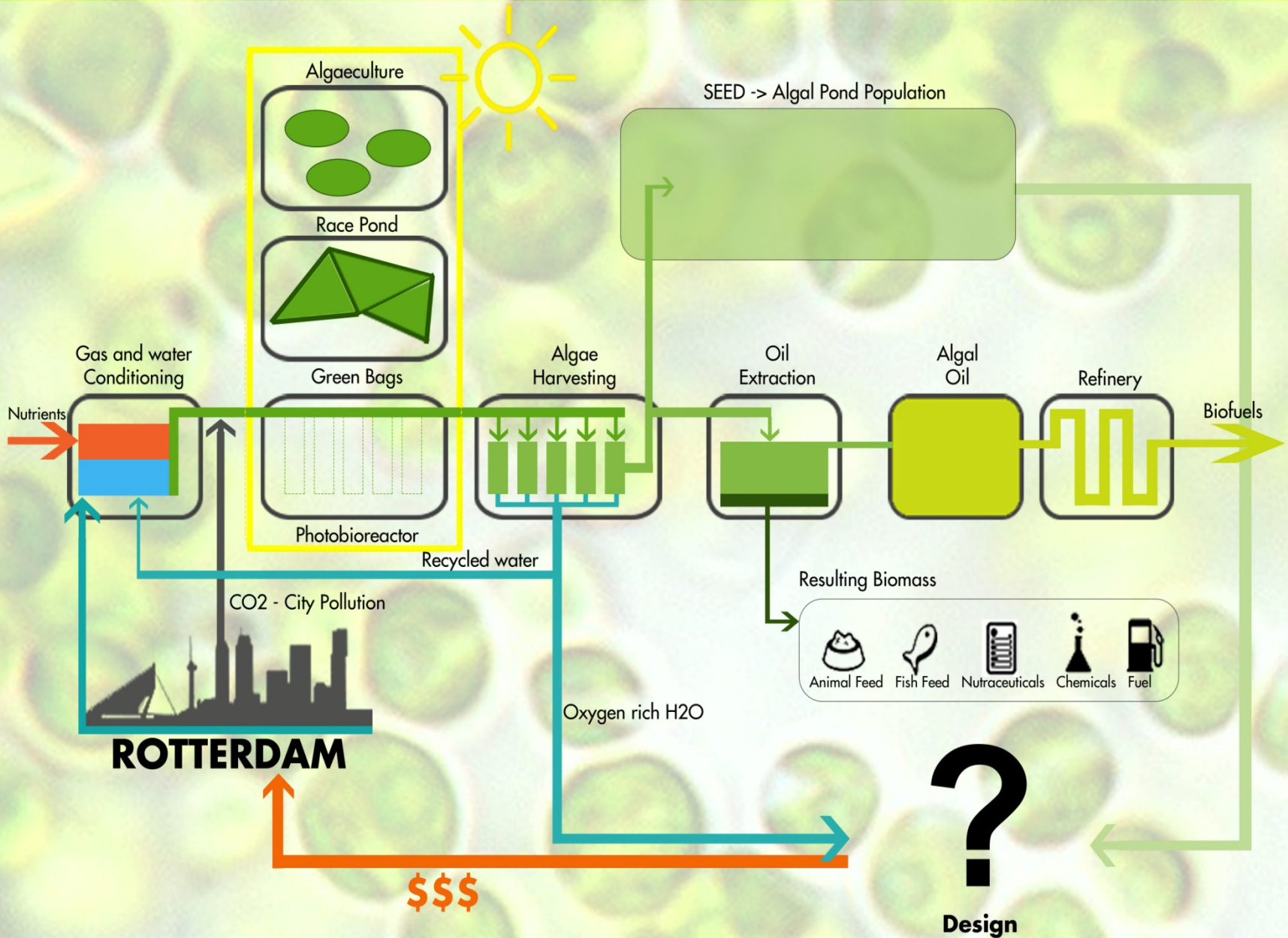
ALGAE SYSTEM - COMPARISON CHART

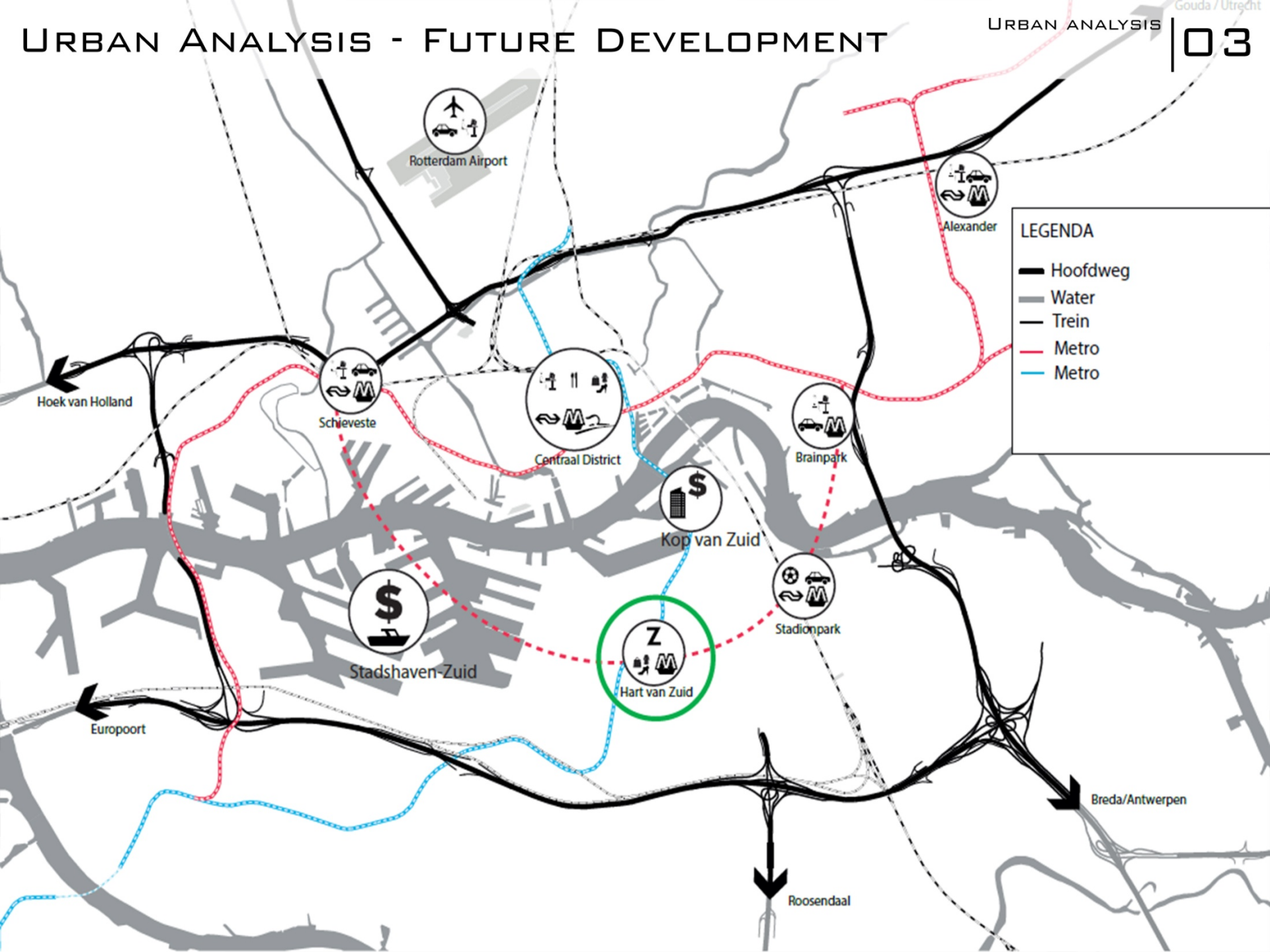
	PBR	RACE/OPEN POND	GREEN BAGS
WATER MEDIA (TONS)			
AREA REQUIREMENT (M ²)	250	250	1200
AREAL PRODUCTIVITY (KG/M ² /DAY)	0,14	0,14	0,05
CONTAMINATION RISK	+++	+++++	+
EVAPORATION LOSSES	++++	+++++	++
ENERGY REQUIREMENT	++	+++	+++
OVERHEATING POTENTIAL	+++++	+++++	++
STAFF REQUIREMENT	+++	+++++	++
MAINTANCE COSTS	++++	+++++	+++
PERIODIC MAINTANCE REQUIREMENT	+++++	+++++	+++
IRREVERSIBLE SYSTEM FAULTS	++++	+++++	++
MICROBIOLOGICAL SAFETY	++	+	+++
AIR CLEANING CAPACITY	+	+	++
WASTE GAS USE CAPACITY	++	+	++
PRODUCTIVITY STABILITY (SEASON, TEMP, SUNLIGHT, ETC)	++	+	+++





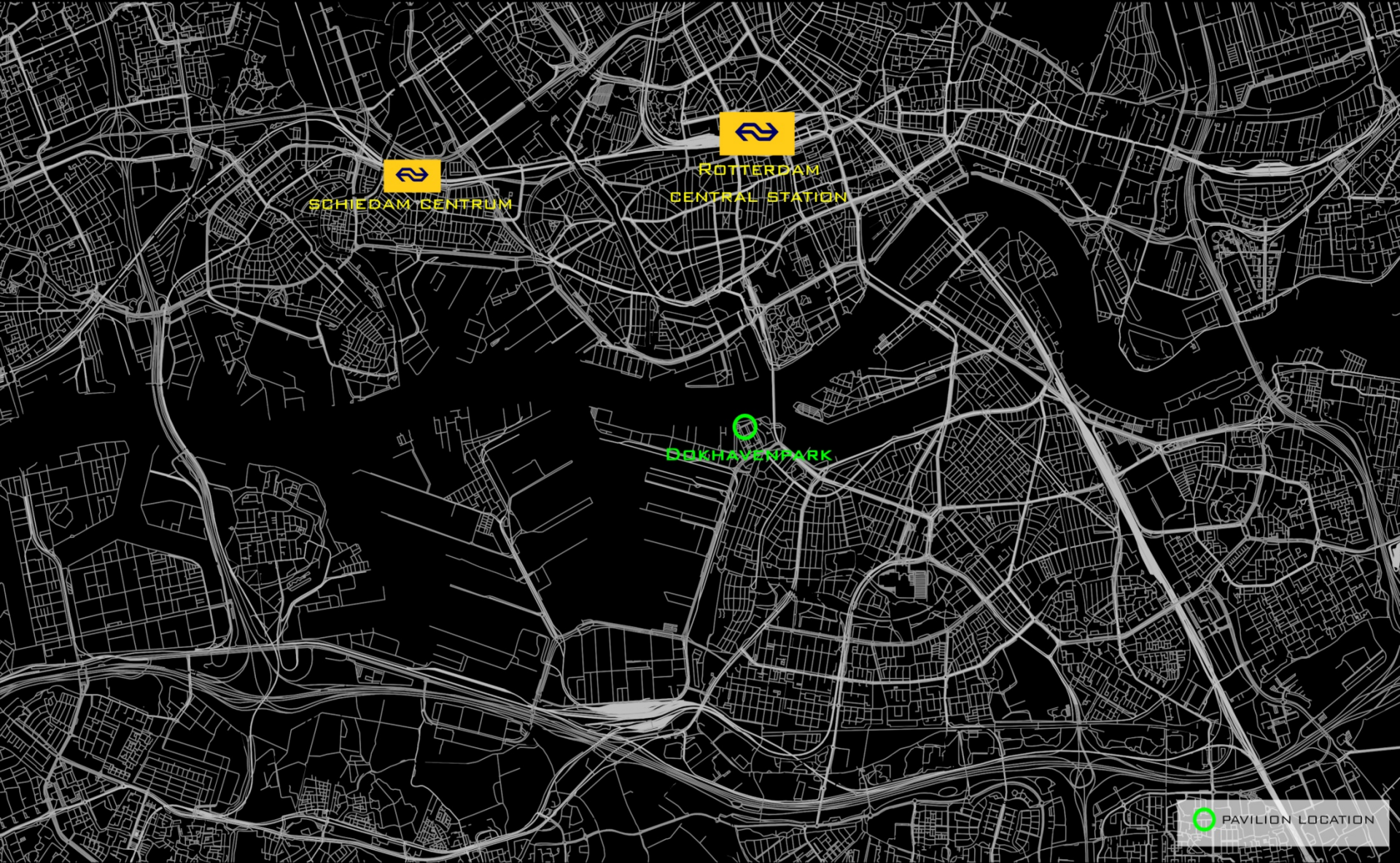




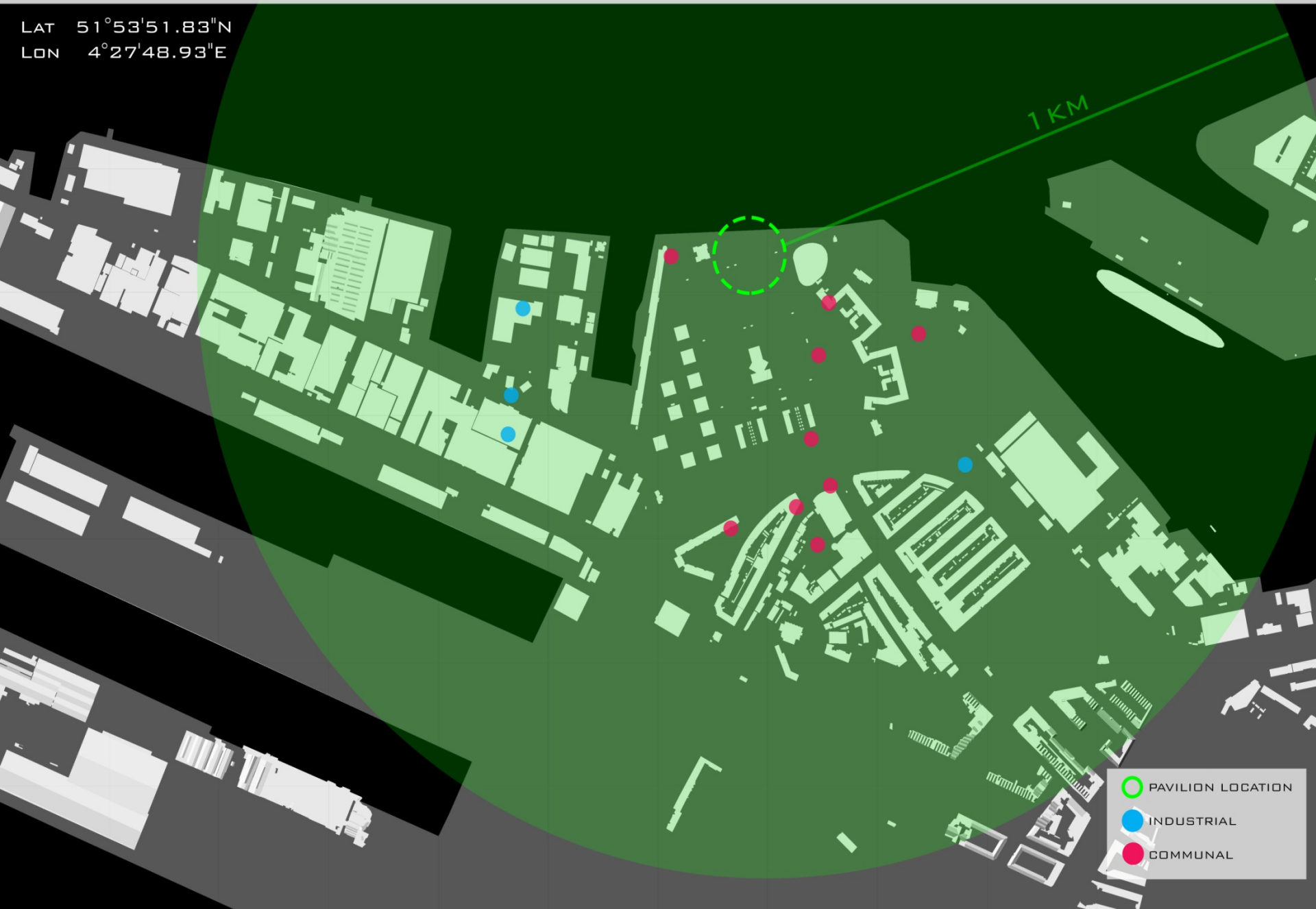


LEGENDA

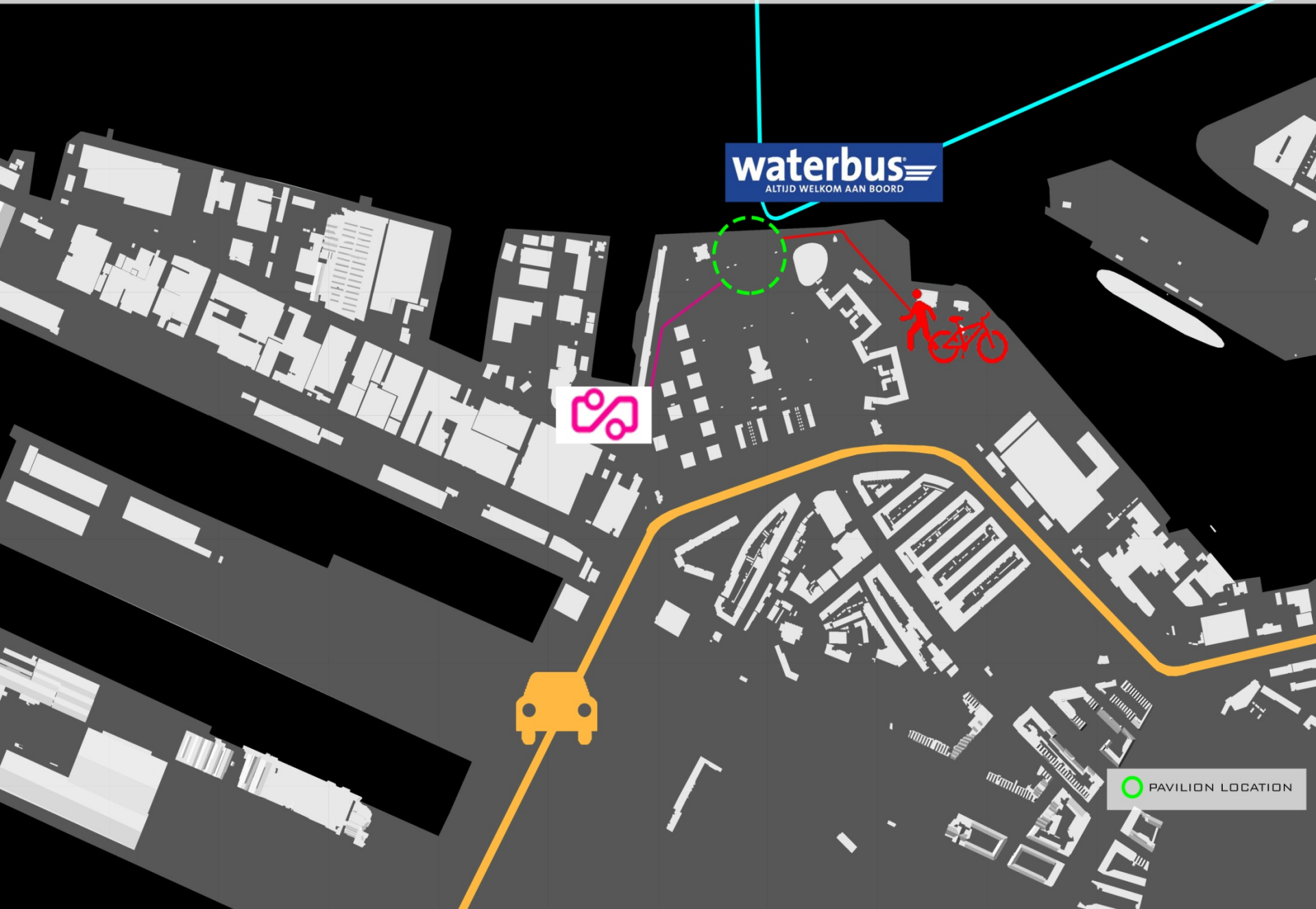
- Hoofdweg
- Water
- Trein
- - - Metro
- - - Metro



LAT 51°53'51.83"N
LON 4°27'48.93"E



- PAVILION LOCATION
- INDUSTRIAL
- COMMUNAL



waterbus
ALTIJD WELKOM AAN BOORD



 PAVILION LOCATION

WORLD EXPO ROTTERDAM 2025

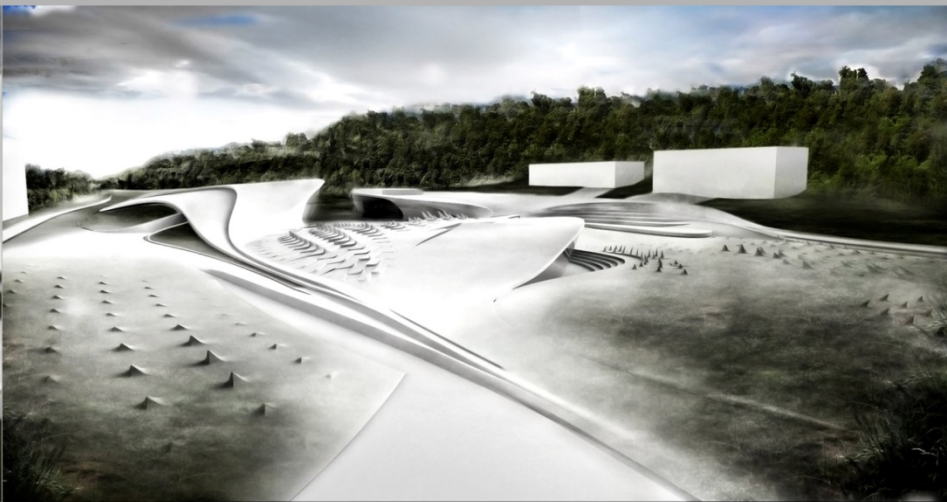
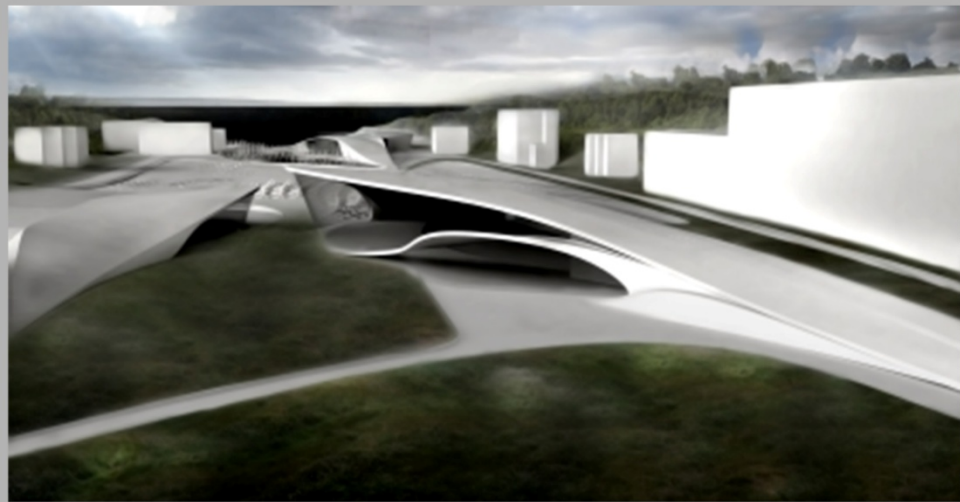
GOALS

- ATTRACTING PEOPLE TO THE SOUTH SIDE OF ROTTERDAM.
- EXPERIENCE THE BENEFITS OF ALGAE ON DIFFERENT SCALES.
- PRODUCTION OF ALGAE BIO-BASED PRODUCTS.
- CLEANER ENVIRONMENT FOR ROTTERDAM CITY.
- CONNECTING THE DIFFERENT COMMUNITIES.

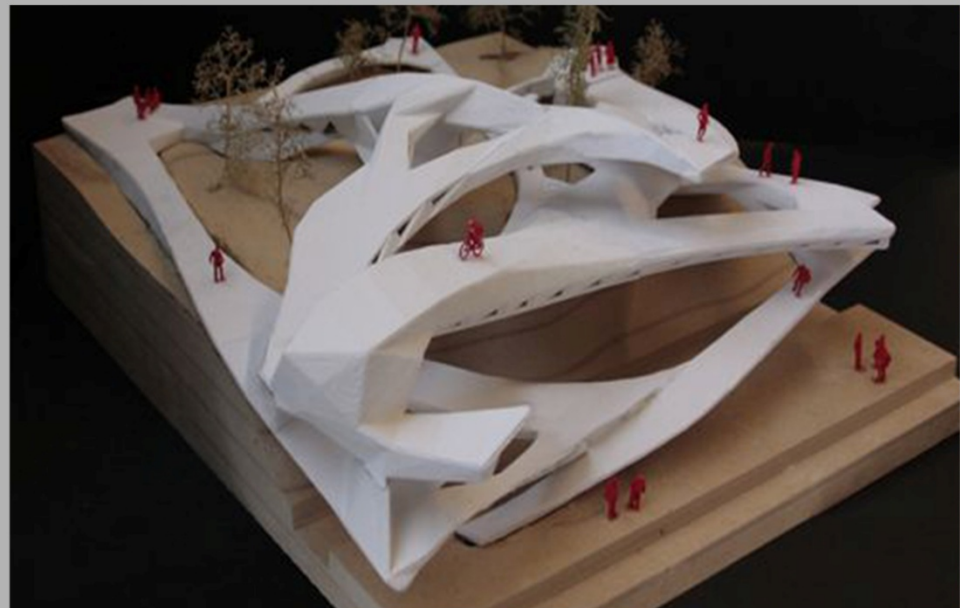
SUB GOALS

- OFFERING NEW JOB OPPORTUNITIES.
- AWARENESS OF THIS ALGAE MOVEMENT.
- LANDSCAPE INTEGRATION IN ITS ENVIRONMENT FOR PERMANENT USAGE.

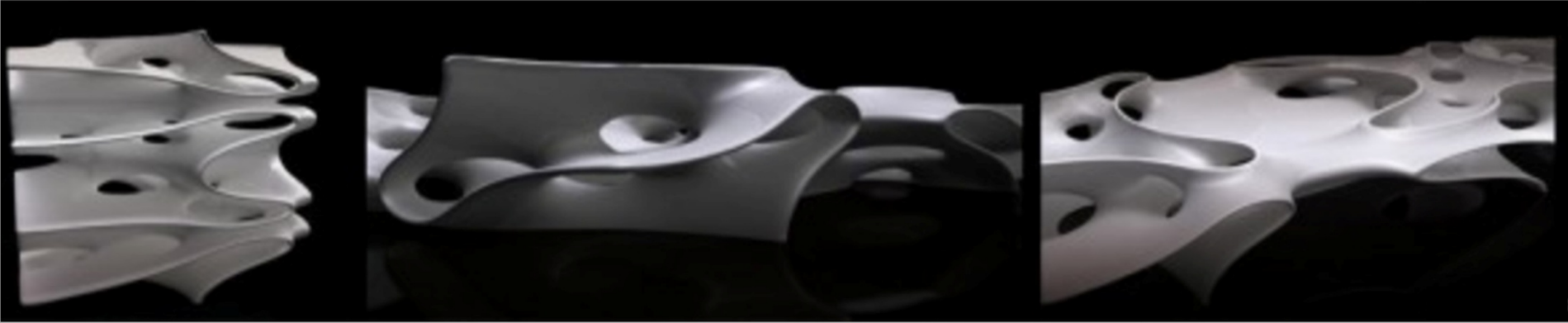
EXTERIOR



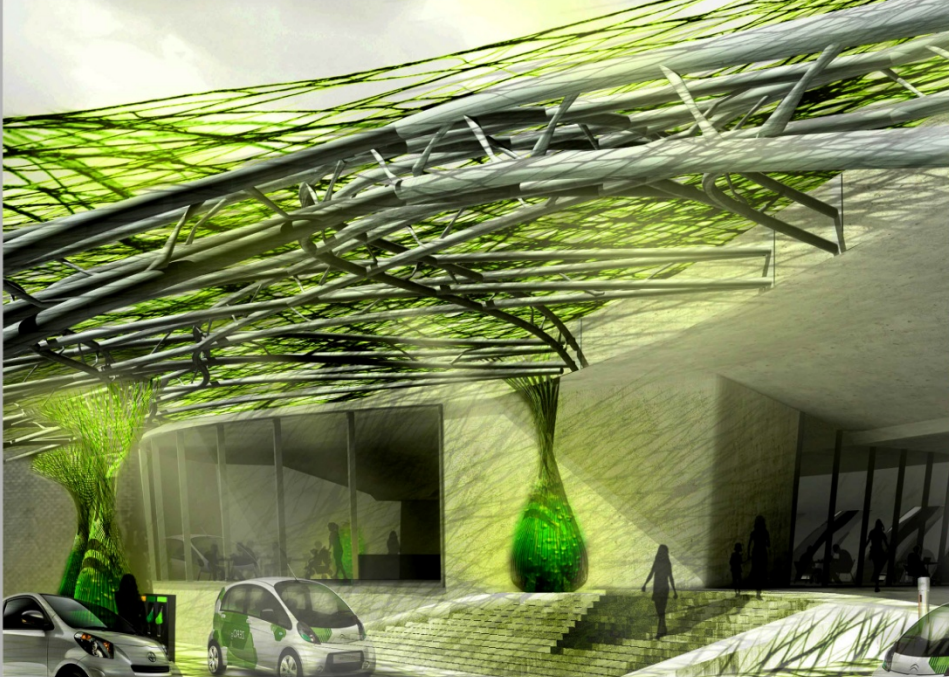
PUBLIC SPACE



INTERIOR



ALGAE



REQUIRED AREAS

Biolab	1000m ²
Exhibition Space	600m ²
Cafe/Restaurant	700m ²
Info booth	150m ²
System Room	1500m ²
Dock/Ferry	200m ²
Conference Hall	700m ²
Offices	400m ²
Utilities	100m ²

Total	5350m ²
Communication space 30% of total =	1605m ²
Total	6955m²

EXPECTATIONS

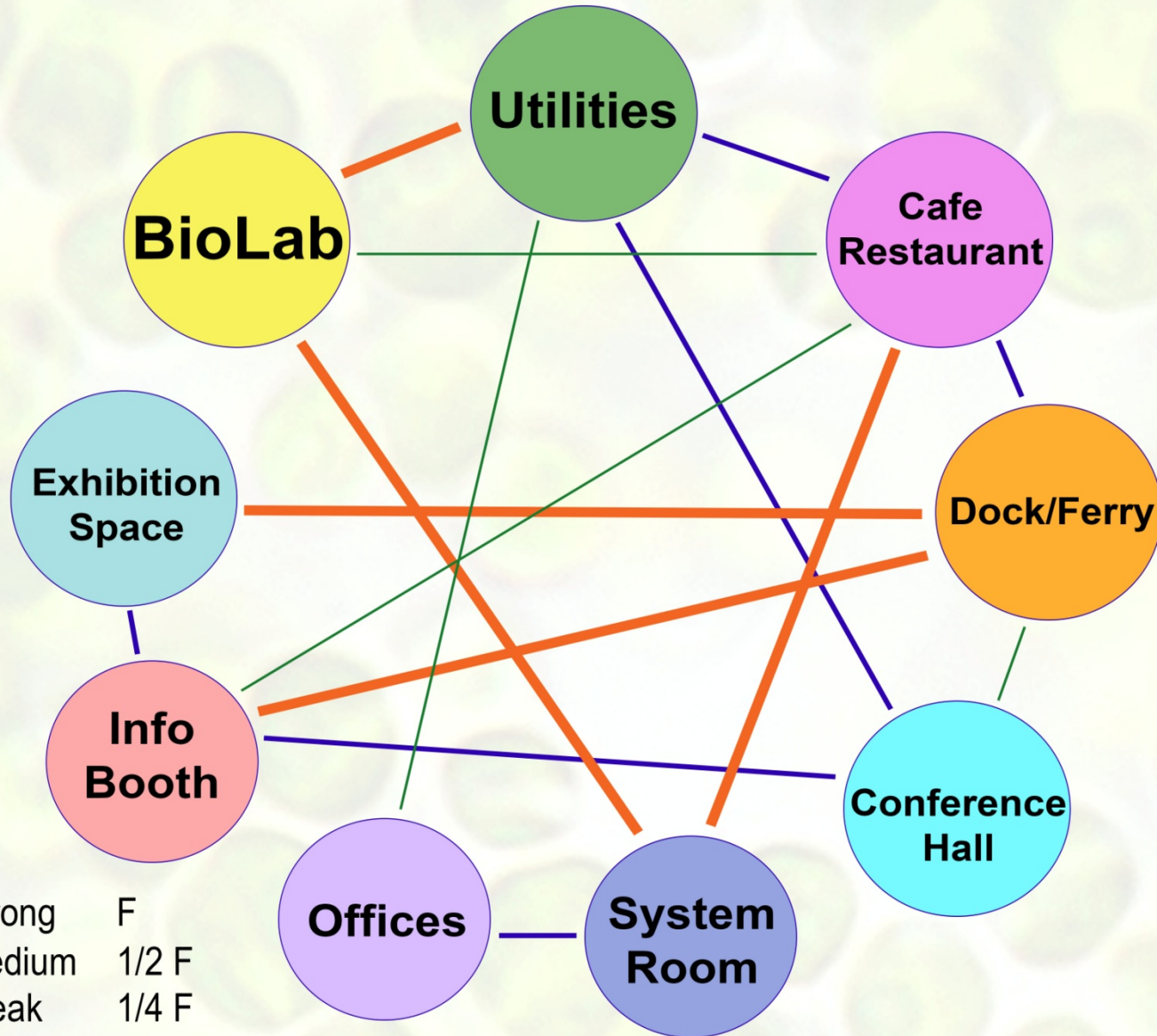
Total visitors 70.000.000
 Per day 70mil/180days= 390.000/day

In a pavilion/day =
 (visitors a day/amount of pavilions)
 390.000/192 = 2031/day in a pavilion

In a pavilion/hour=2031/10h= 203/hour
 m²/people = 7000m²/203 = 34,5 m²

USER GROUPS

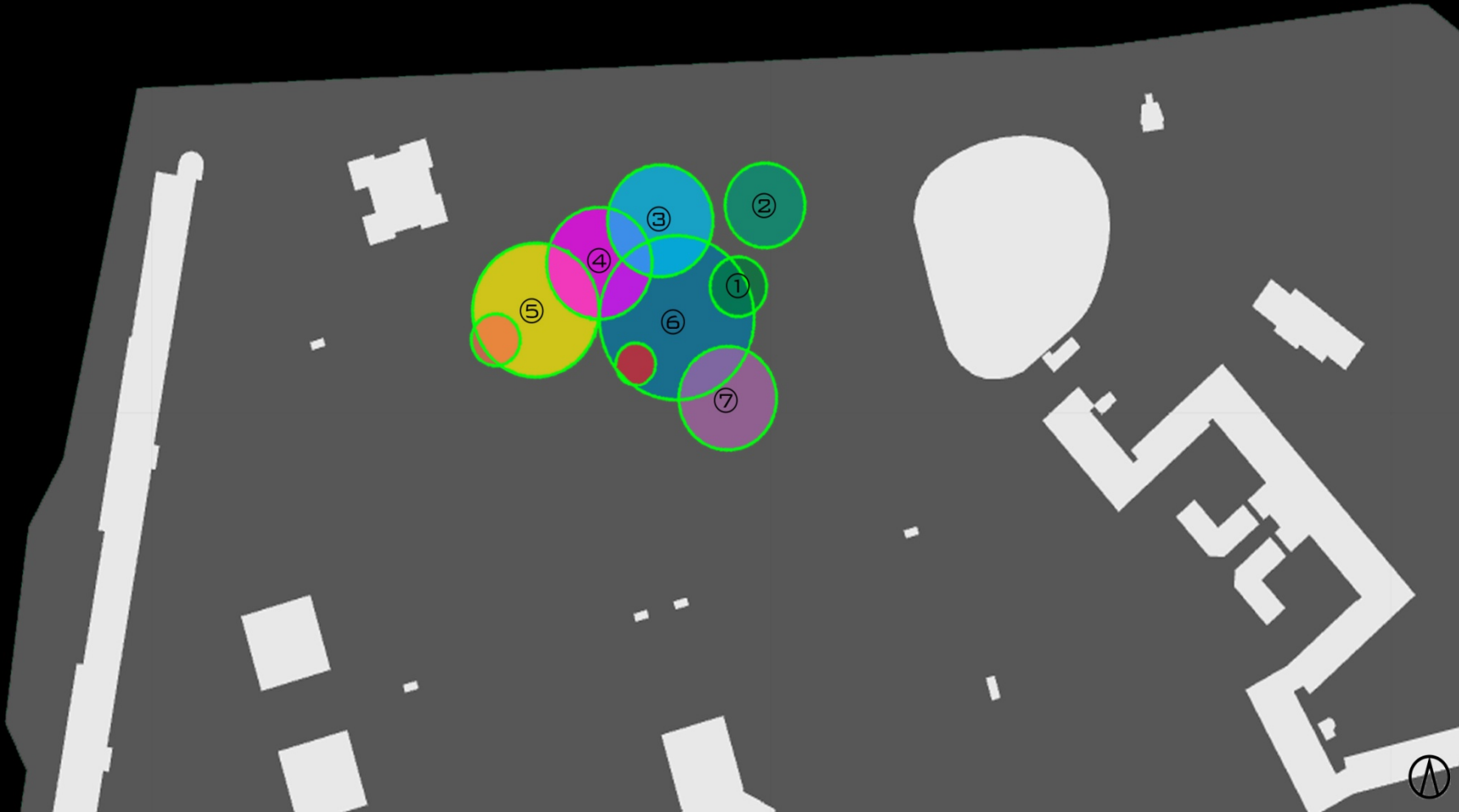


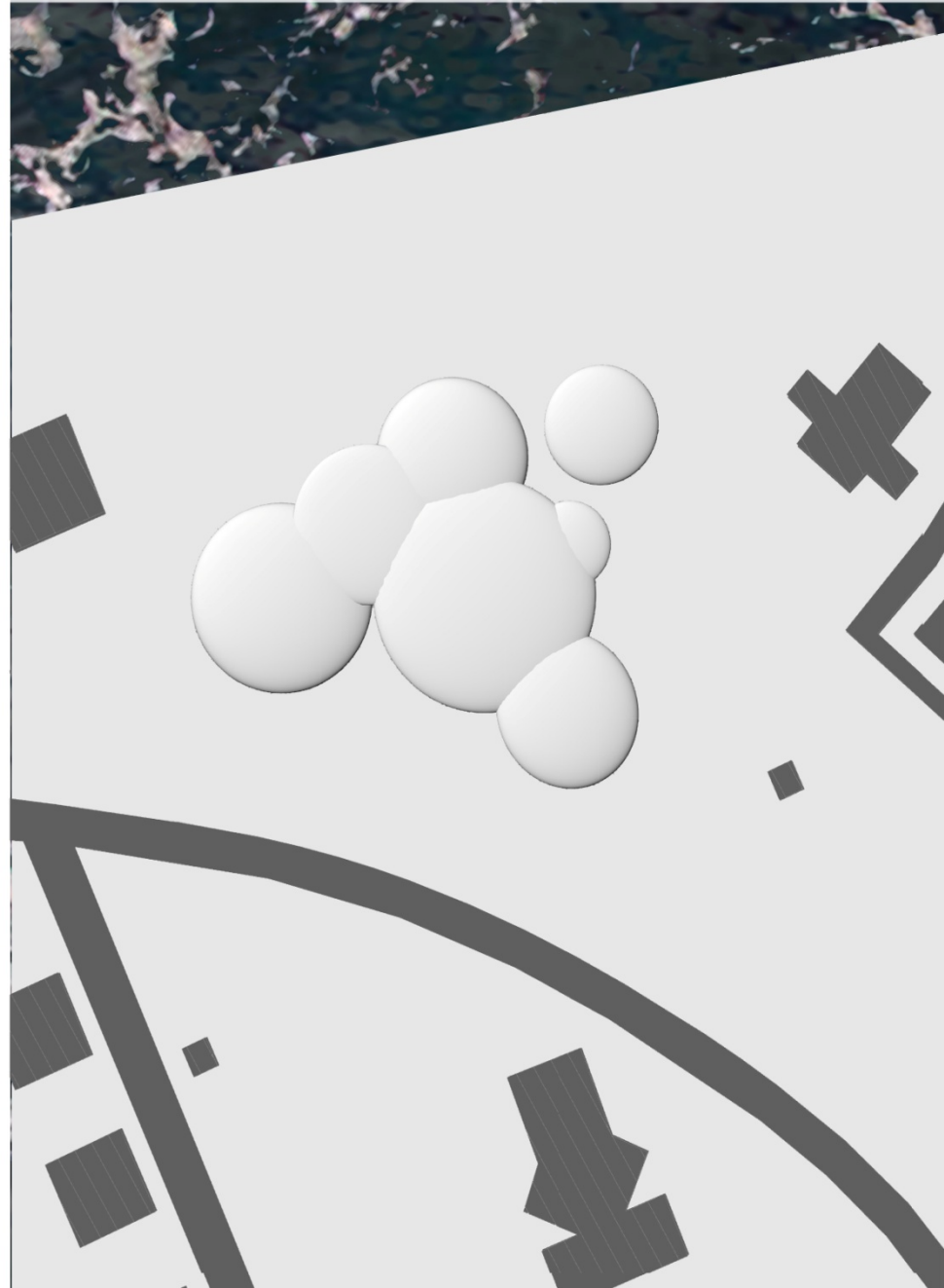
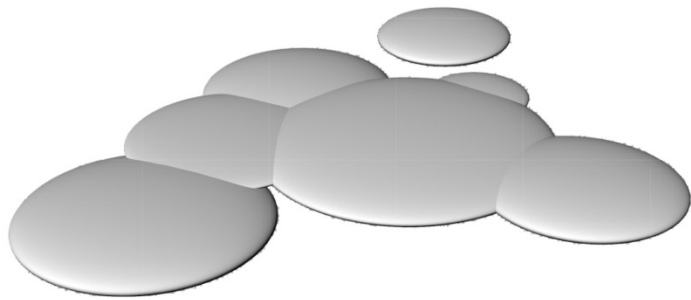


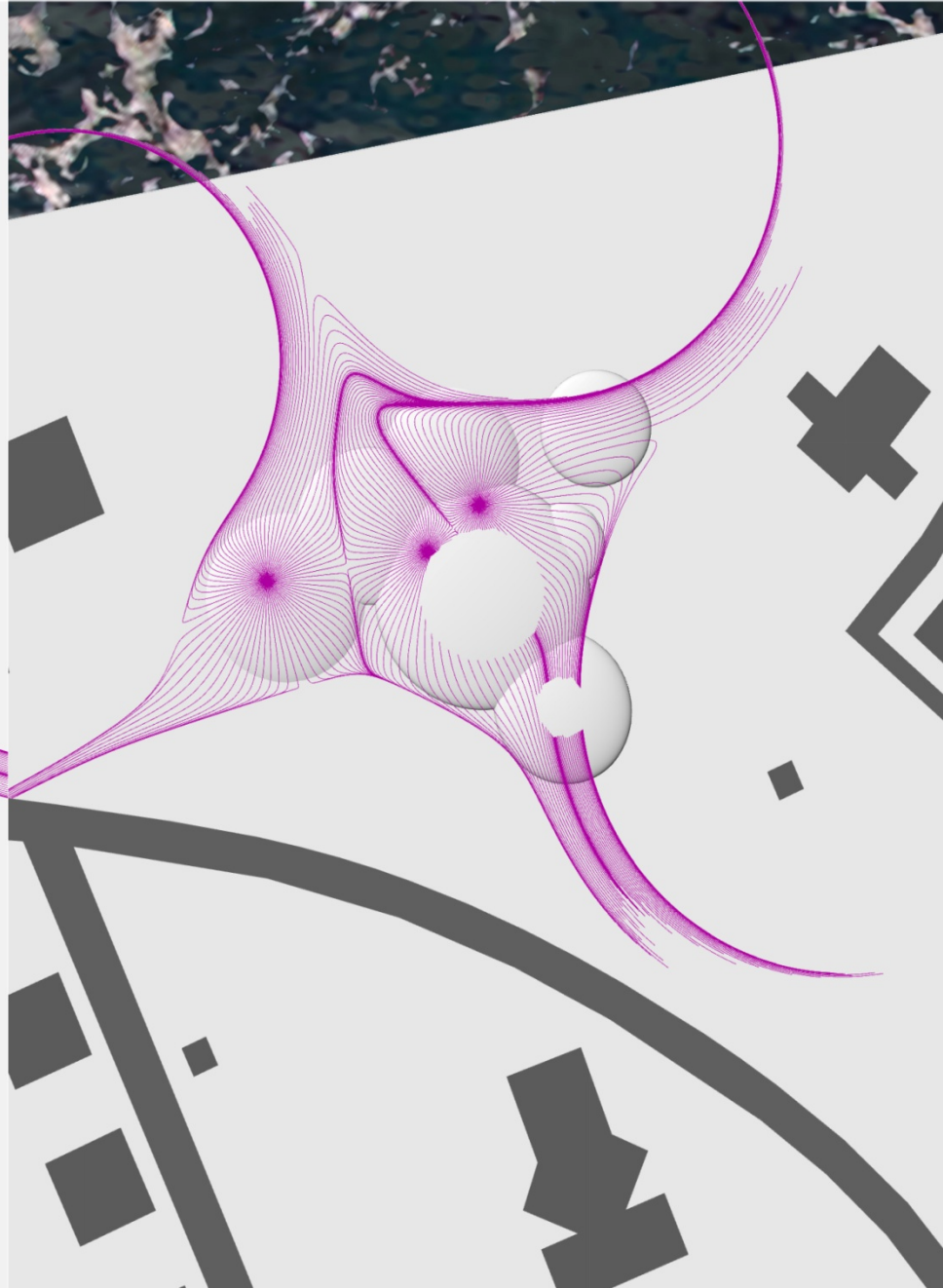
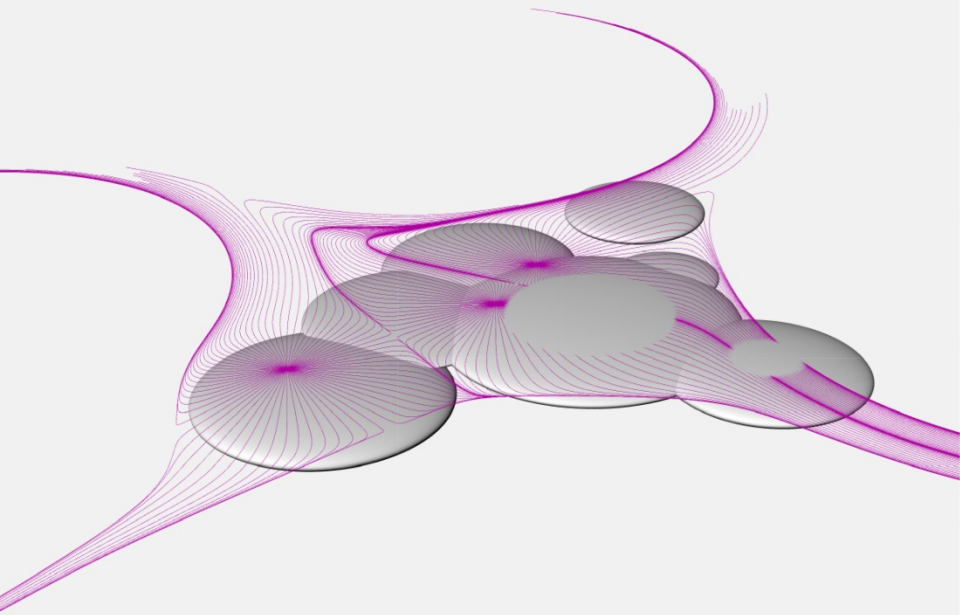
LAT 51°53'51.83"N
LON 4°27'48.93"E

FUNCTIONS

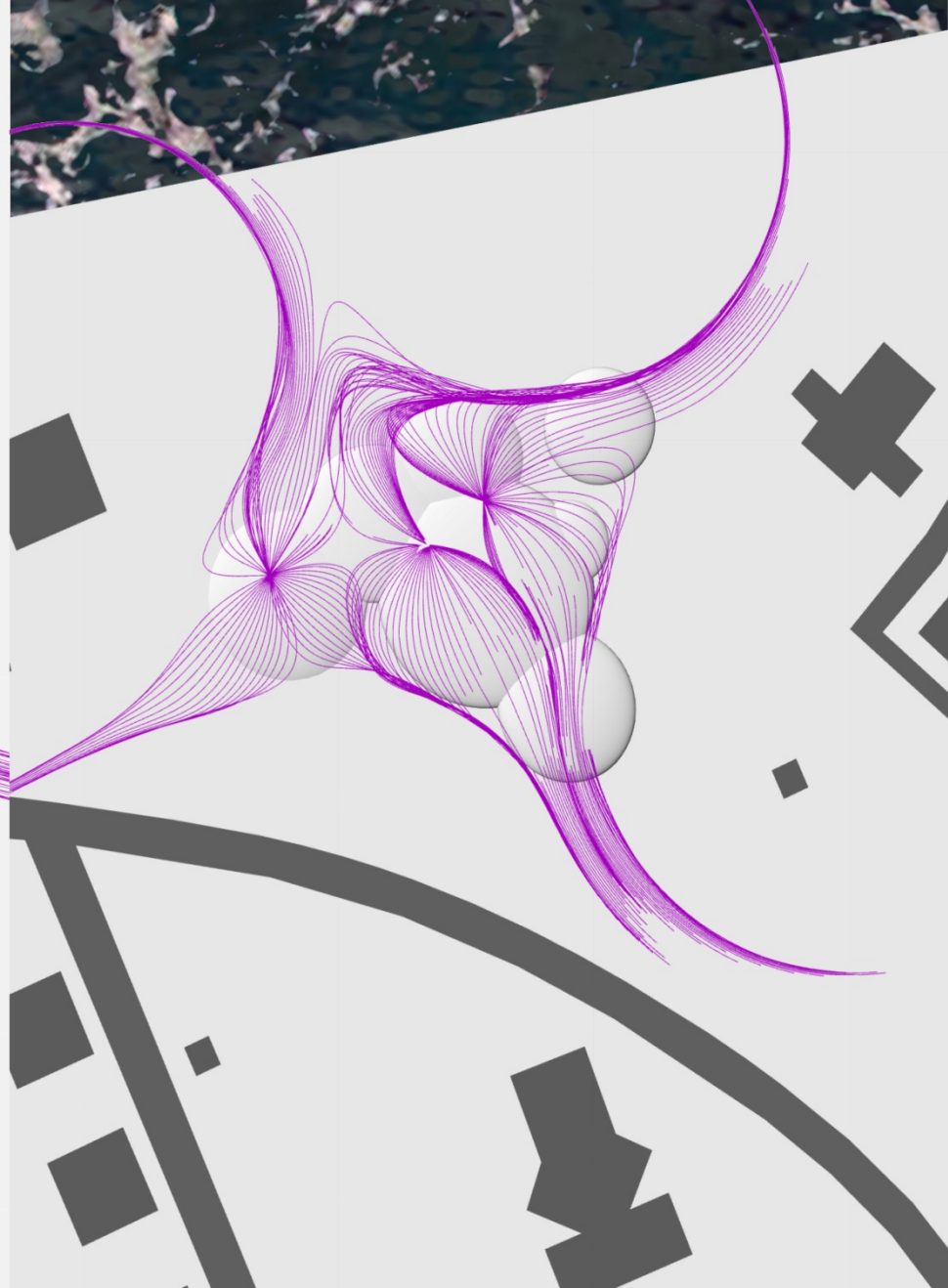
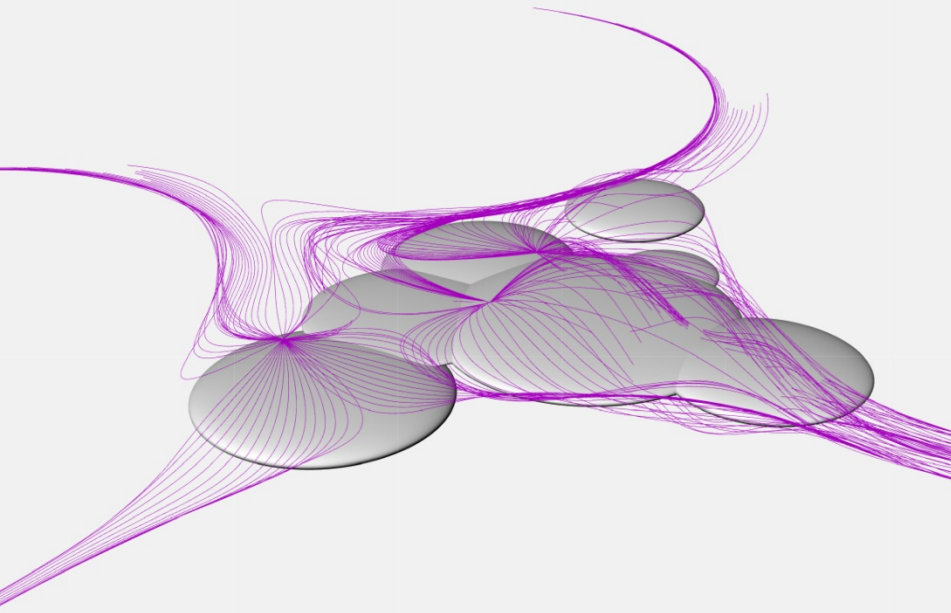
1. INFO BOOTH
2. CONFERENCE HALL
3. EXHIBITION SPACE
4. RESTAURANT
5. BIOLAB
6. SYSTEM ROOM
7. OFFICES

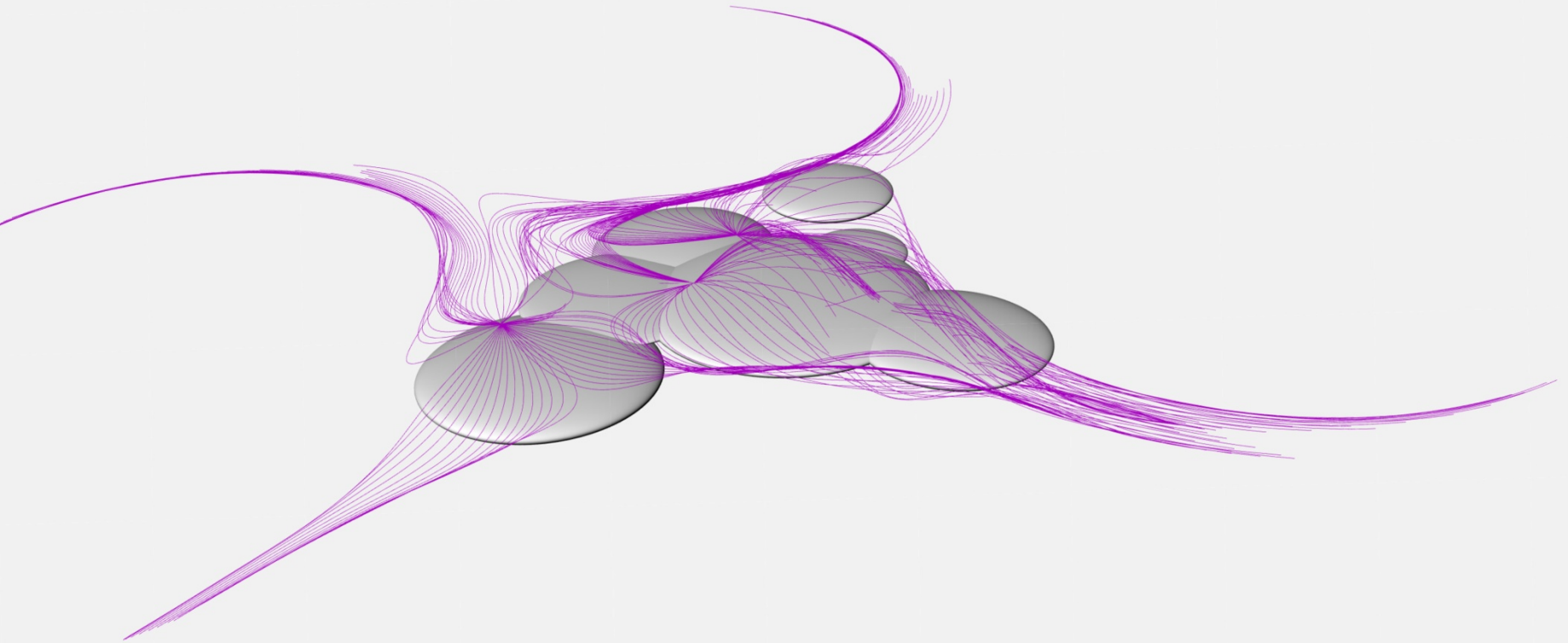


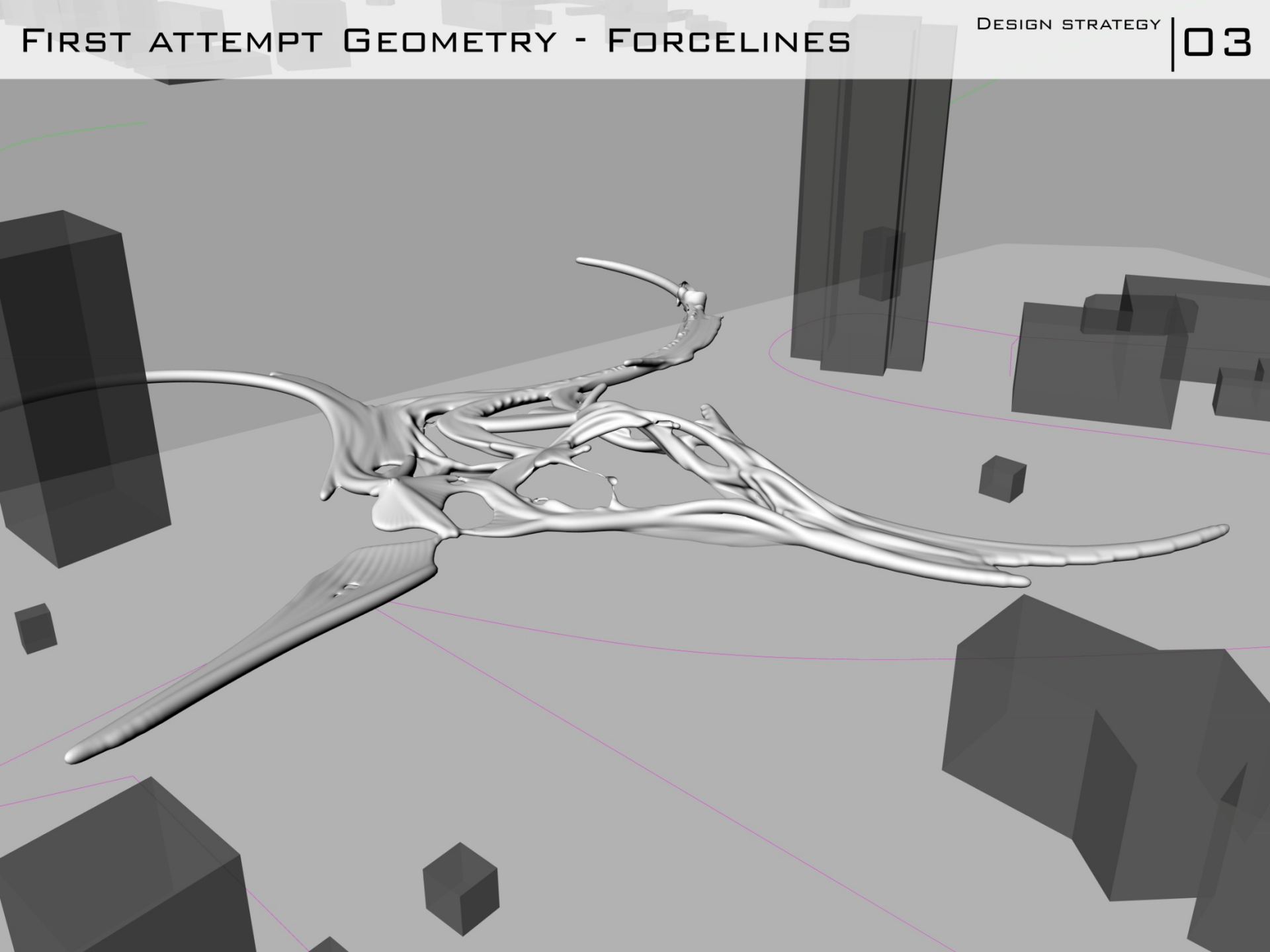




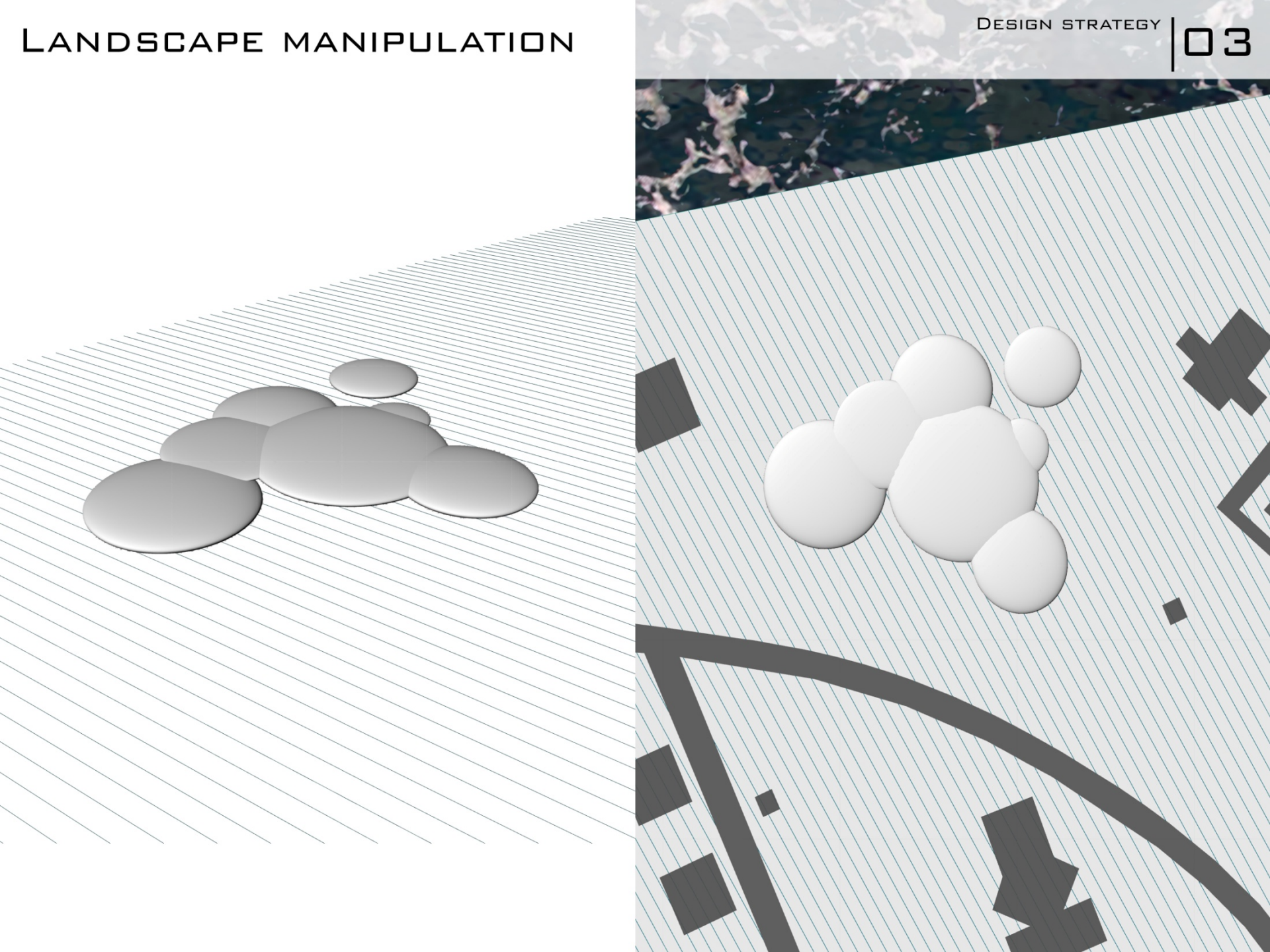
FORCELINES - HEIGHT OF GEOMETRY





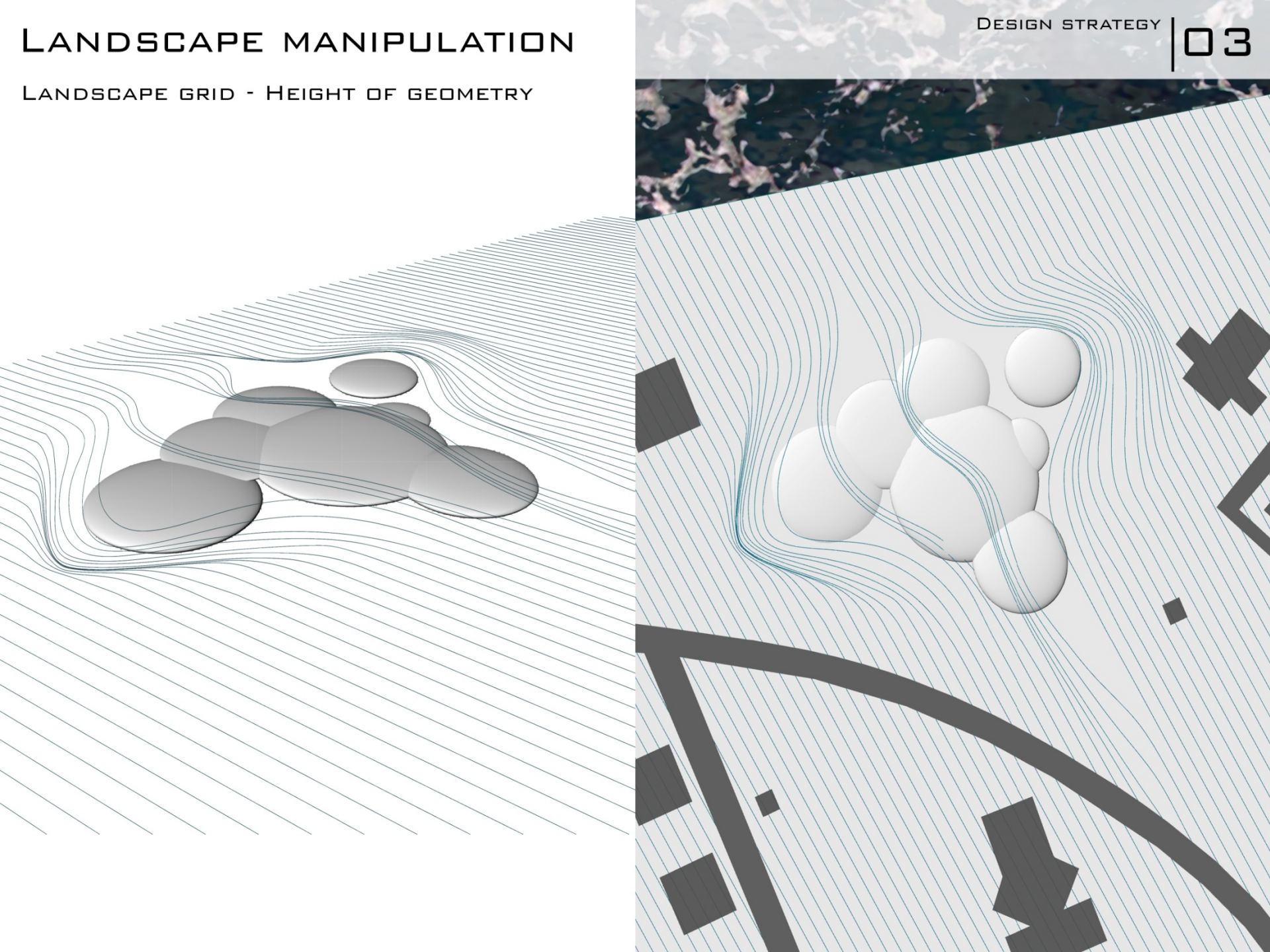


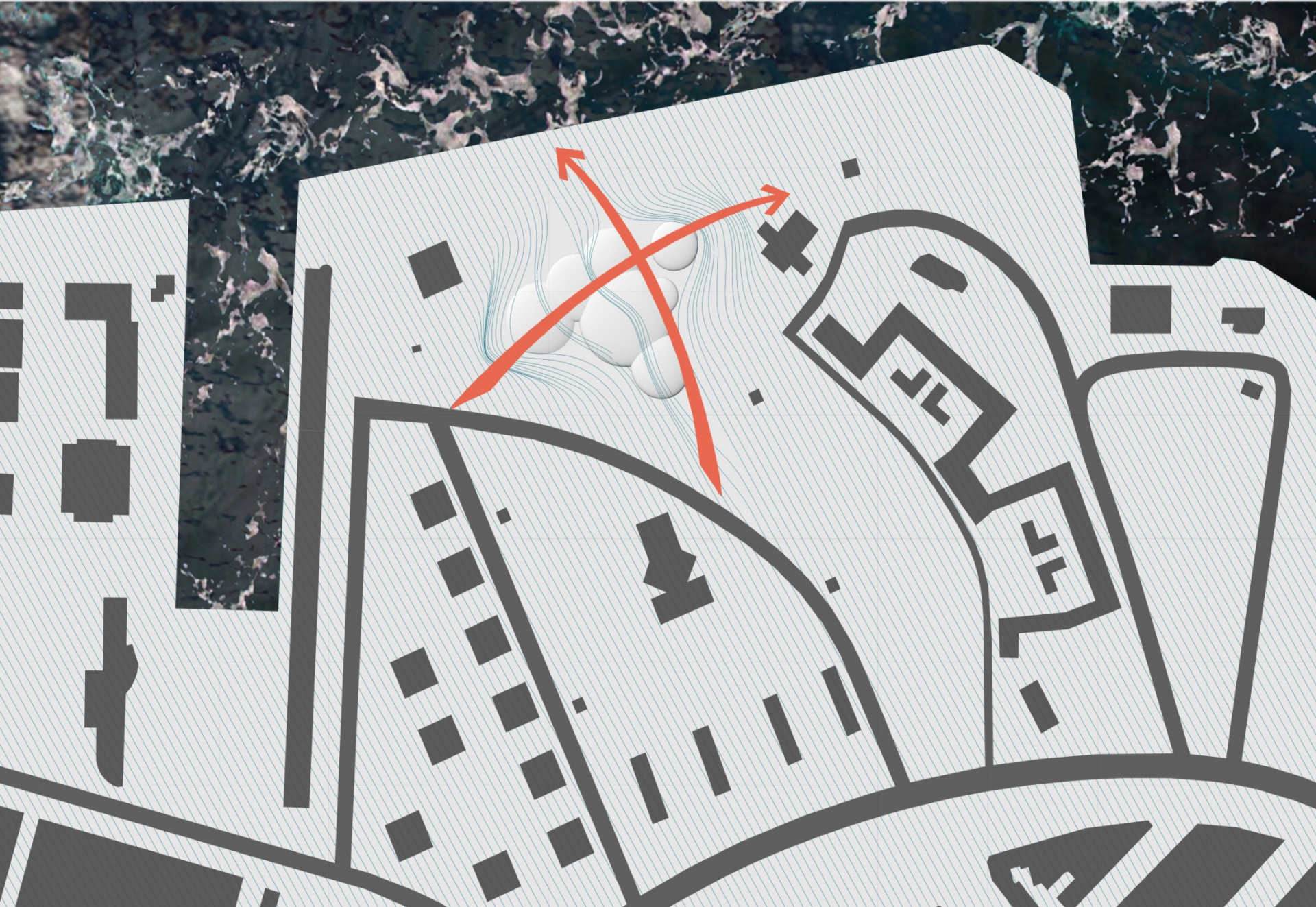




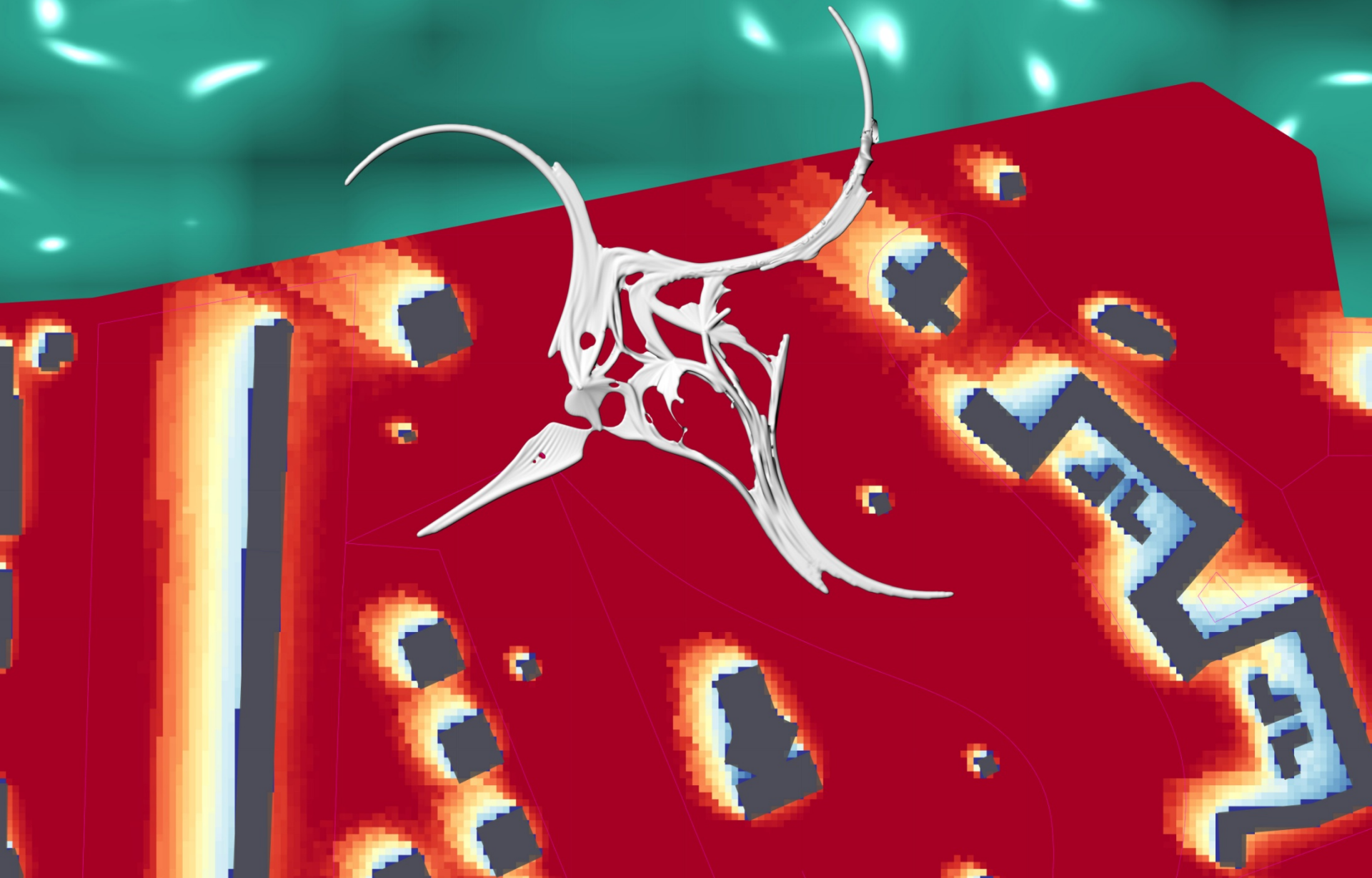
LANDSCAPE MANIPULATION

LANDSCAPE GRID - HEIGHT OF GEOMETRY

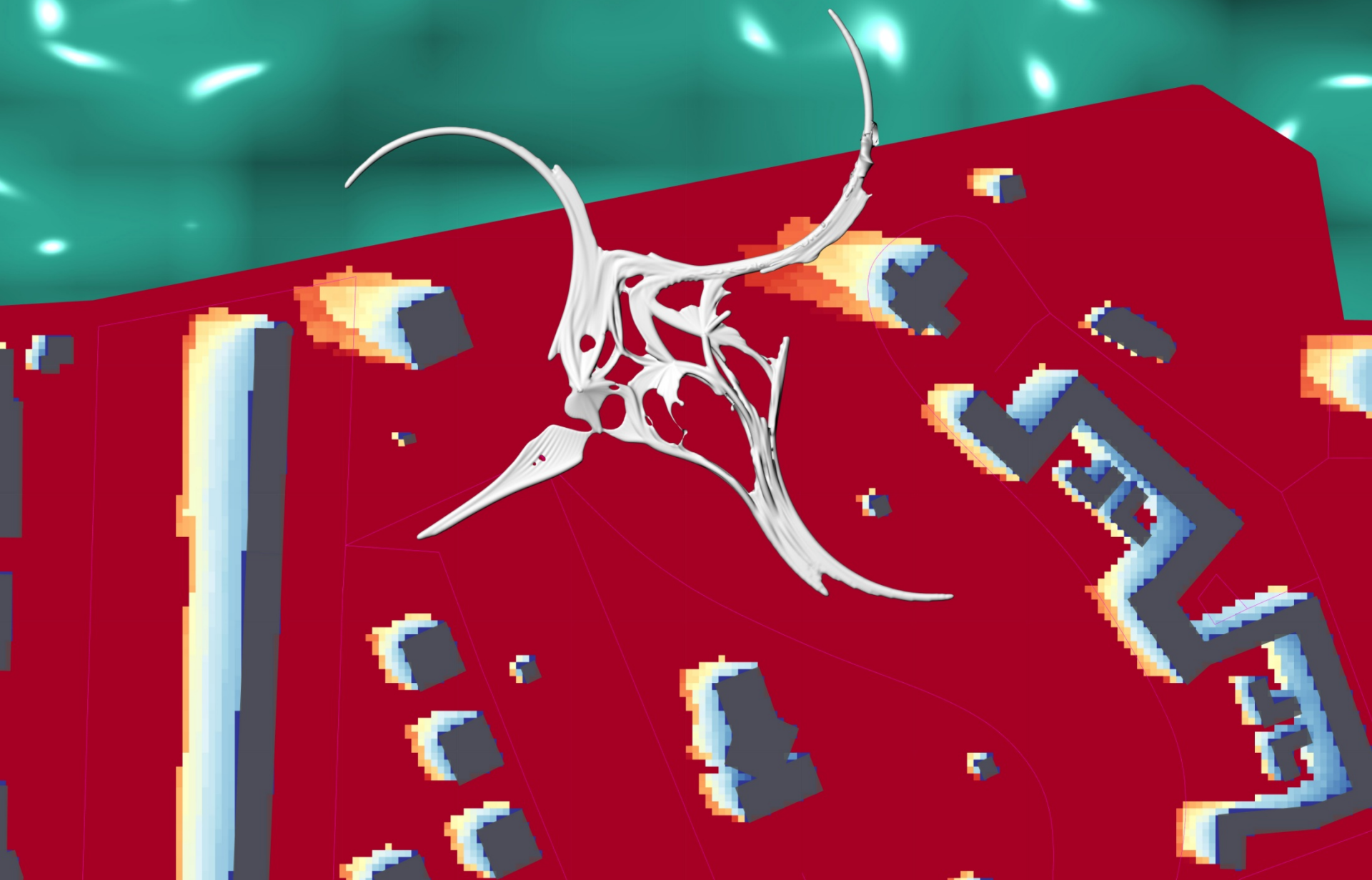




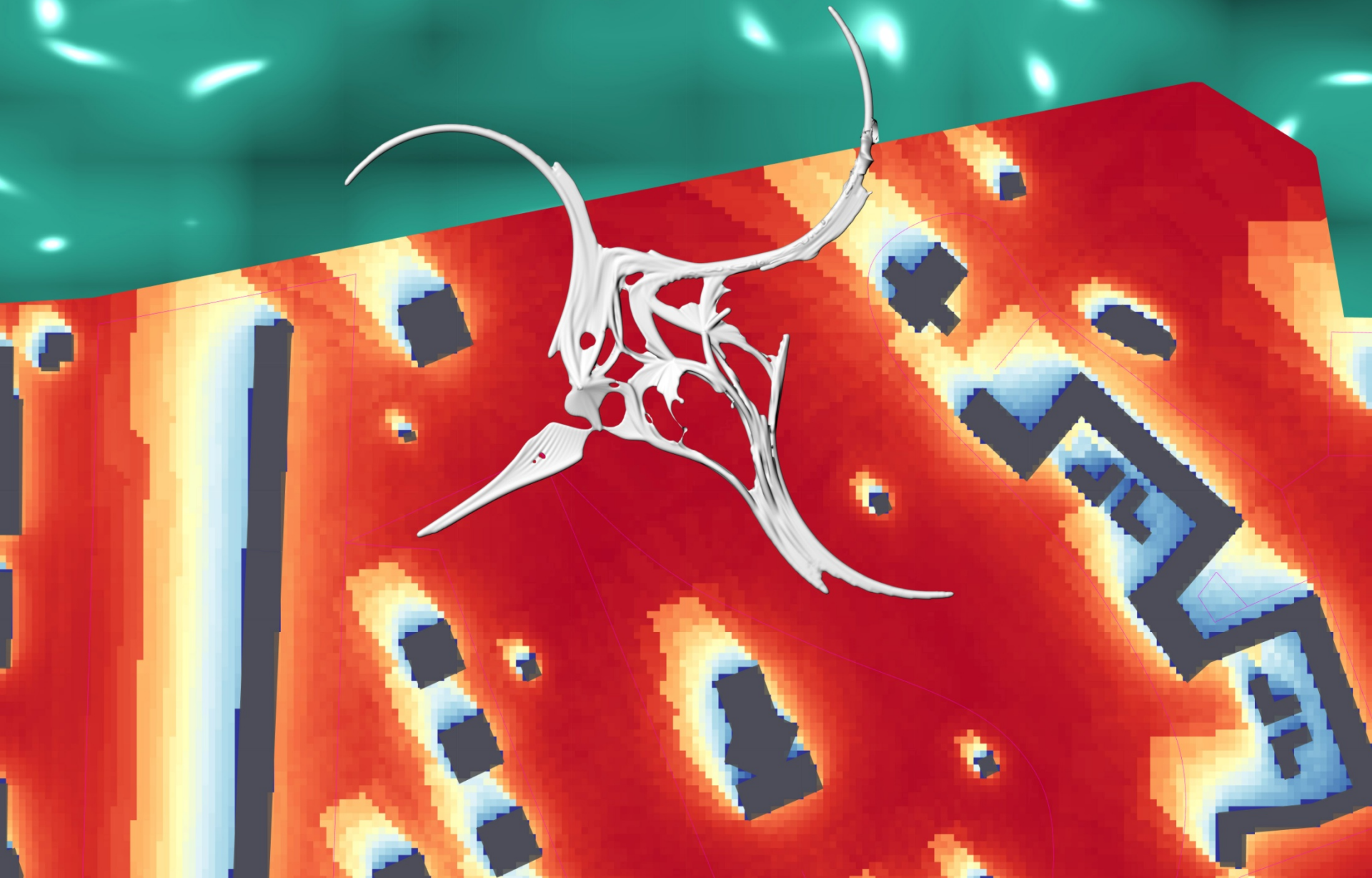
SPRING - APRIL 15TH



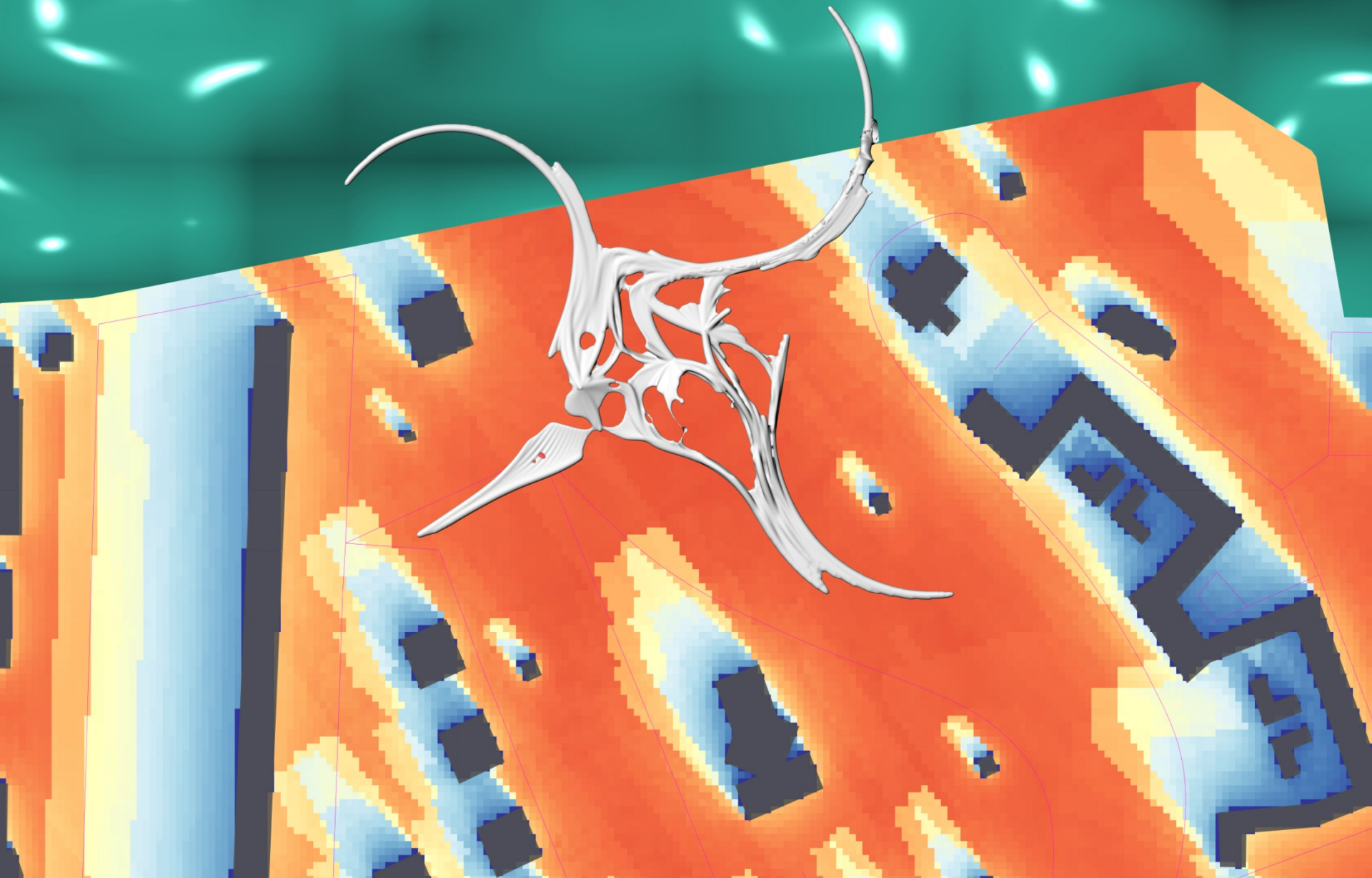
SUMMER - JULY 15TH

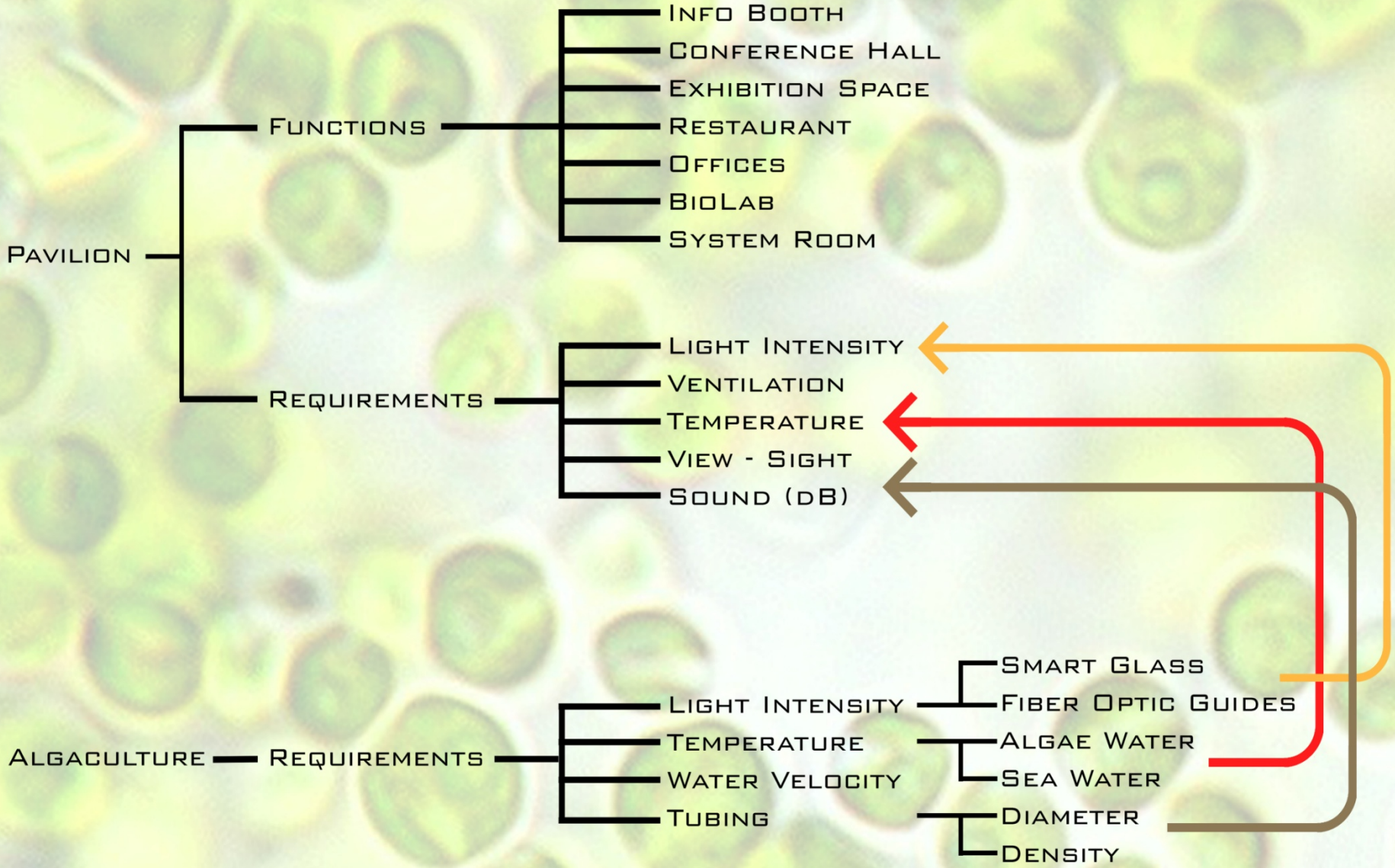


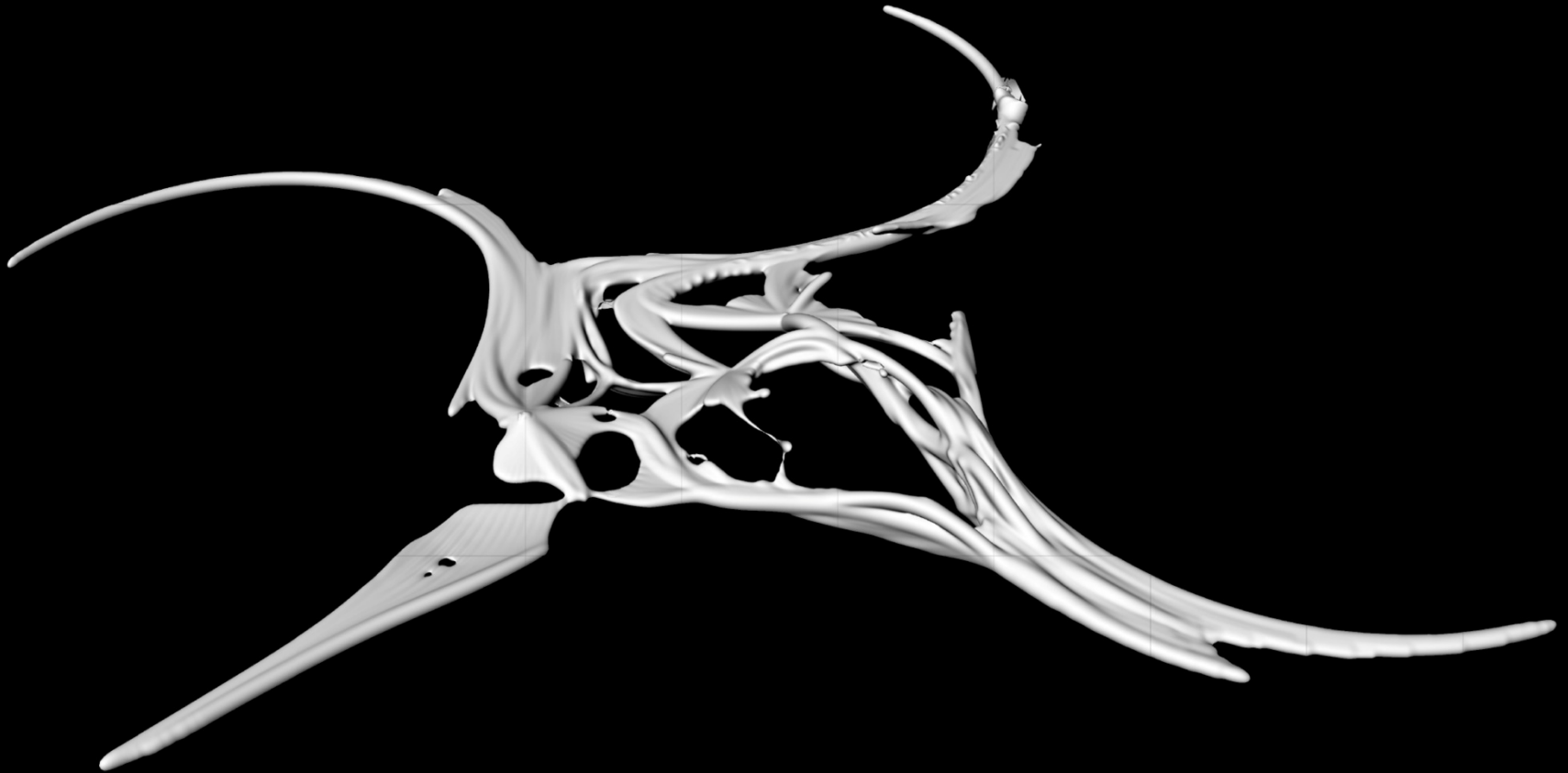
FALL - OCTOBER 15TH

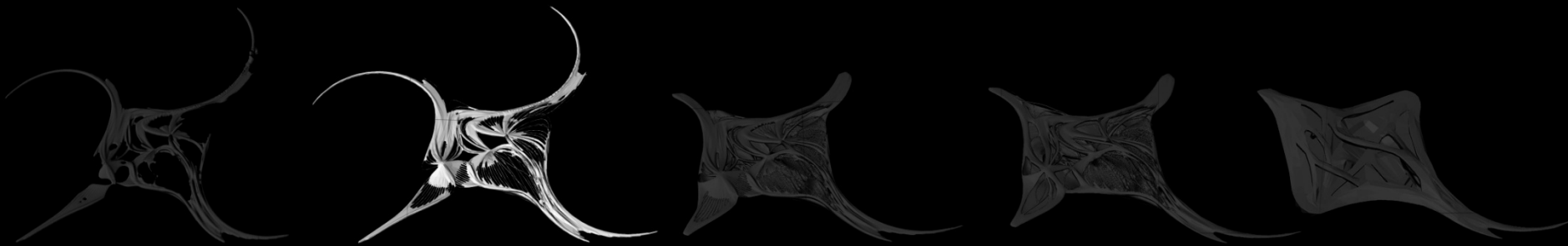
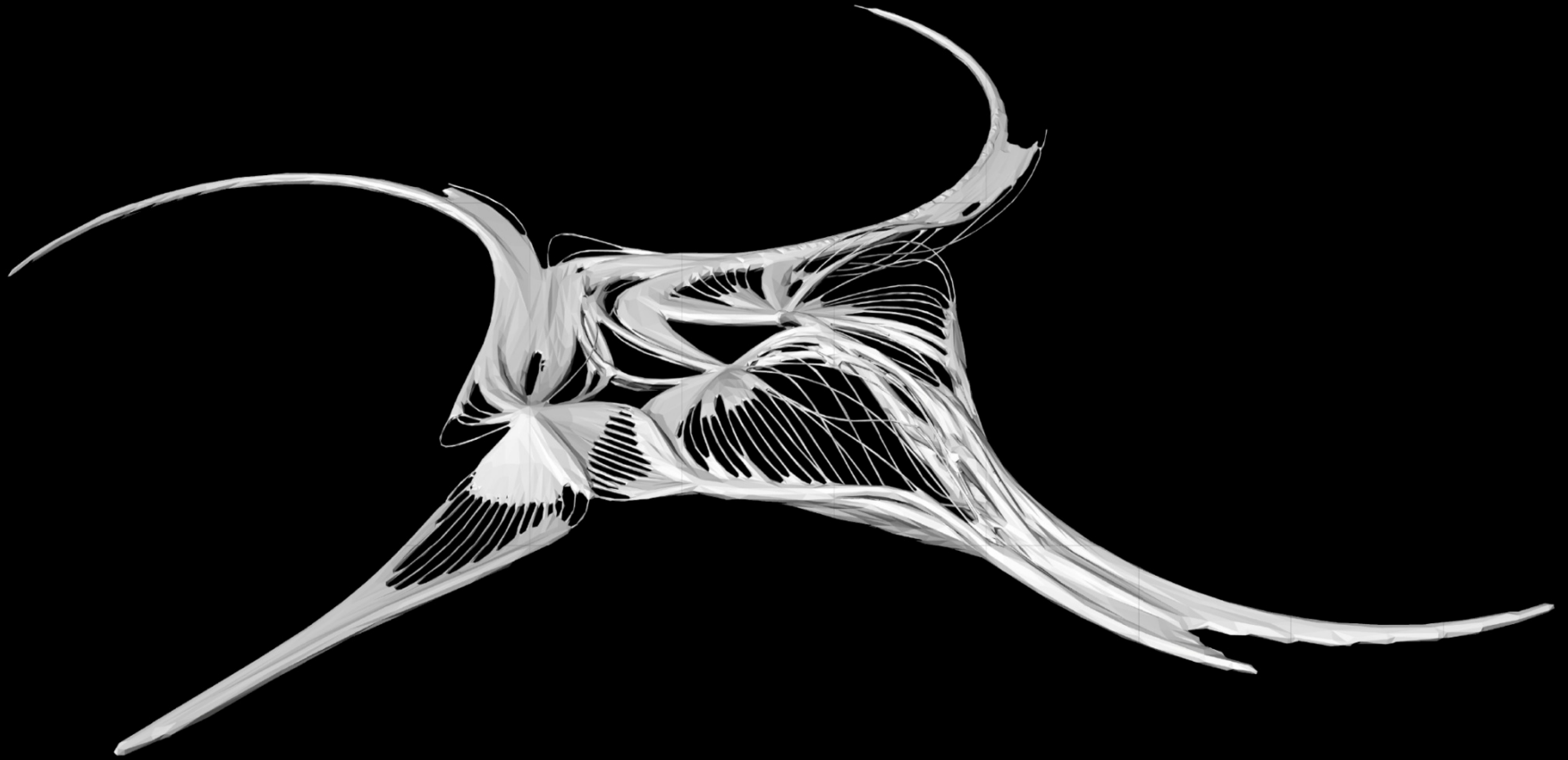


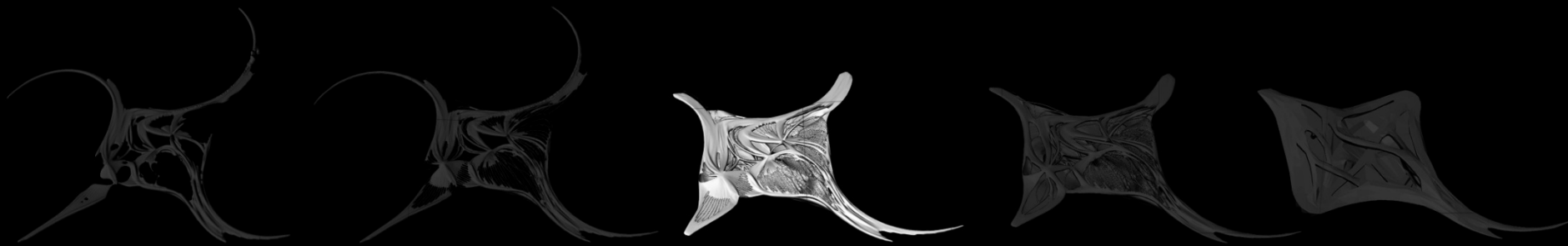
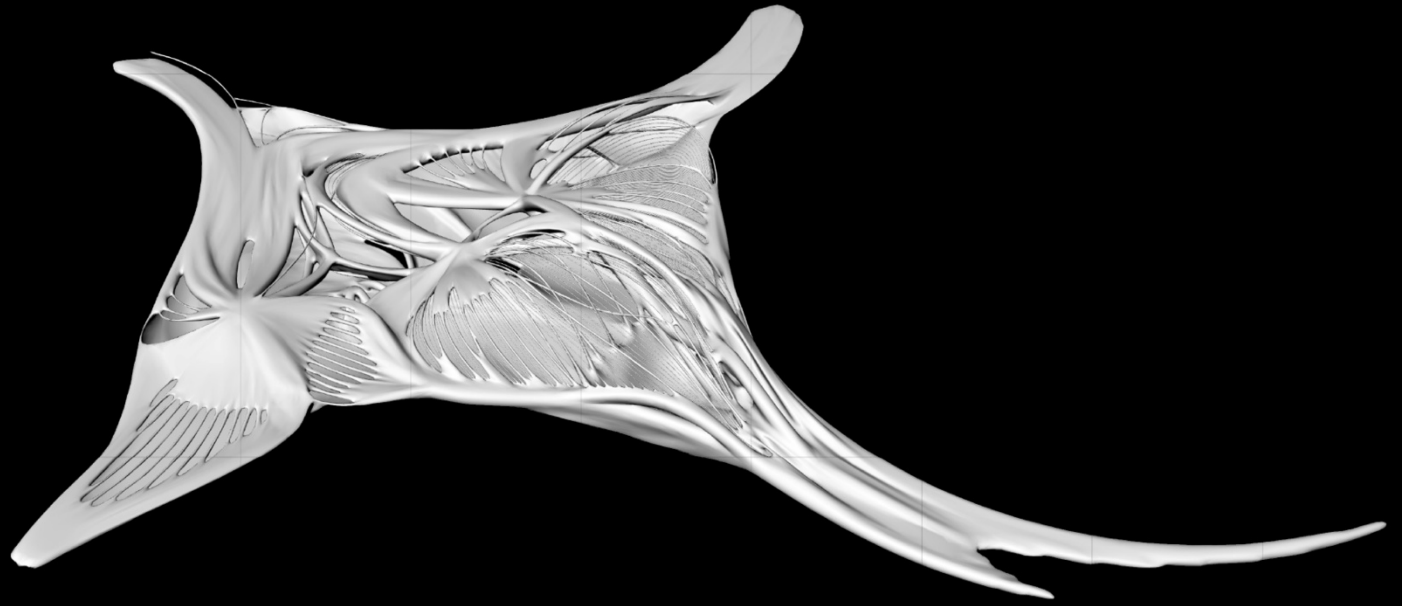
WINTER - JANUARY 15TH

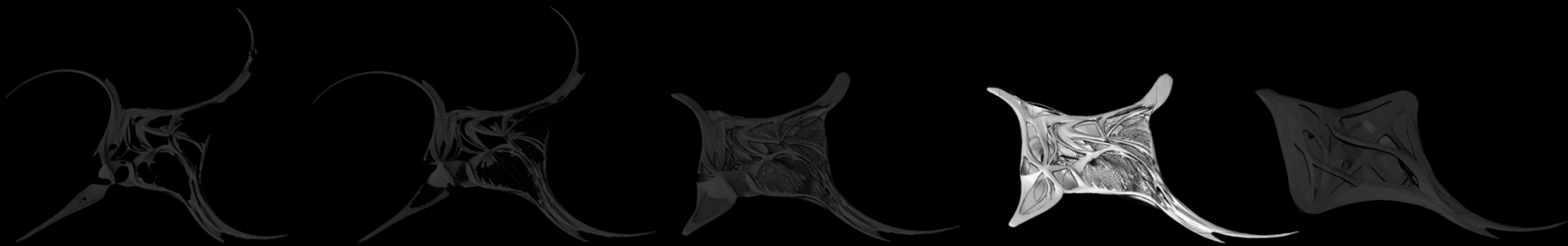
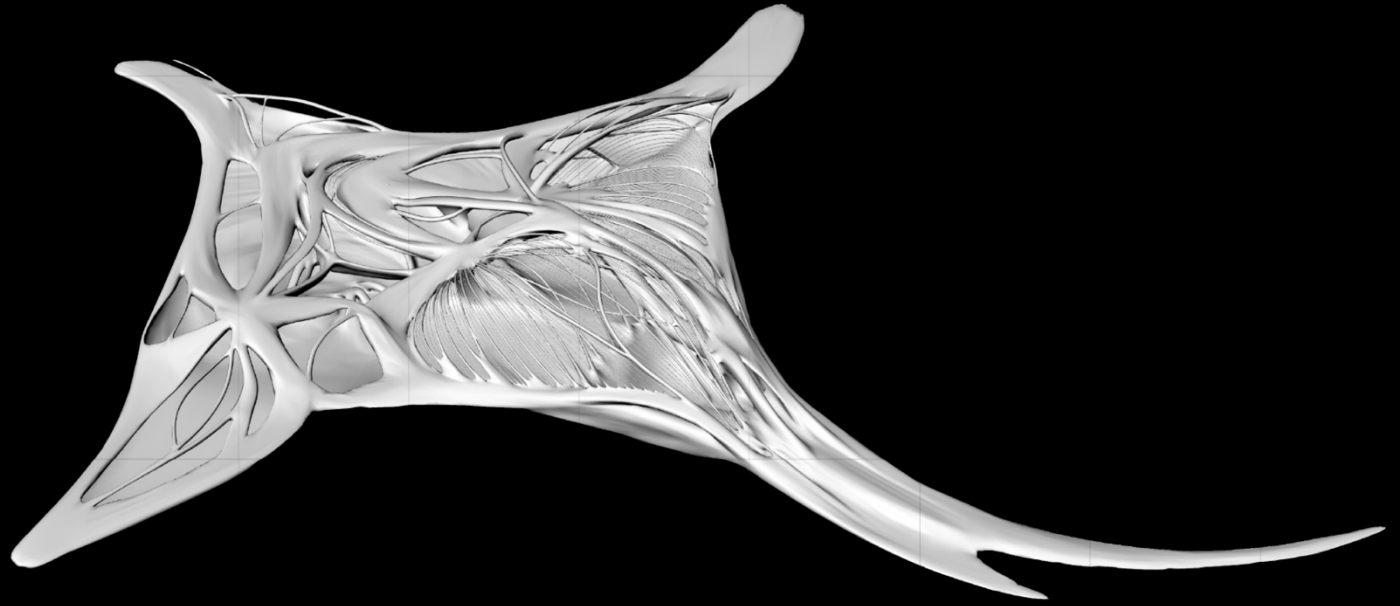


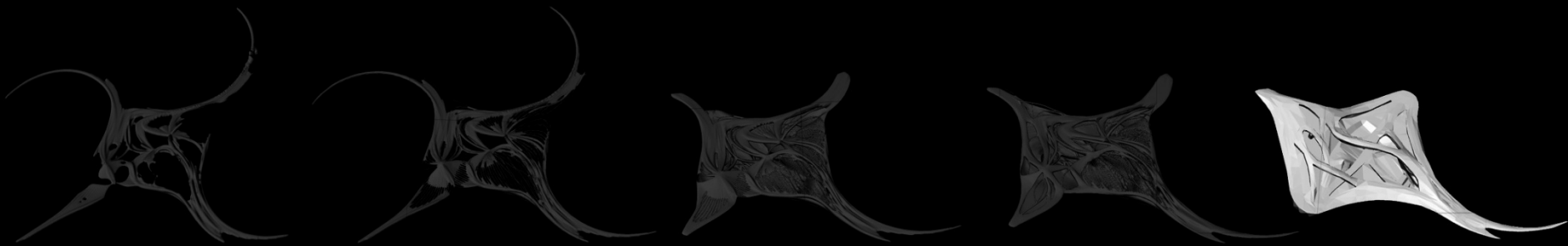
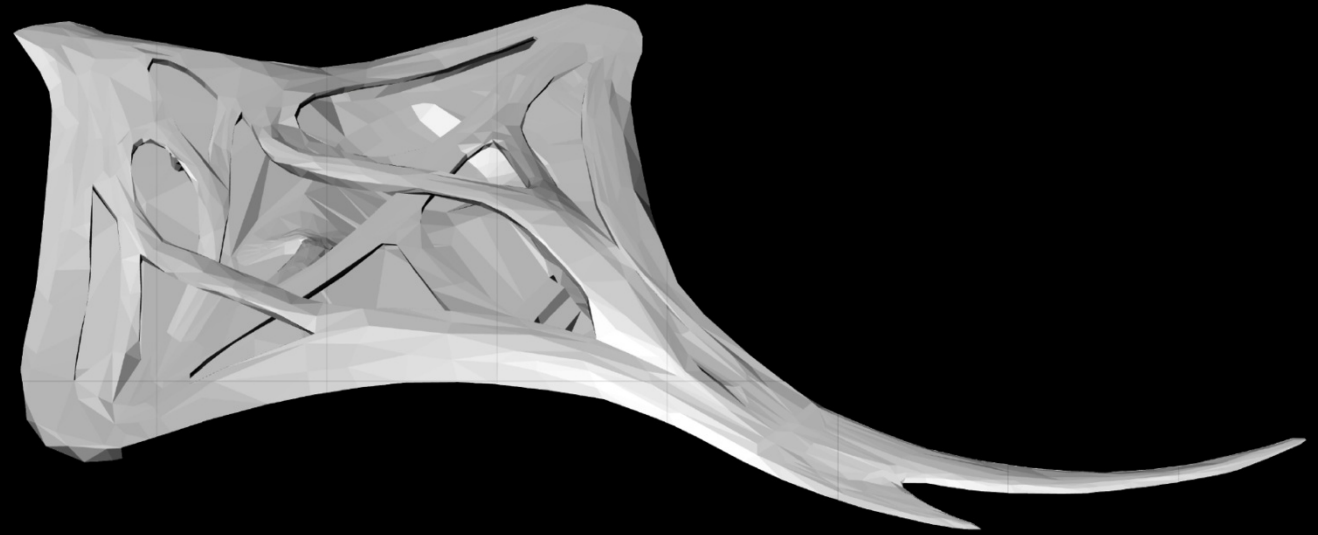


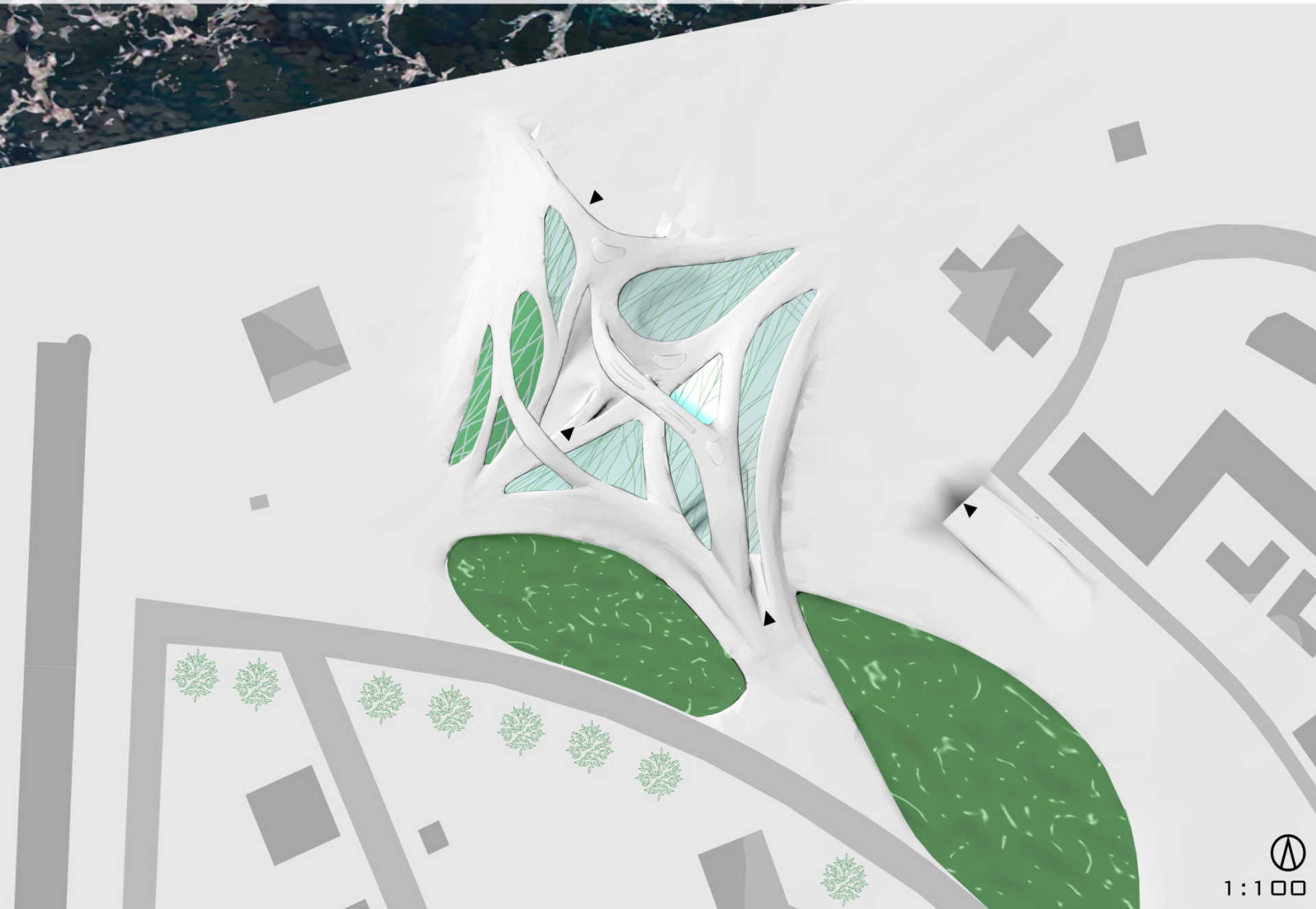






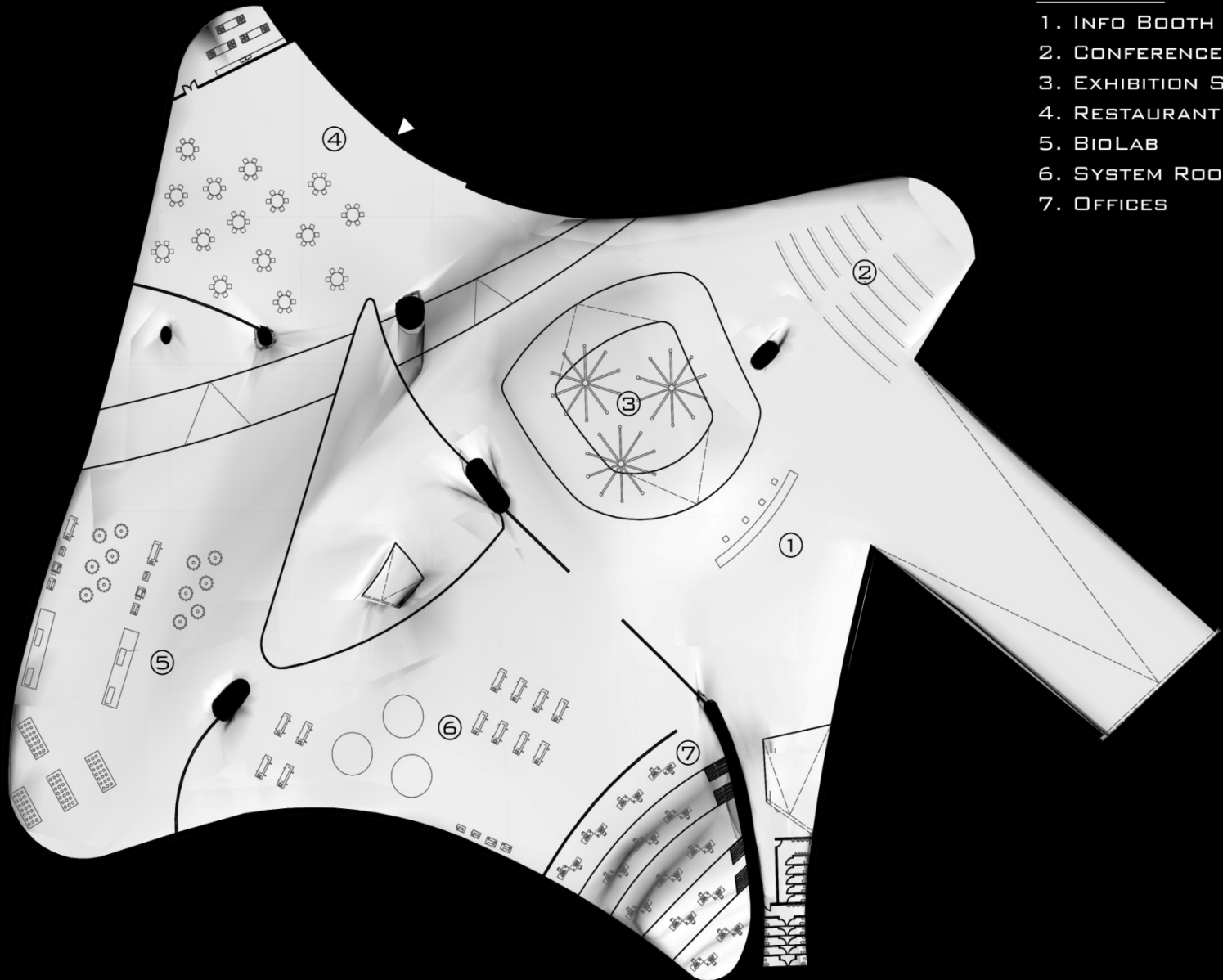


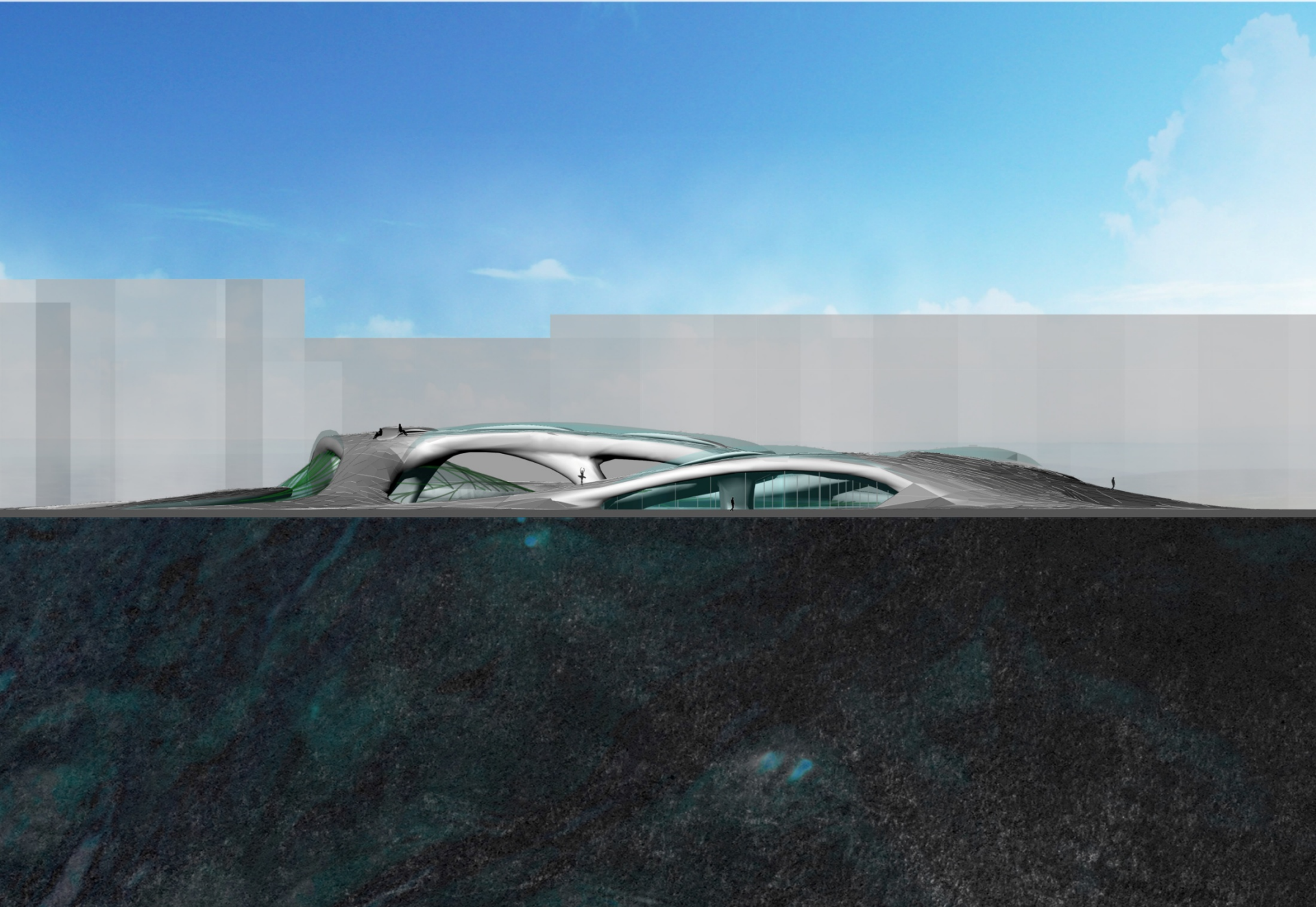


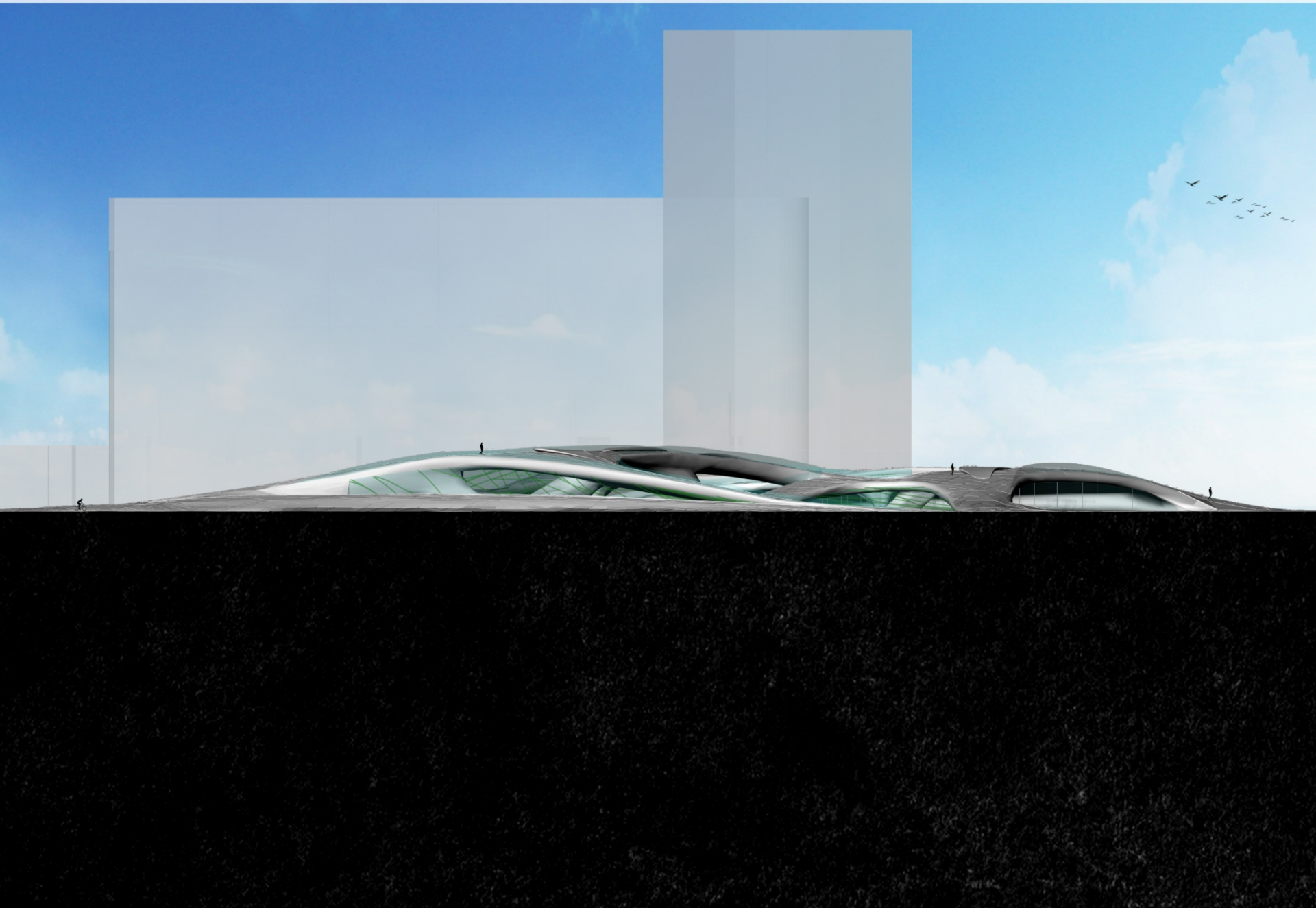


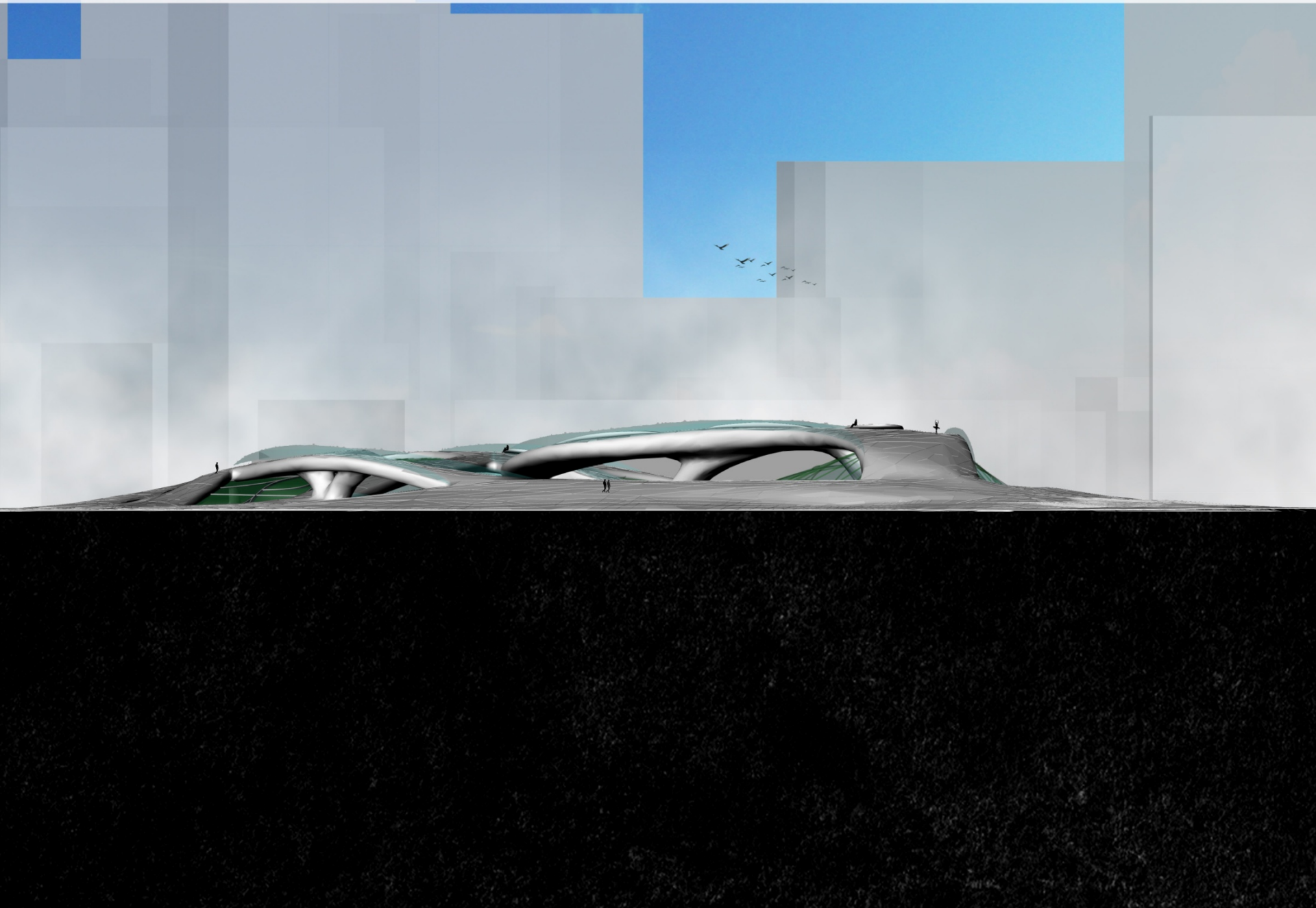
FUNCTIONS

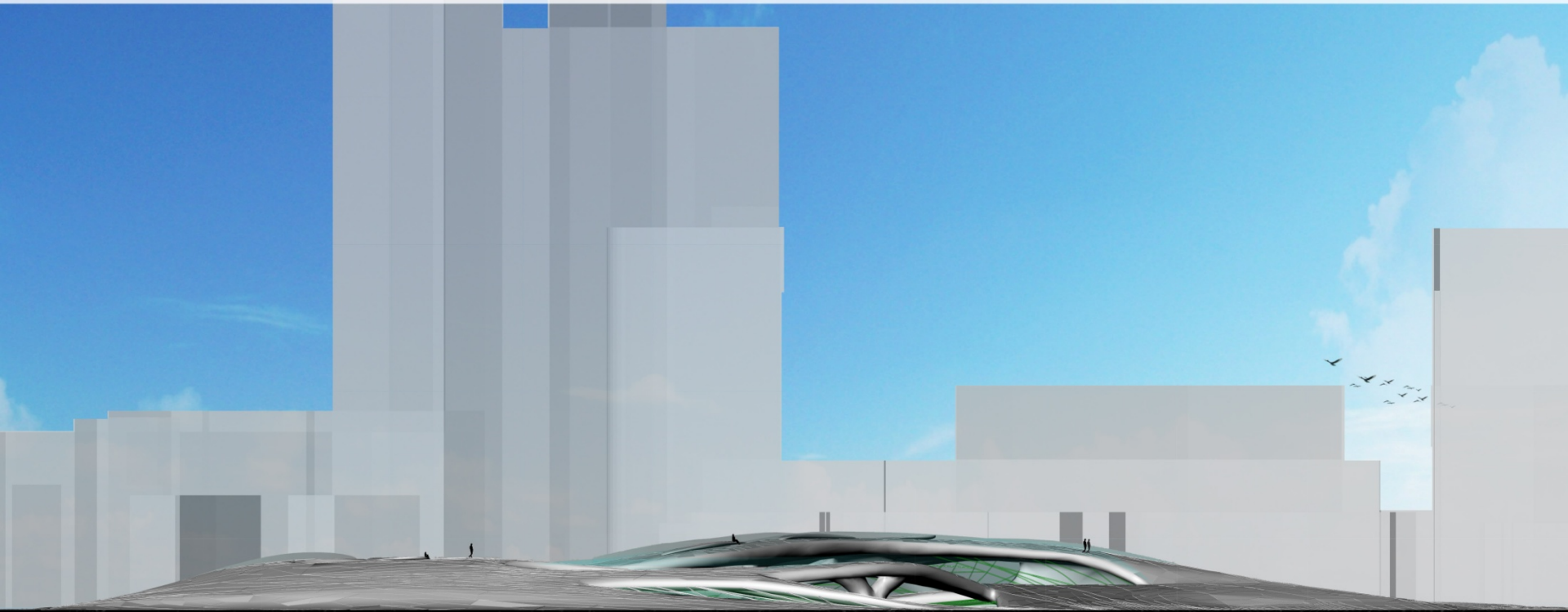
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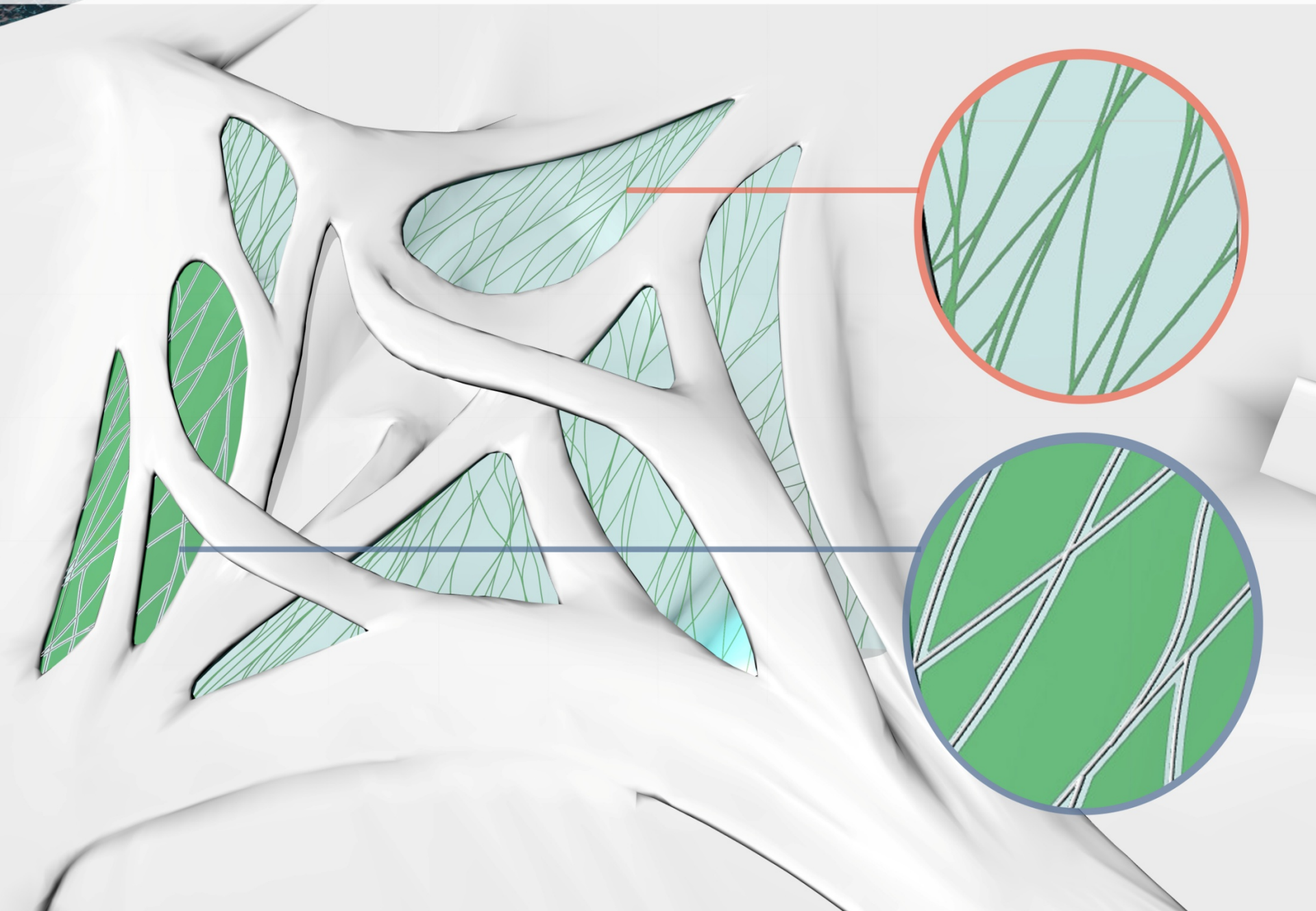


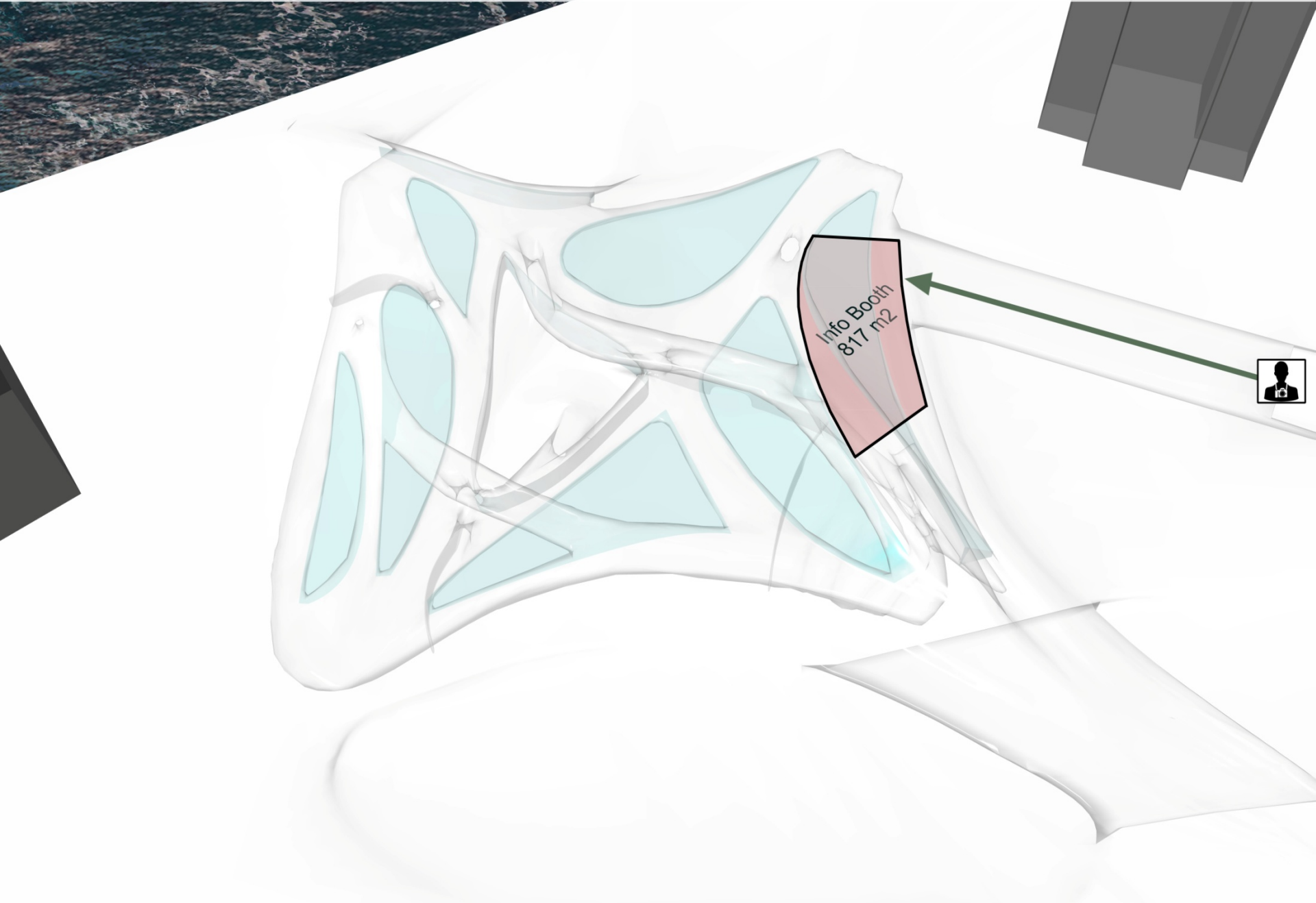






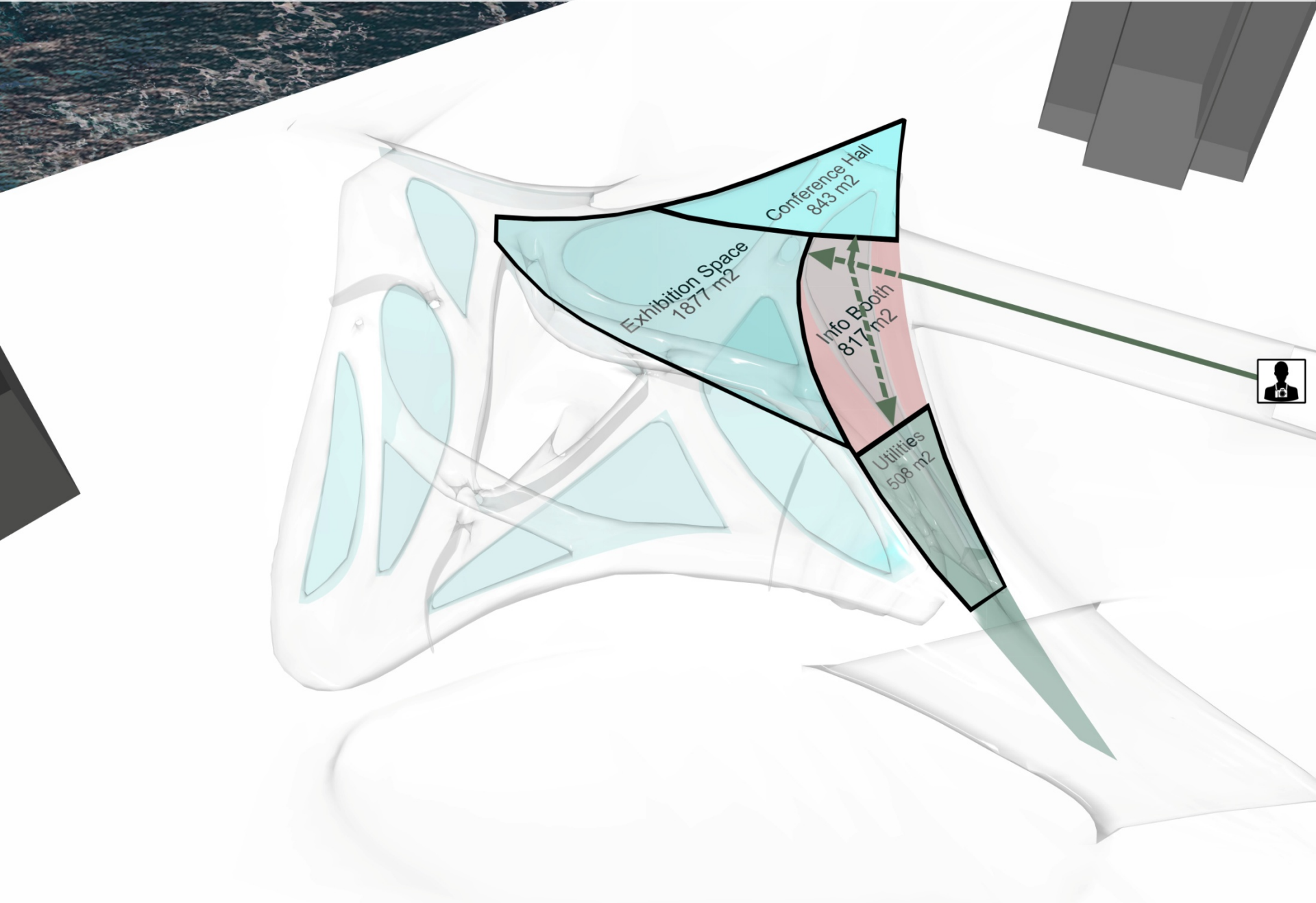






Info Booth
817 m2





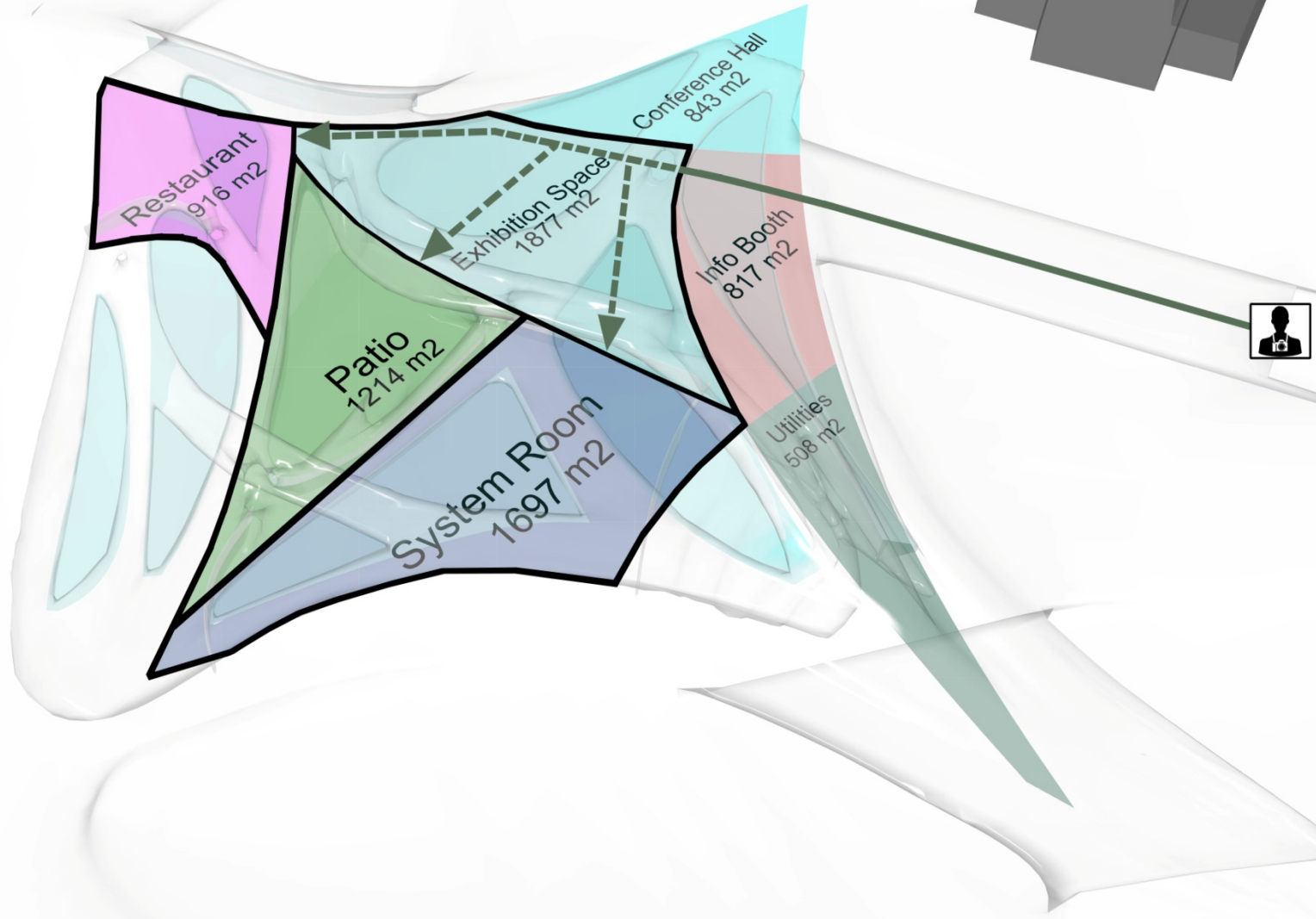
Exhibition Space
1877 m²

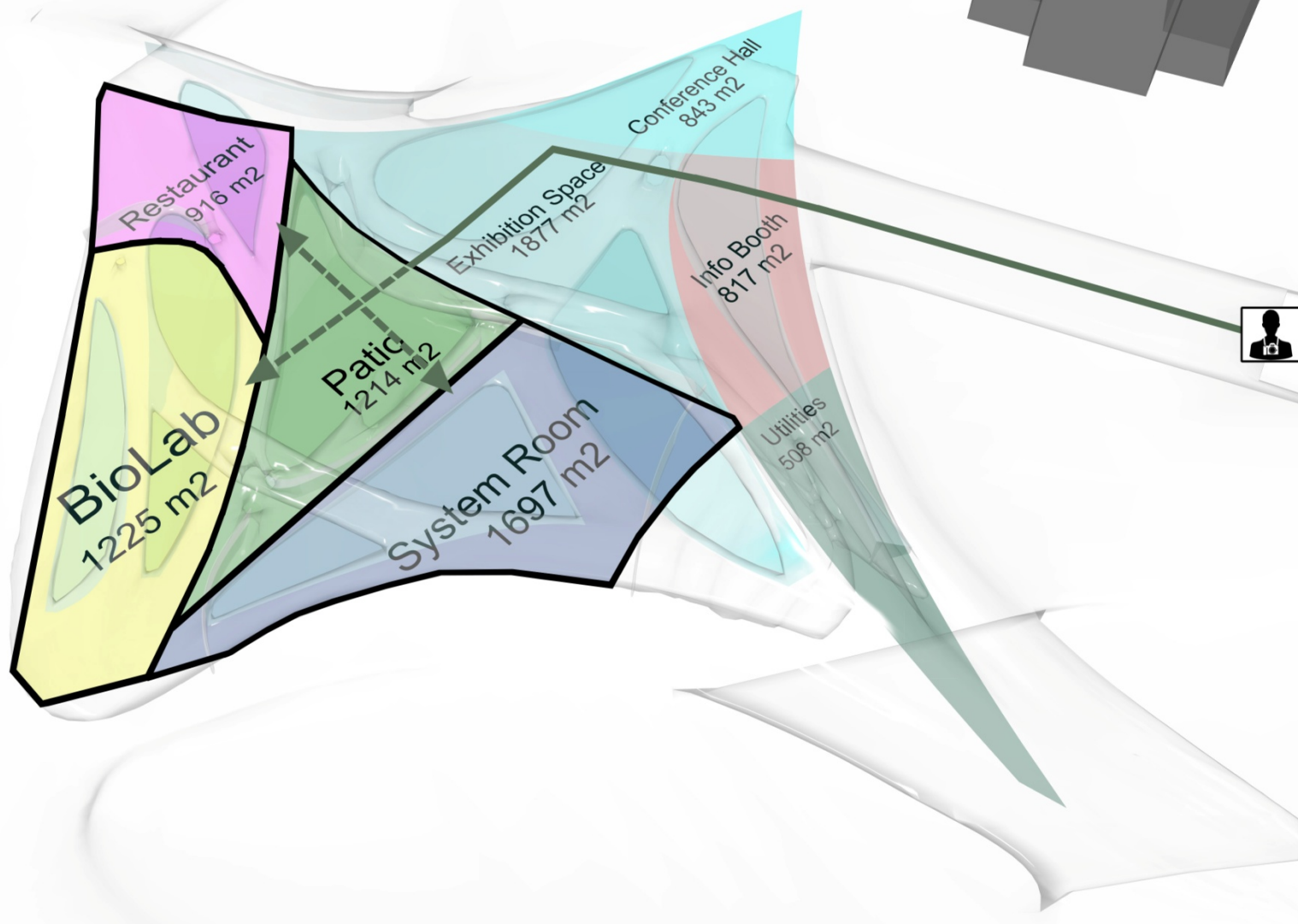
Conference Hall
843 m²

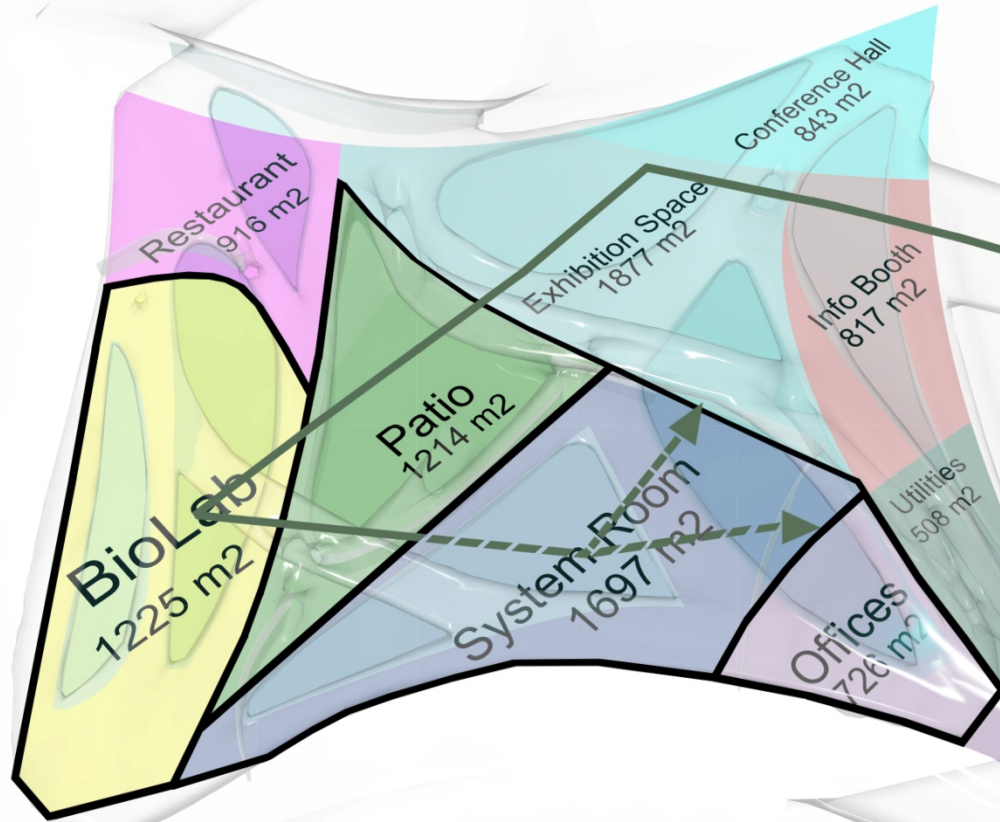
Info Booth
817 m²

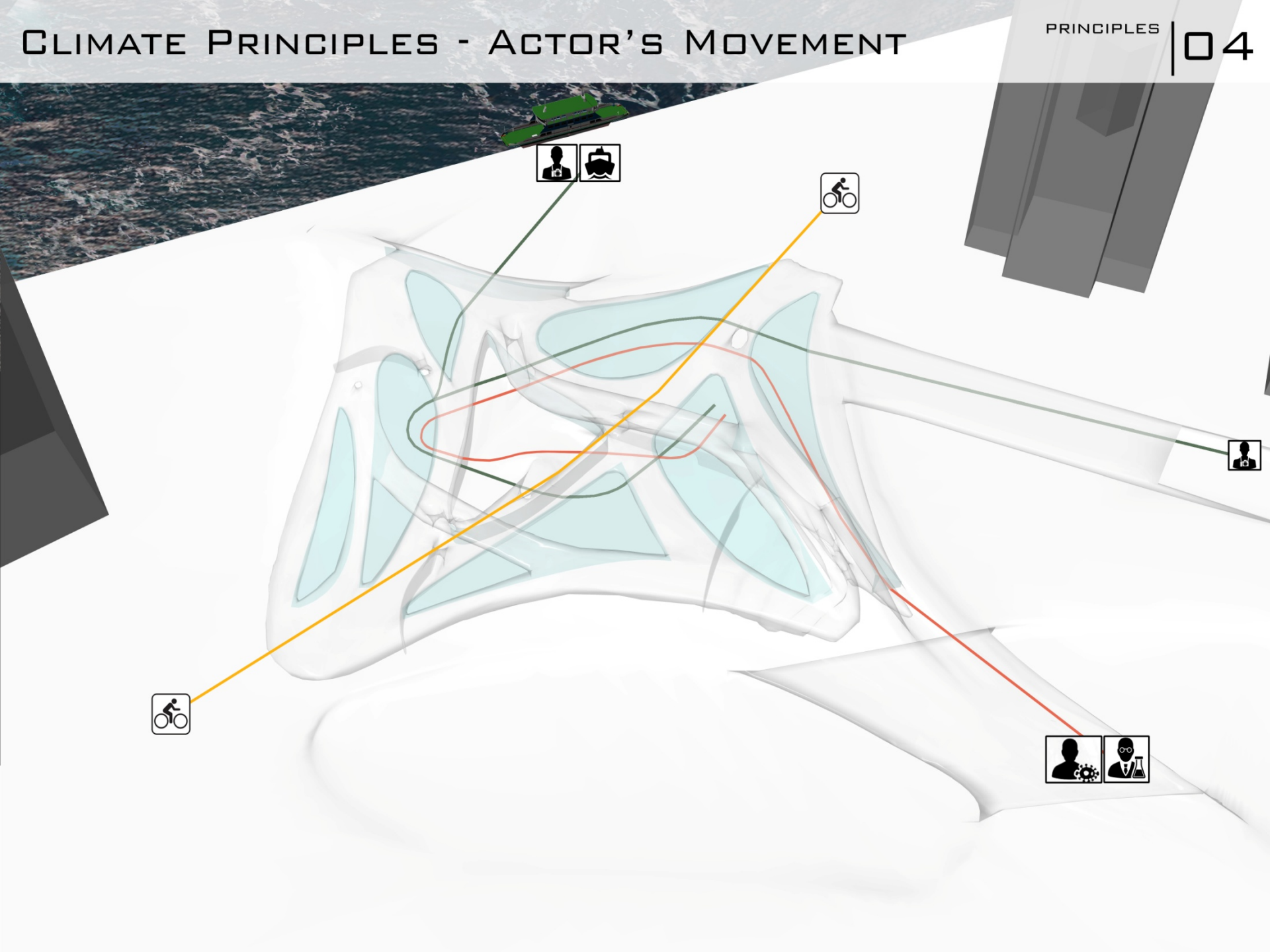
Utilities
508 m²



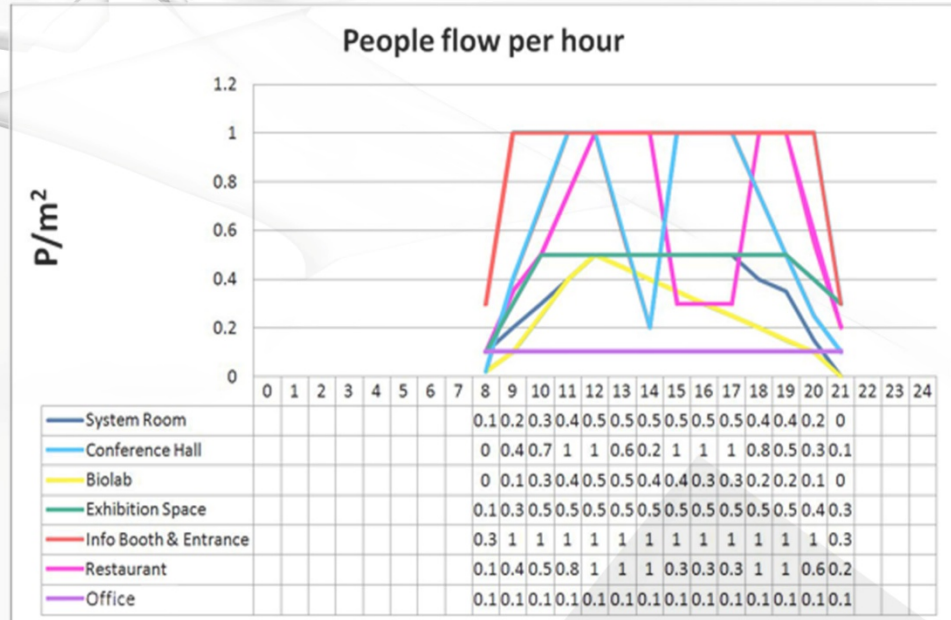
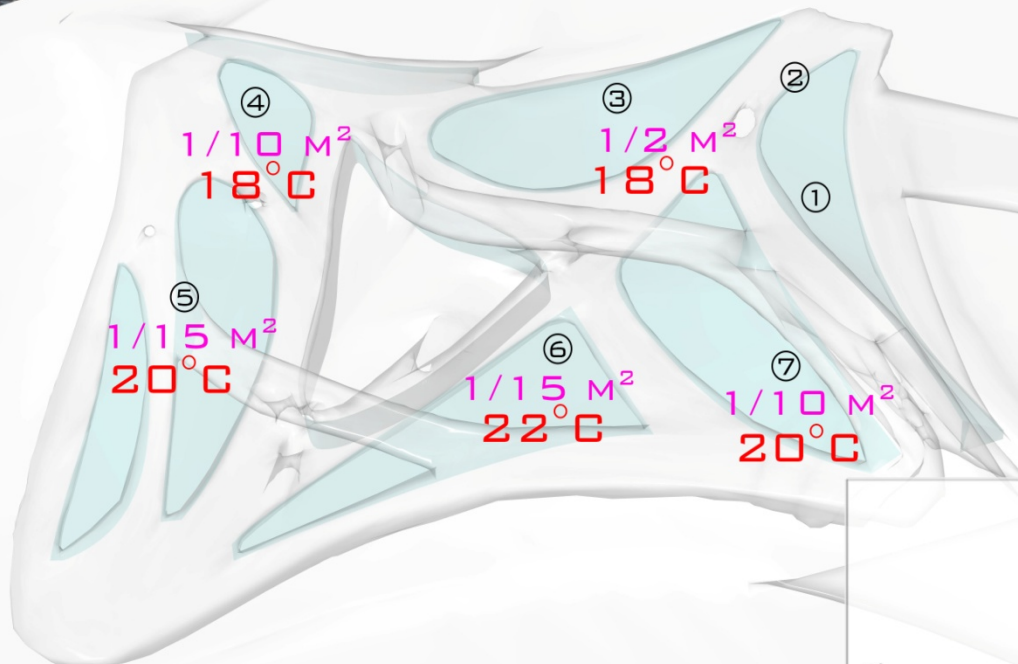






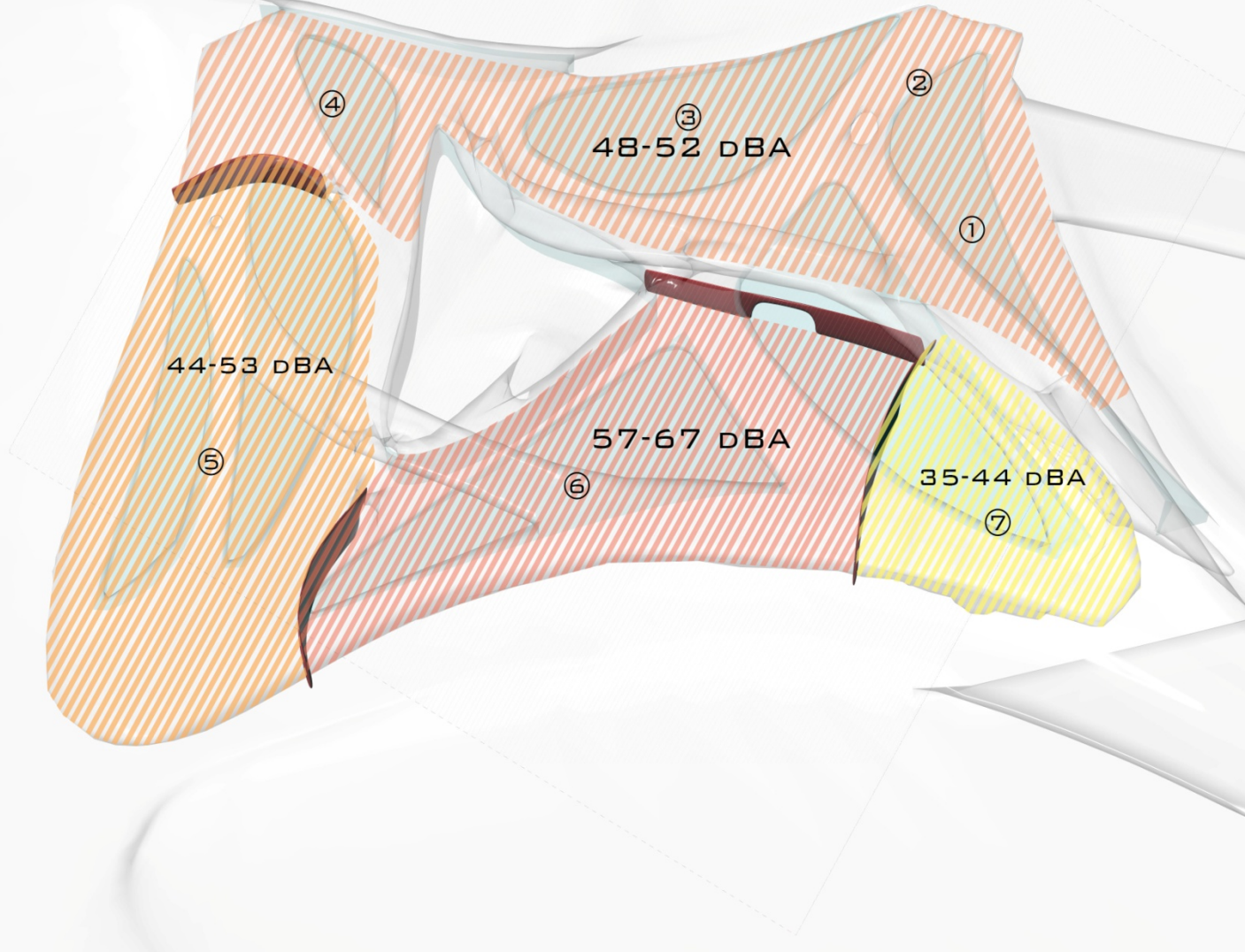


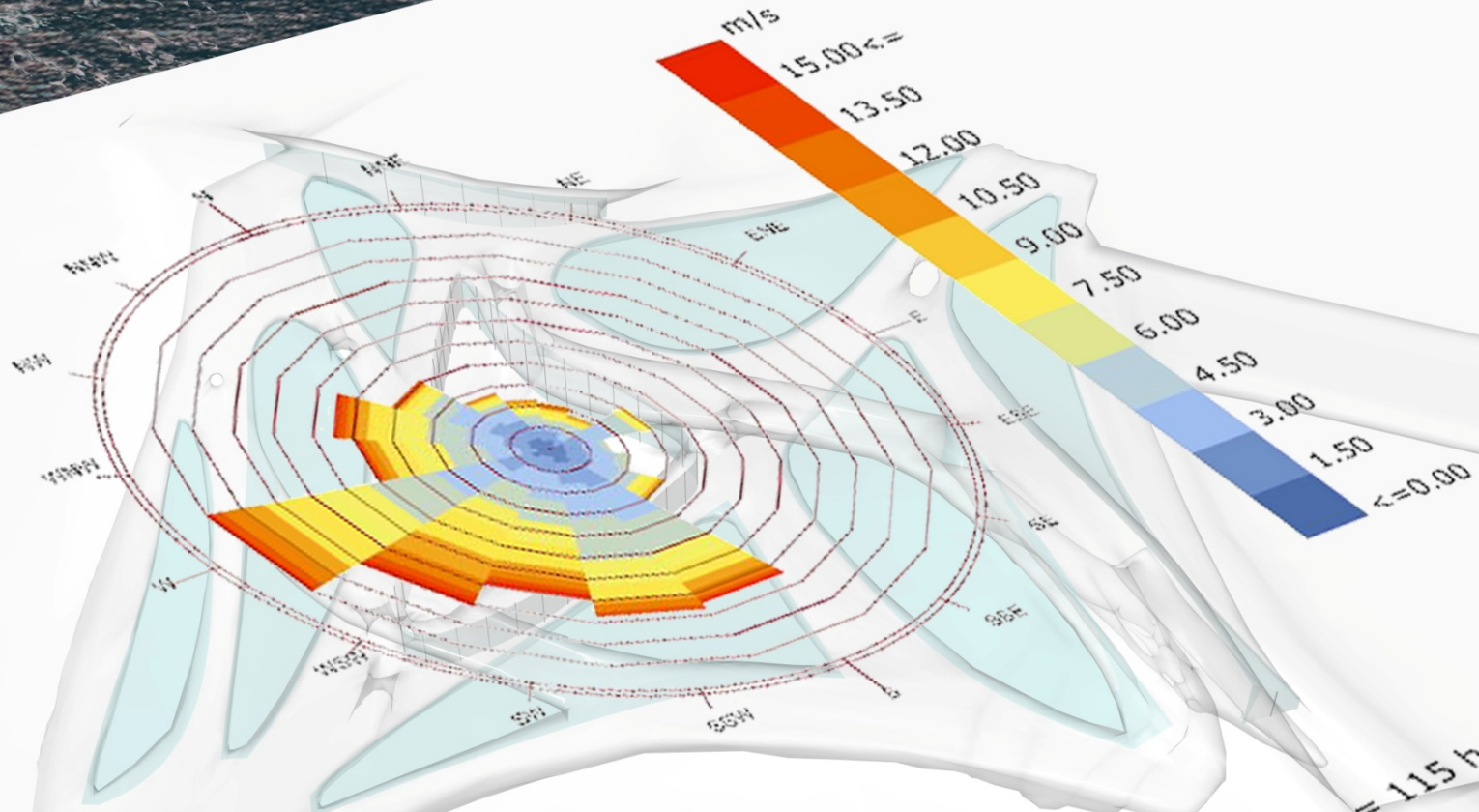
- FUNCTIONS**
1. INFO BOOTH
 2. CONFERENCE HALL
 3. EXHIBITION SPACE
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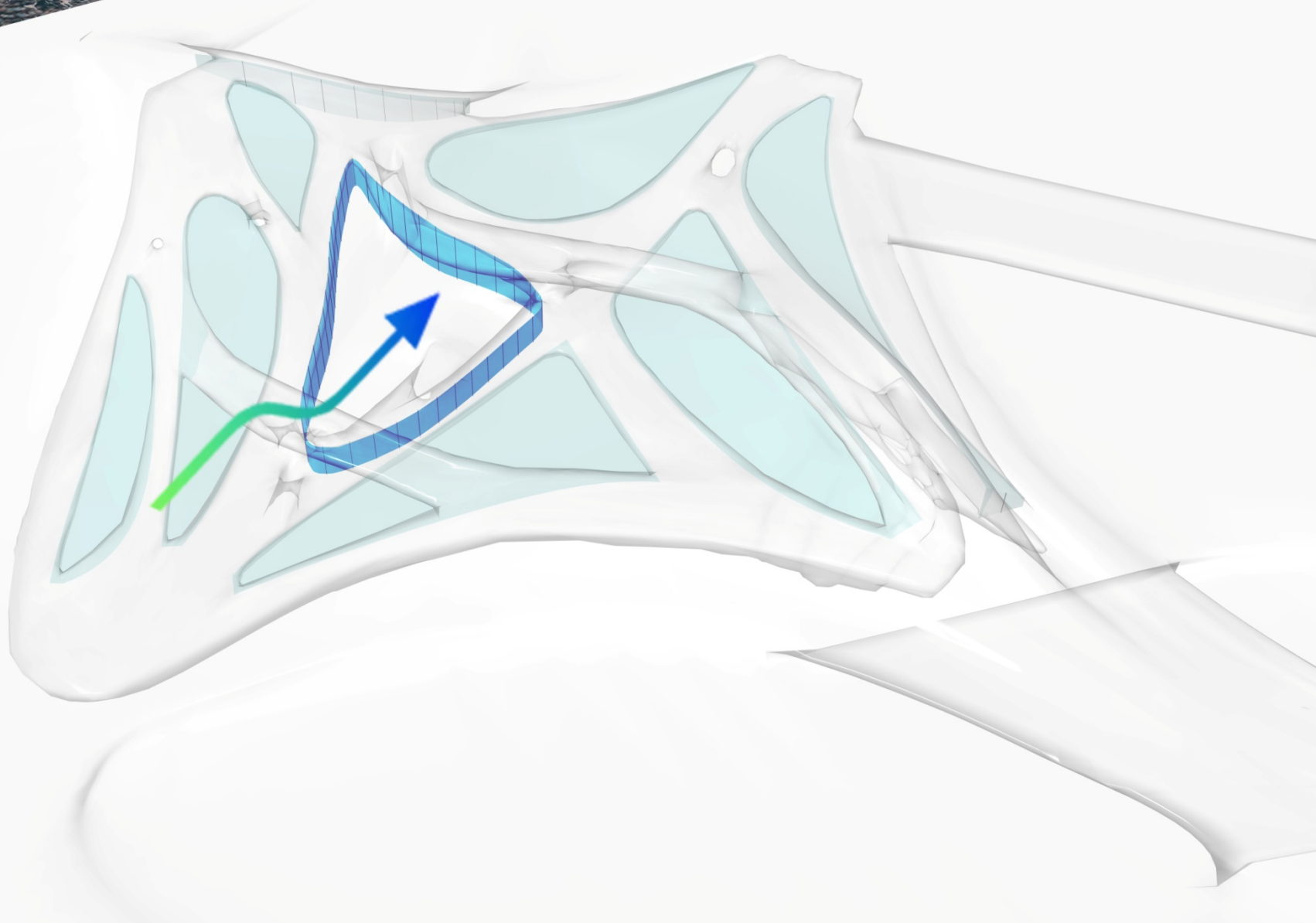
FUNCTIONS

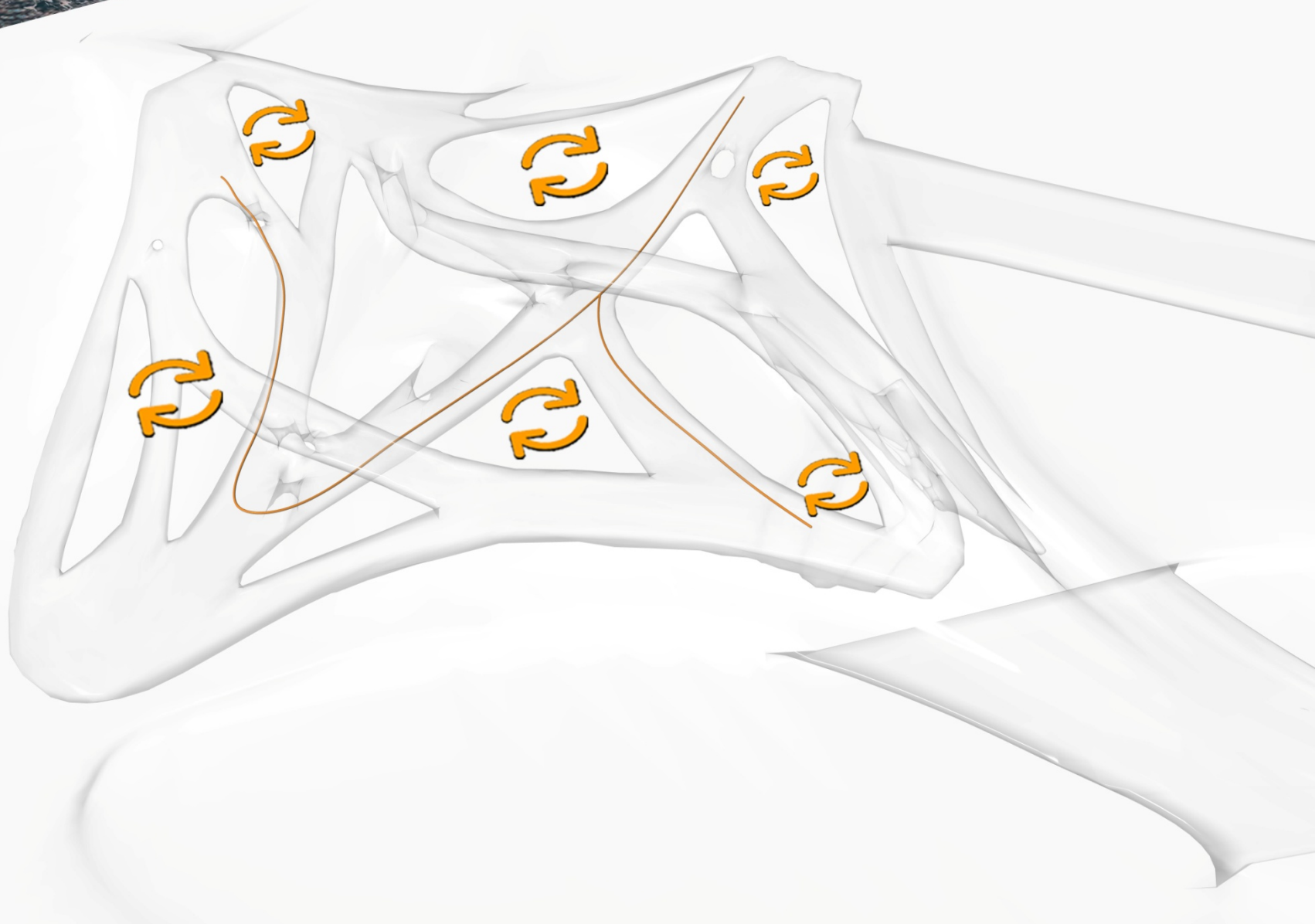
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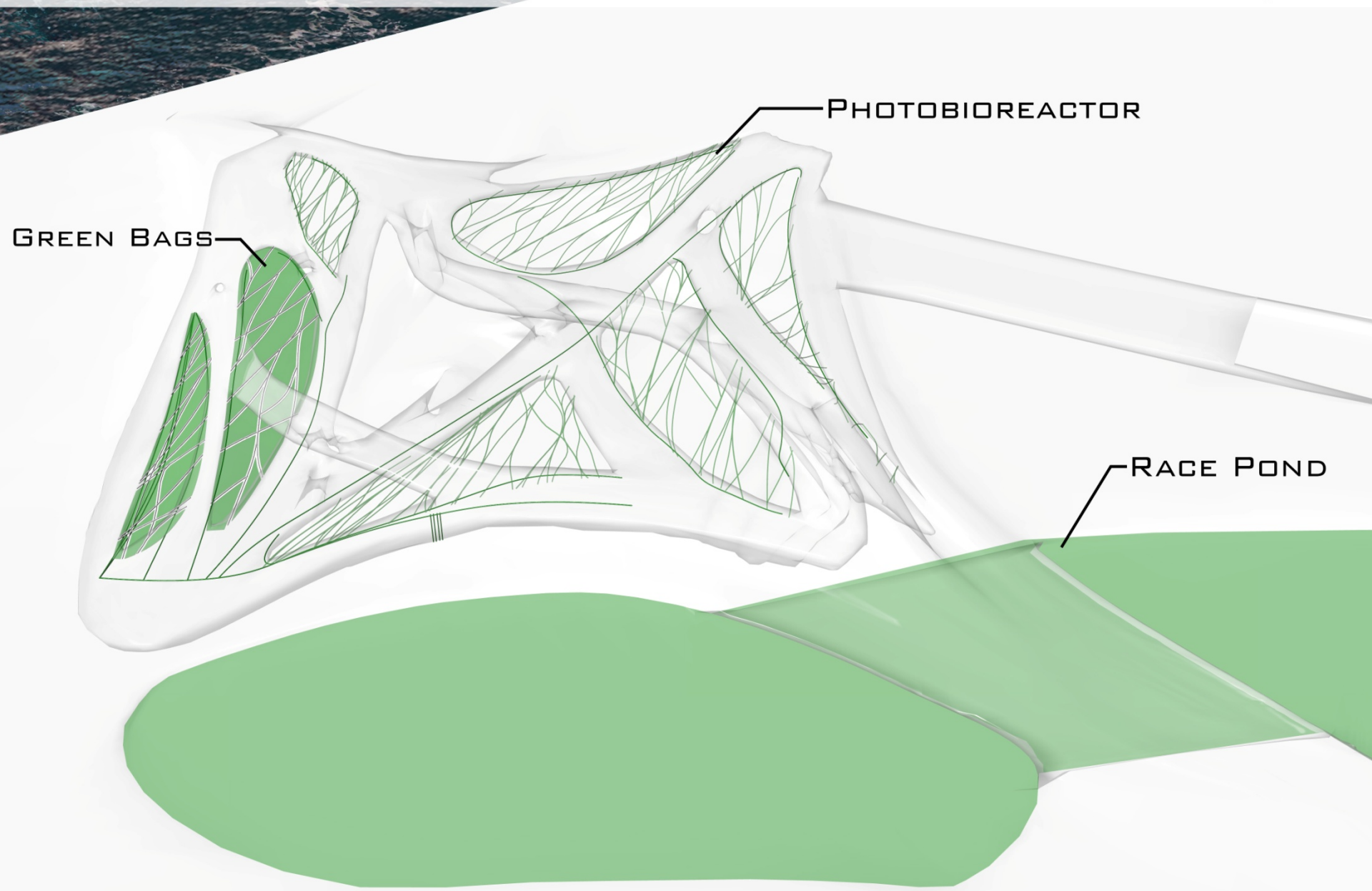




Wind-Rose
AMSTERDAM_NLD
1 JAN 1:00 - 31 DEC 24:00
Hourly Data: Wind Speed (m/s)
Calm for 0.66% of the time = 58 hours.
Each closed polyline shows frequency of 1.3%. = 115 hours.



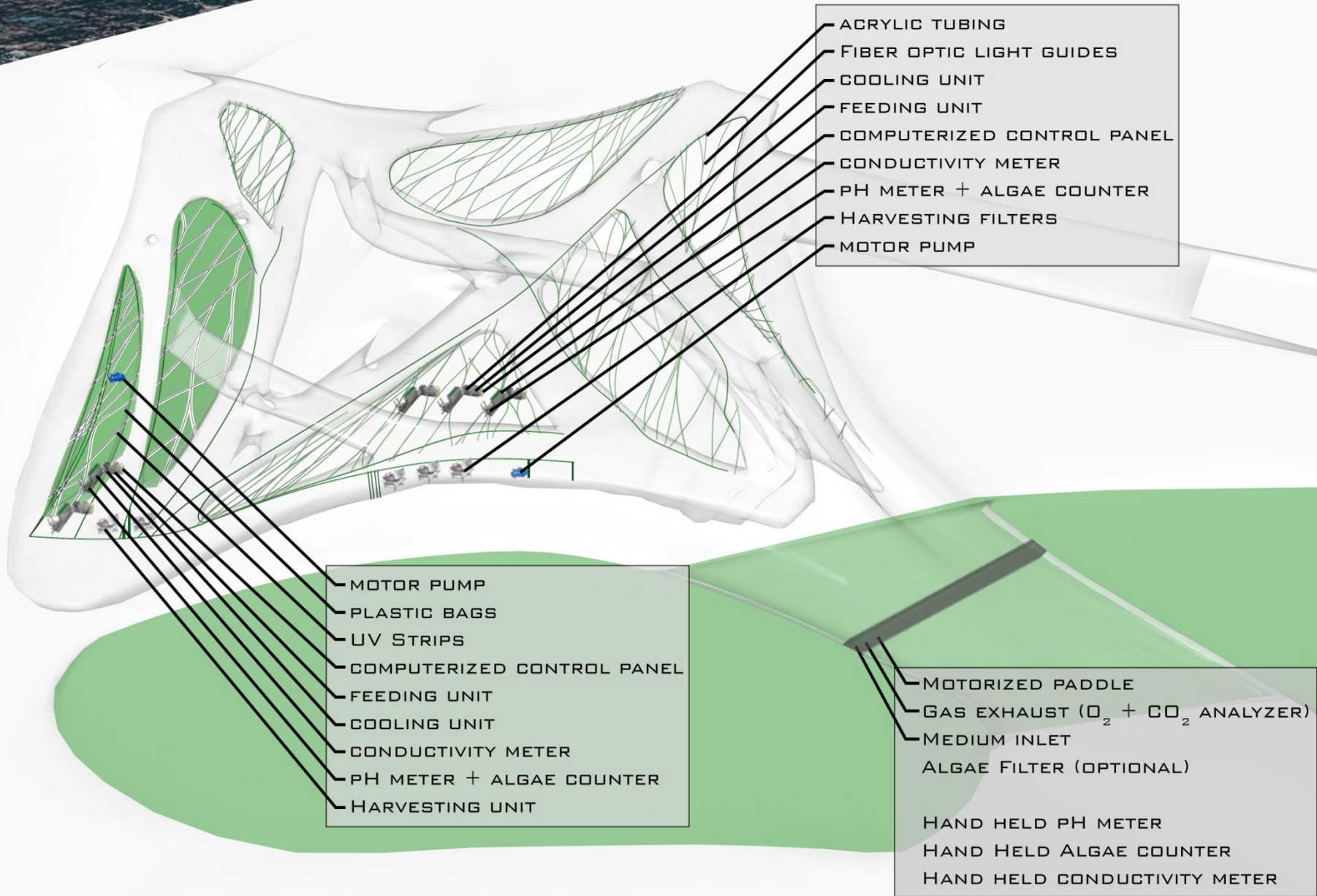


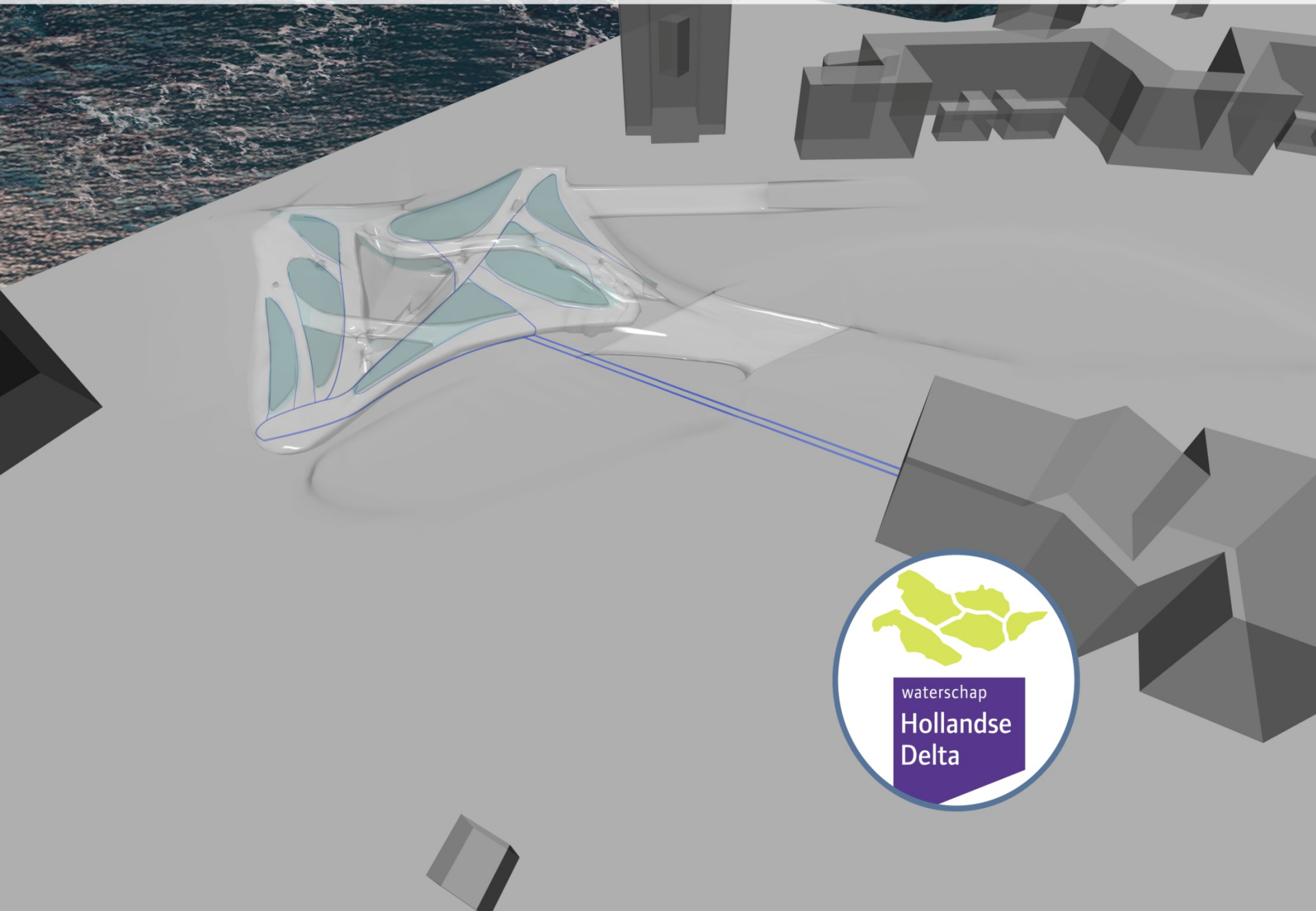


GREEN BAGS

PHOTOBIOREACTOR

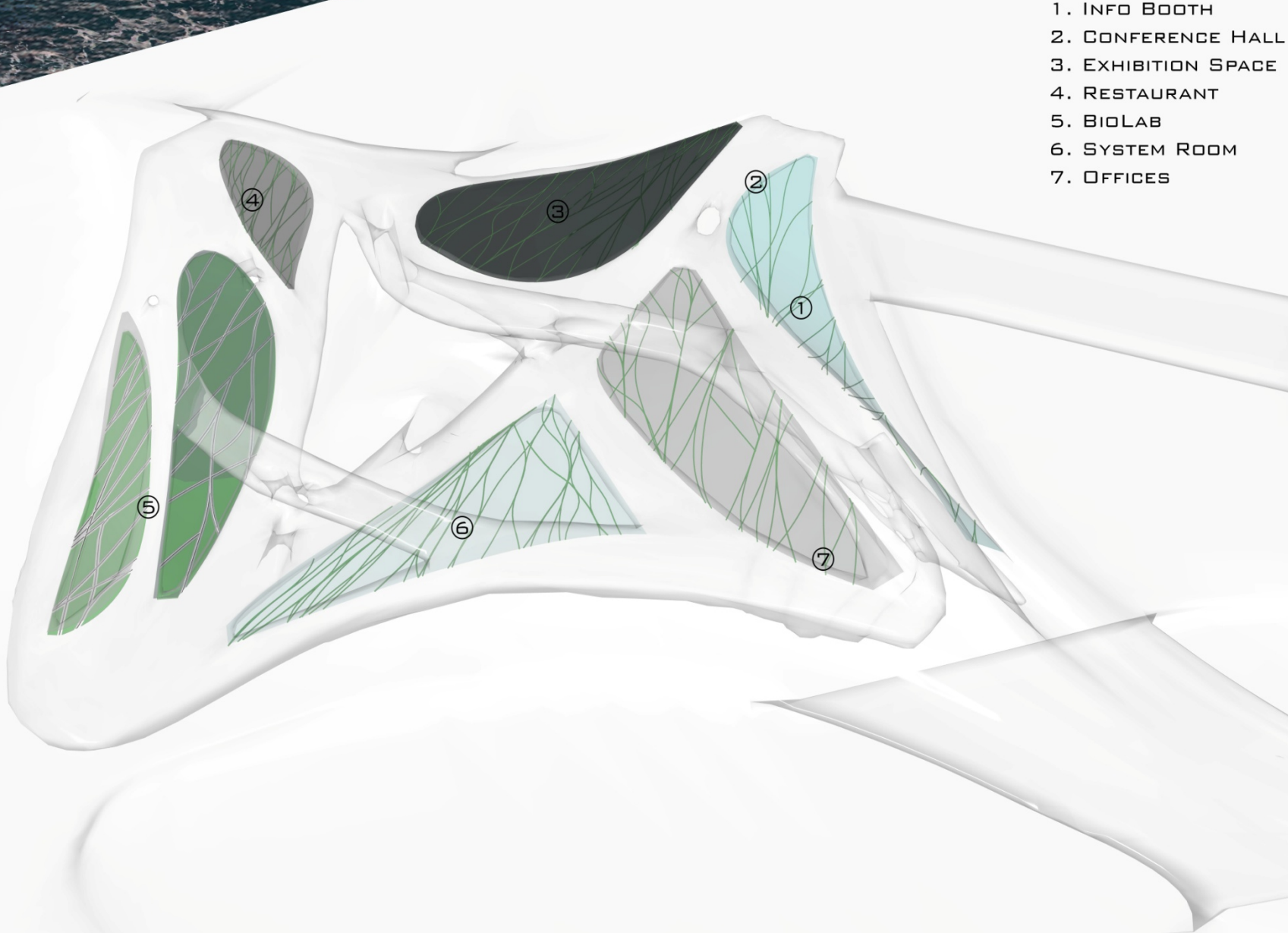
RACE POND





FUNCTIONS

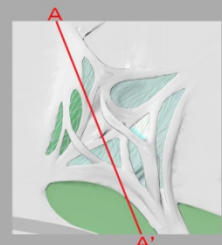
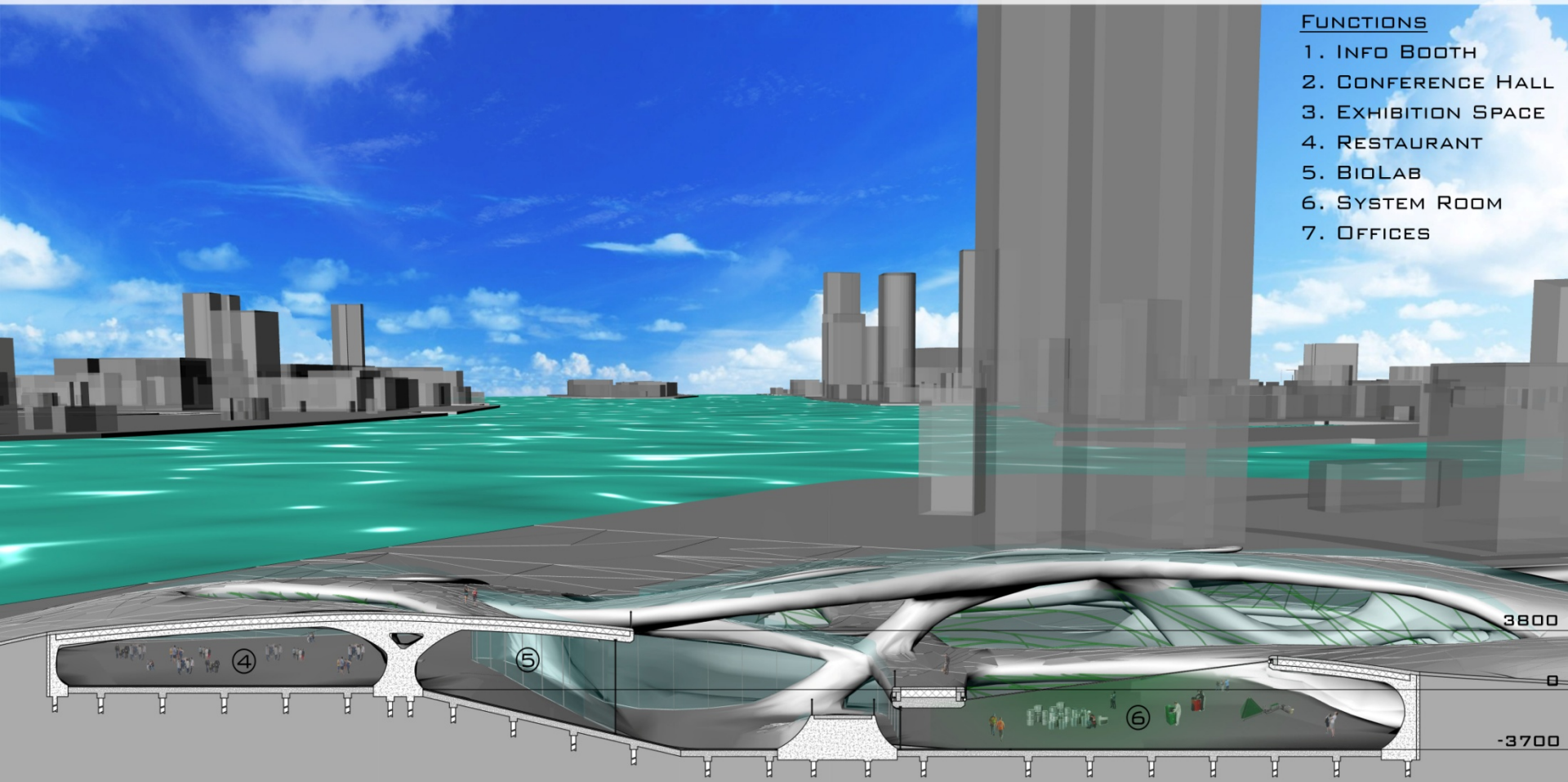
1. INFO BOOTH
2. CONFERENCE HALL
3. EXHIBITION SPACE
4. RESTAURANT
5. BIOLAB
6. SYSTEM ROOM
7. OFFICES



SECTION AA'

FUNCTIONS

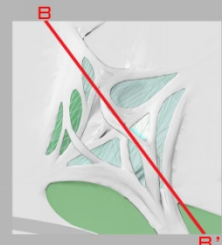
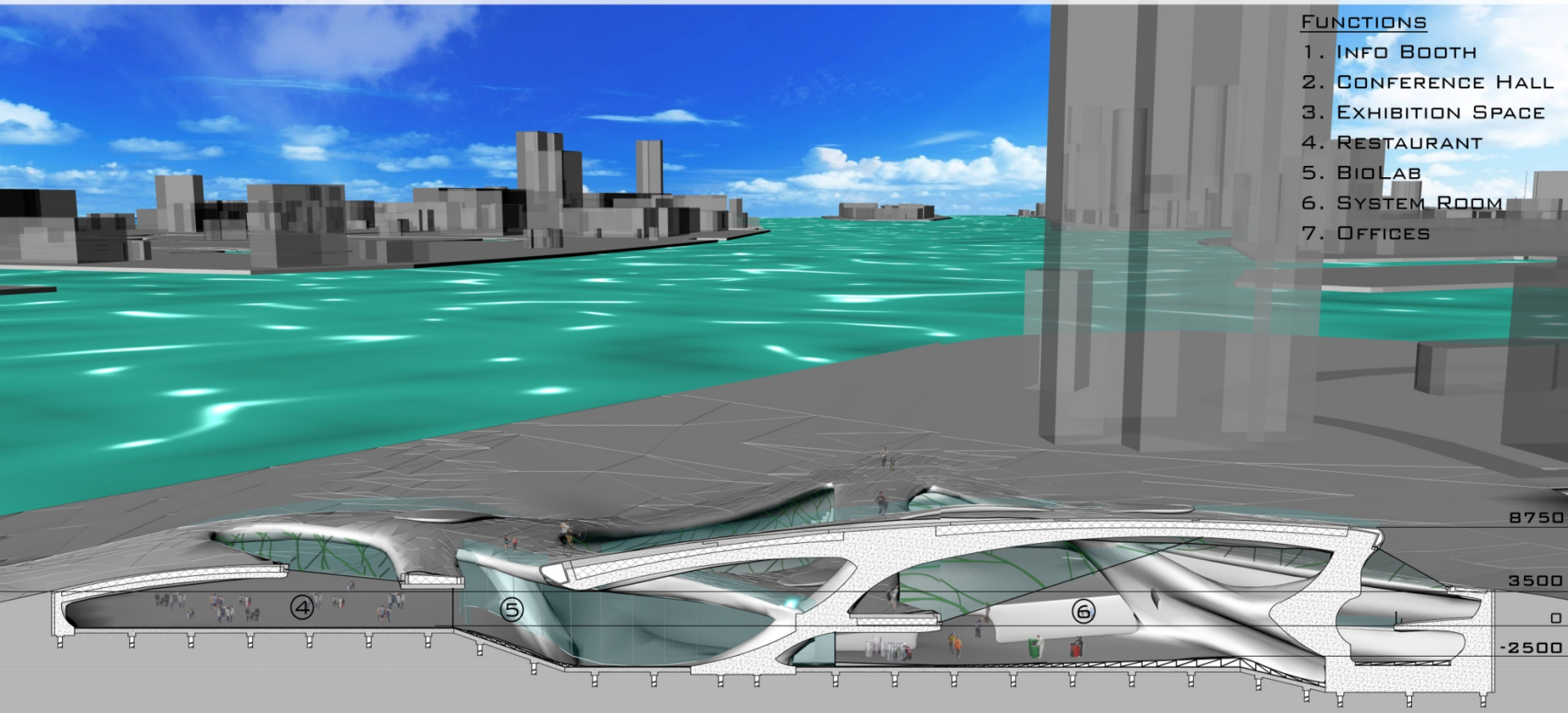
- 1. INFO BOOTH
- 2. CONFERENCE HALL
- 3. EXHIBITION SPACE
- 4. RESTAURANT
- 5. BIOLAB
- 6. SYSTEM ROOM
- 7. OFFICES



SECTION BB'

FUNCTIONS

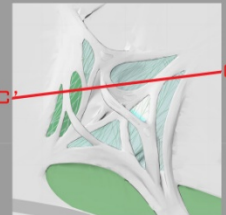
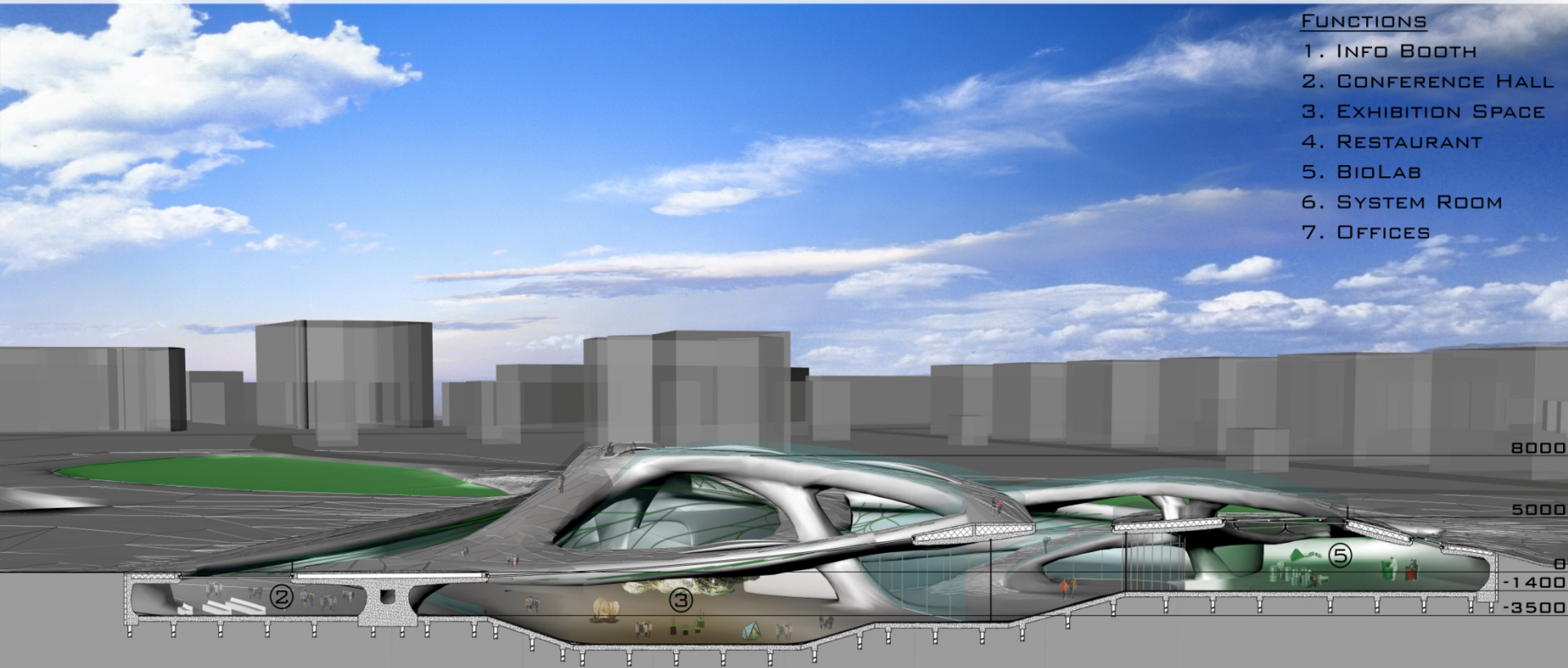
- 1. INFO BOOTH
- 2. CONFERENCE HALL
- 3. EXHIBITION SPACE
- 4. RESTAURANT
- 5. BIOLAB
- 6. SYSTEM ROOM
- 7. OFFICES

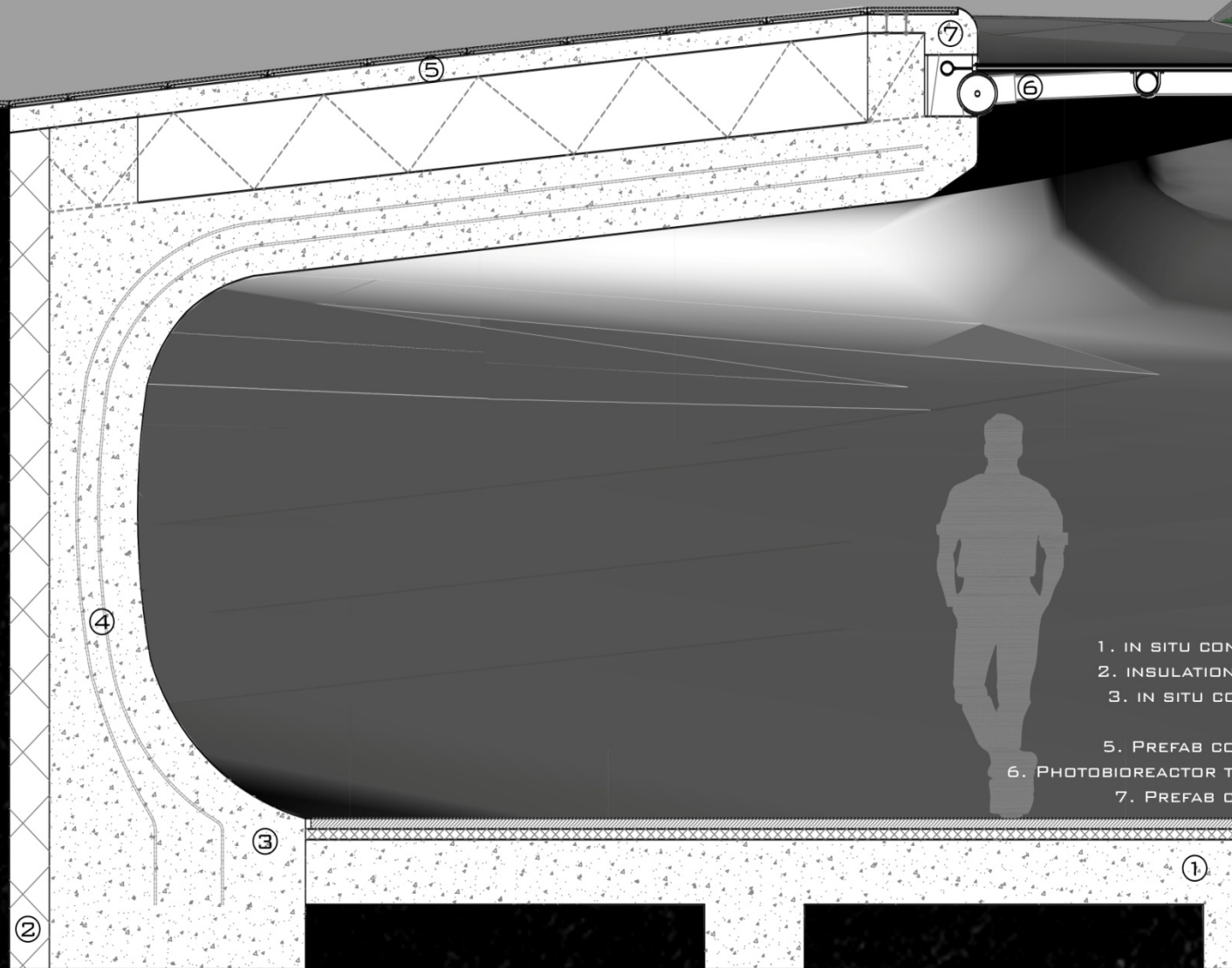


SECTION CC'

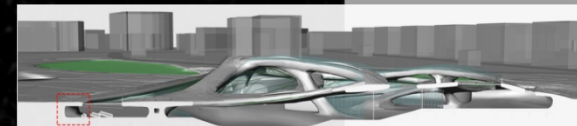
FUNCTIONS

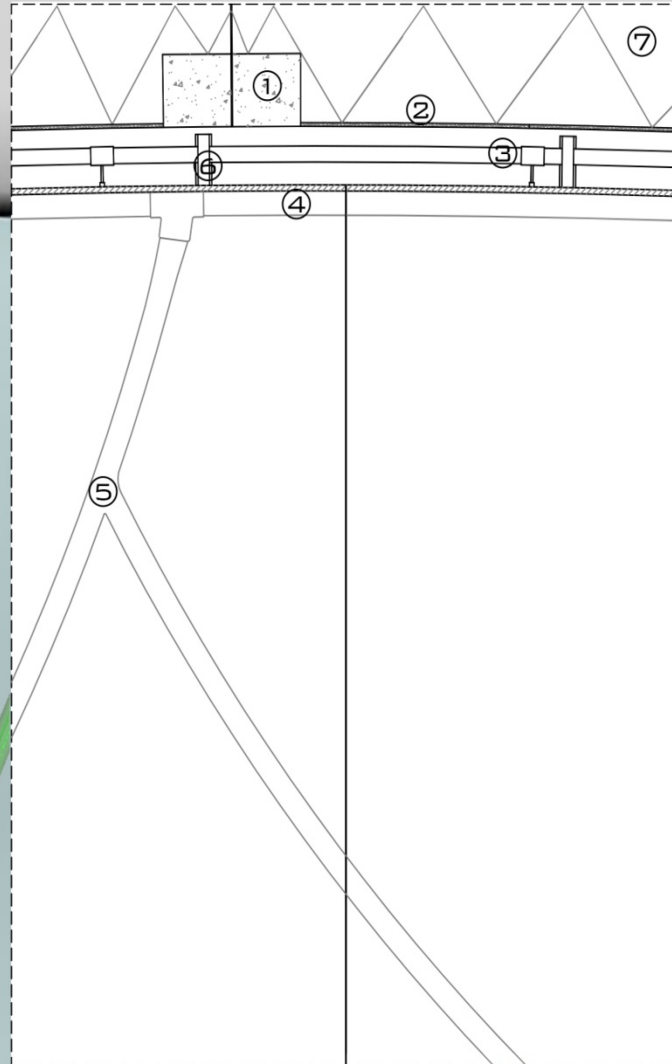
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2. CONFERENCE HALL
3. EXHIBITION SPACE
4. RESTAURANT
5. BIOLAB
6. SYSTEM ROOM
7. OFFICES



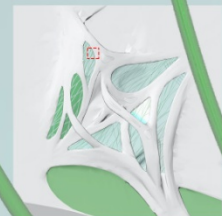


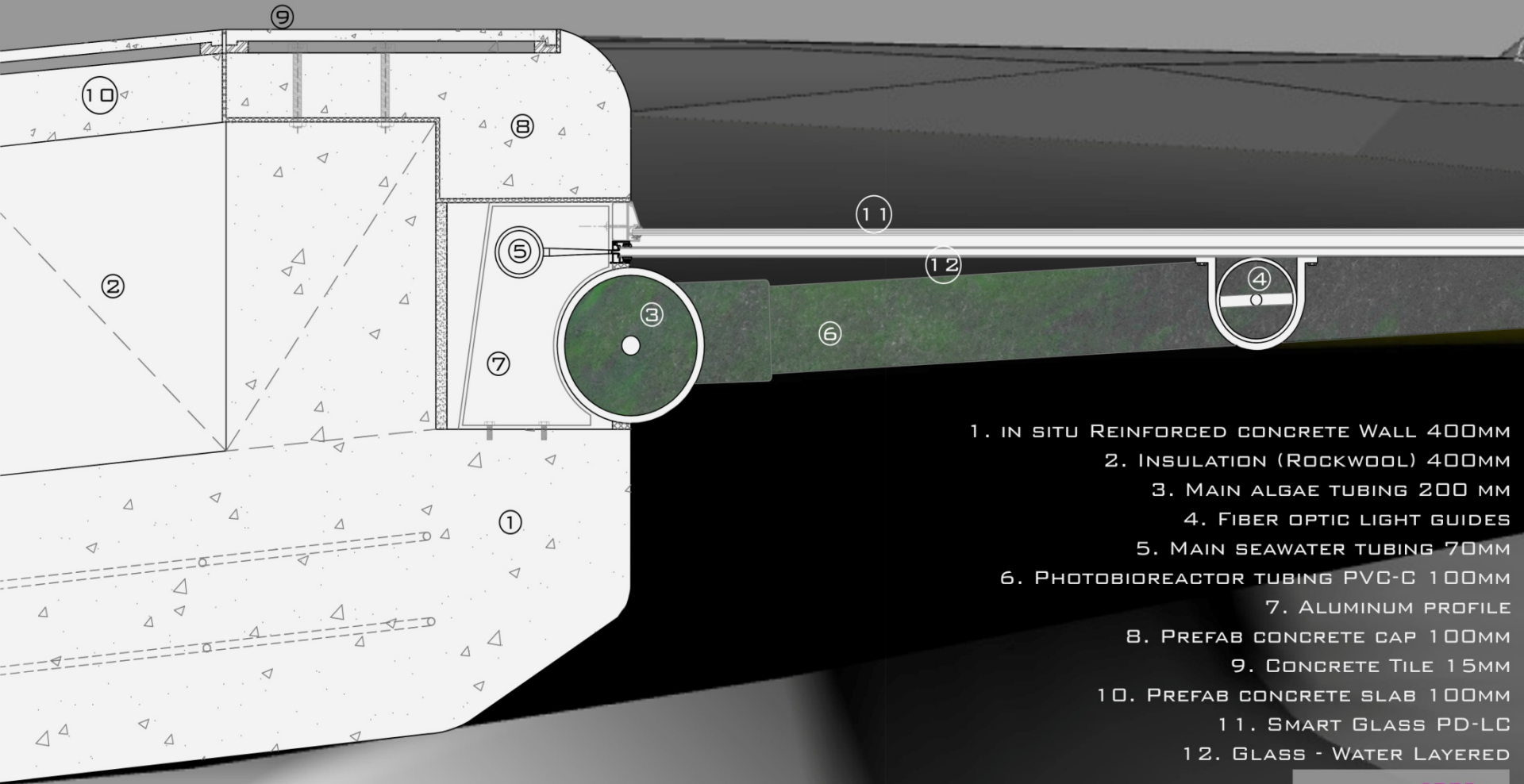
- 1. IN SITU CONCRETE FLOOR 400MM
- 2. INSULATION (ROCKWOOL) 400MM
- 3. IN SITU CONCRETE WALL 700MM
- 4. REINFORCEMENT
- 5. PREFAB CONCRETE SLAB 100MM
- 6. PHOTOBIOREACTOR TUBING PVC-C 100MM
- 7. PREFAB CONCRETE CAP 100MM



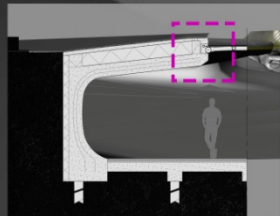


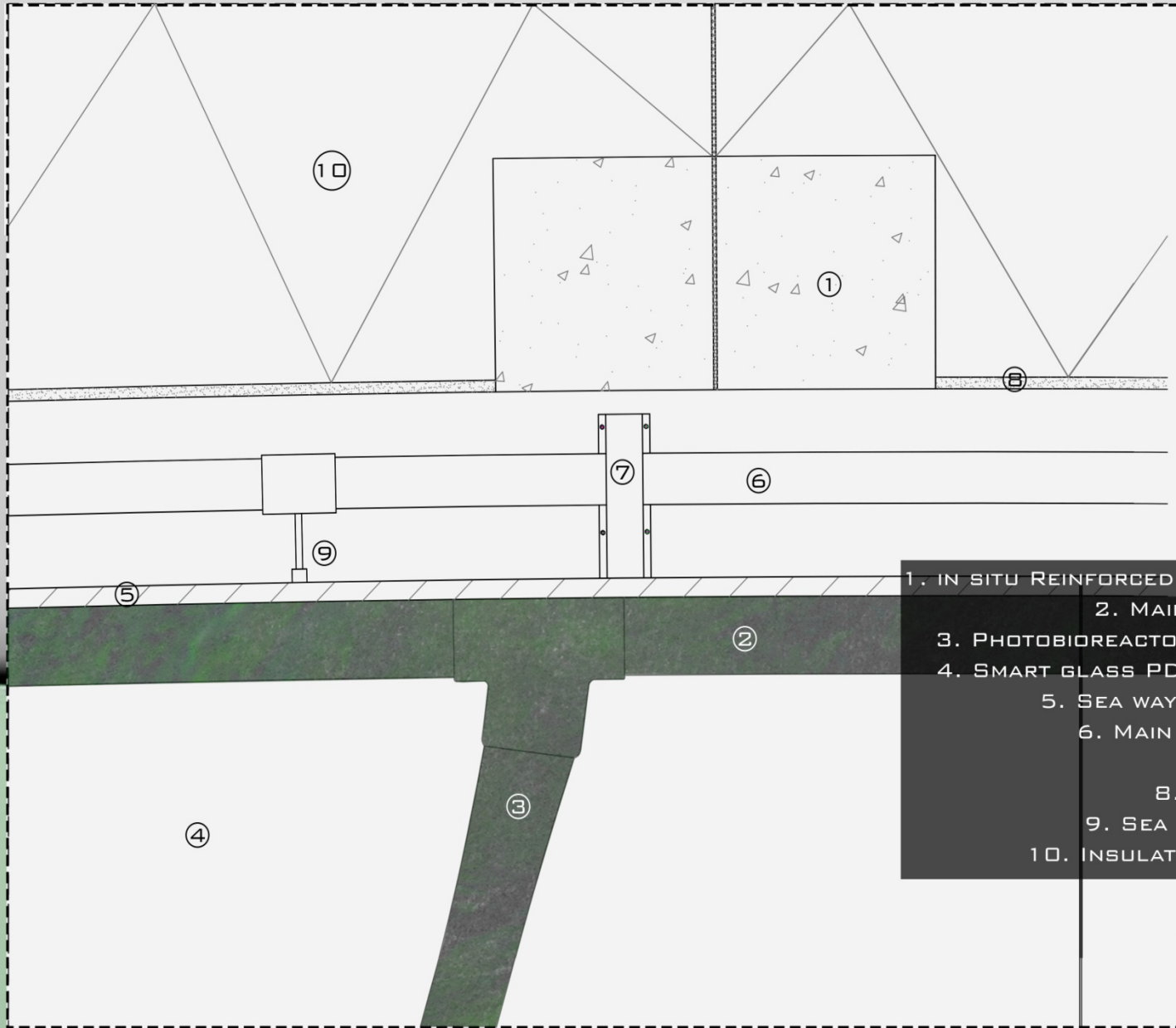
- 1. IN SITU CONCRETE WALL 400MM
- 2. GYPSUM PLATING 20MM
- 3. MAIN SEAWATER TUBING 70MM
- 4. MAIN ALGAE TUBING 200 MM
- 5. PHOTOBIOREACTOR TUBING PVC-C 100MM
- 6. ALUMINUM PROFILE
- 7. INSULATION (ROCKWOOL) 400MM



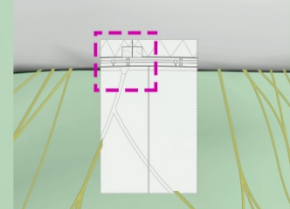


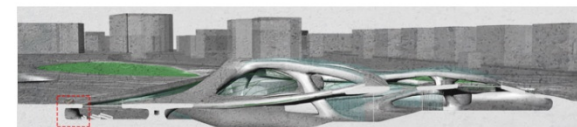
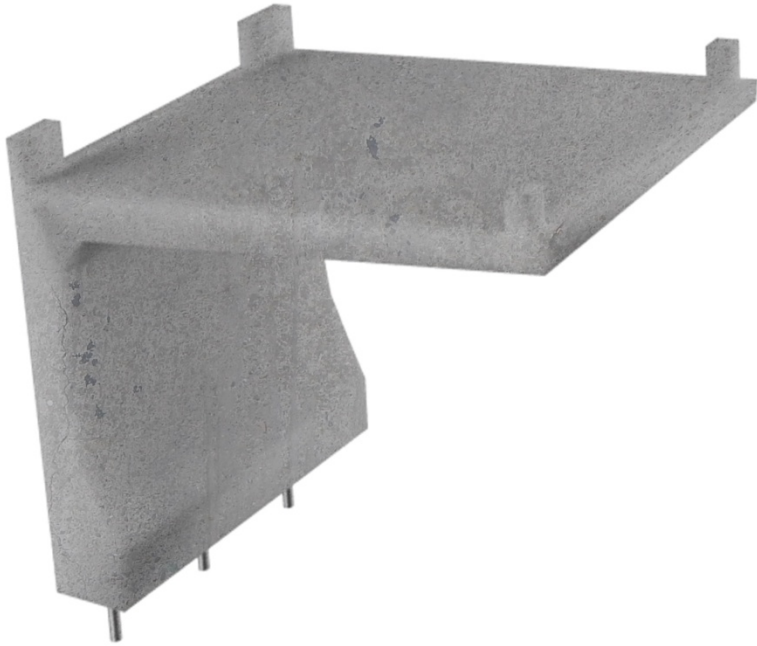
- 1. IN SITU REINFORCED CONCRETE WALL 400MM
- 2. INSULATION (ROCKWOOL) 400MM
- 3. MAIN ALGAE TUBING 200 MM
- 4. FIBER OPTIC LIGHT GUIDES
- 5. MAIN SEAWATER TUBING 70MM
- 6. PHOTOBIOREACTOR TUBING PVC-C 100MM
- 7. ALUMINUM PROFILE
- 8. PREFAB CONCRETE CAP 100MM
- 9. CONCRETE TILE 15MM
- 10. PREFAB CONCRETE SLAB 100MM
- 11. SMART GLASS PD-LC
- 12. GLASS - WATER LAYERED

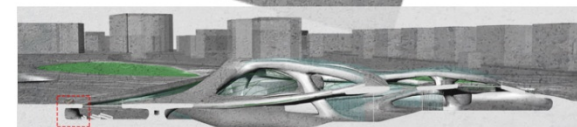
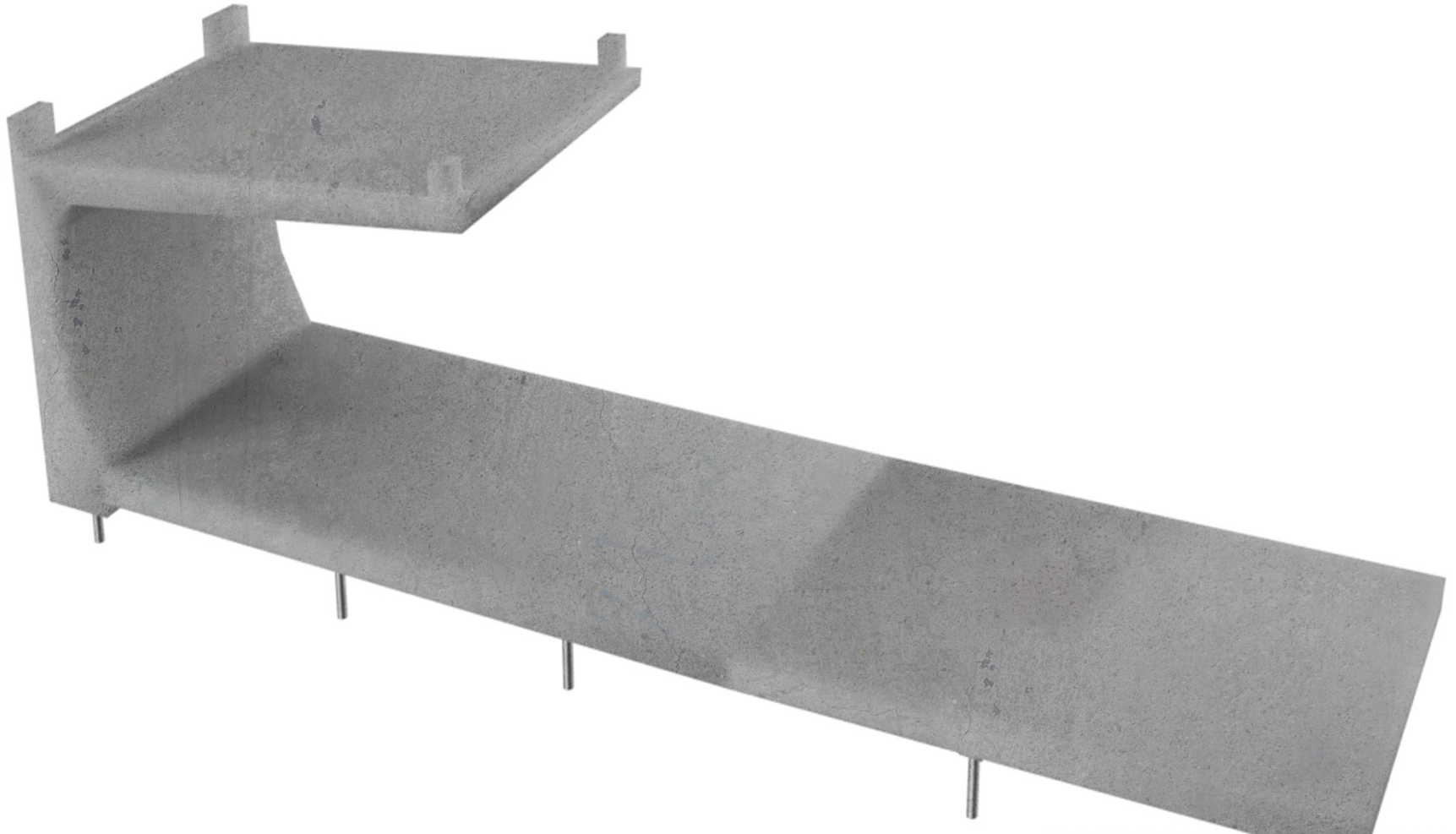


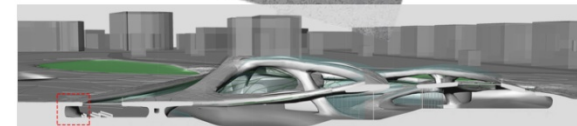
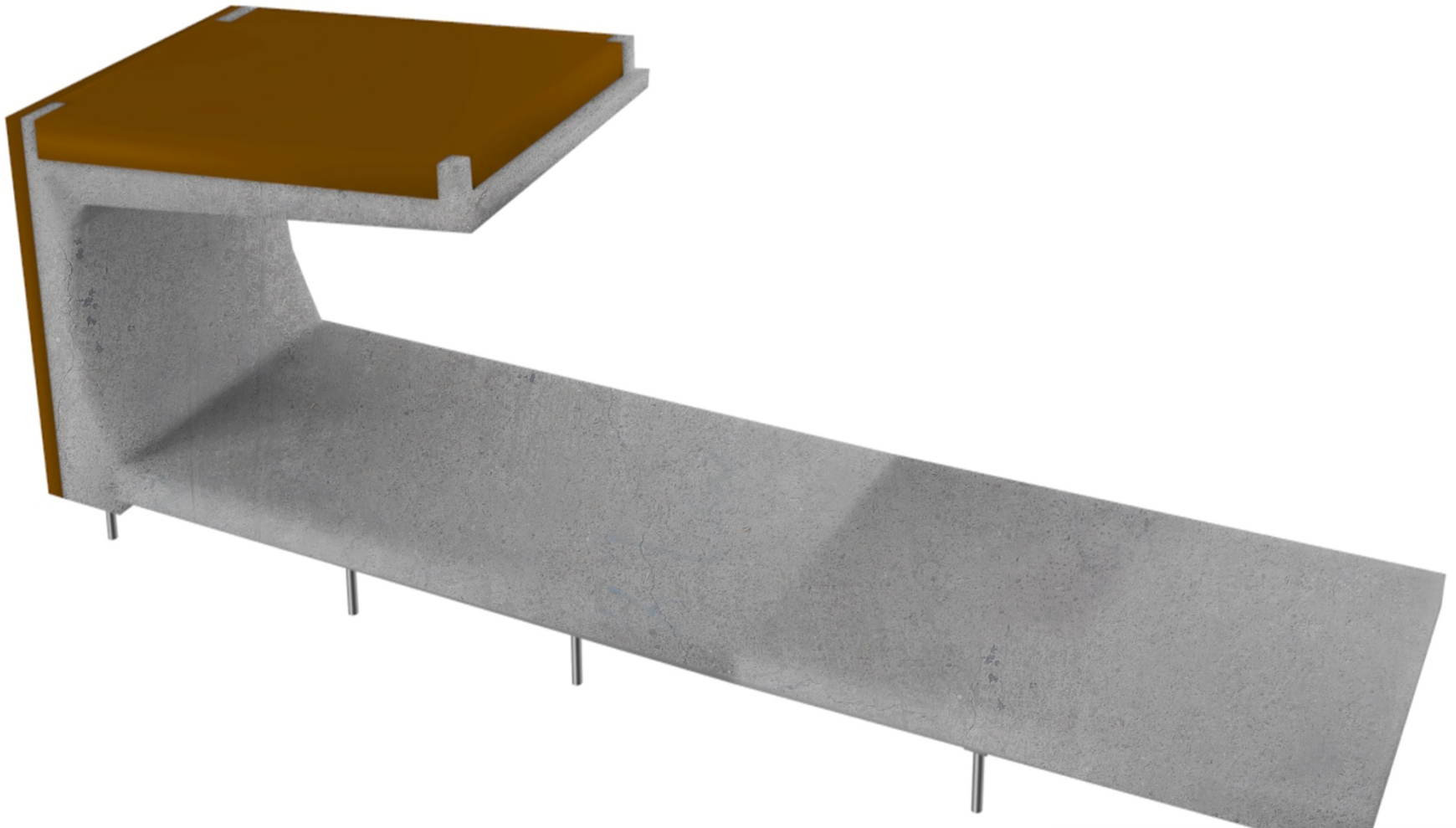


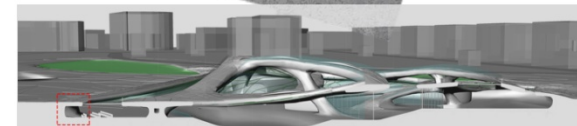
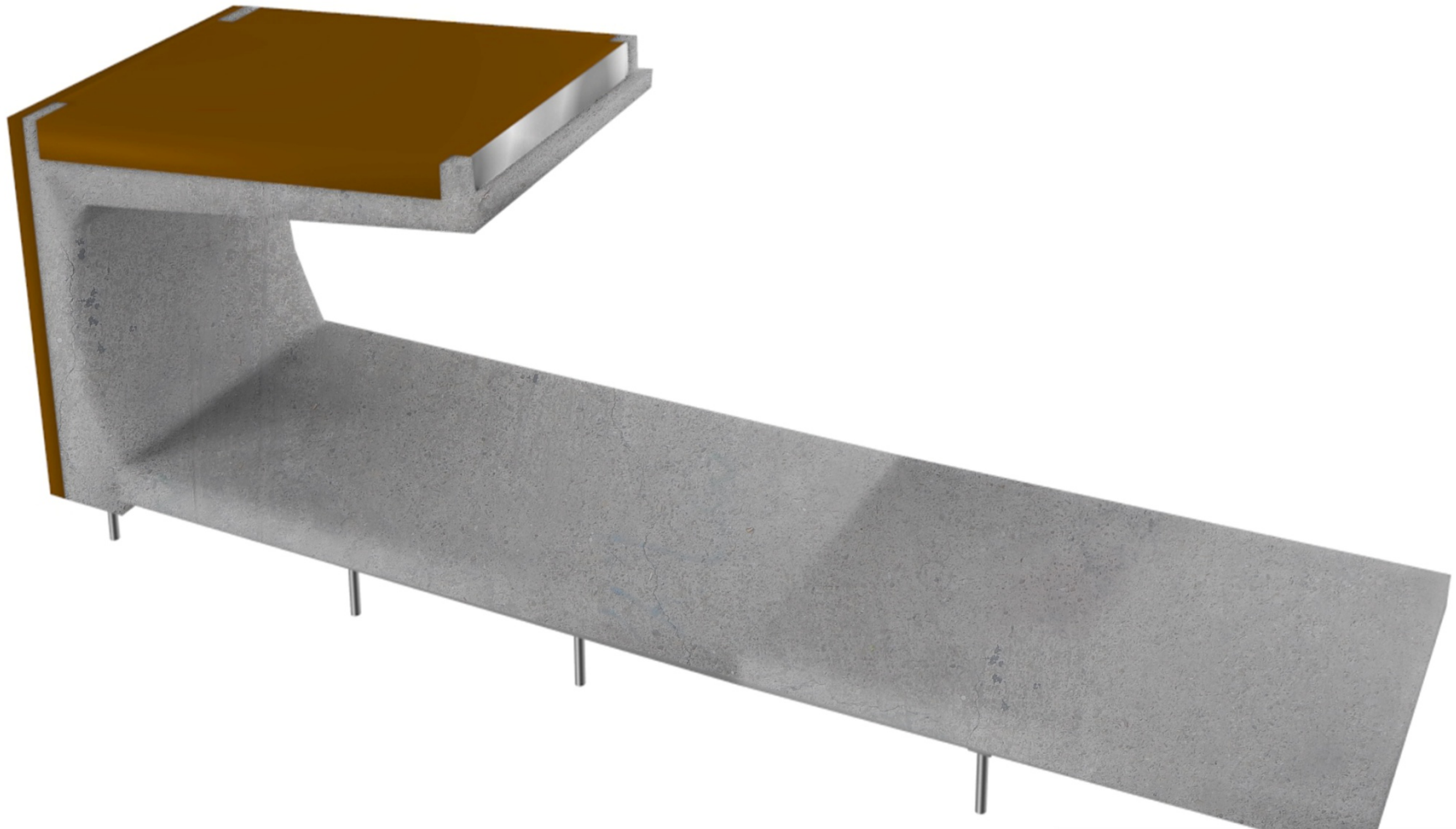
- 1. IN SITU REINFORCED CONCRETE WALL 400MM
- 2. MAIN ALGAE TUBING 200 MM
- 3. PHOTOBIOREACTOR TUBING PVC-C 100MM
- 4. SMART GLASS PD-LC + SEA WATER LAYER
- 5. SEA WATER LAYER WINDOW FRAME
- 6. MAIN SEAWATER TUBING 70MM
- 7. ALUMINUM PROFILE
- 8. GYPSUM PLATING 20MM
- 9. SEA WATER CONNECTING TUBE
- 10. INSULATION (ROCKWOOL) 400MM

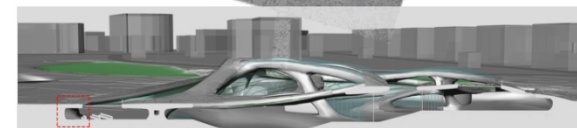
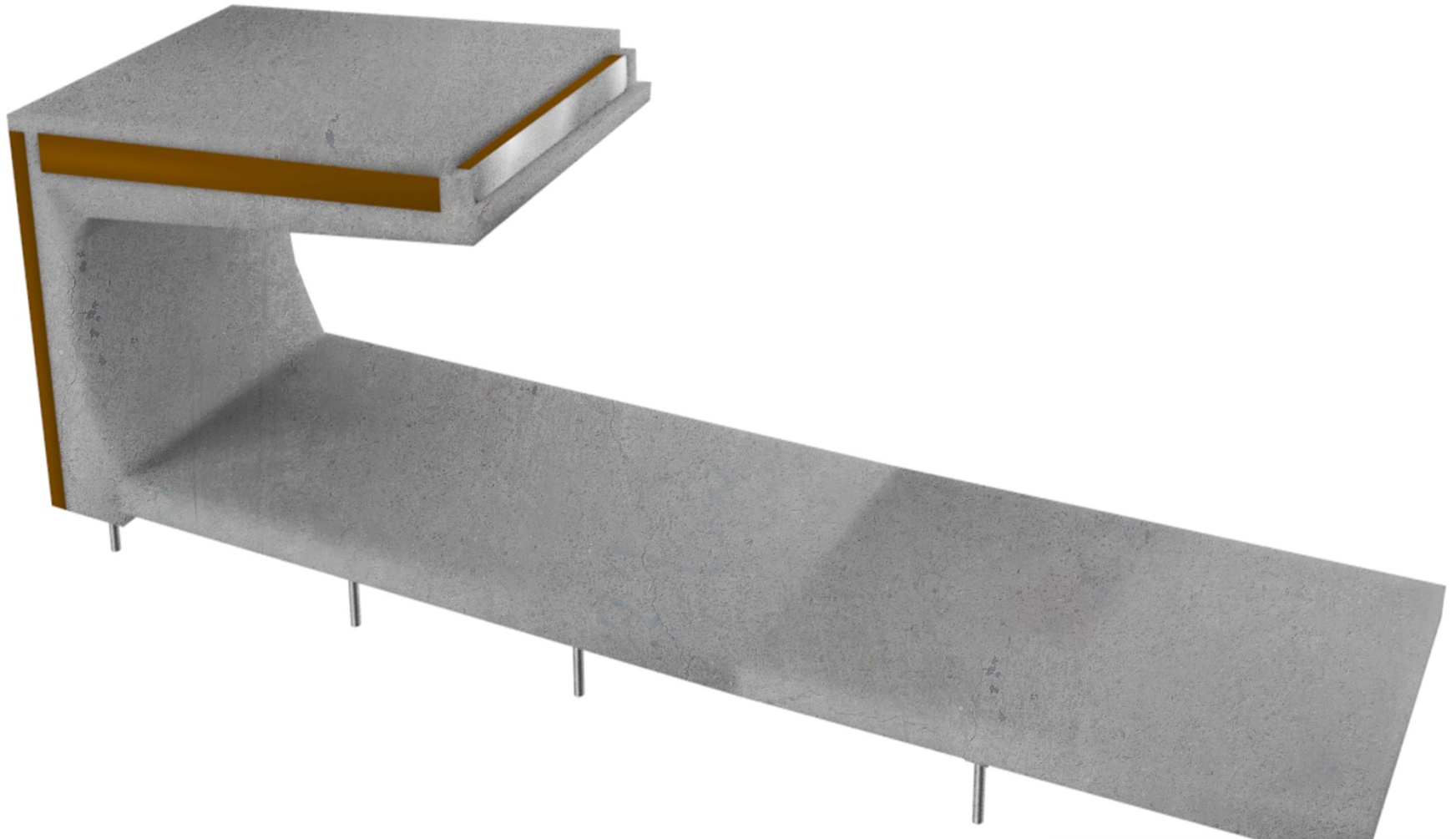


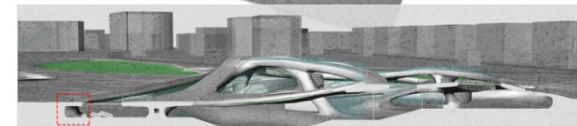
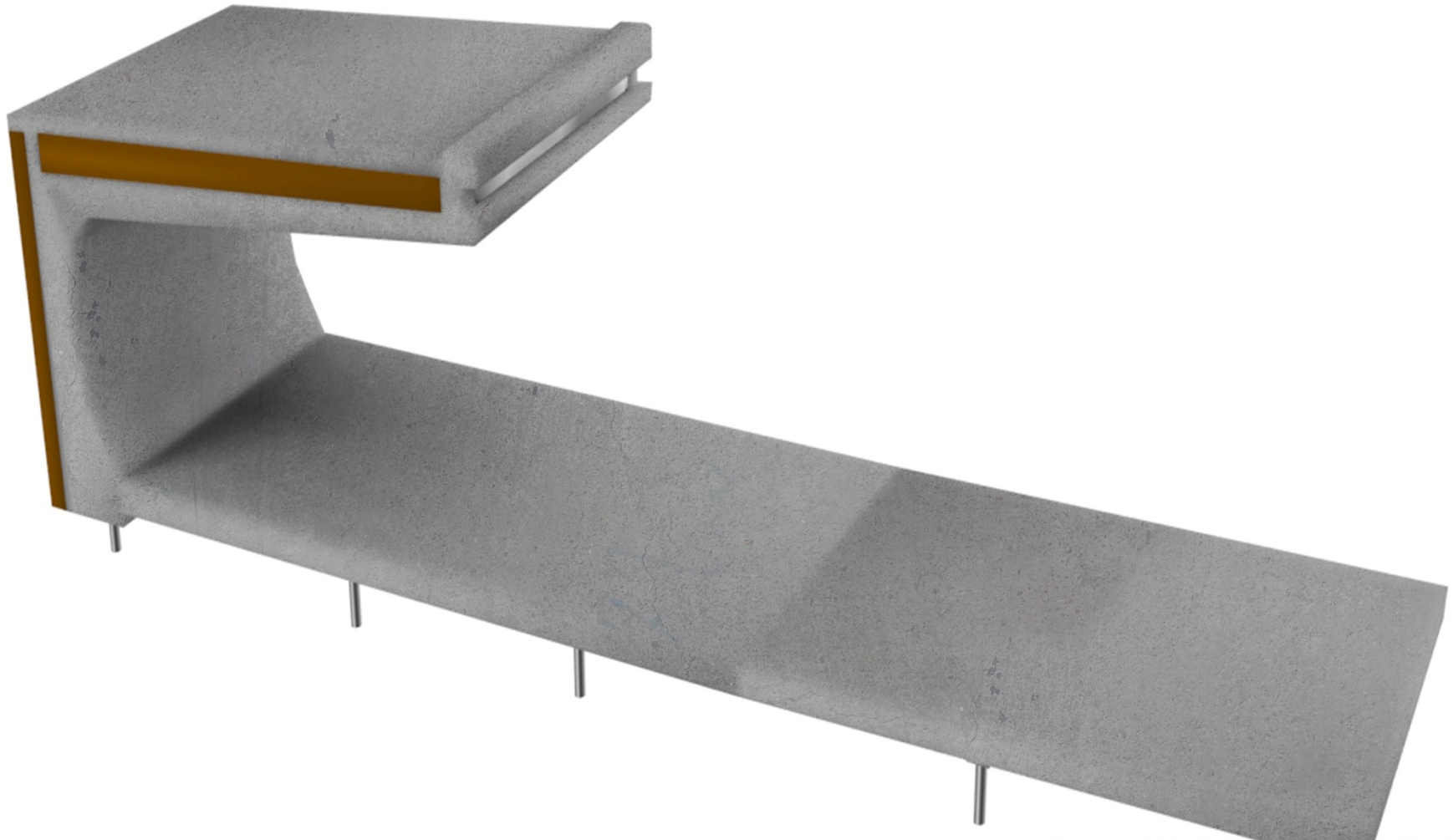




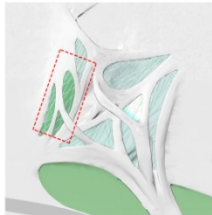
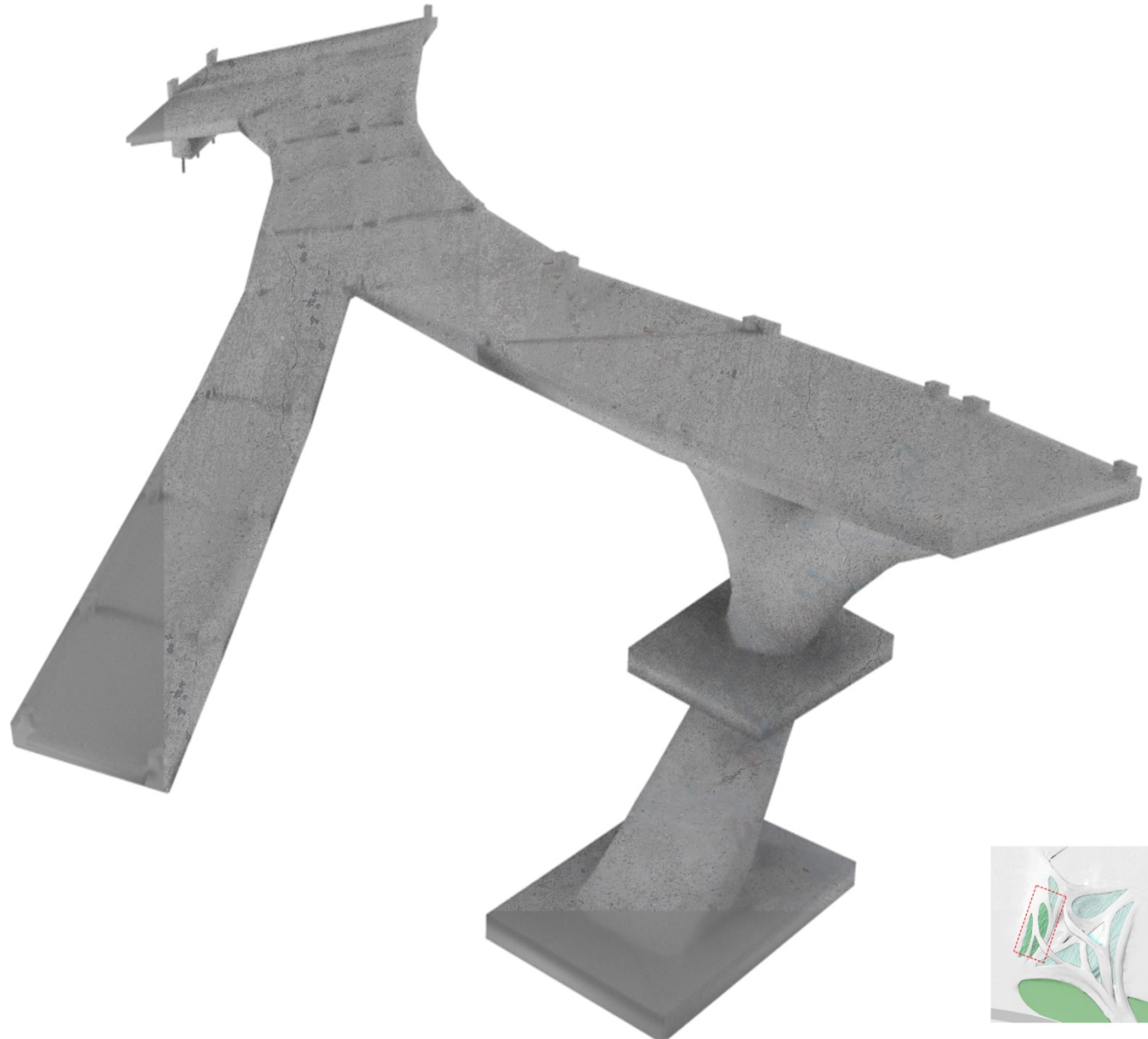




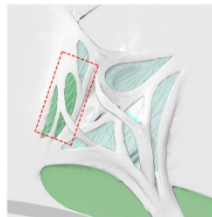
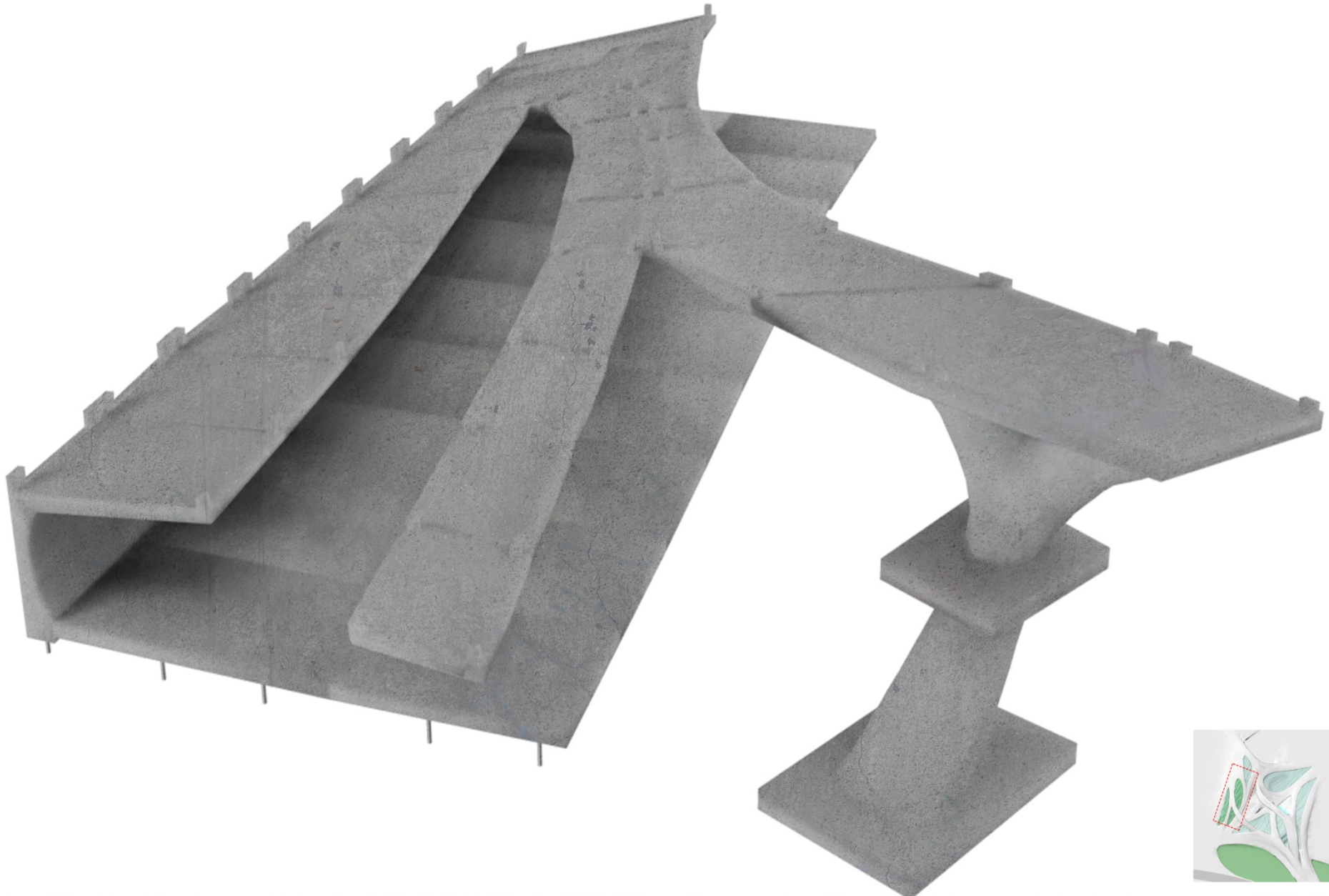


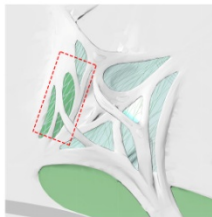
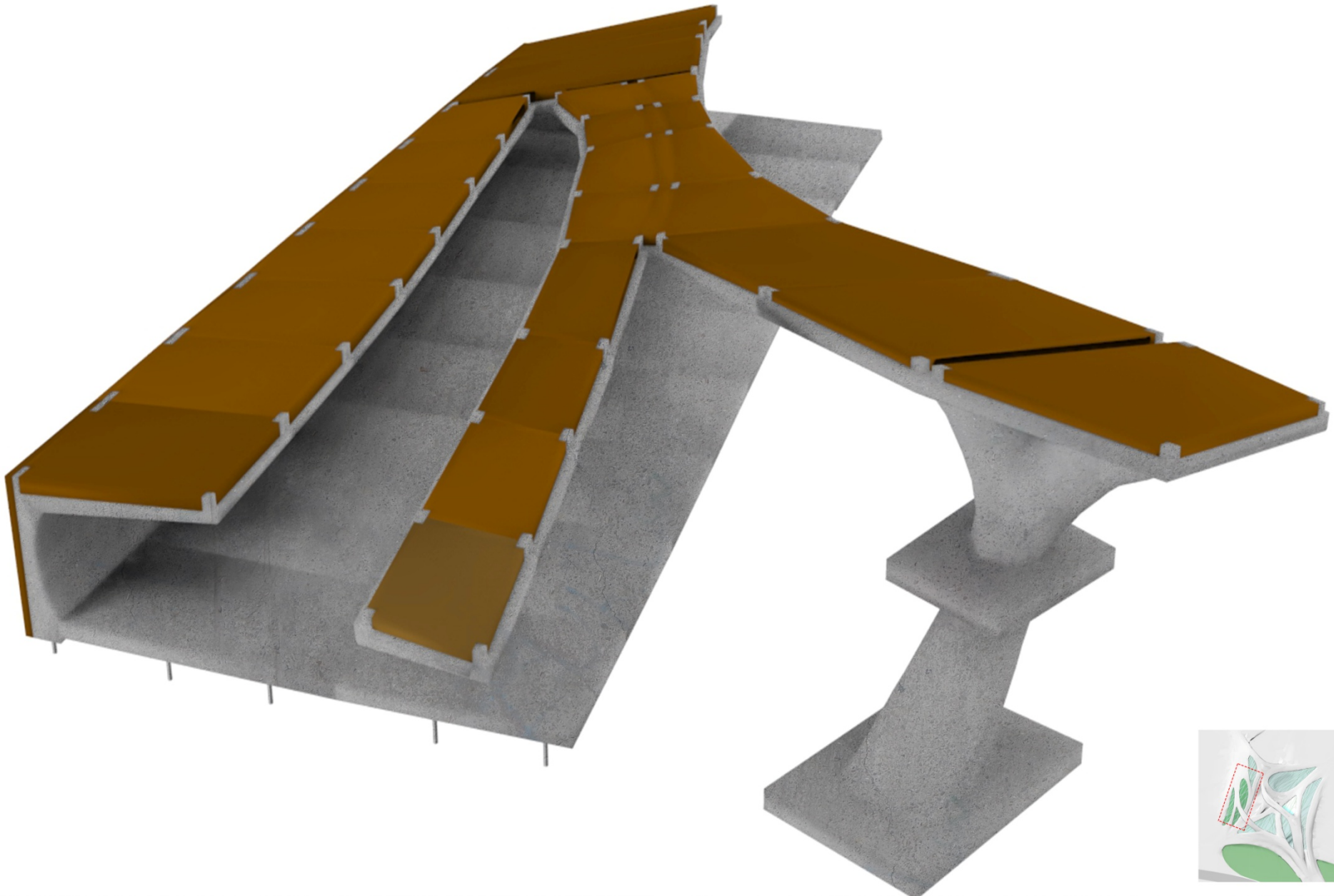


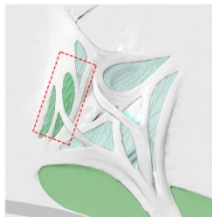
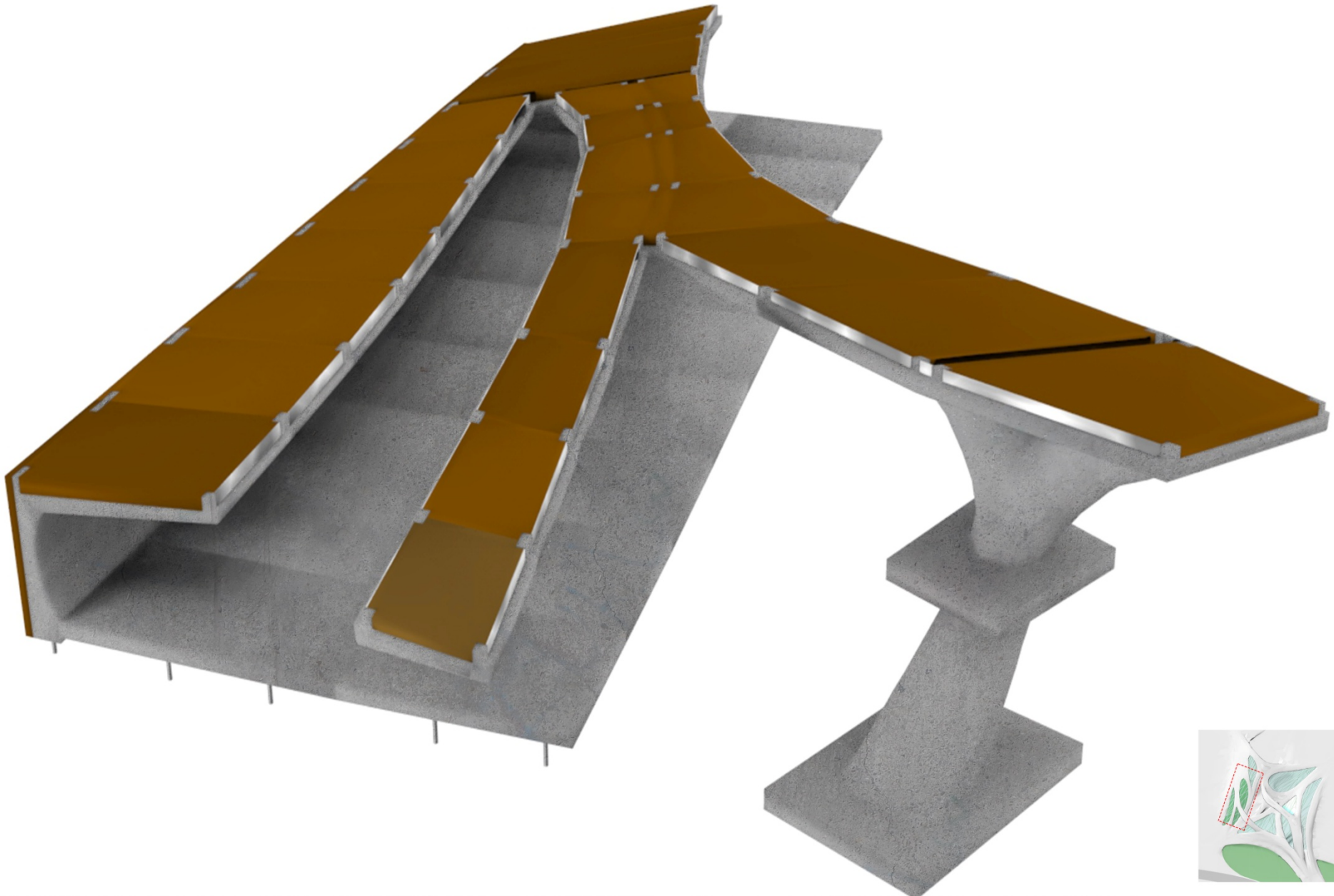
IN SITU REINFORCED CONCRETE

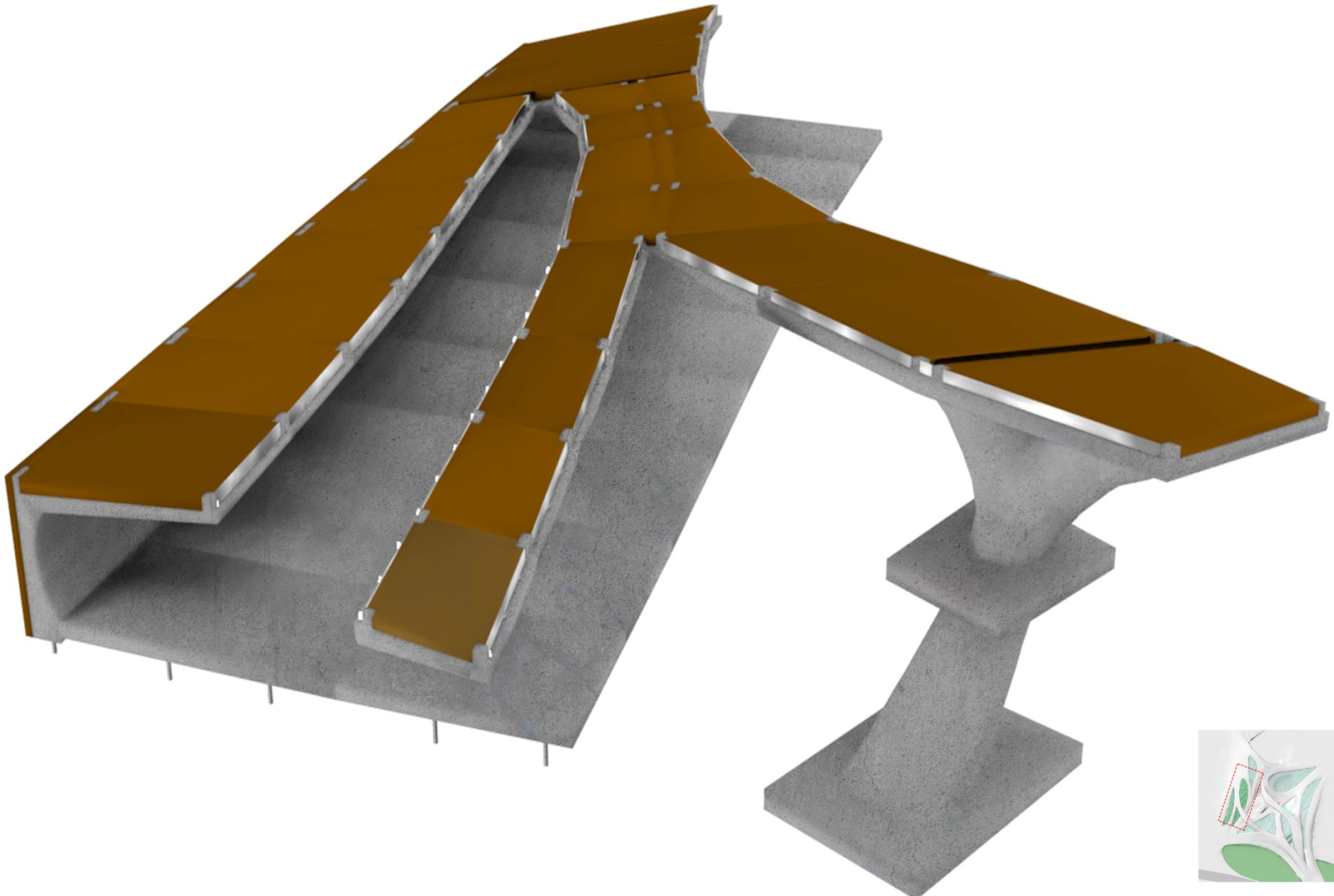


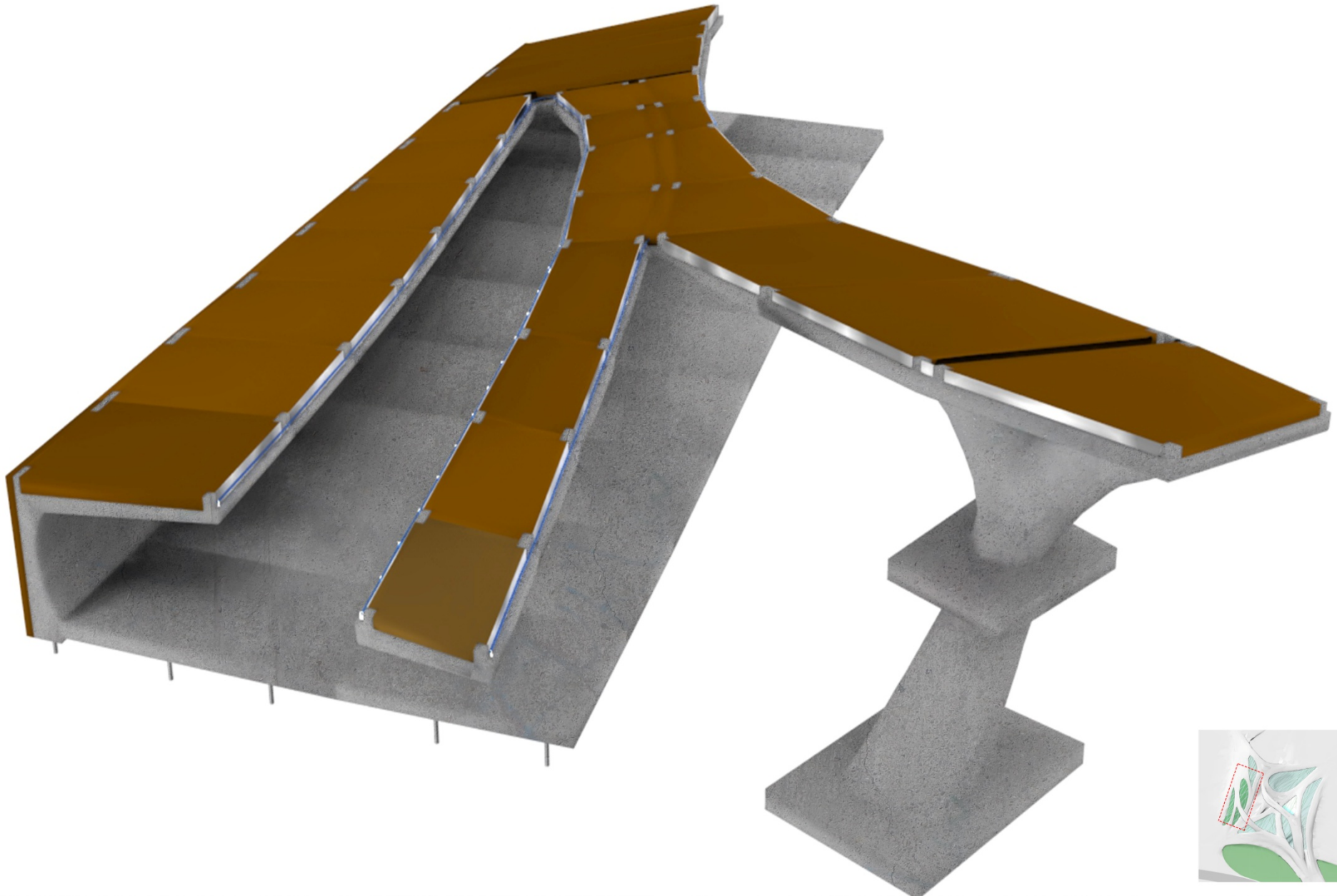
IN SITU CONCRETE FLOORS & WALLS

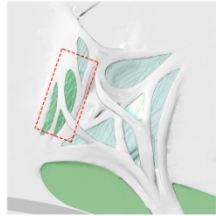
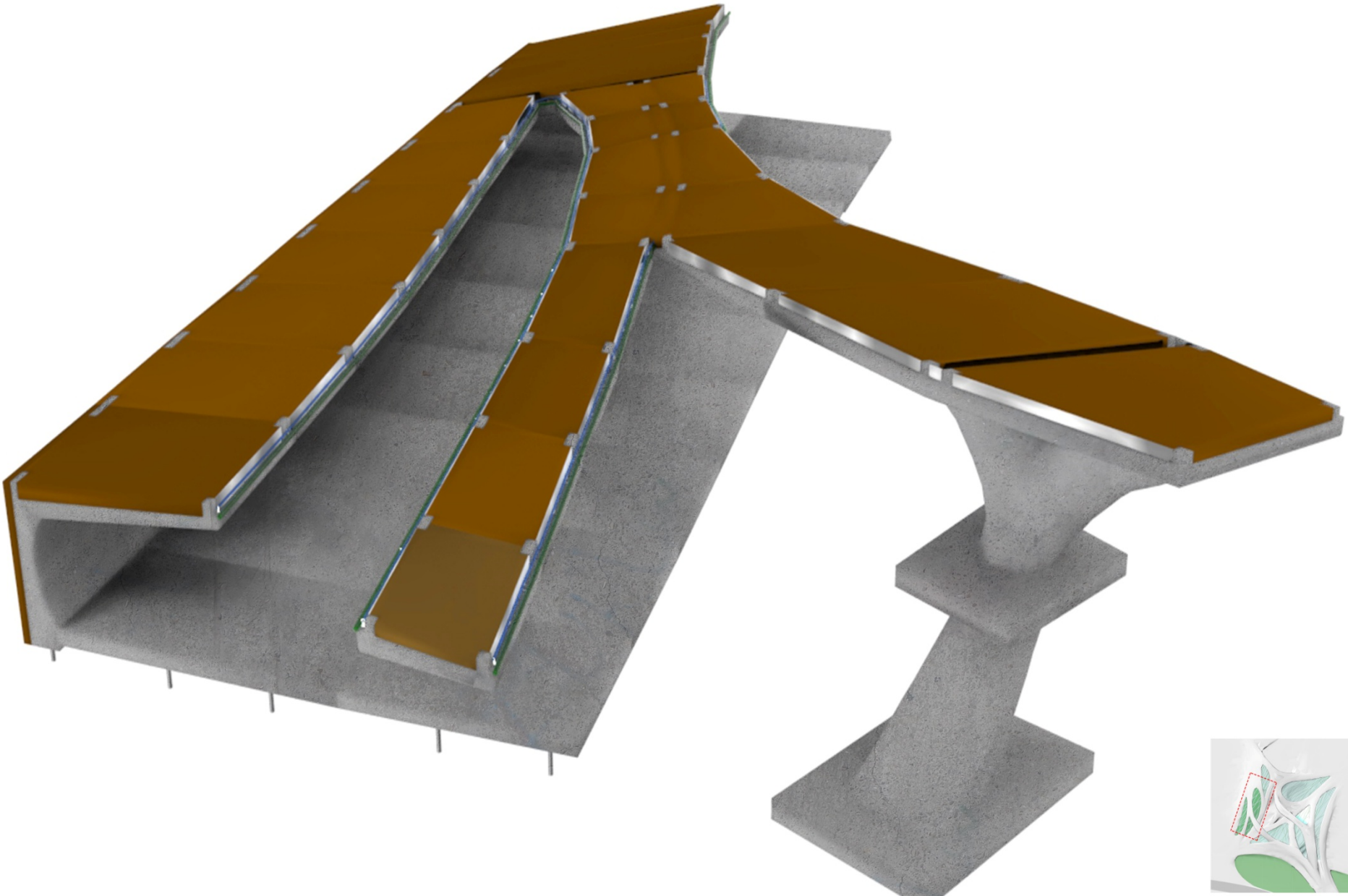


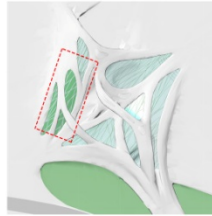
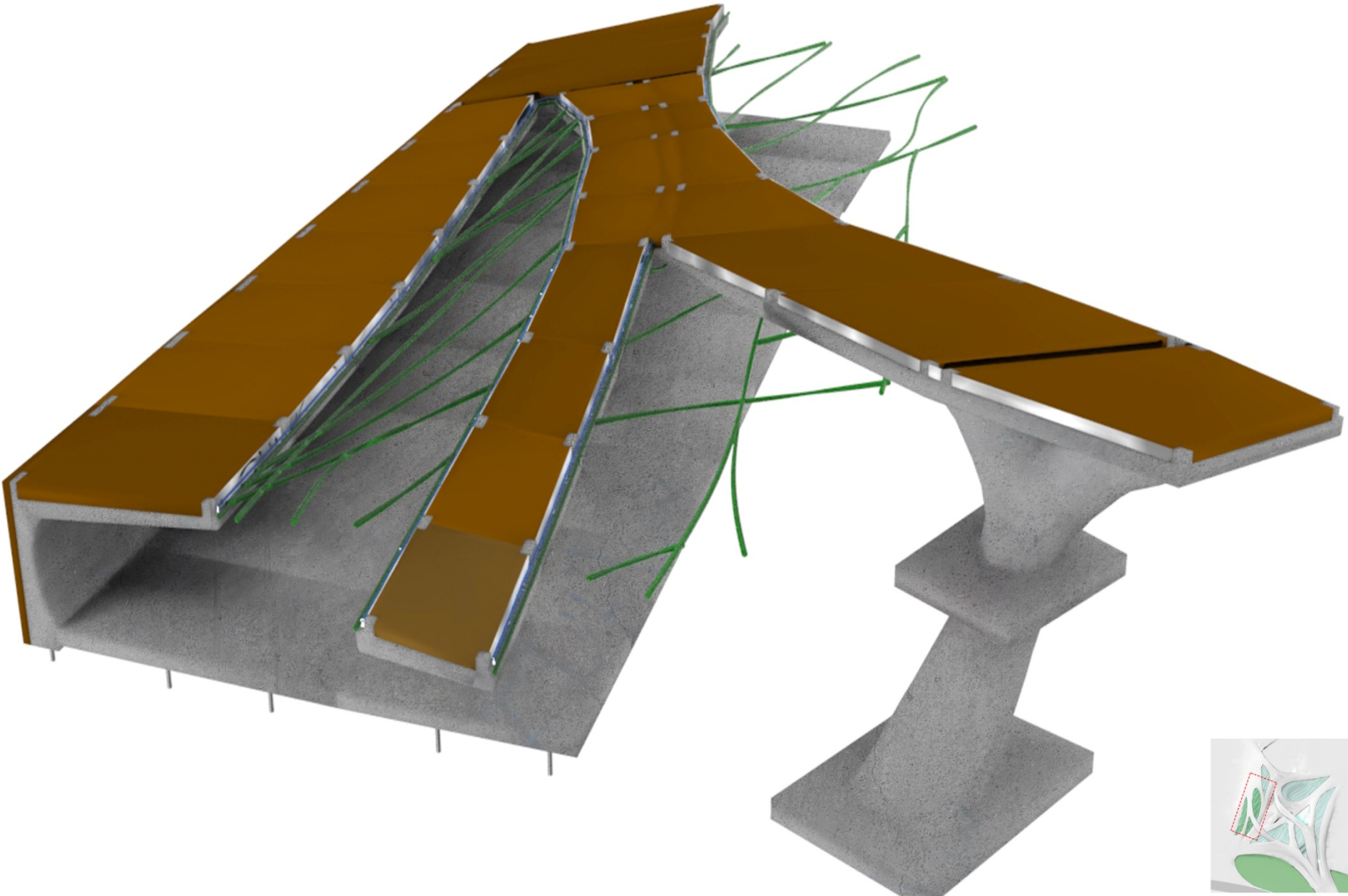


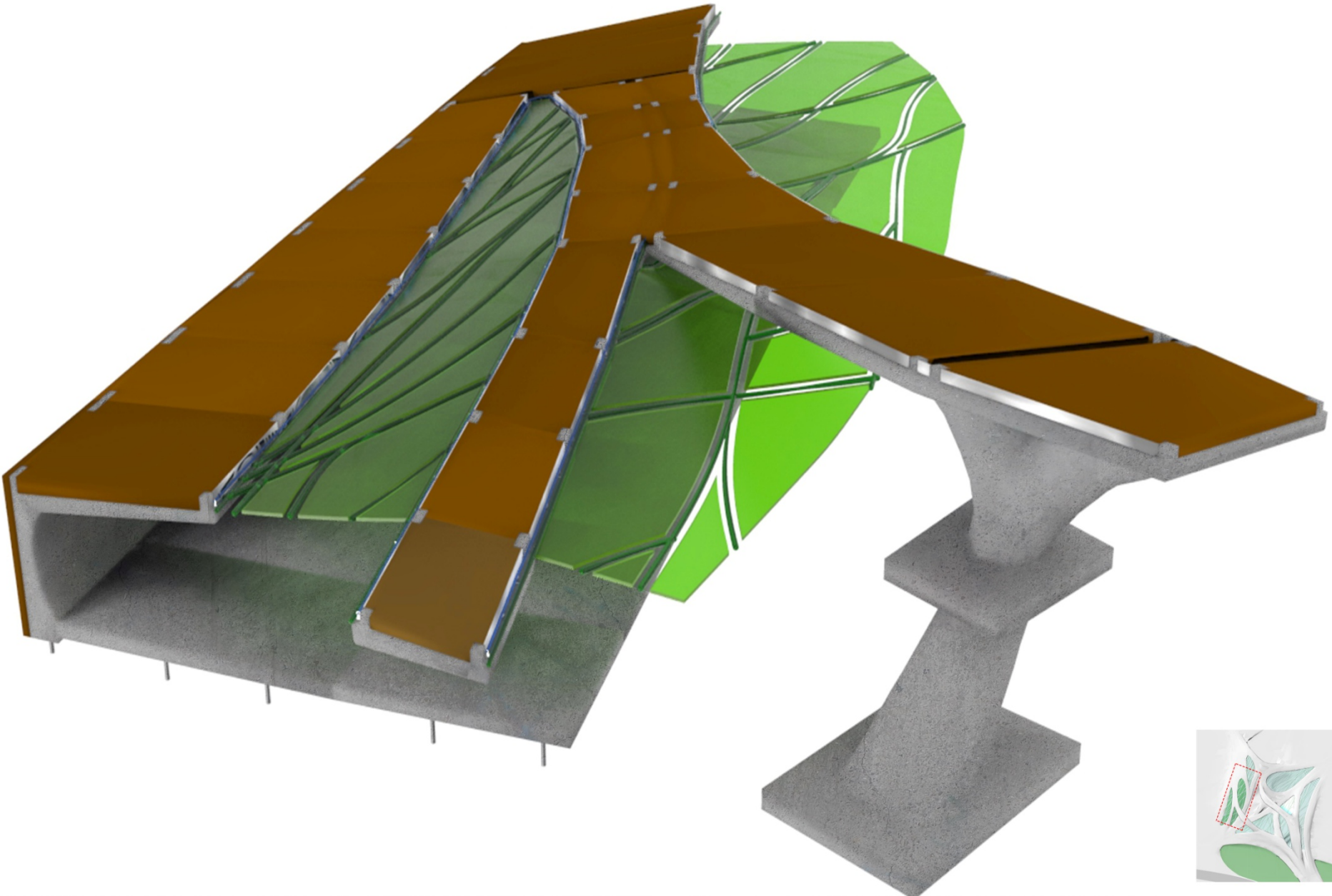


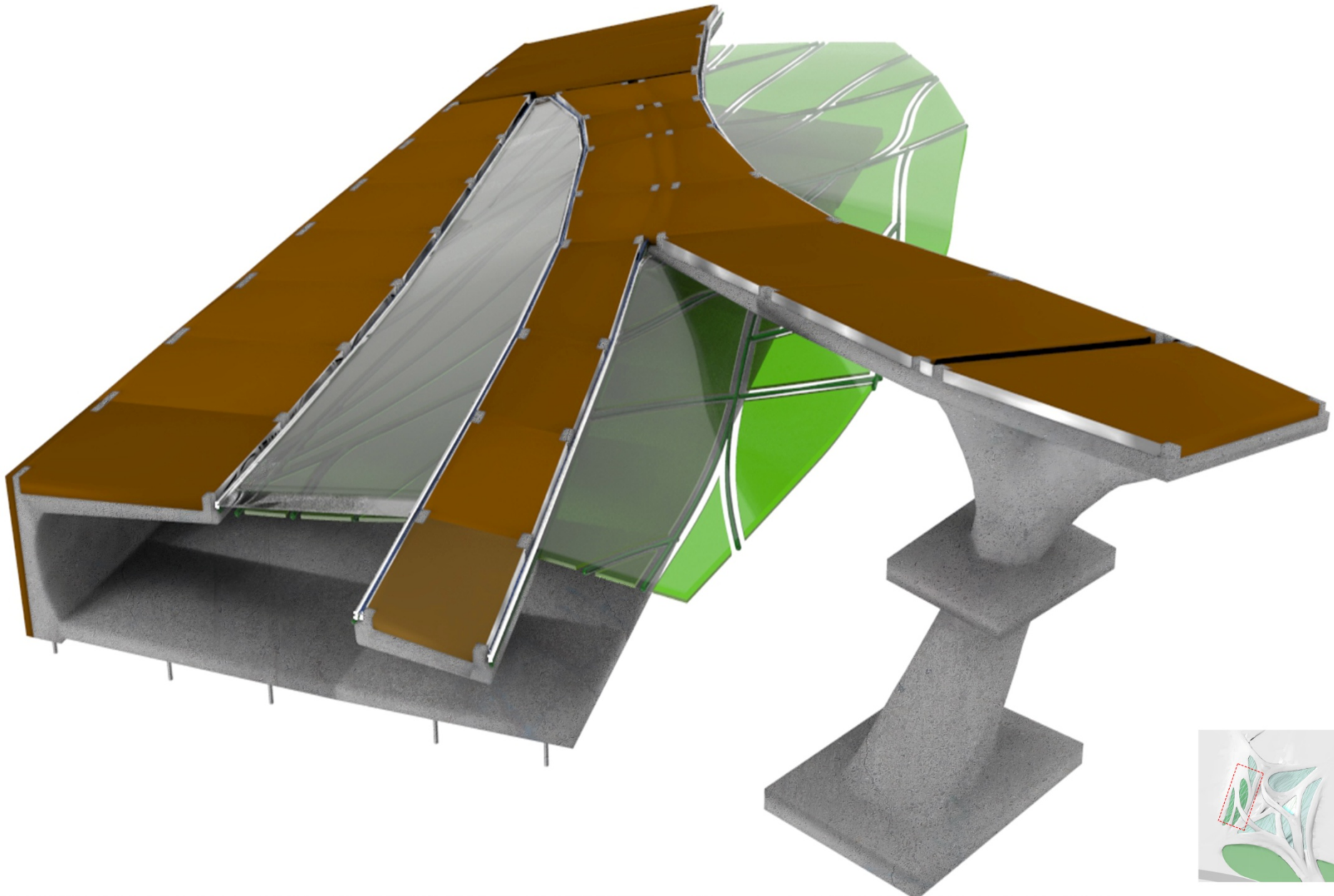


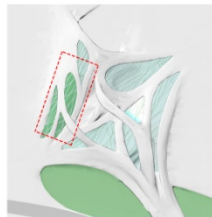
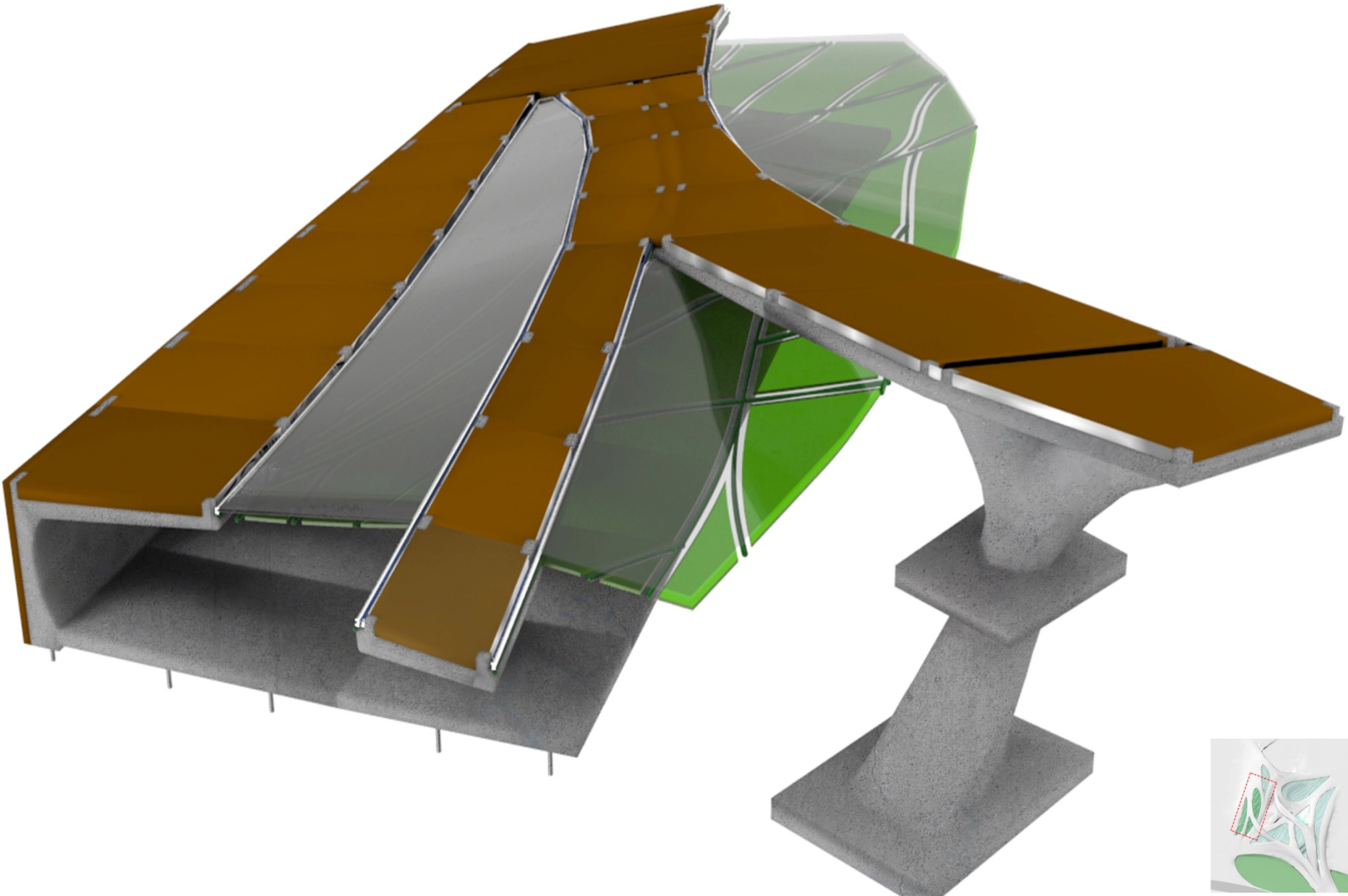


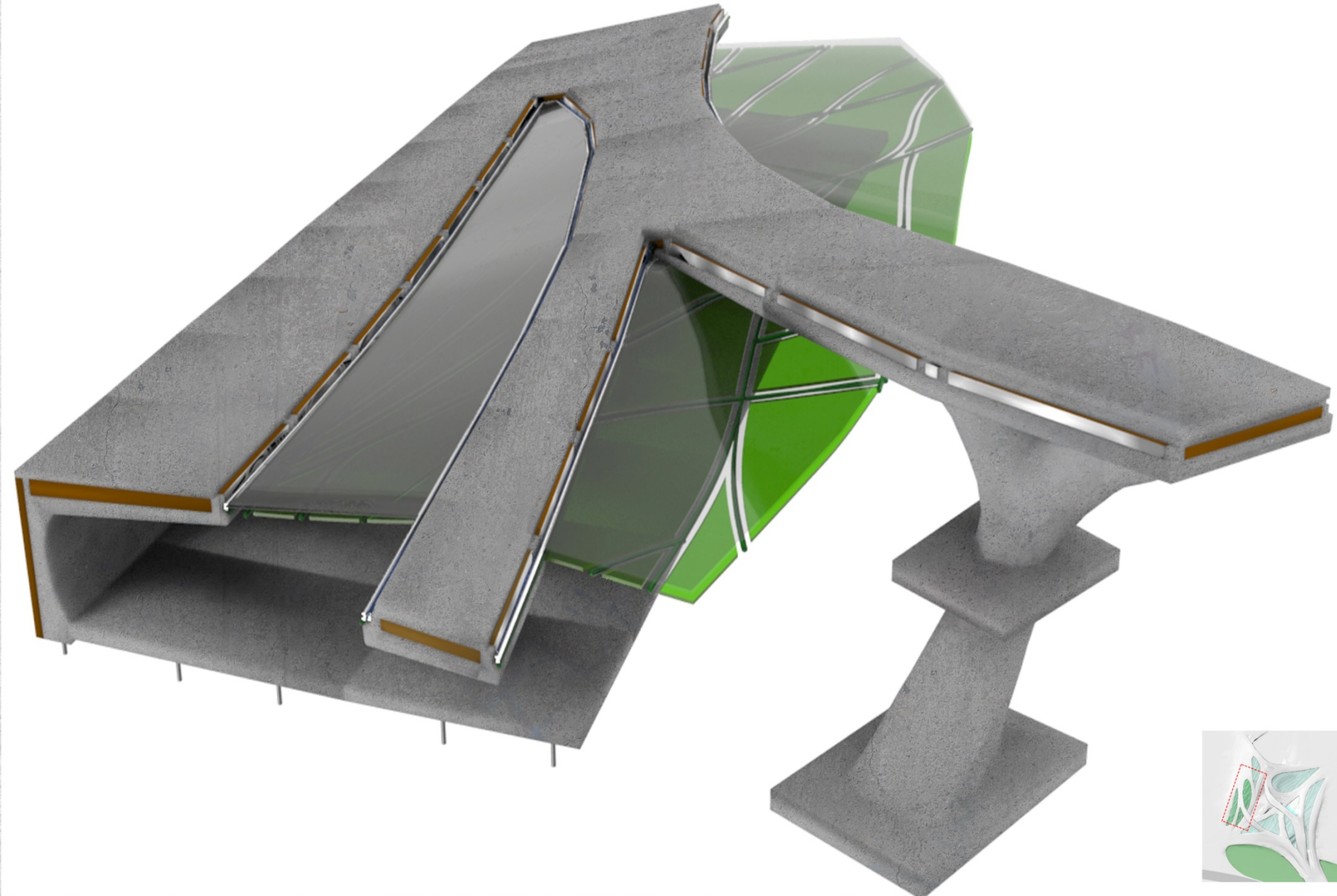


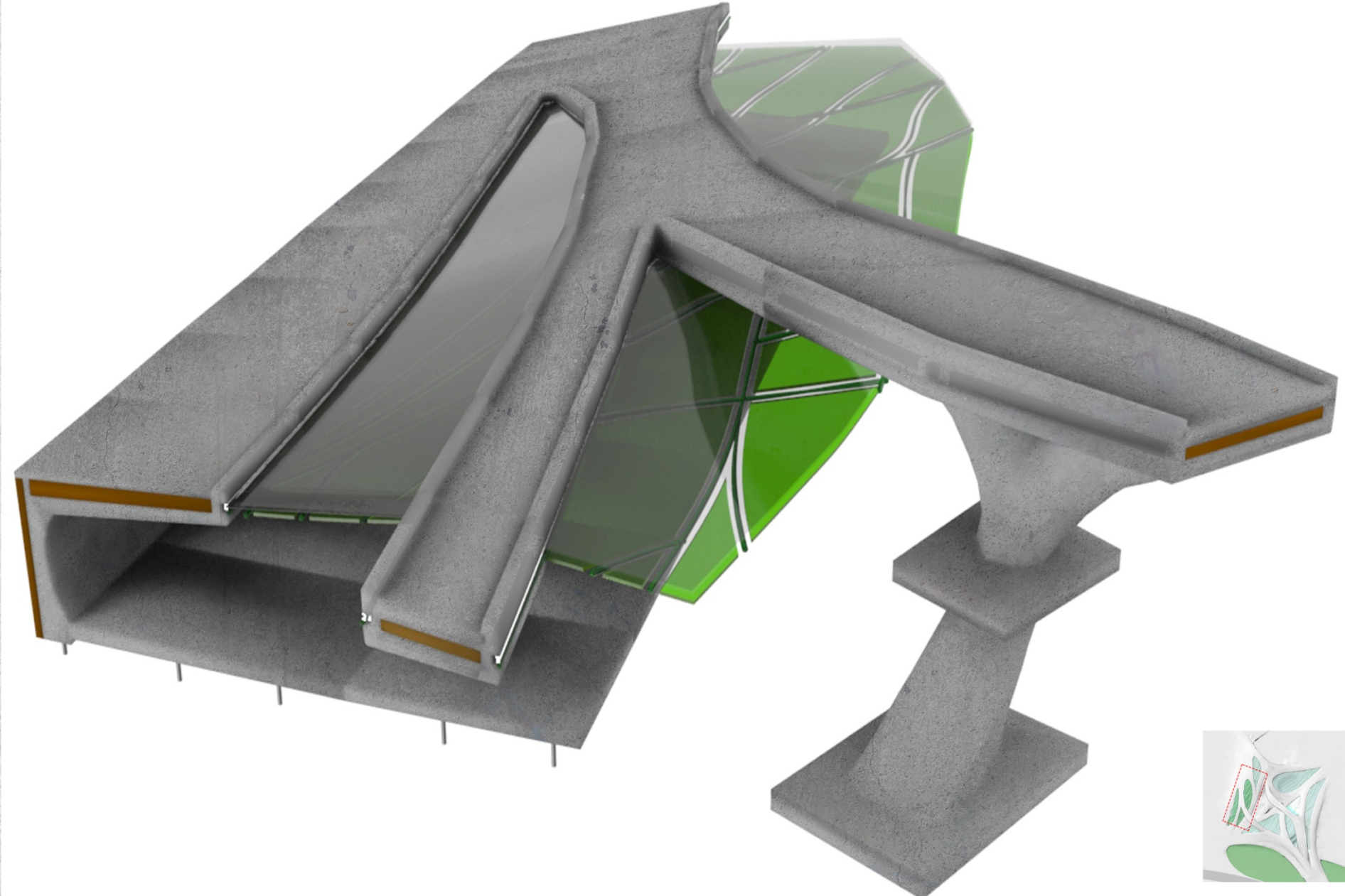


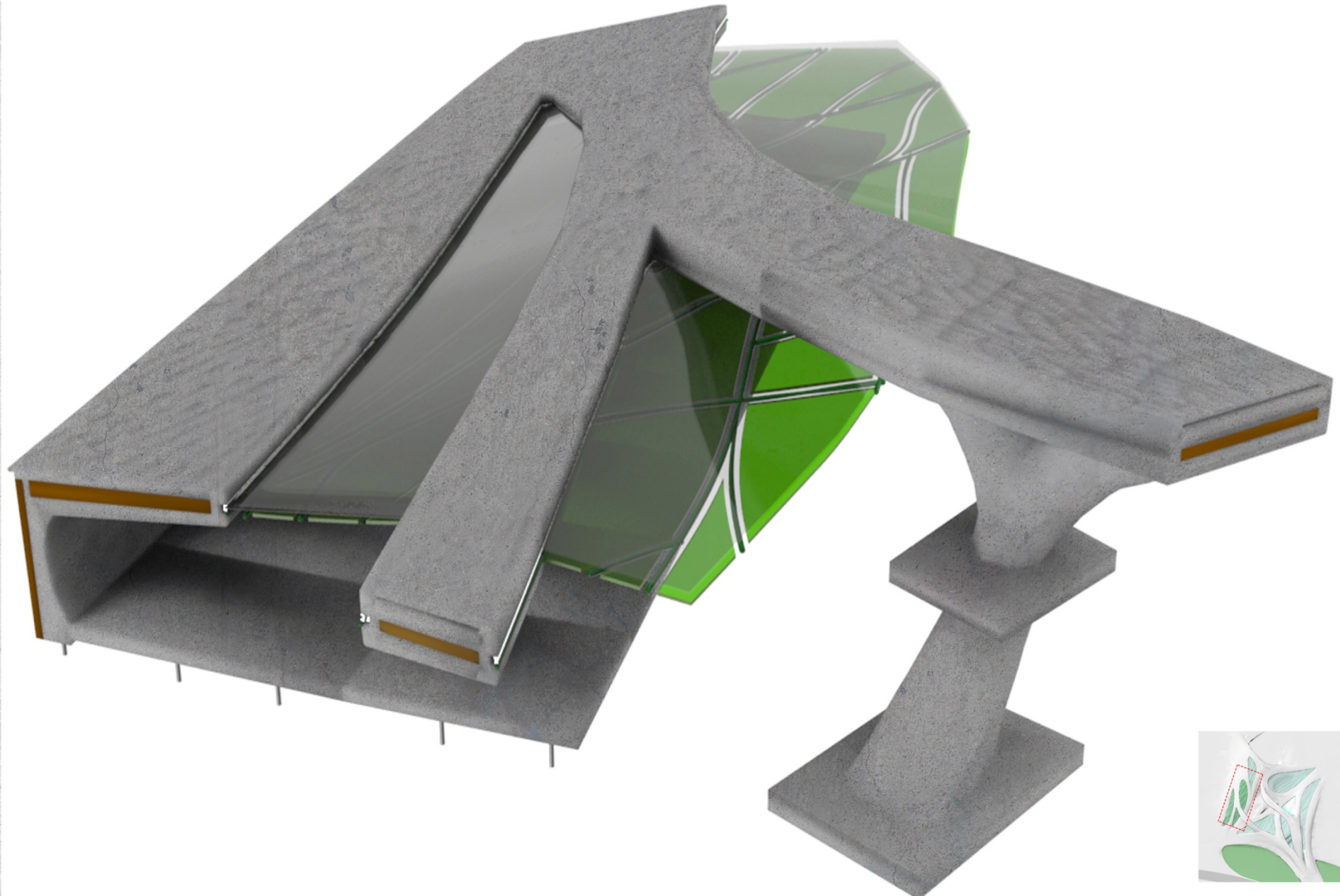










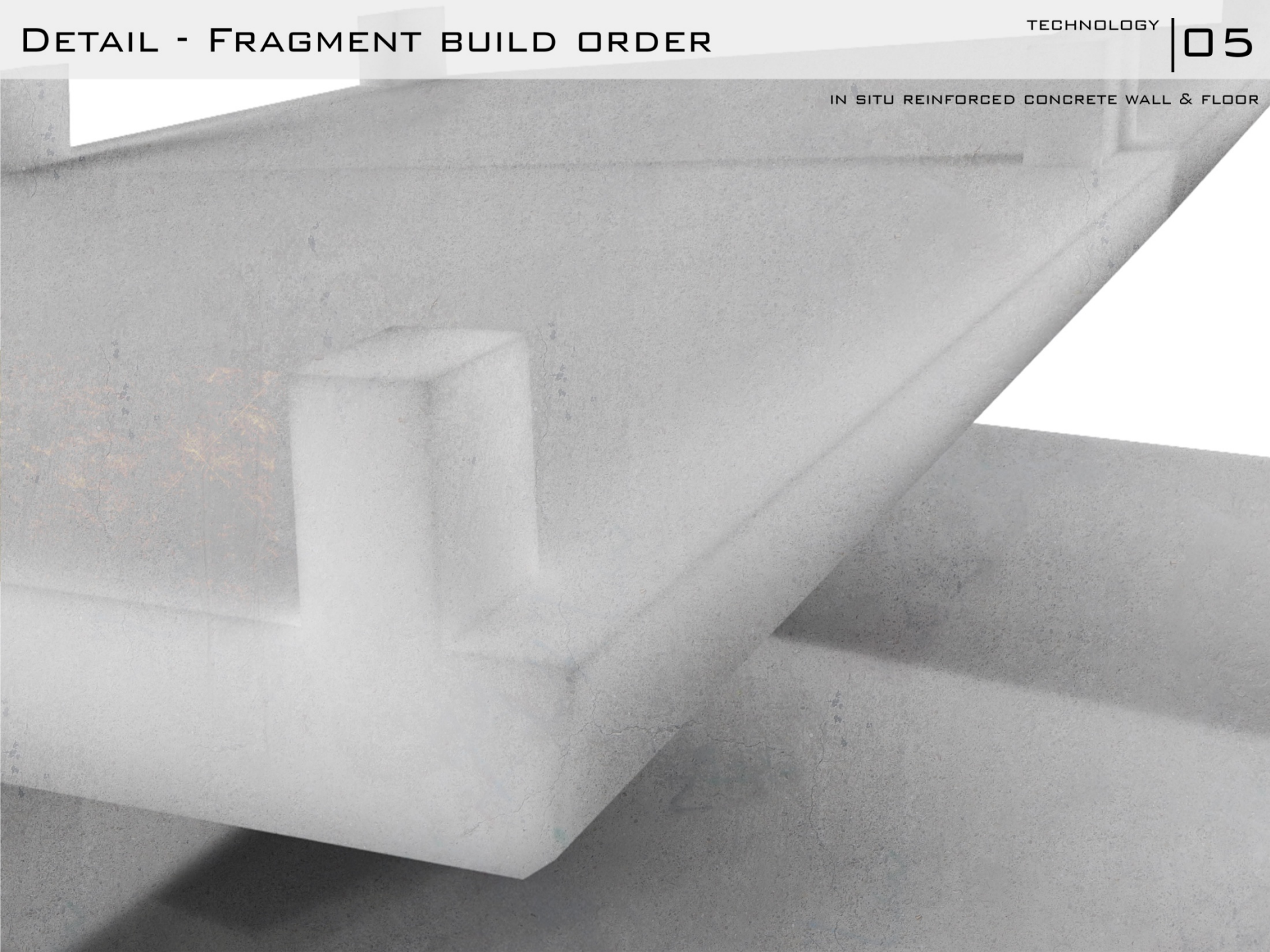


DETAIL - FRAGMENT BUILD ORDER

TECHNOLOGY

05

IN SITU REINFORCED CONCRETE WALL & FLOOR

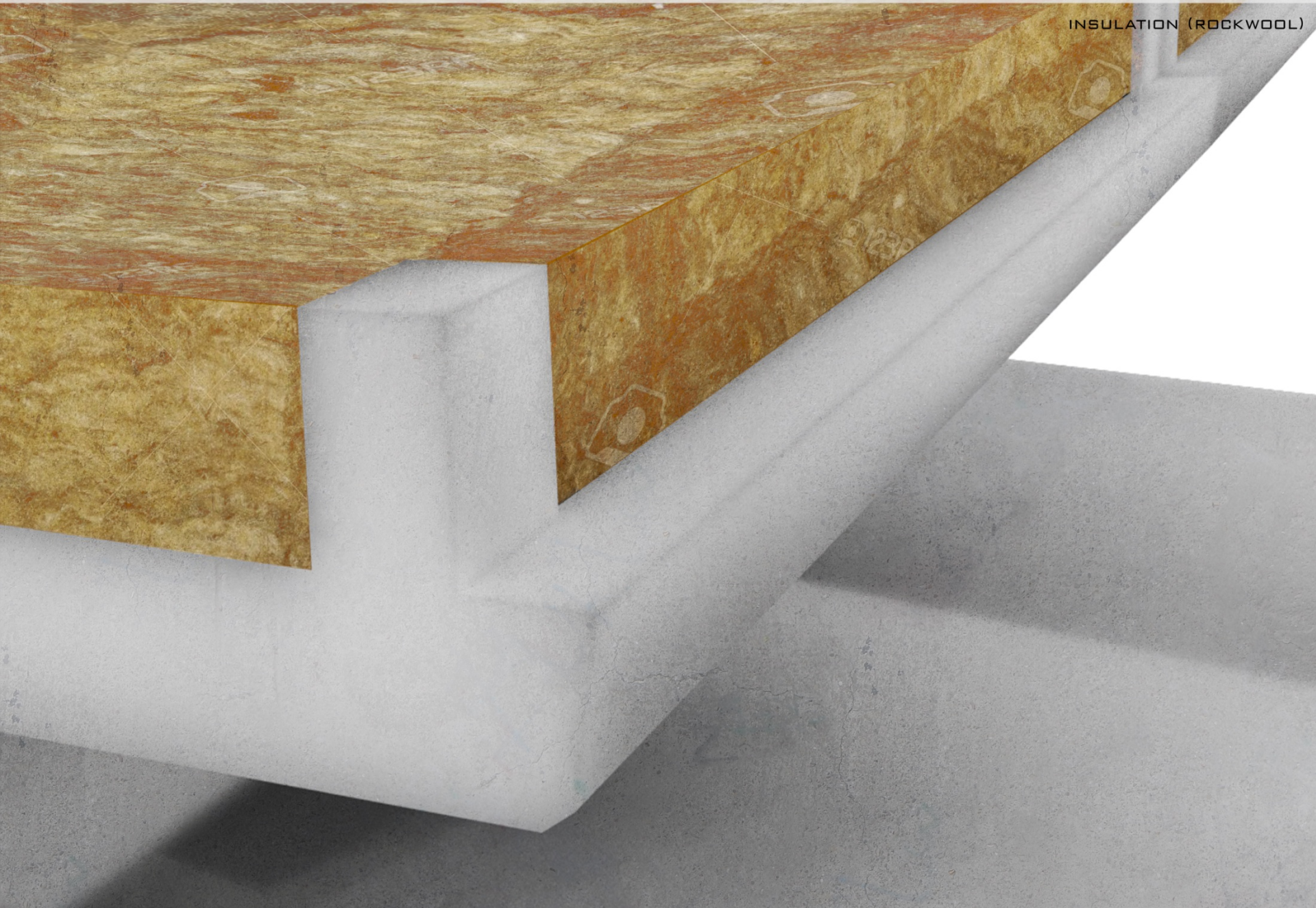


DETAIL - FRAGMENT BUILD ORDER

TECHNOLOGY

05

INSULATION (ROCKWOOL)

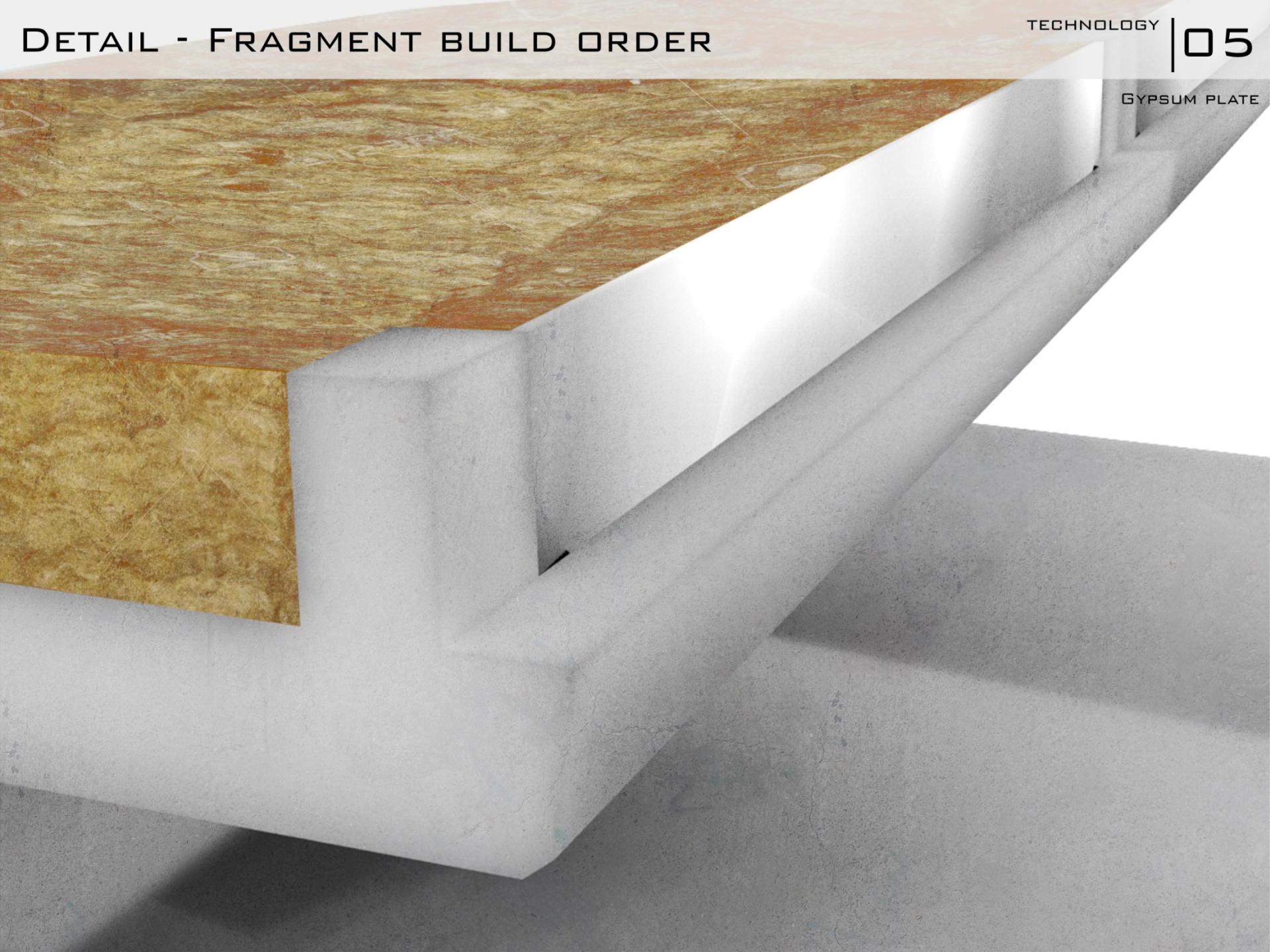


DETAIL - FRAGMENT BUILD ORDER

TECHNOLOGY

05

GYPSUM PLATE

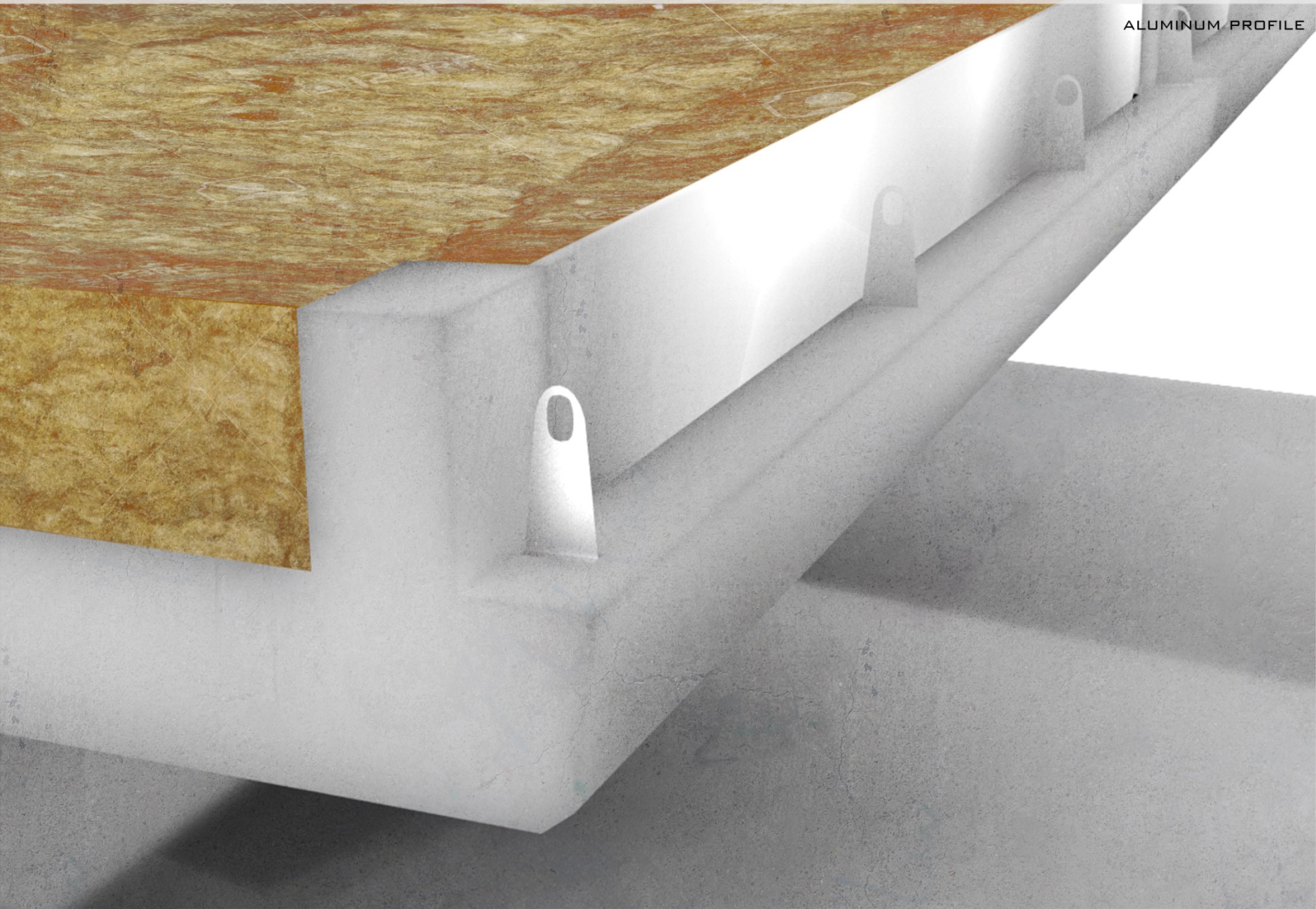


DETAIL - FRAGMENT BUILD ORDER

TECHNOLOGY

05

ALUMINUM PROFILE

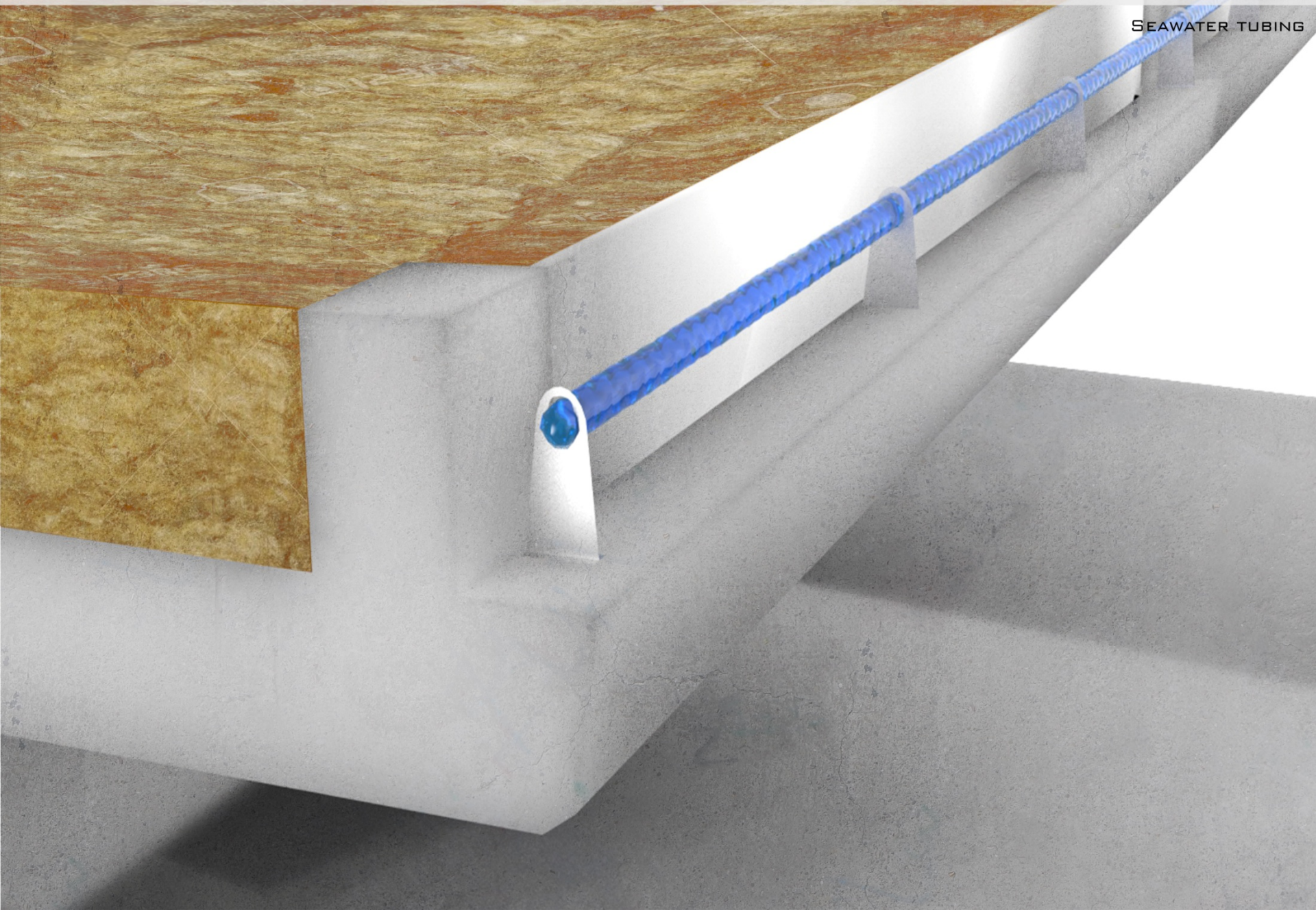


DETAIL - FRAGMENT BUILD ORDER

TECHNOLOGY

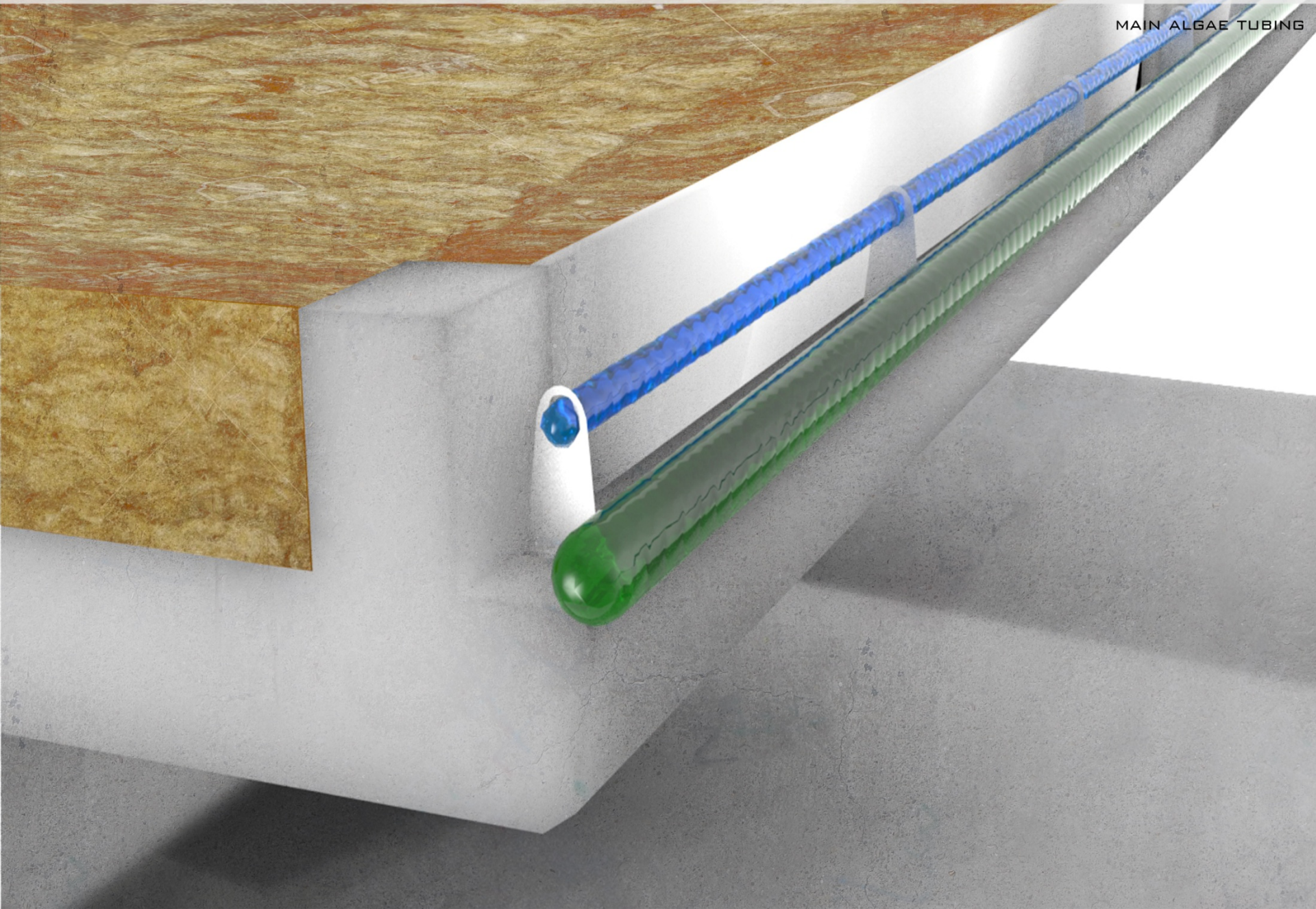
05

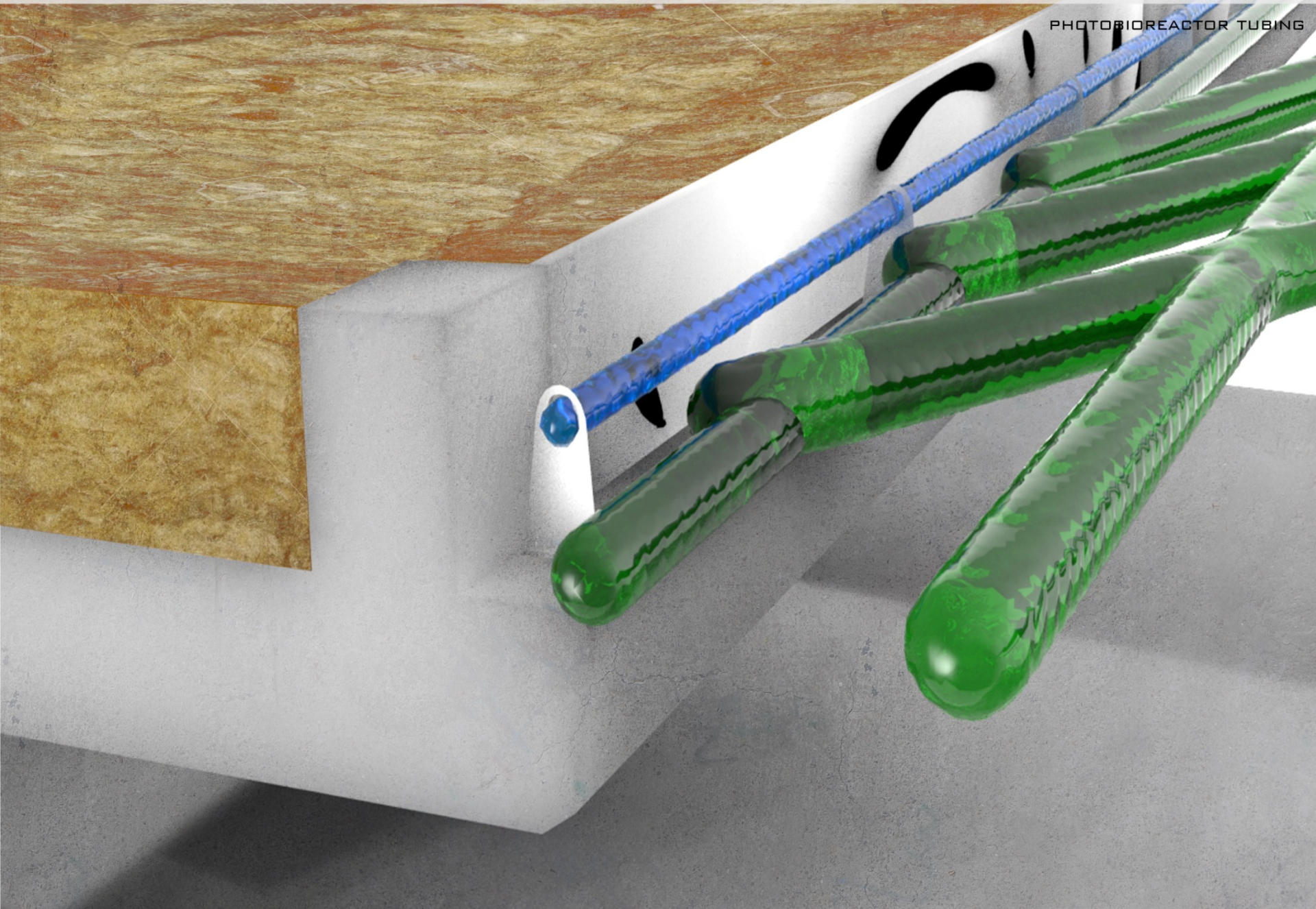
SEAWATER TUBING

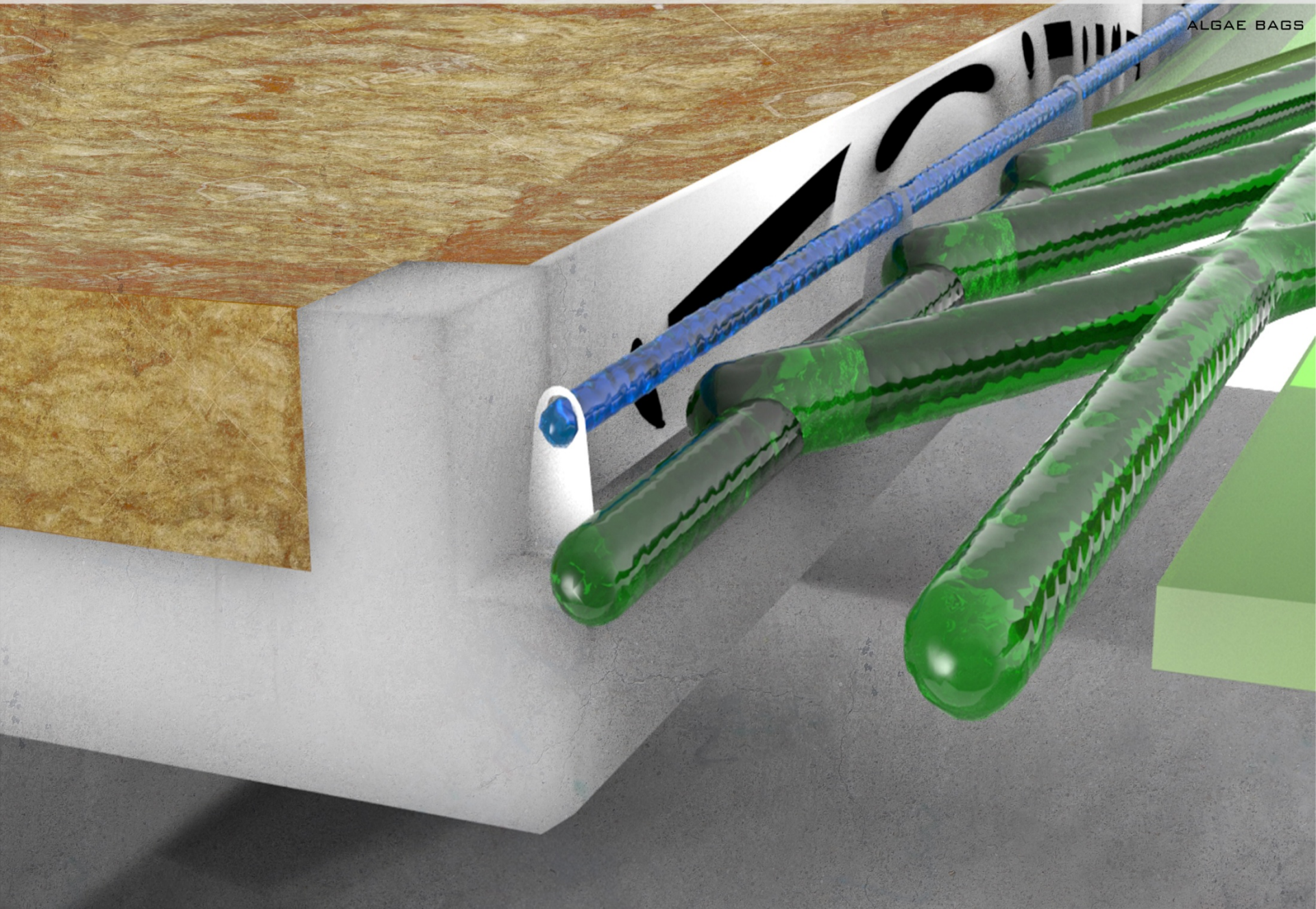


DETAIL - FRAGMENT BUILD ORDER

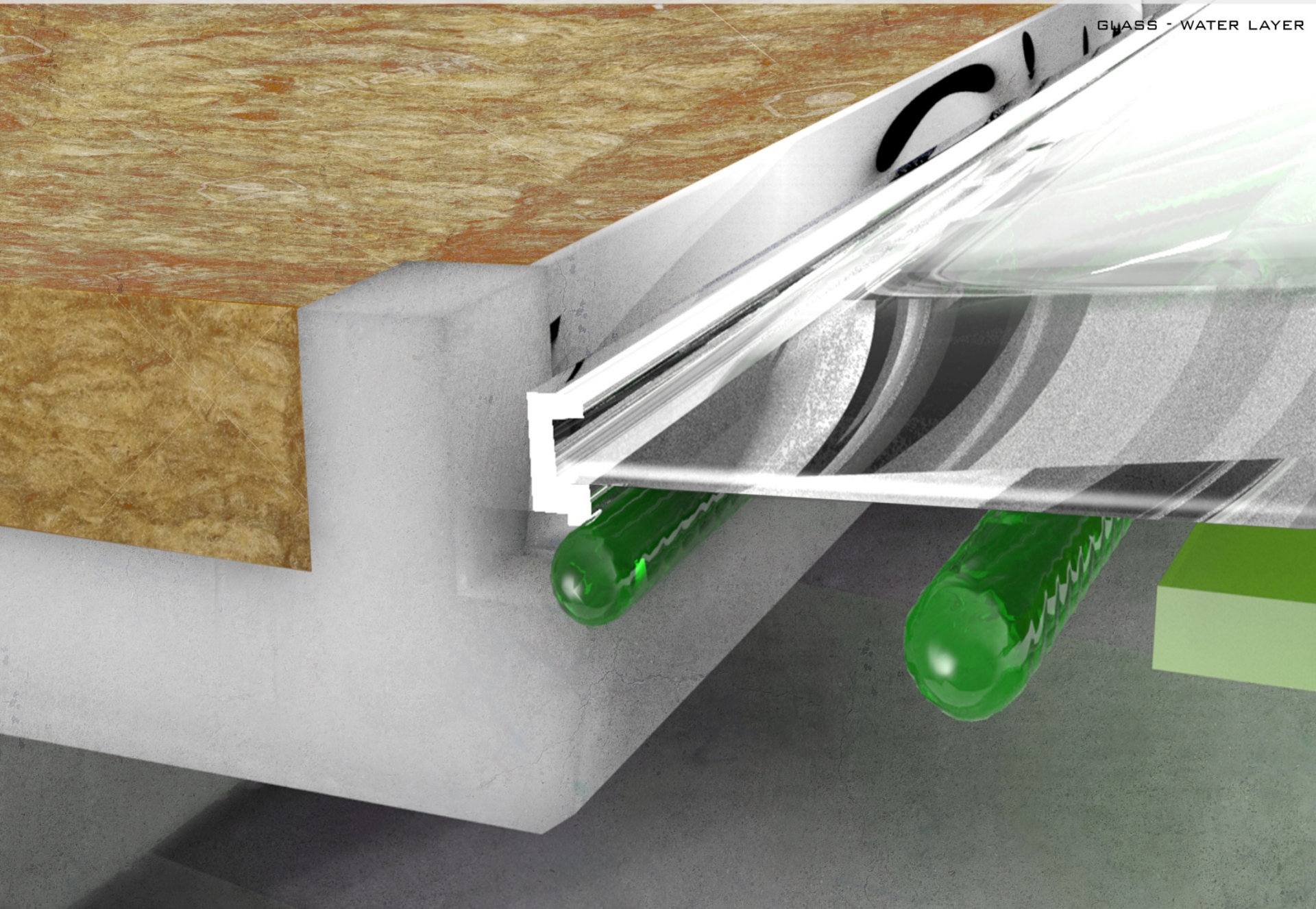
MAIN ALGAE TUBING

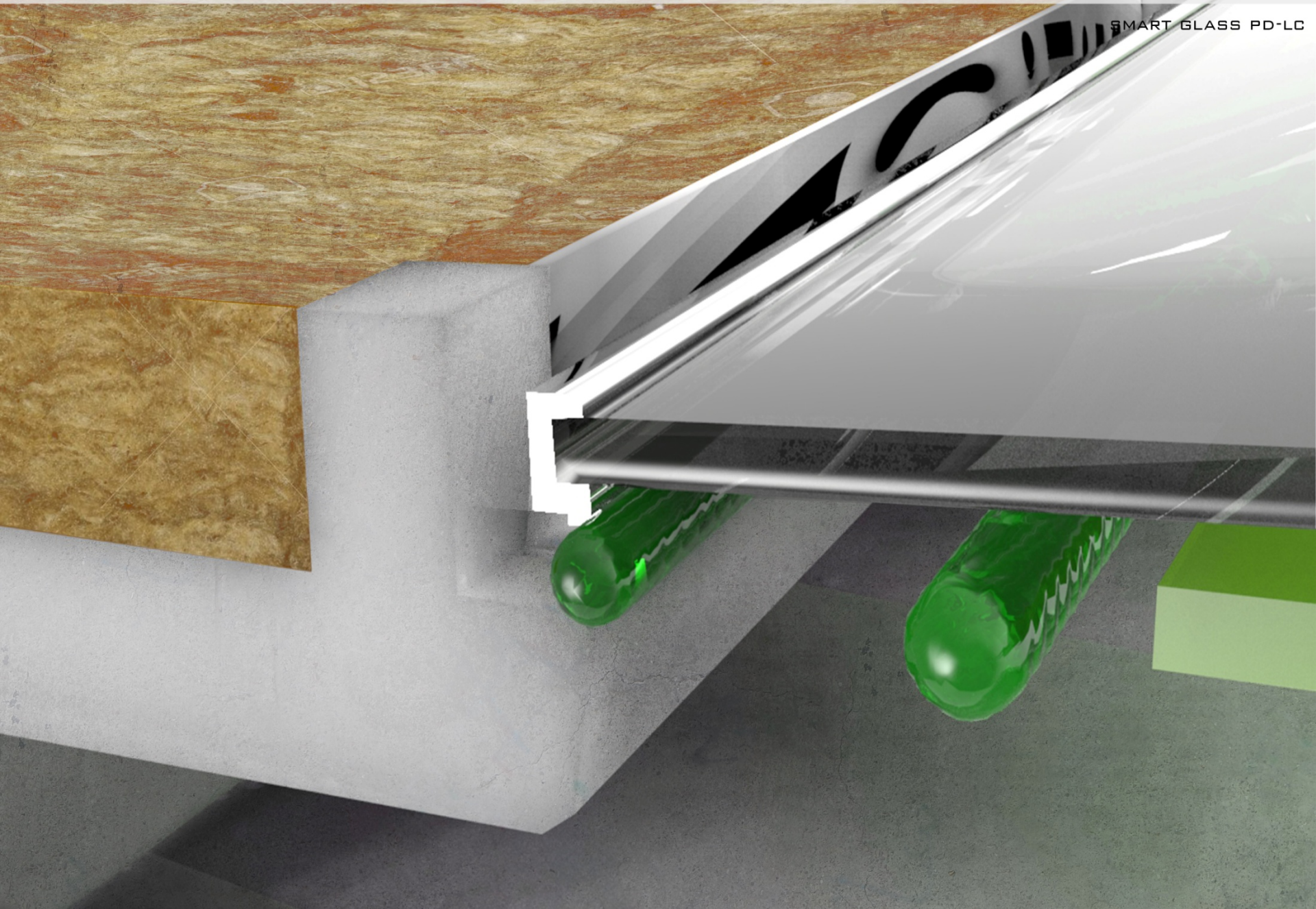




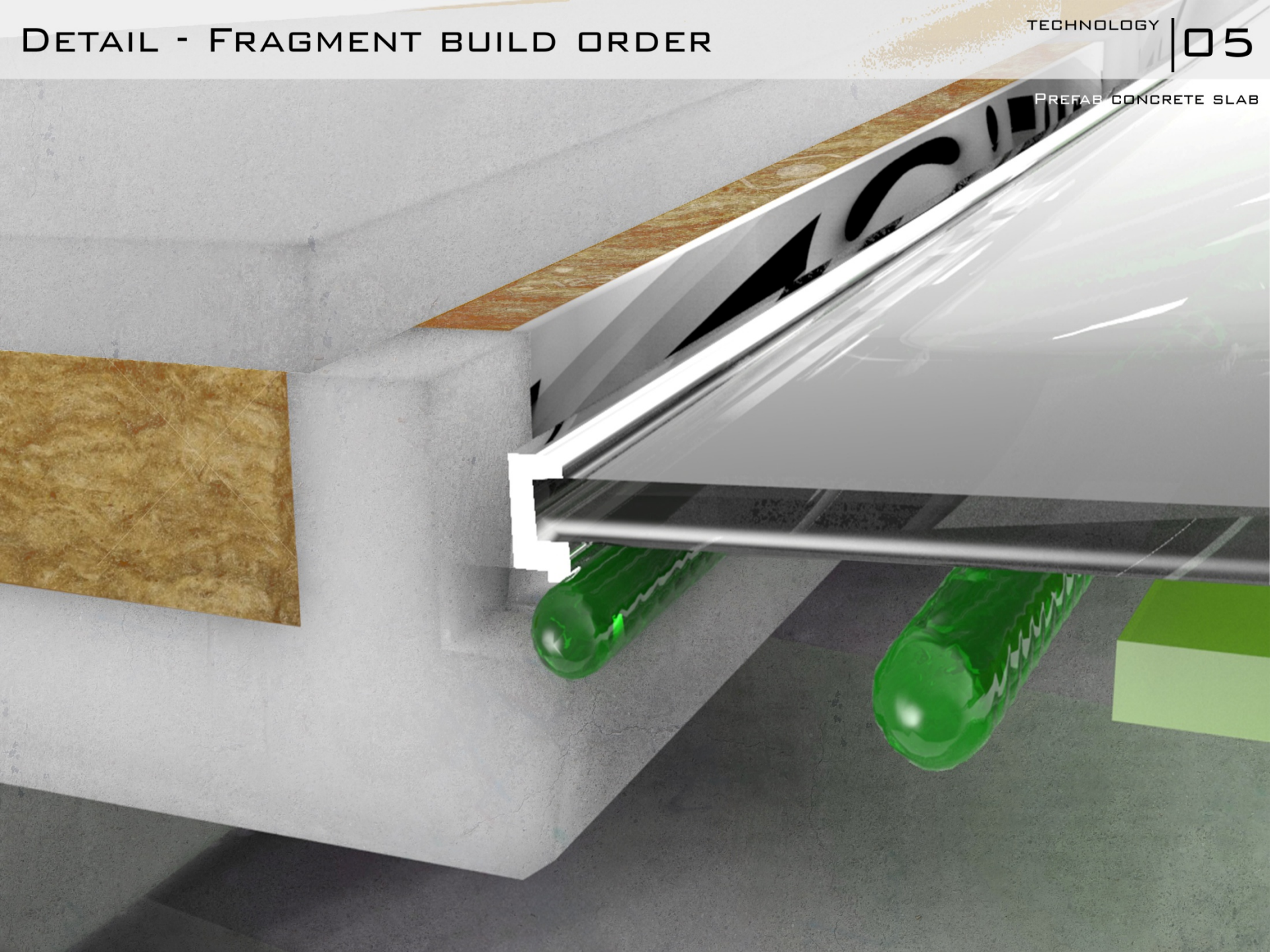


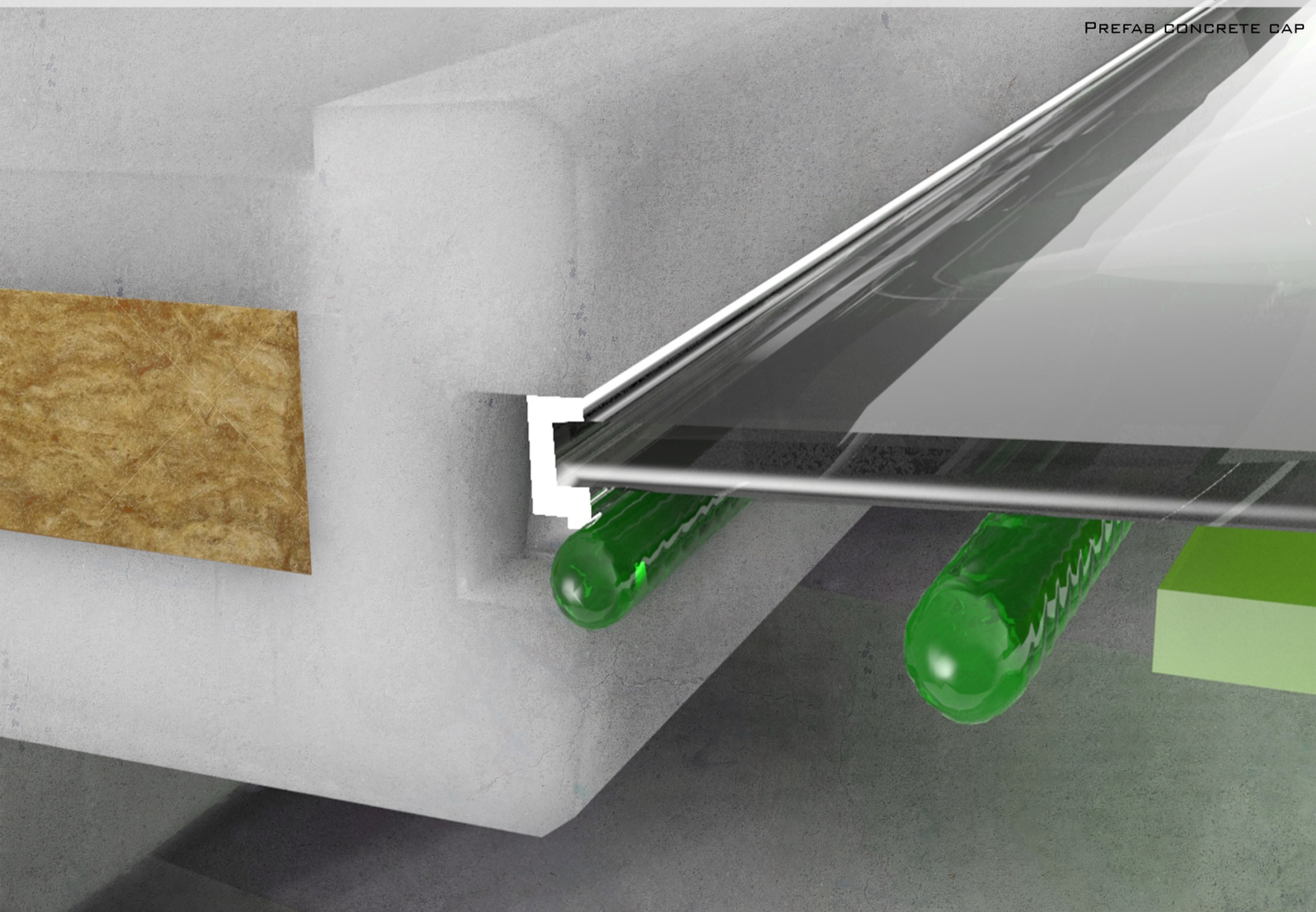
GLASS - WATER LAYER

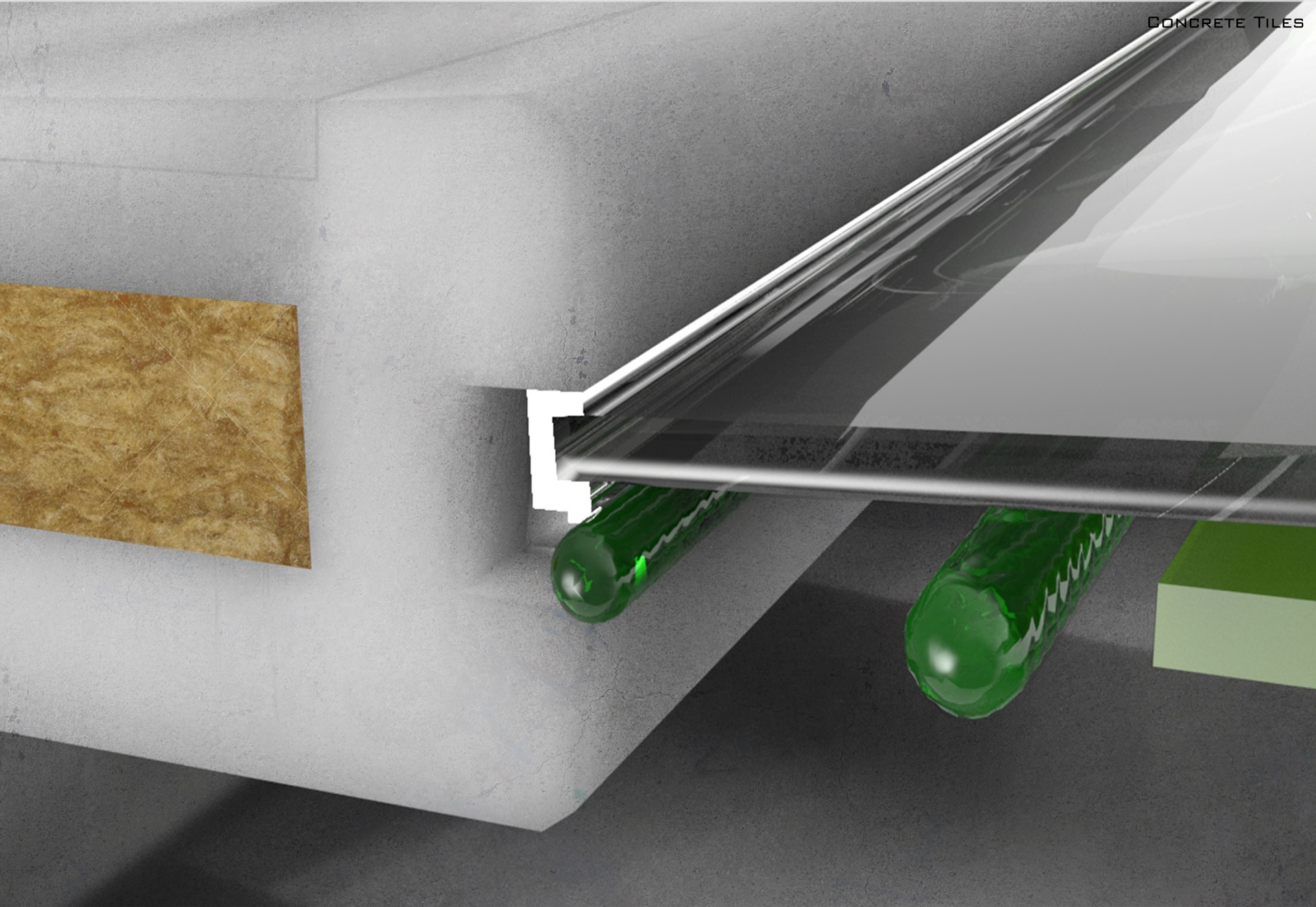




DETAIL - FRAGMENT BUILD ORDER







CONTAINING

ALGAE BAGS: 585,75 M² (38 PCS)

PBR TUBING: 3995,25 M (183 PCS)

- ARCHITECTURAL INTEGRATION WITH PAVILION
- RELATION TO FUNCTIONS BENEATH
- RELATION BETWEEN MACRO- AND MESO SCALE

CONTAINING

ALGAE BAGS: 299,68 M² (262 PCS)

PBR TUBING: 6617,92 M (324 PCS)

- NO INTEGRATION WITH PAVILION
- GOES FOR OPTIMUM FUNCTIONALITY
- NO RELATION WITH FUNCTIONS BENEATH
- NO RELATION BETWEEN MACRO- AND MESO SCALE

ALGAE PRODUCTION & SALES

GREEN BAGS

AMOUNT: 38

$$\begin{aligned} \text{VOLUME: } 585,75 \text{ m}^2 \times 0,1 \text{ m} &= 58,575 \text{ m}^3 \\ &= 58.575 \text{ DM}^3 \text{ (L)} \end{aligned}$$

PRODUCTION

1 DAY

$$\begin{aligned} \text{WITH } 20\% \text{ CO}_2 \text{ FIXATION} &= 0,624 \text{ g/L.DAY} \\ \text{TOTAL: } 58.575 \times 0,624 &= 36.551 \text{ g/L.DAY} \\ &= \underline{36,551 \text{ KG/L.DAY}} \end{aligned}$$

PRODUCTION COSTS

$$\begin{aligned} \text{FLAT PANELS: } &\text{€}42,32 \text{ PER KG} \\ \text{TOTAL: } 36,551 \times \text{€}42,32 &= \text{€}1.546 \text{ PER DAY} \end{aligned}$$

SELL COST

$$\begin{aligned} \text{GREEN ALGAE PIGMENTS: } &\text{€}900 \text{ PER KG} \\ \text{TOTAL: } 36,551 \times \text{€}900 &= \text{€}32.895,9 \end{aligned}$$

PROFIT: €31.349,90

PHOTOBIOREACTOR TUBES

AMOUNT: 183 (LENGTH: 3995 M)

$$\begin{aligned} \text{VOLUME: } \pi \times R^2 \times L \\ \pi \times (0,05)^2 \times 3995 &= 31,38 \text{ L} \end{aligned}$$

PRODUCTION

1 DAY

$$\begin{aligned} \text{WITH } 20\% \text{ CO}_2 \text{ FIXATION} &= 0,624 \text{ g/L.DAY} \\ \text{TOTAL: } 31,38 \times 0,624 &= 19.581 \text{ g/L.DAY} \\ &= \underline{19,581 \text{ KG/L.DAY}} \end{aligned}$$

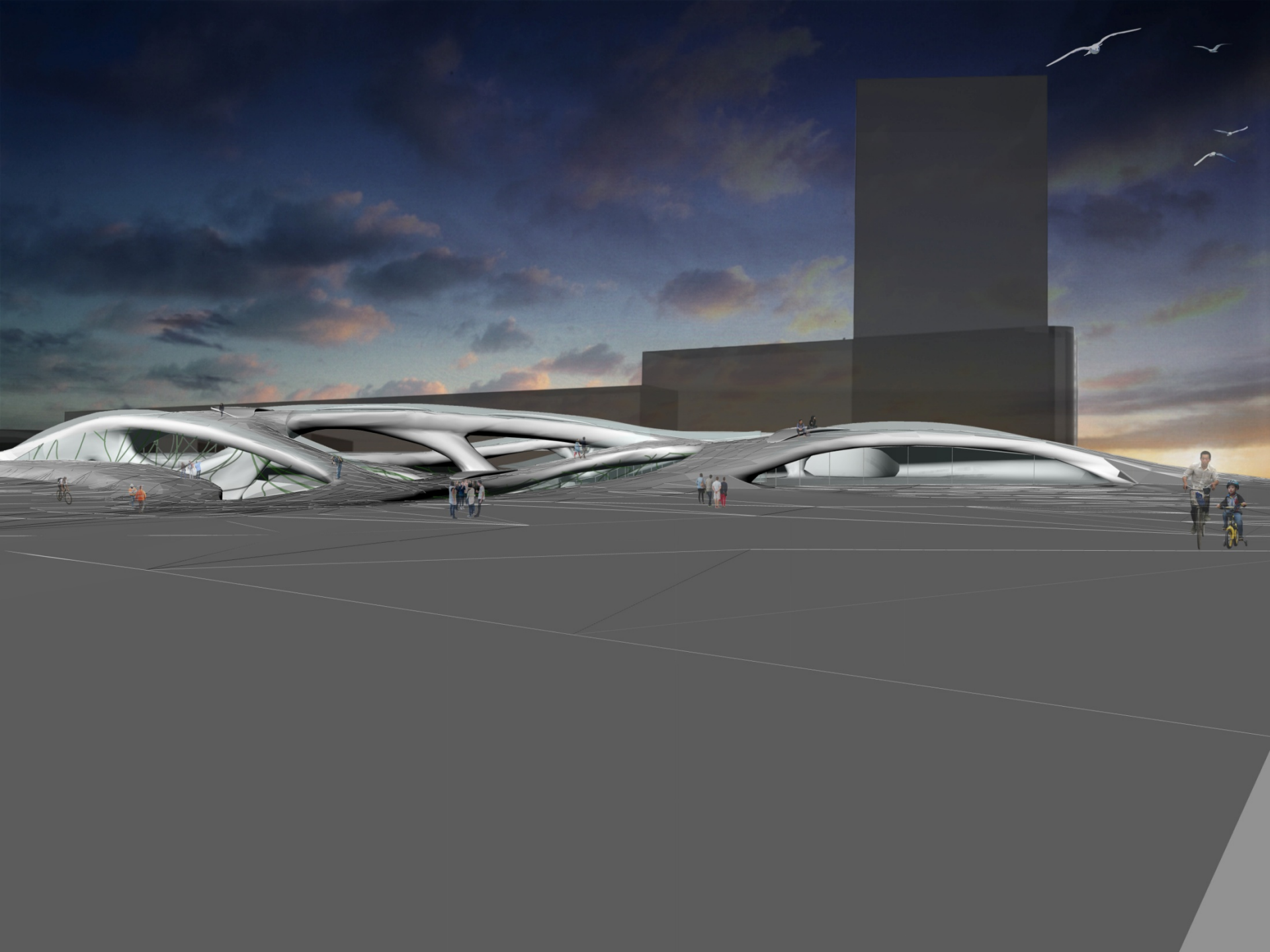
PRODUCTION COSTS

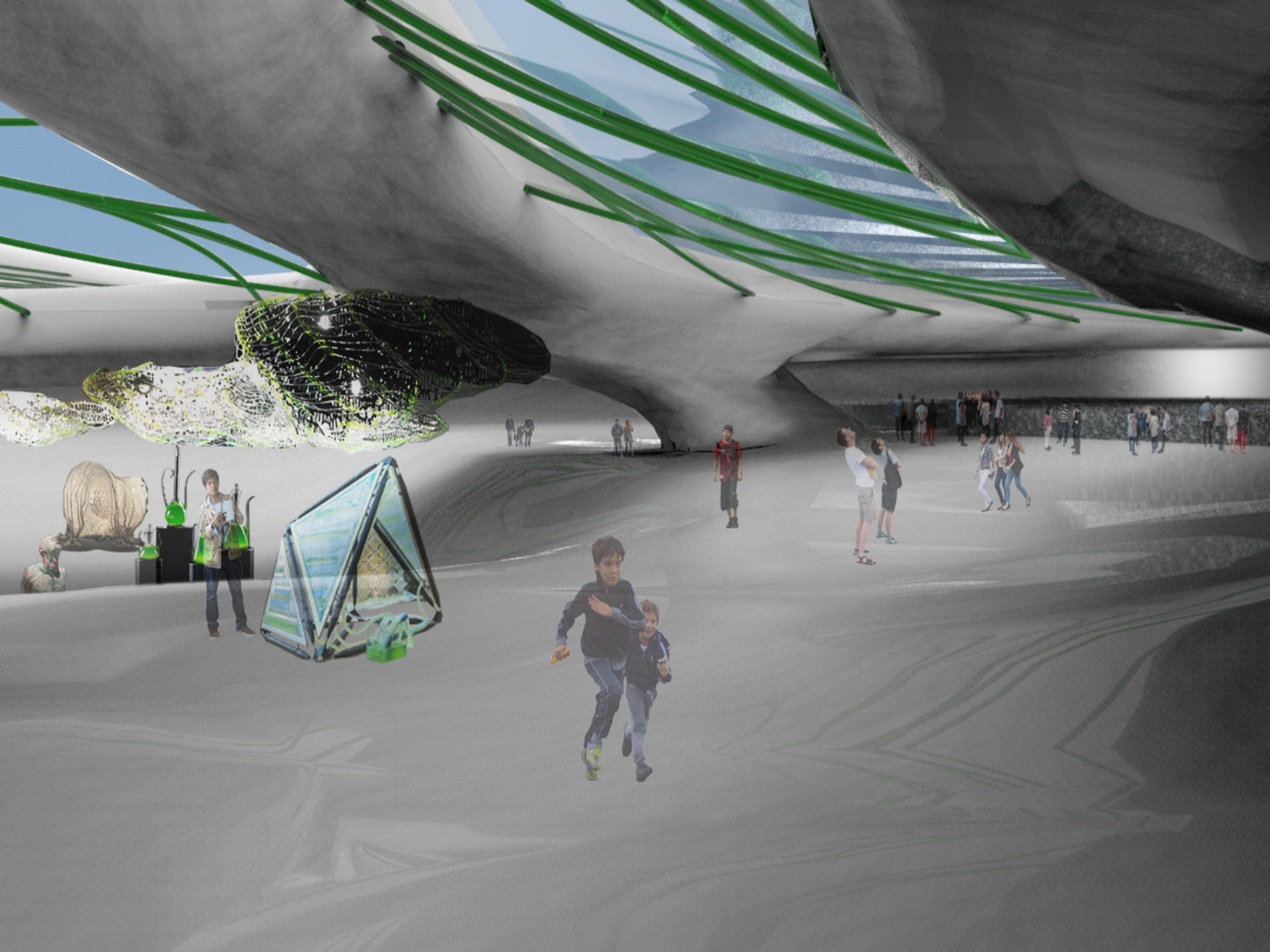
$$\begin{aligned} \text{PBR 1 ACRE PRICE: } &\text{€}44 \text{ PER KG} \\ \text{TOTAL: } 19,581 \times \text{€}44 &= \text{€}861.56 \text{ PER DAY} \end{aligned}$$

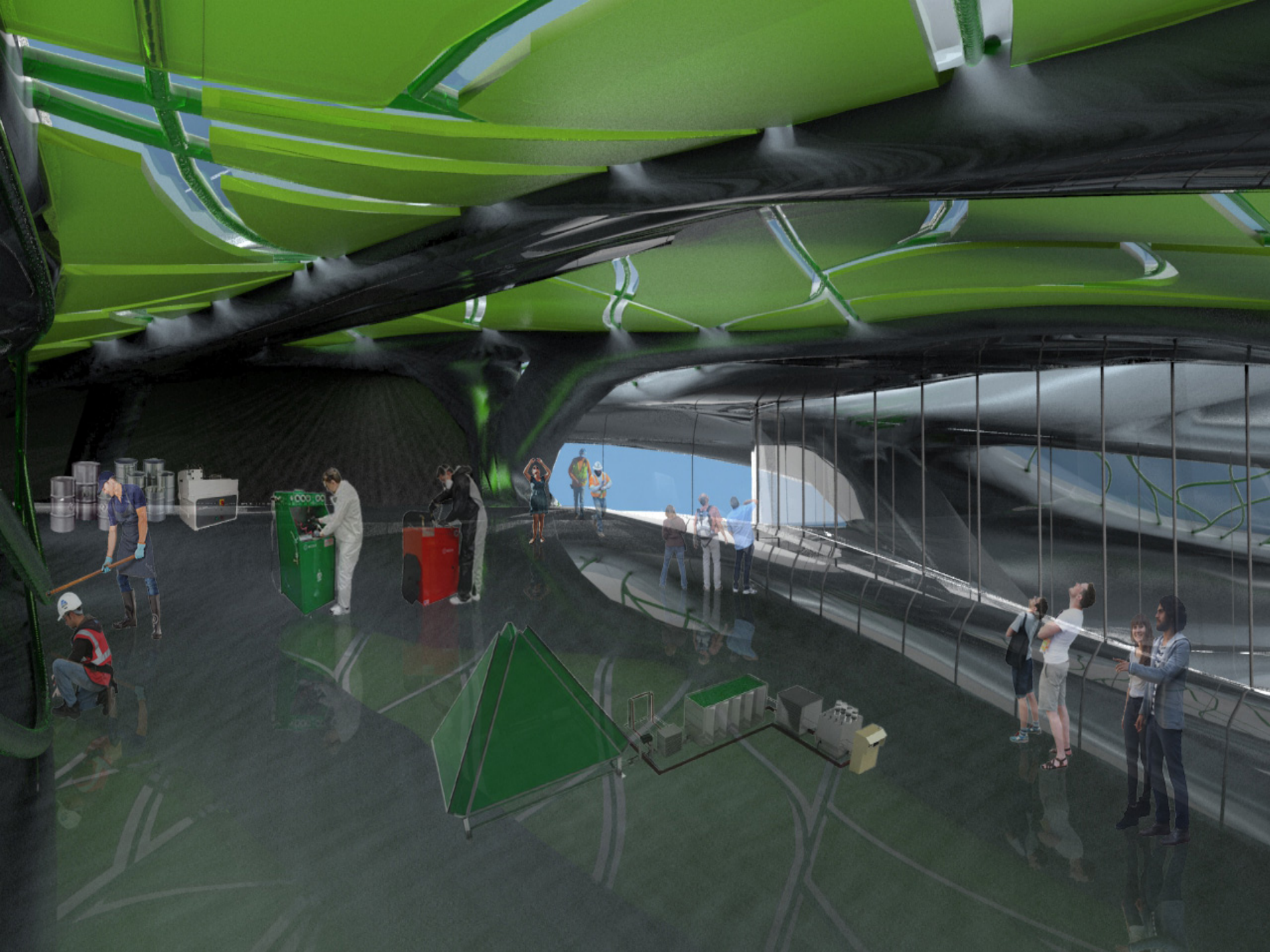
SELL COST

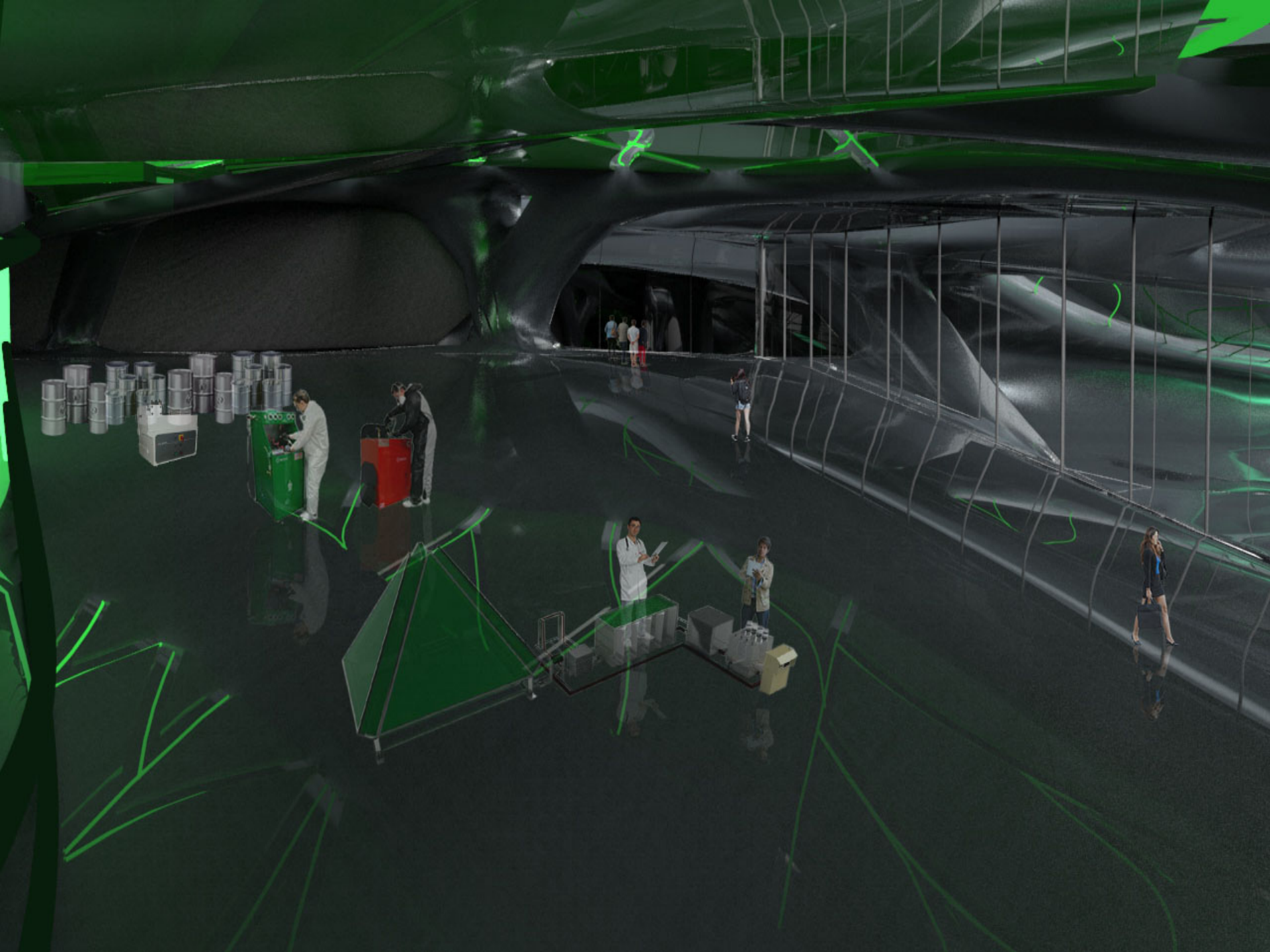
$$\begin{aligned} \text{GREEN ALGAE PIGMENTS: } &\text{€}900 \text{ PER KG} \\ \text{TOTAL: } 19,581 \times \text{€}900 &= \text{€}17.622,9 \end{aligned}$$

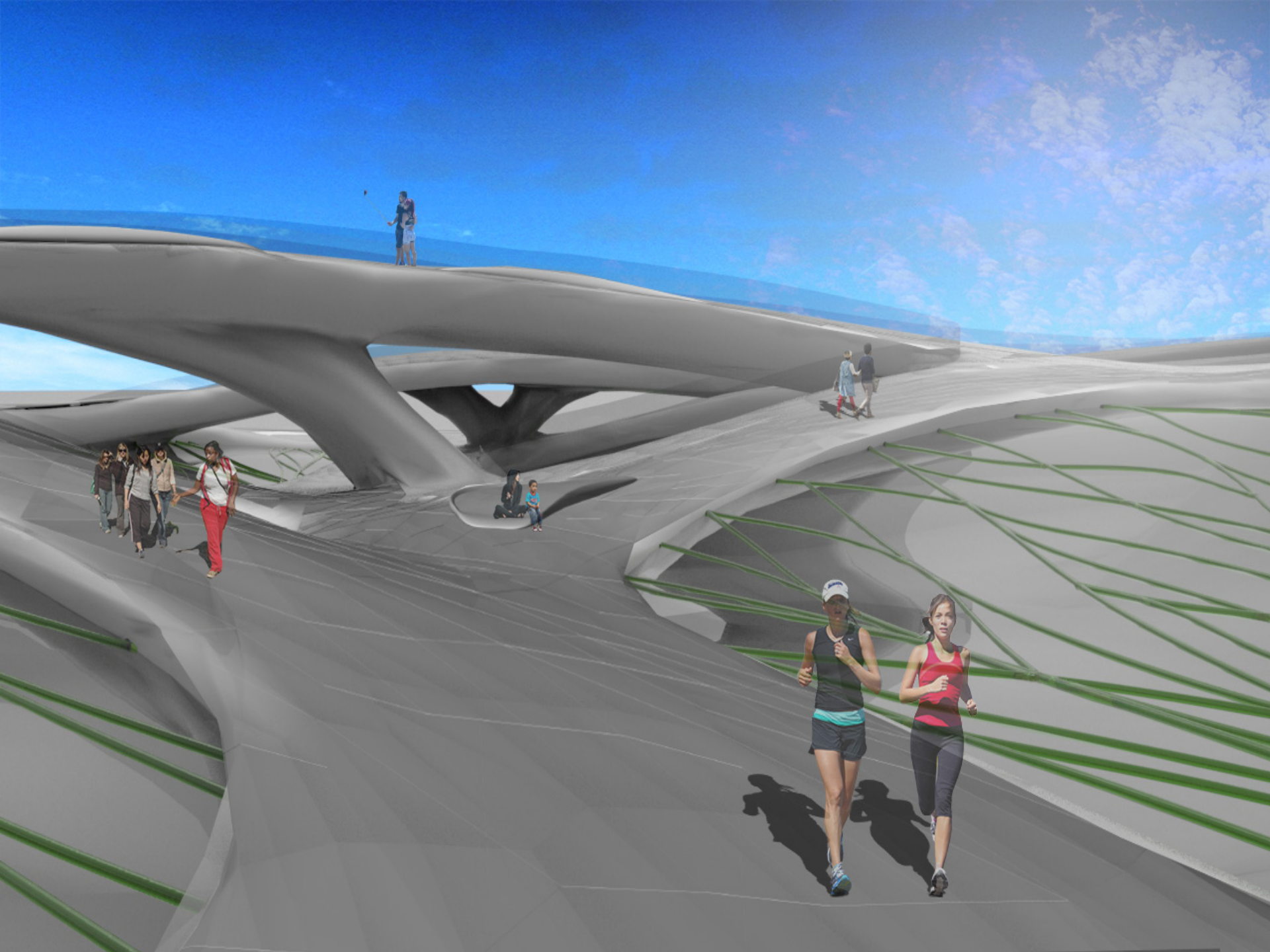
PROFIT: €16.761,34

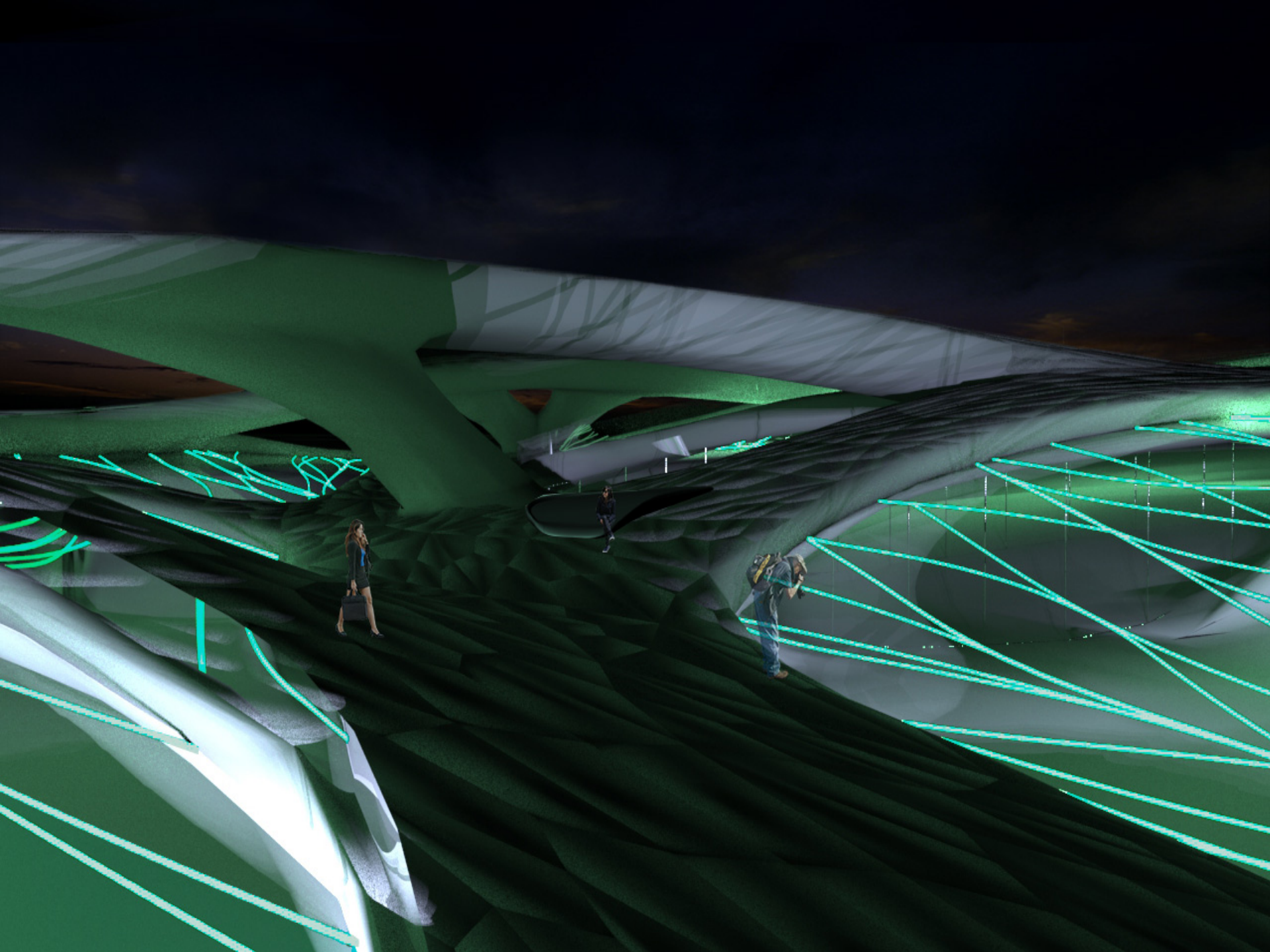


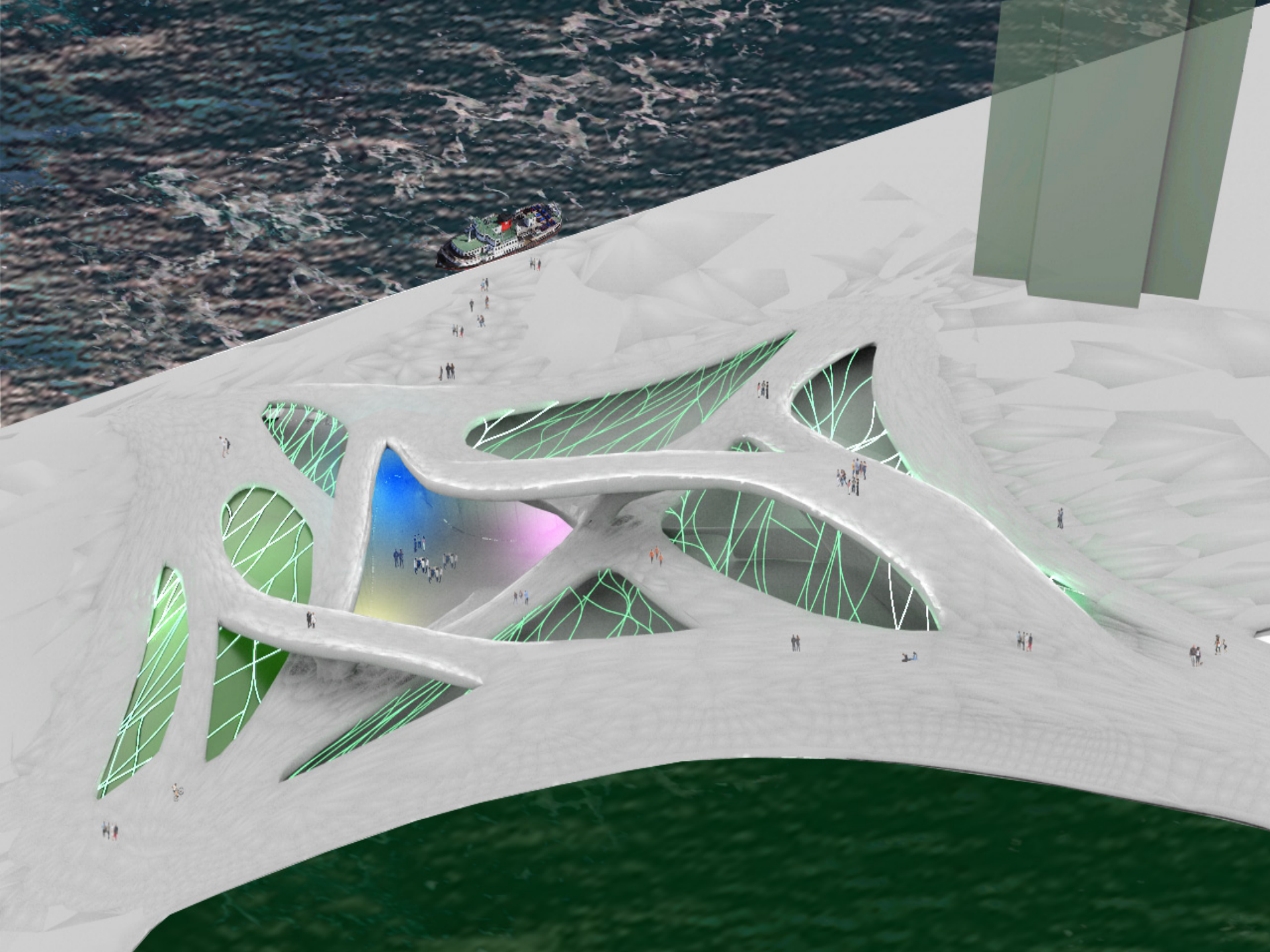


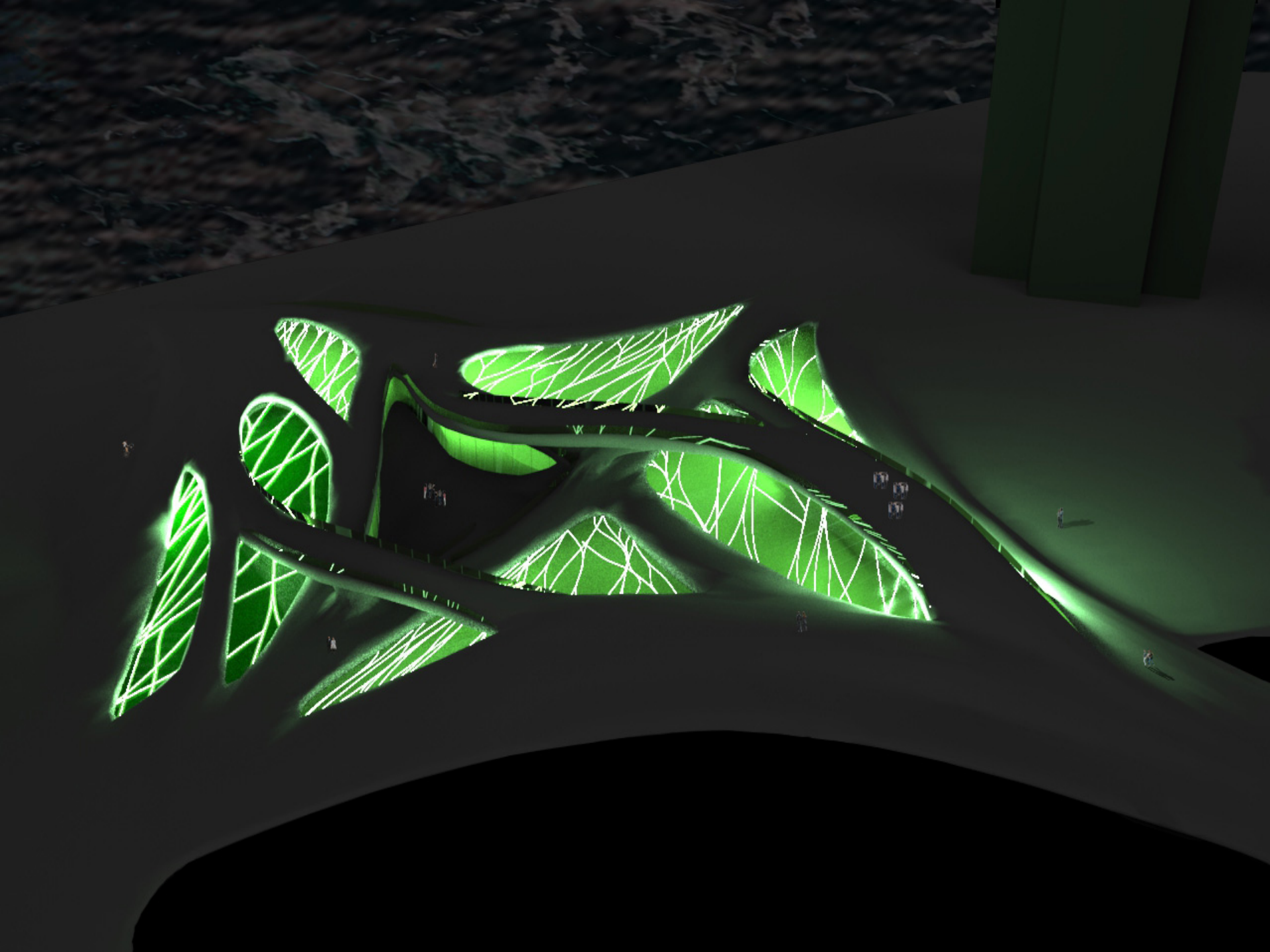














THANK YOU