

Graduation Presentation Joël Klerks
“Grandstand Design for Disassembly”

Architectural Engineering



Friday 30th January 2015



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1. Introduction

2. Concept

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1. Introduction

Fascination



1. Introduction

Fascination



1. Introduction

Problem statement

The Atlantic
Empty Nest: Beijing's Olympic Stadium Is a Vacant 'Museum Piece'



theguardian
Winner of the Pulitzer prize
London 2012: Legacy of Beijing is that
Bird's Nest will take 30 years to pay off

1. Introduction

Problem statement



FNB Stadium in Johannesburg, South Africa, 2010

At full capacity: 94.000 people



Nowadays at its maximum only half full.

1. Introduction

Problem statement



Olympic beach volley stadium, Athens 2004.



The stadium in the same year after the Olympics.

1. Introduction

Problem statement



1. Introduction

Problem statement



1. Introduction

Problem statement

Brazil Wastes \$300 Million to Build "Arena Amazonia" Exclusively for the 2014 FIFA World Cup

**BUSINESS
INSIDER**

**The Remote City That's Hosting The US-Portugal Game
Is The Most Glaring Example Of World Cup Waste**



TONY MANFRED



JUN. 19, 2014, 10:41 AM

🔥 122,237

💬 35

1. Introduction

Possible solution: dwellings after the Olympics



1. Introduction

Current solutions: temporary structures



1. Introduction

Current solutions: temporary structures



Current temporary solutions for sports grandstands.



Scaffolding as functional solution without any aesthetic value.

1. Introduction

Possibilities



1. Introduction

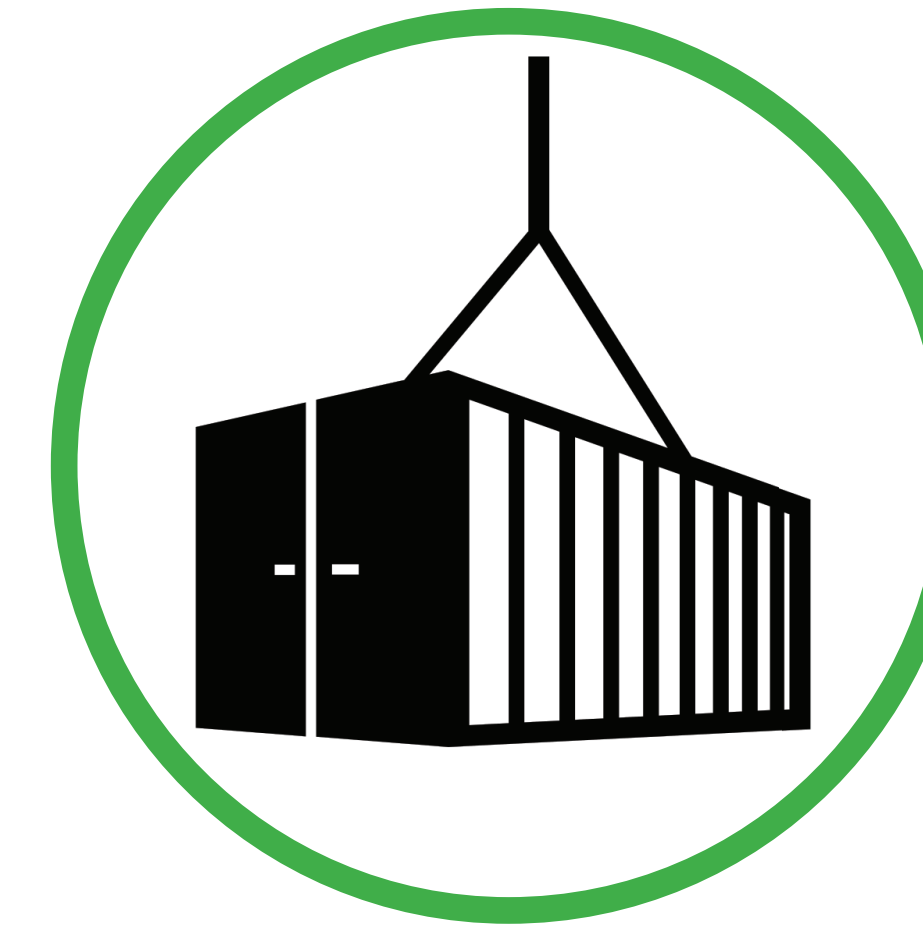
Research question

How can the requested visitor capacity for sports events temporarily be provided and also give an added value to these events?

1. Introduction

The goal of the design project

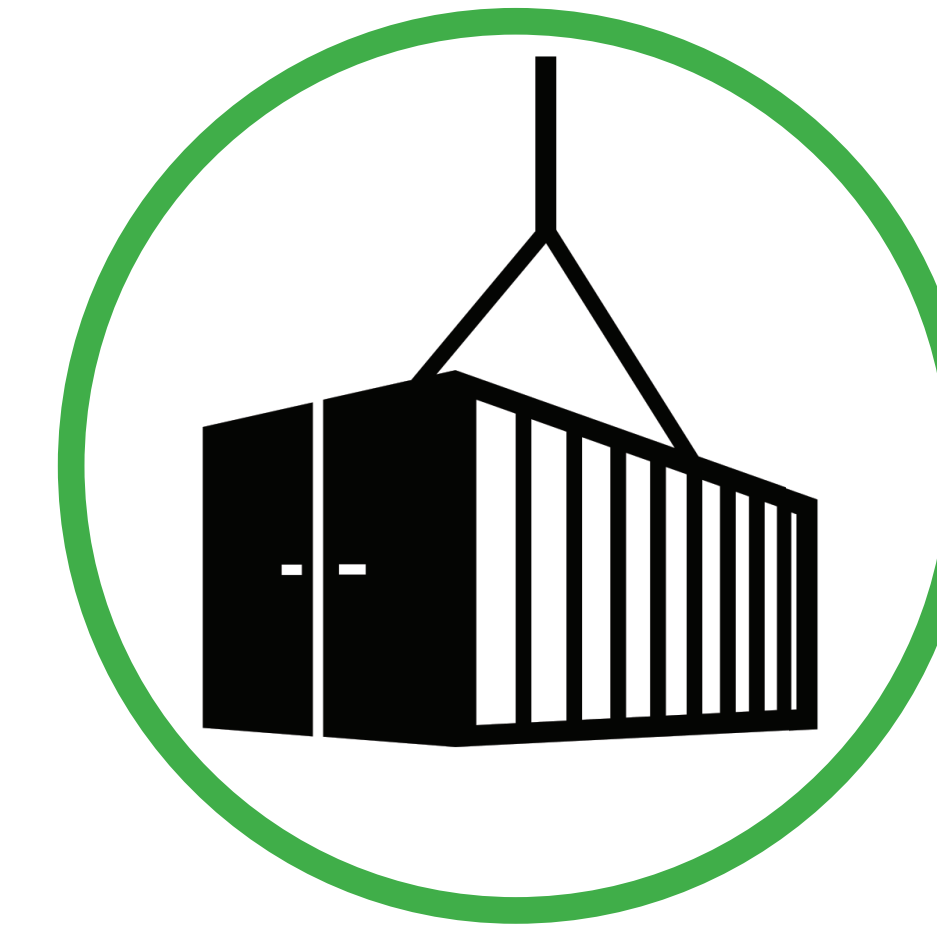
To design a temporary structure



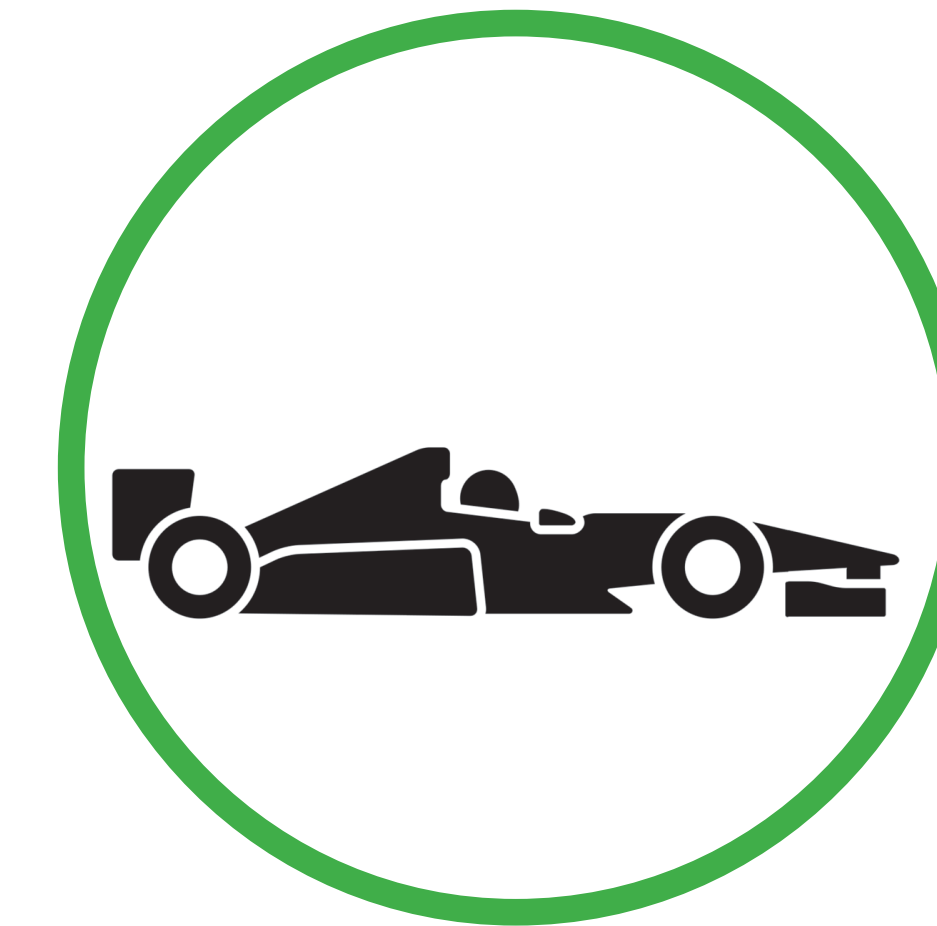
1. Introduction

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To design a temporary structure



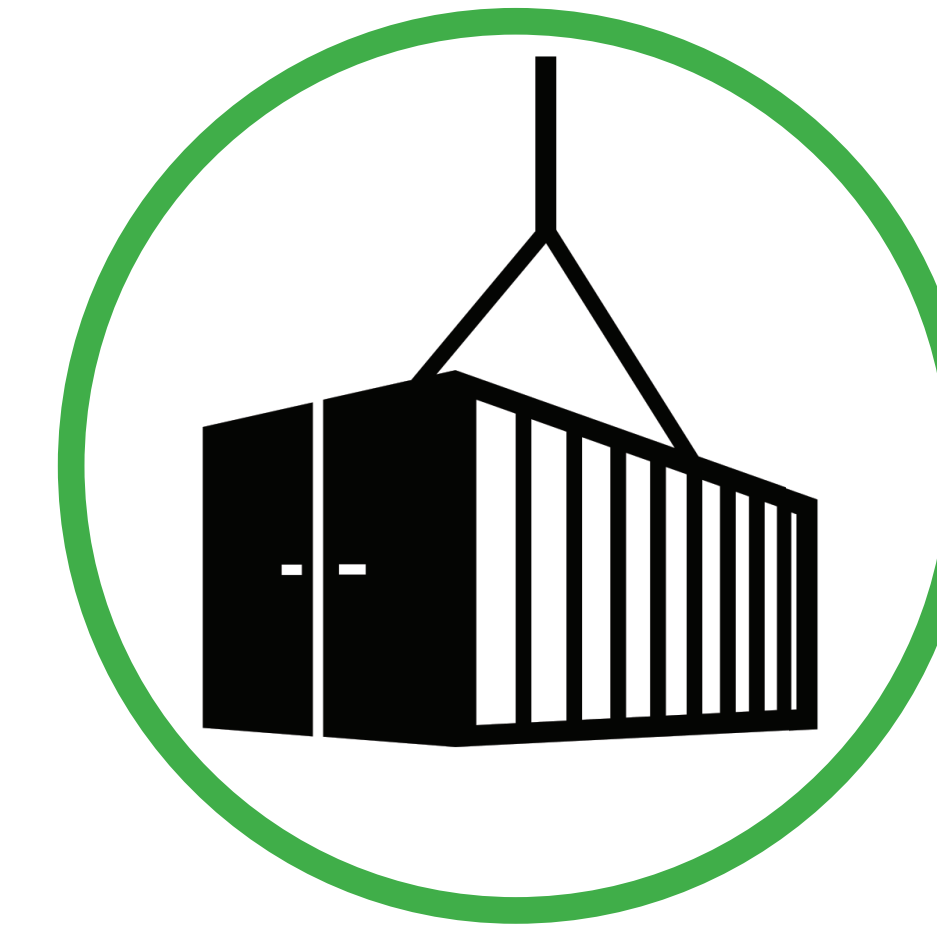
for visitors of all kinds of sports events



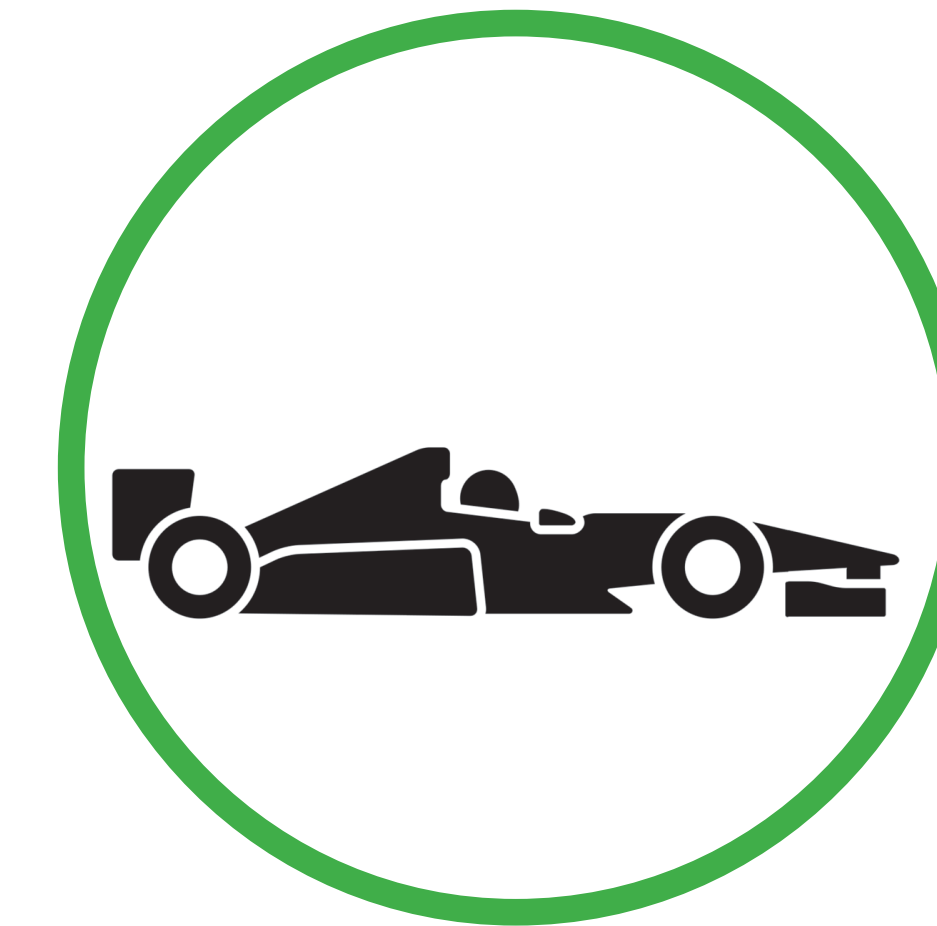
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The goal of the design project

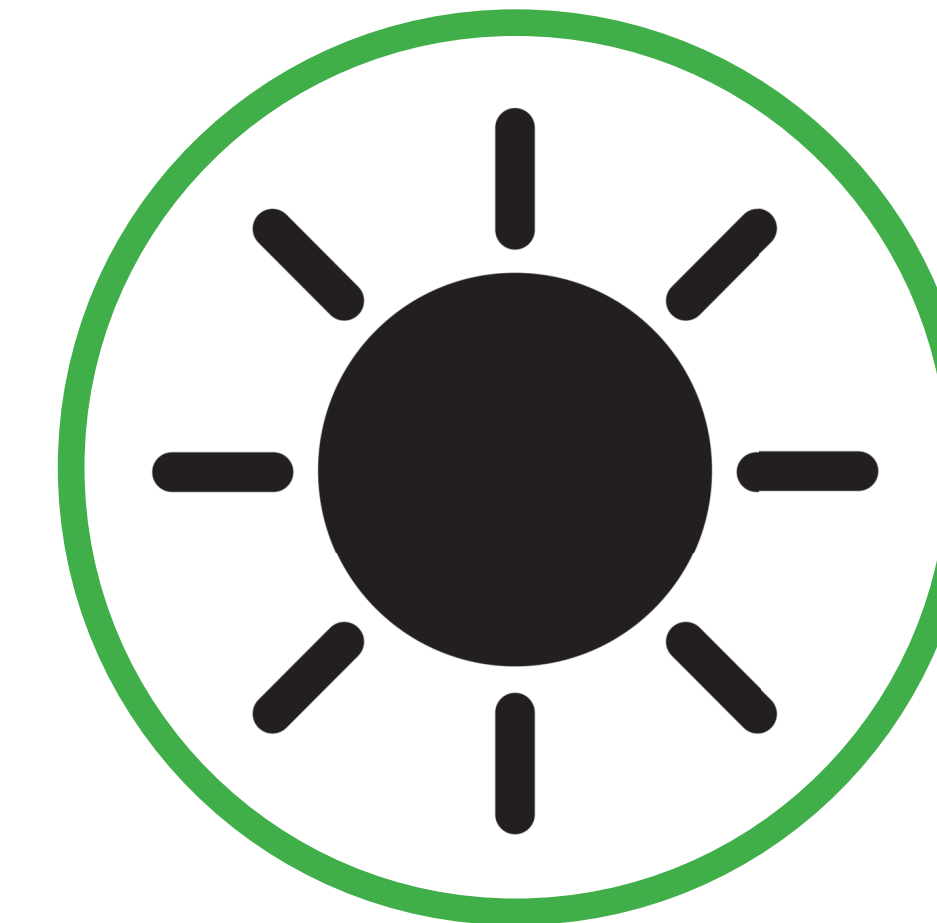
To design a temporary structure



for visitors of all kinds of sports events



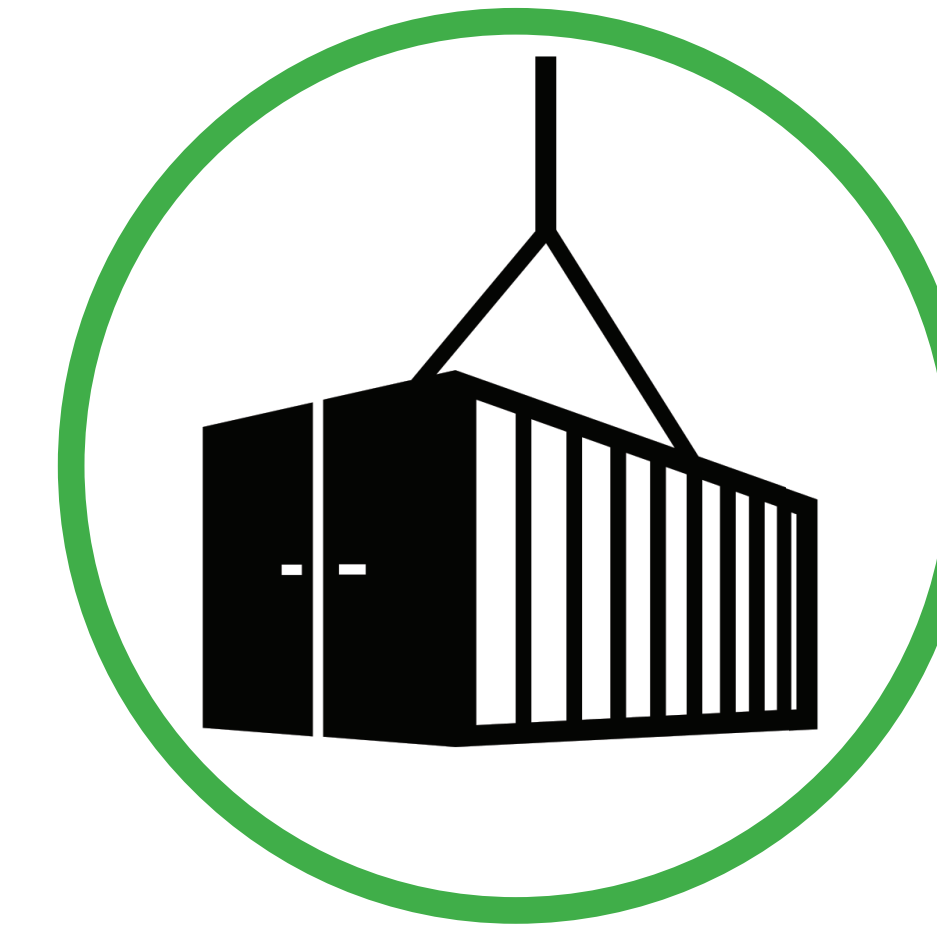
on a great variety of locations



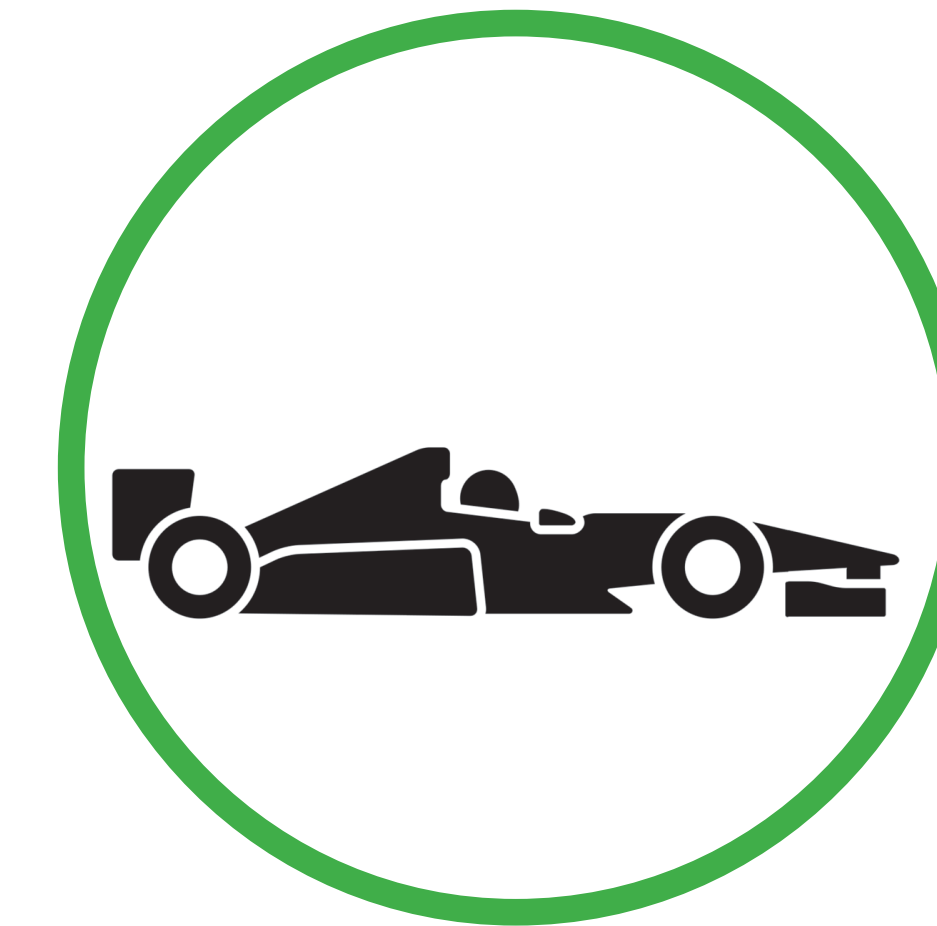
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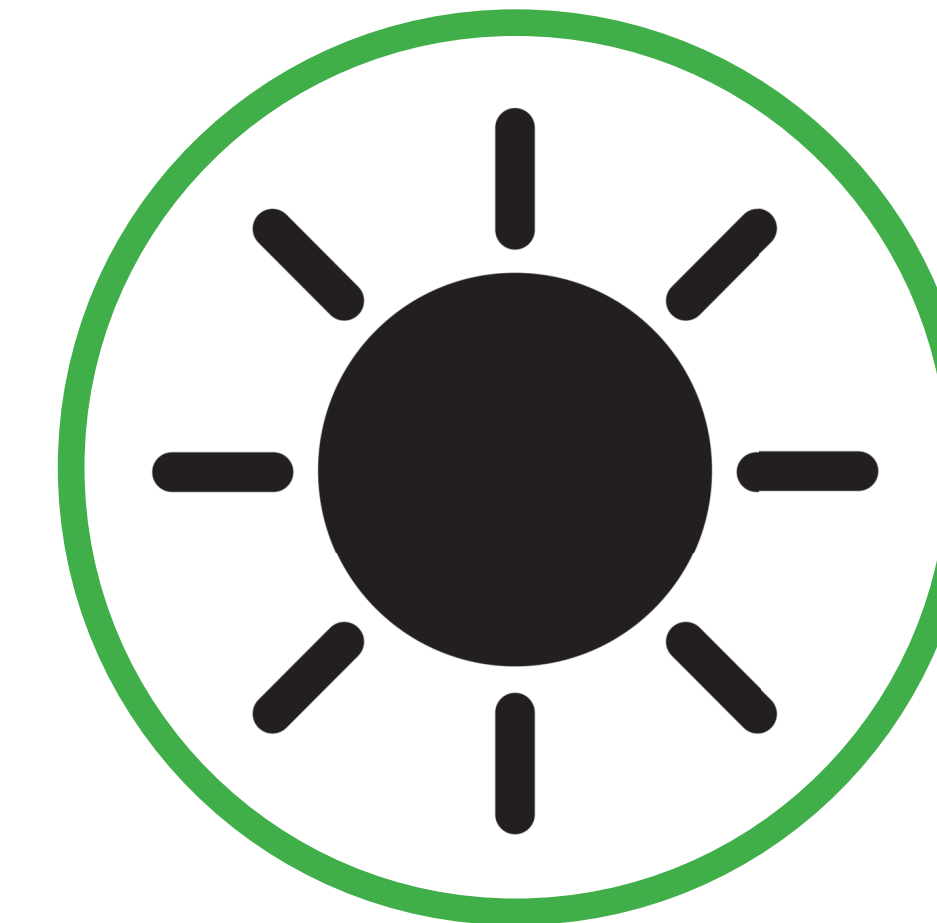
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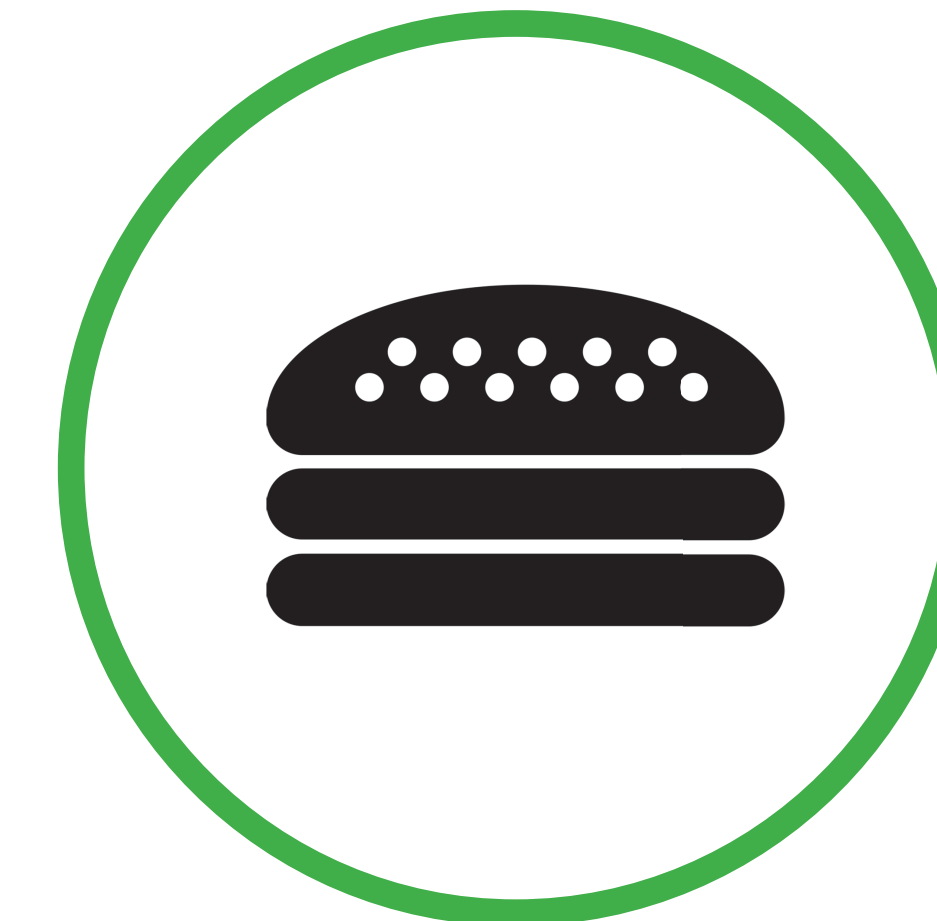
for visitors of all kinds of sports events



on a great variety of locations



with spaces for all types of functions.



1. Introduction

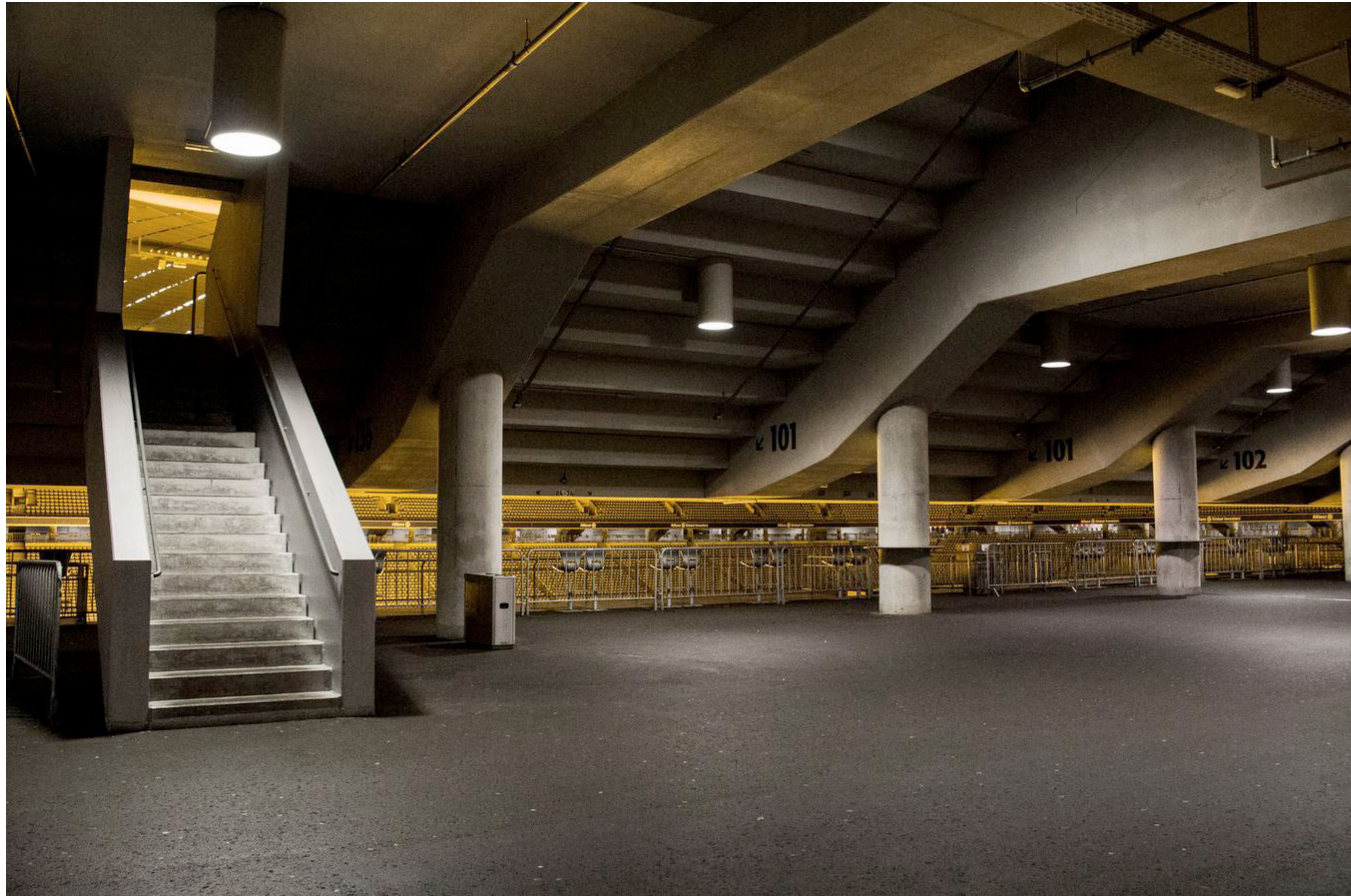
2. Concept

3. Design

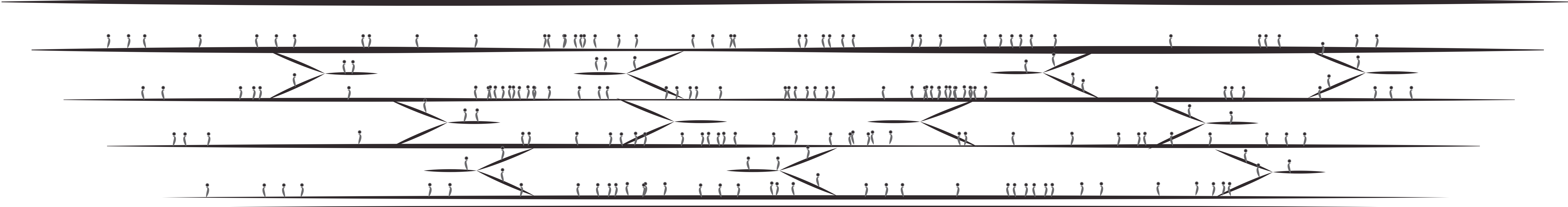
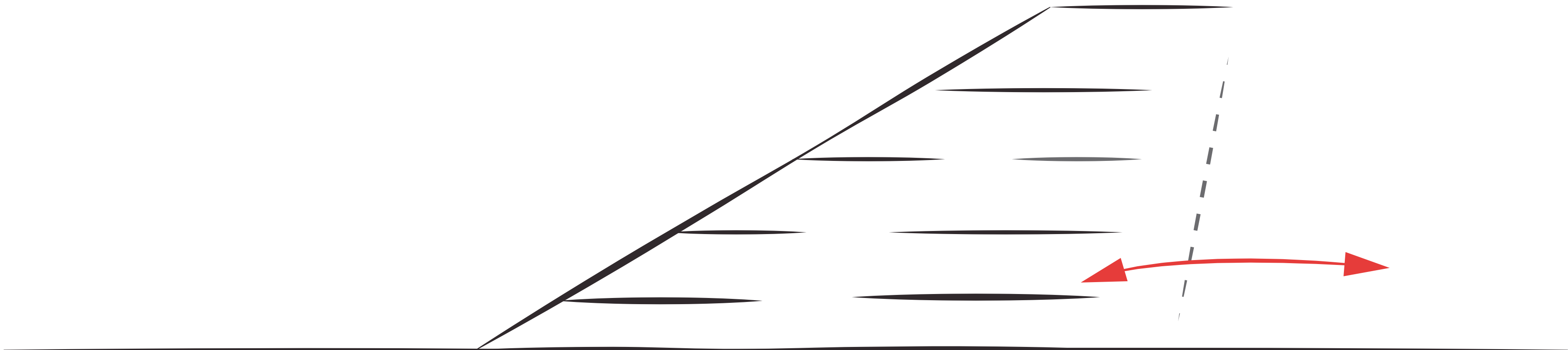
4. Design for Disassembly

5. Conclusions

2. Concept

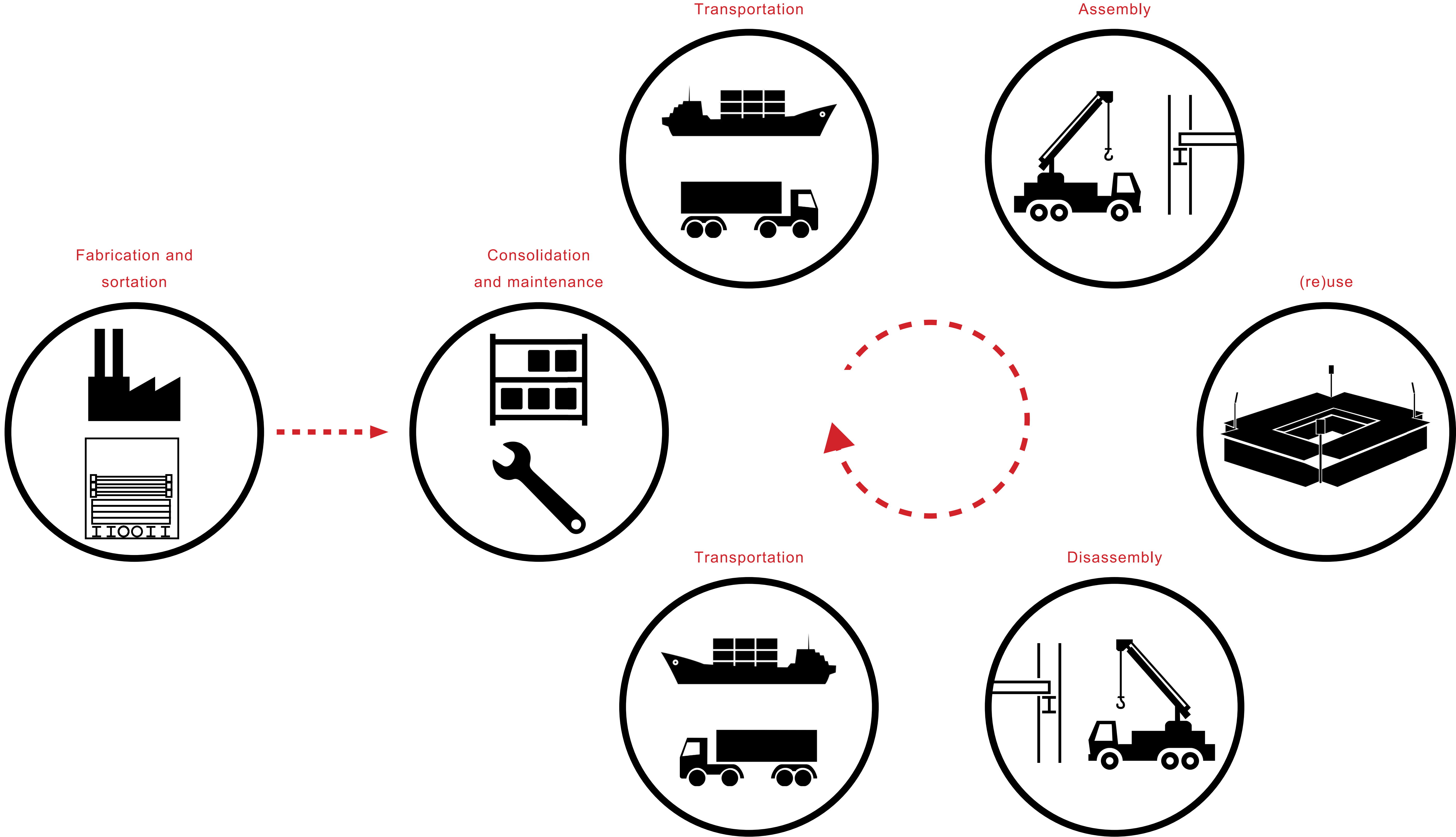


2. Concept



2. Concept

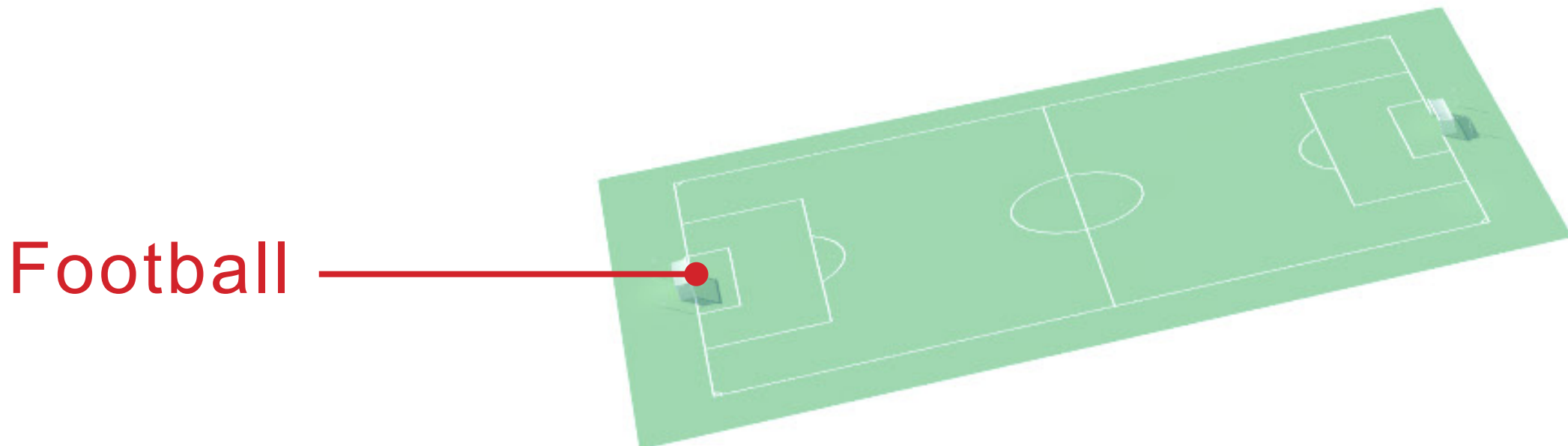
Design for disassembly



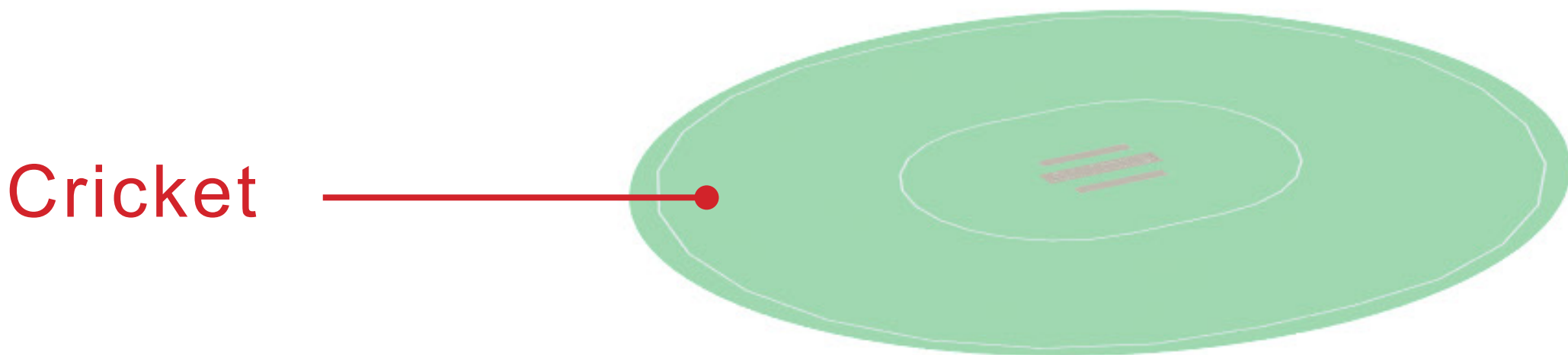
The building process is repetitive. The building and disassembly process has to be as simple and quick as possible.

2. Concept

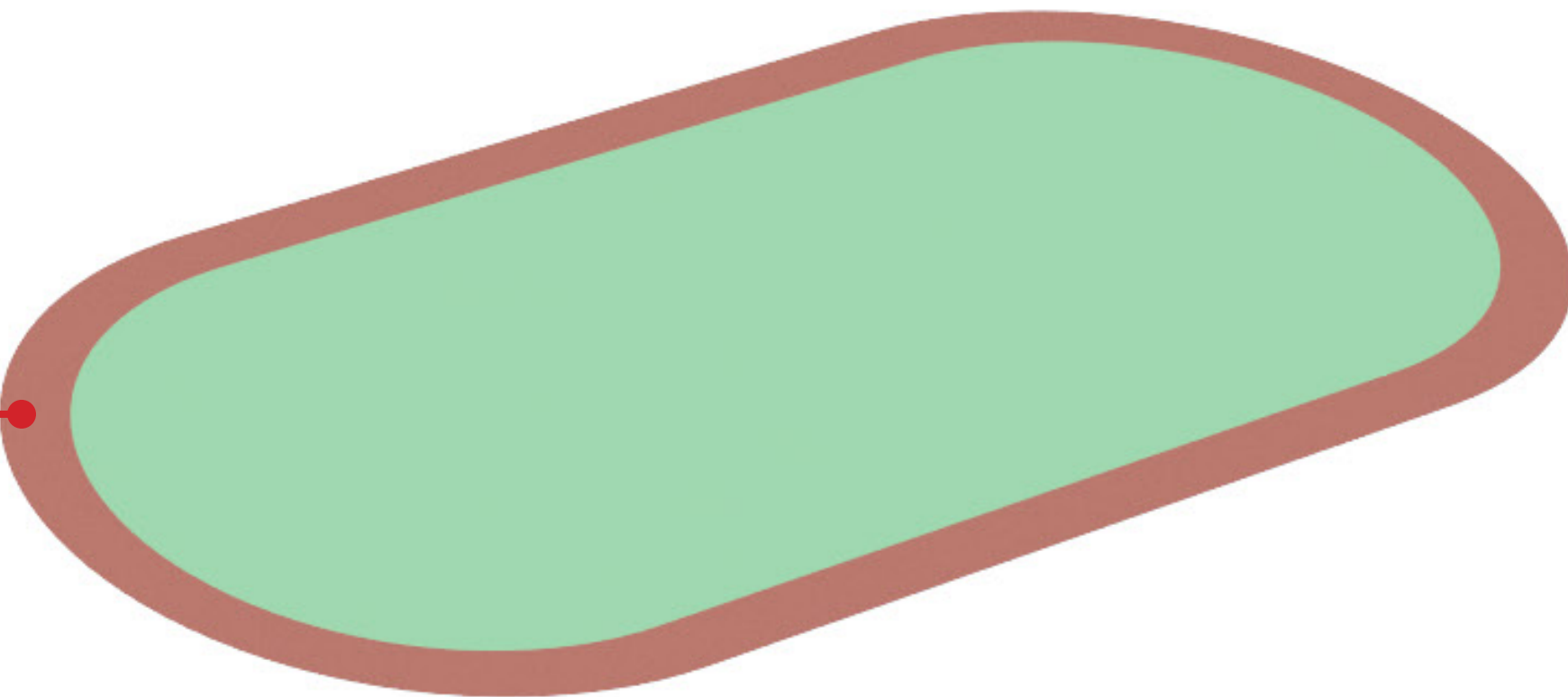
Design with modularity



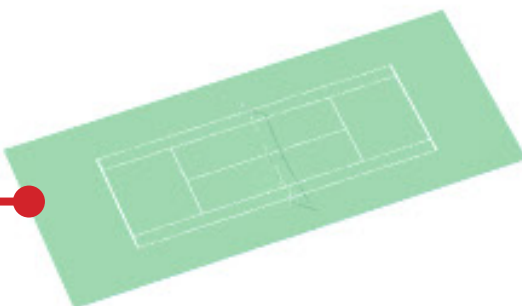
Football



Cricket



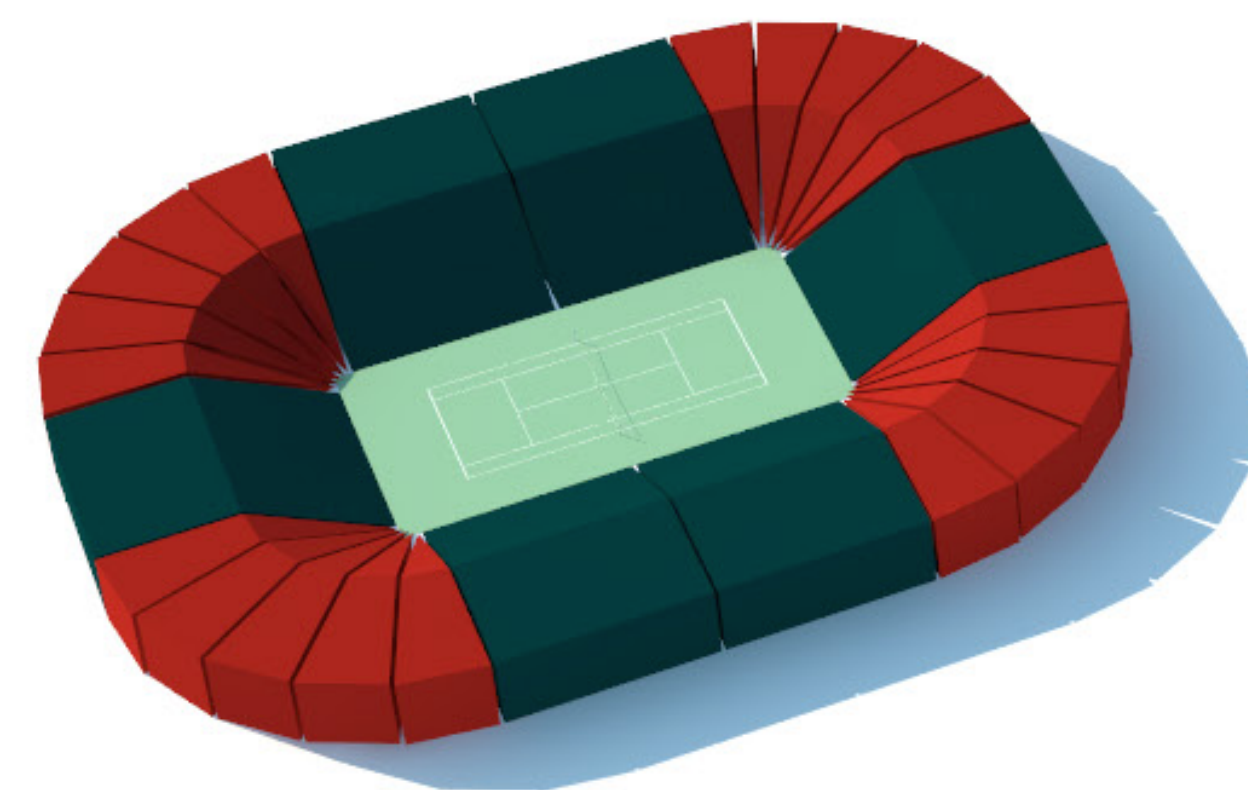
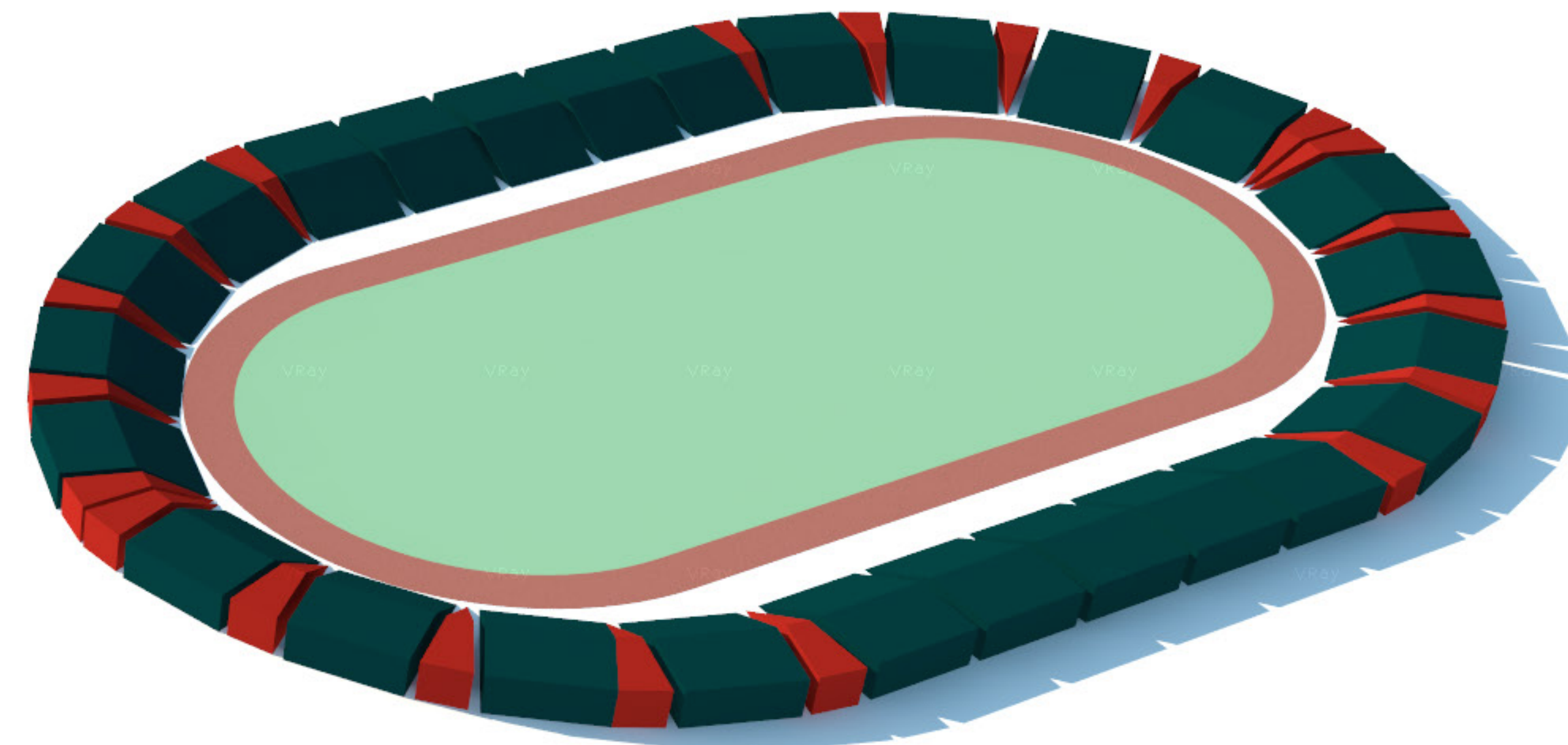
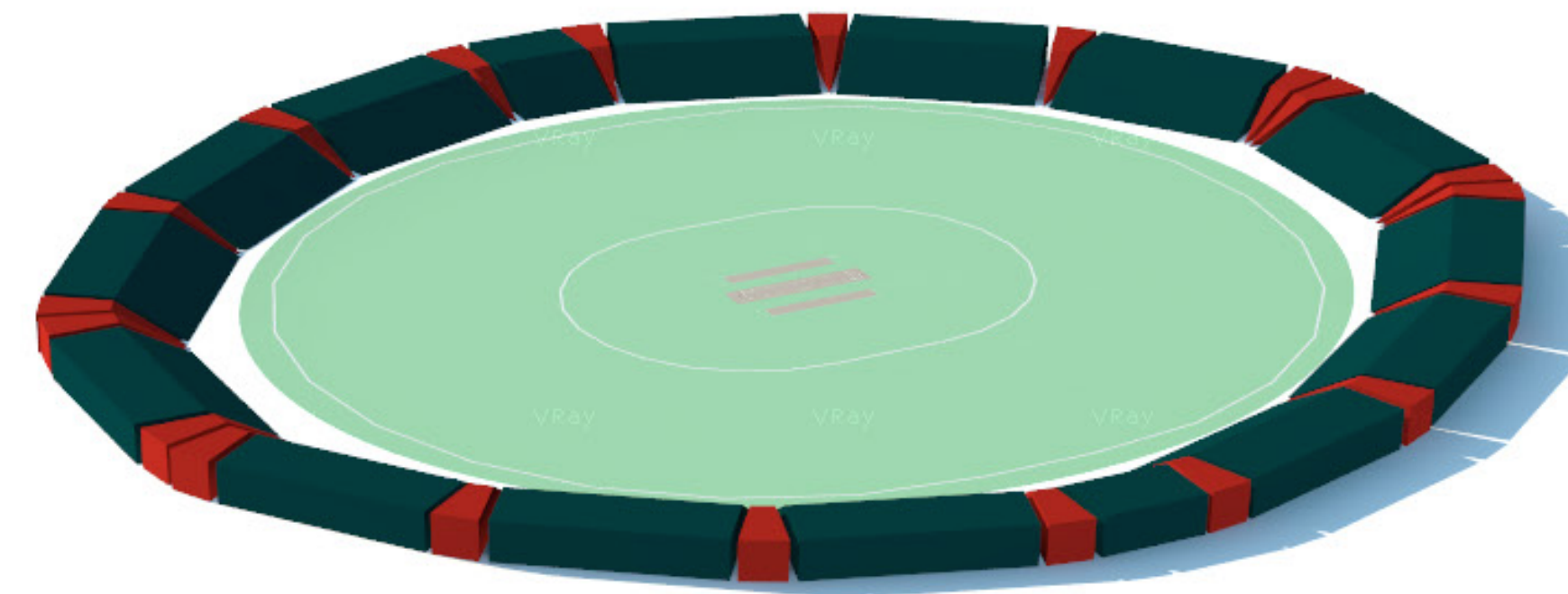
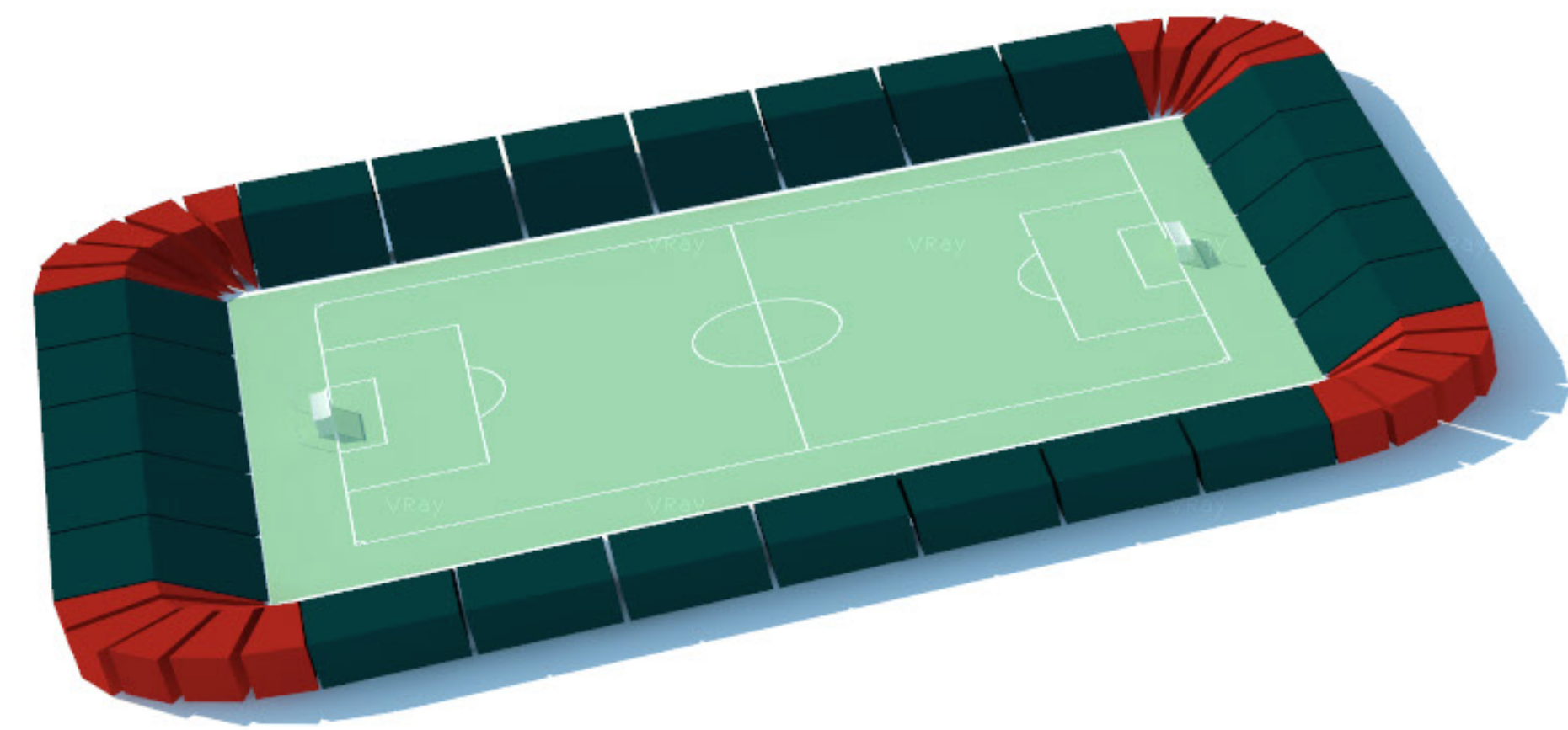
Running
track



Tennis

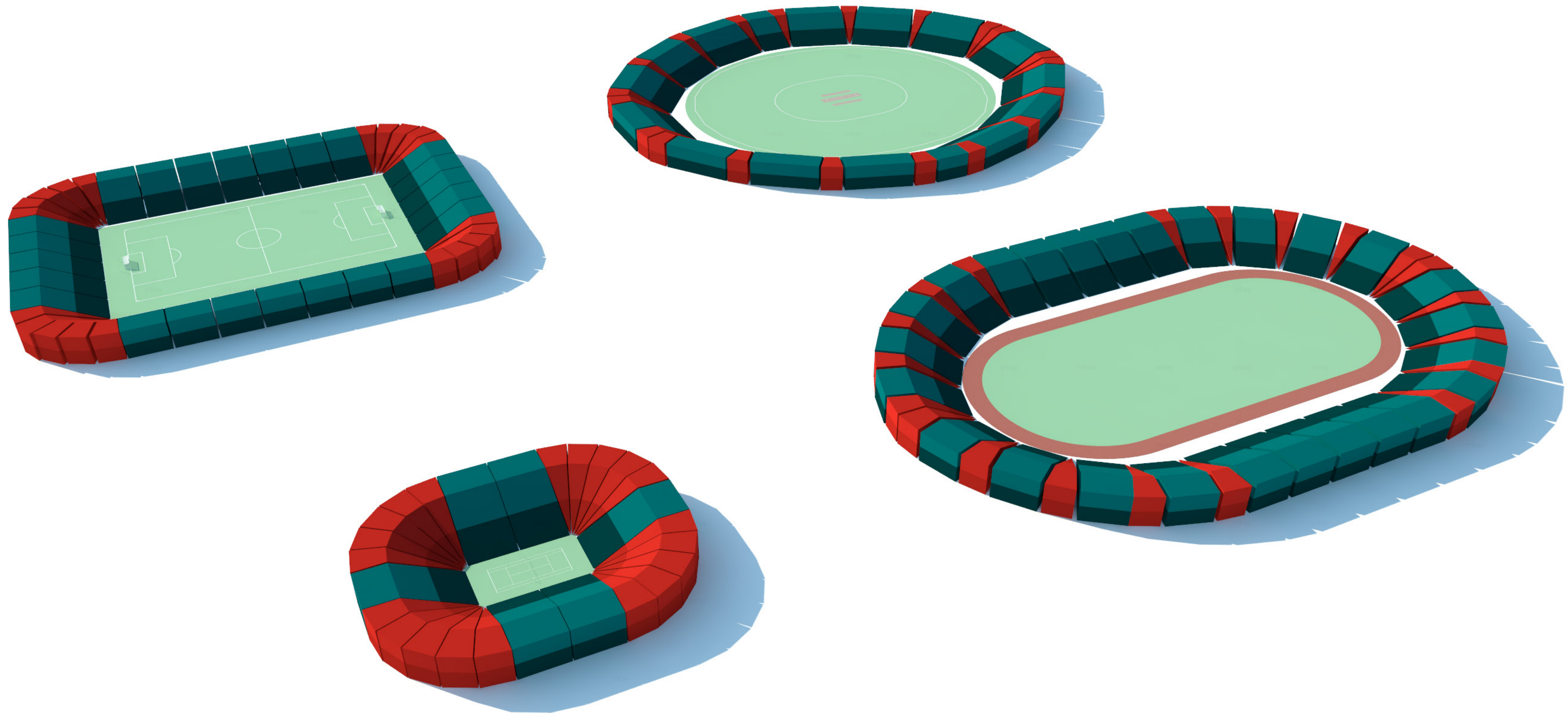
2. Concept

Design with modularity



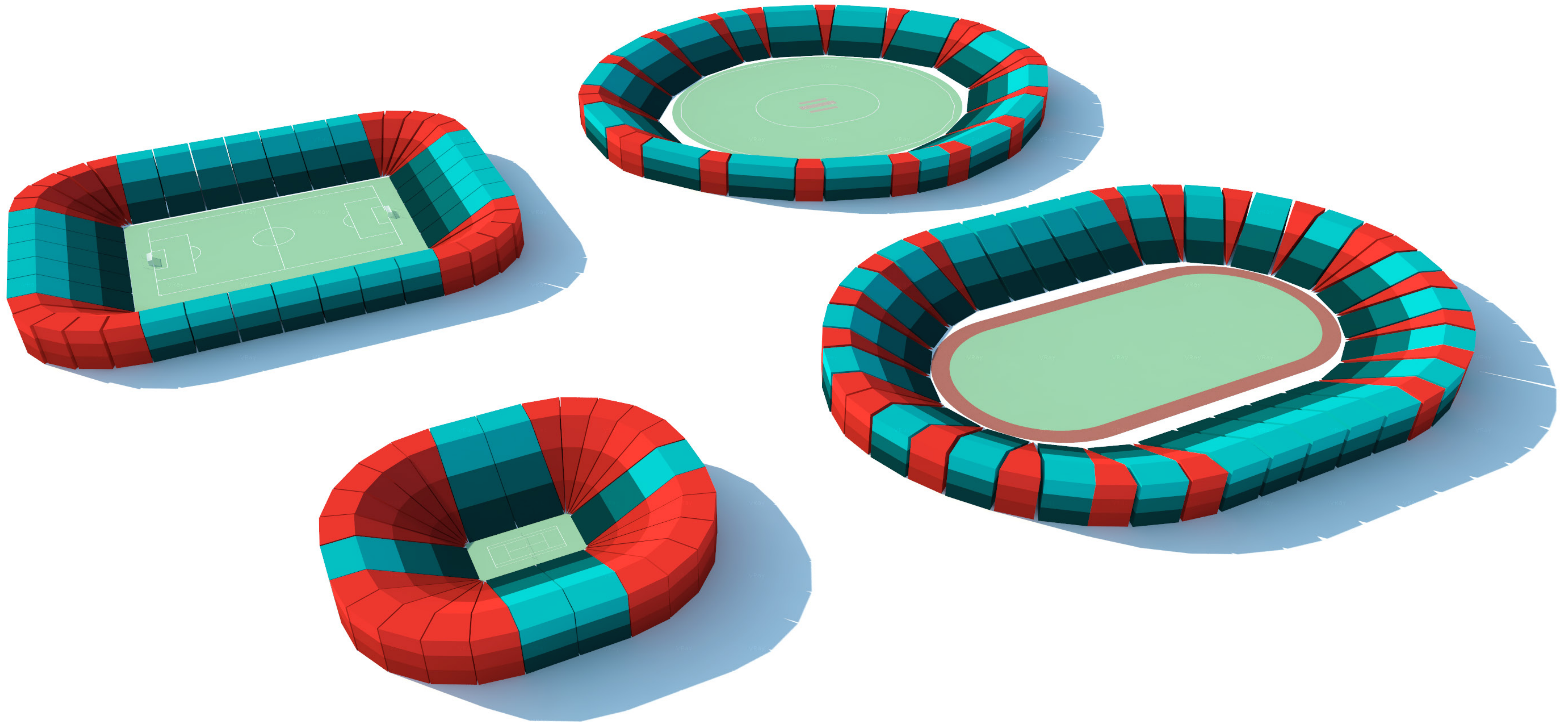
2. Concept

Design with modularity



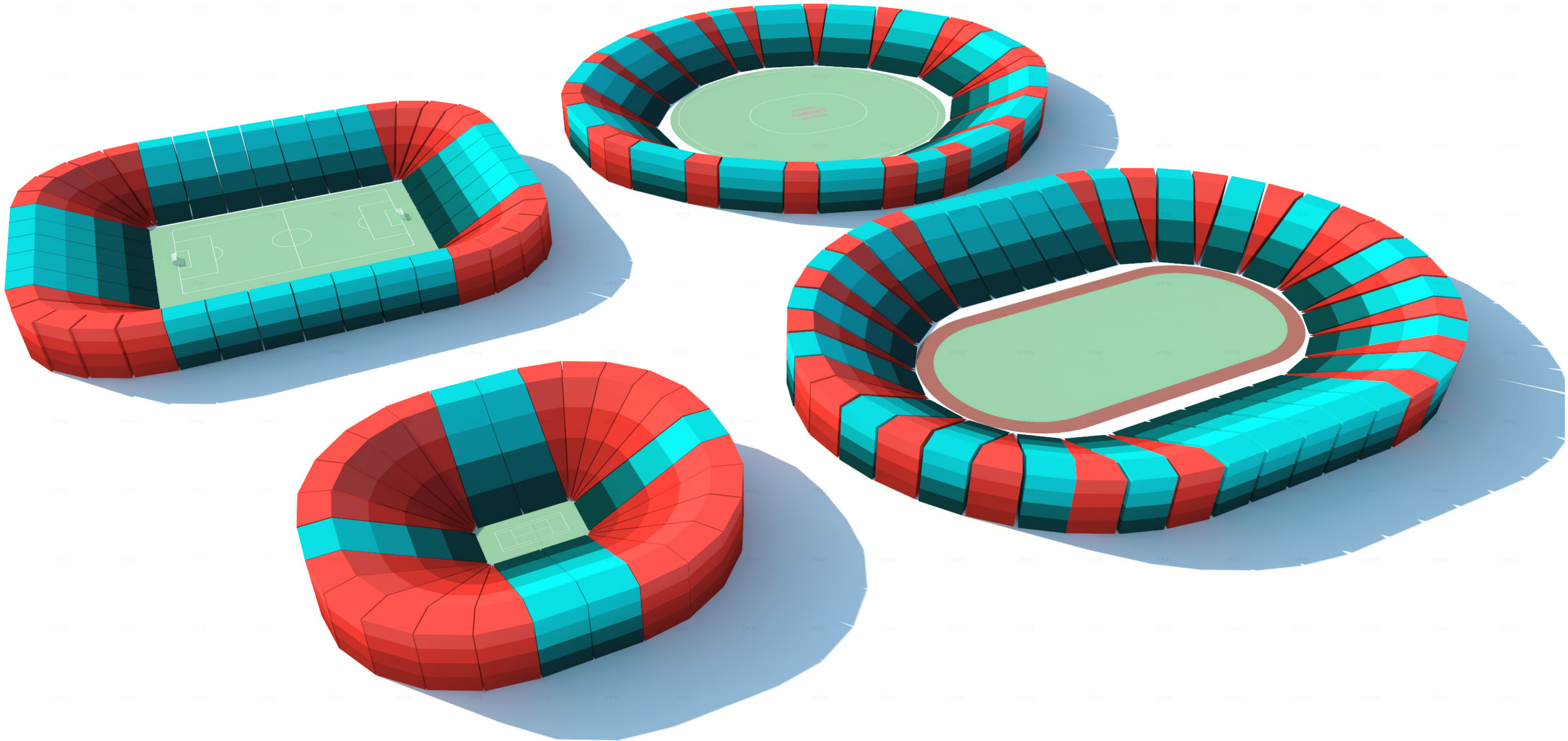
2. Concept

Design with modularity



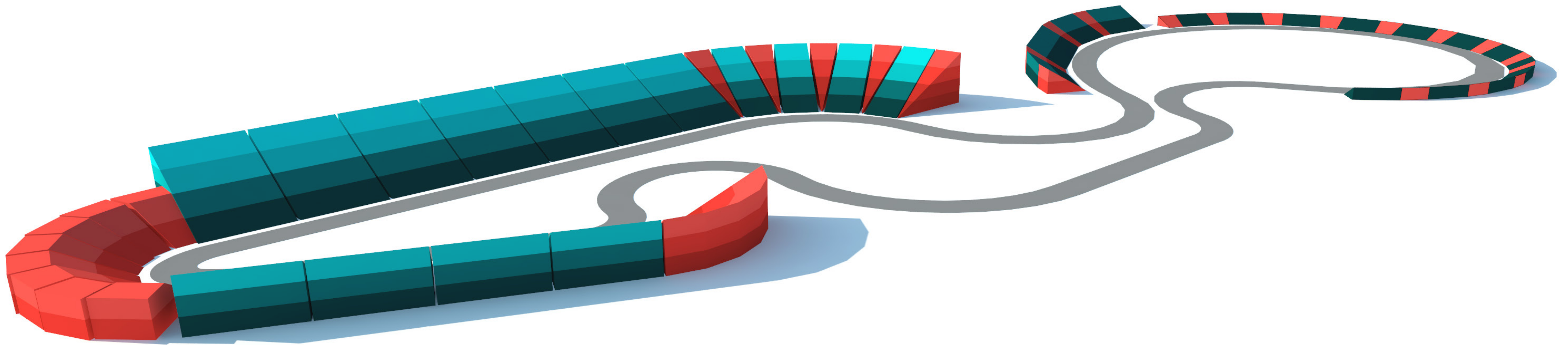
2. Concept

Design with modularity



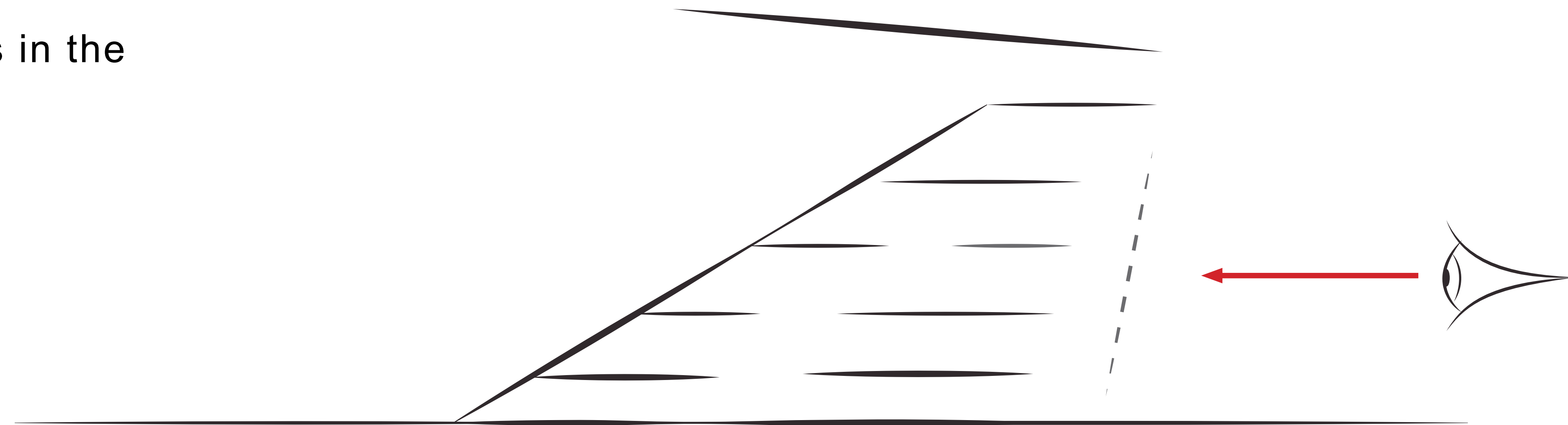
2. Concept

Design with modularity



2. Concept

What does the event organiser want to show to the visitors and the viewers in the world?



1. Introduction

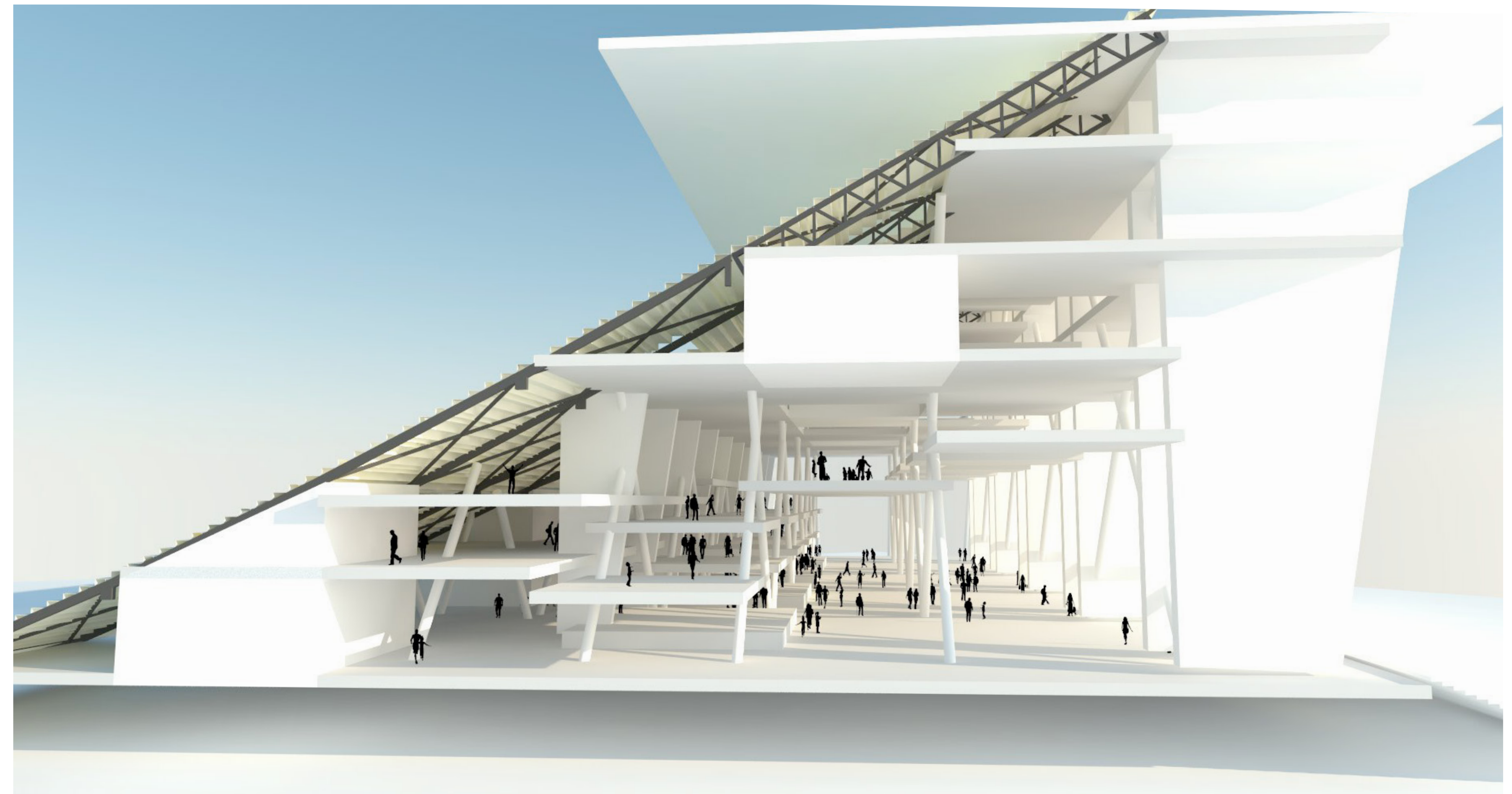
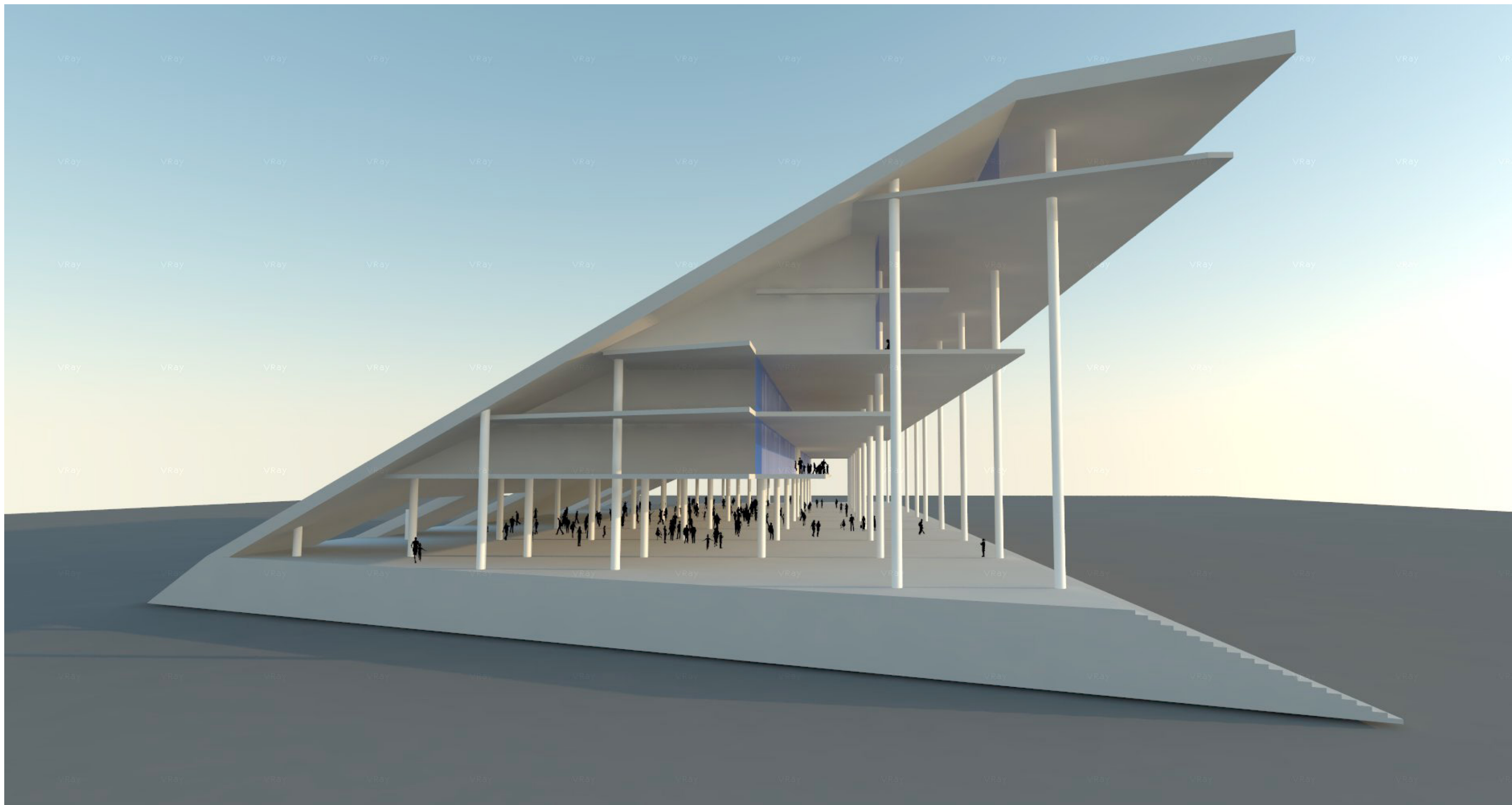
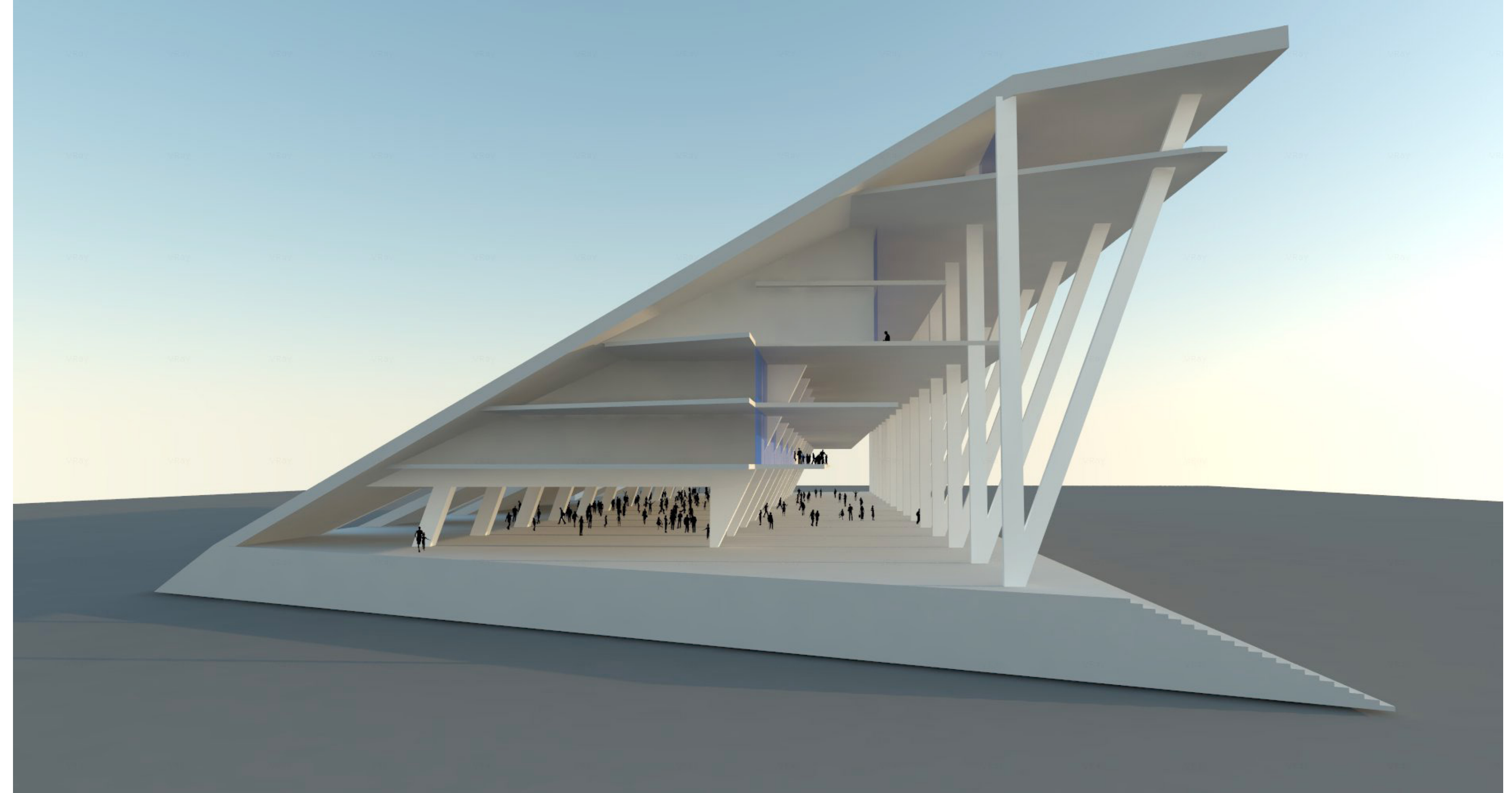
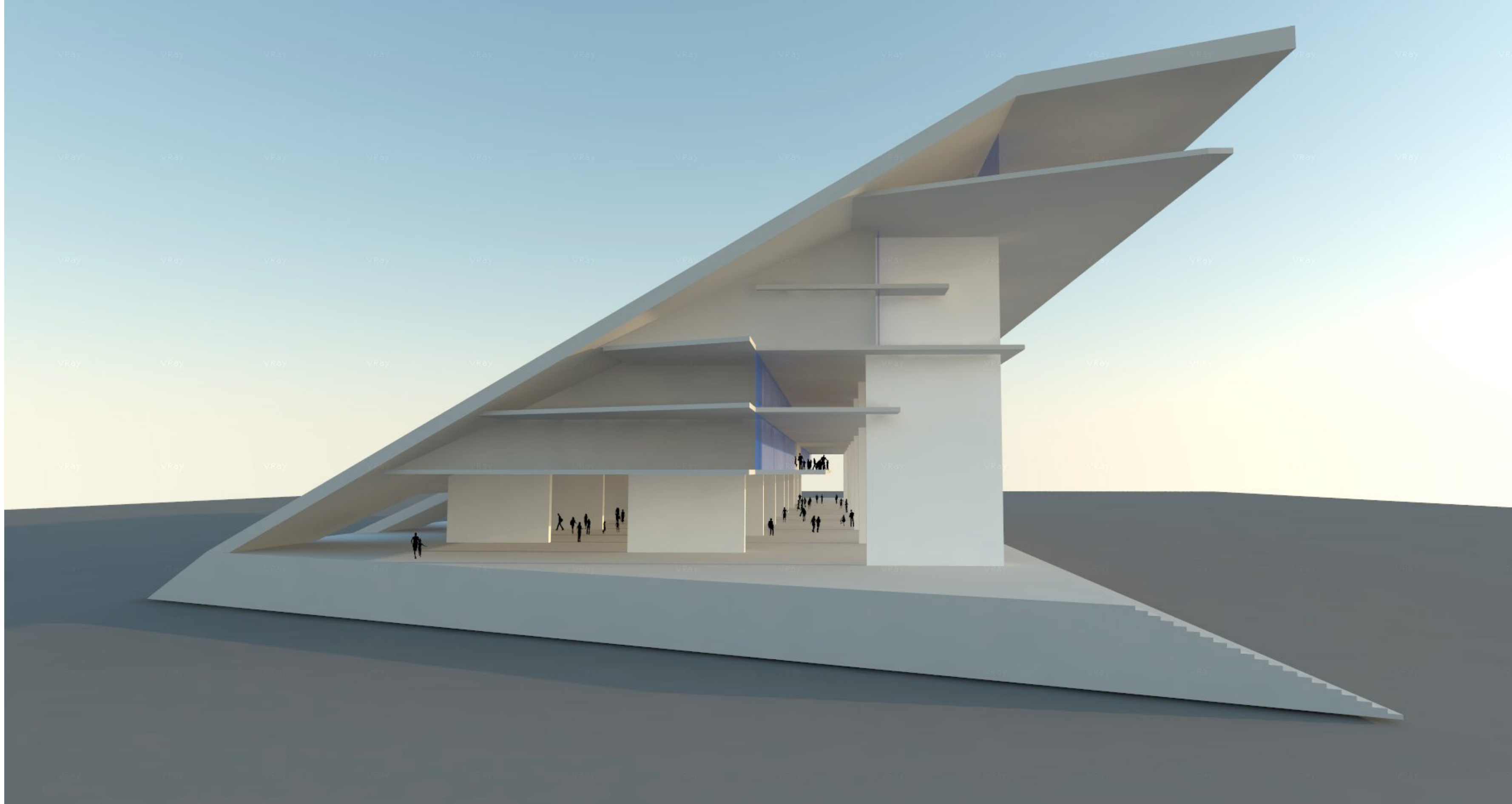
2. Concept

3. Design

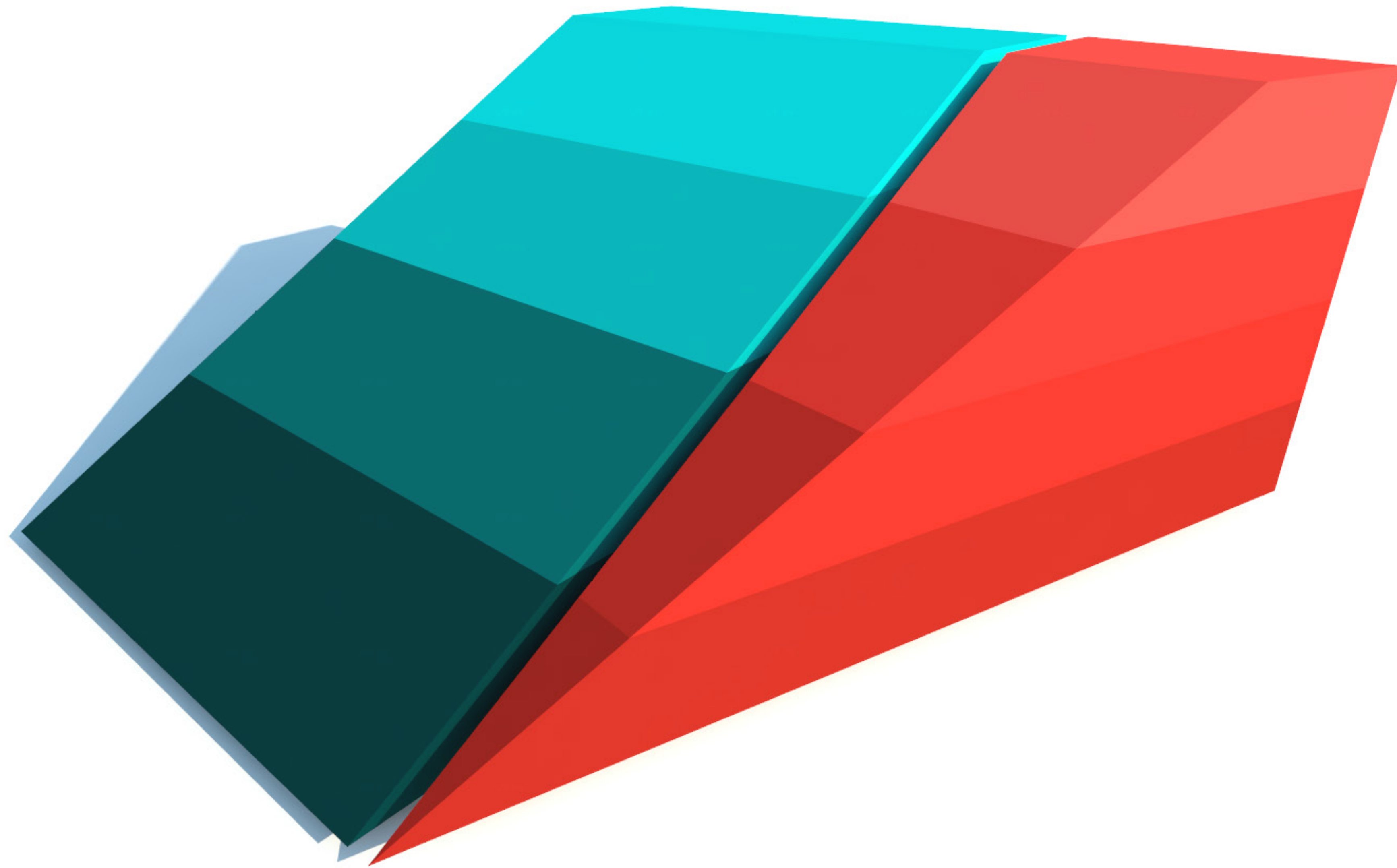
4. Design for Disassembly

5. Conclusions

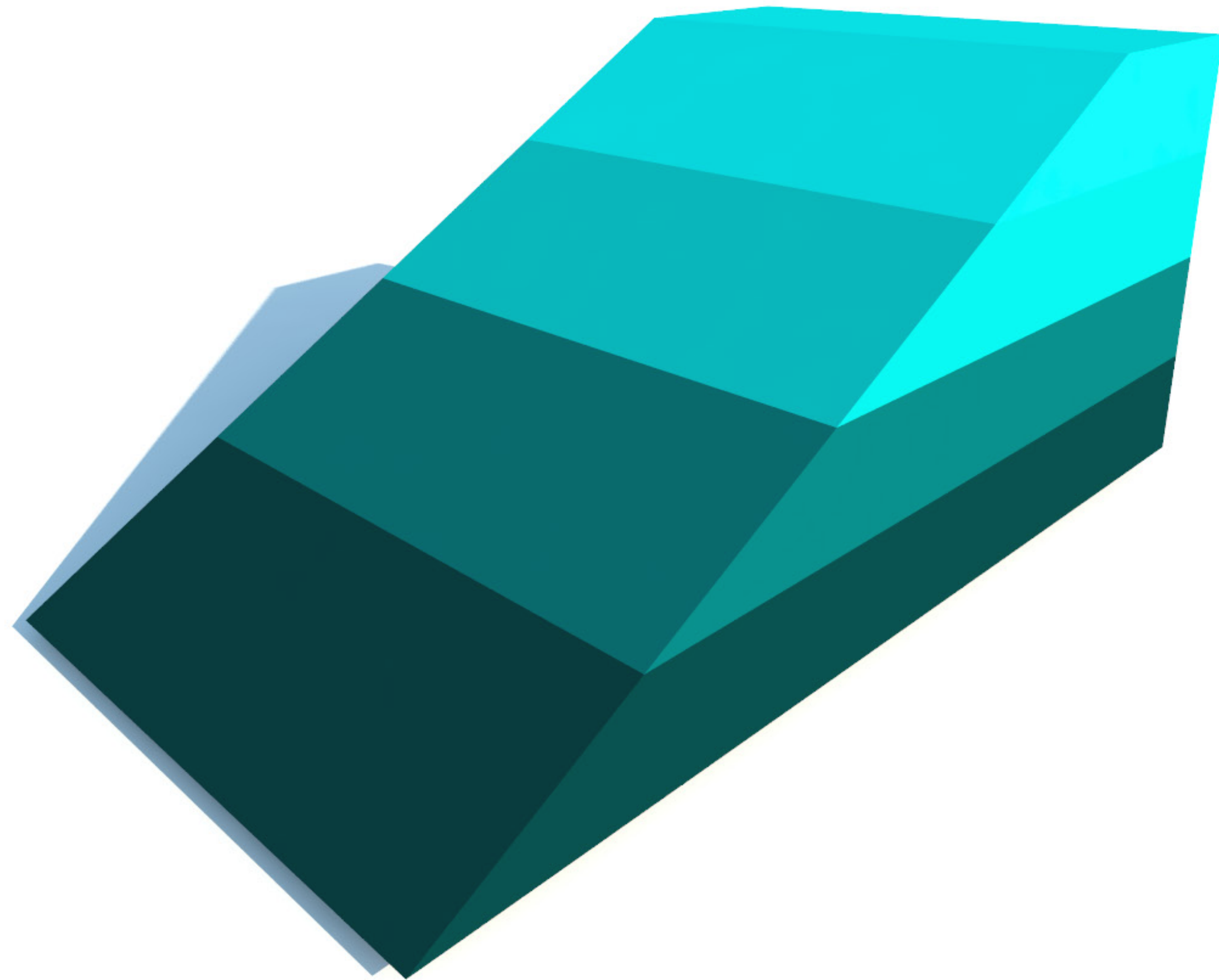
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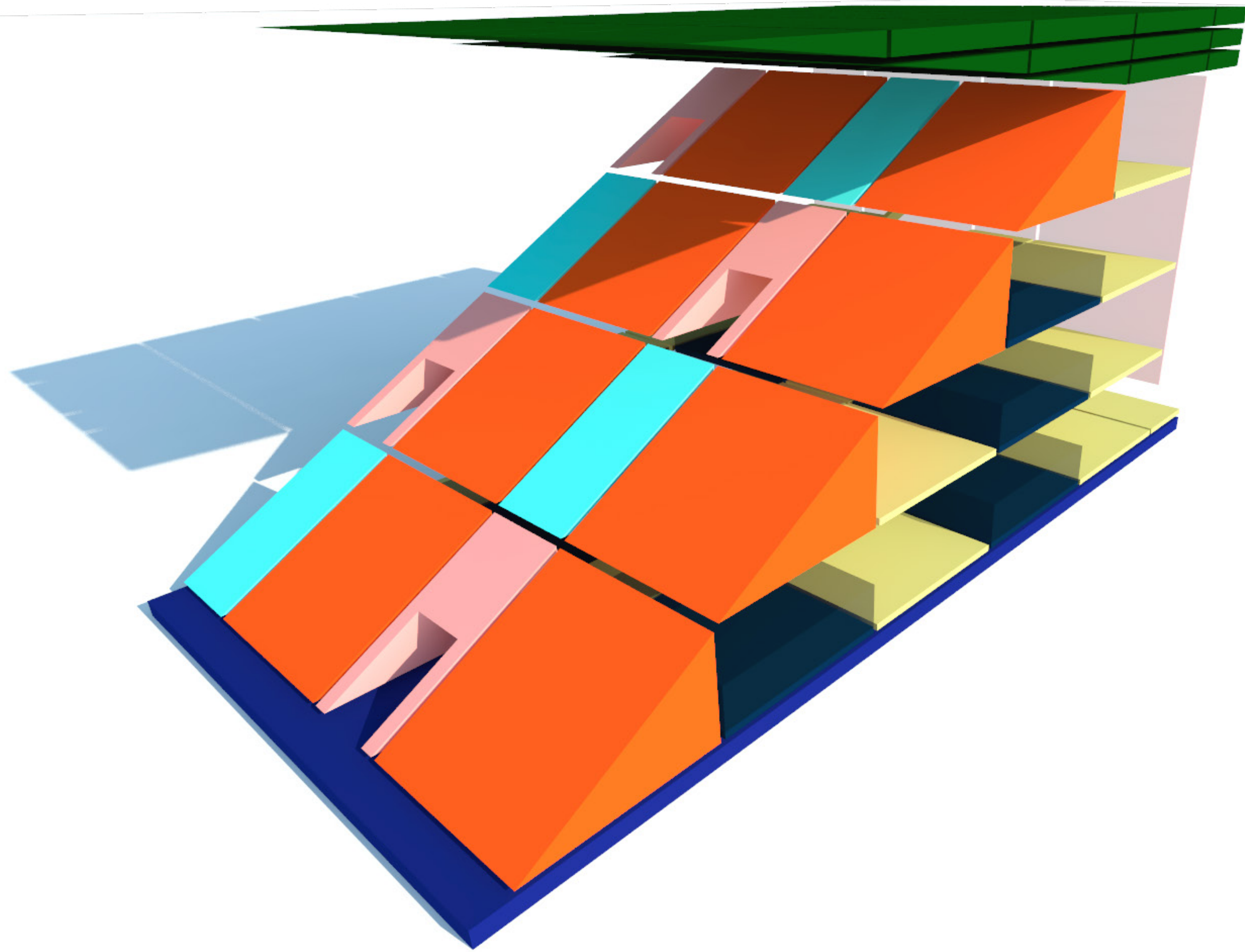
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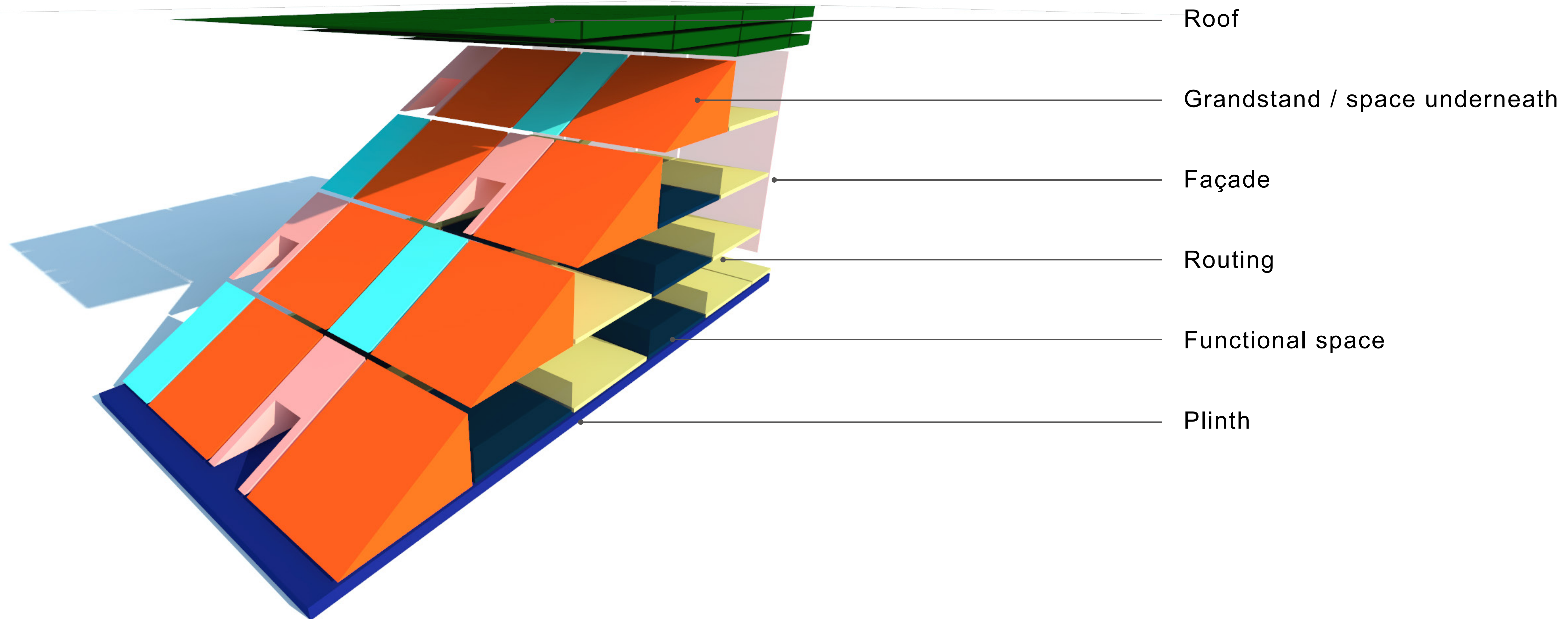
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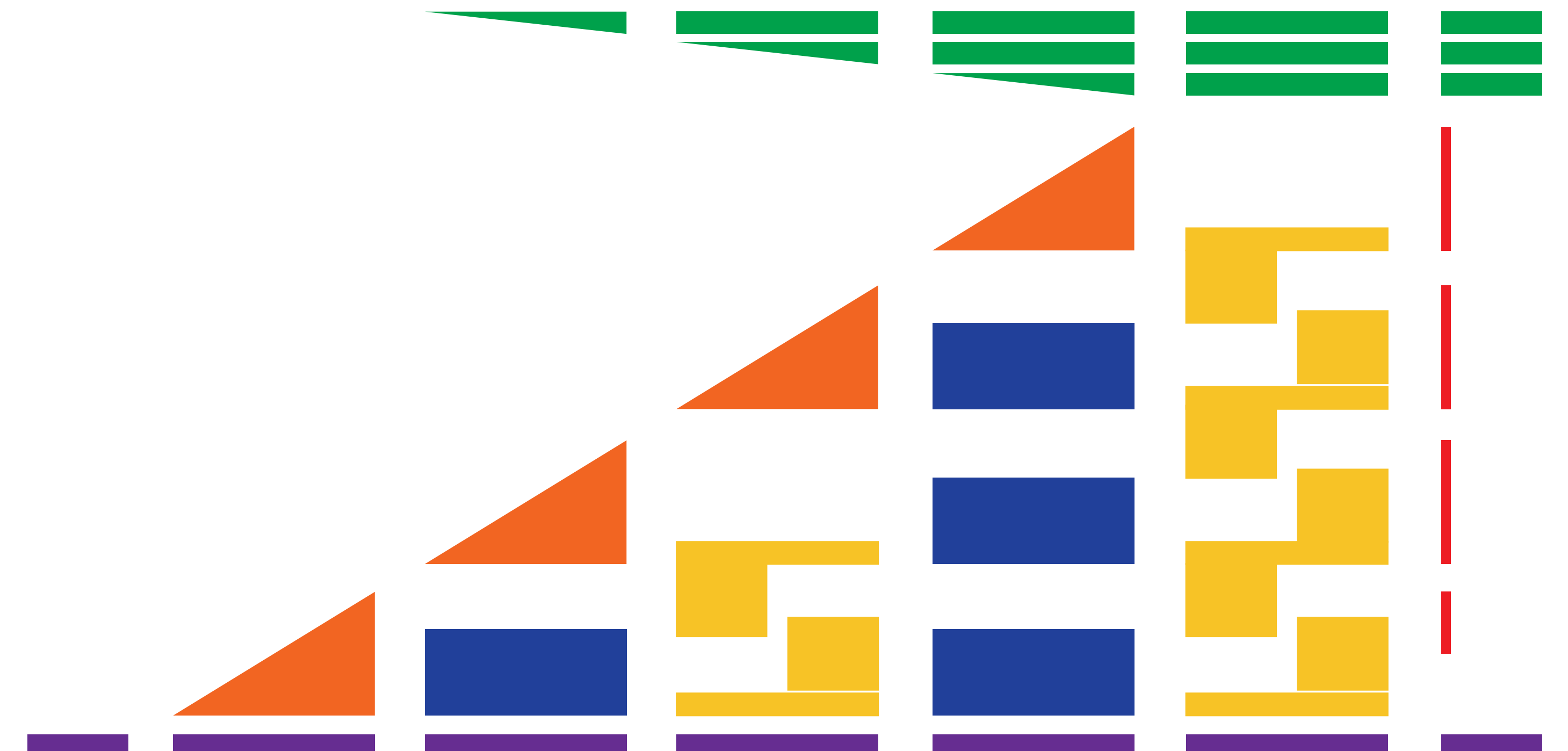
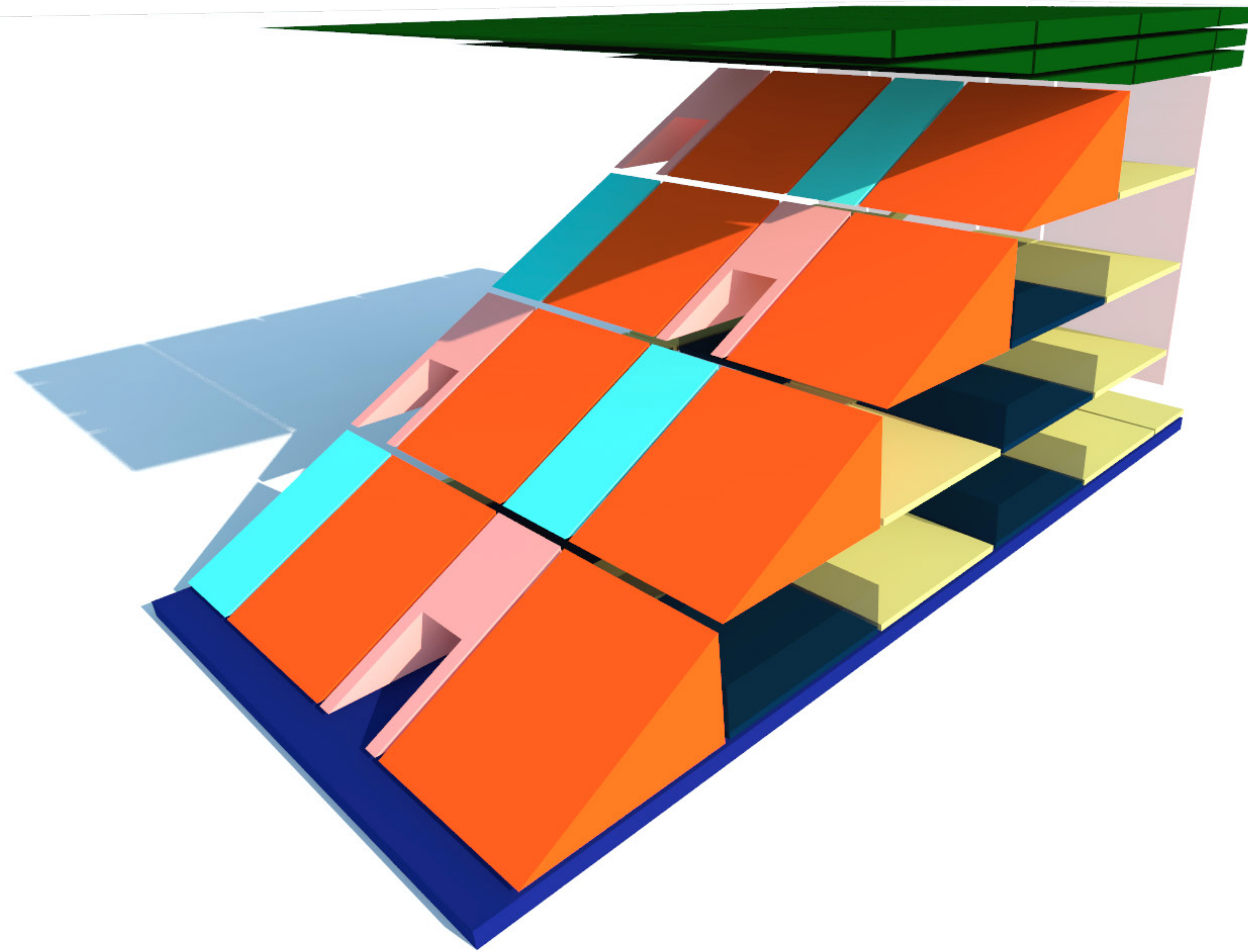
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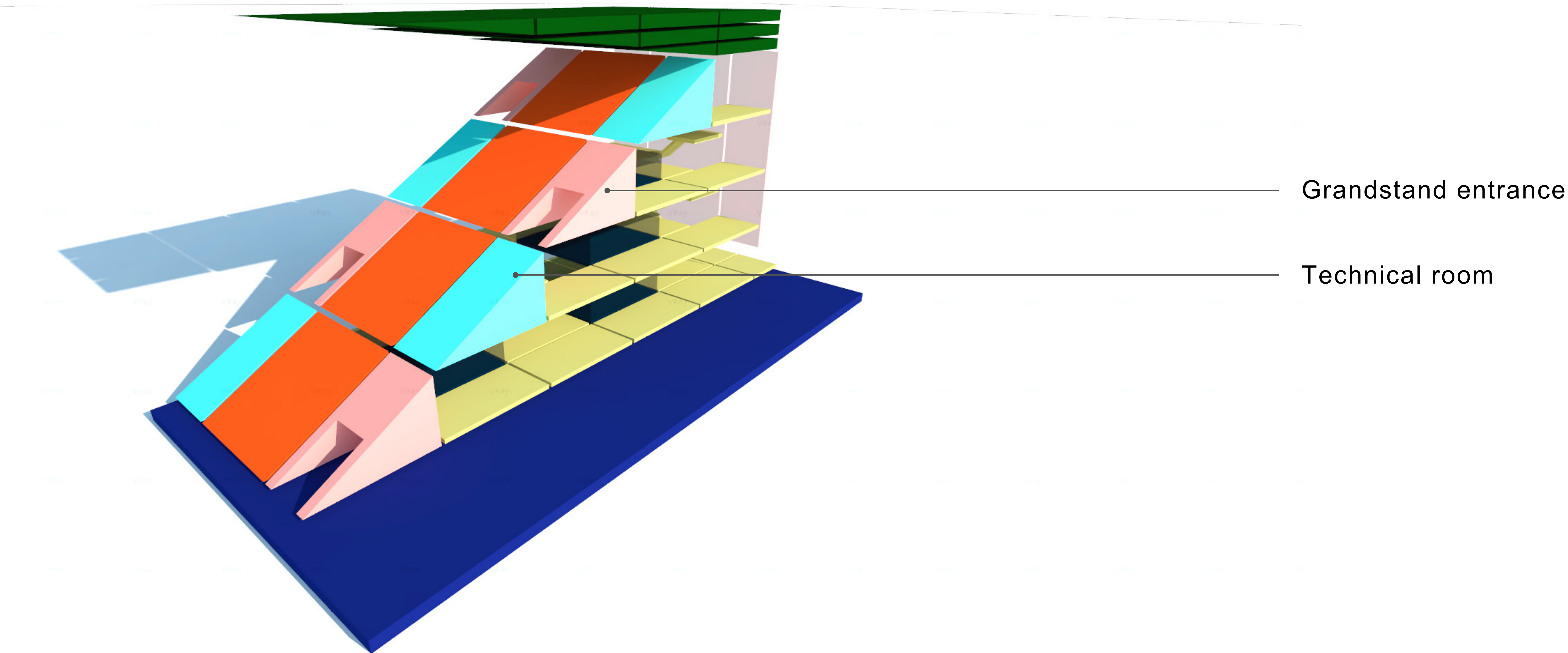
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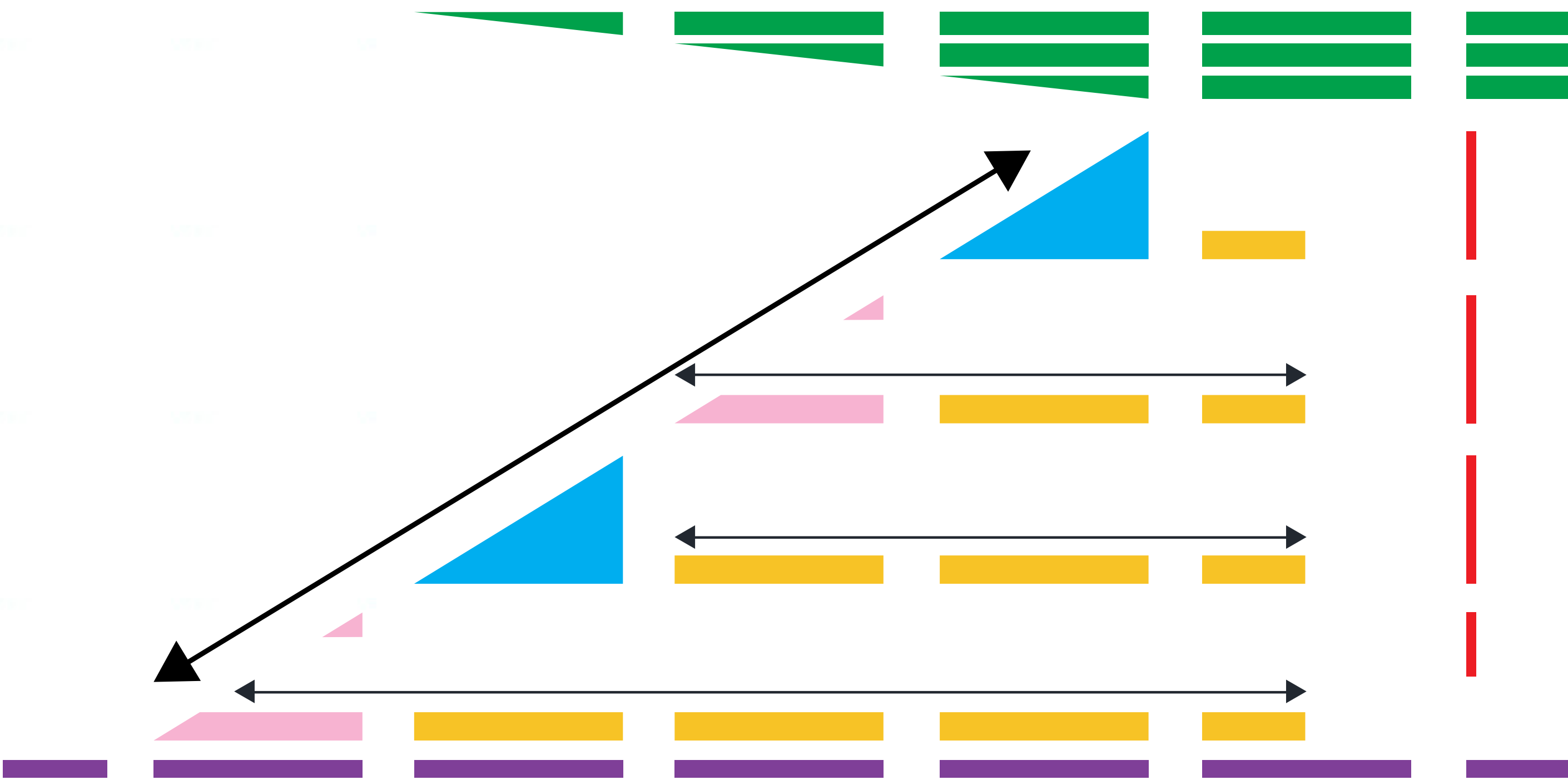
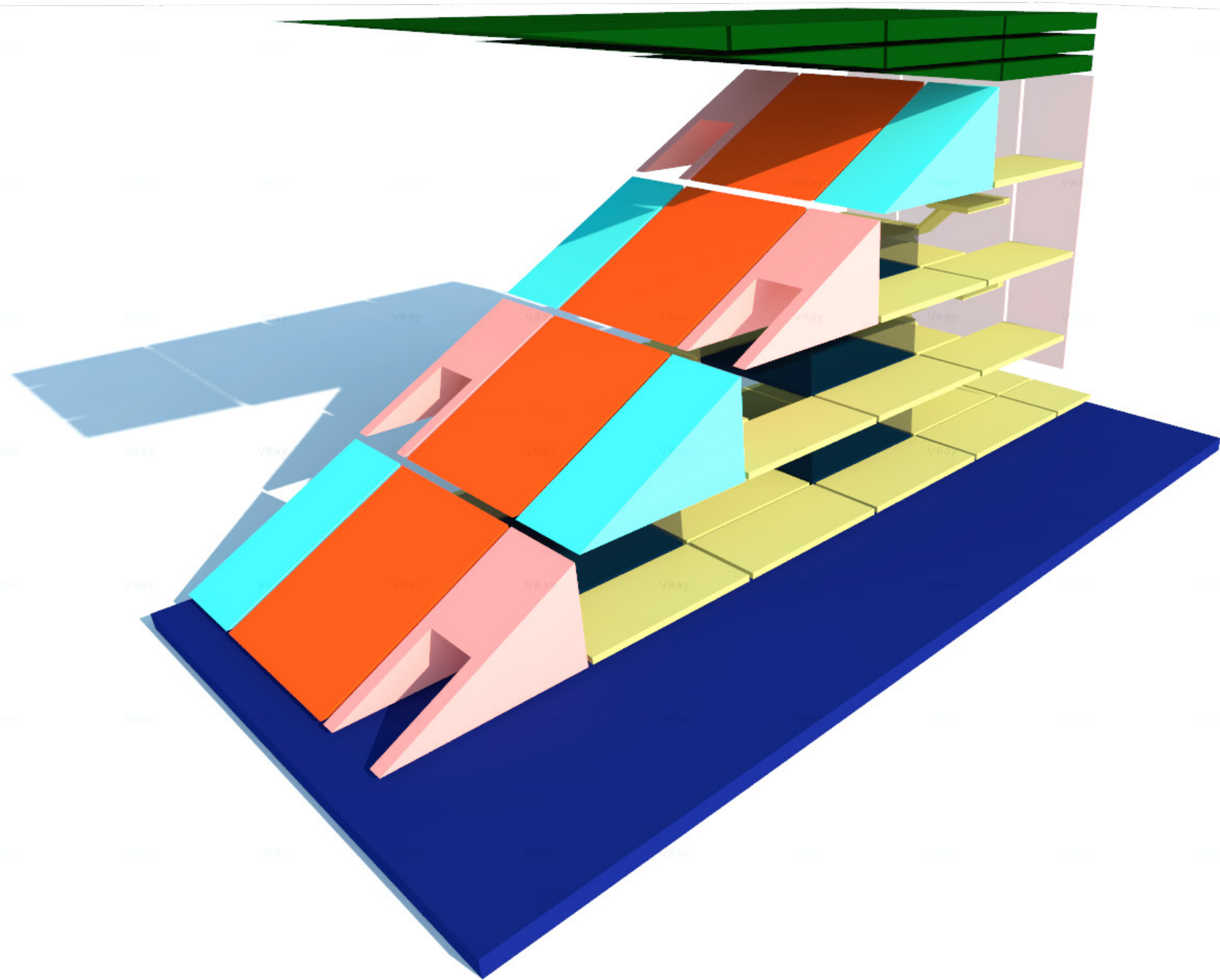
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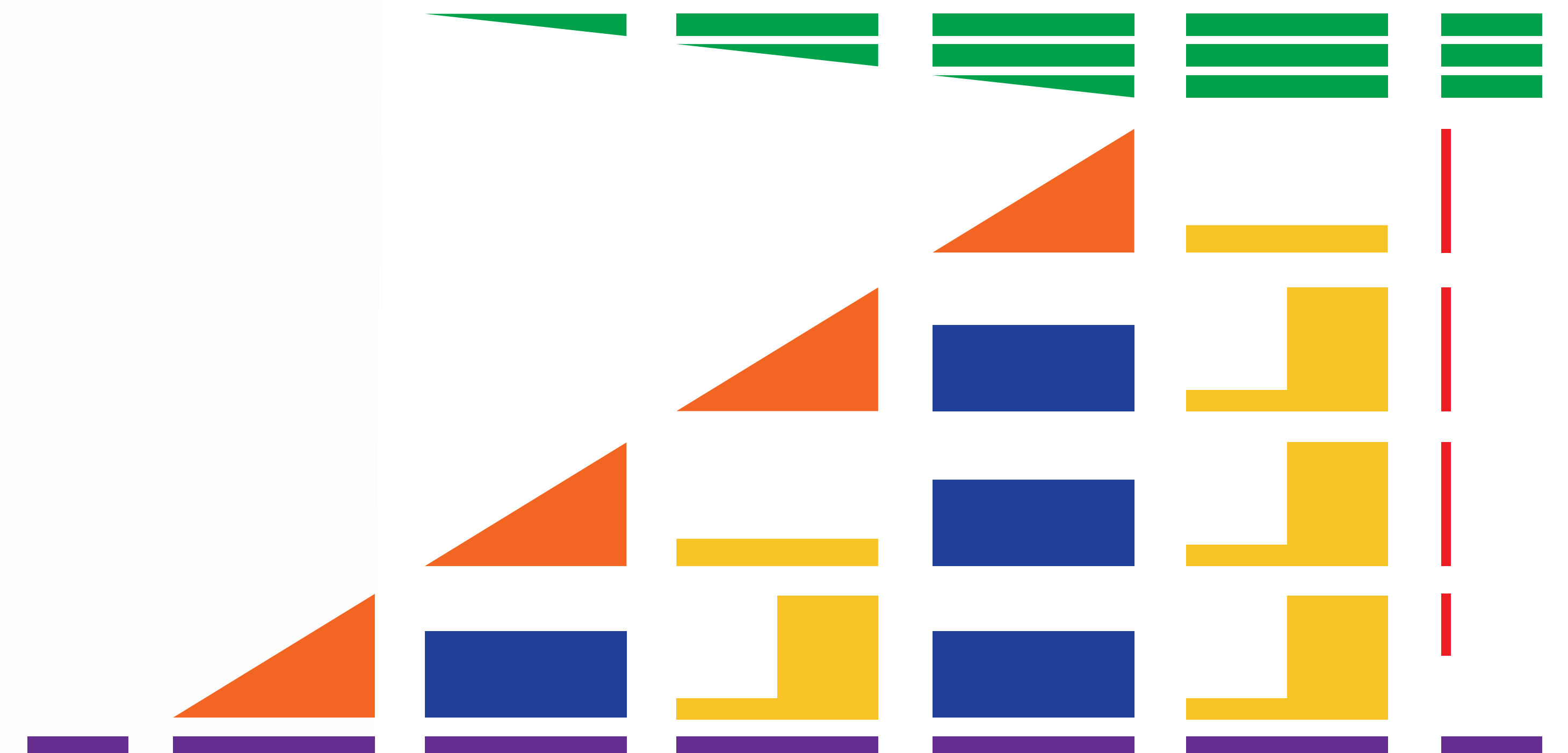
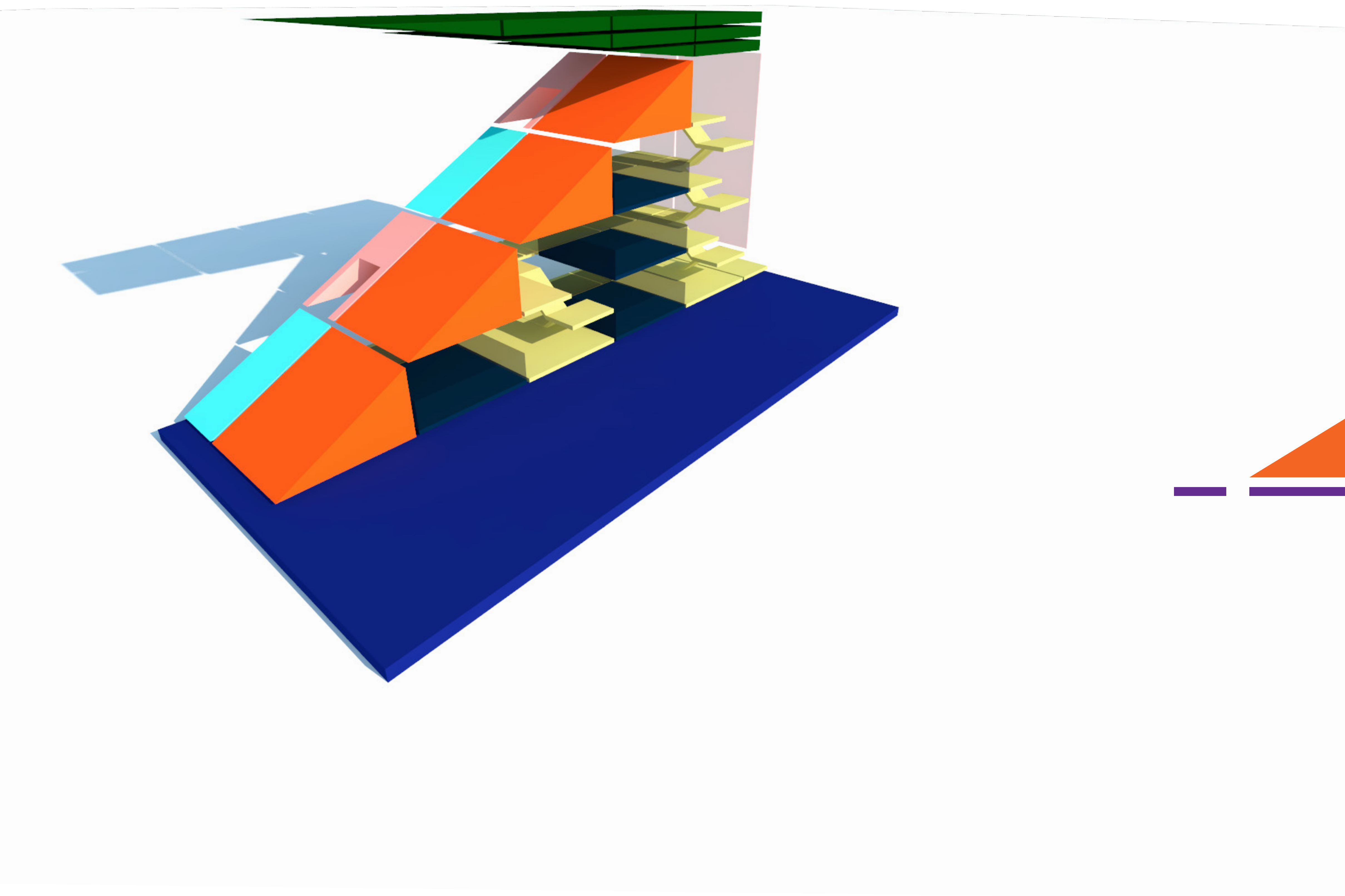
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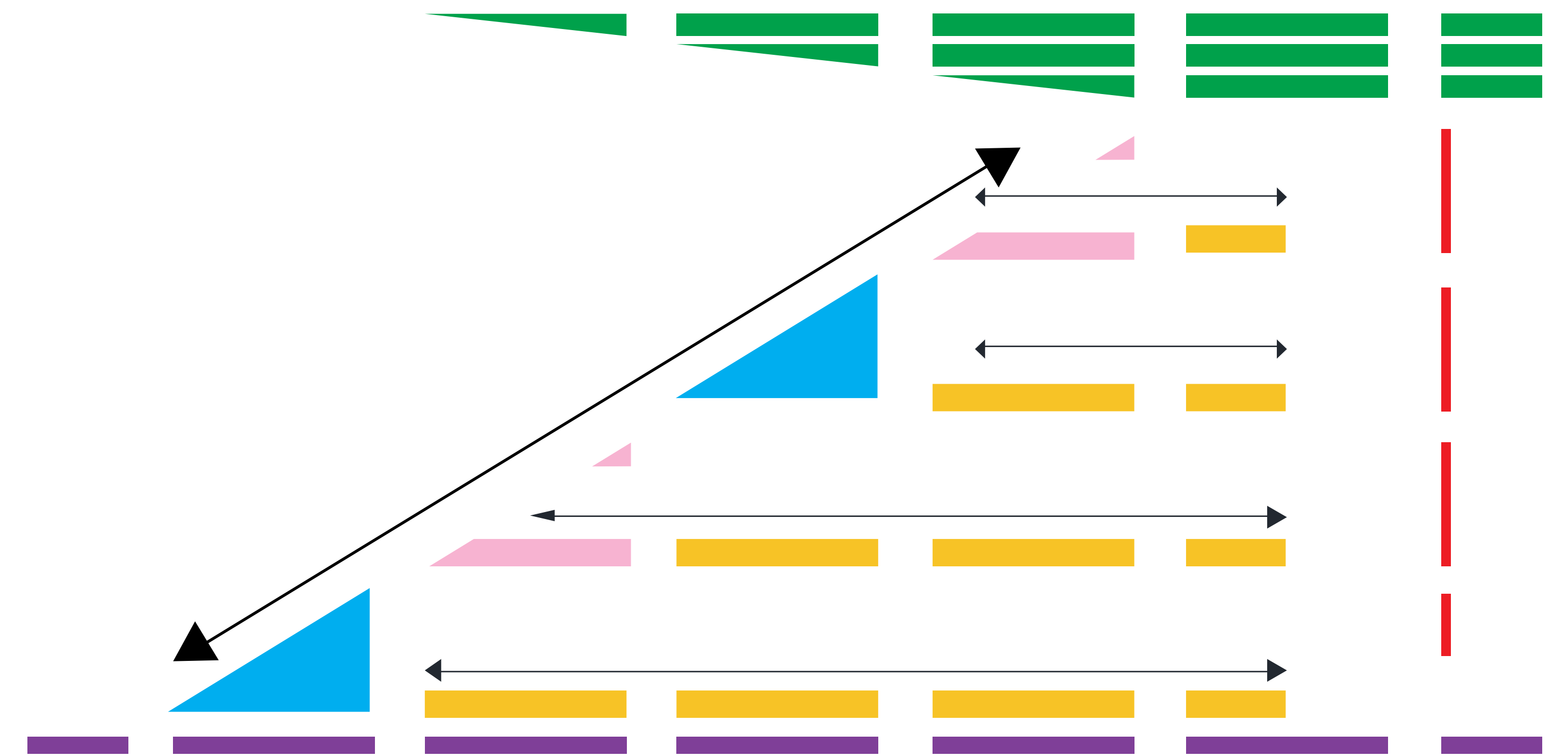
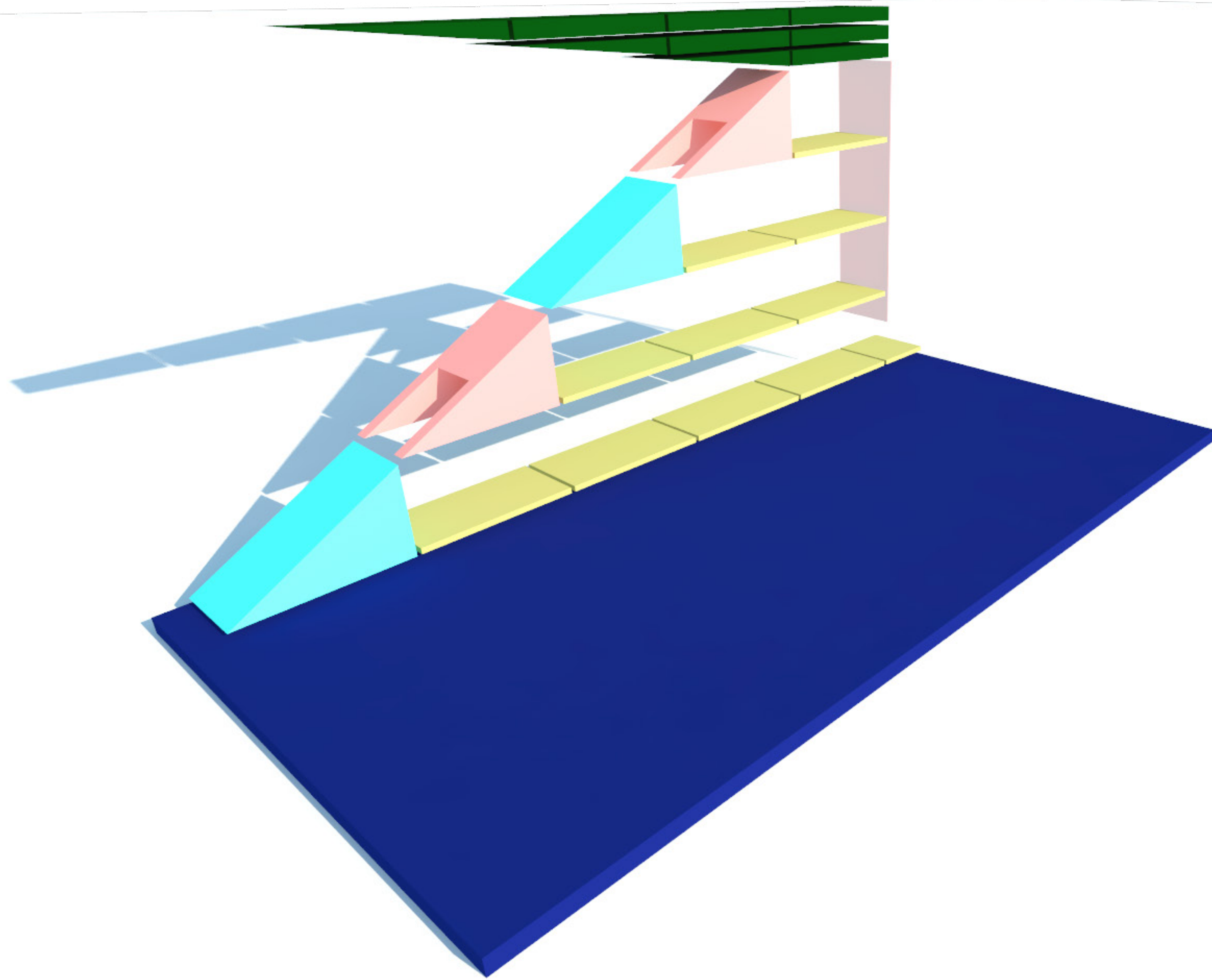
3. Design



3. Design

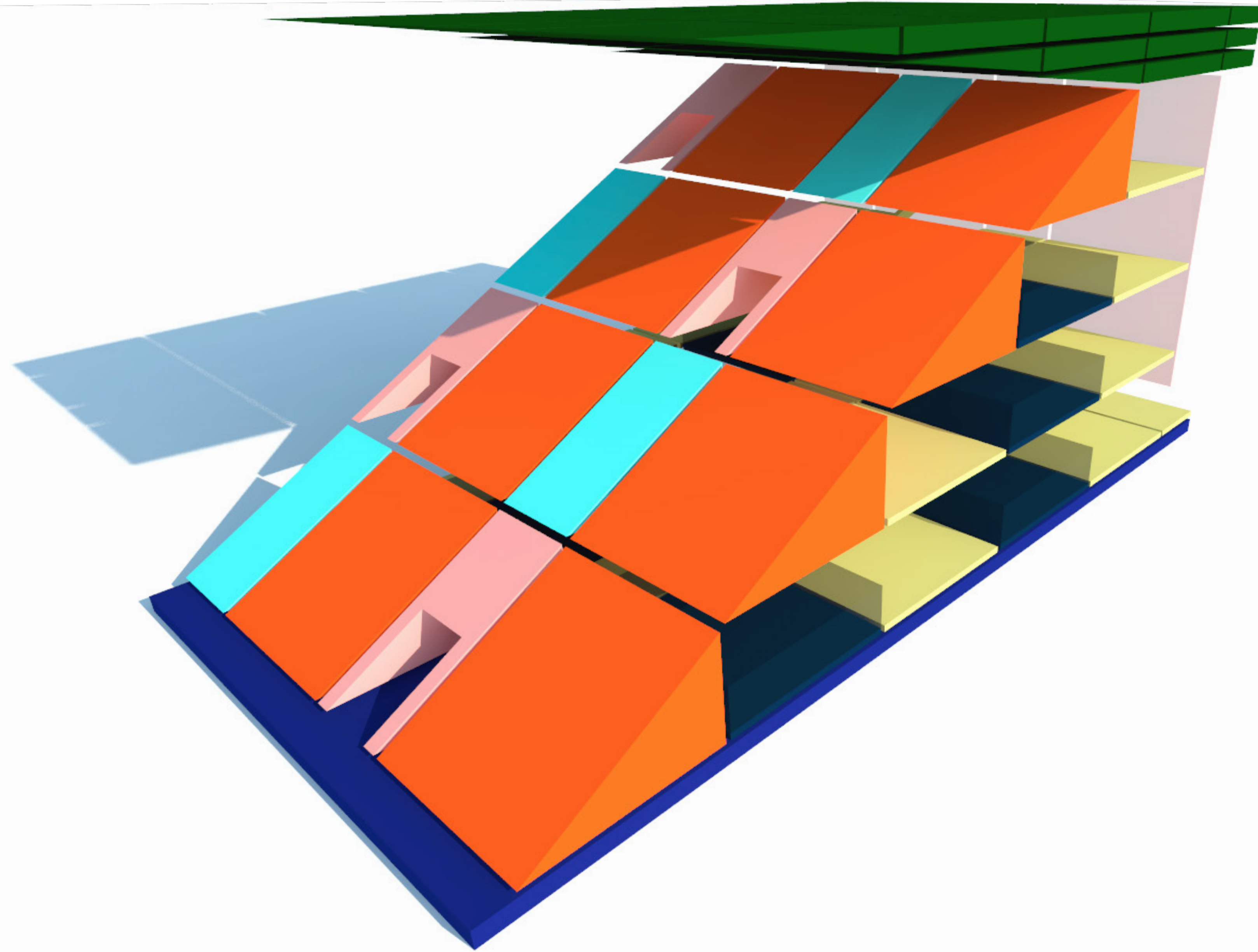


3. Design



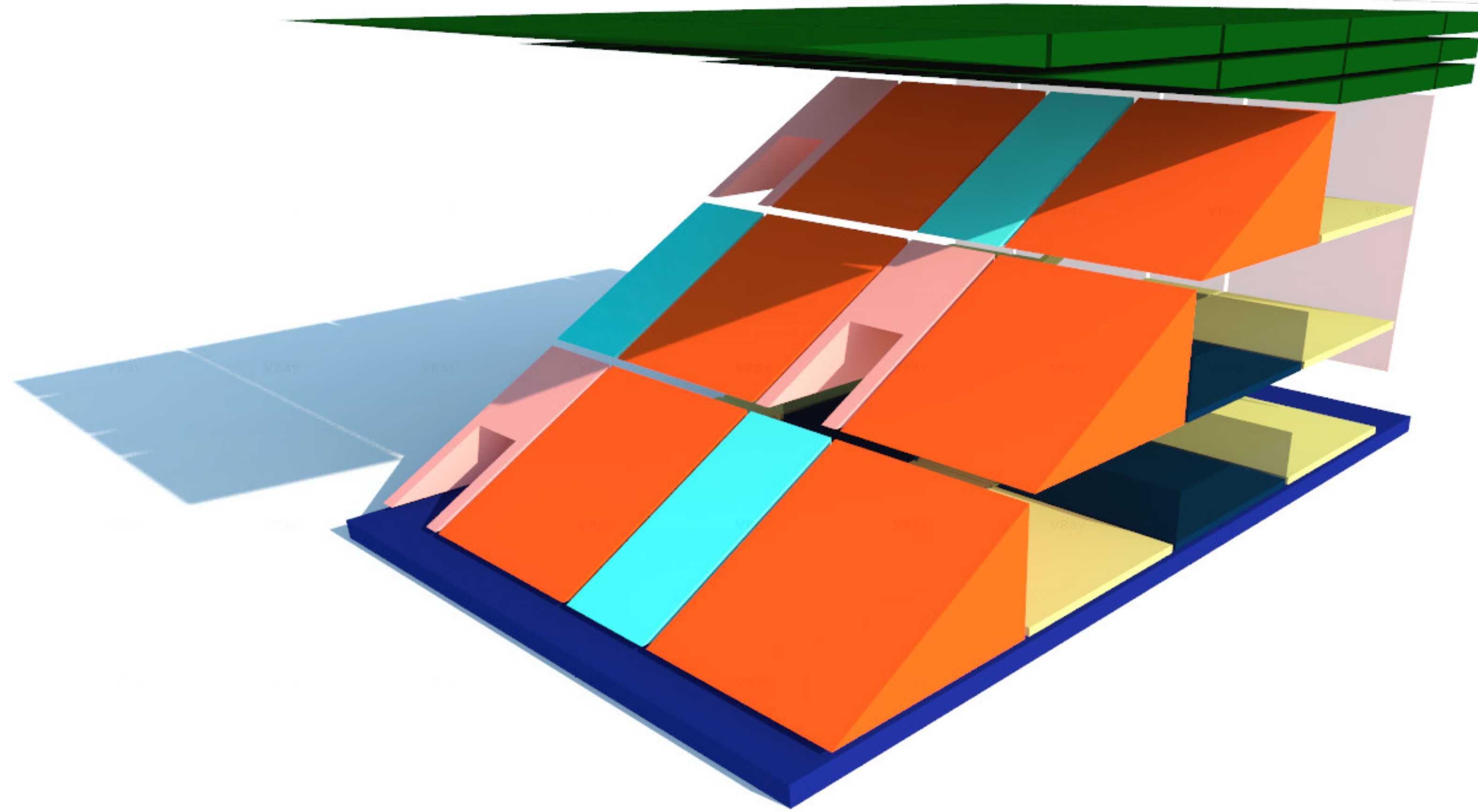
3. Design

Able to scale for different capacities



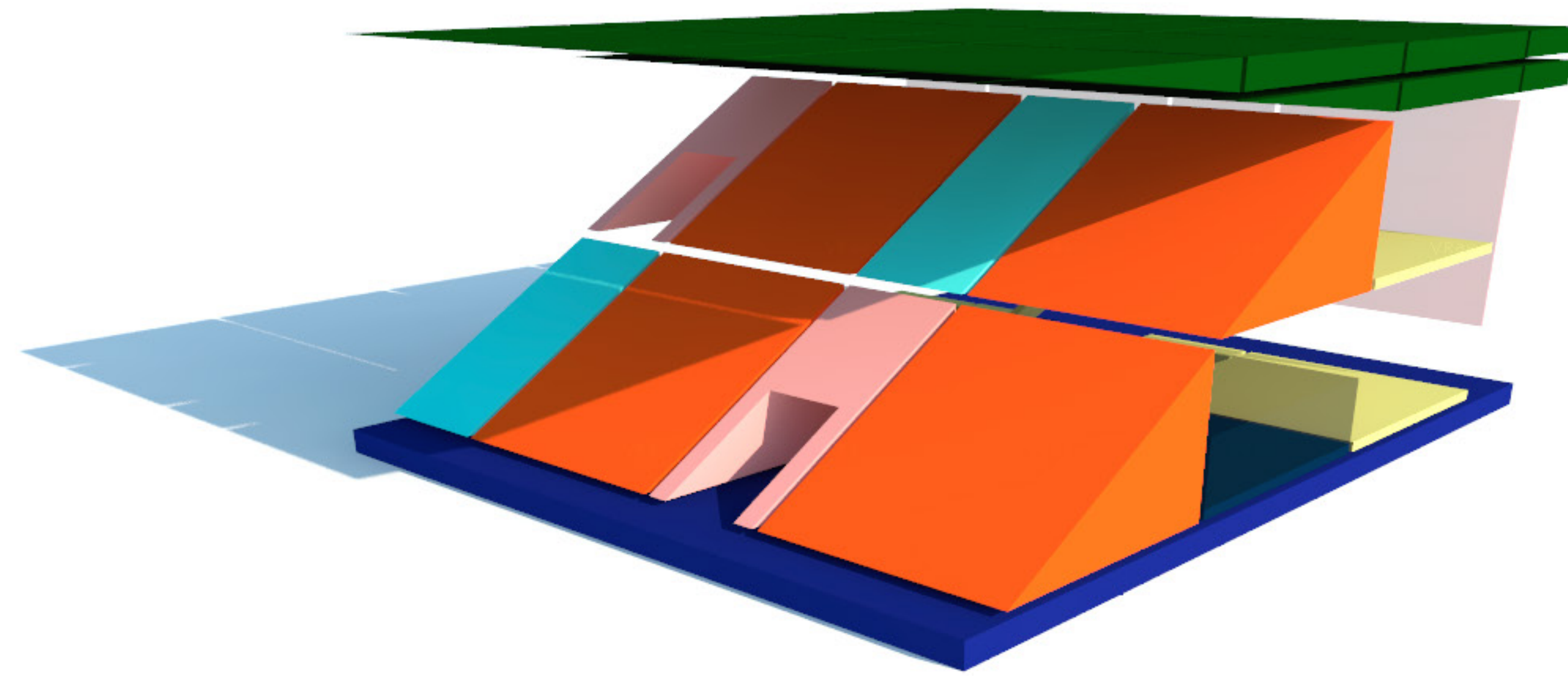
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Able to scale for different capacities



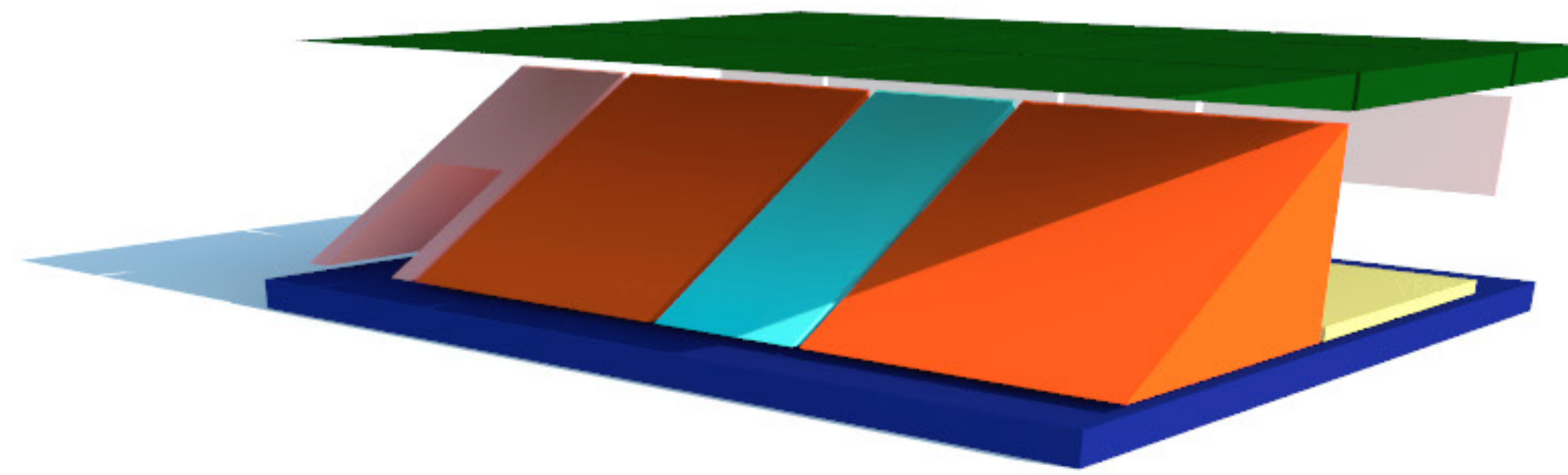
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Able to scale for different capacities



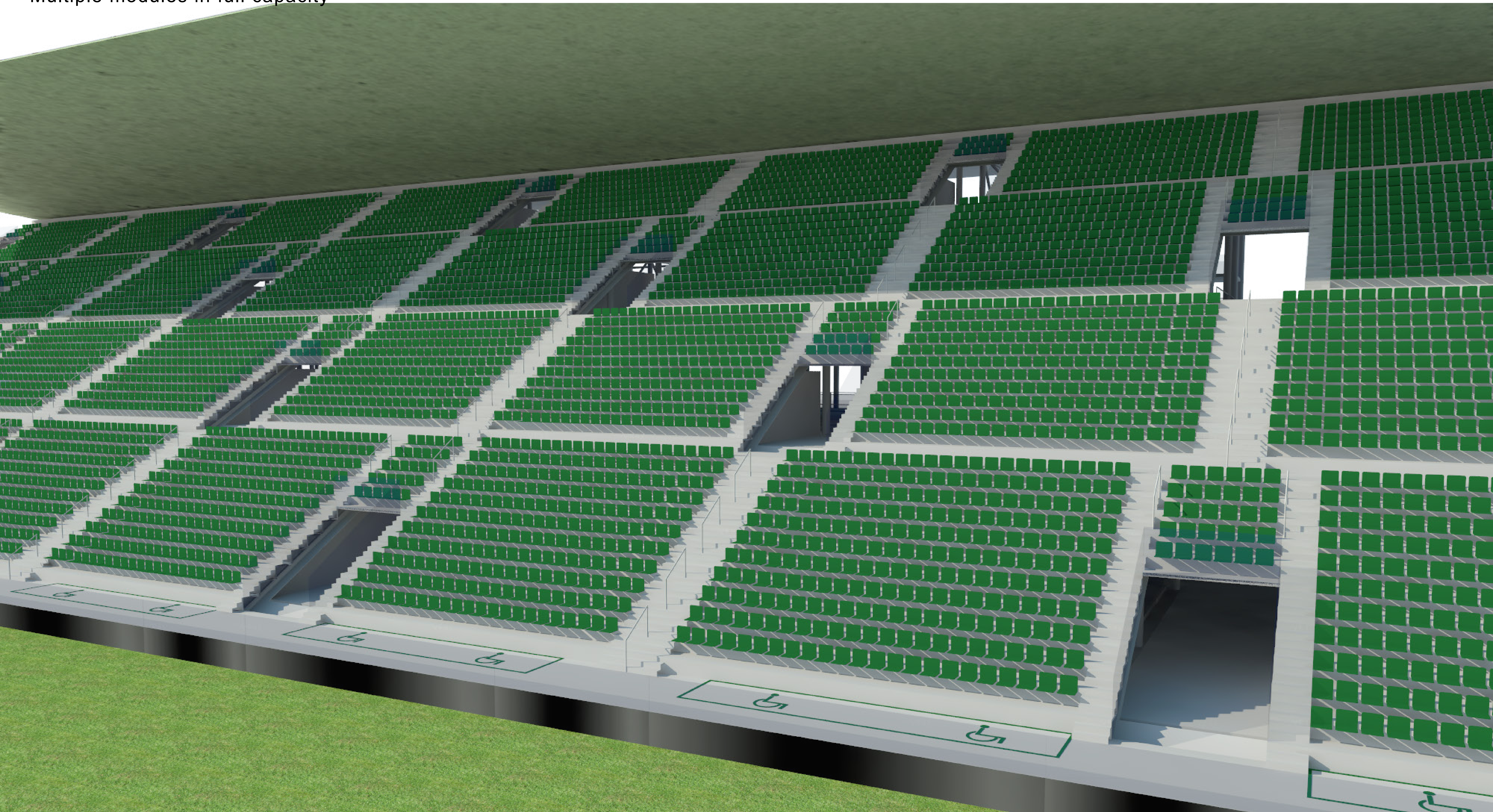
3. Design

Able to scale for different capacities

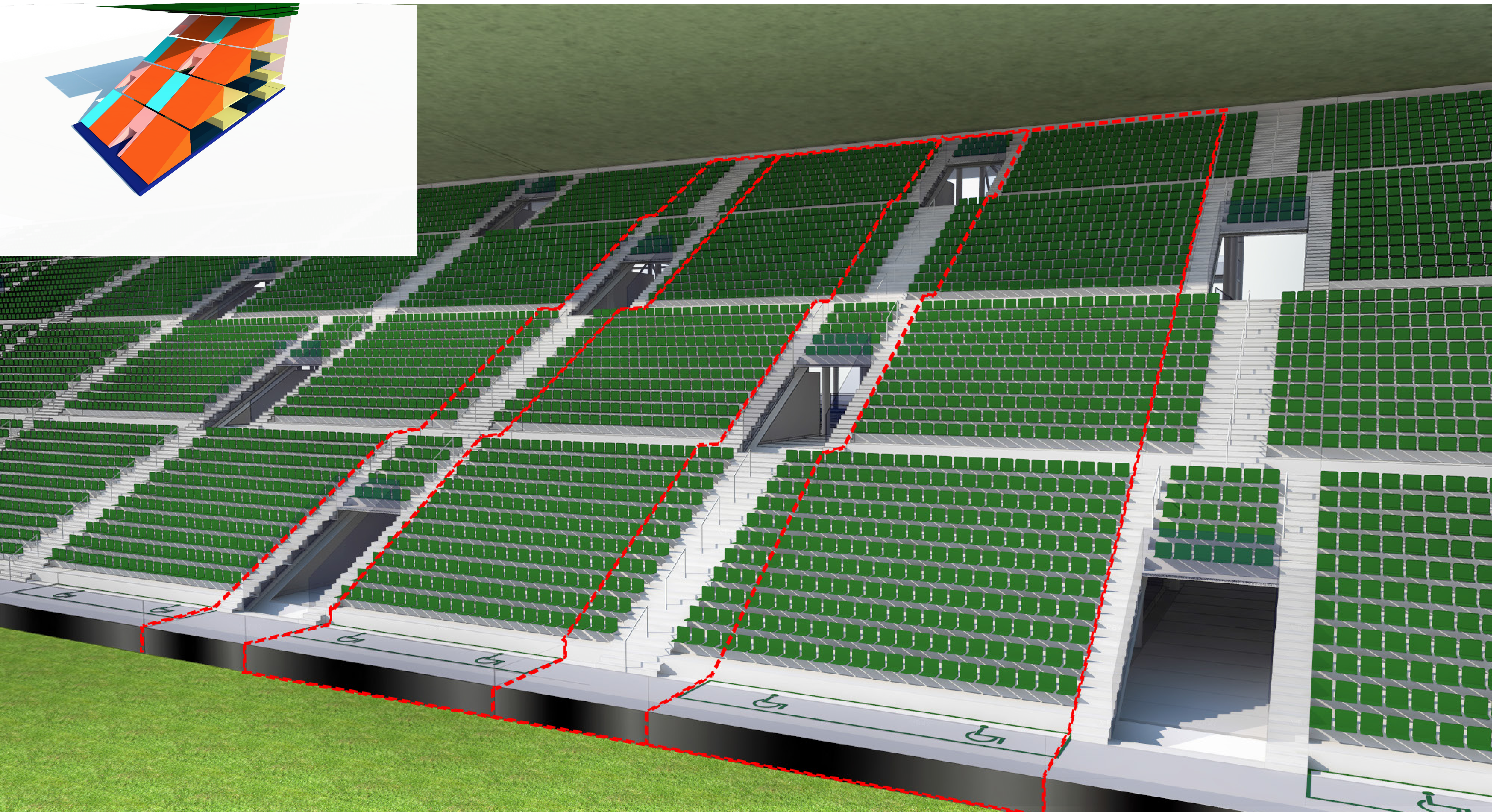


3. Design

Multiple modules in full capacity

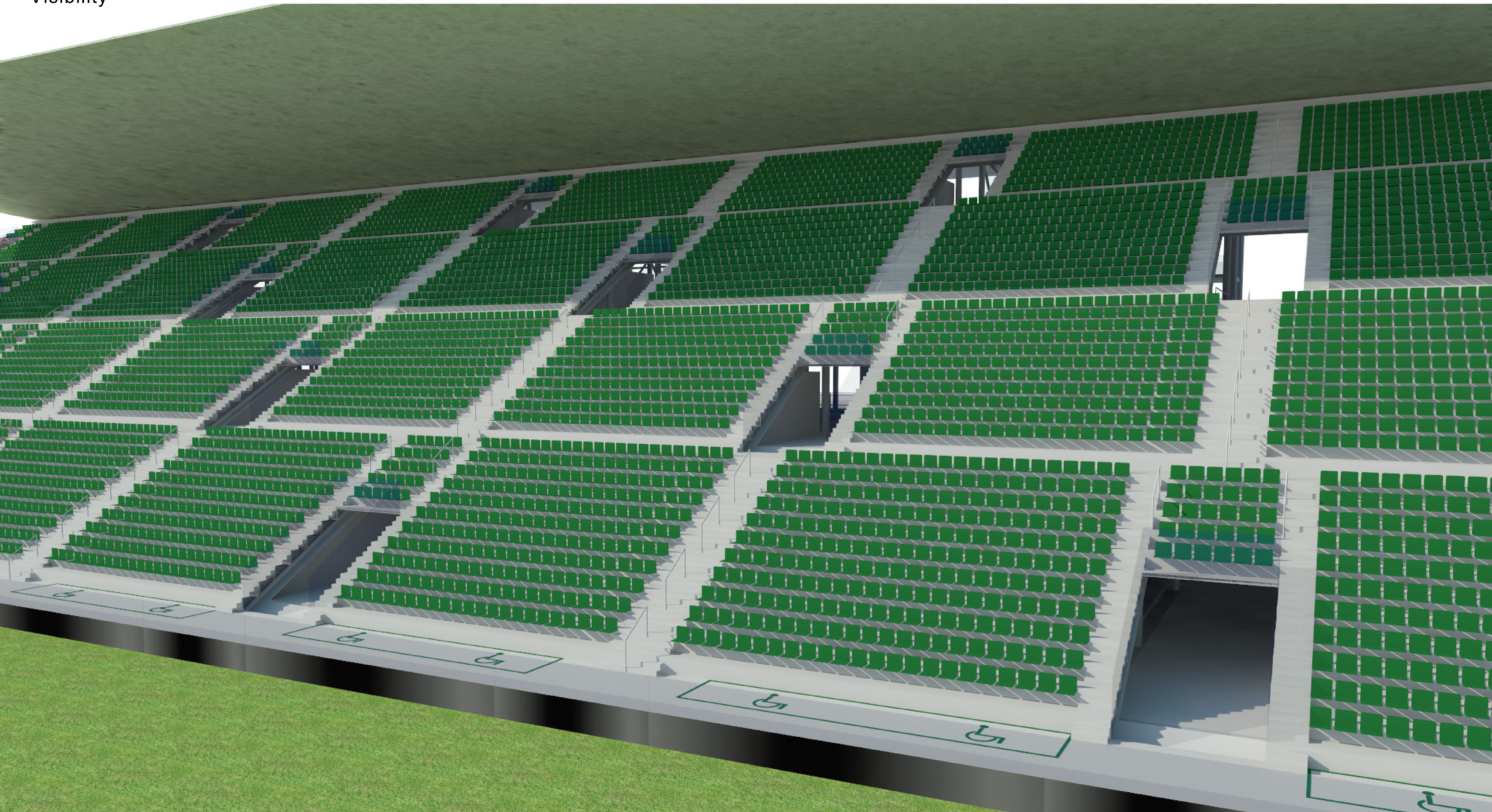


3. Design



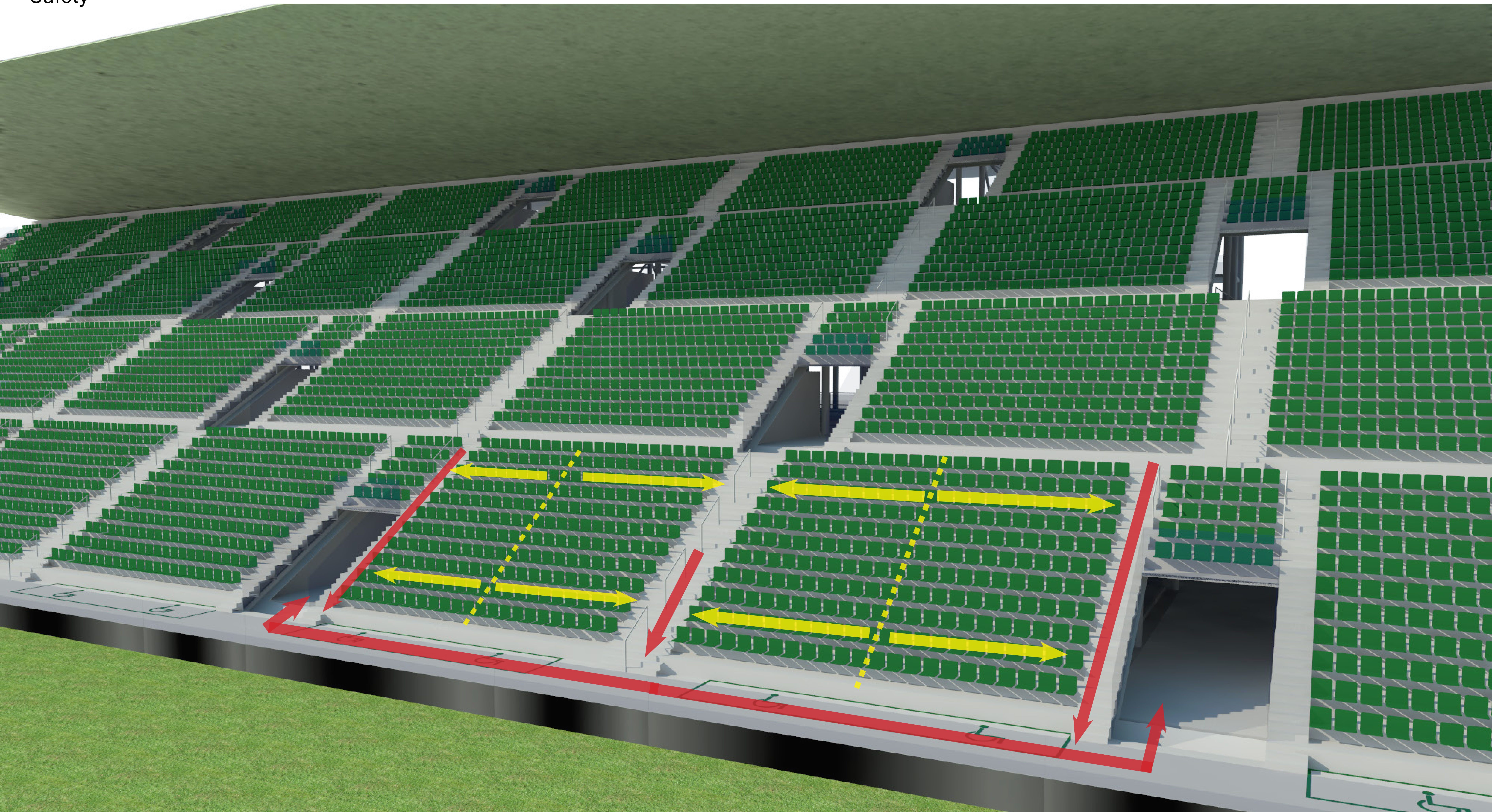
3. Design

Visibility



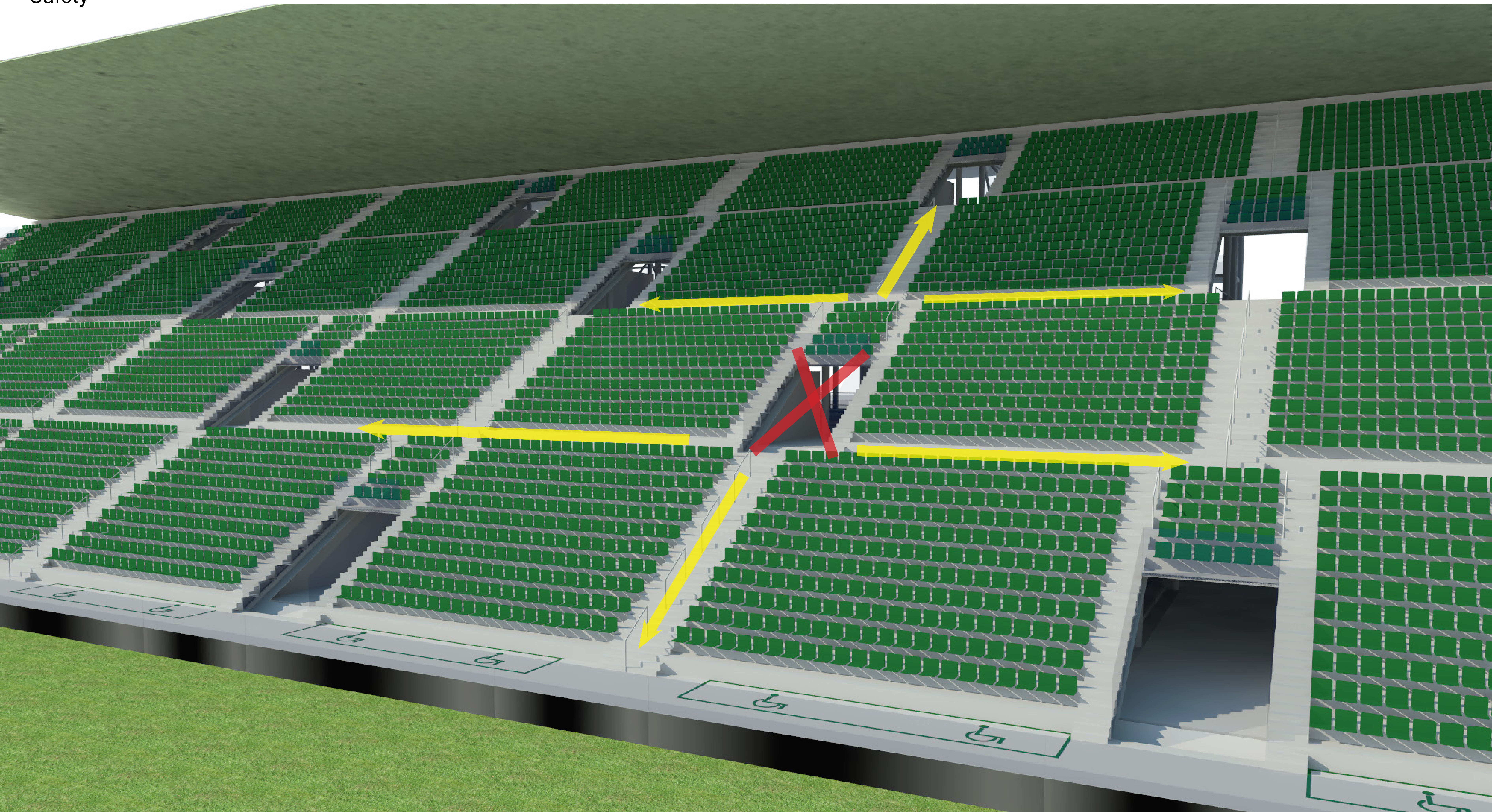
3. Design

Safety



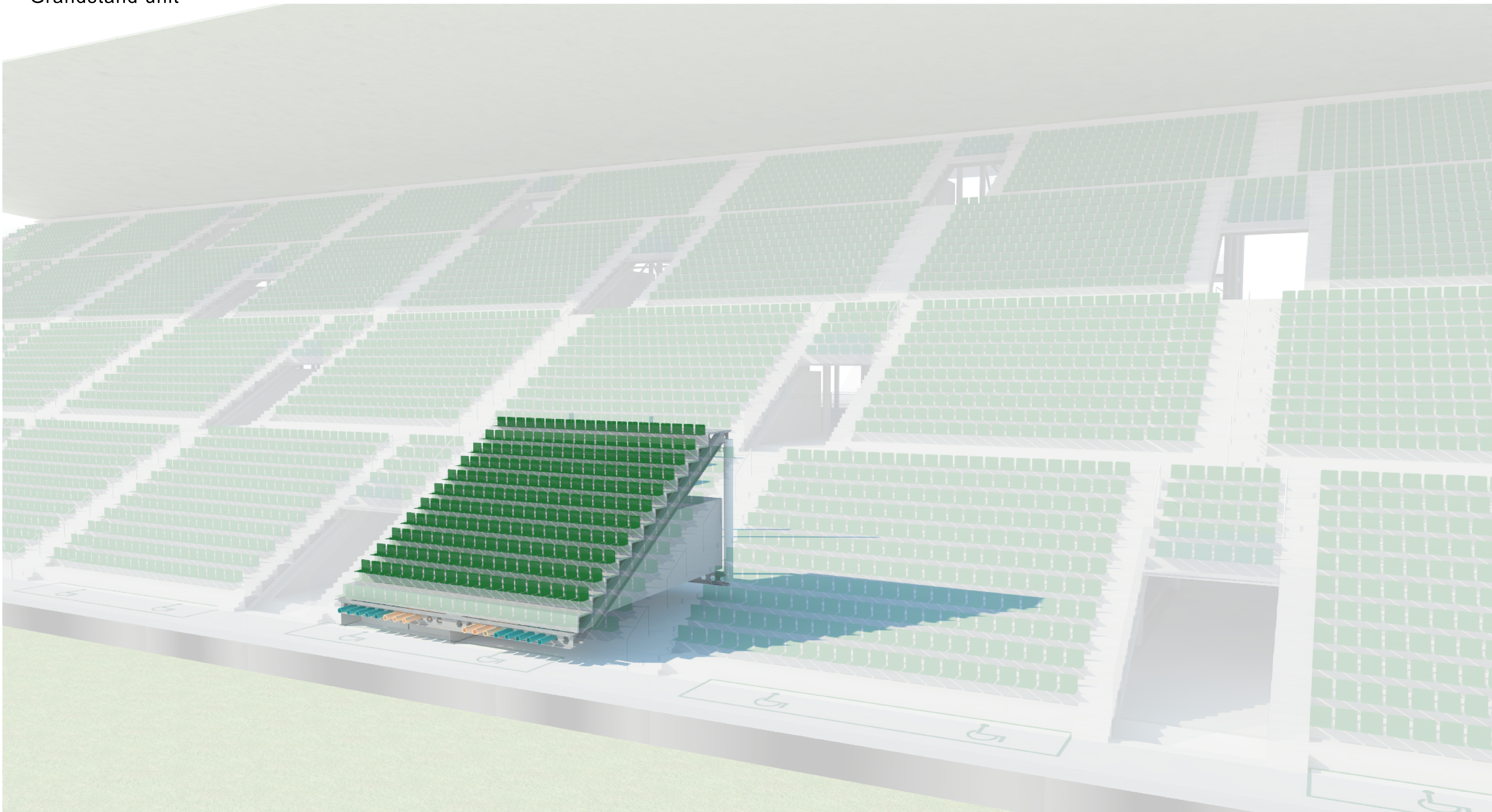
3. Design

Safety

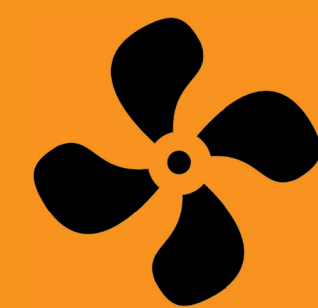
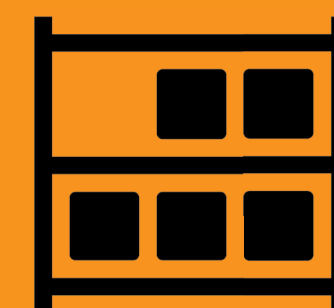
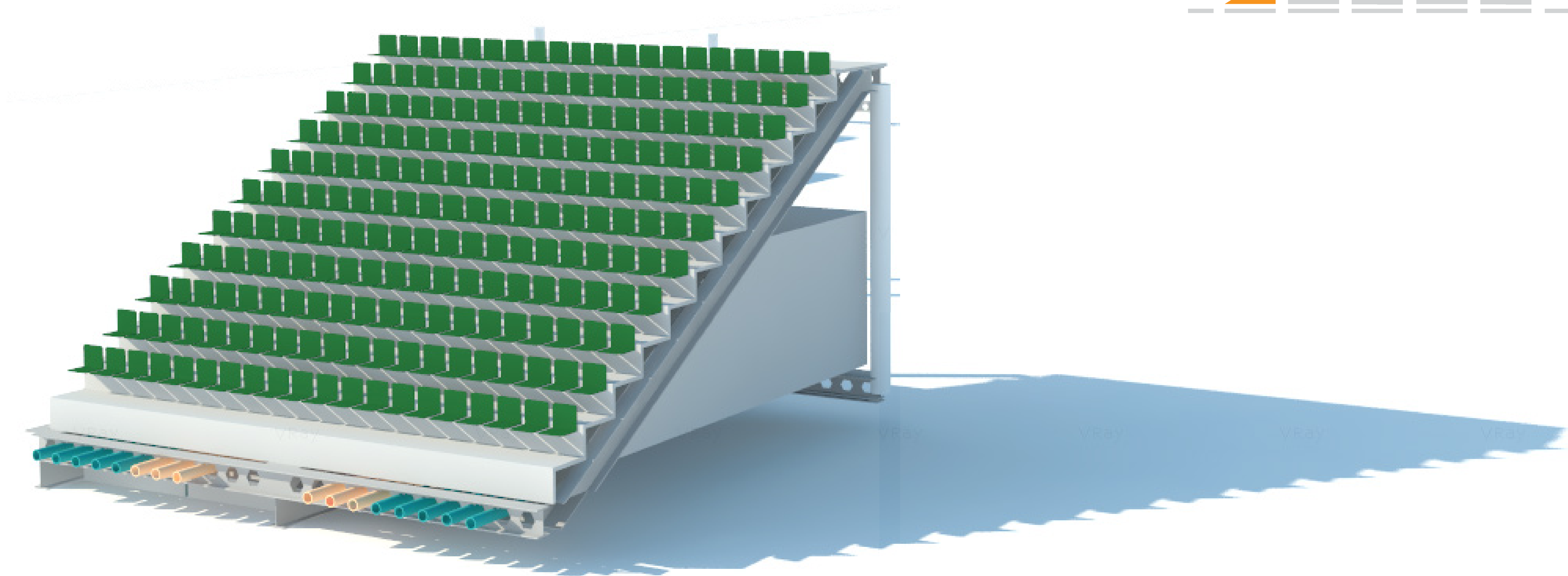


3. Design

Grandstand unit



3. Design



3. Design

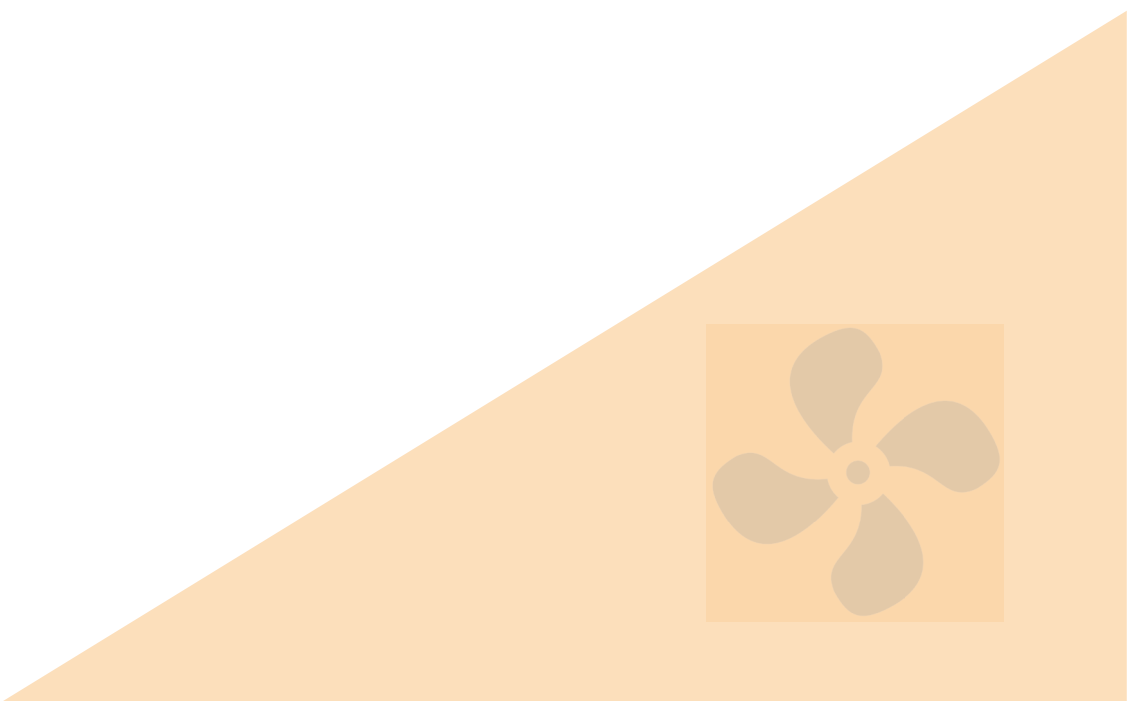
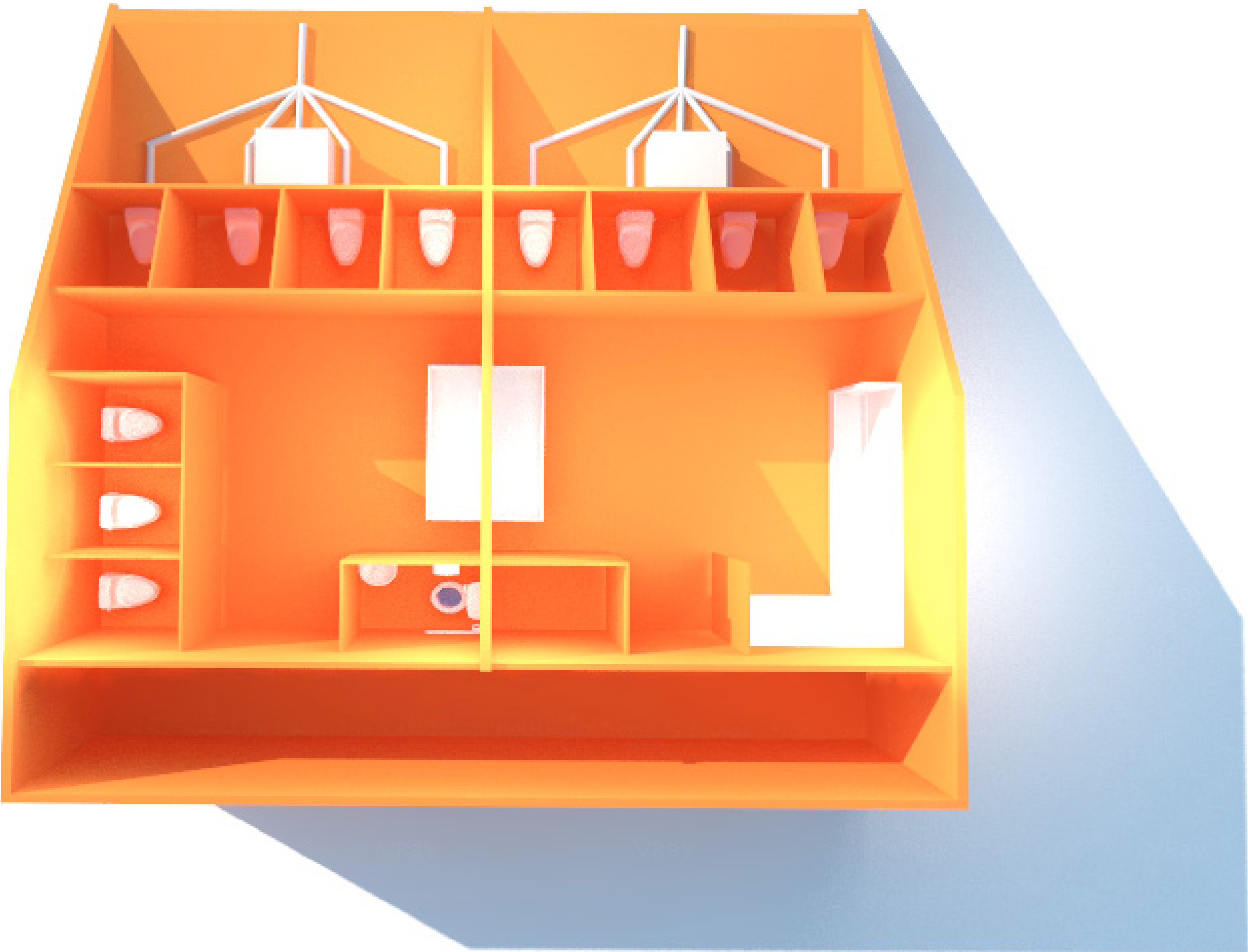
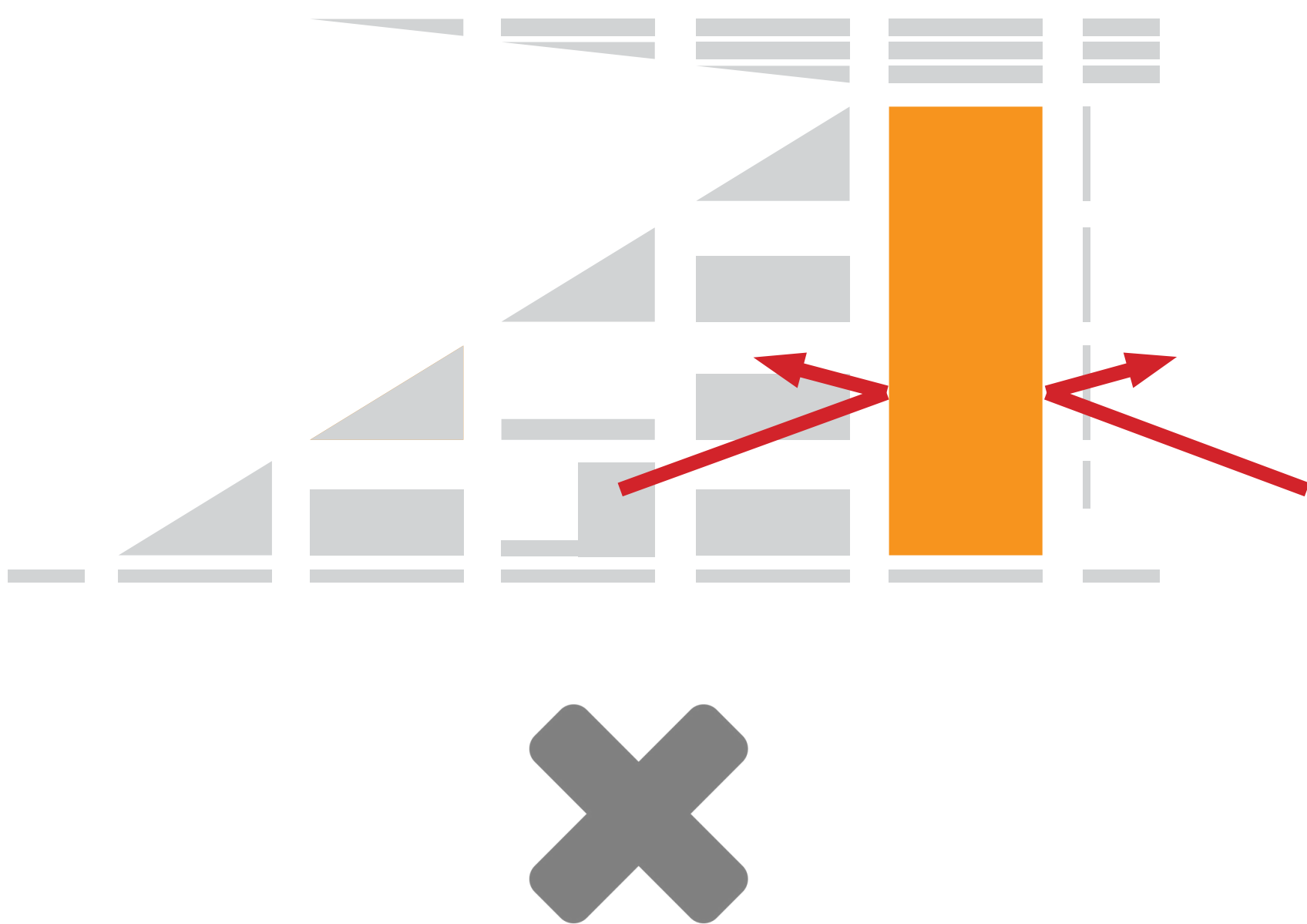
Toilets

Demands:

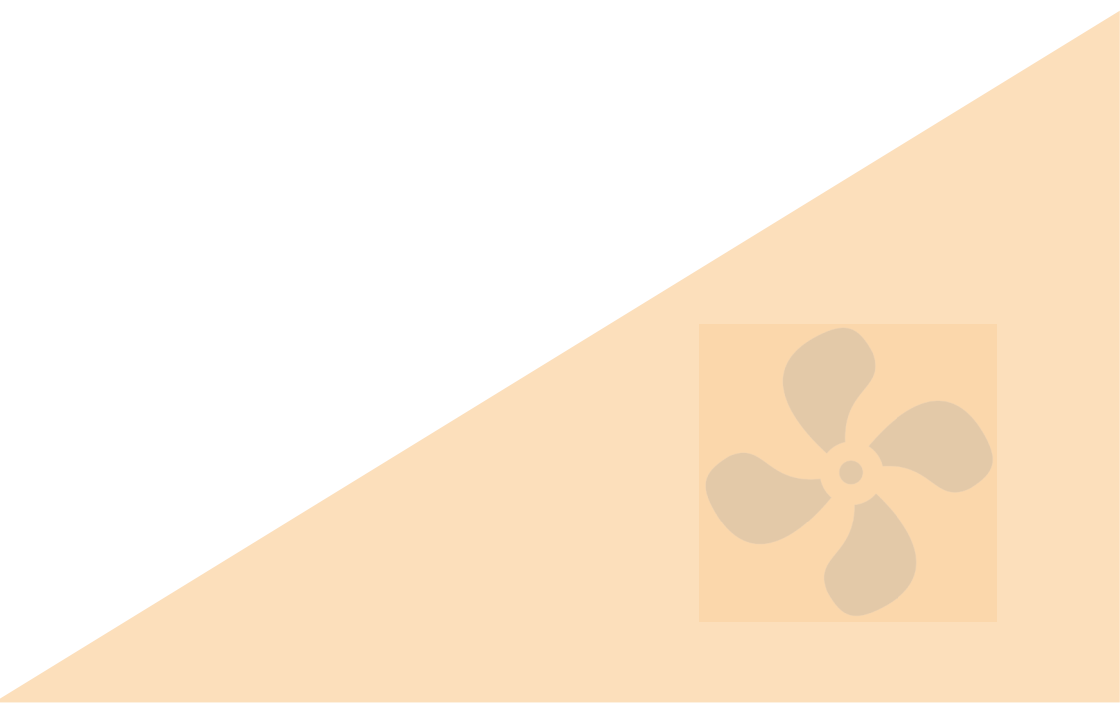
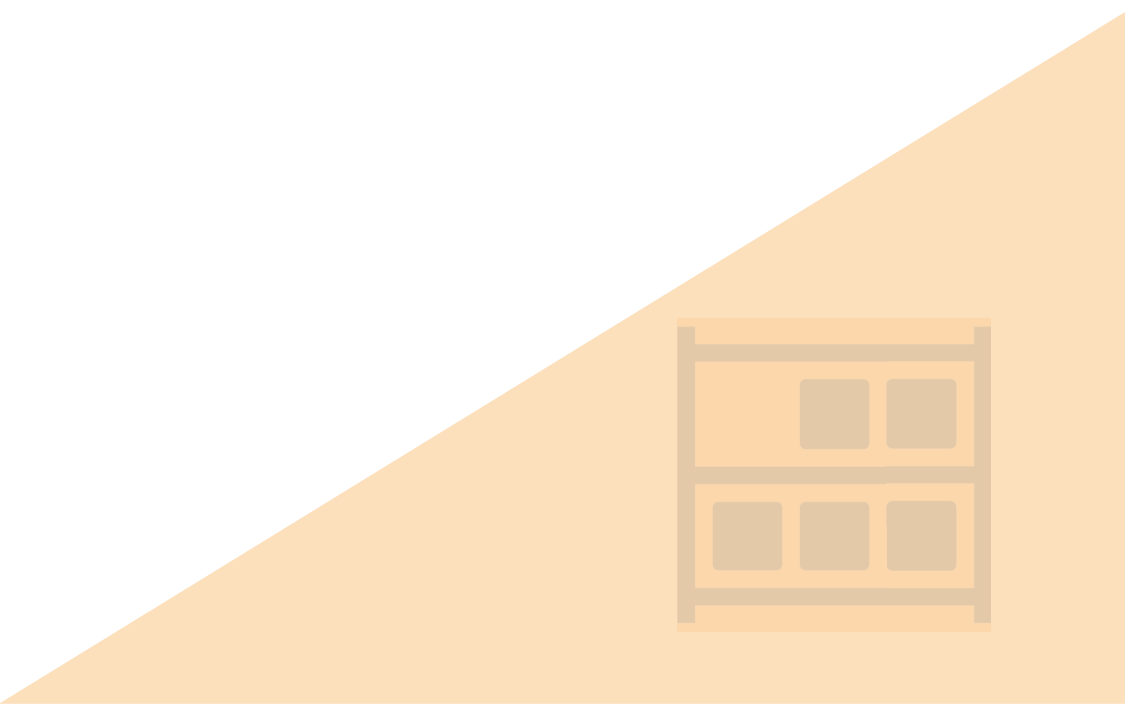
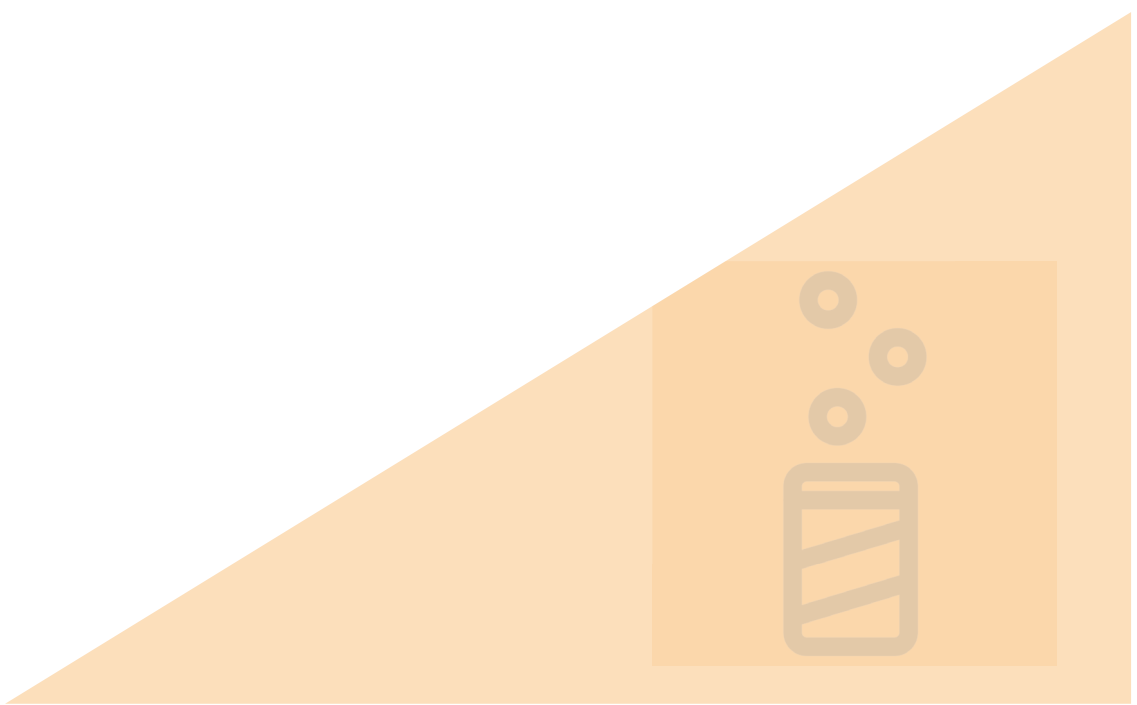
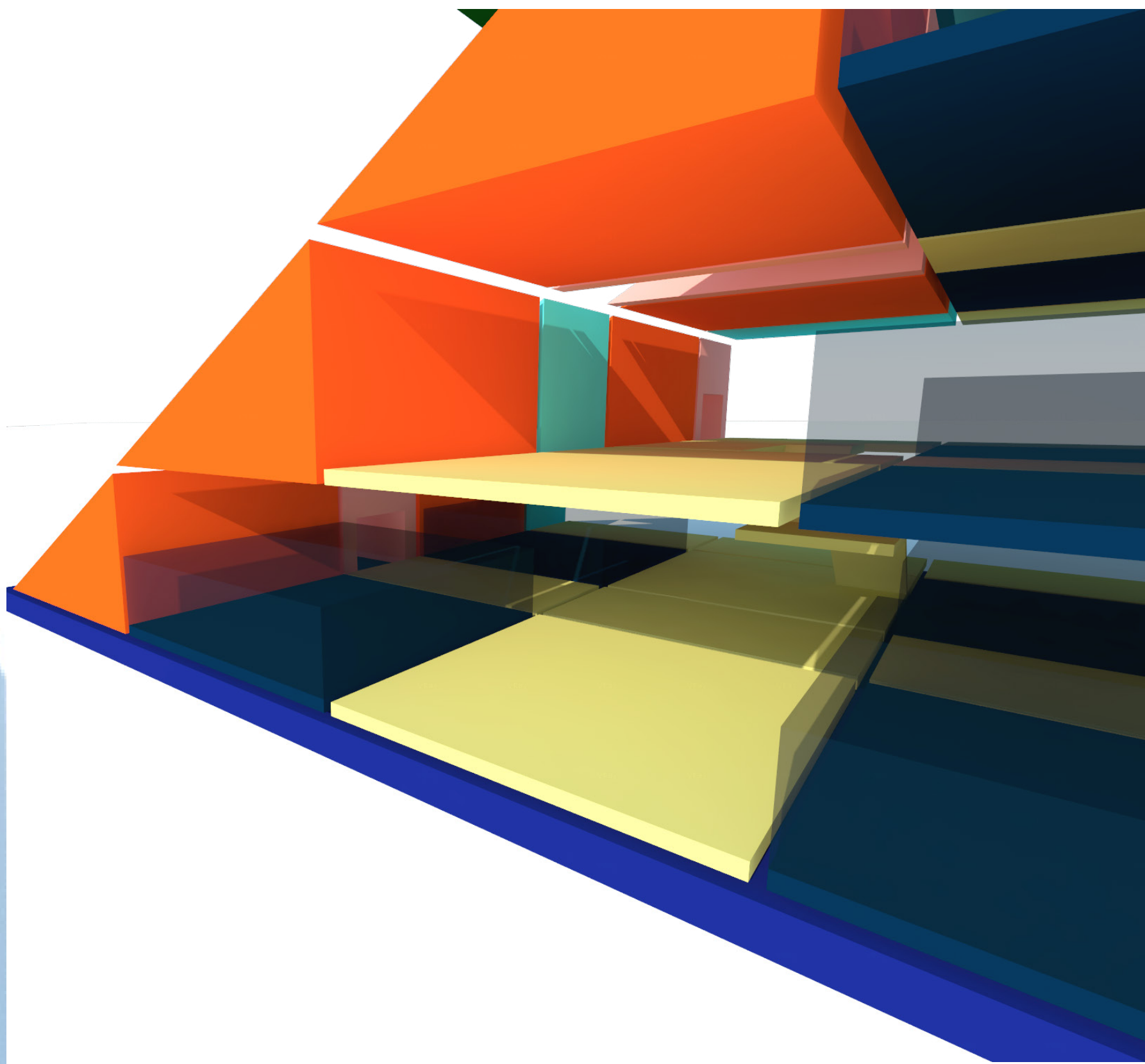
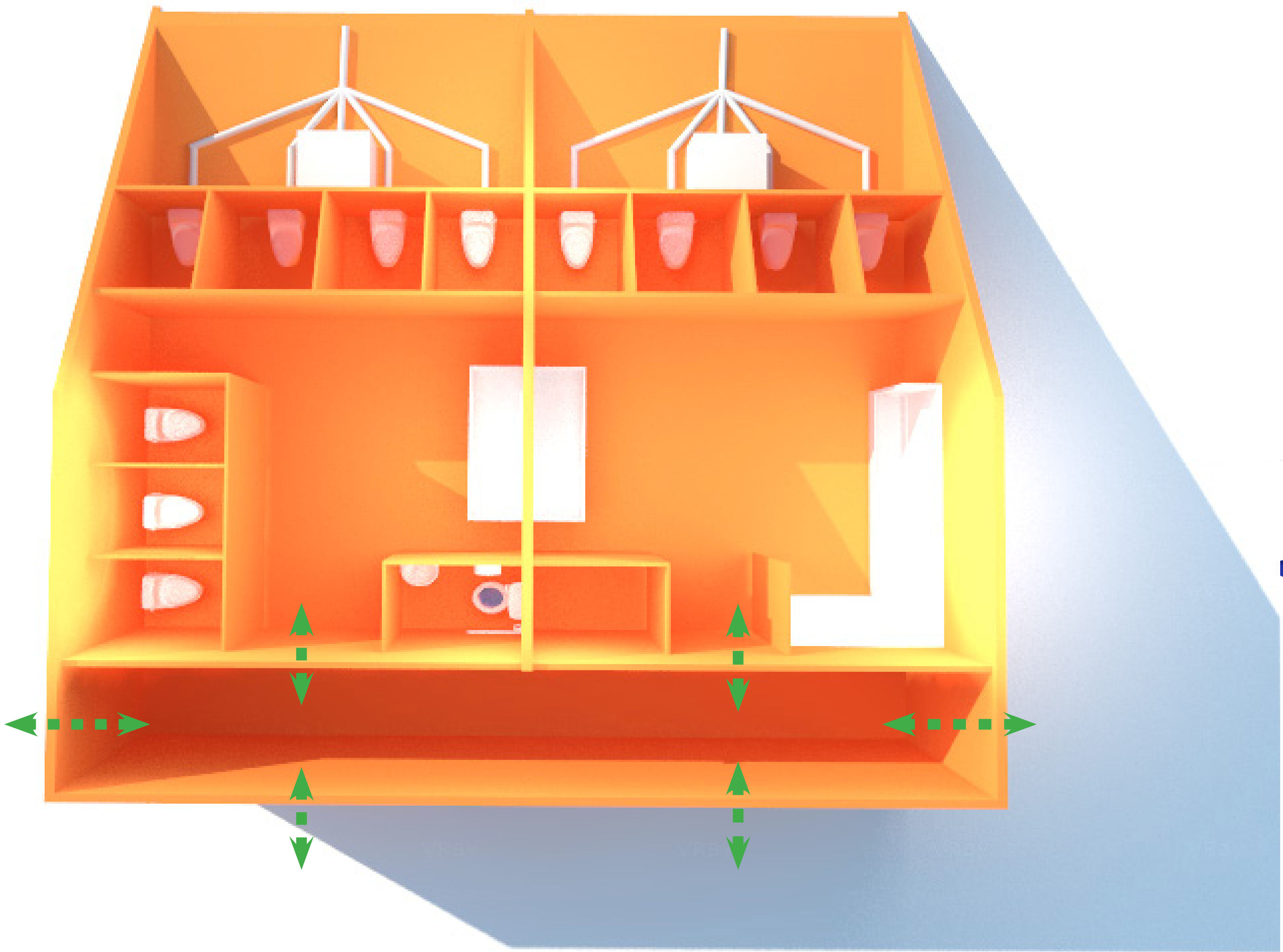
- . Apply at least as much toilets as prescribed
- . Shorten the walking distance as much as possible
- . Position the toilets so that they will conflict with the concept



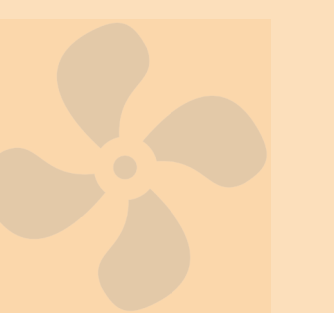
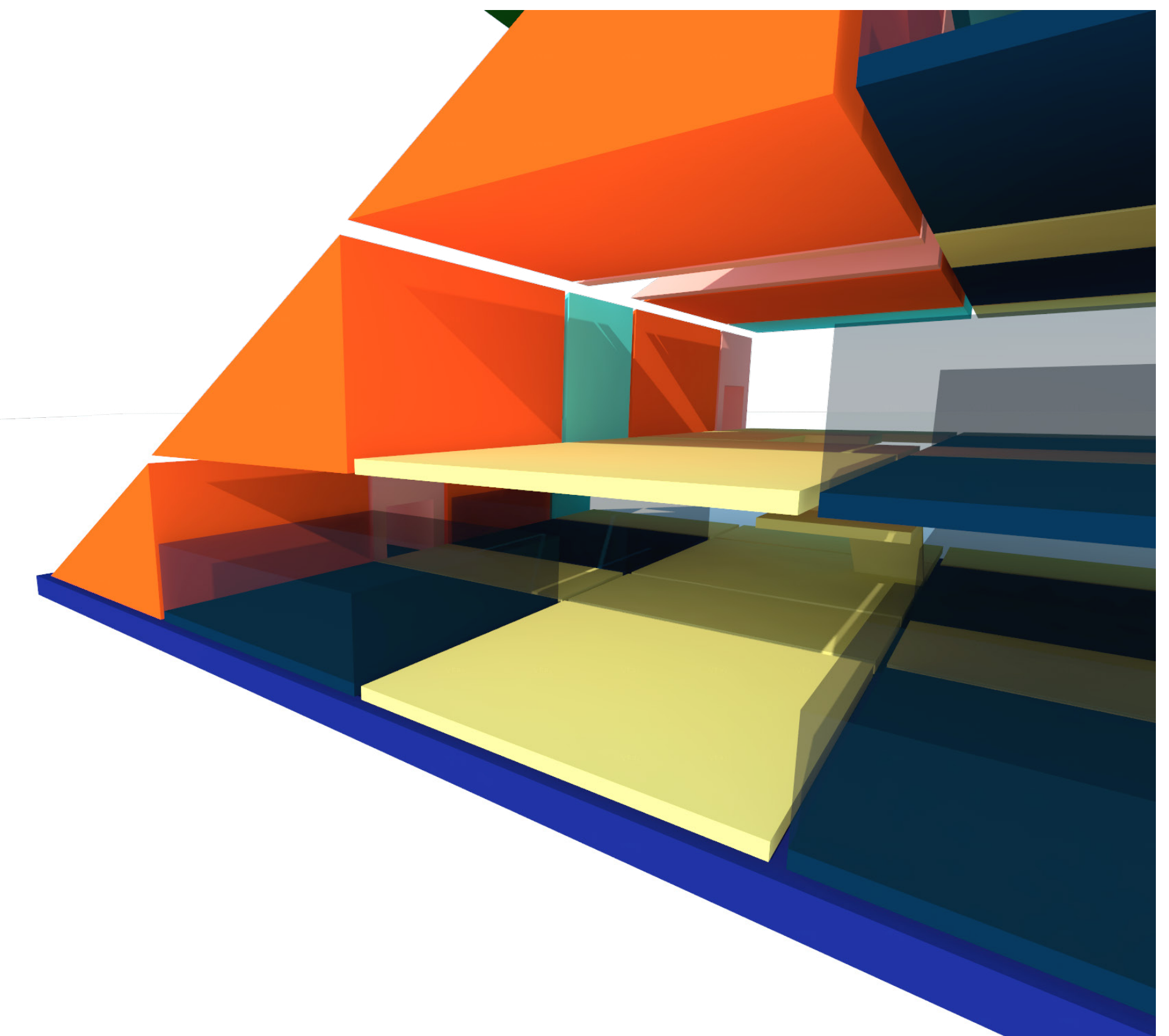
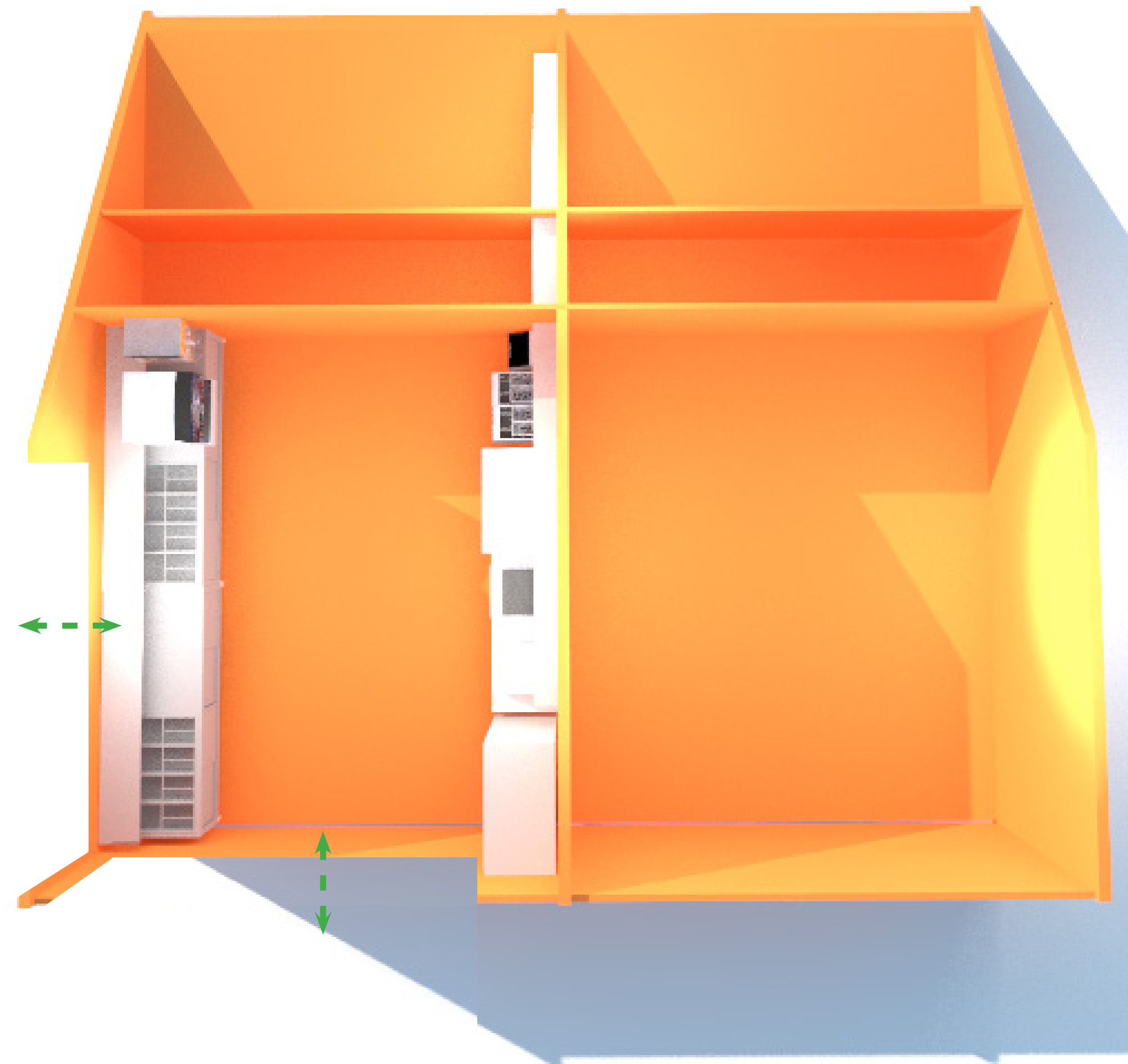
3. Design



3. Design



3. Design



3. Design

Functions

Demands:

- . Areas are created to be hired per event by companies
- . The platforms must allow a great variety of functions
- . Different identities or characters must be created for different types of functions

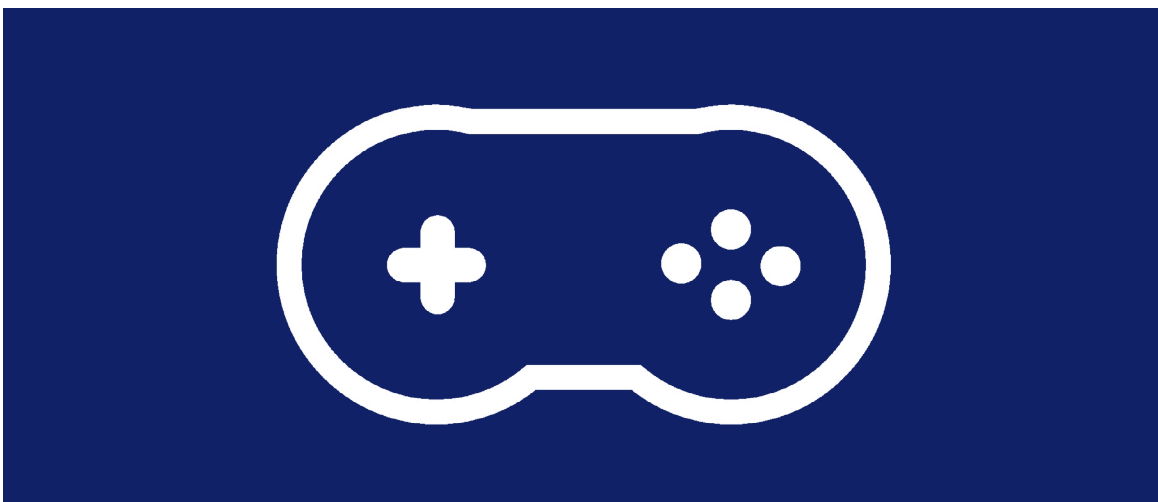
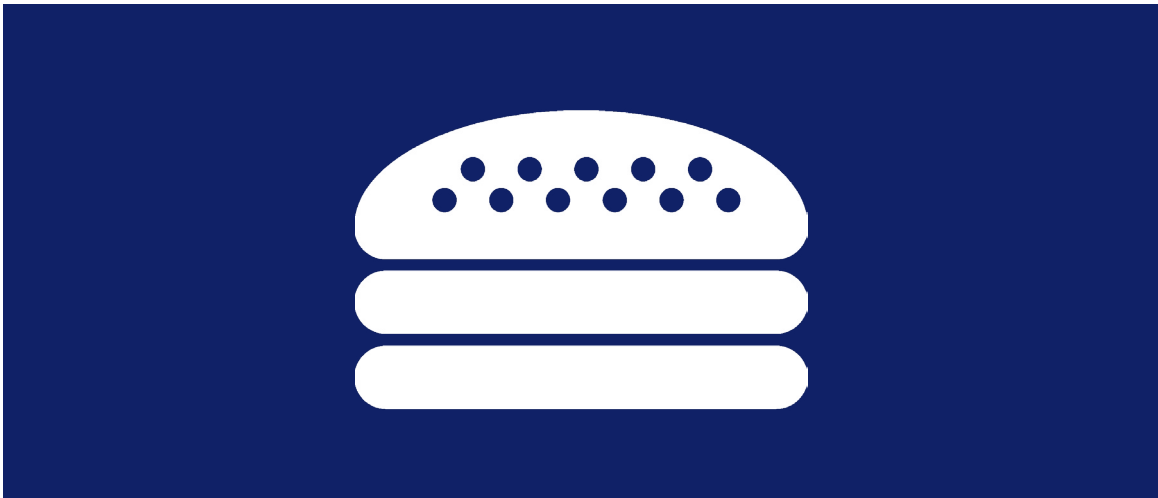


3. Design

Functions

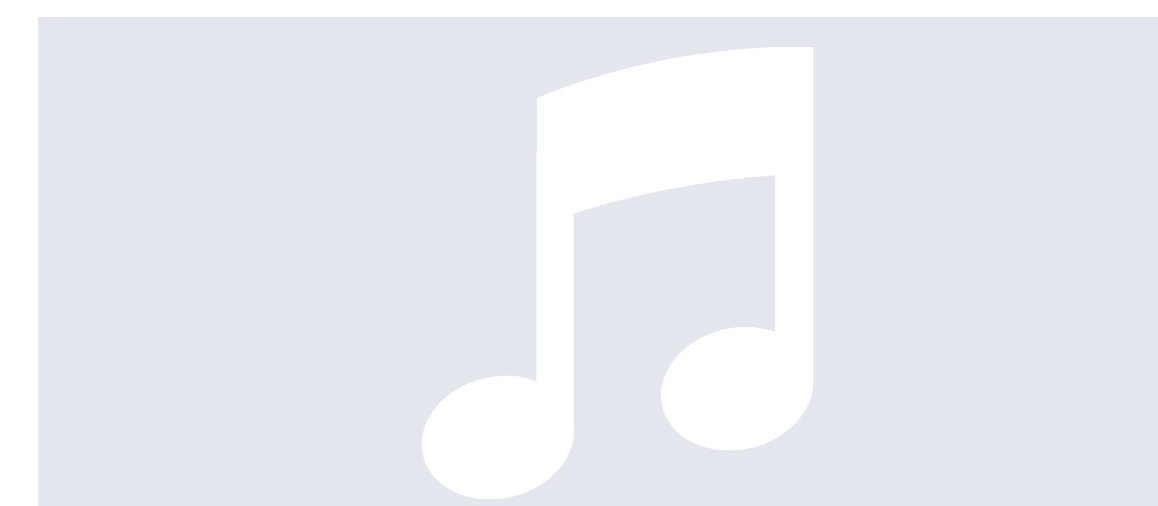
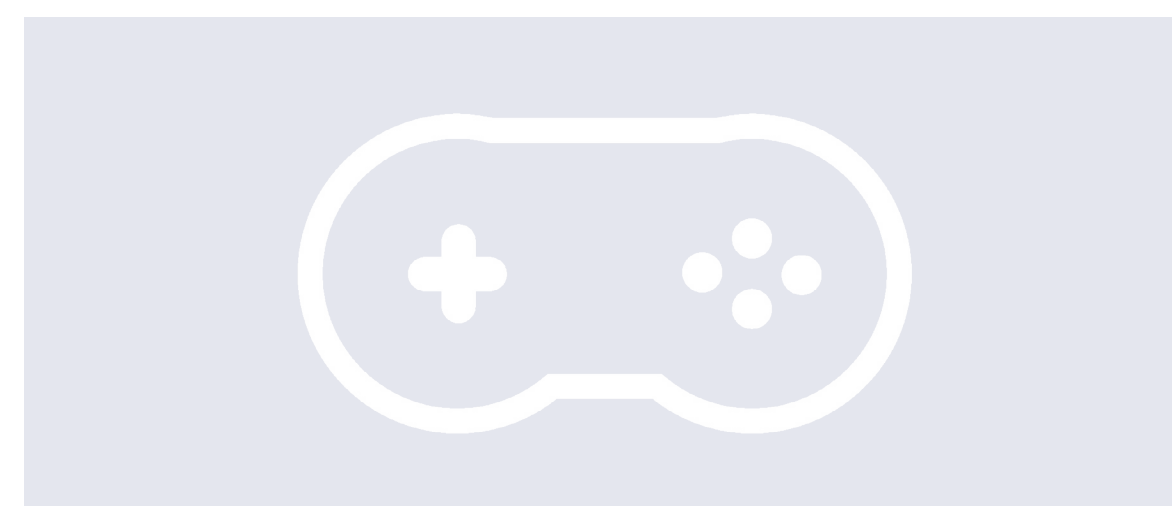
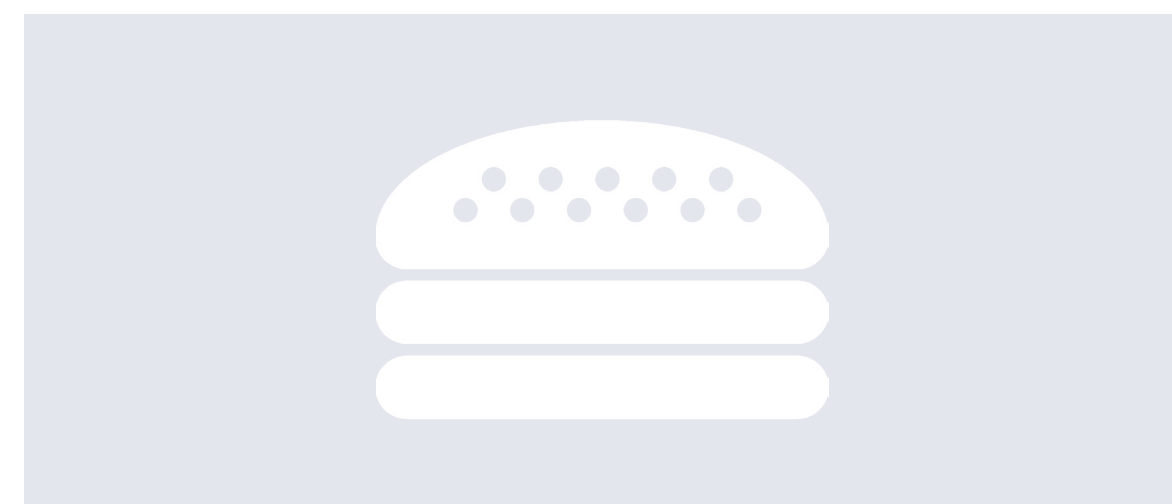
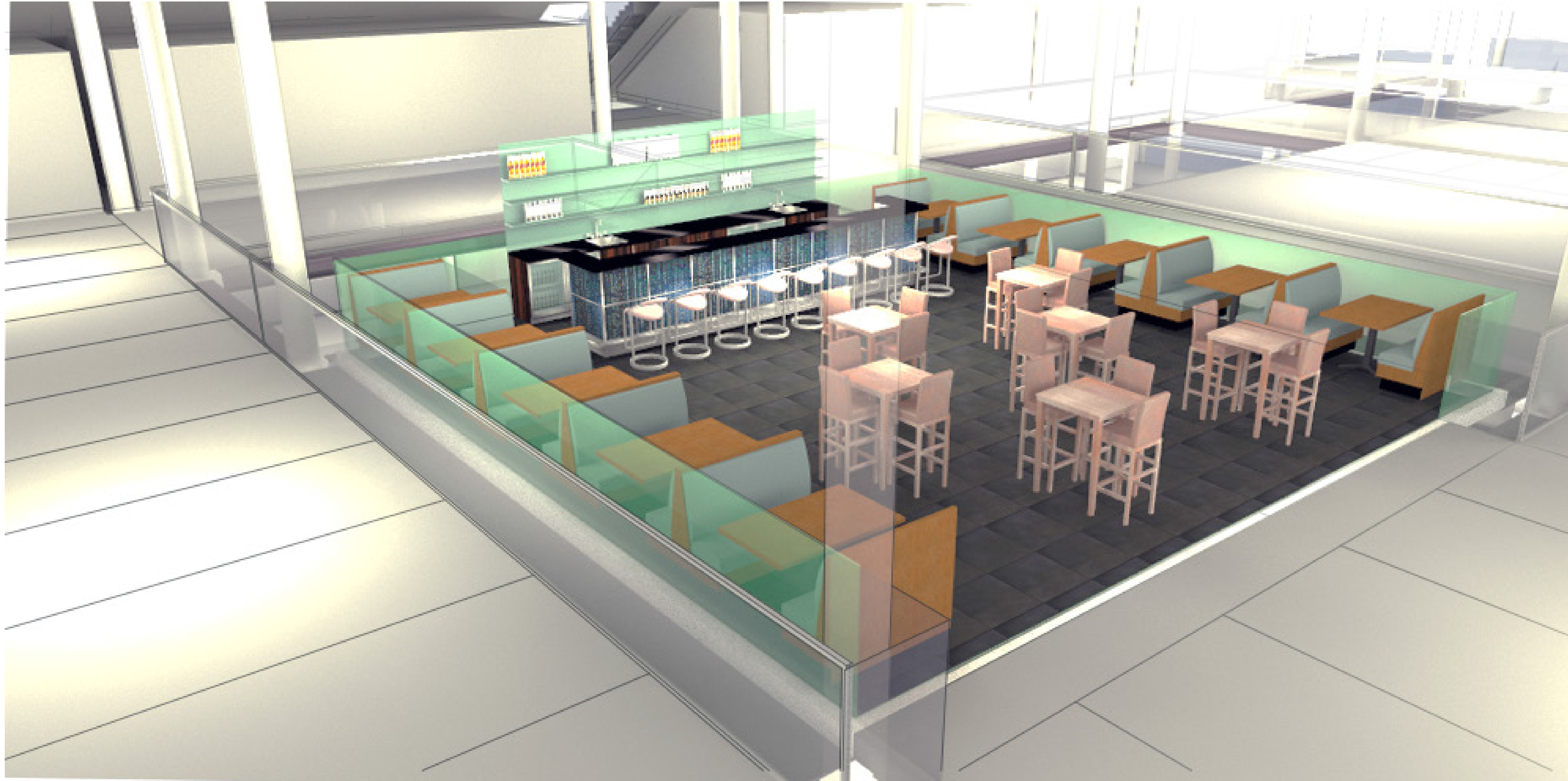
Demands:

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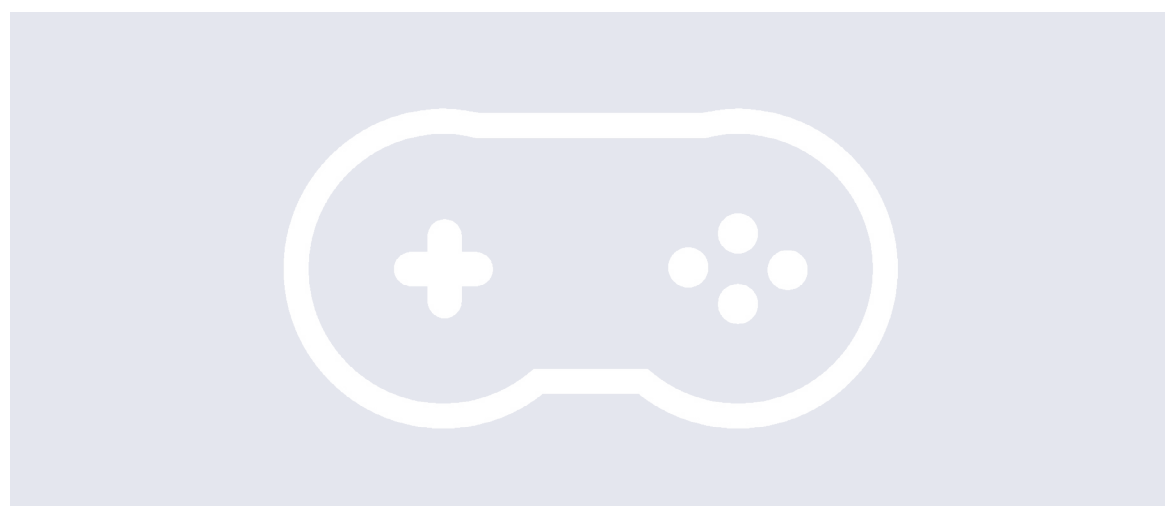
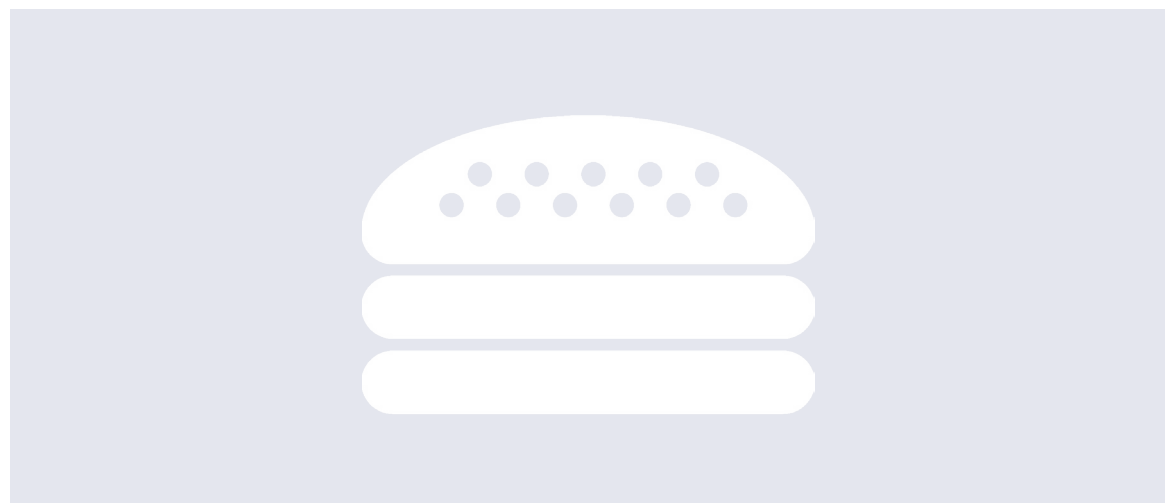
3. Design

Functions



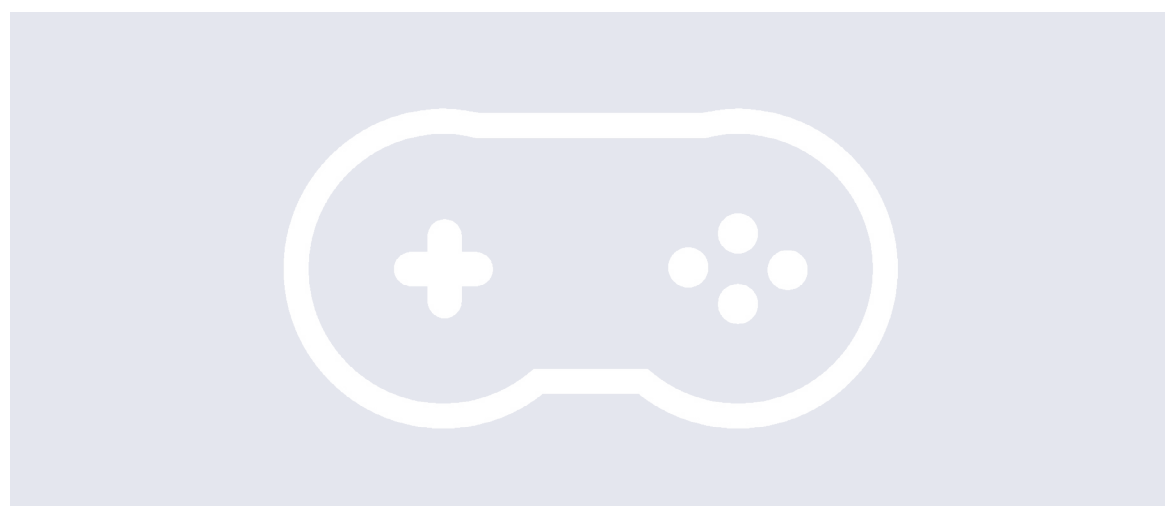
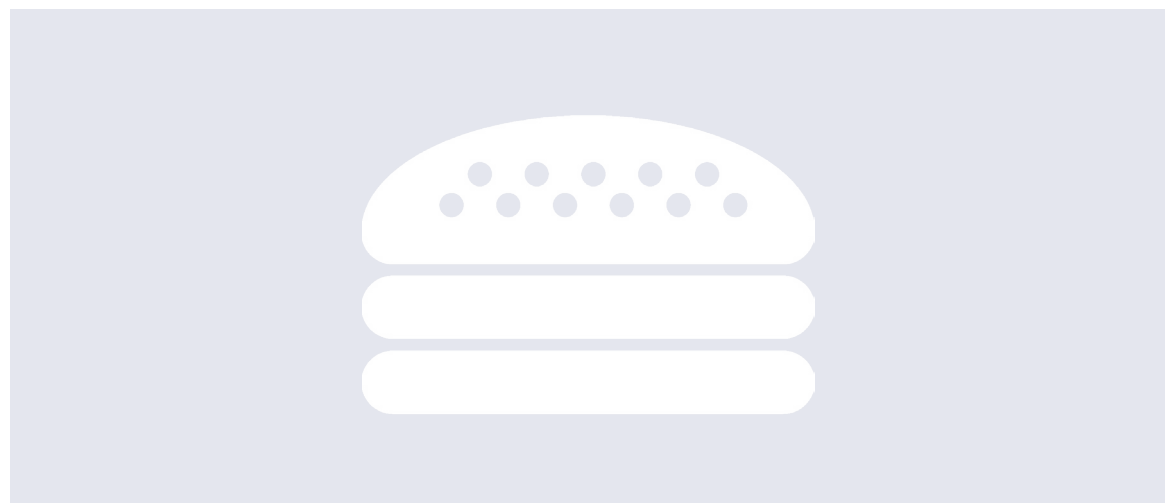
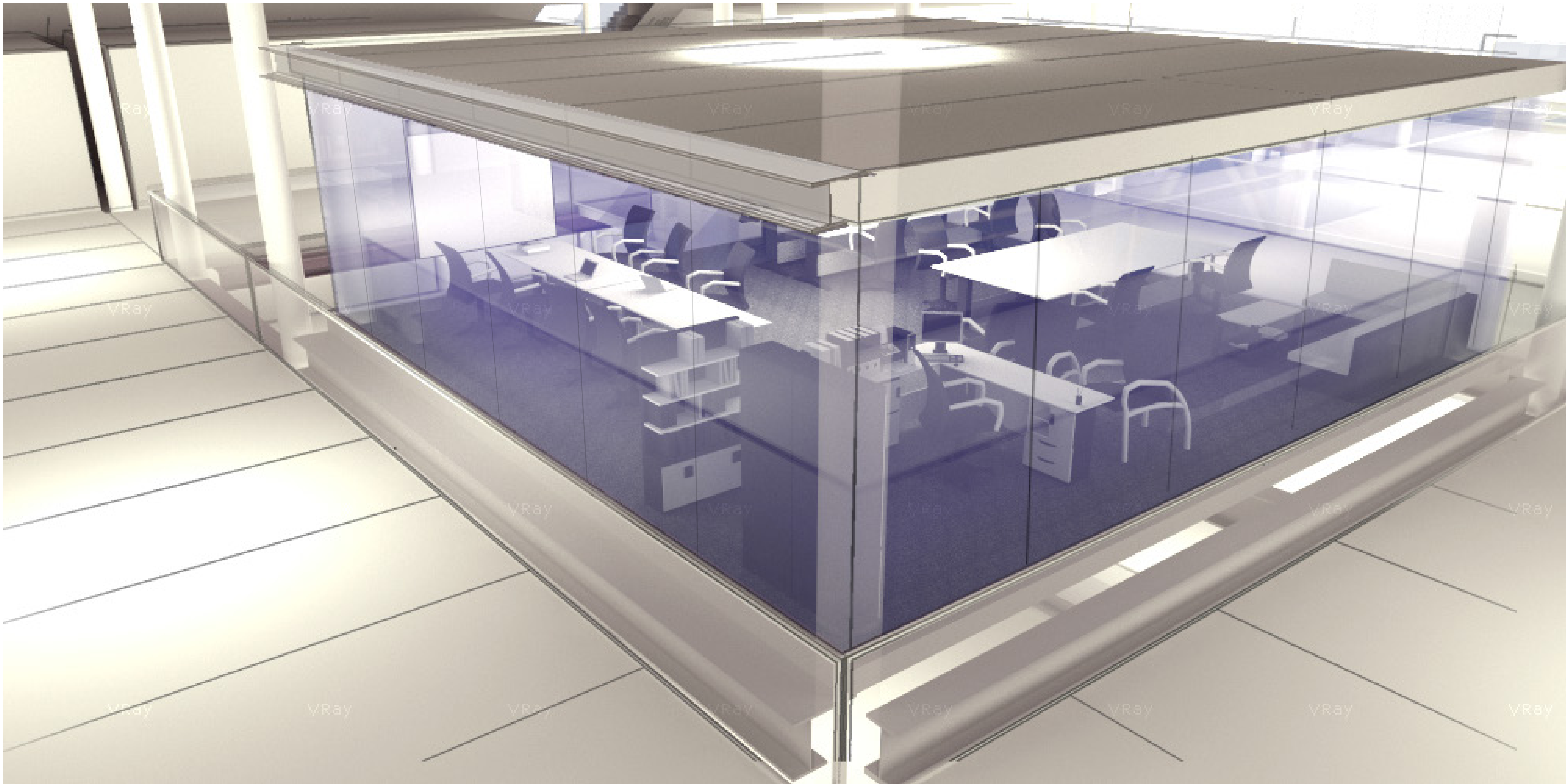
3. Design

Functions



3. Design

Functions

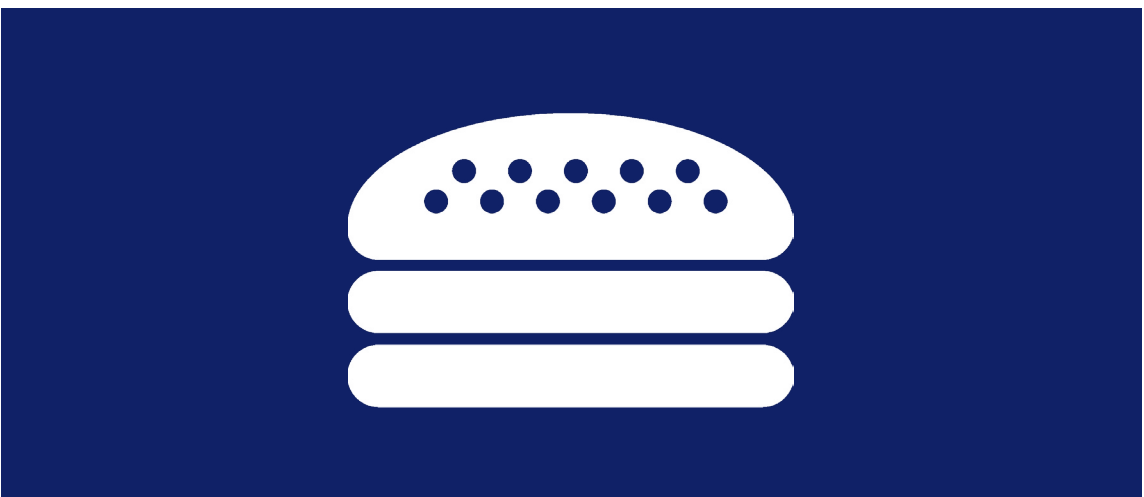
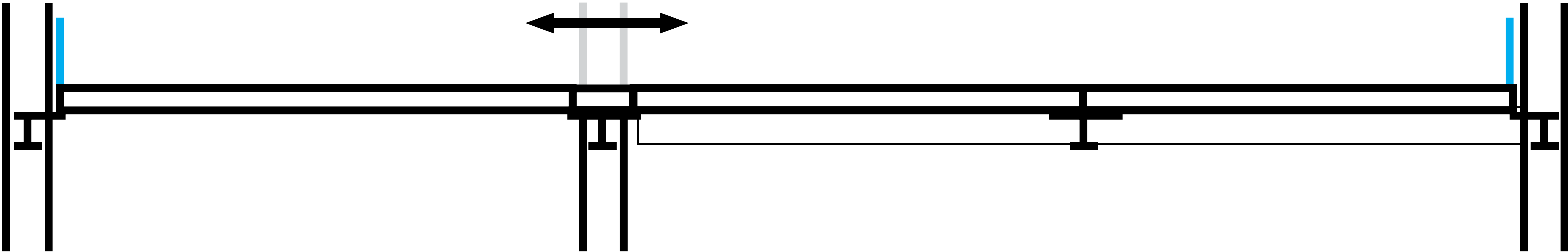


3. Design

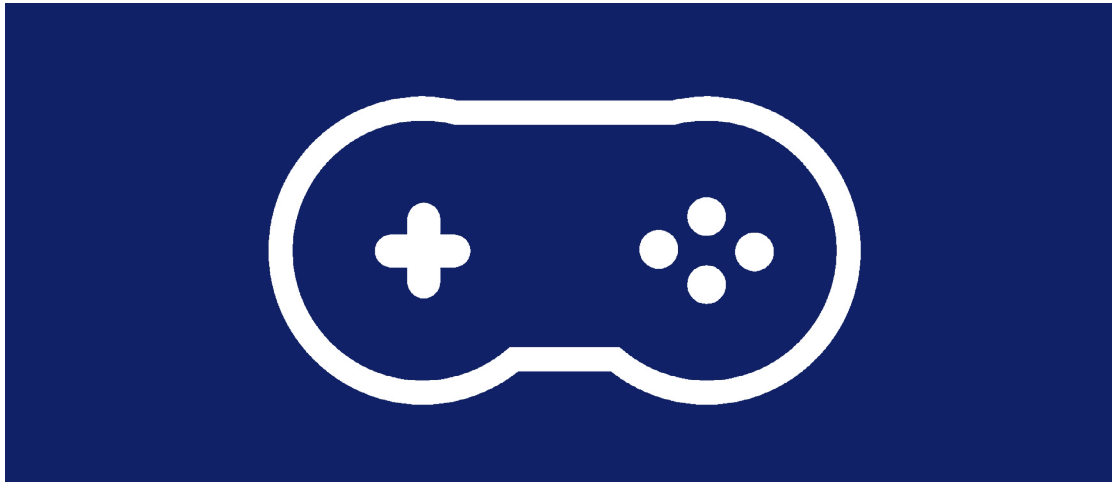
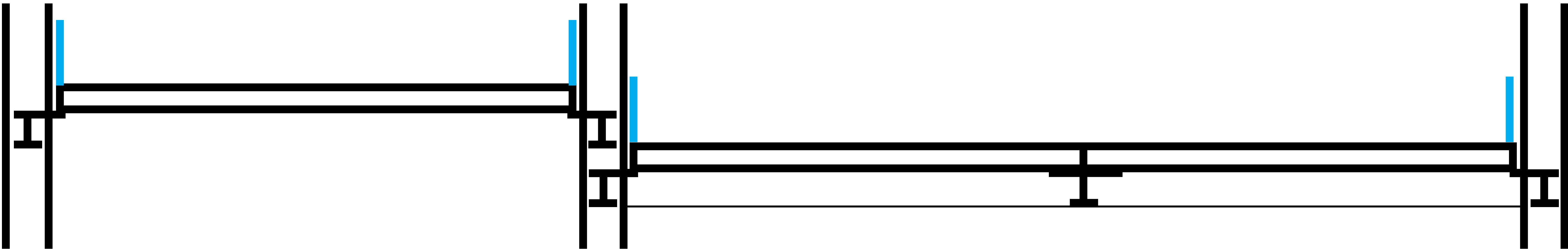
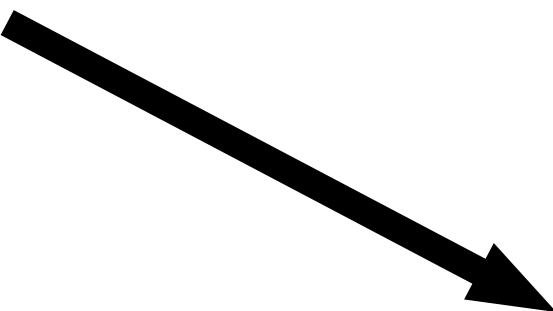
Functions

Demands:

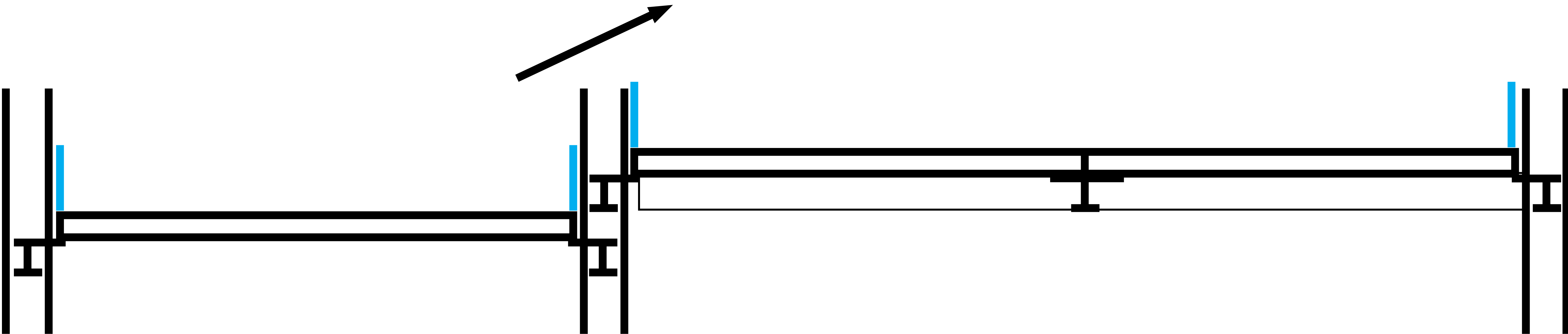
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3. Design



3. Design



3. Design



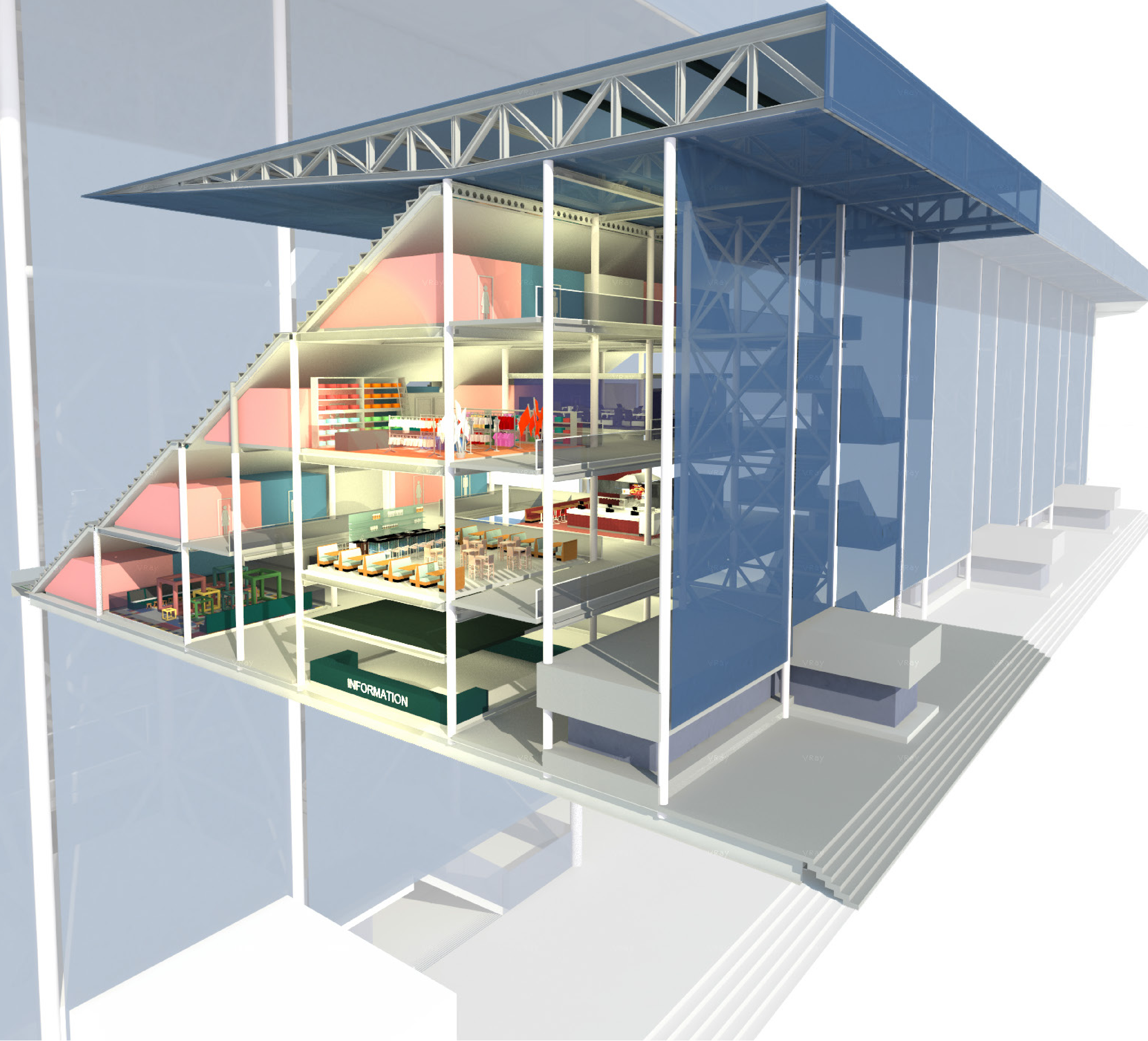
3. Design



3. Design



3. Design

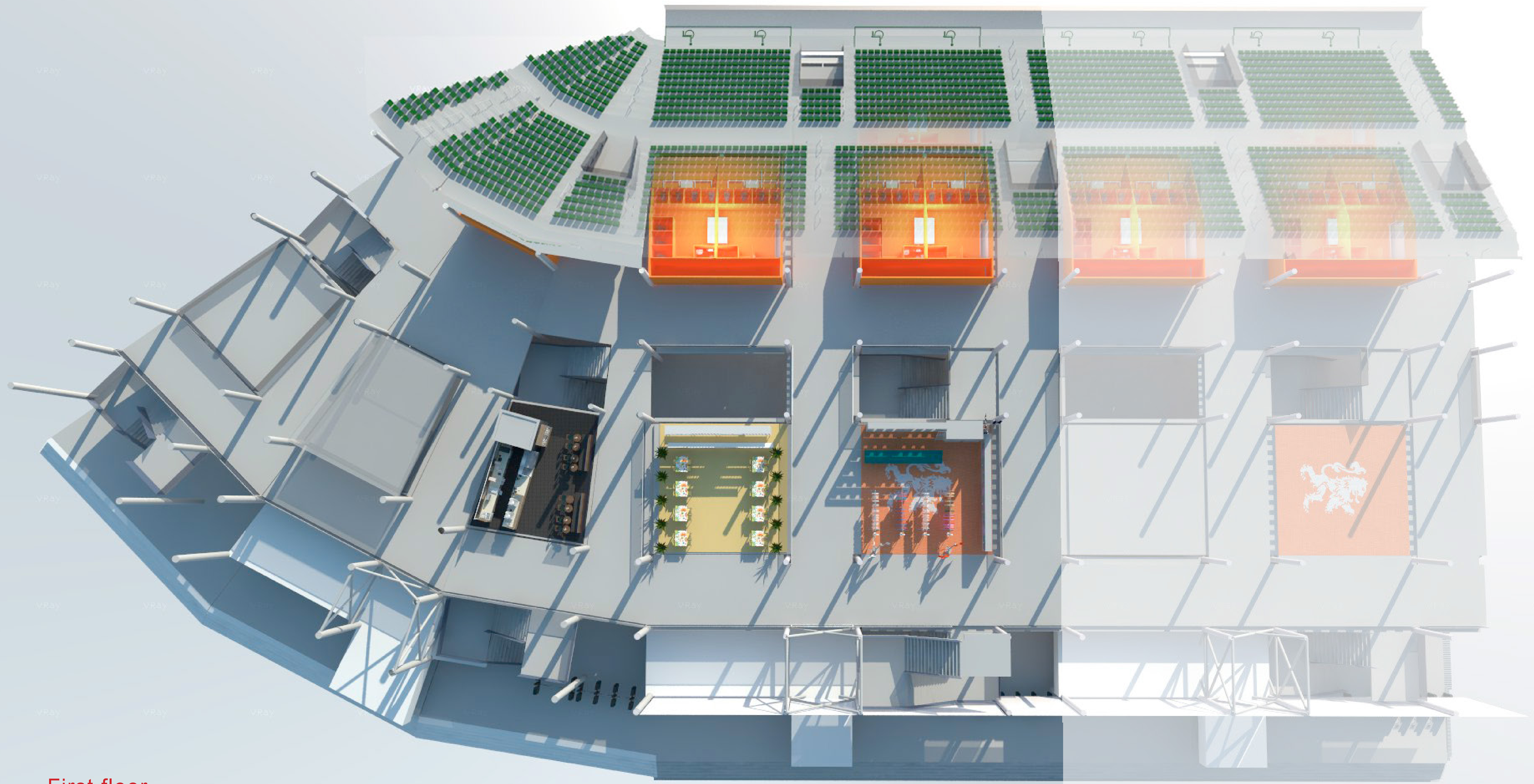


3. Design

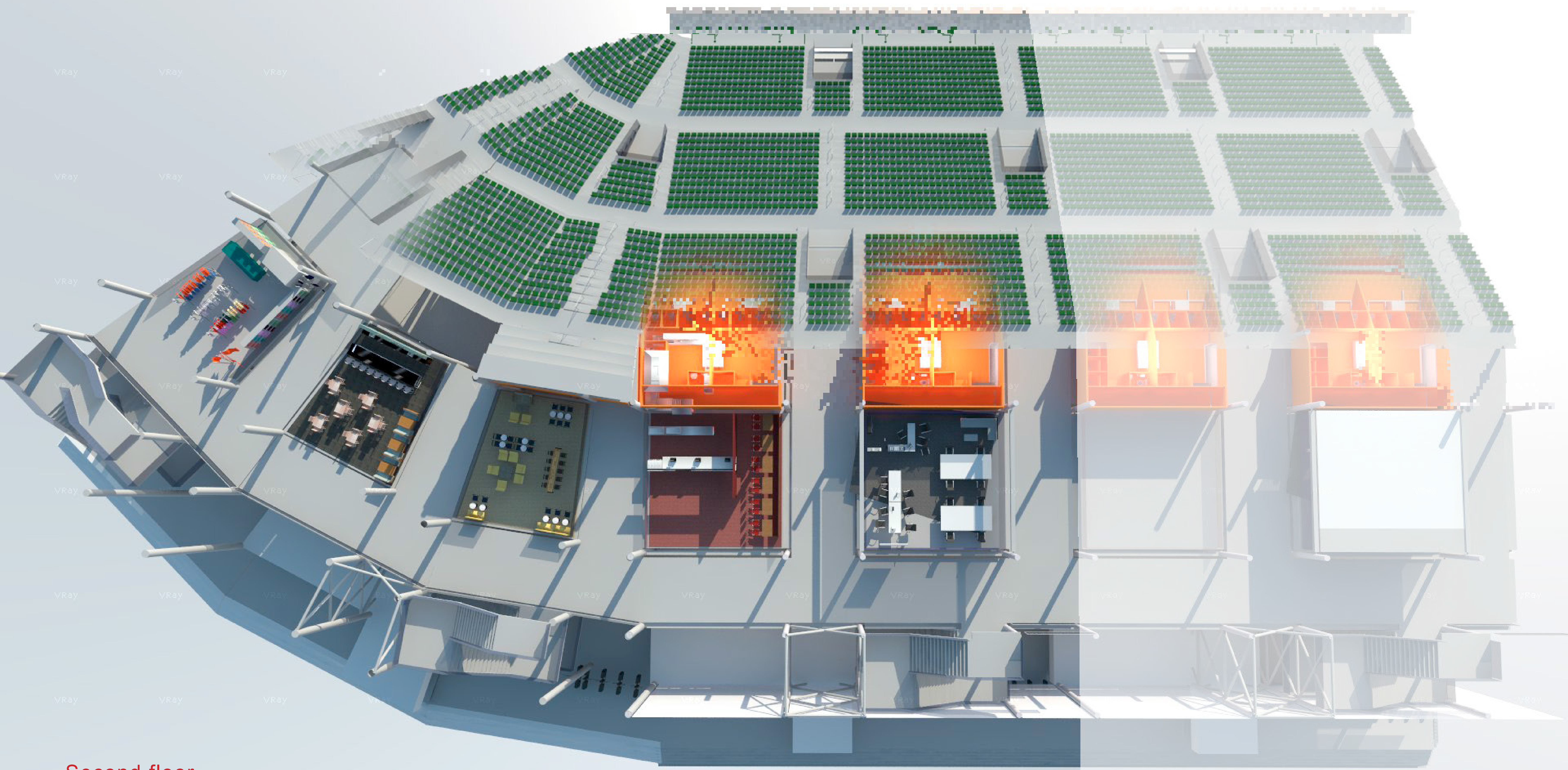




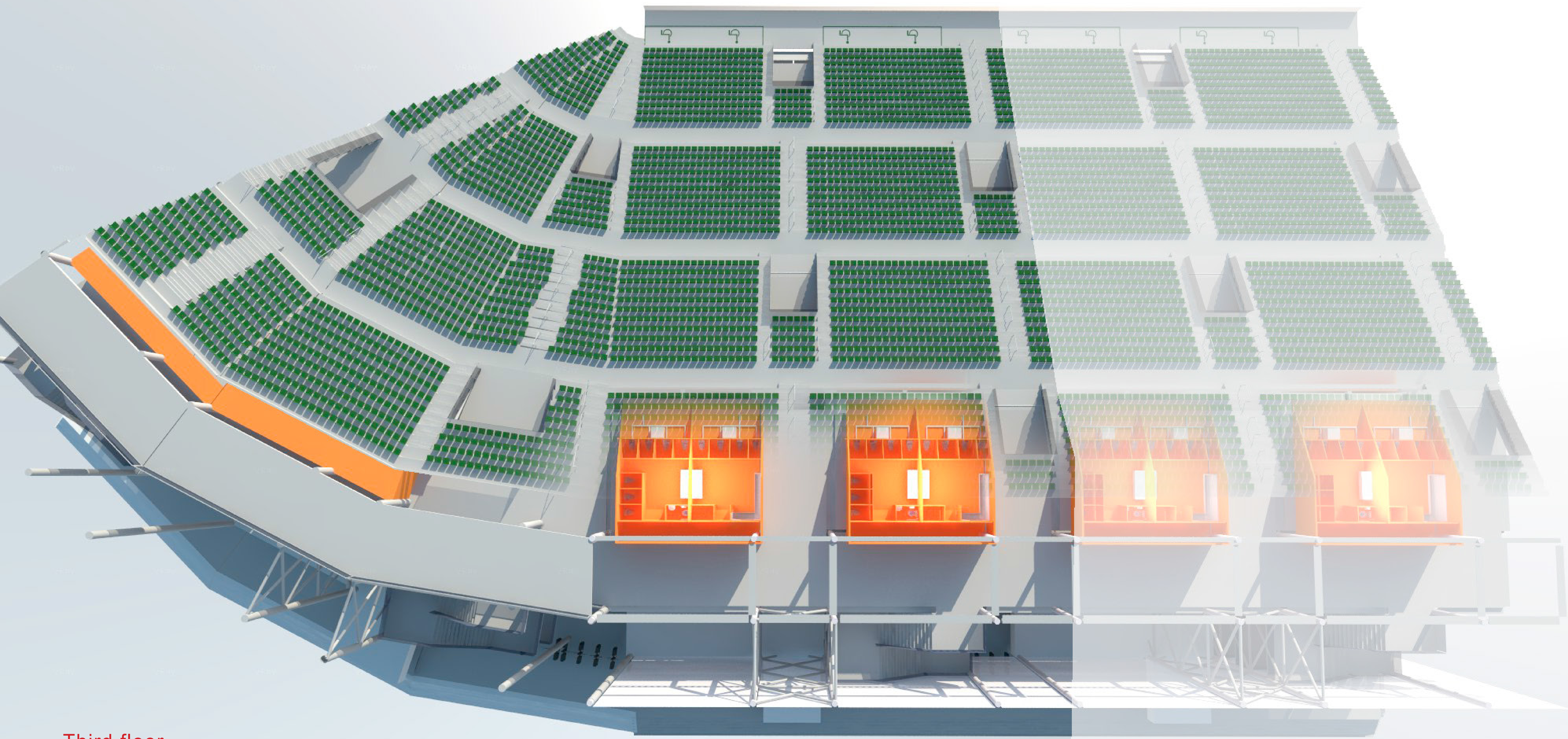
Ground floor



First floor



Second floor



Third floor

3. Design

Plinth

Demands:

- . Create awareness of entering a building, but do this gradually
- . Welcome people with disabilities as well



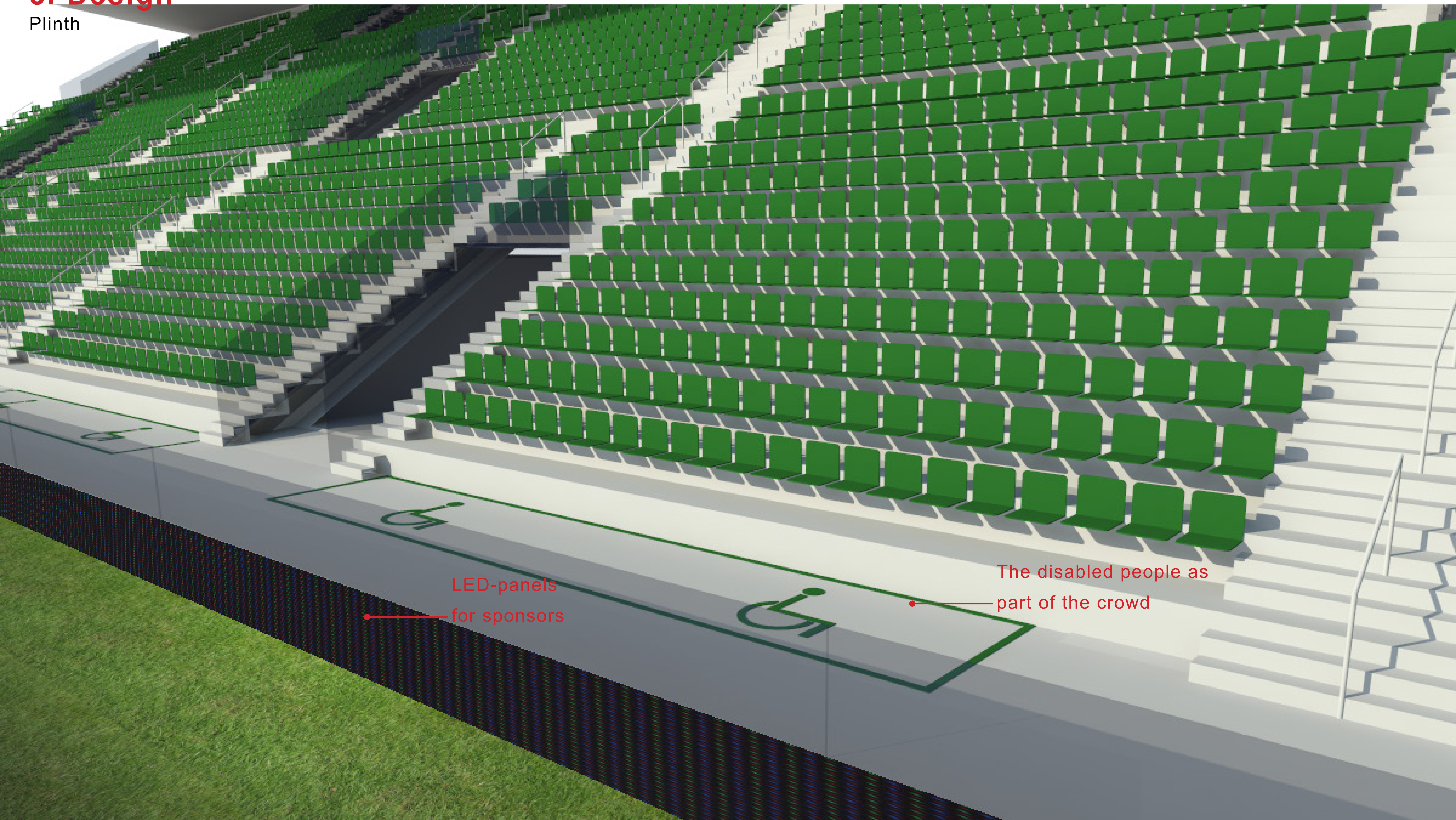
3. Design

Plinth



3. Design

Plinth



LED-panels
for sponsors

The disabled people as
part of the crowd

3. Design

Plinth



3. Design

Façade

Demands:

- . Changeable for every location, using the same building principle
- . Interactive, representing what the event organiser wants
- . Still meeting the conceptual goals
- . Easily transportable

3. Design

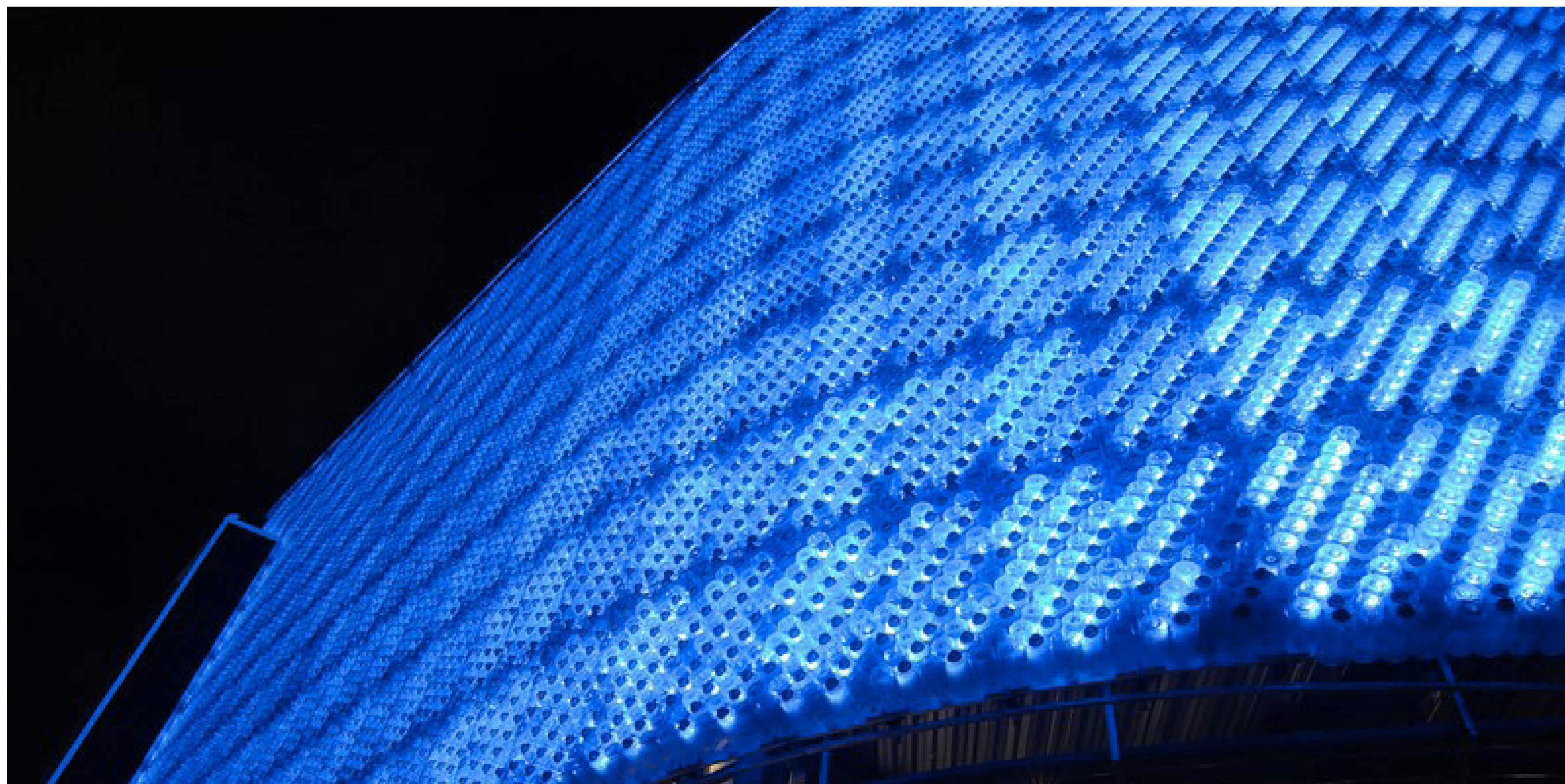
Façade options



LED-screen



ETFE-foil



Polli-bricks



Textiles

3. Design

Textiles



Are lightweight materials

Can easily be transported

Cover a great surface

Can easily be assembled

Can function as a projection screen

Can be printed in any desired print

Can have almost any desired opacity and translucency



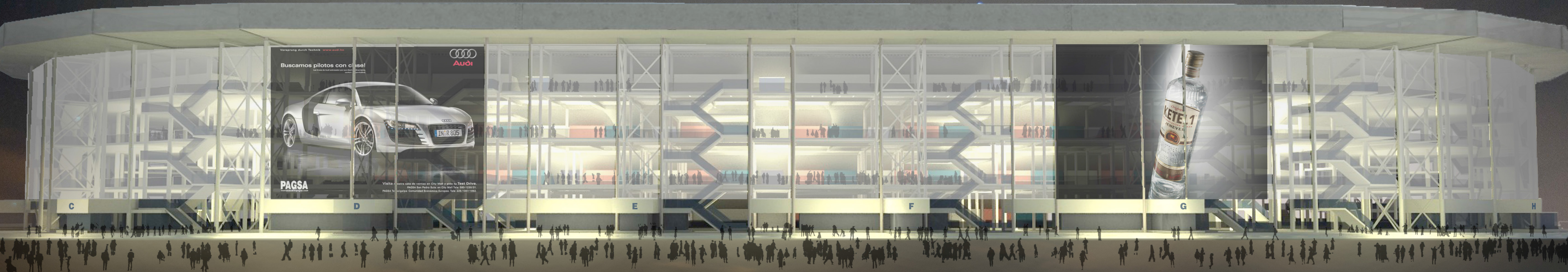
3. Design

Façade



3. Design

Façade - projections



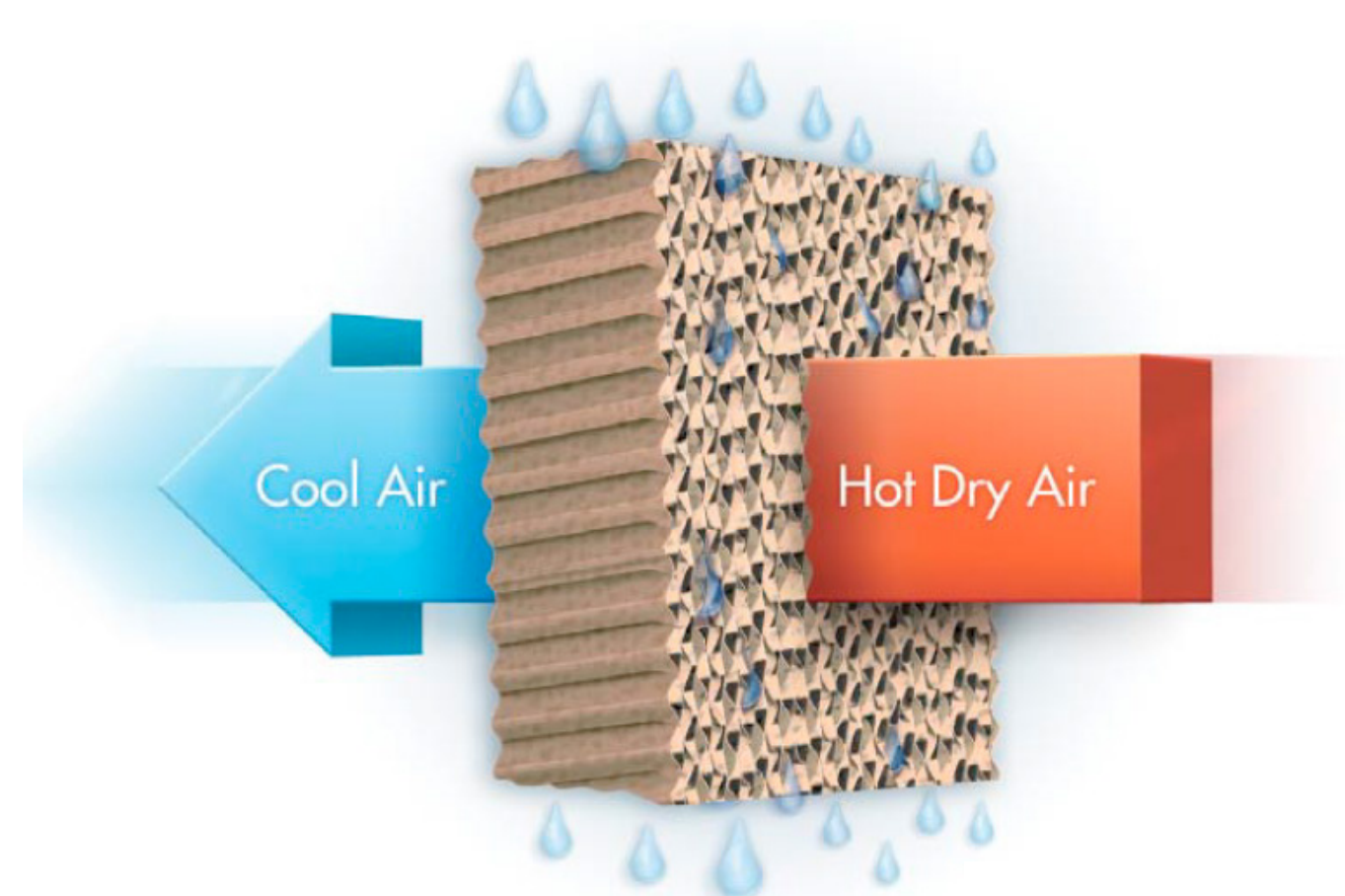
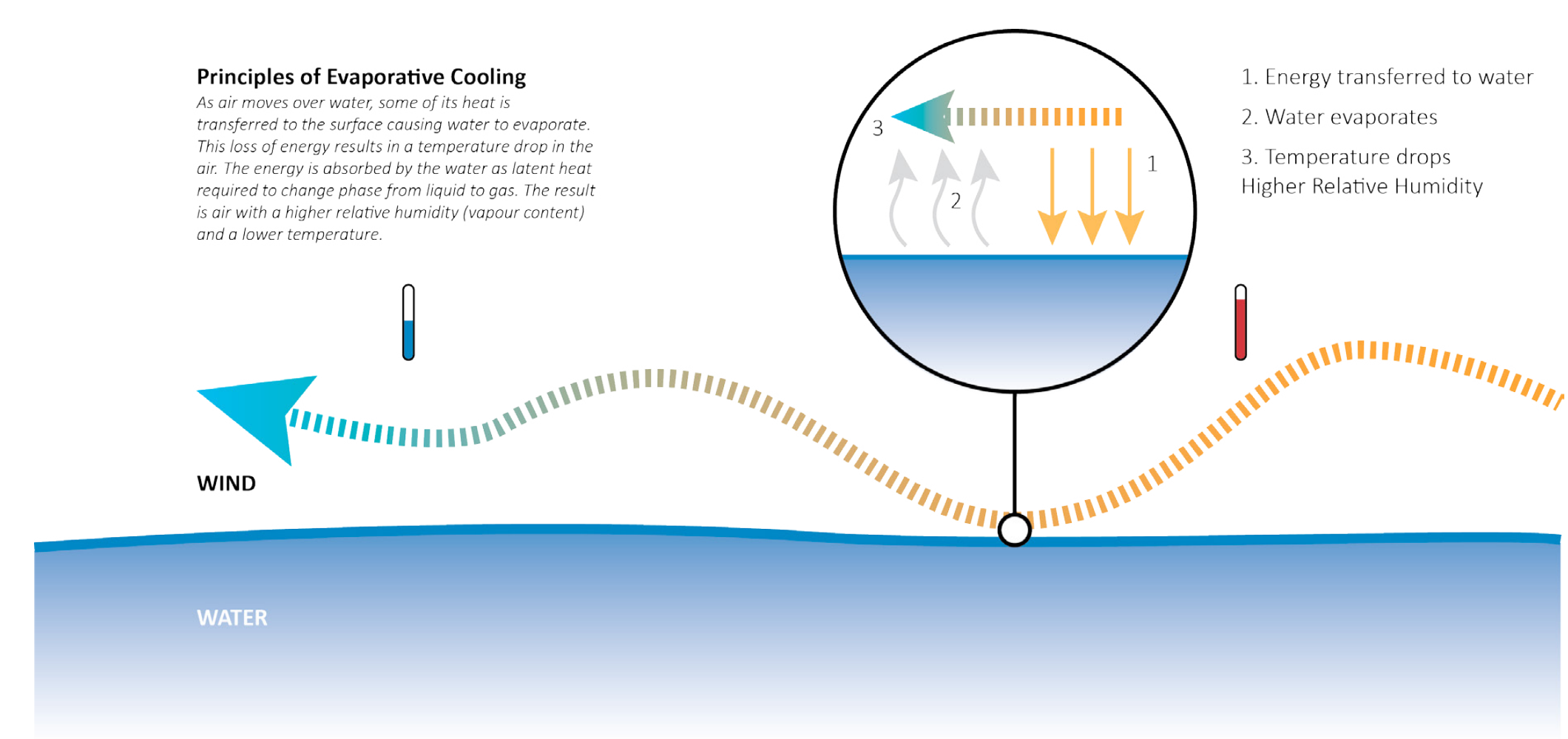
3. Design

Façade - playful with light

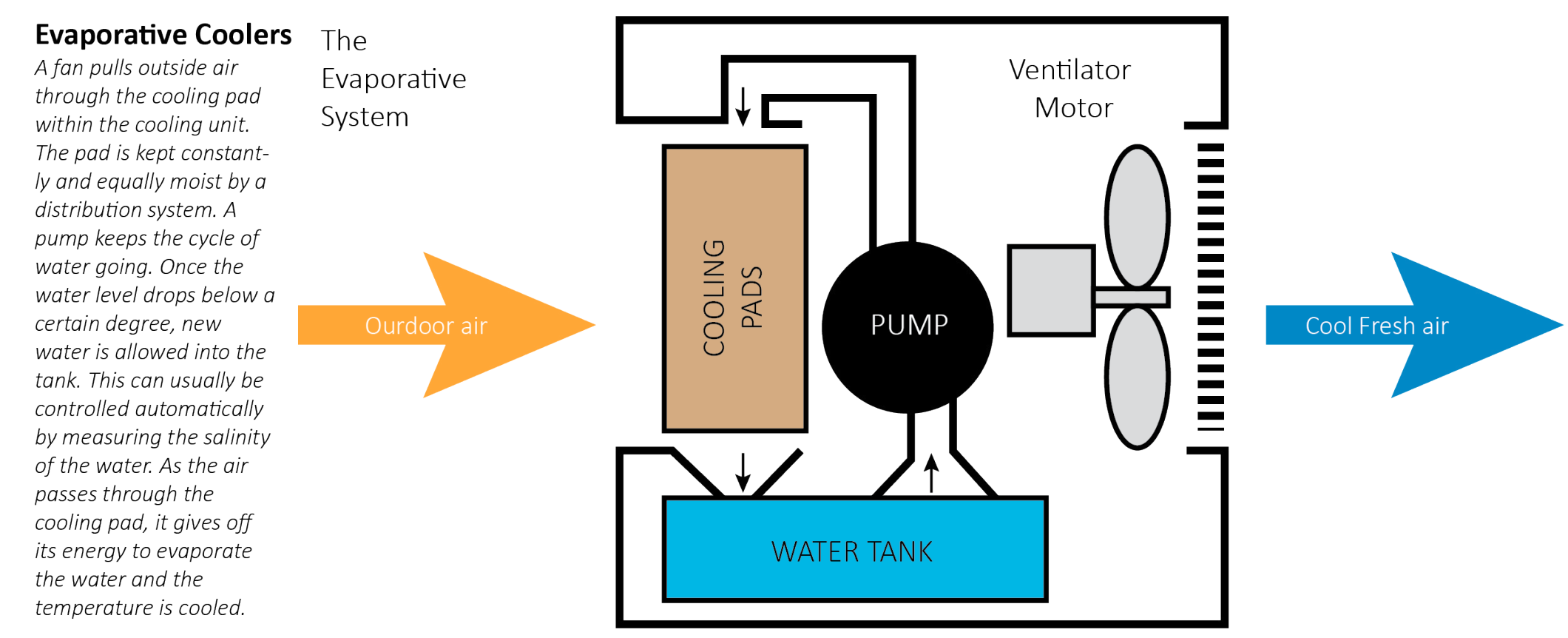


3. Design

Façade - Evaporative cooling in hot and dry climates



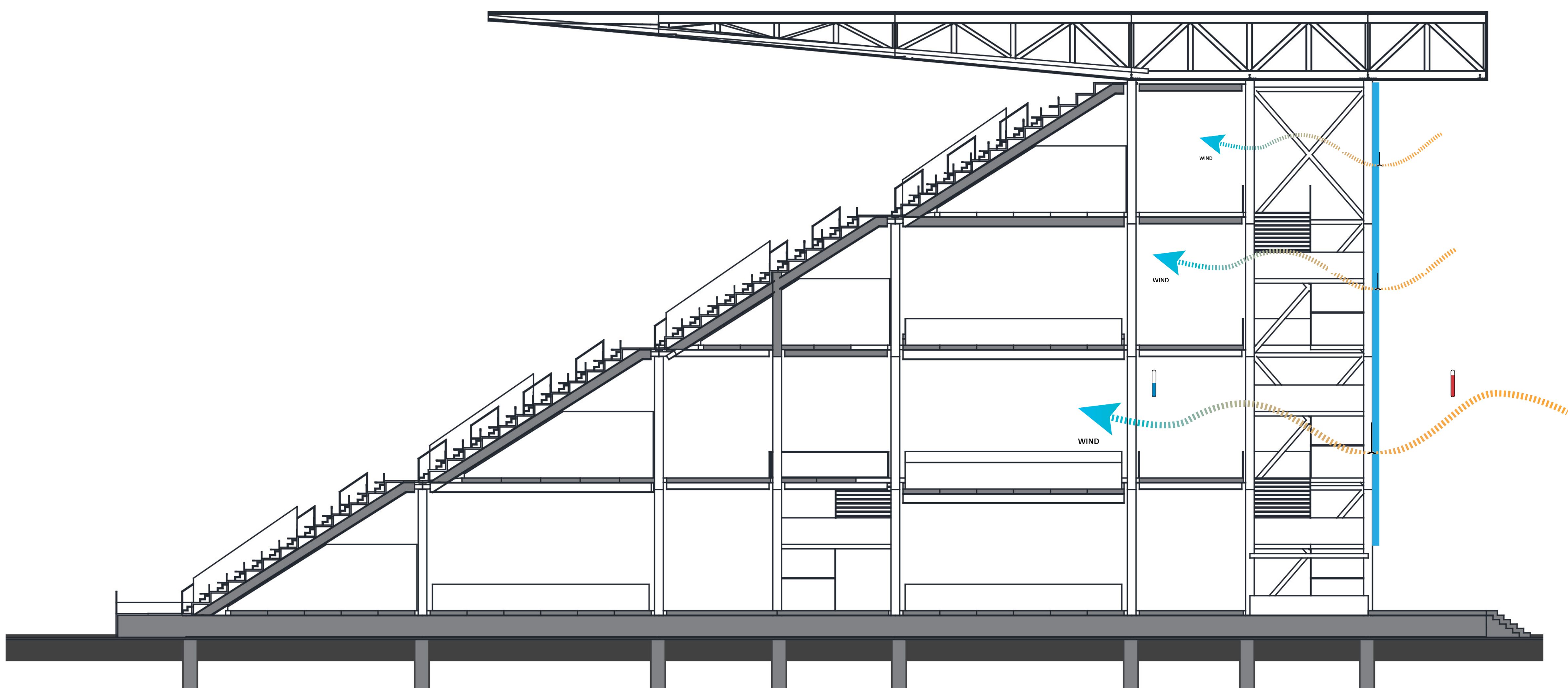
Source: Kuulaire (2013)



Naji (2014)
“Aquarena: The Coolest stadium in the world (cup)”
Graduation Project Architecture, TU Delft

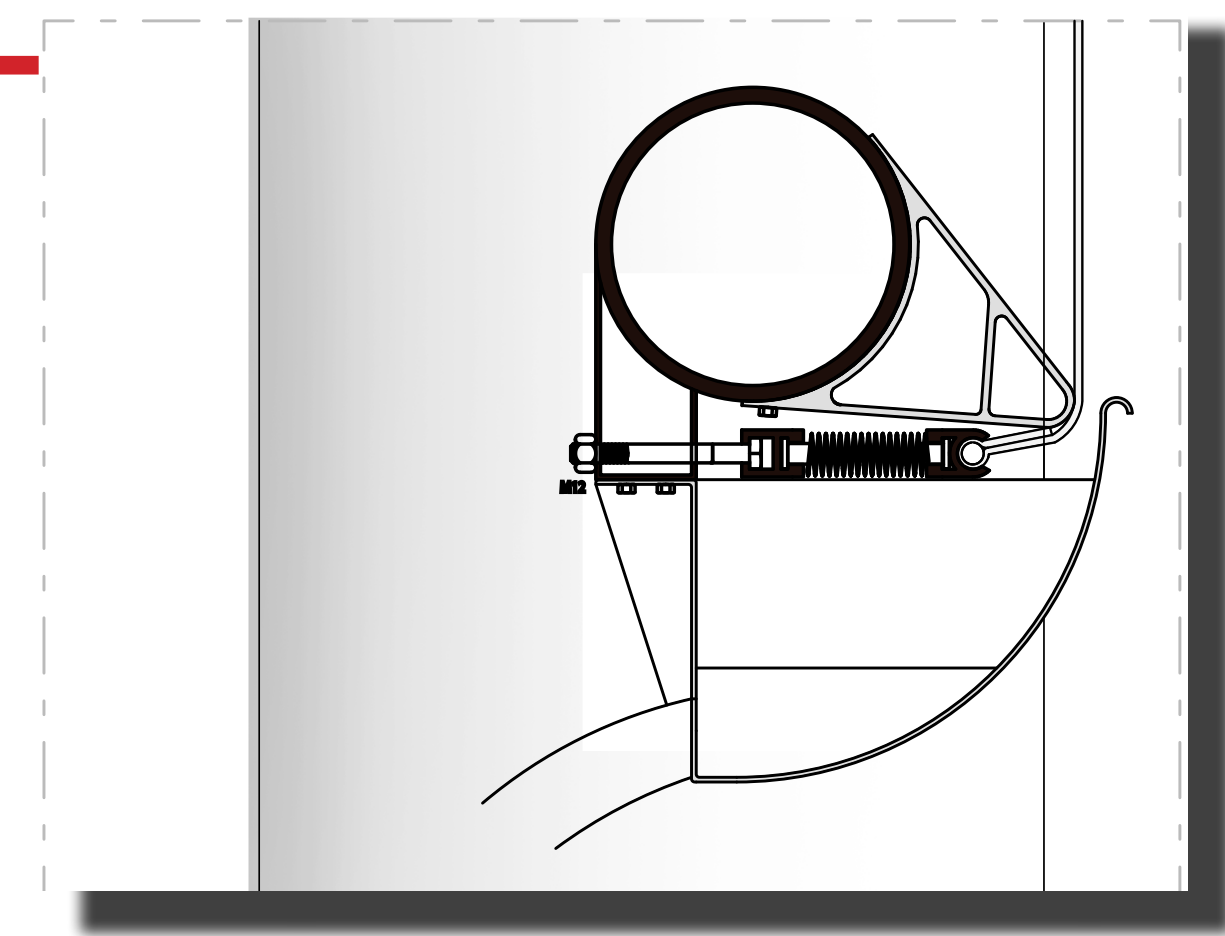
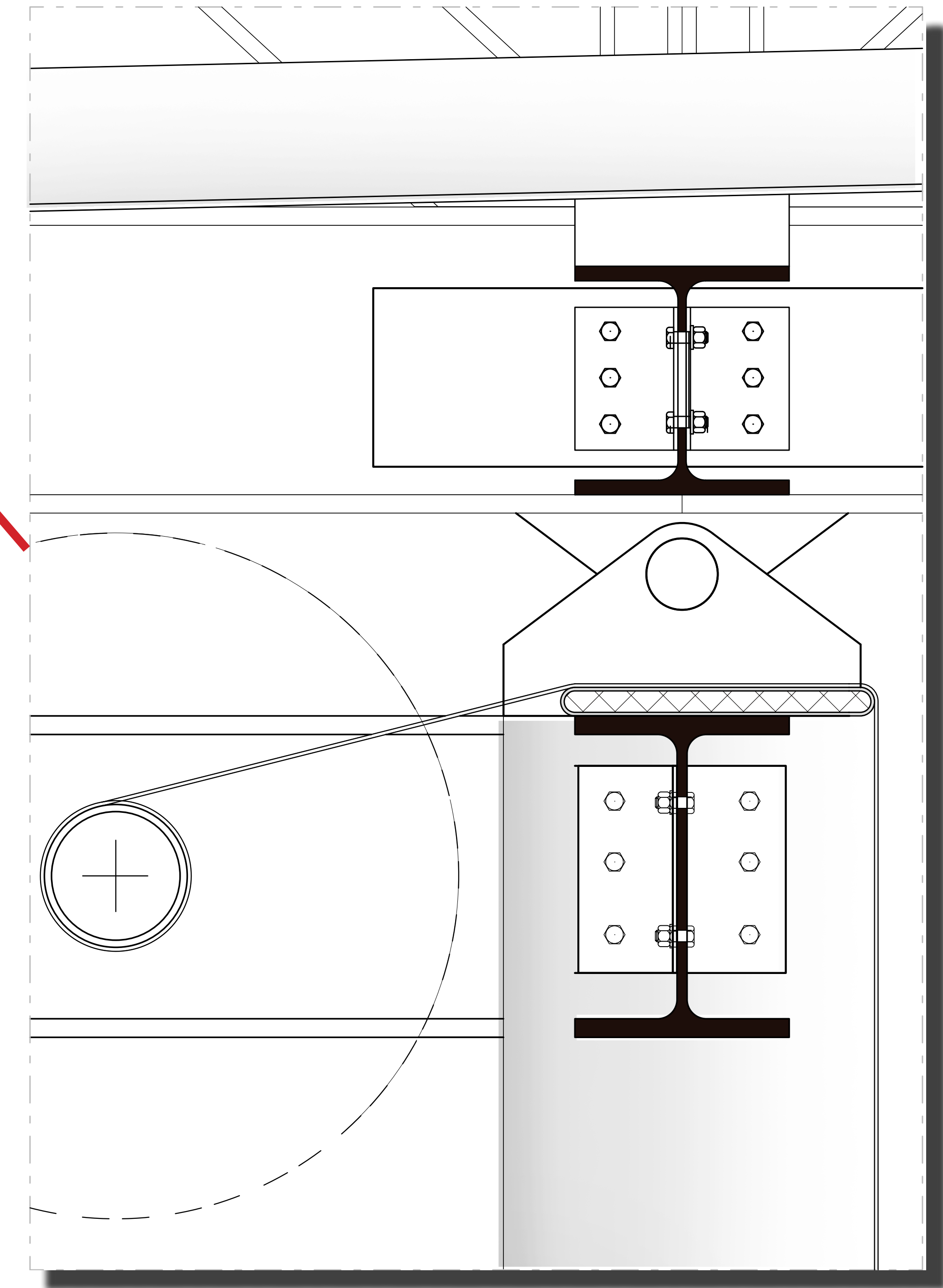
An air temperature reduction by evaporating water into the air stream. Adiabatic process: energy is lost from the air into the water as latent heat transforms the water into vapour thus causing a drop in air temperature.

Temperature and humidity
How higher the temperature ‘outside’ the more vapour it can absorb. For evaporative cooling: the drier the climate the more effective the cooling will be.



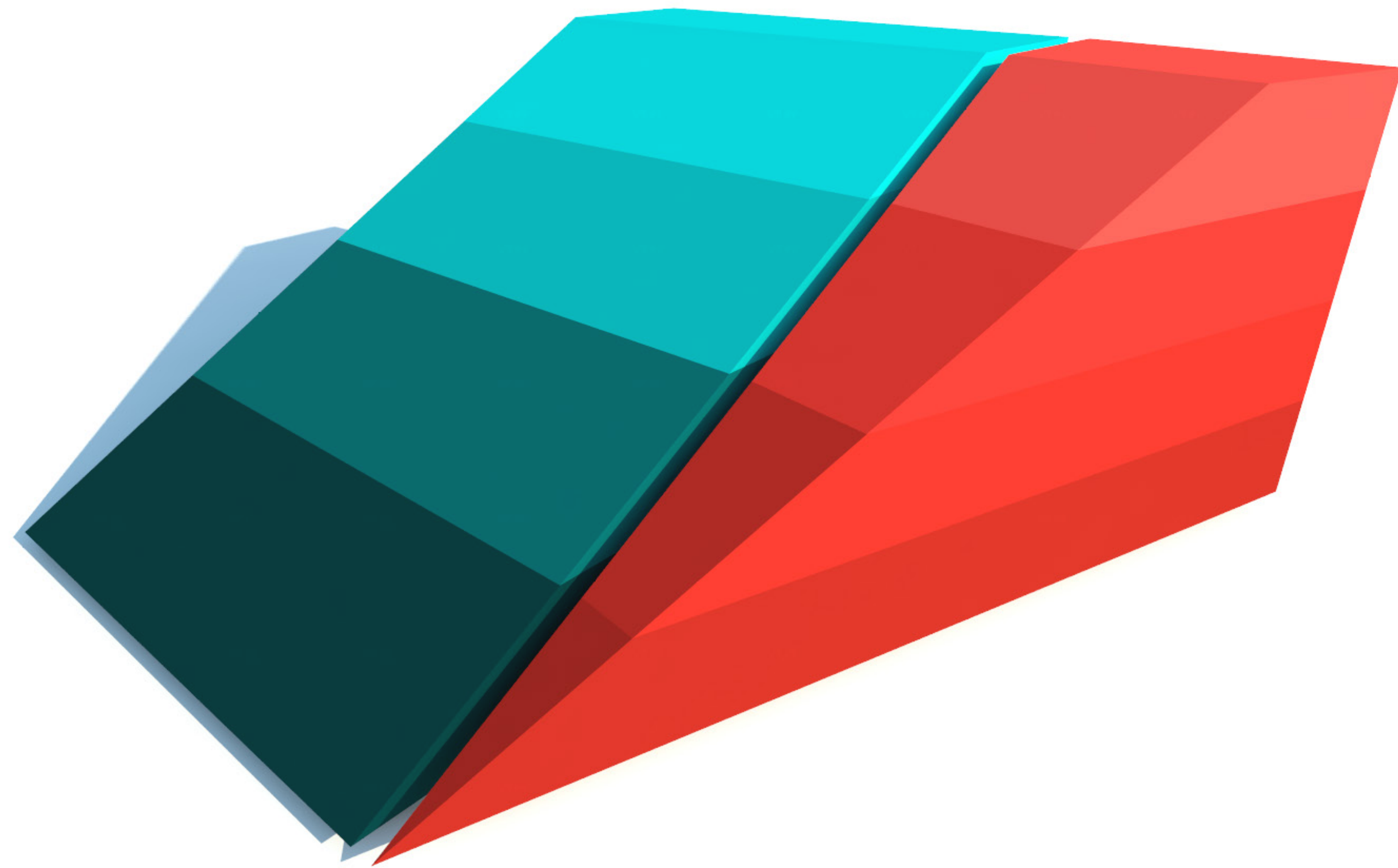
3. Design

Façade - Detail



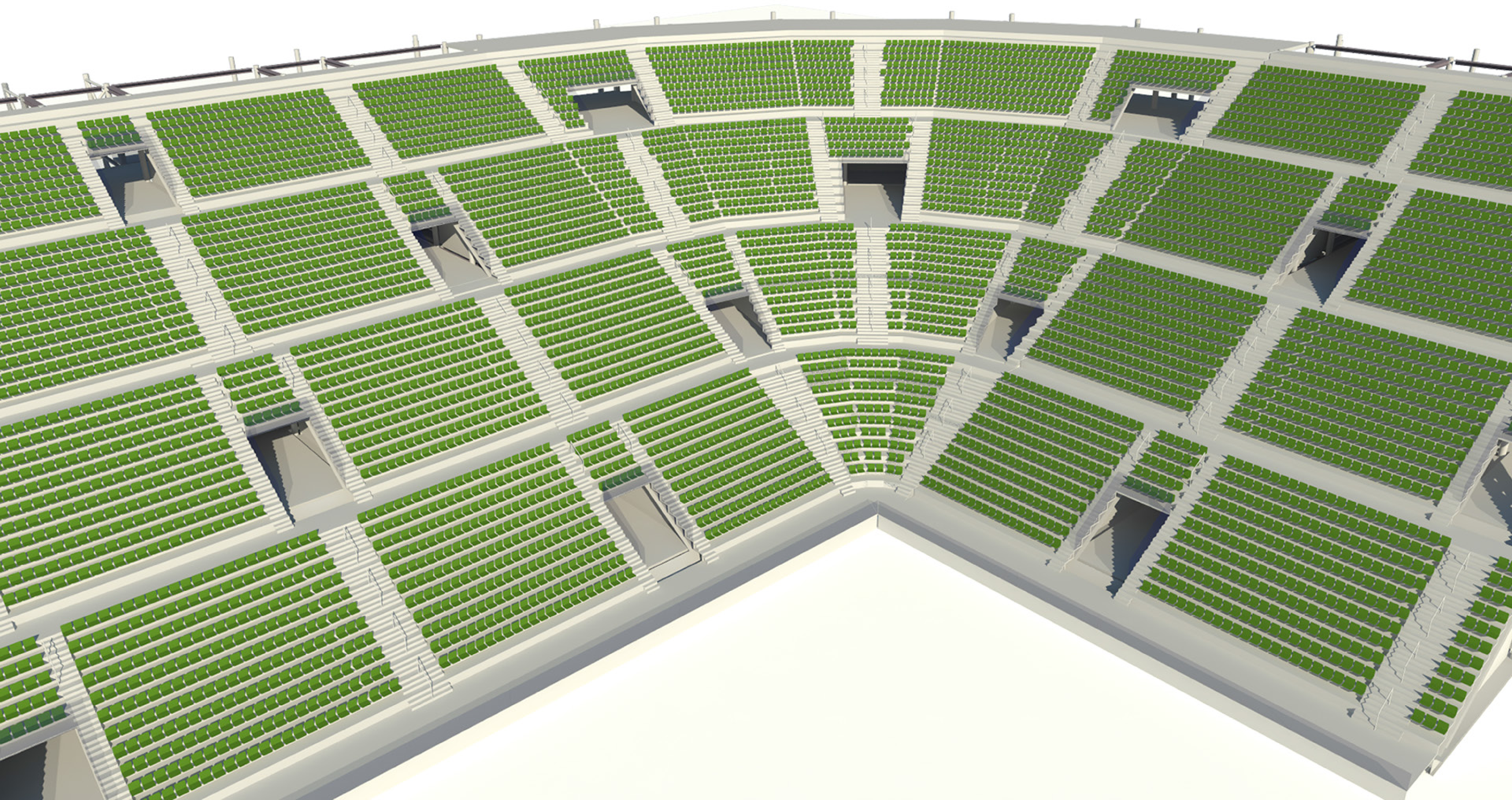
3. Design

Curvature



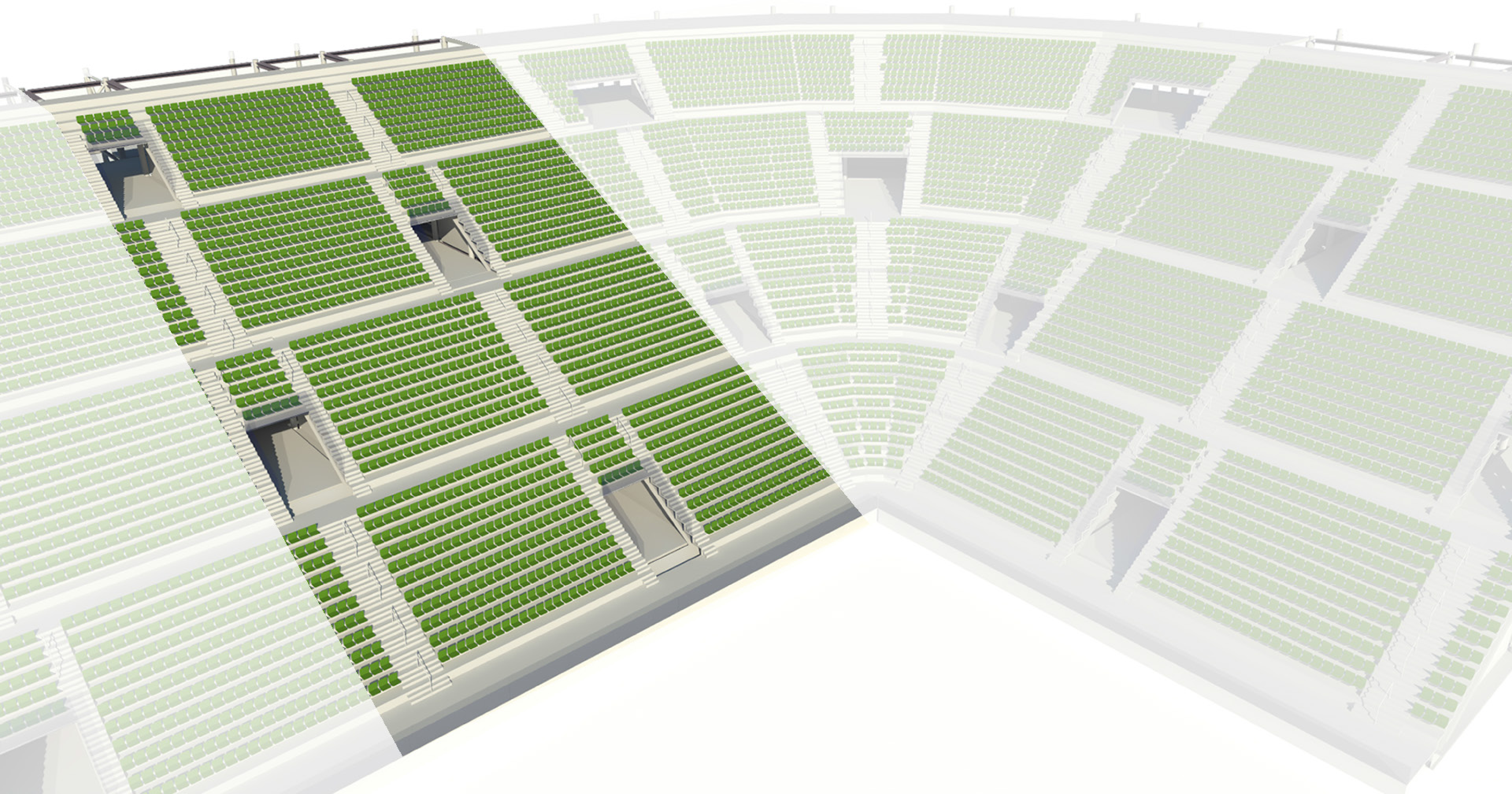
3. Design

Curvature



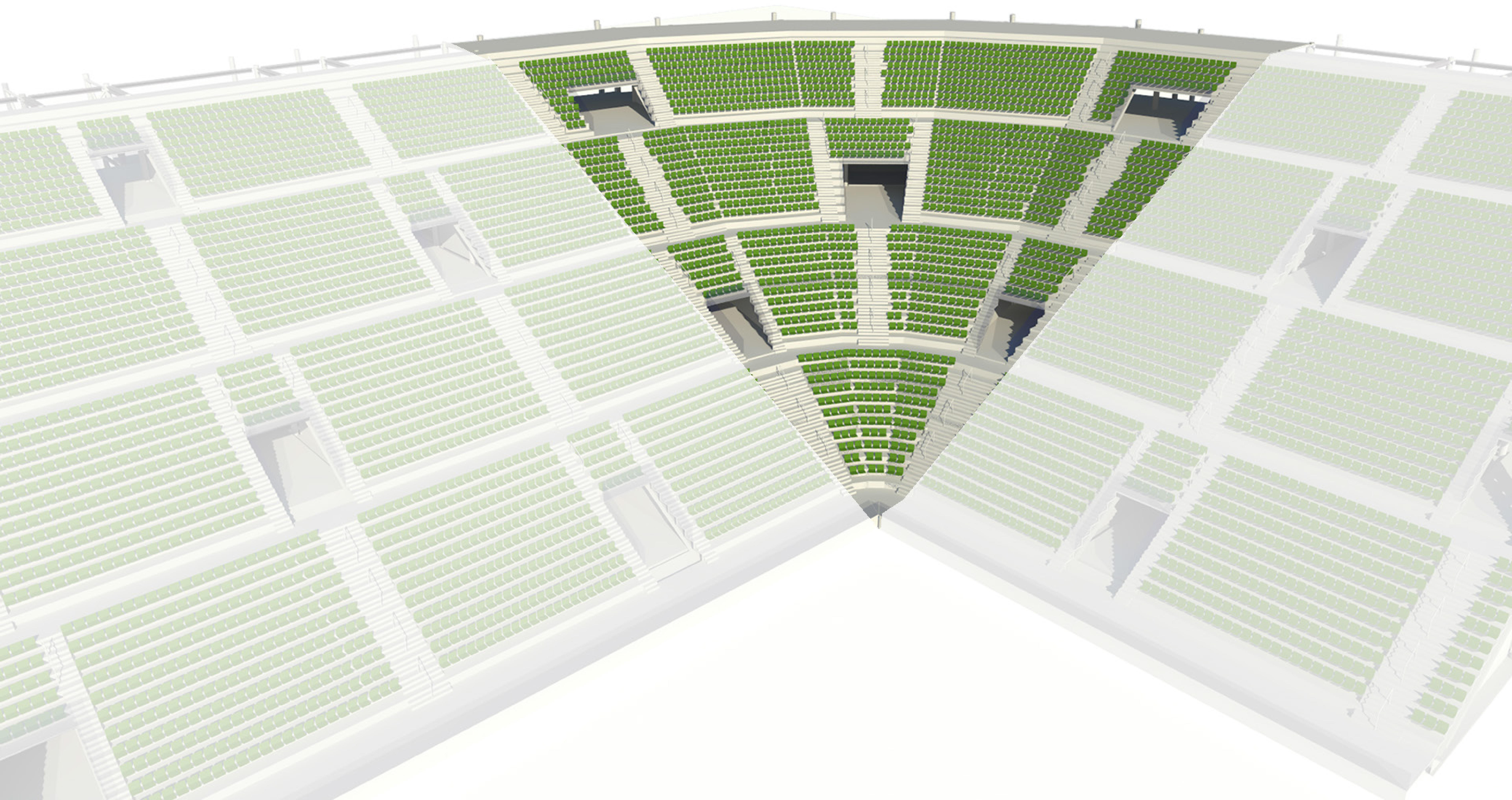
3. Design

Curvature



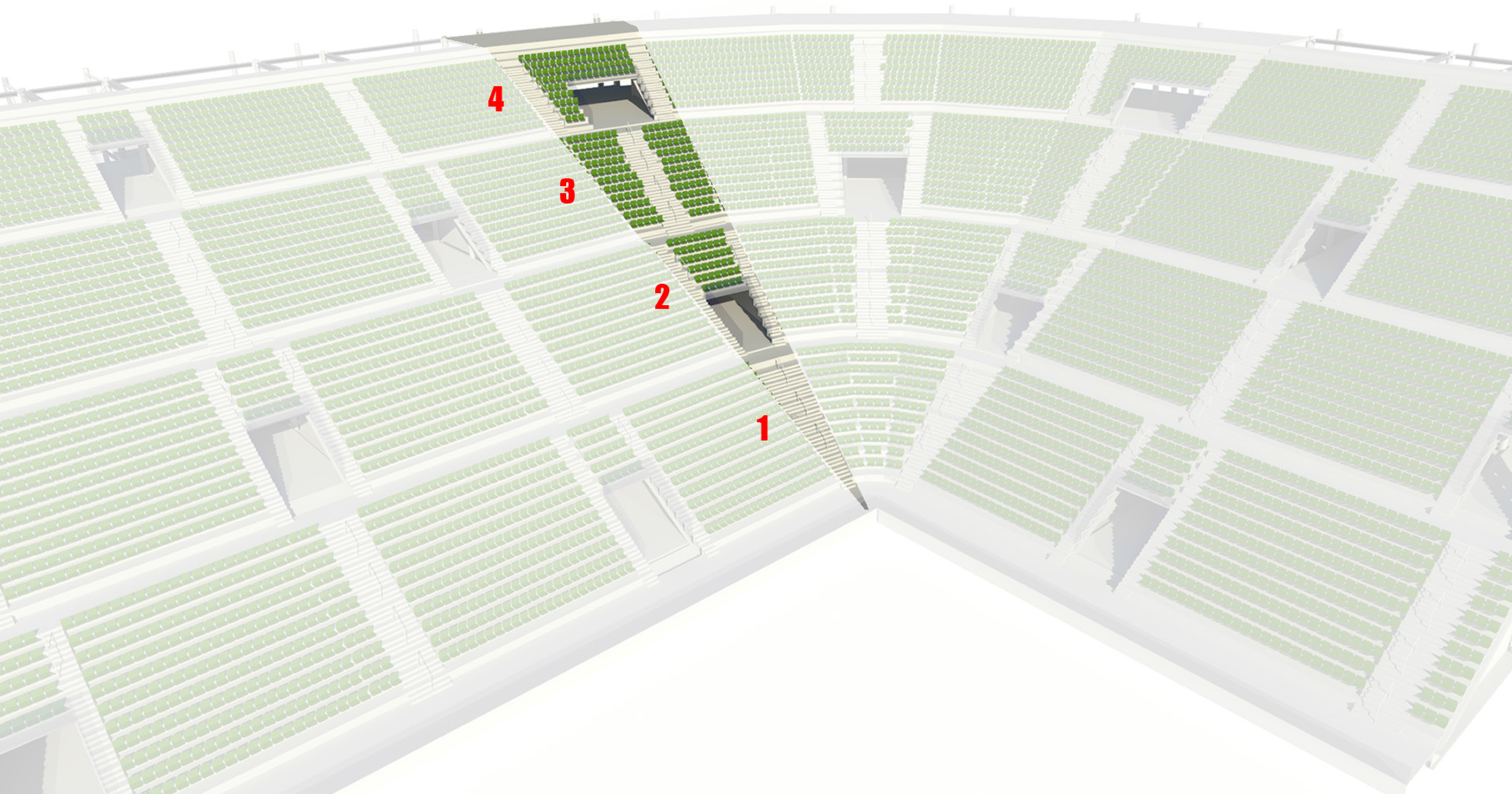
3. Design

Curvature



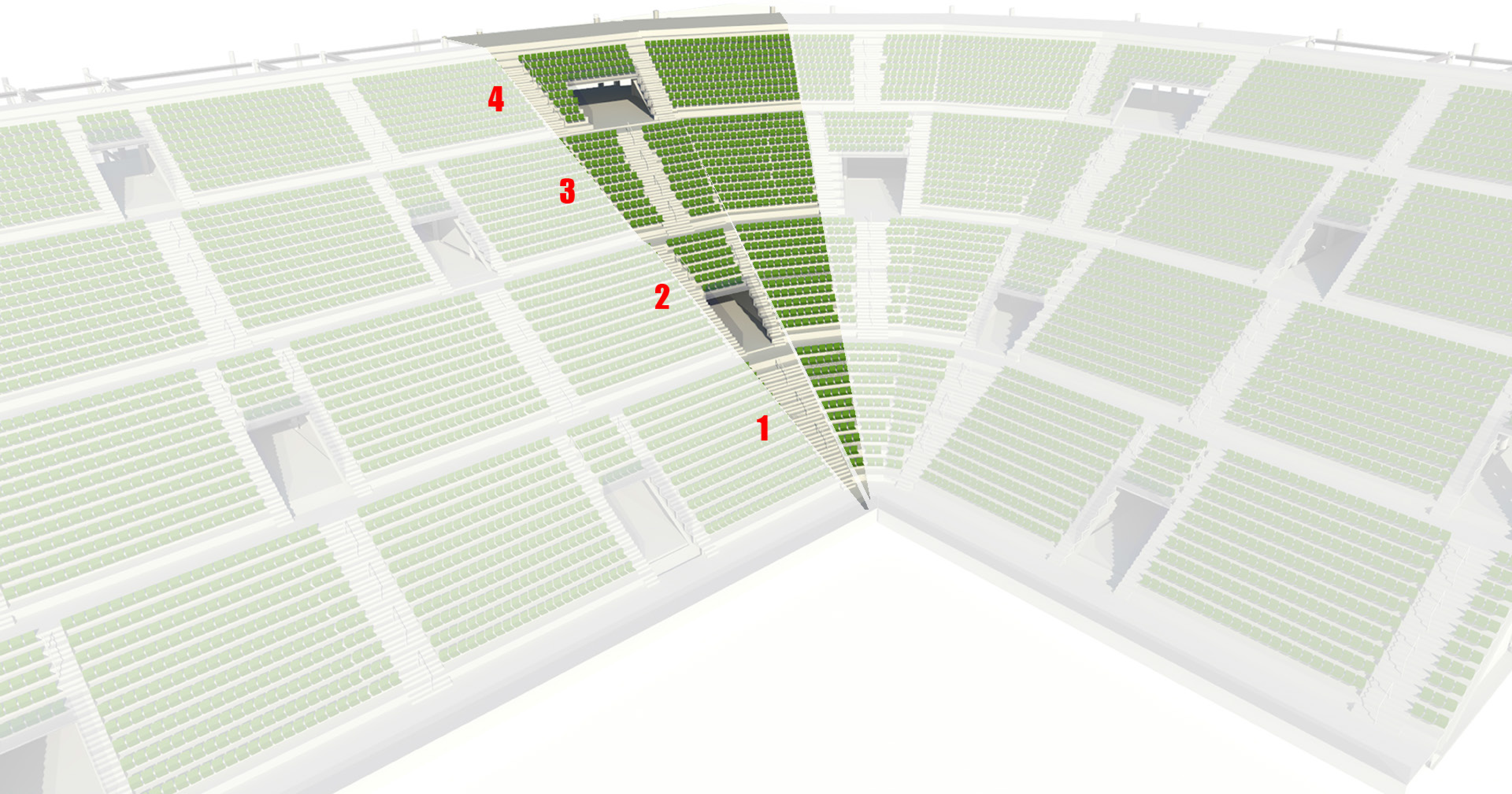
3. Design

Curvature



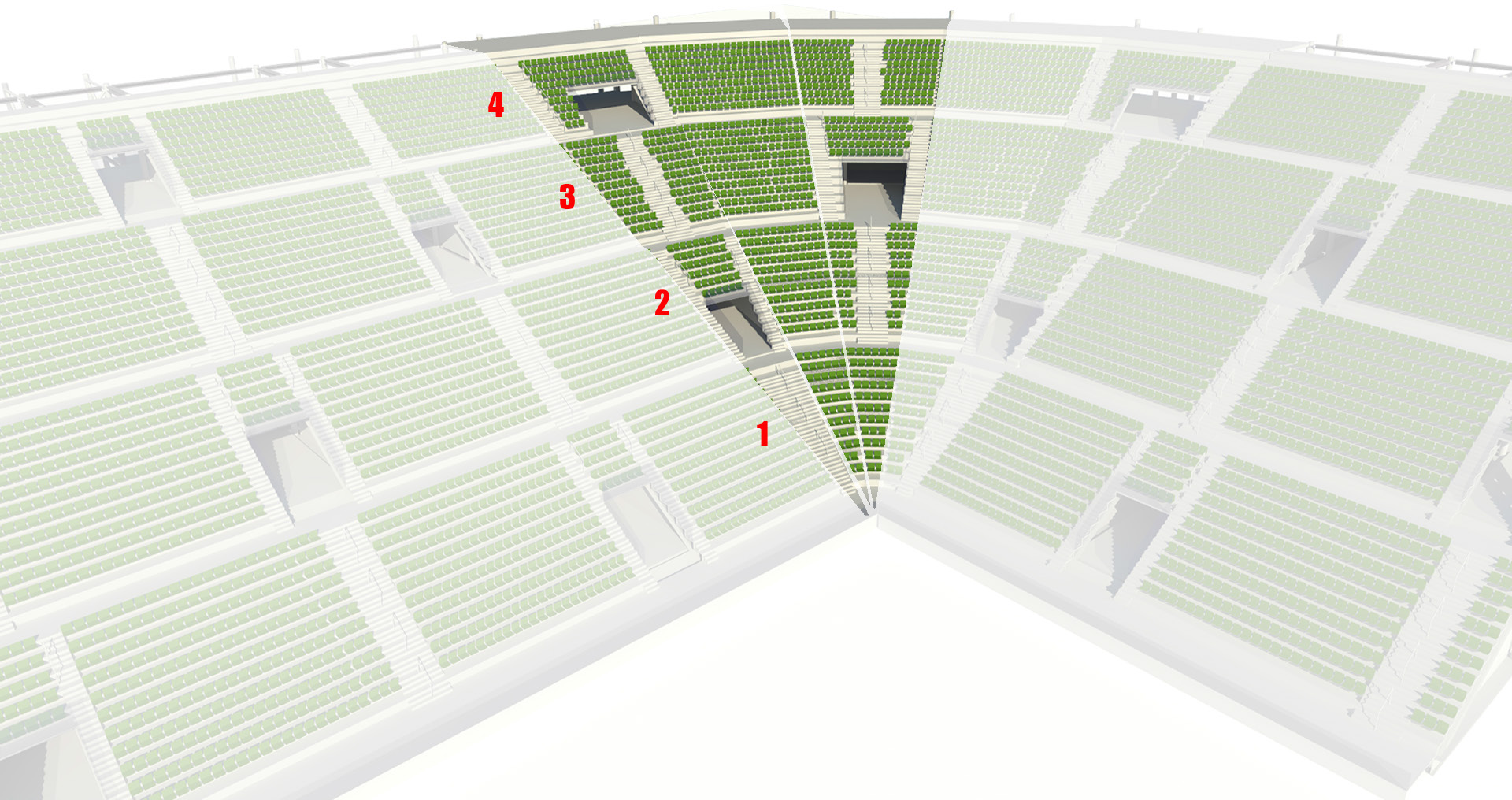
3. Design

Curvature



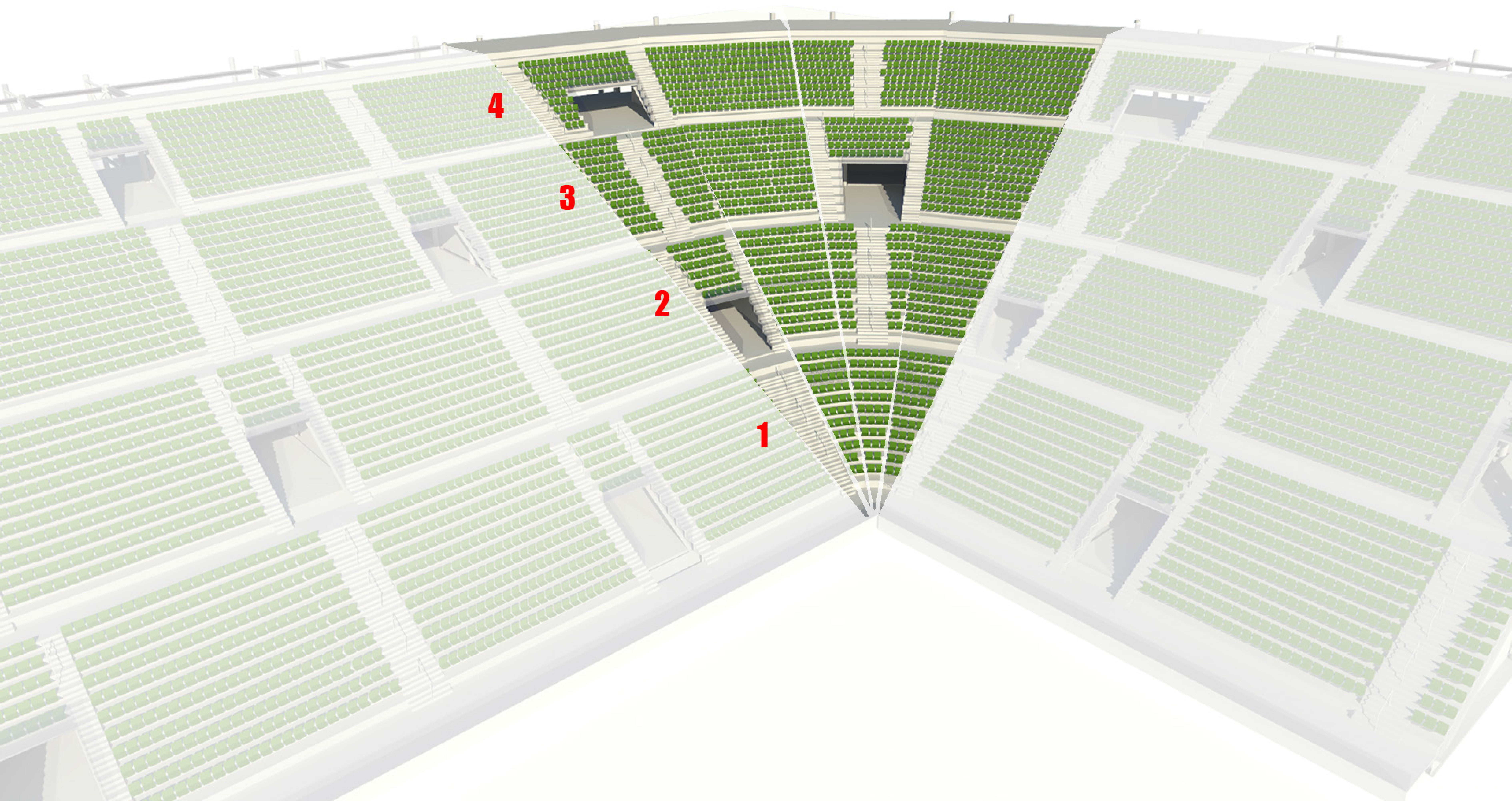
3. Design

Curvature



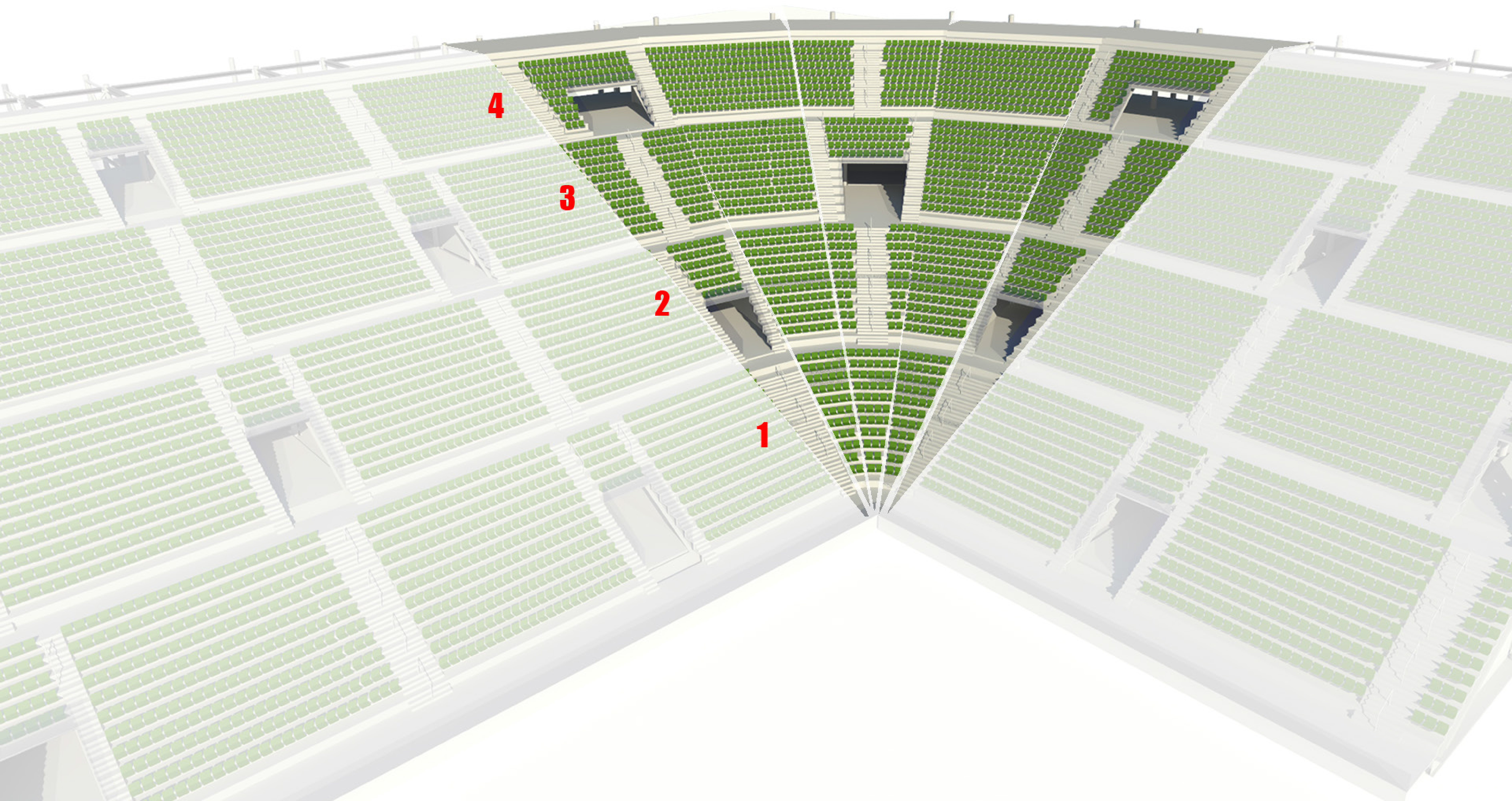
3. Design

Curvature



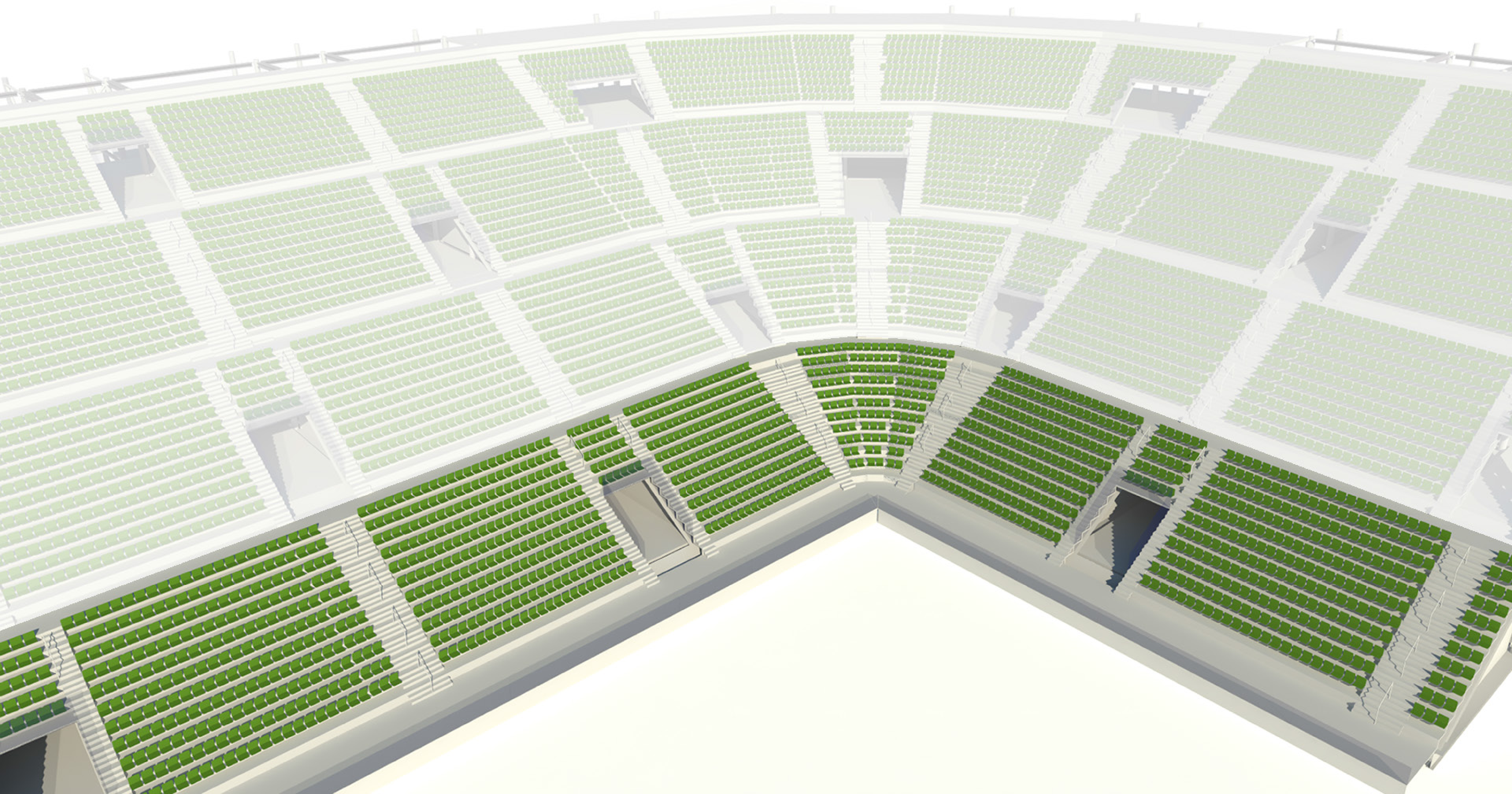
3. Design

Curvature



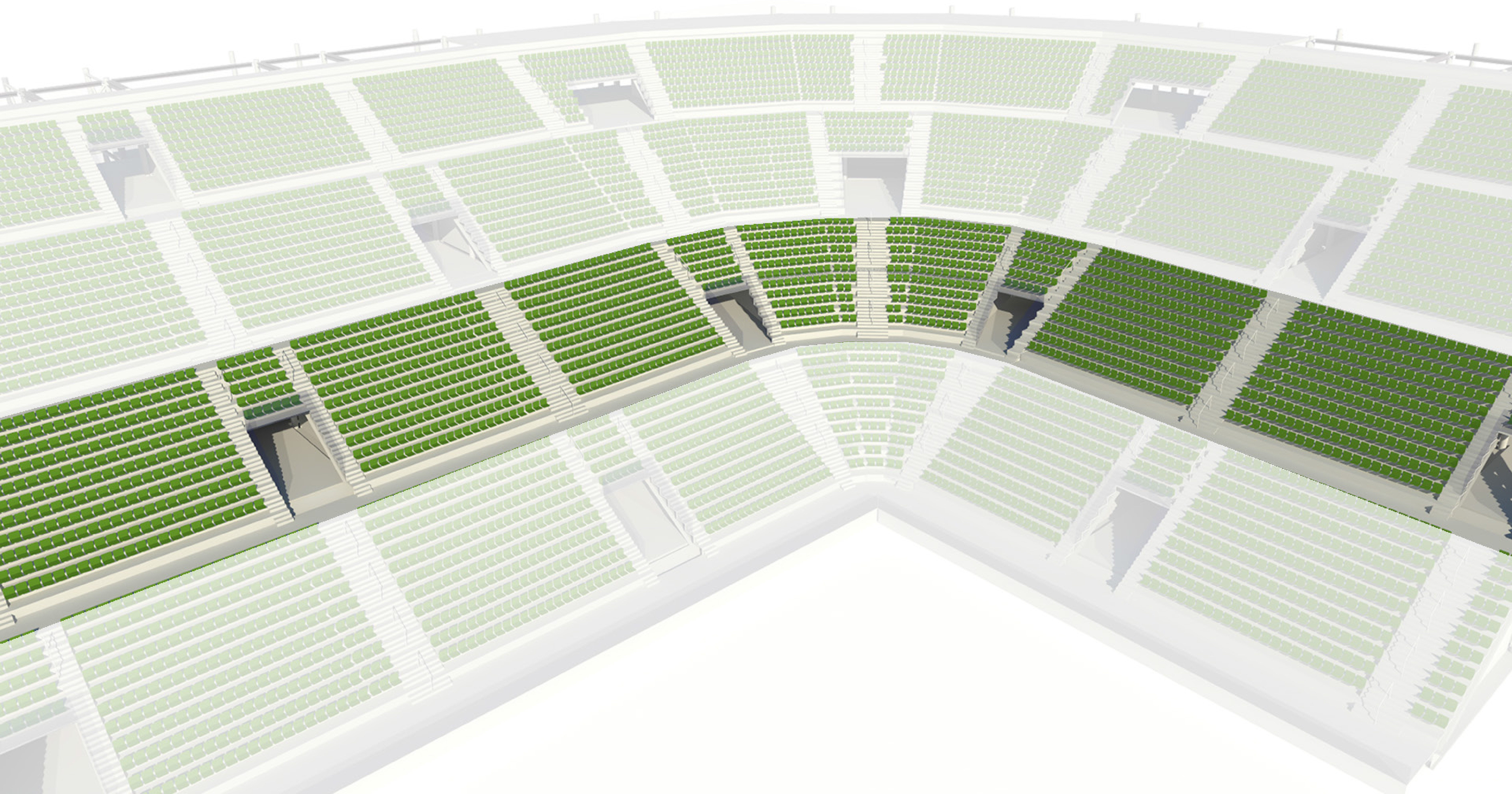
3. Design

Curvature



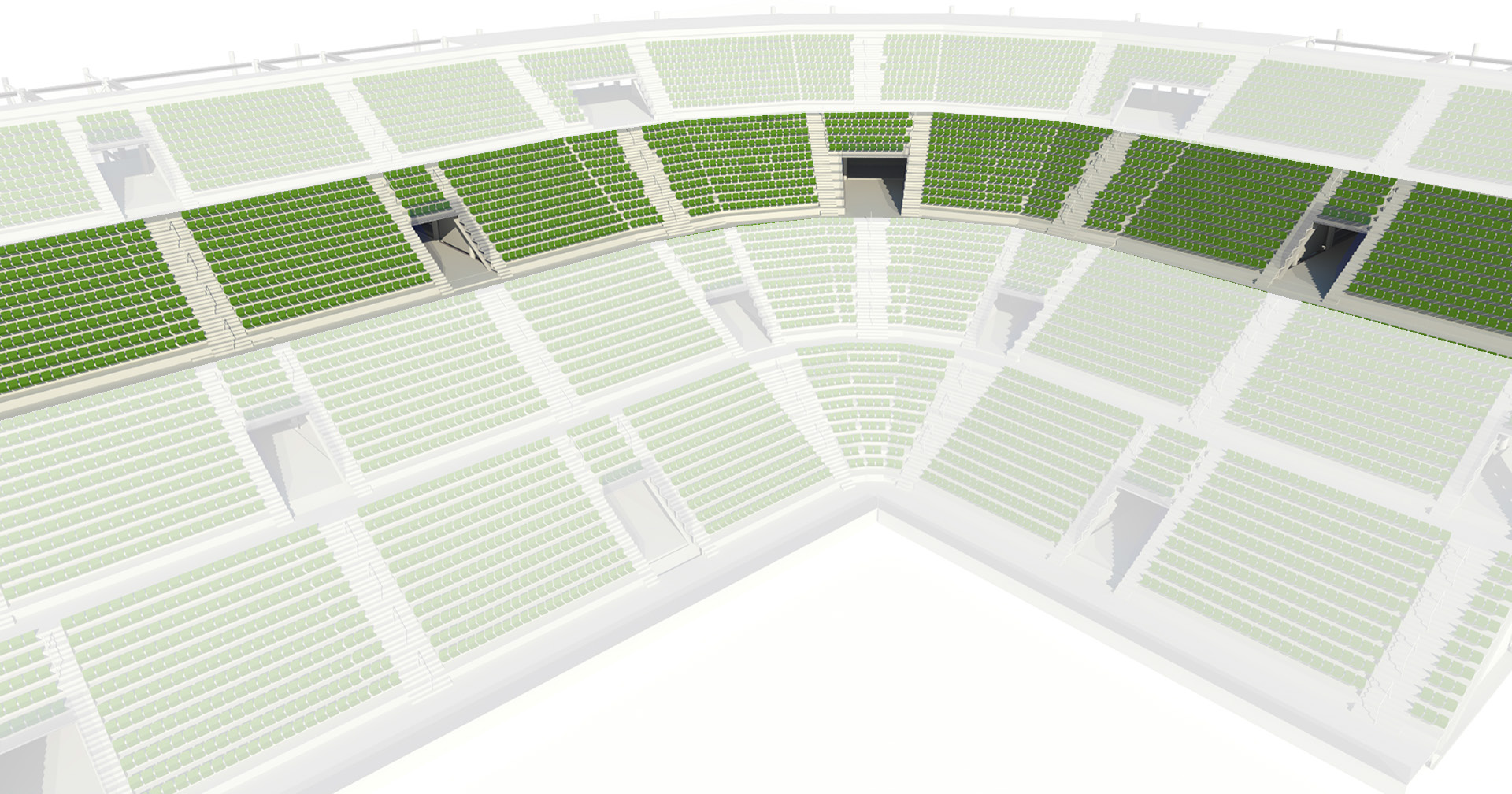
3. Design

Curvature



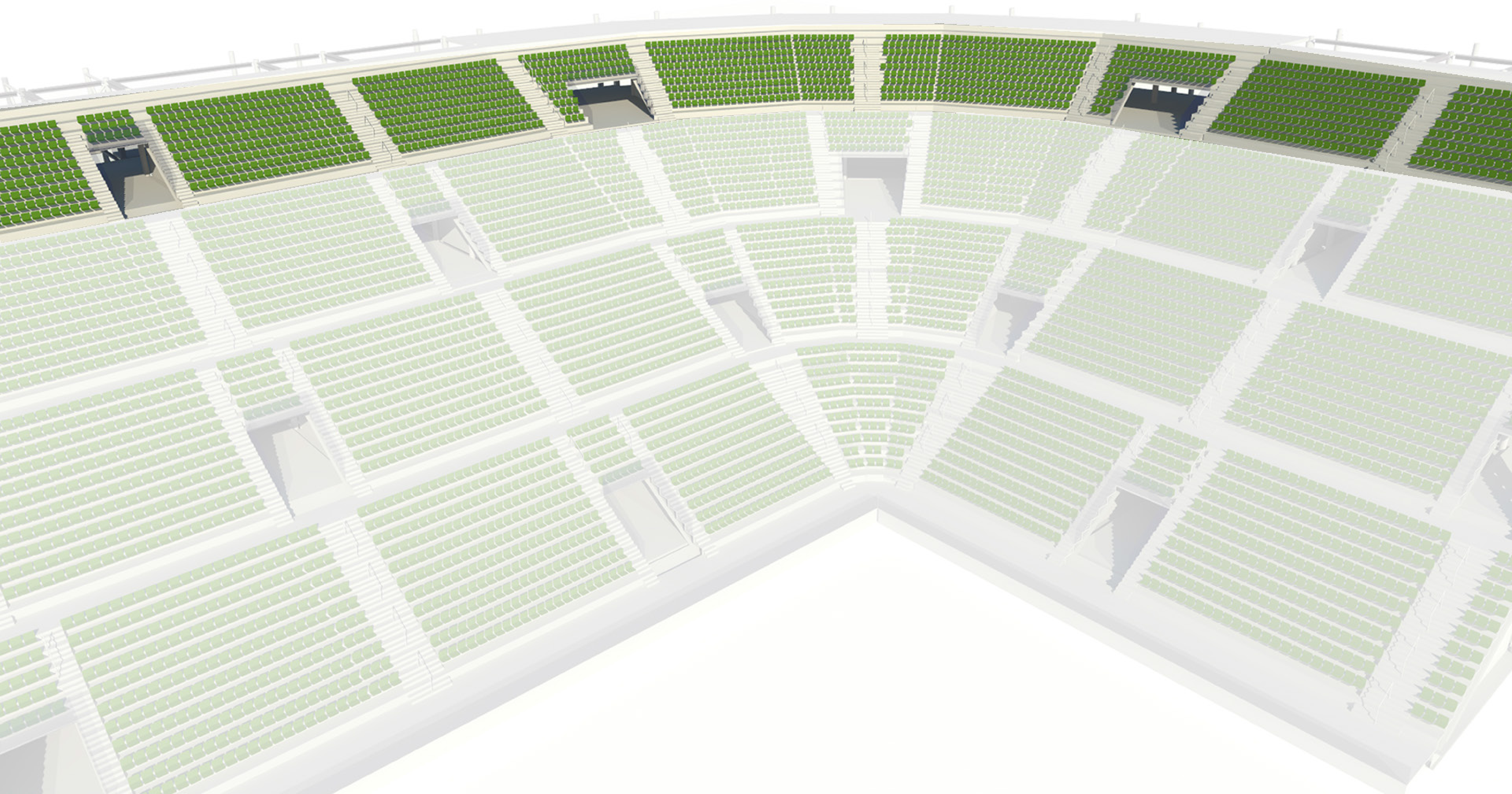
3. Design

Curvature



3. Design

Curvature



1. Introduction

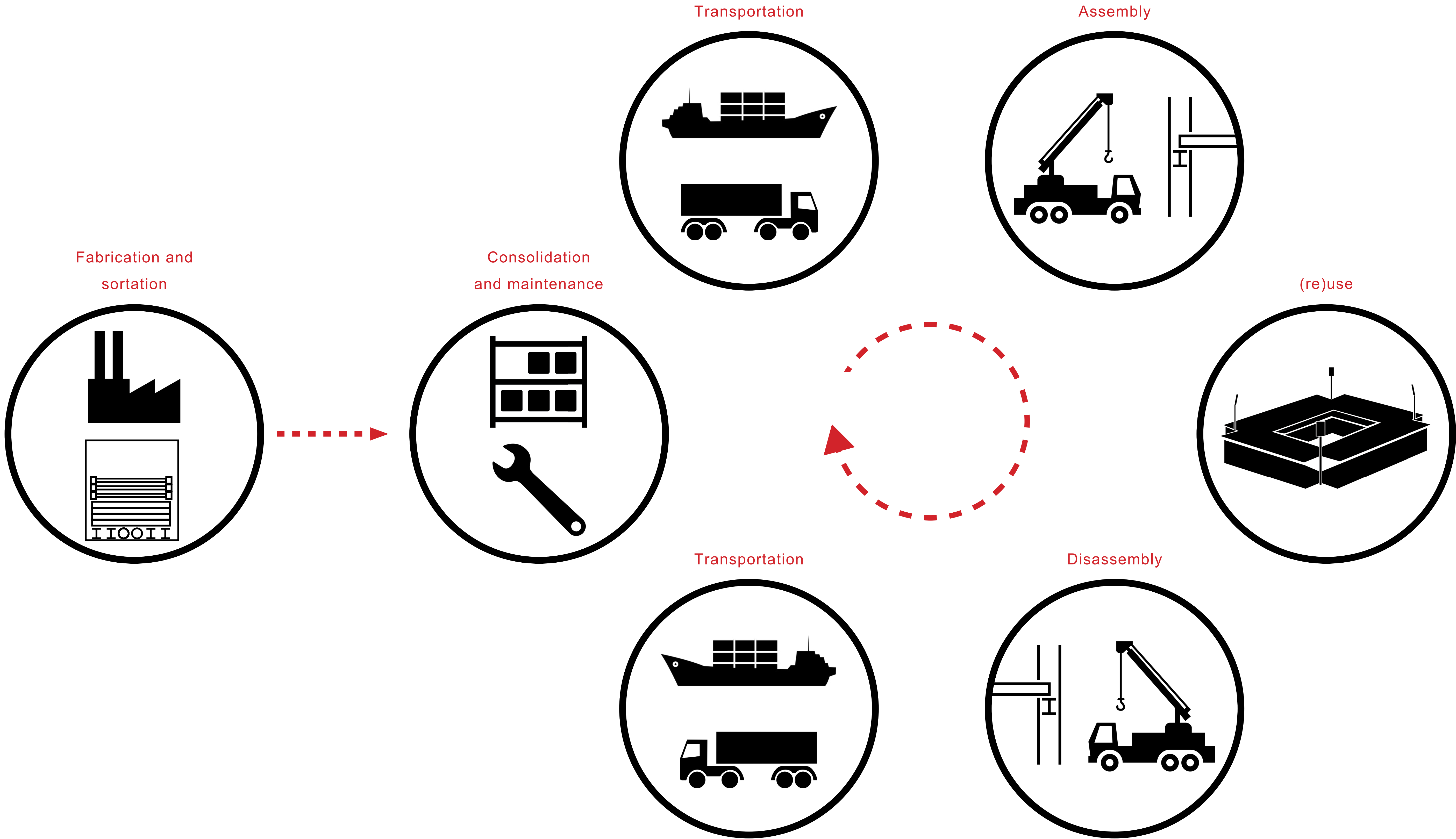
2. Concept

3. Design

4. Design for Disassembly

5. Conclusions

4. Design for disassembly



The building process is repetitive. The building and disassembly process has to be as simple and quick as possible.

4. Design for disassembly



4. Design for disassembly



4. Design for disassembly



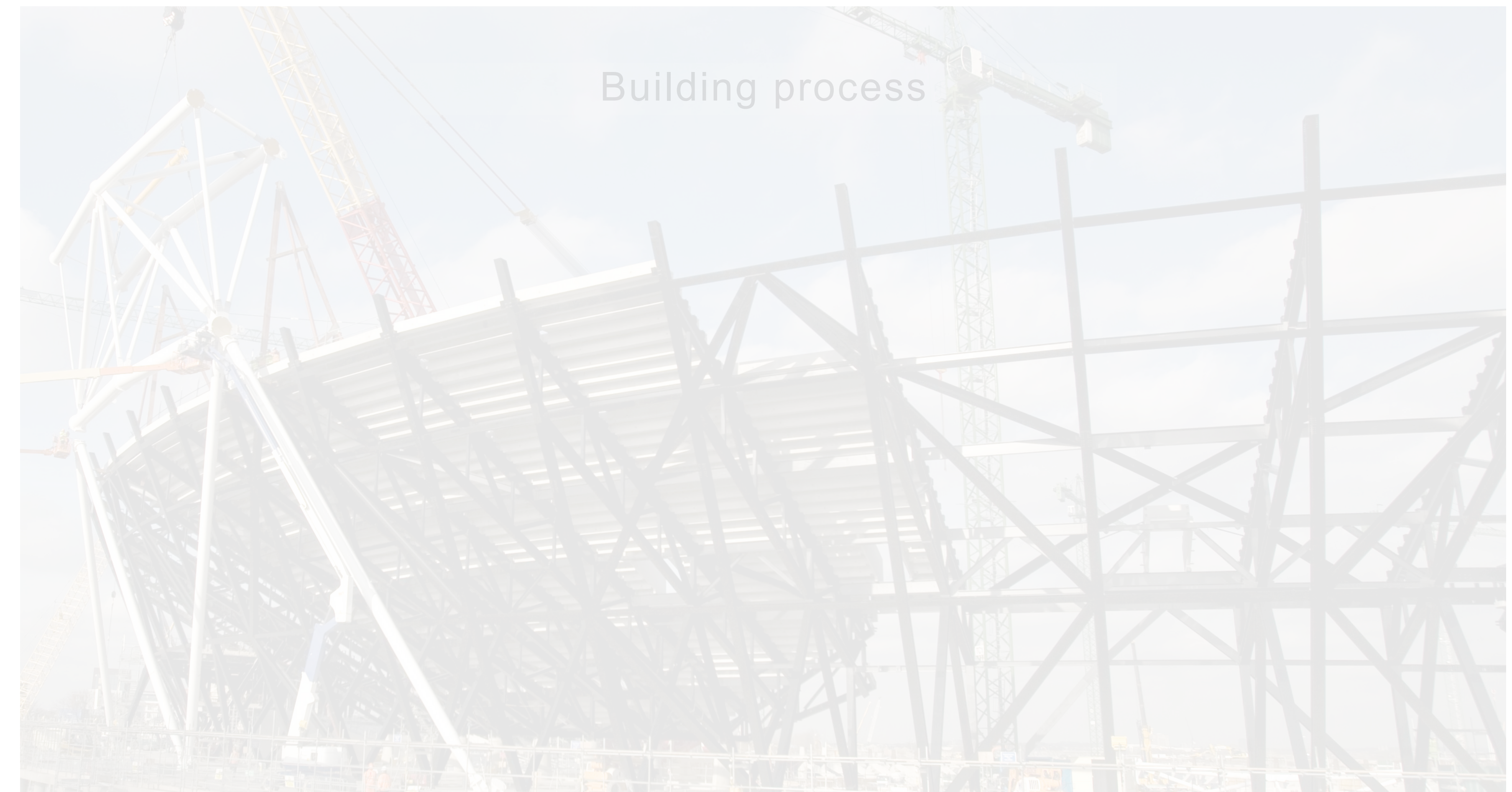
4. Design for disassembly



Demands:

For this demountable structure, the **materials** have to be

- . Strong
- . Durable
- . Lightweight
- . Prefabricated
- . Easily replaceable



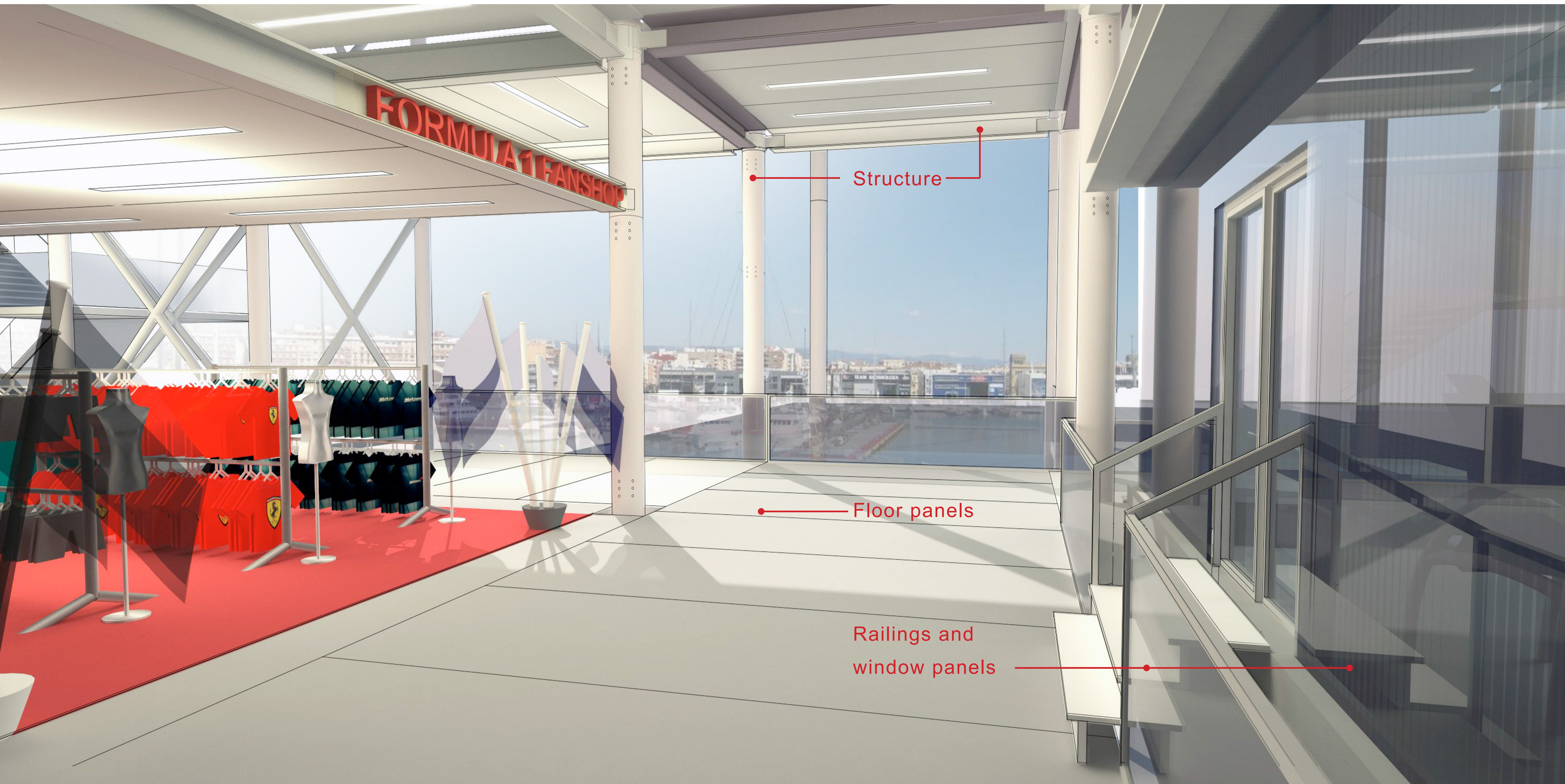
4. Design for disassembly

Building materials



4. Design for disassembly

Building materials



4. Design for disassembly

Building materials

Structure

Floors and grandstand

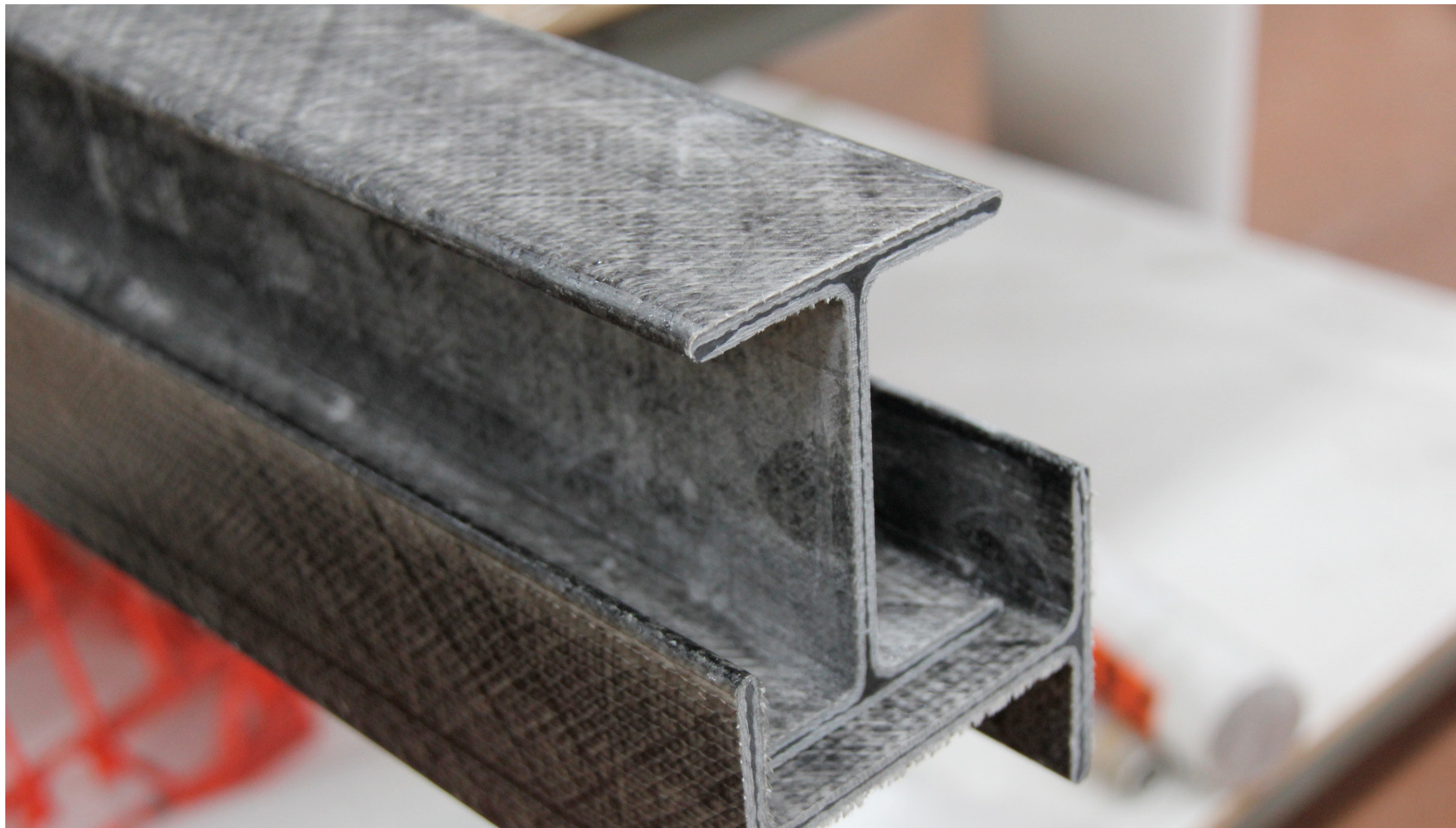


Concrete



Stainless steel

Railings and window panels



Fibre composites

Cladding



Timber

4. Design for disassembly

Building materials

Structure

Floors and grandstand

Railings and window
panels

Cladding



Stainless steel

Best size and strength ratio, price, and durability in comparison with the other materials.

4. Design for disassembly

Building materials

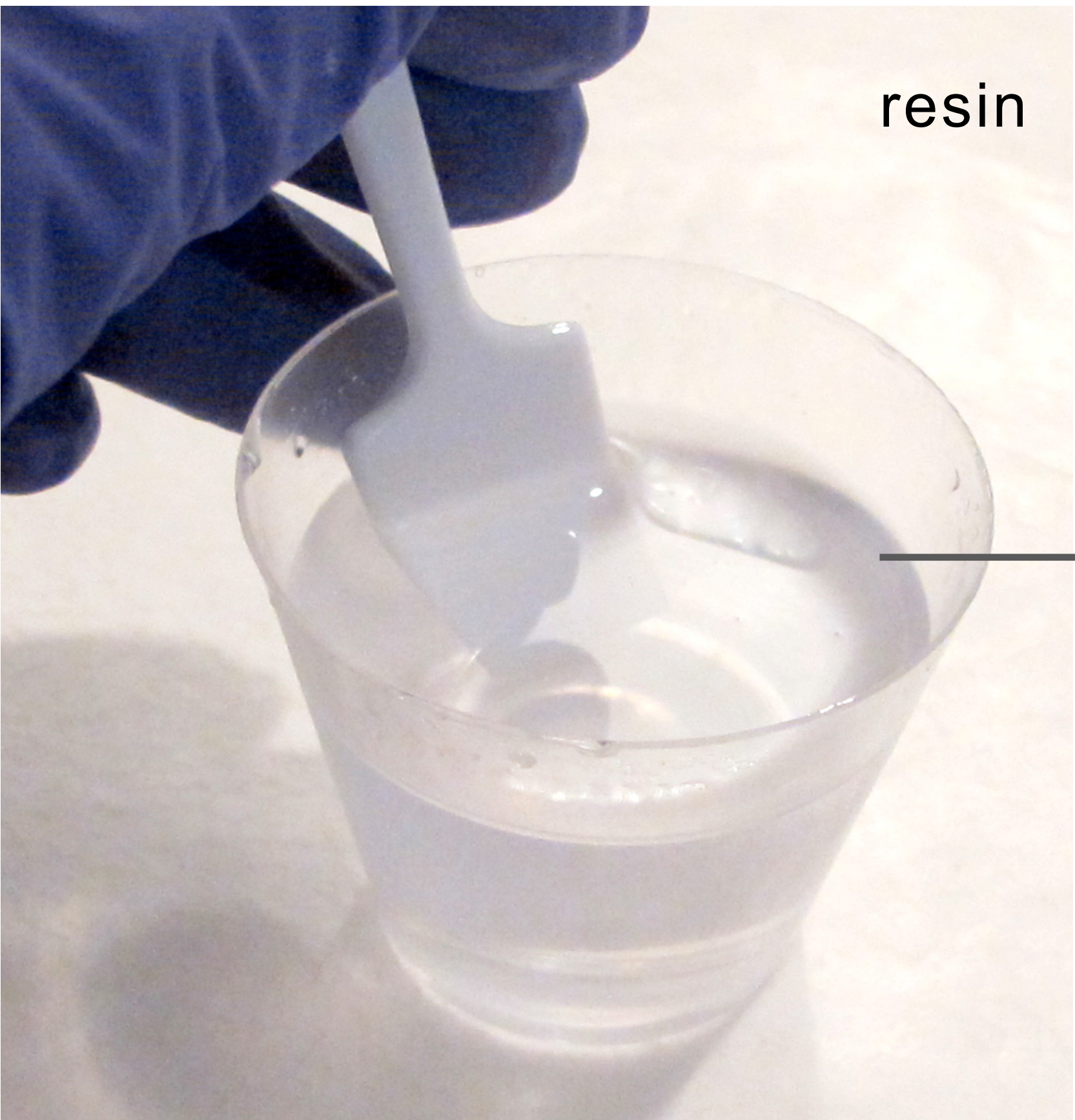
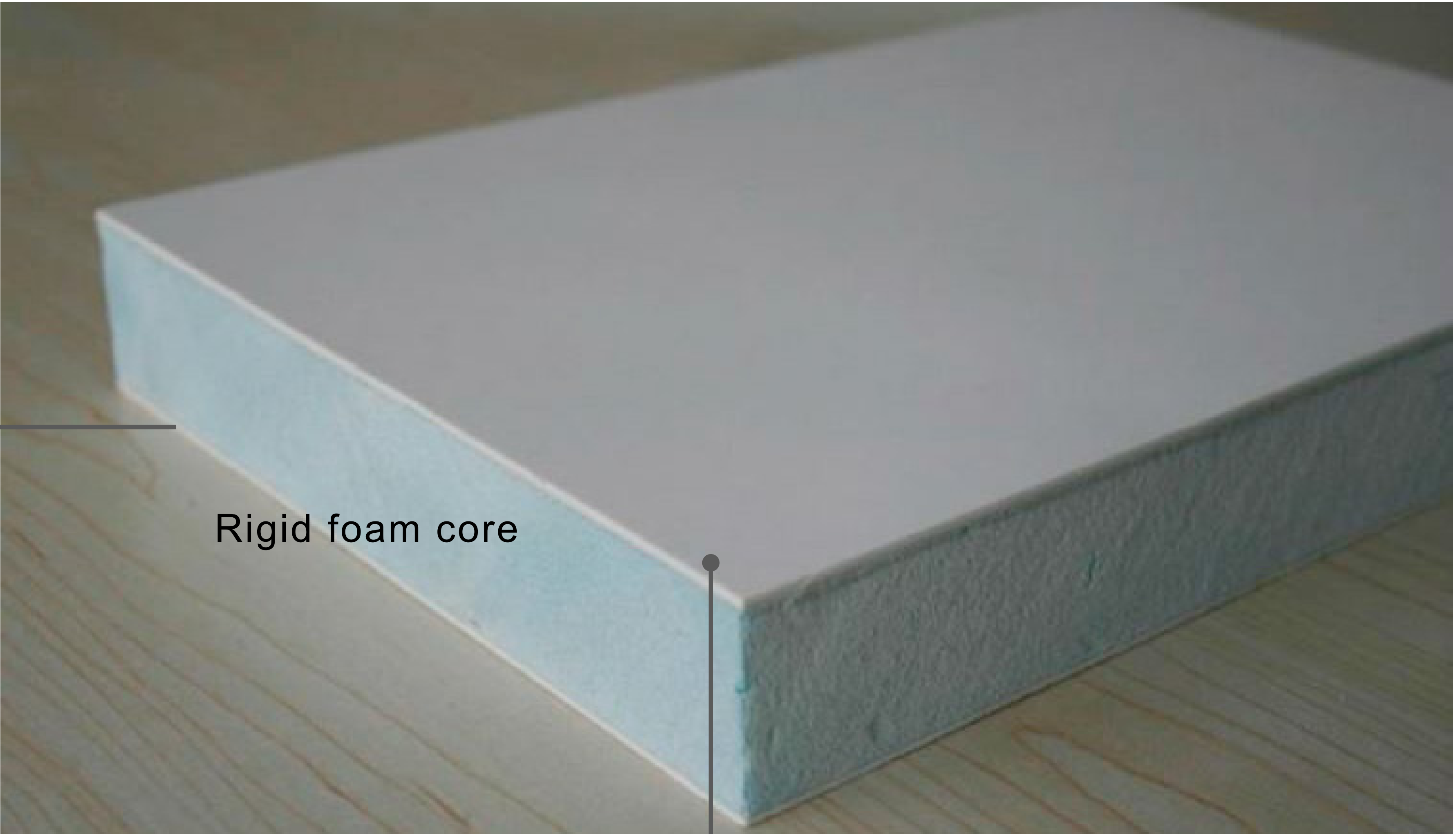
Structure

Floors and grandstand

Railings and window panels

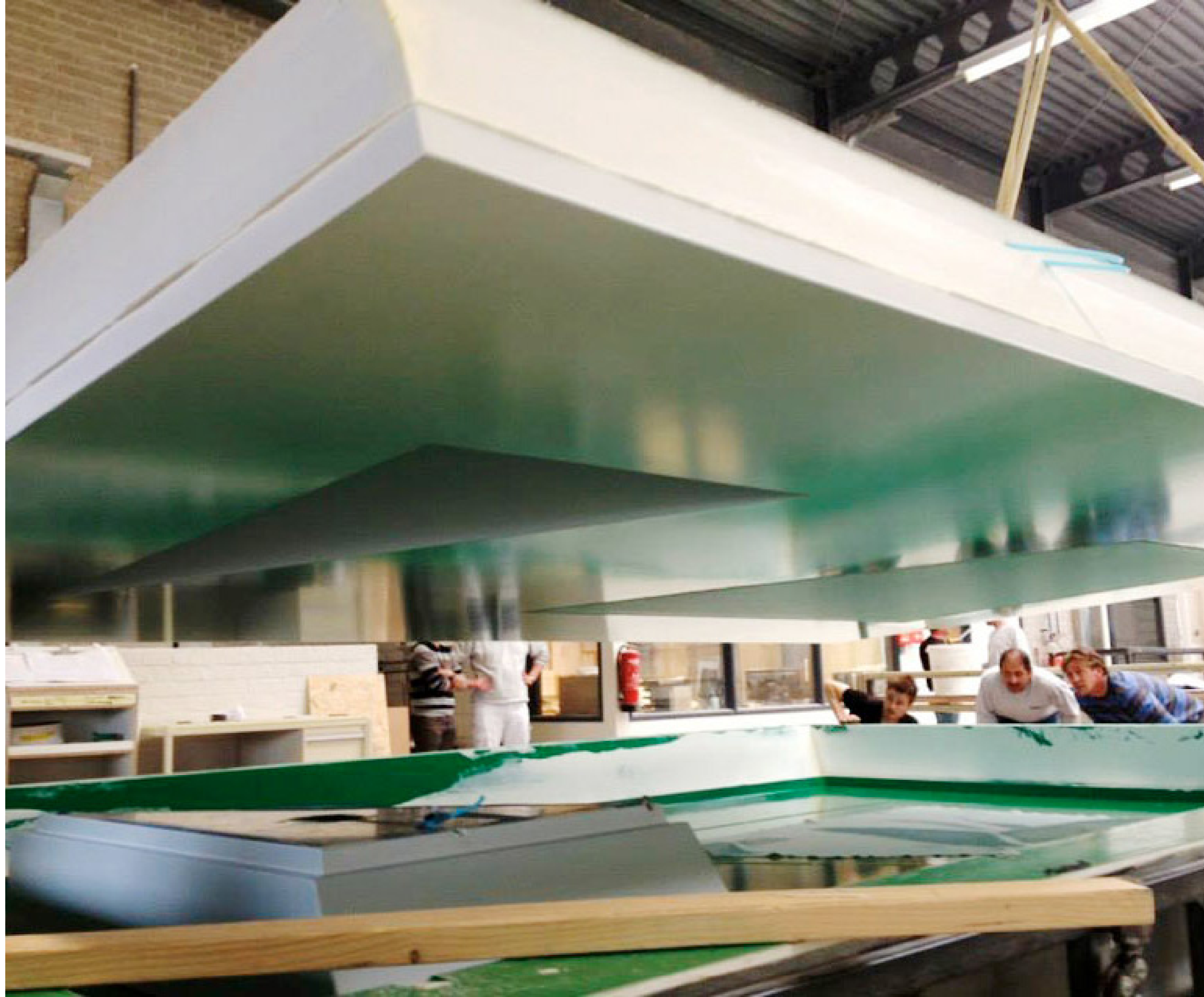
Cladding

Prefabricated glass fibre reinforced polymer sandwich floor slabs with insulating foam core



4. Design for disassembly

Structure



Floors and grandstand



Railings and window panels

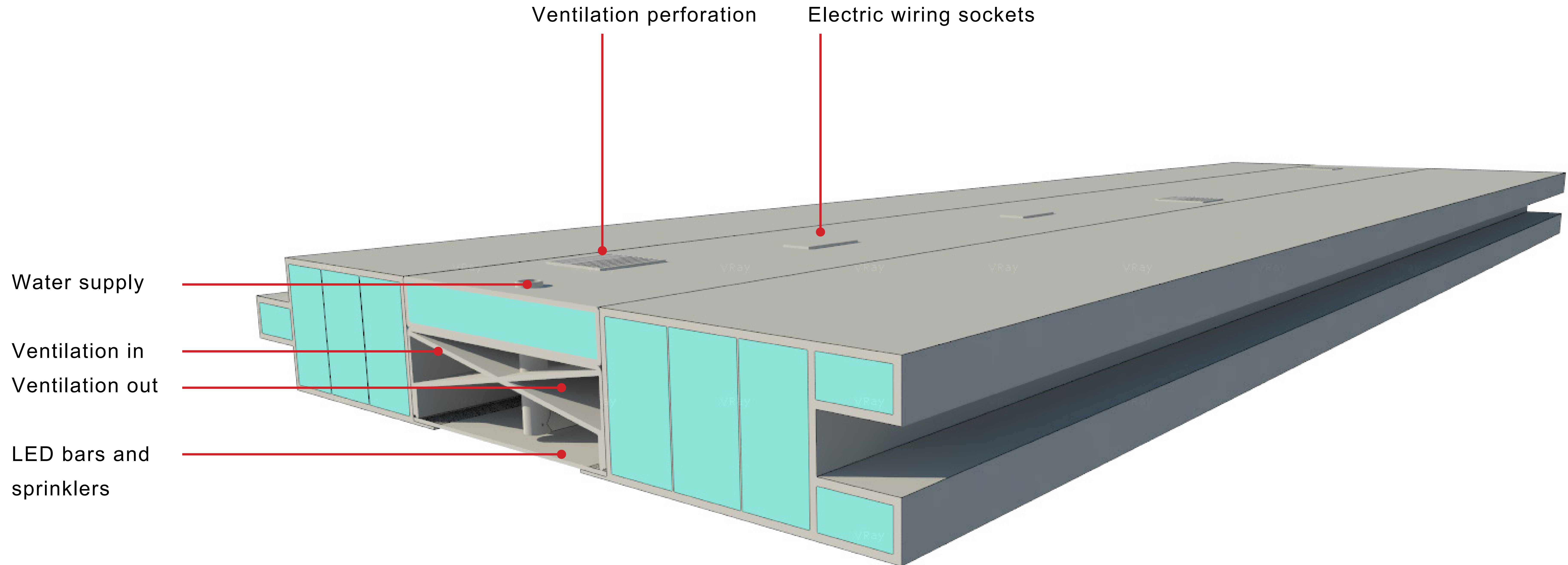


Cladding



4. Design for disassembly

Building materials



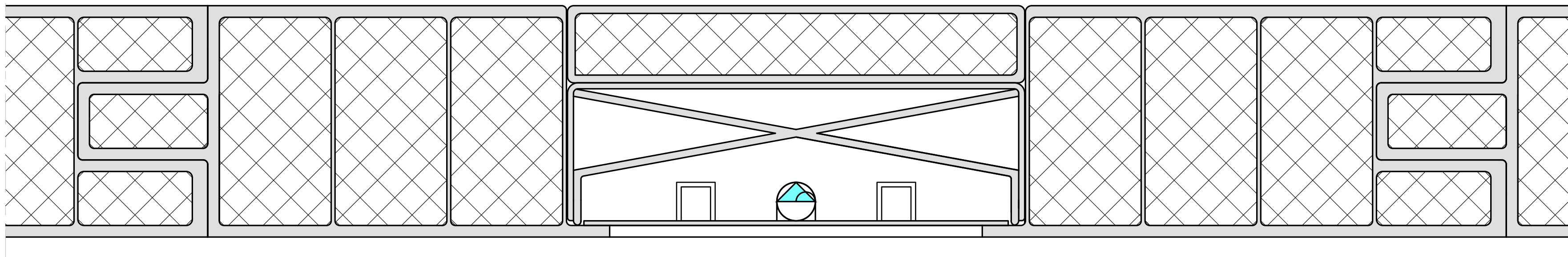
Van Stormbroek (2008)

“Development of a floor made from fiber reinforced polymers (FRP) with integrated installations”

Graduation Project Civil Engineering, TU Delft

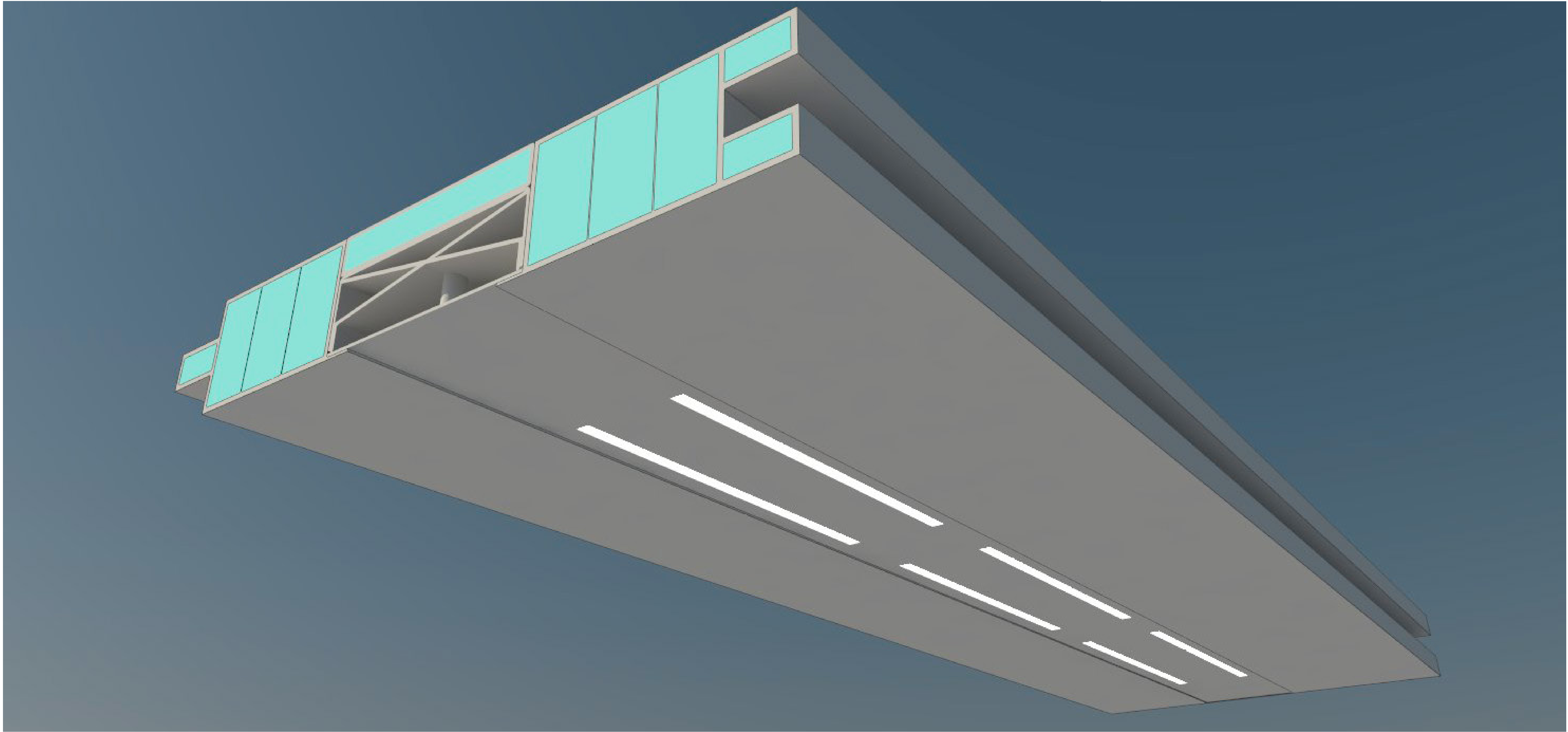
4. Design for disassembly

Building materials



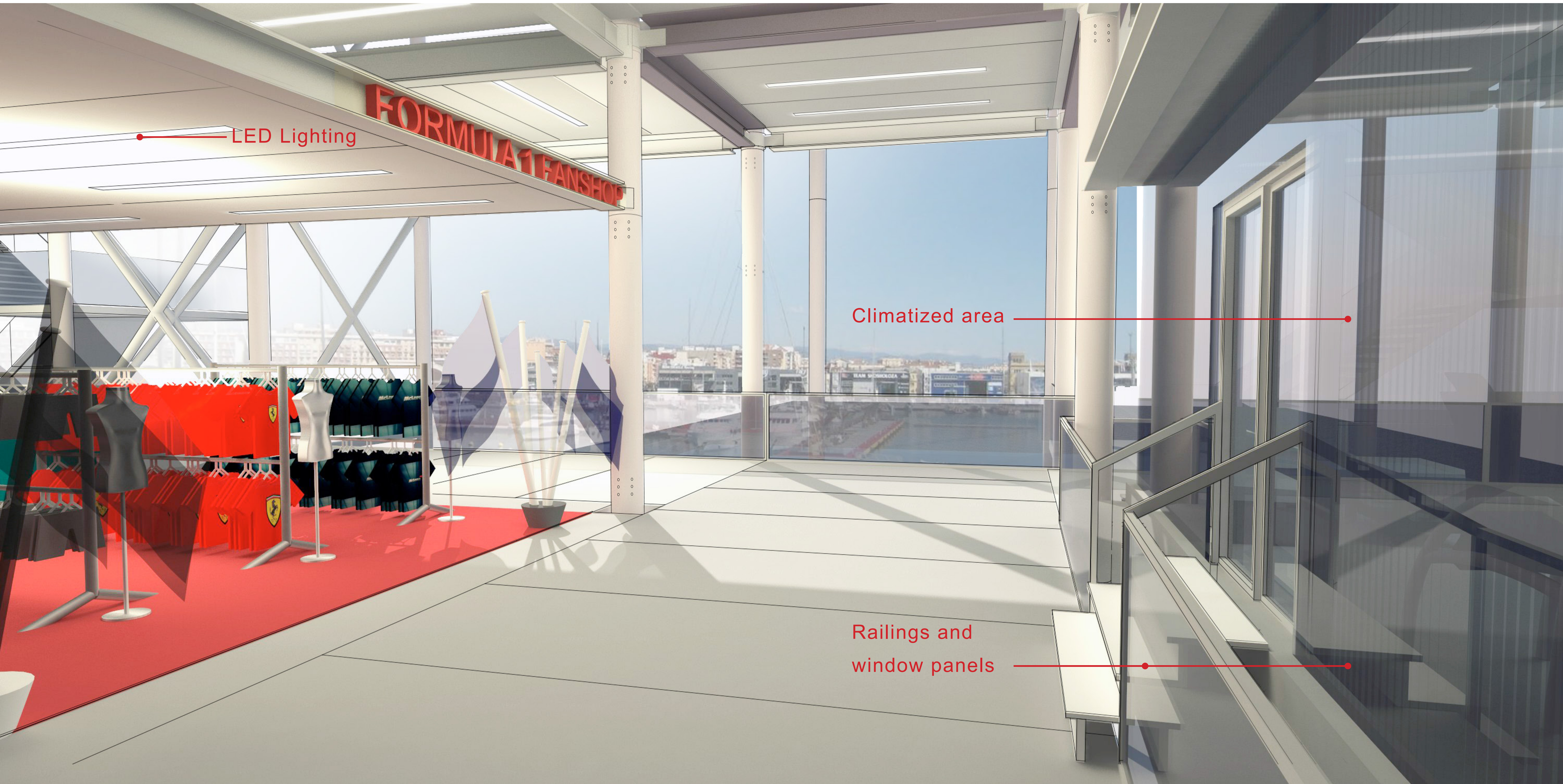
Included LED lighting

Possible electrical floor heating mats



4. Design for disassembly

Building materials

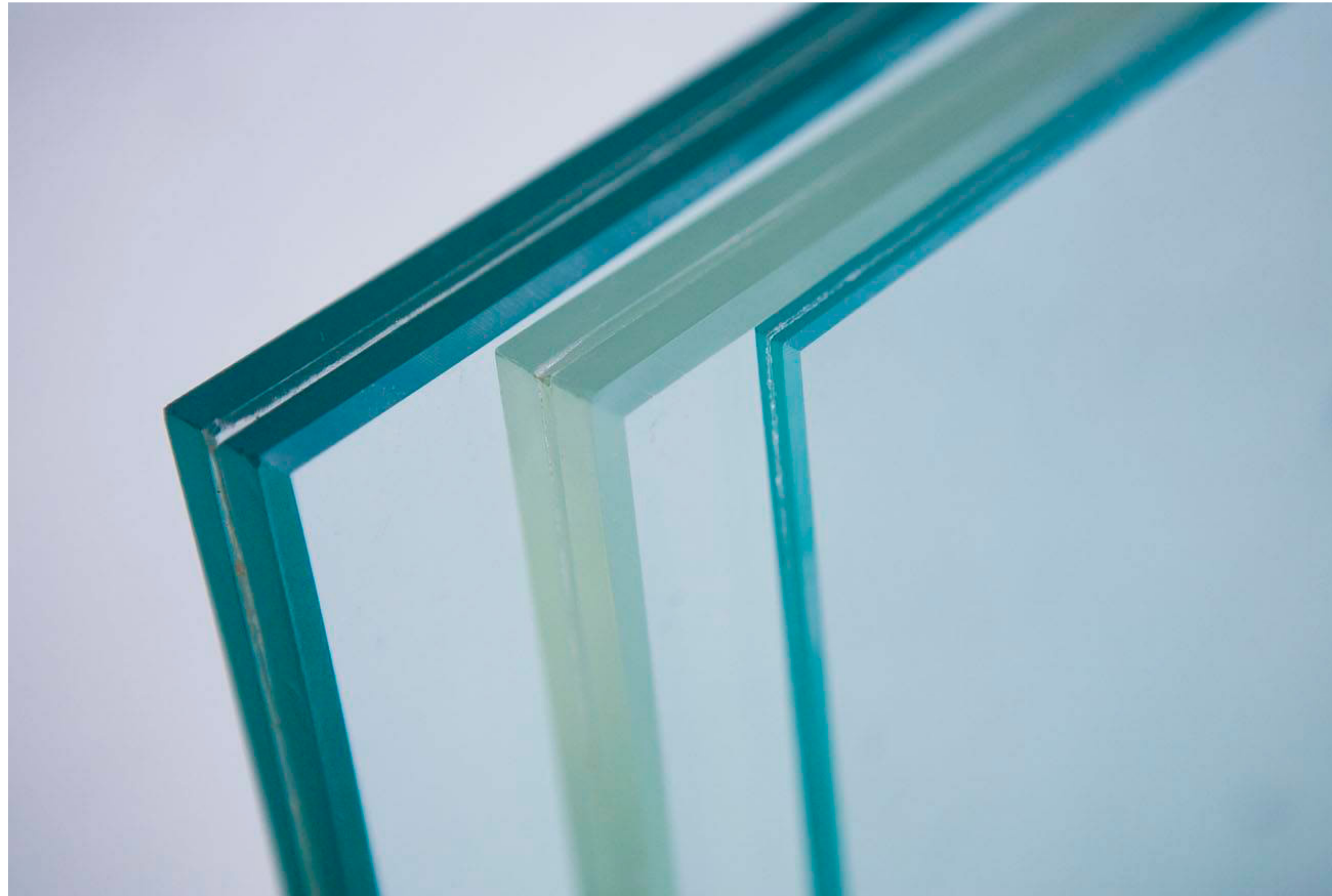


4. Design for disassembly

Building materials

Structure

Floors and grandstand



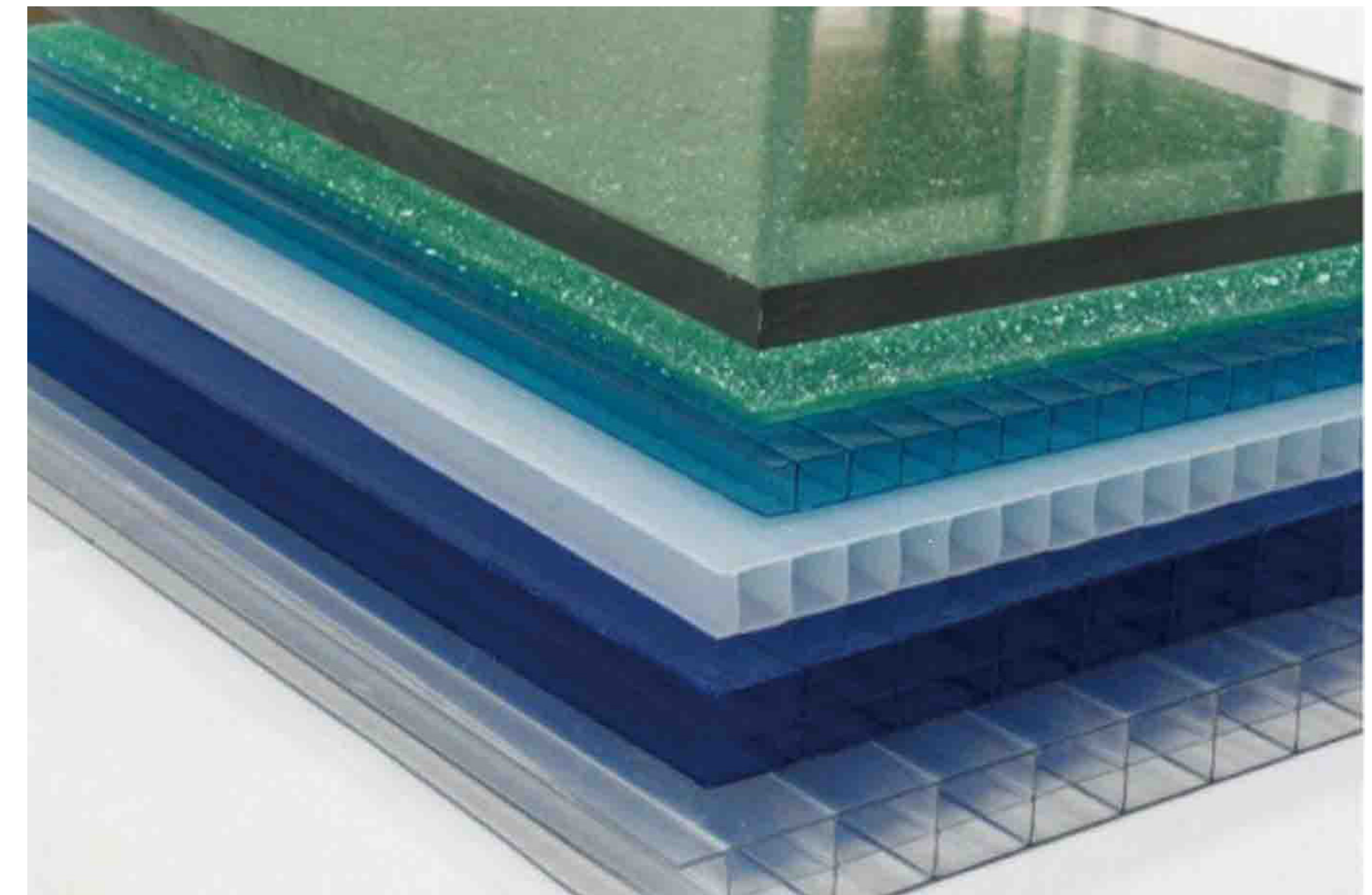
Glass

Railings and window
panels

Cladding



Acrylic glass



Polycarbonate

4. Design for disassembly

Structure

Floors and grandstand



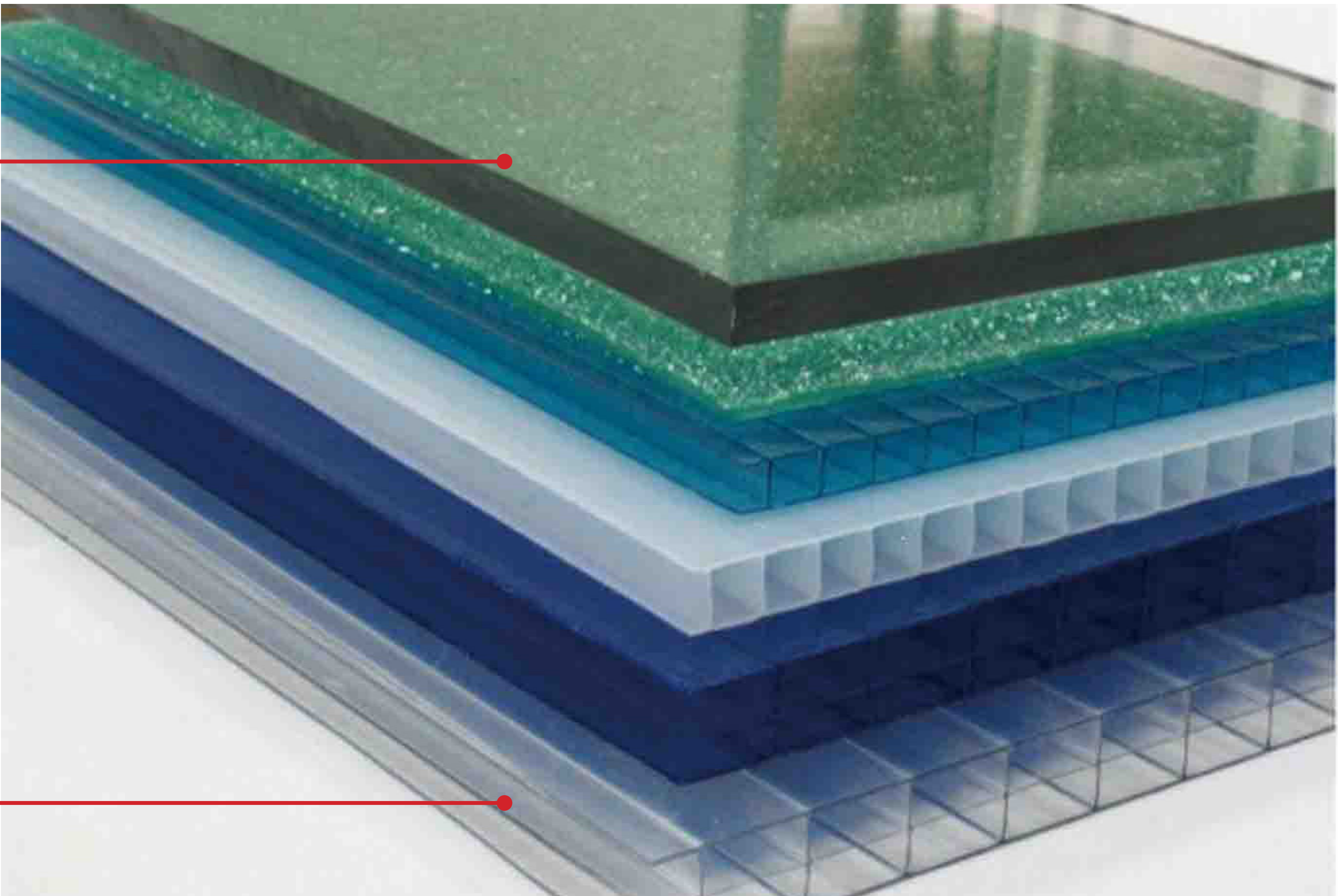
Glass



Acrylic glass

Railings and window panels

Railings



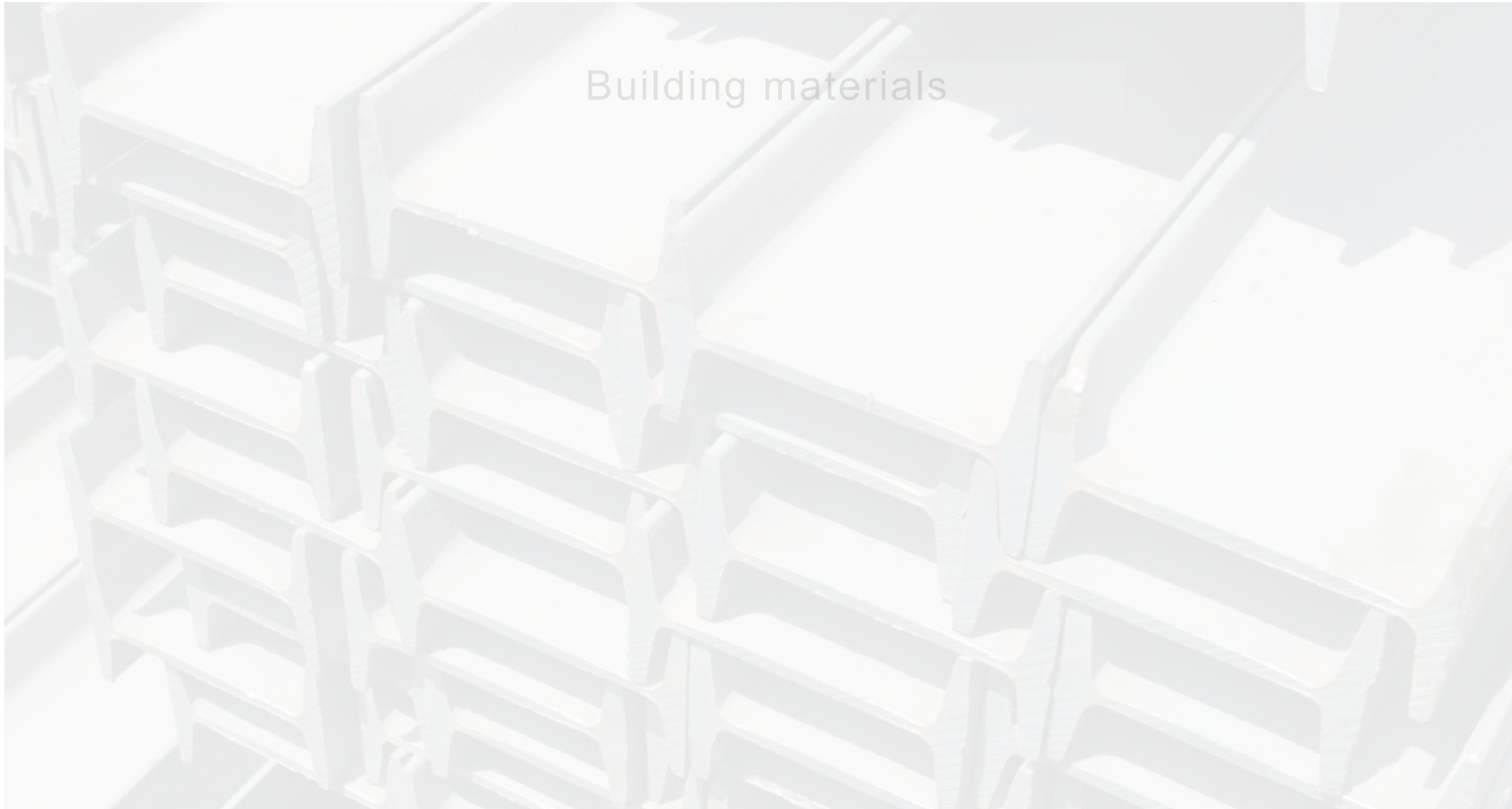
Windows

because of the insulating property

Cladding

Polycarbonate

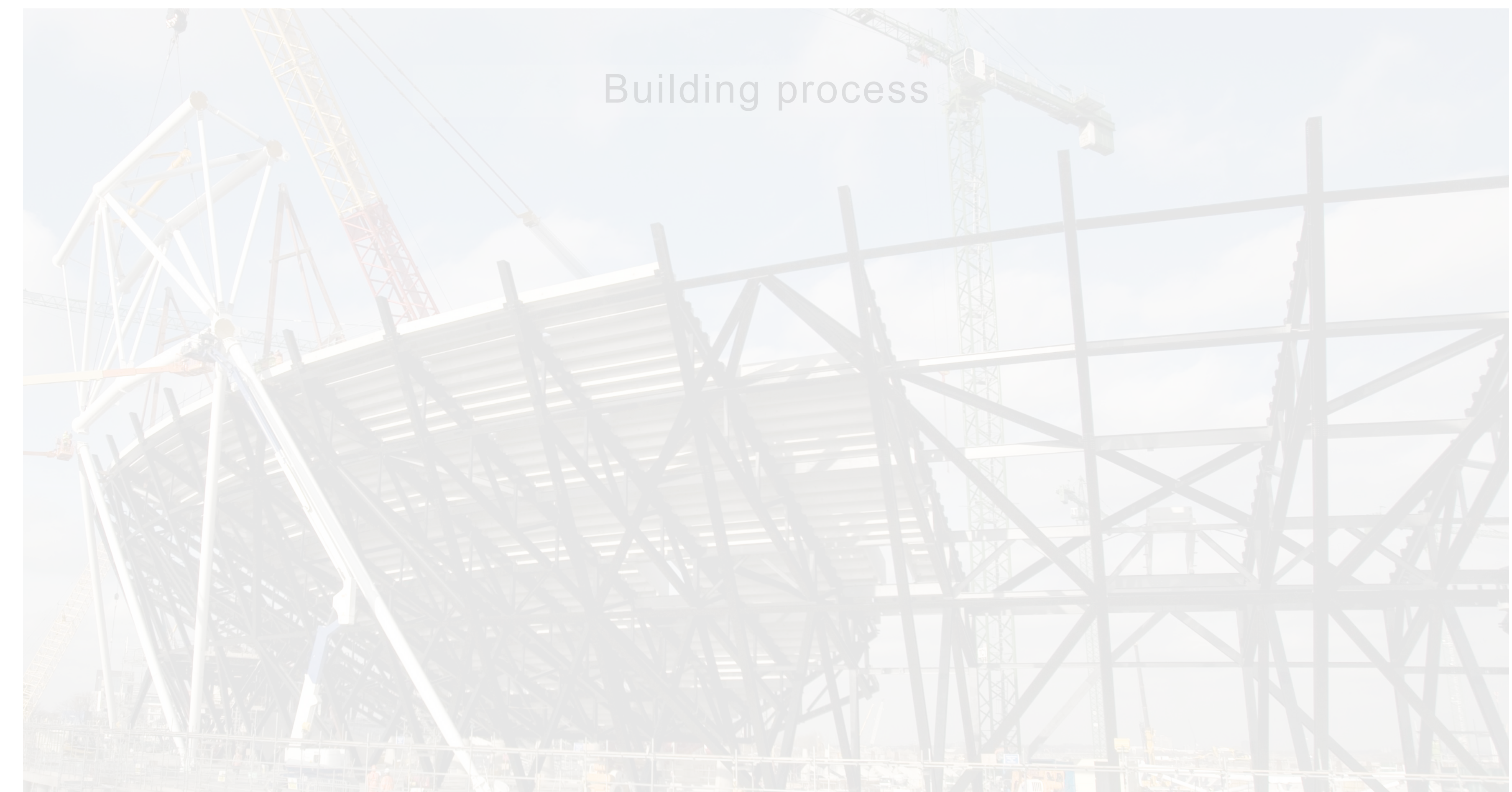
4. Design for disassembly



Demands:

For this demountable structure, the **transport** has to be

- . Conventional
- . As big as possible
- . Able to go by roads, railways and seas.



4. Design for disassembly

Transport



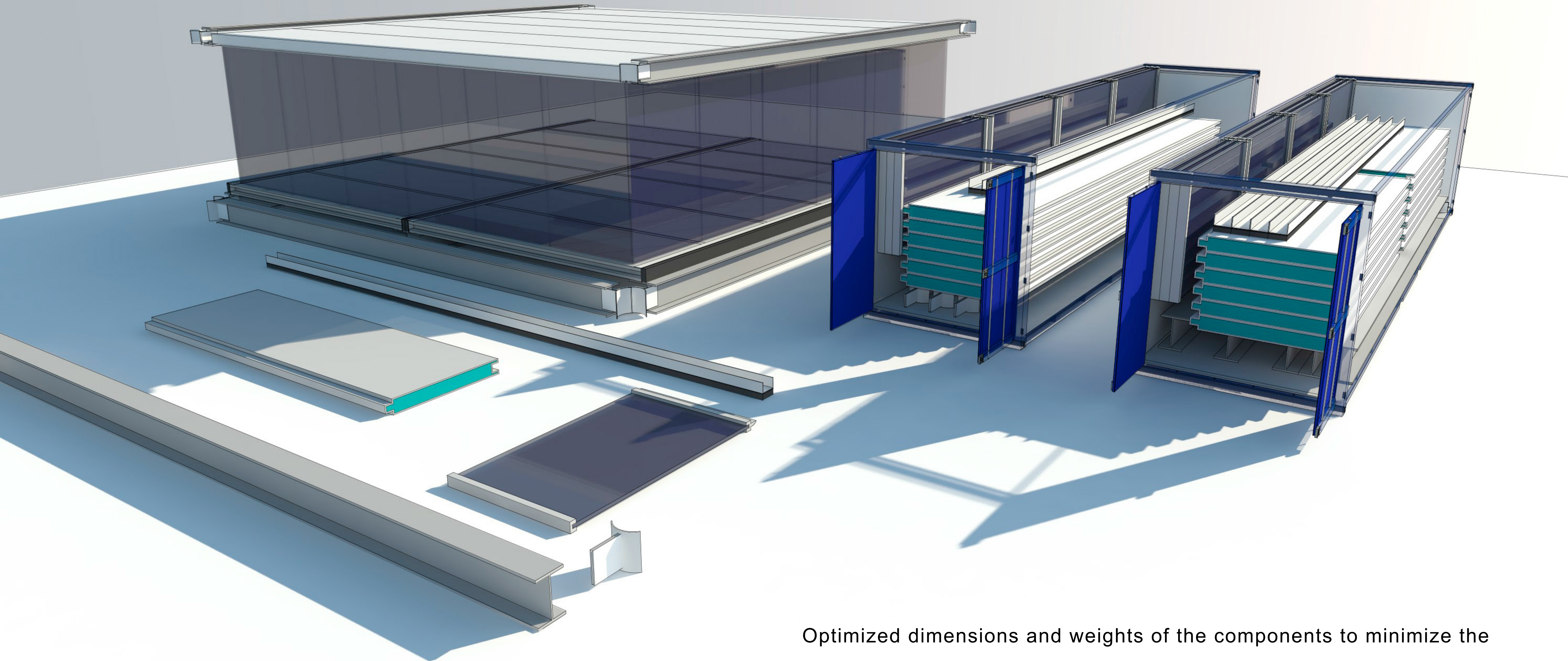
Different sizes of the construction elements mean more effort in transporting it to the locations.



Putting all elements in shipping containers allows easy transportation with the cheapest feasible means.

4. Design for disassembly

Transport



Optimized dimensions and weights of the components to minimize the amount of shipping containers. The restrictions were 12.19 x 2.43 x 2.59m for the dimensions and 28 tonnes for the maximum weight.

4. Design for disassembly



4. Design for disassembly

Building materials



Transport



Demands:

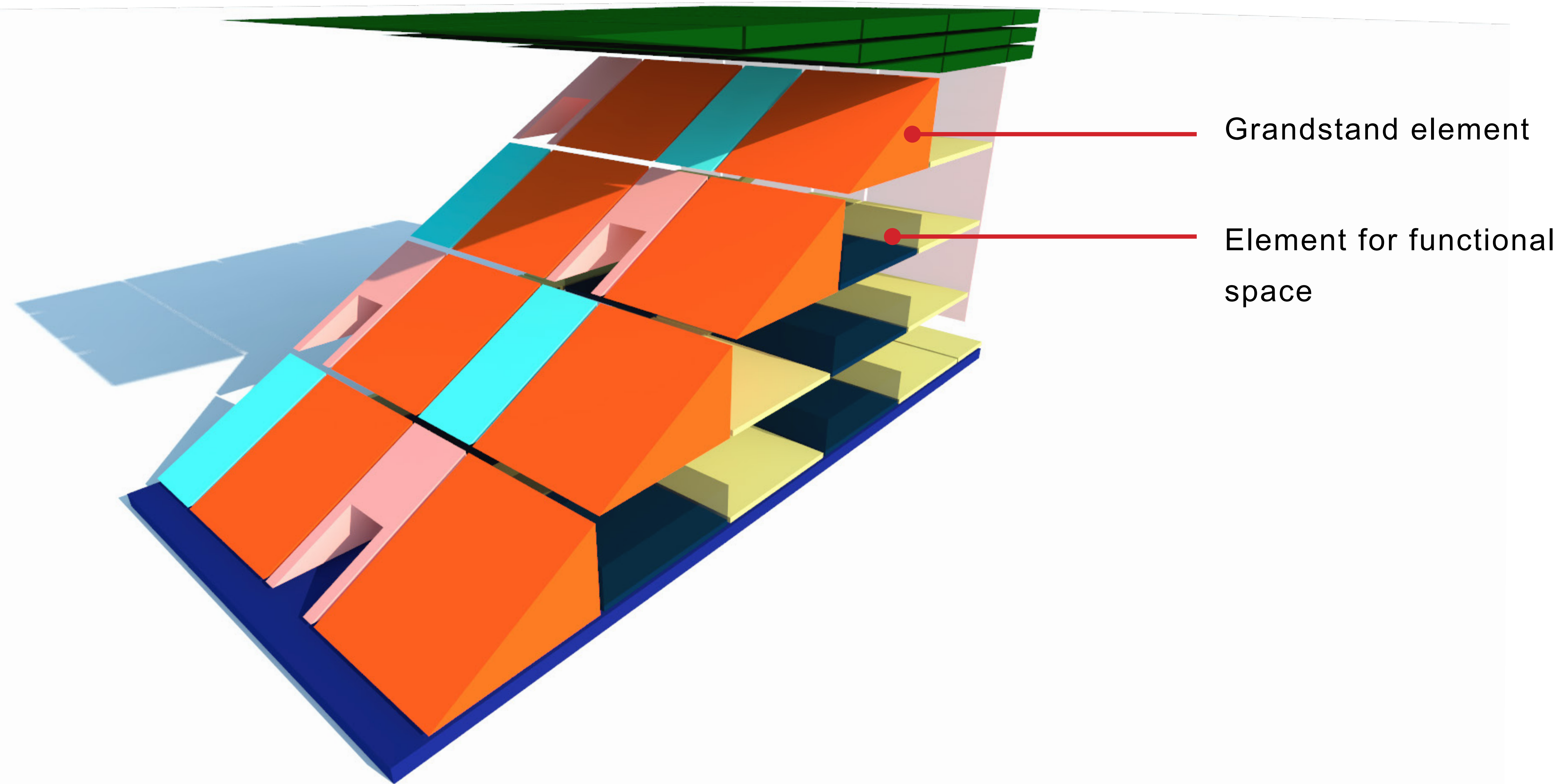
For this demountable structure, the **building process** has to...

1. ...be repetitive
2. ...have a small amount of building elements
3. ...be with a reduced amount of building methods

Building process



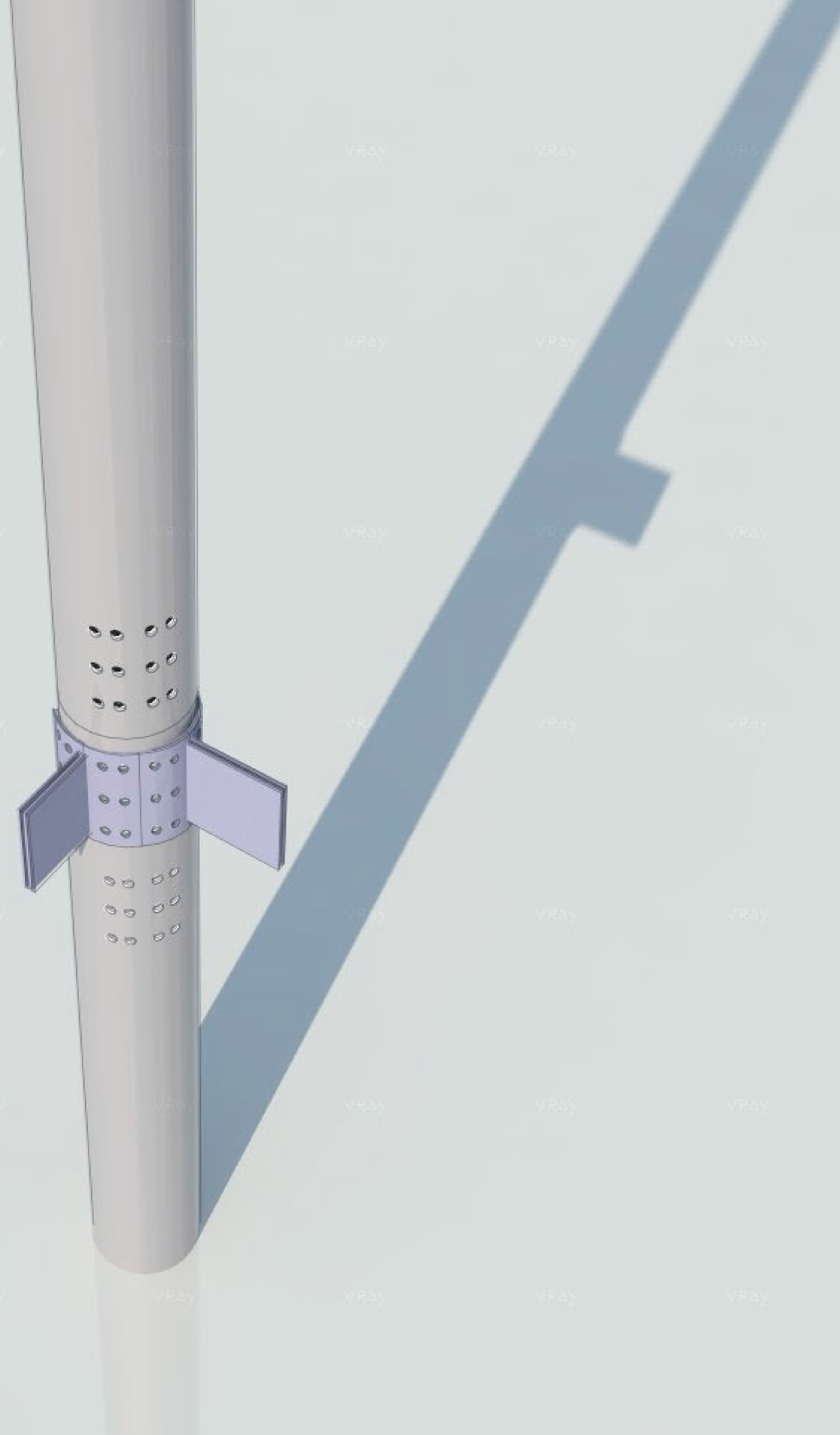
4. Design for disassembly



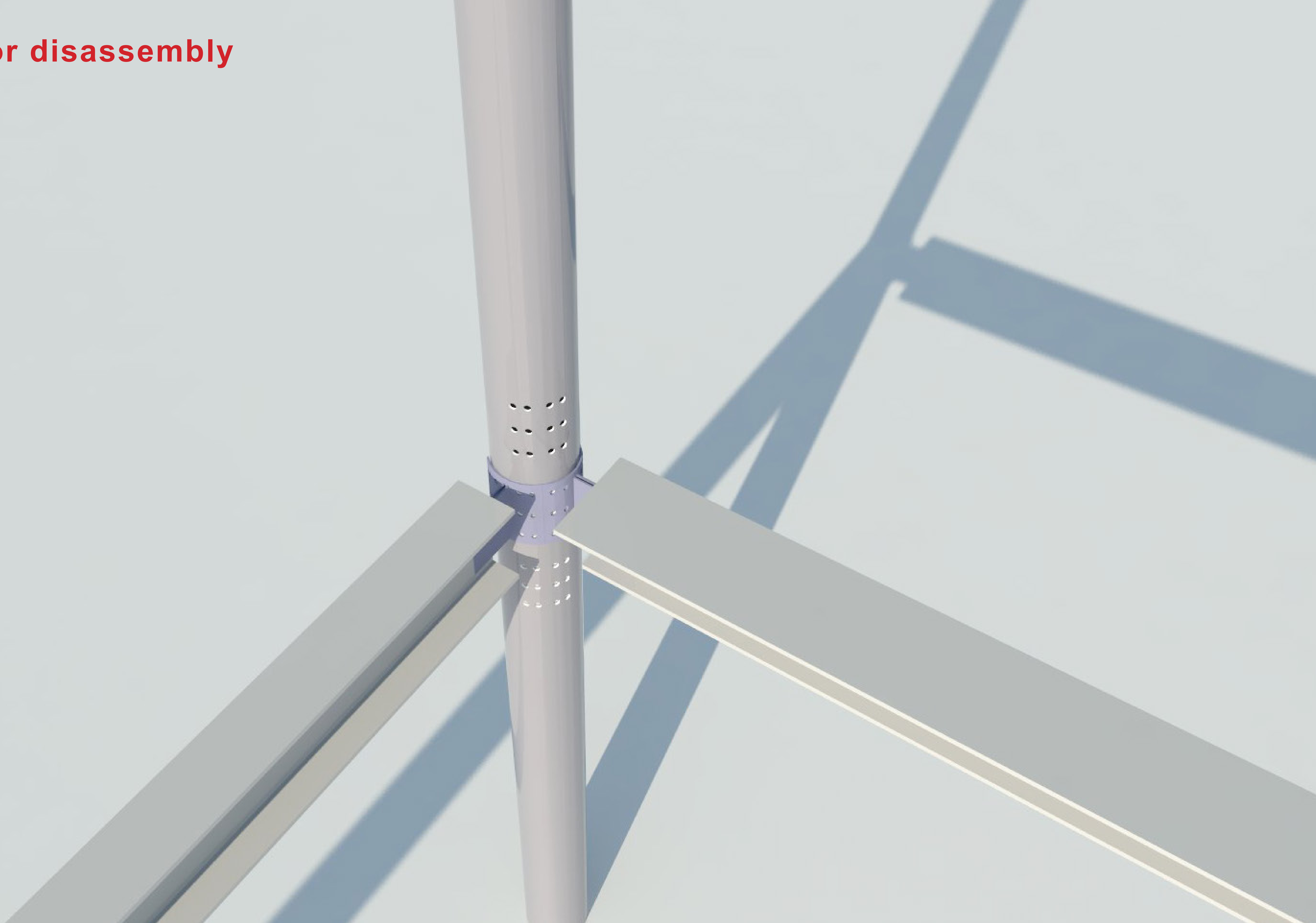
4. Design for disassembly



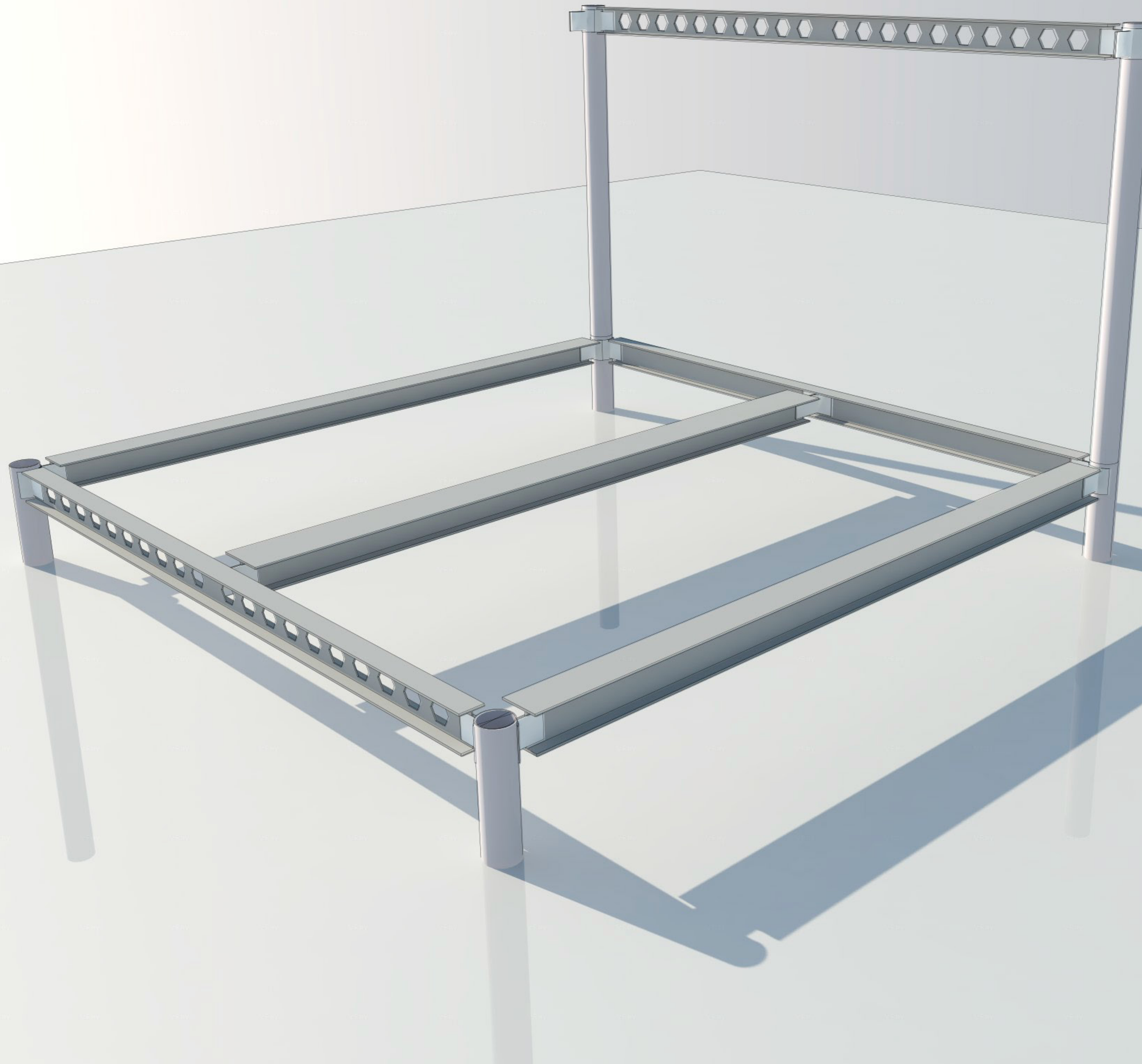
4. Design for disassembly



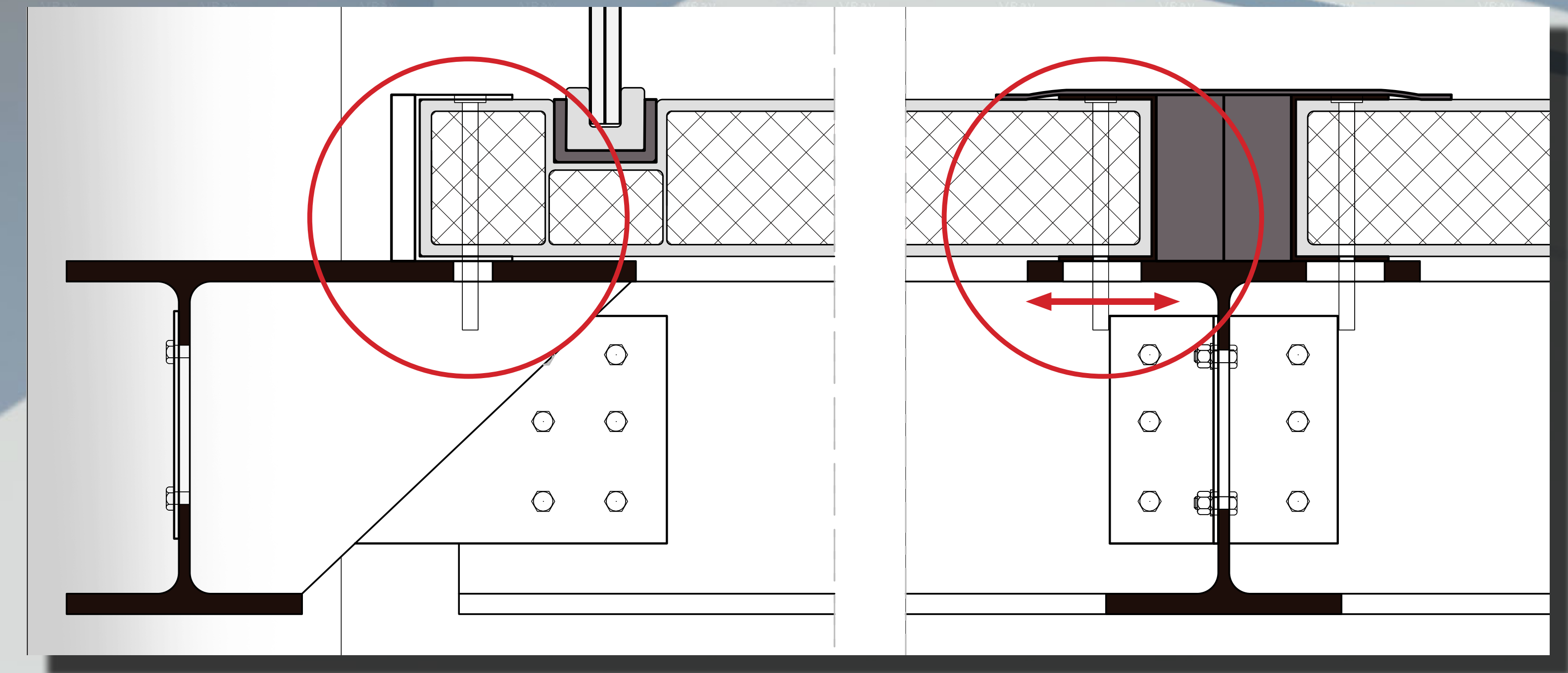
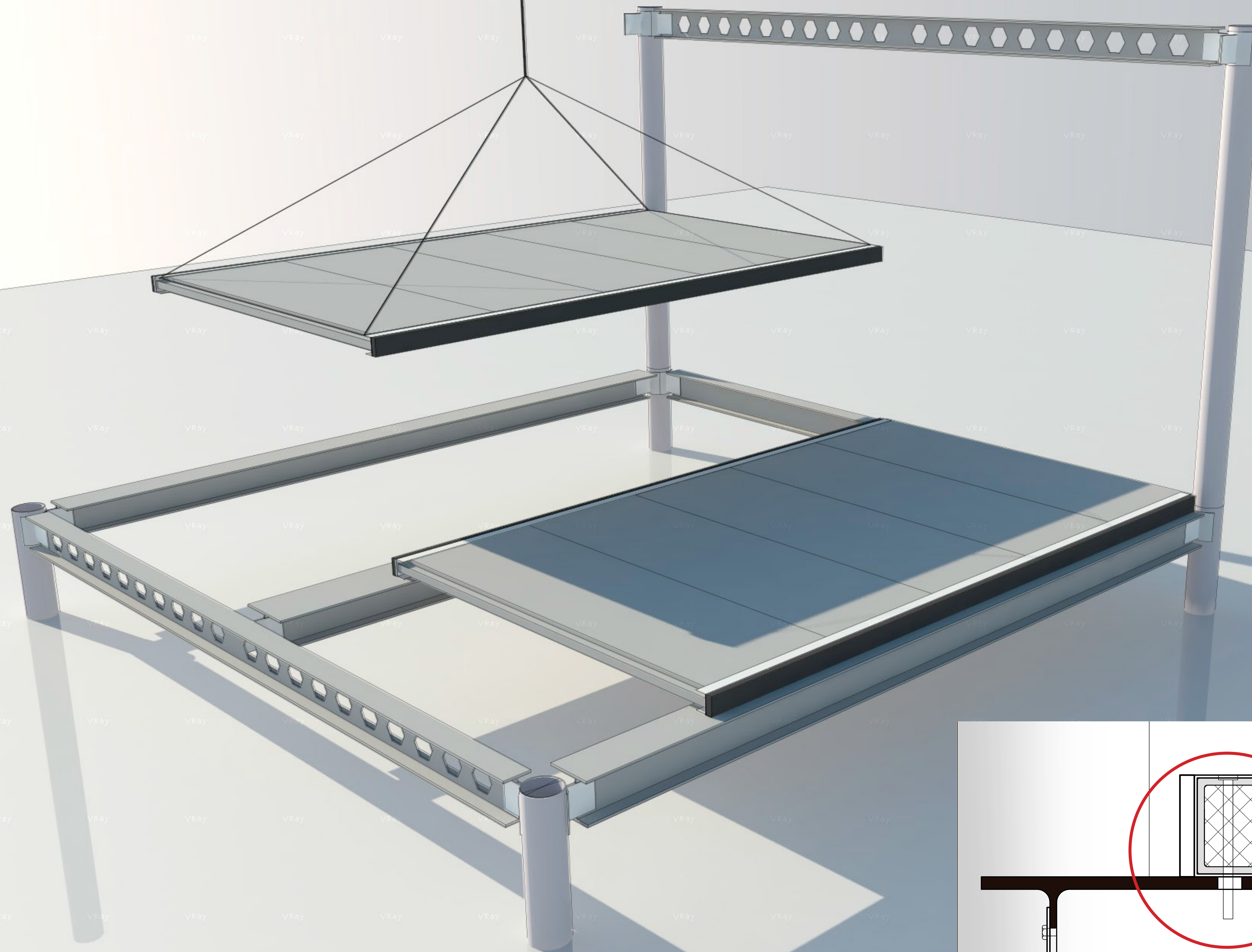
4. Design for disassembly



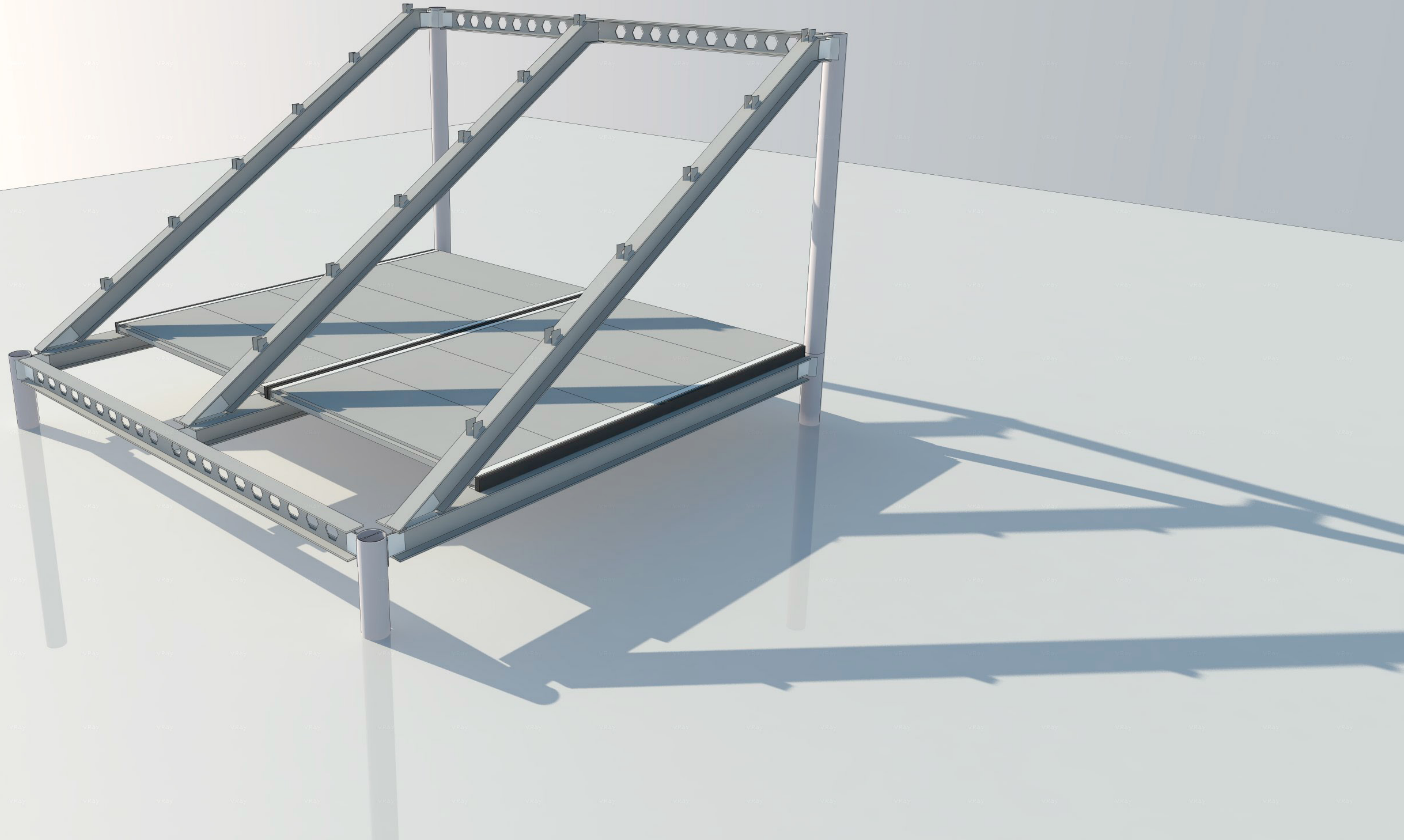
4. Design for disassembly



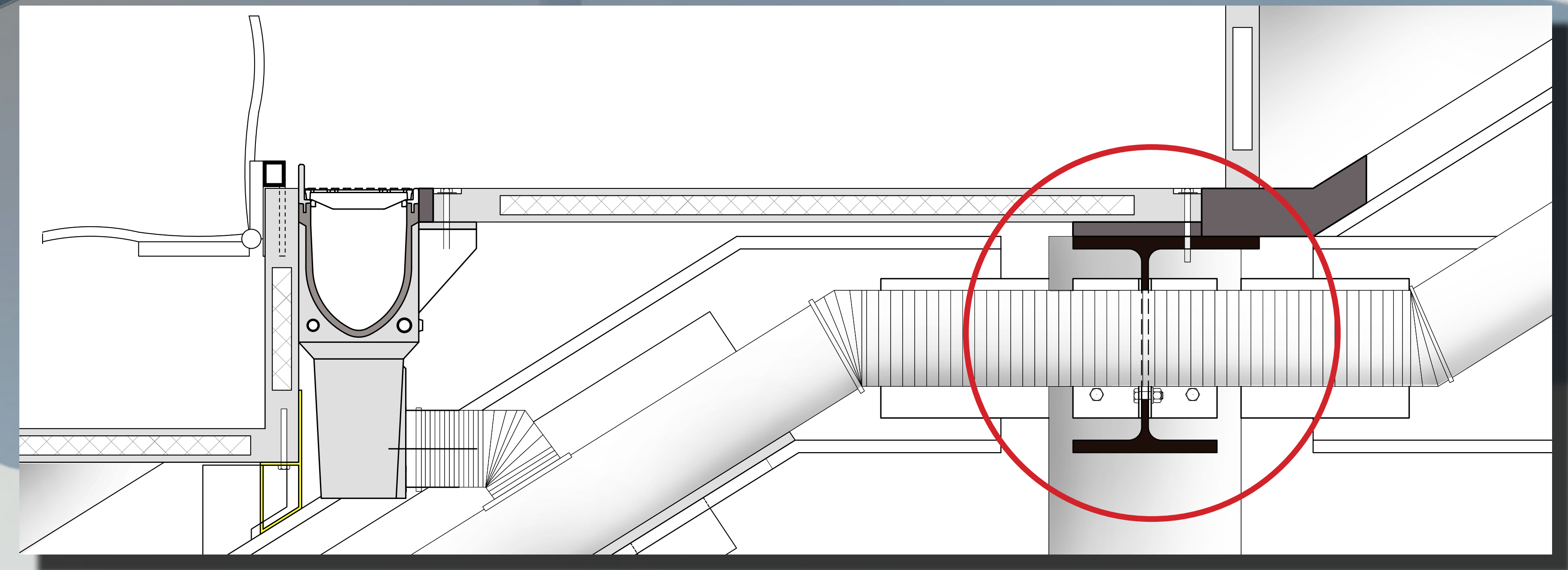
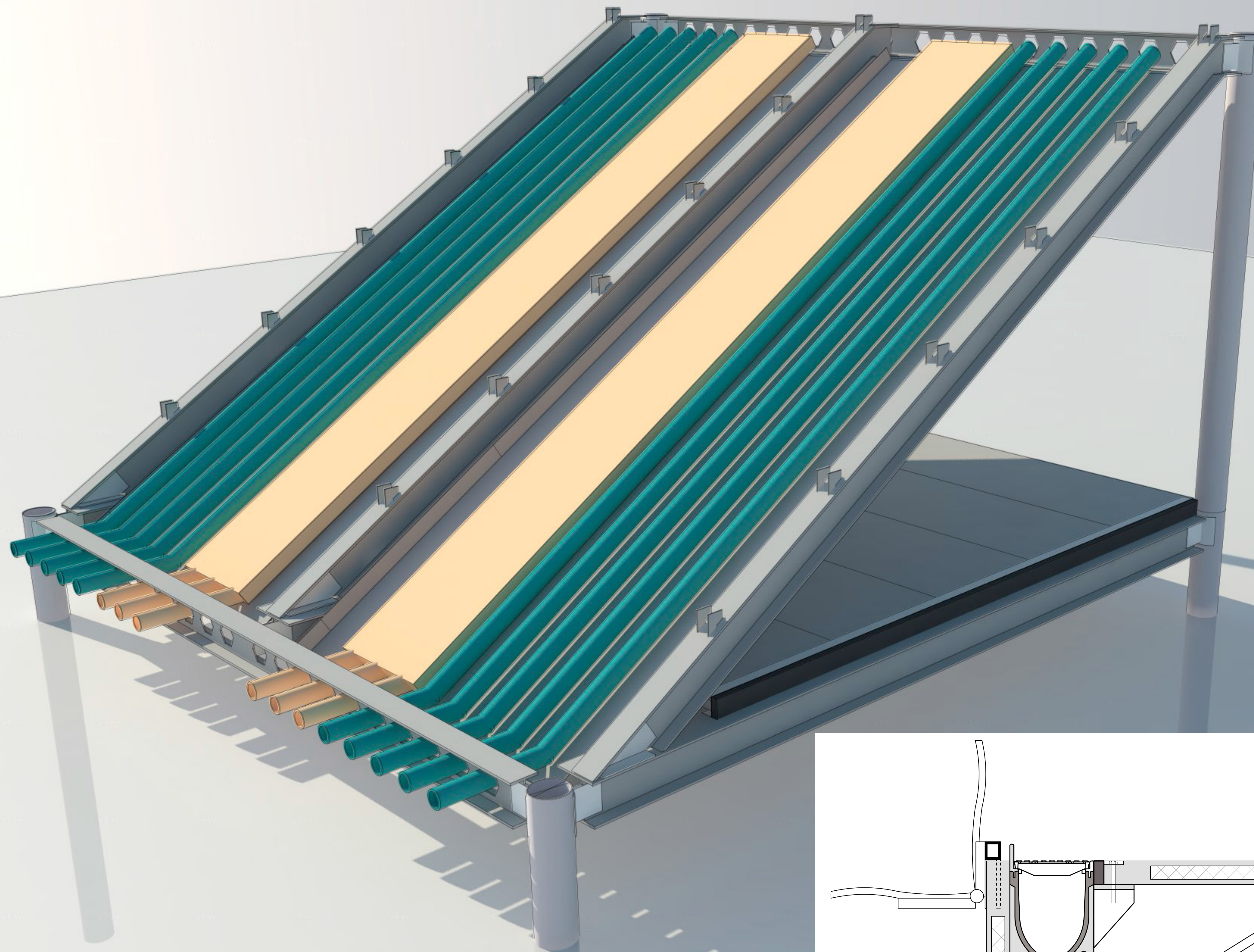
4. Design for disassembly



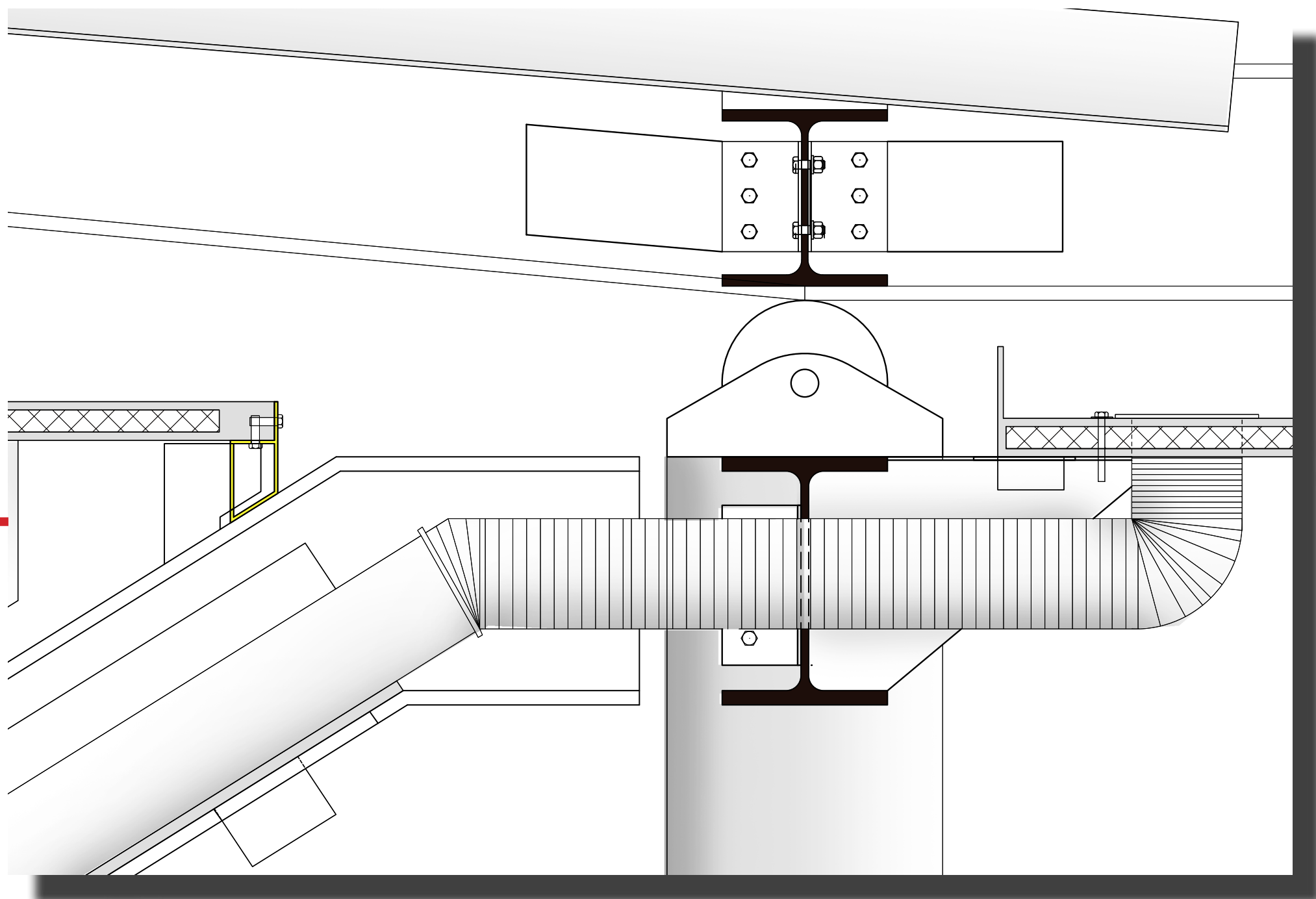
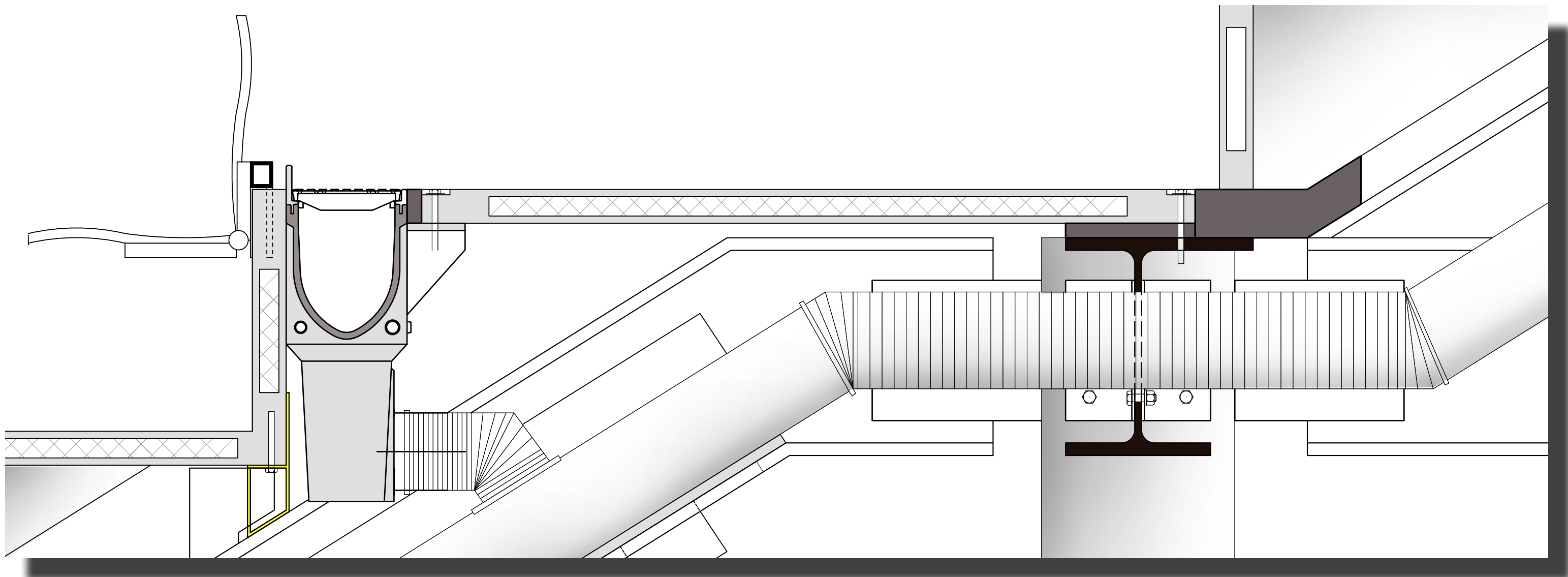
4. Design for disassembly



4. Design for disassembly



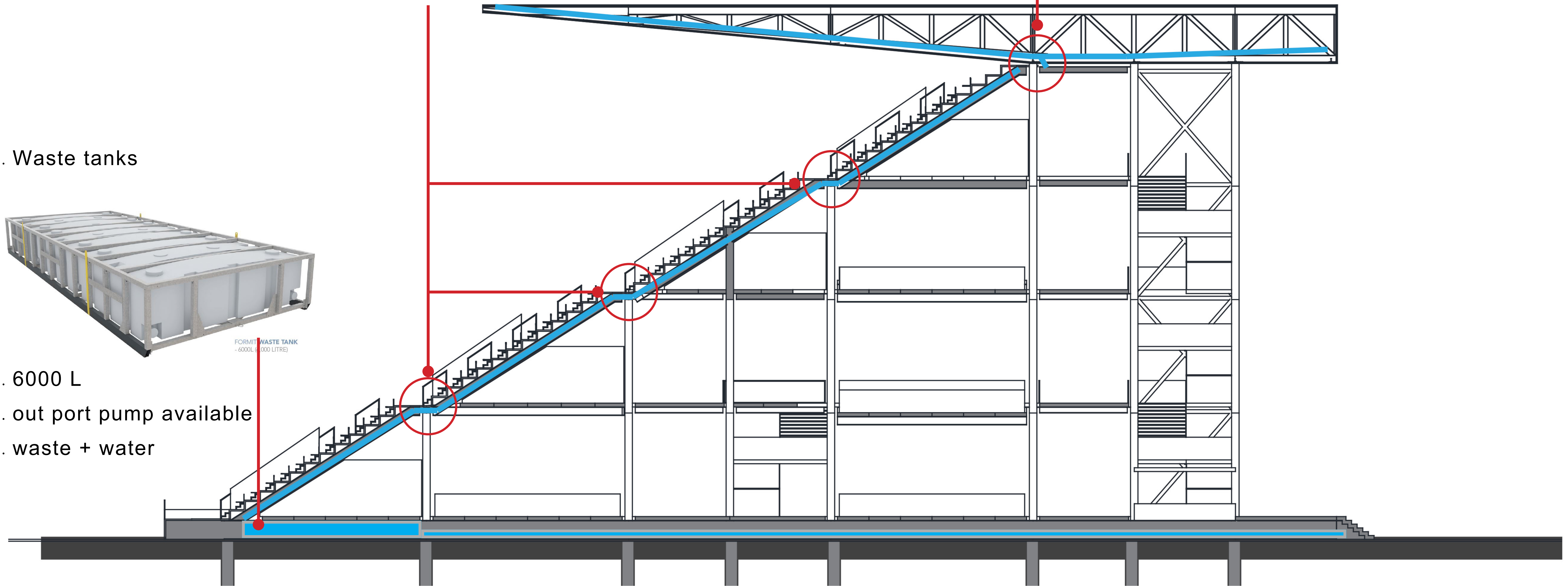
4. Design for disassembly



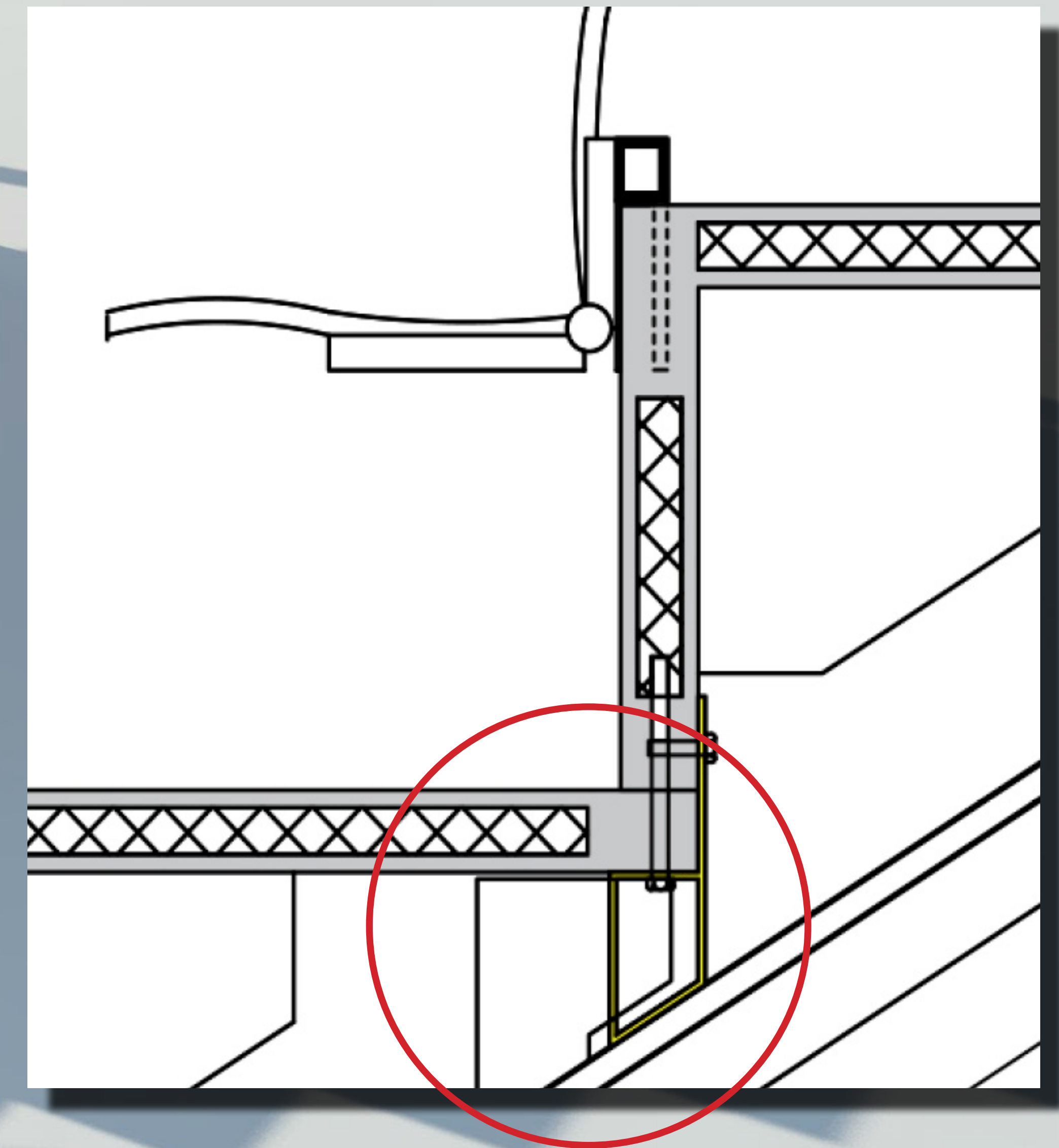
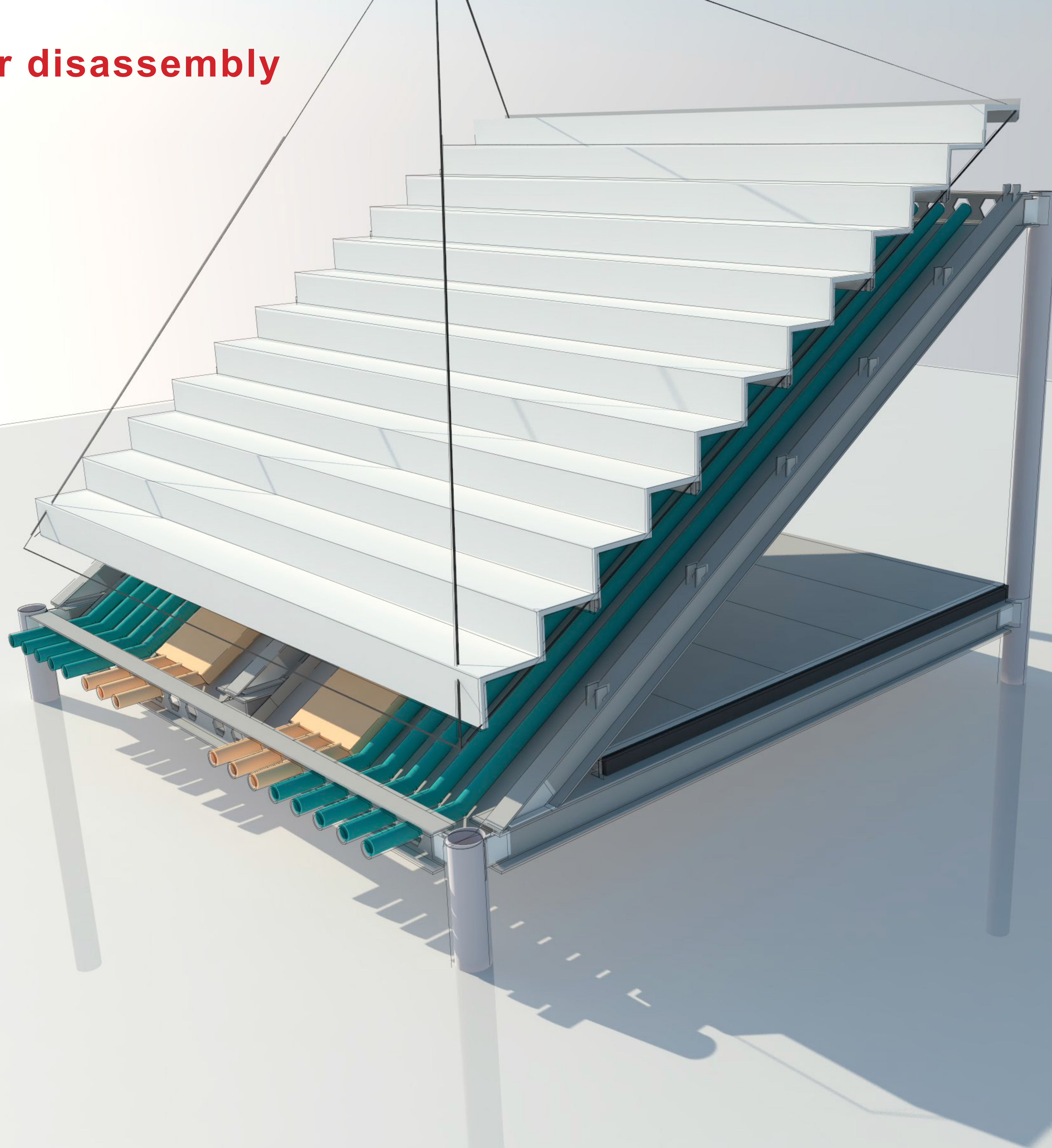
. Waste tanks



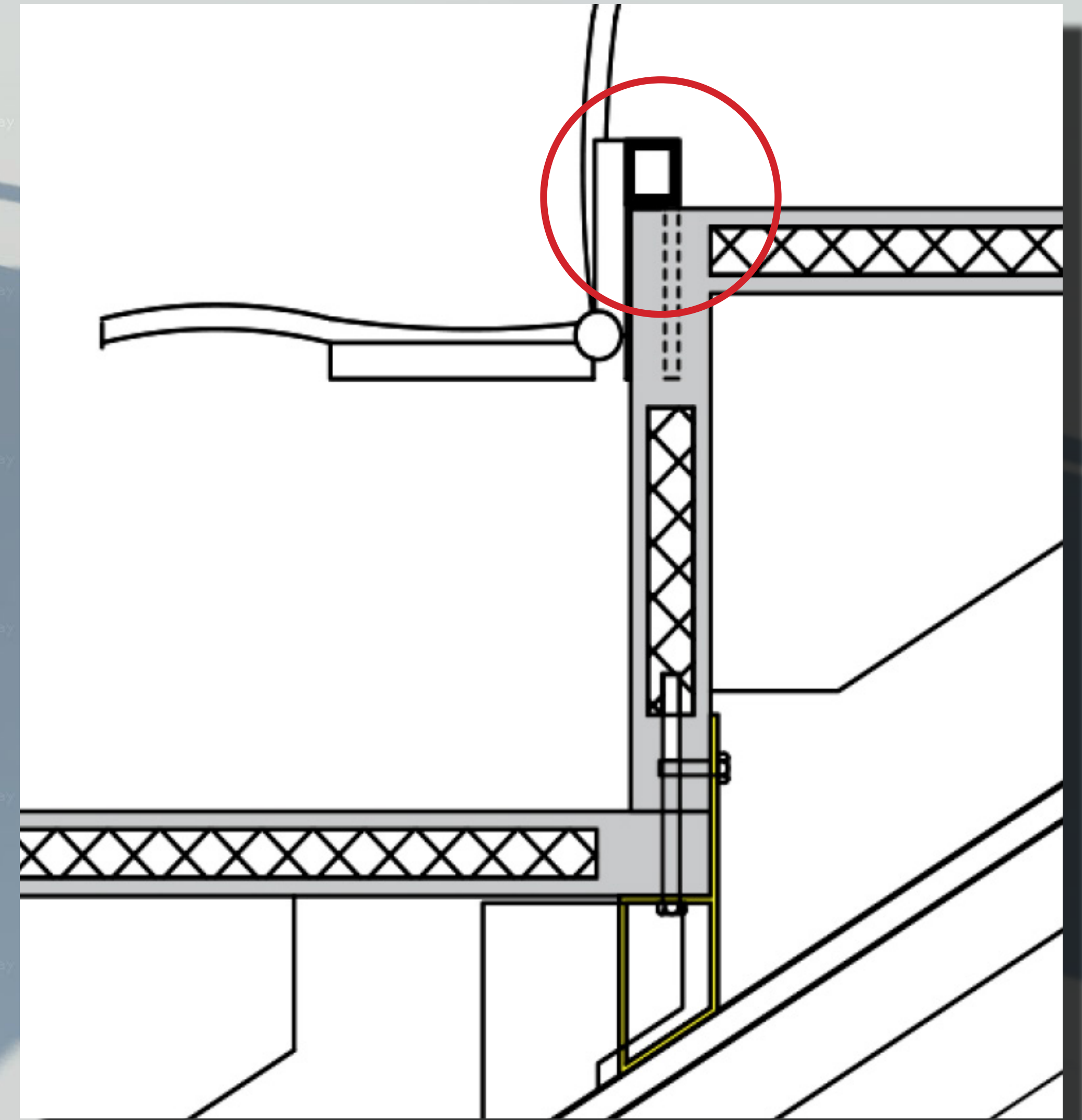
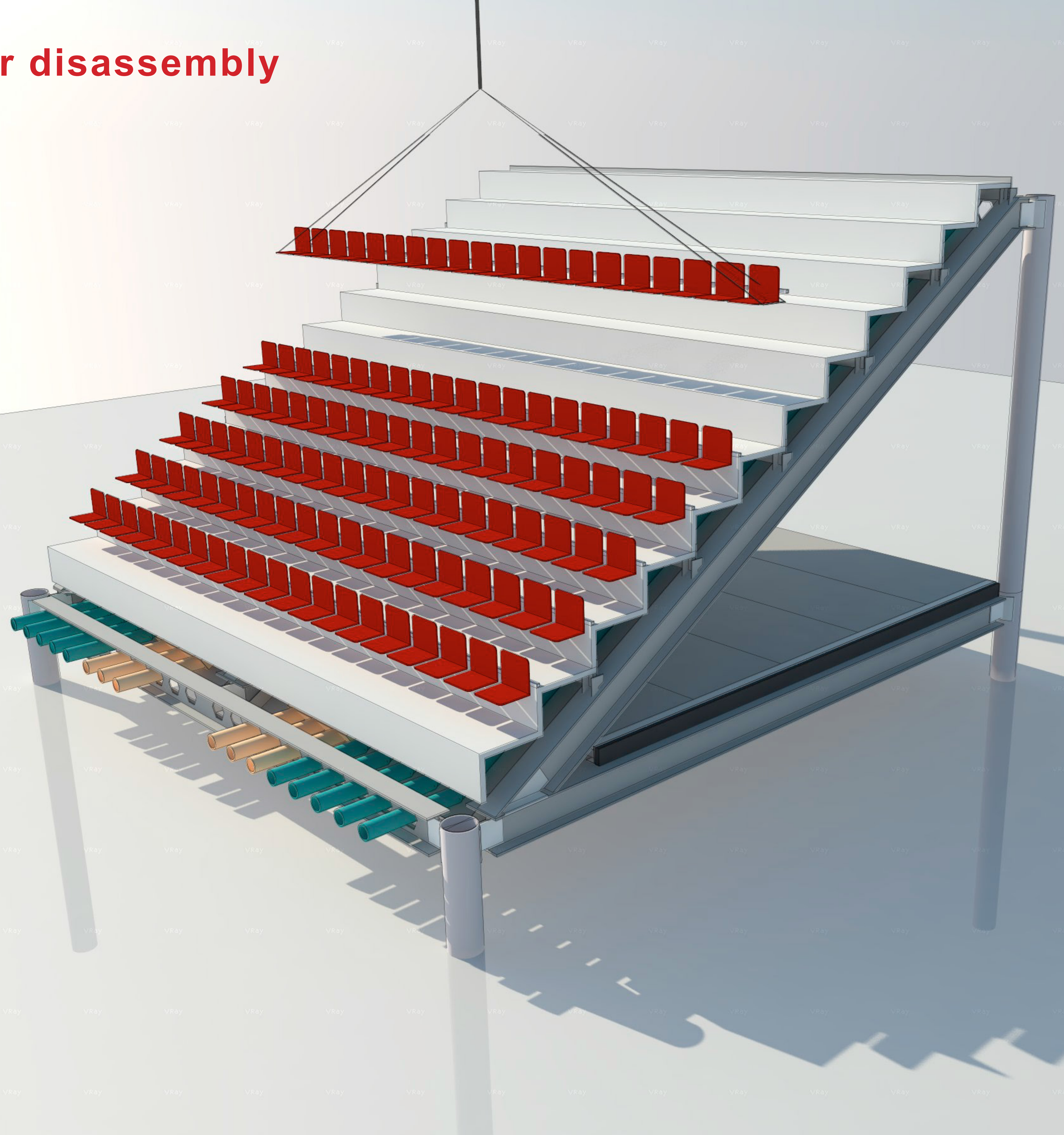
- . 6000 L
- . out port pump available
- . waste + water



4. Design for disassembly



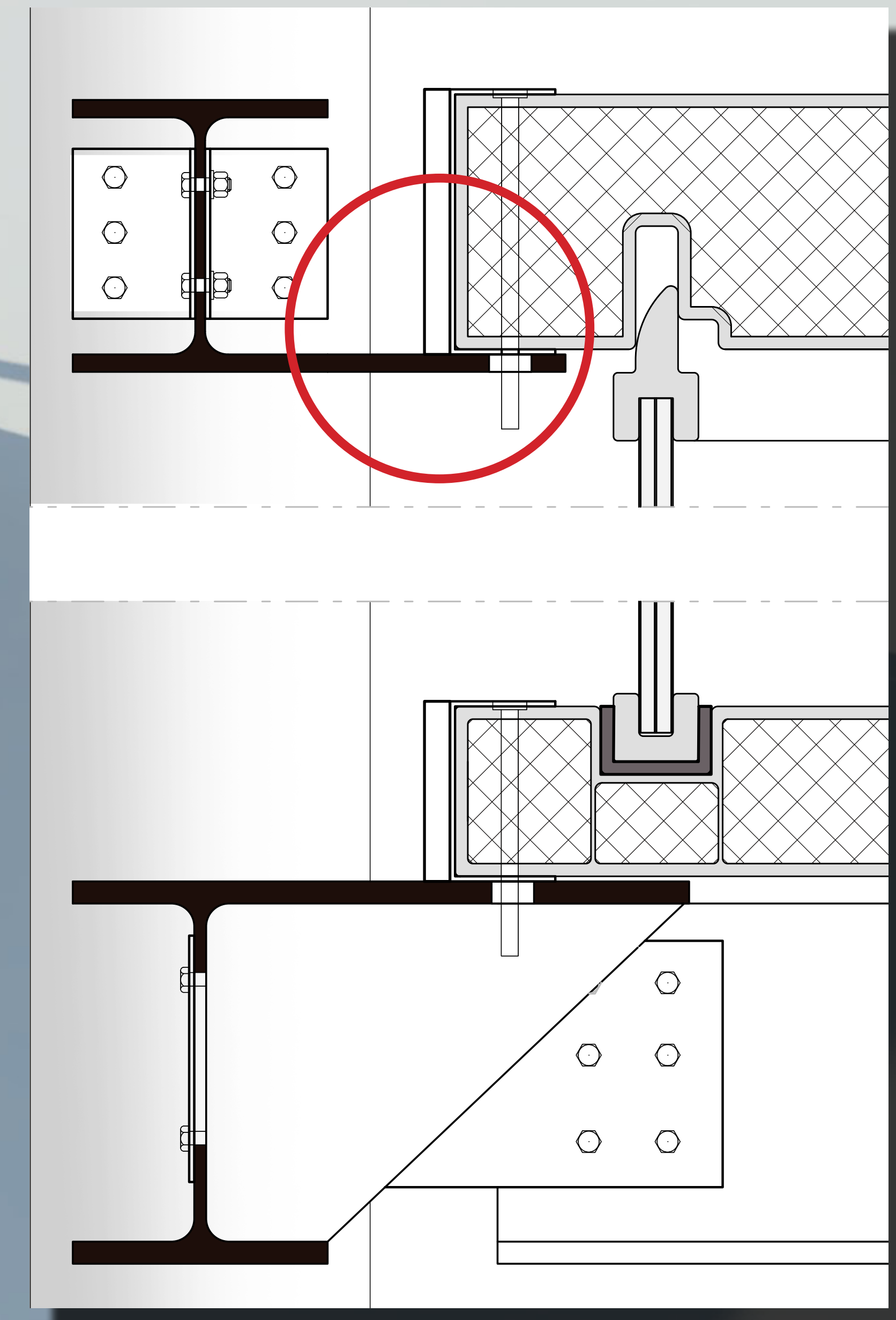
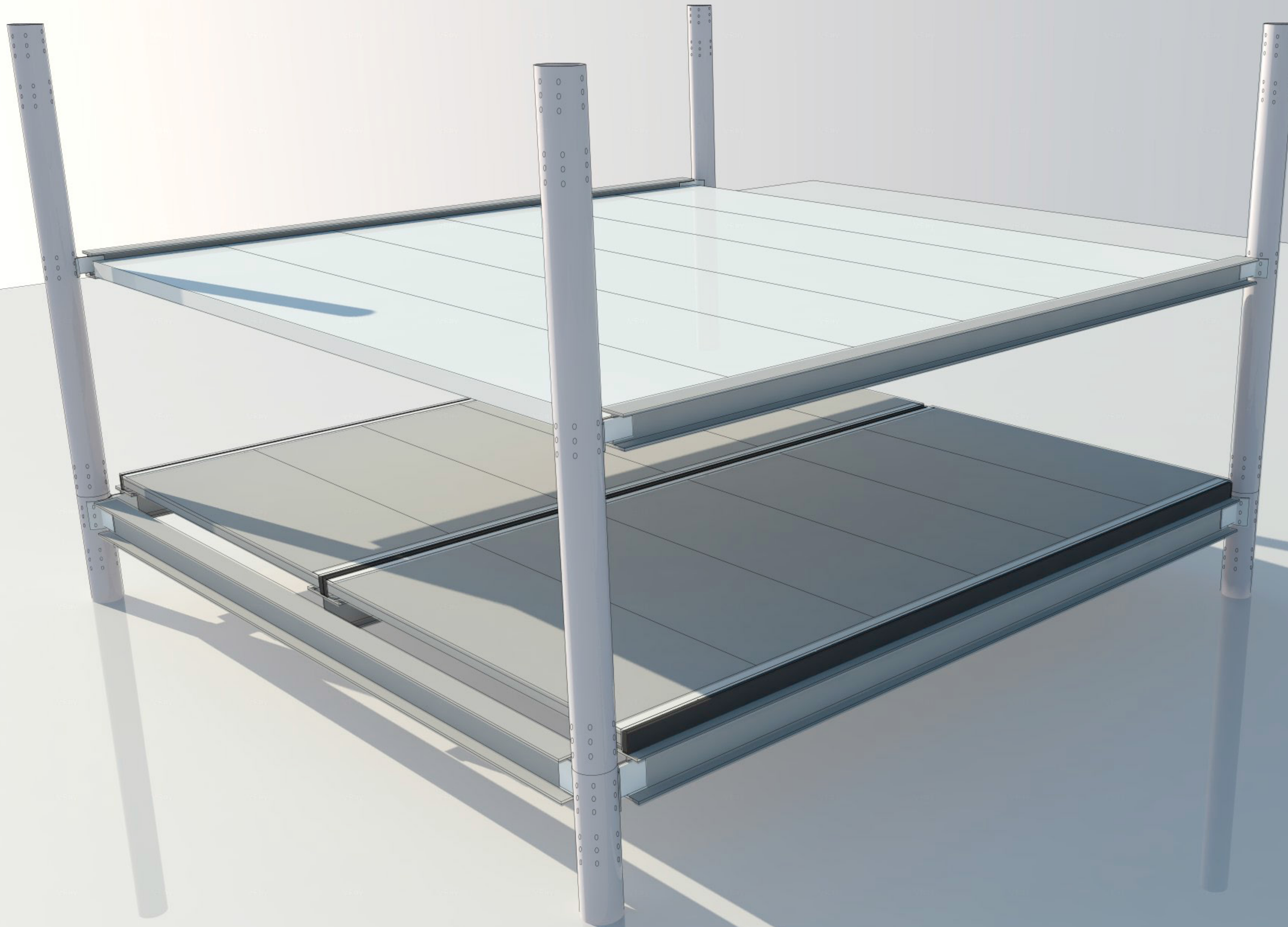
4. Design for disassembly



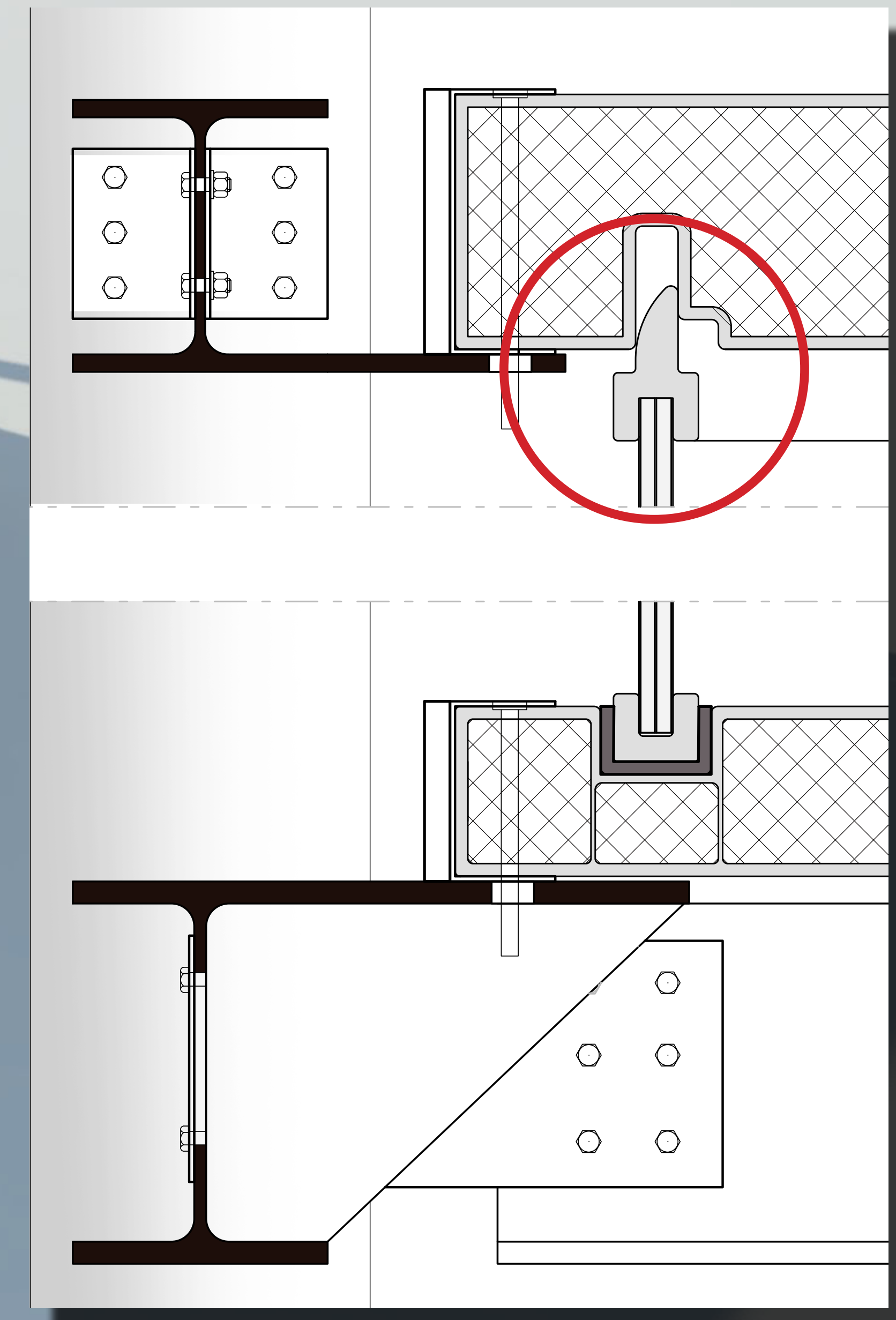
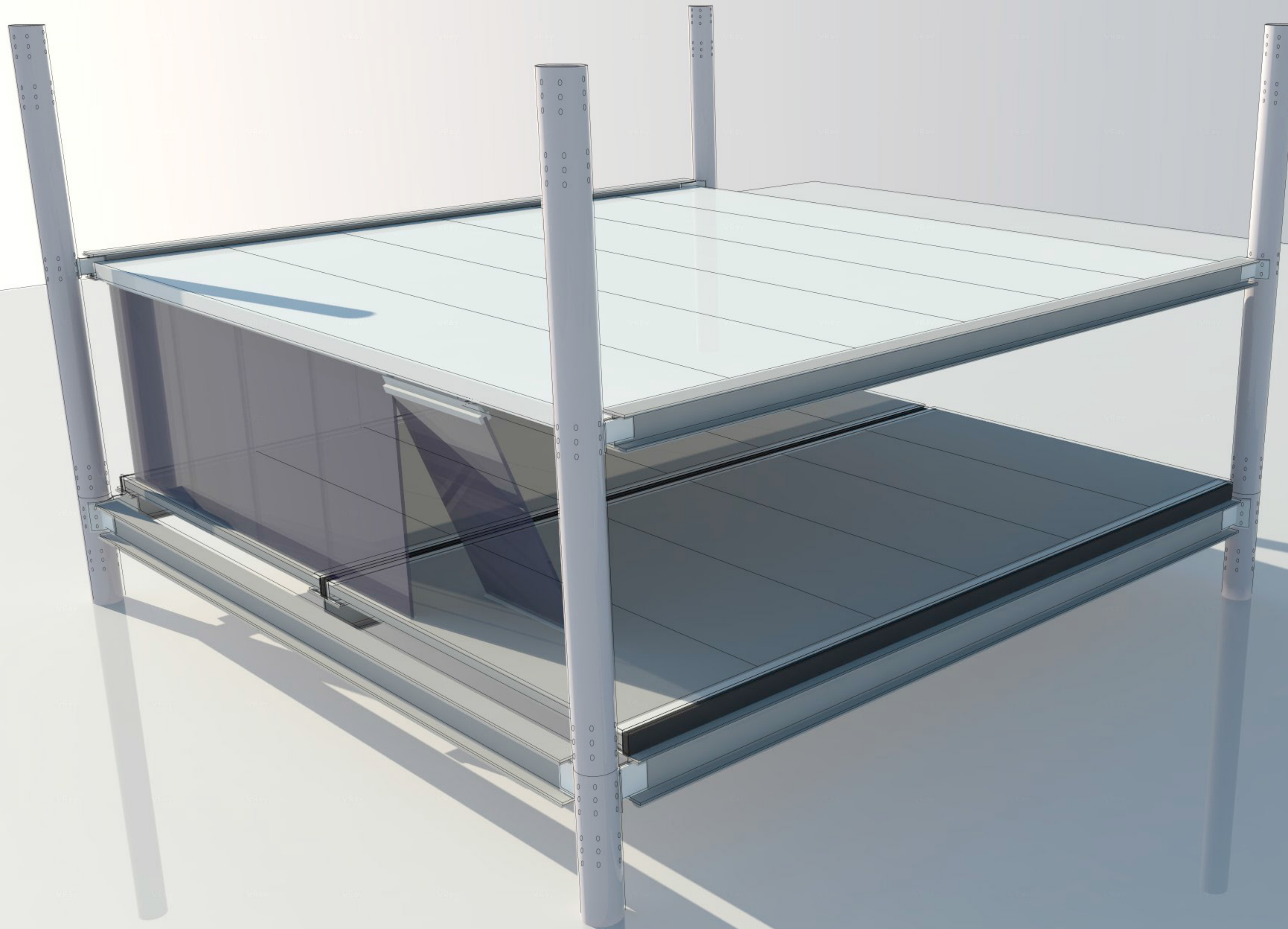
4. Design for disassembly



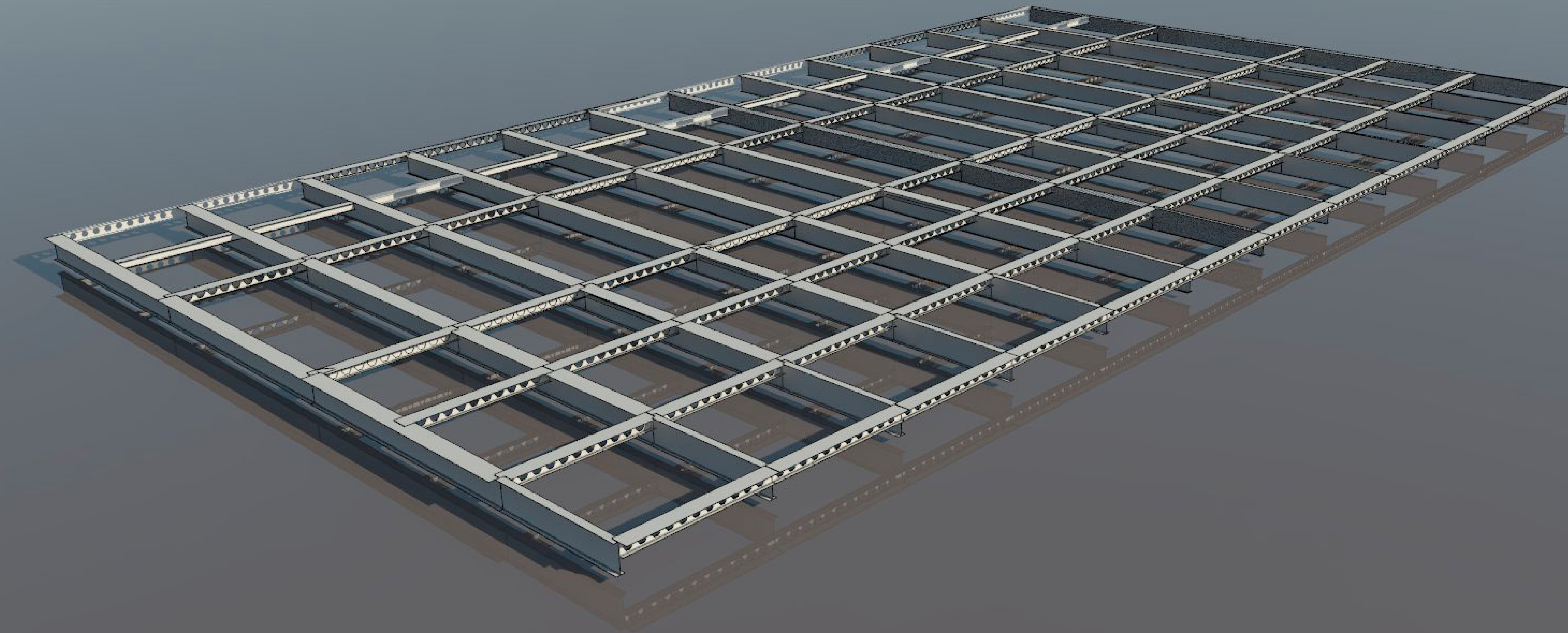
4. Design for disassembly



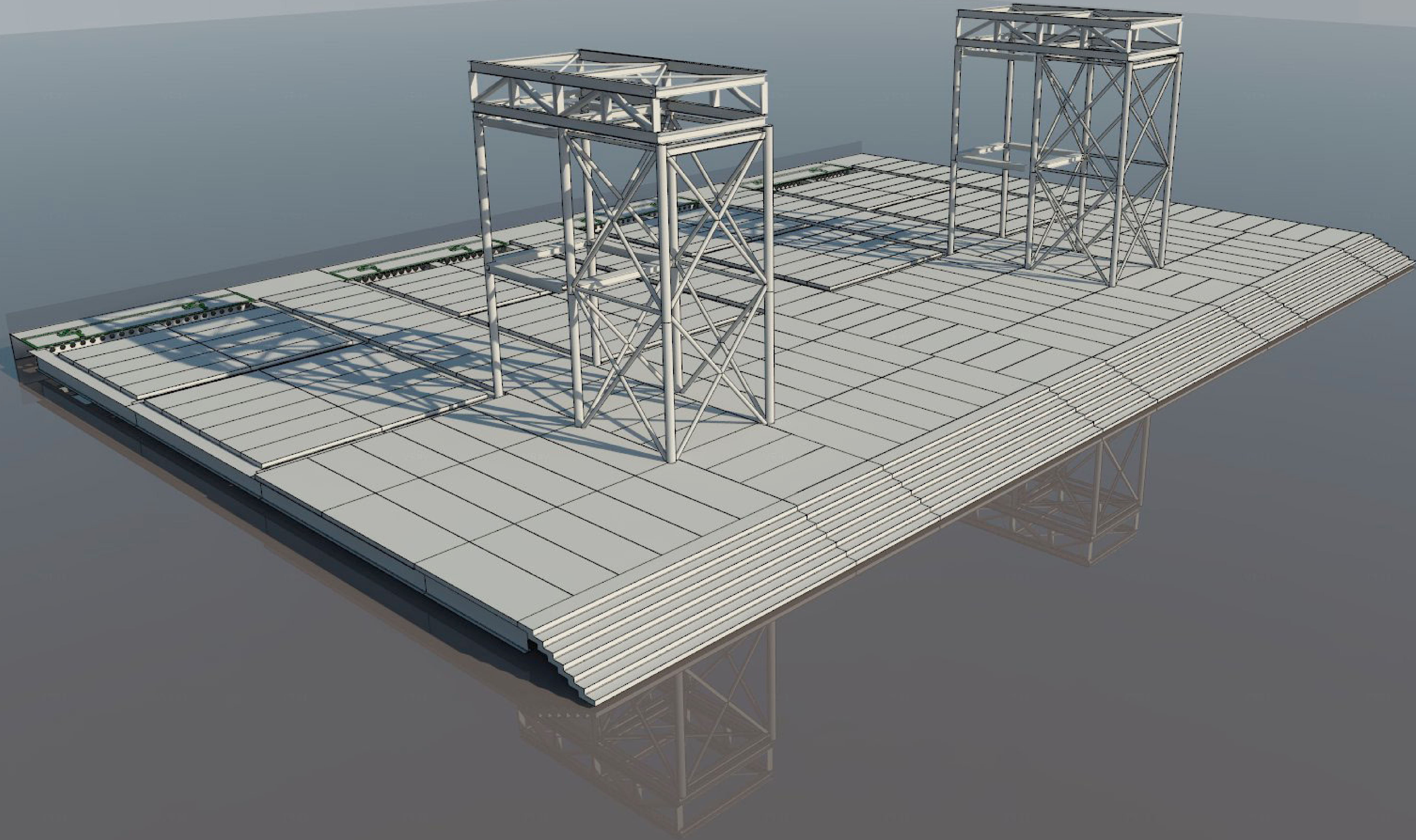
4. Design for disassembly



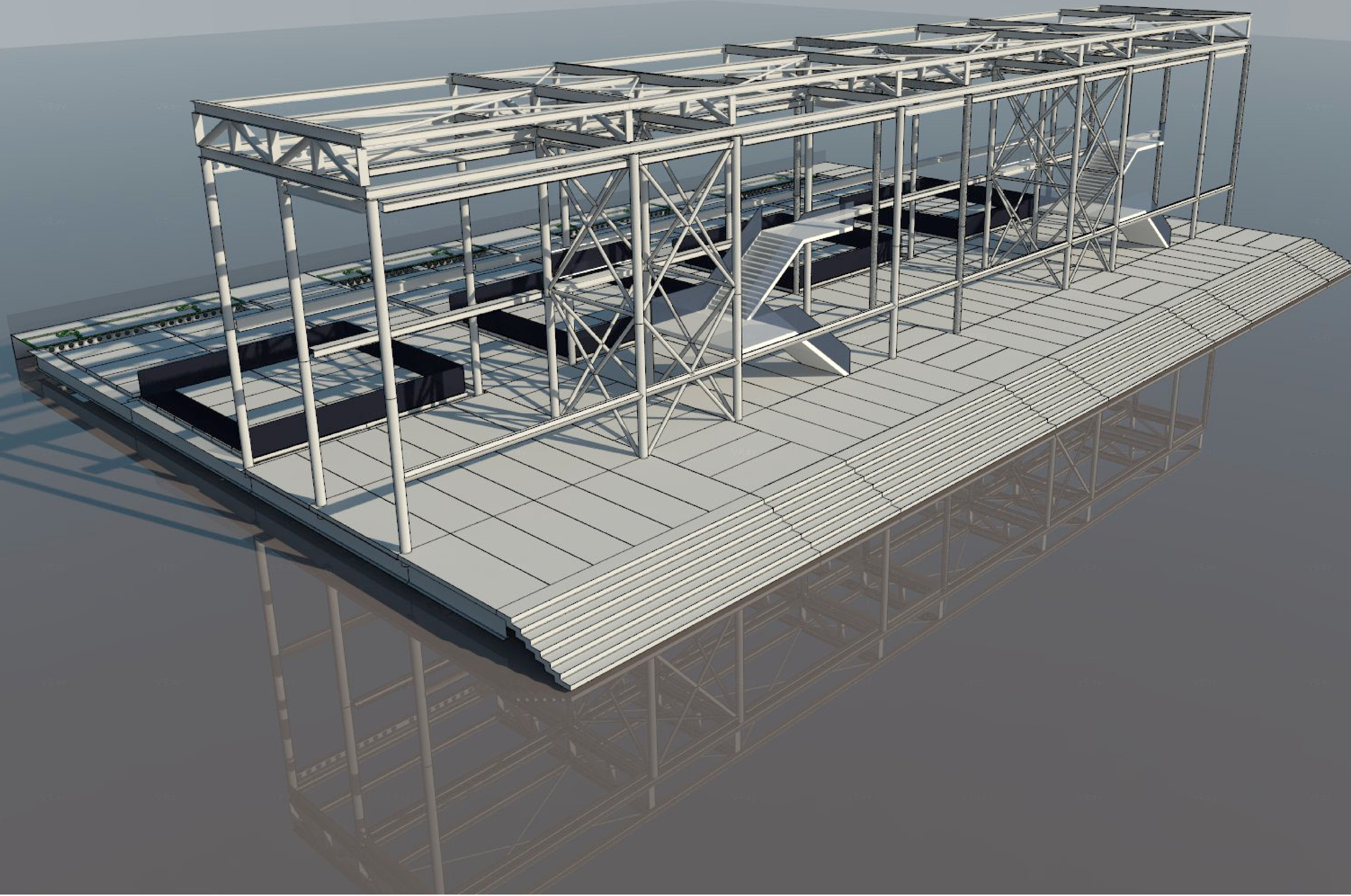
4. Design for disassembly



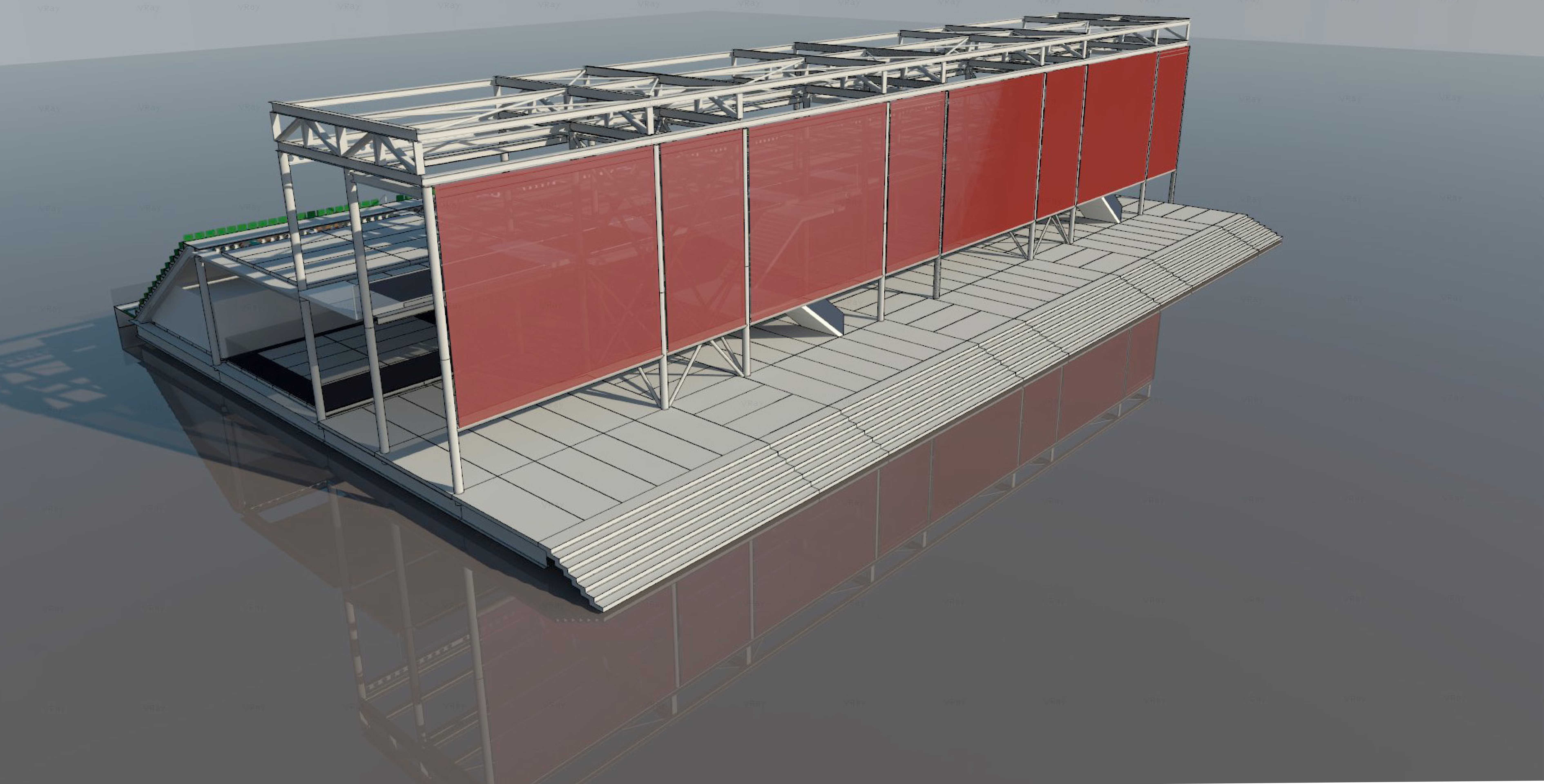
4. Design for disassembly



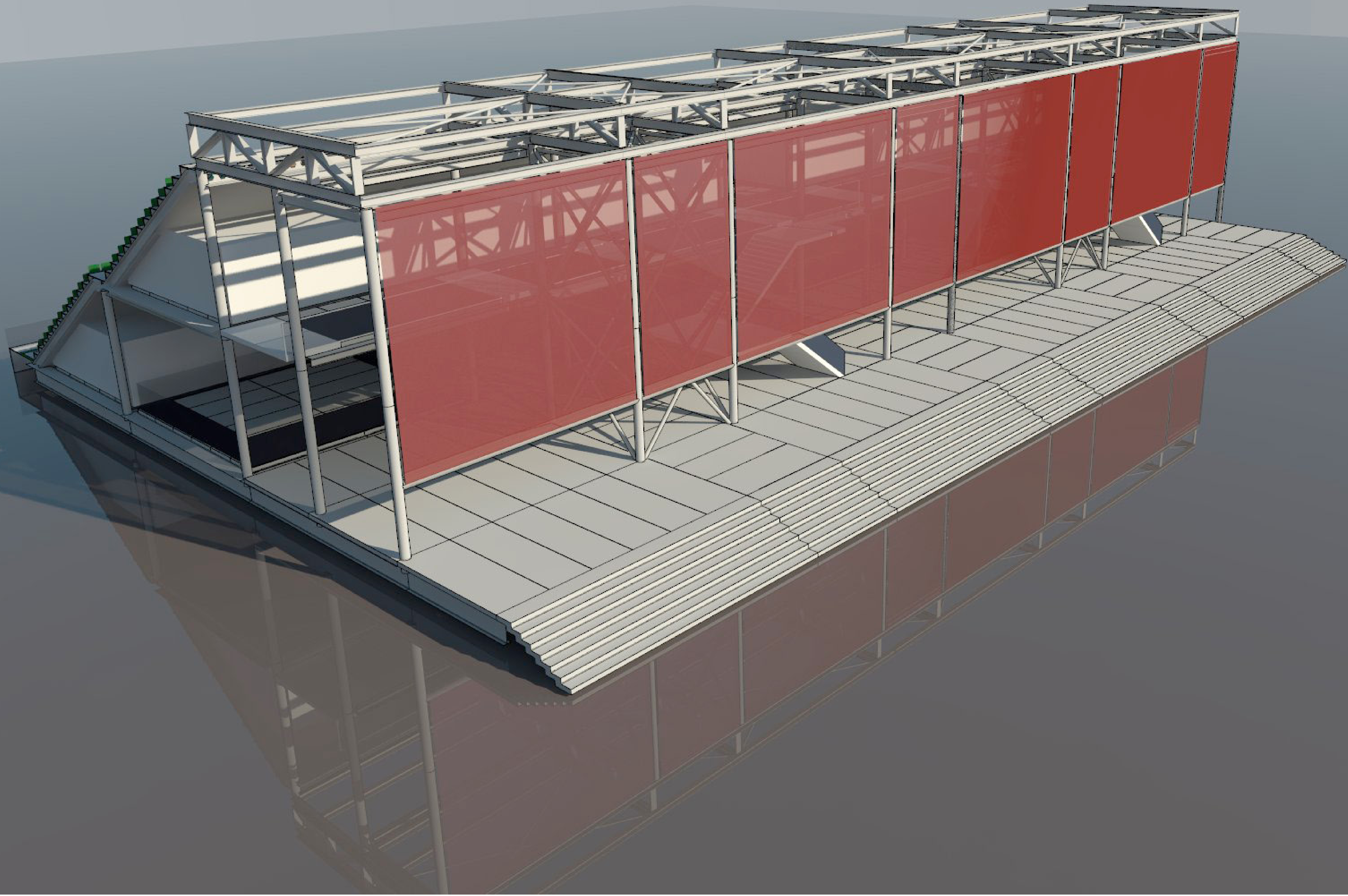
4. Design for disassembly



4. Design for disassembly



4. Design for disassembly



4. Design for disassembly



1. Introduction

2. Concept

3. Design

4. Design for Disassembly

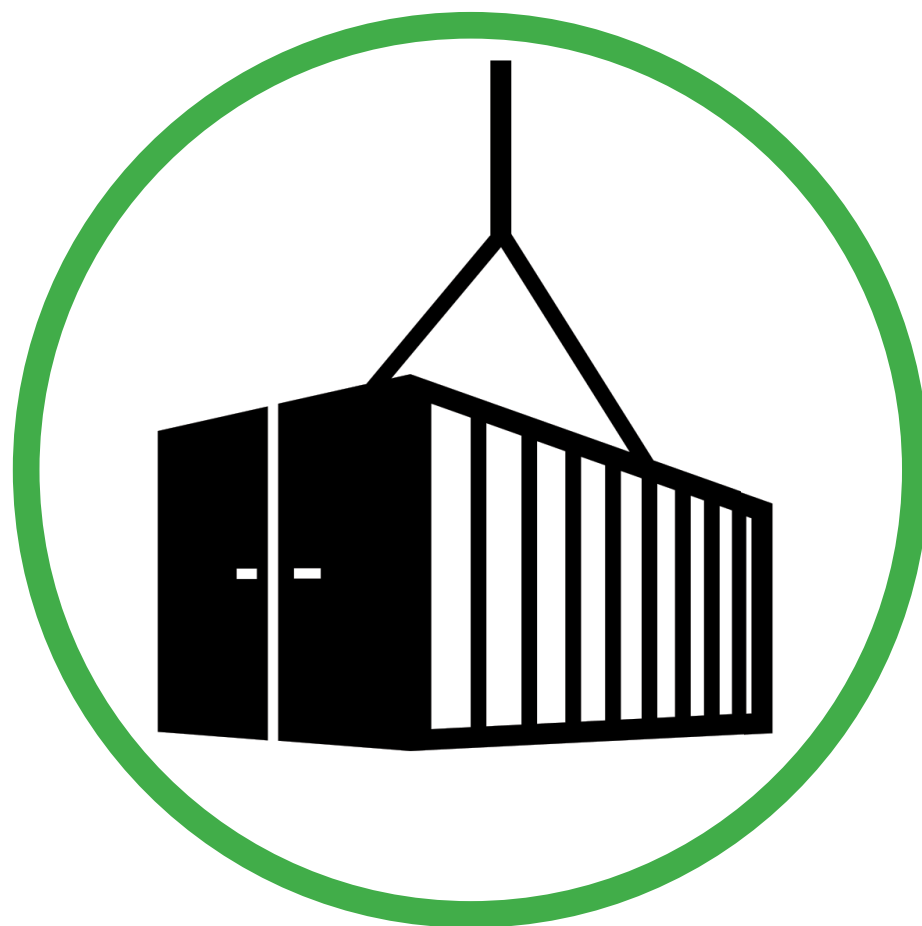
5. Conclusions

5. Conclusions

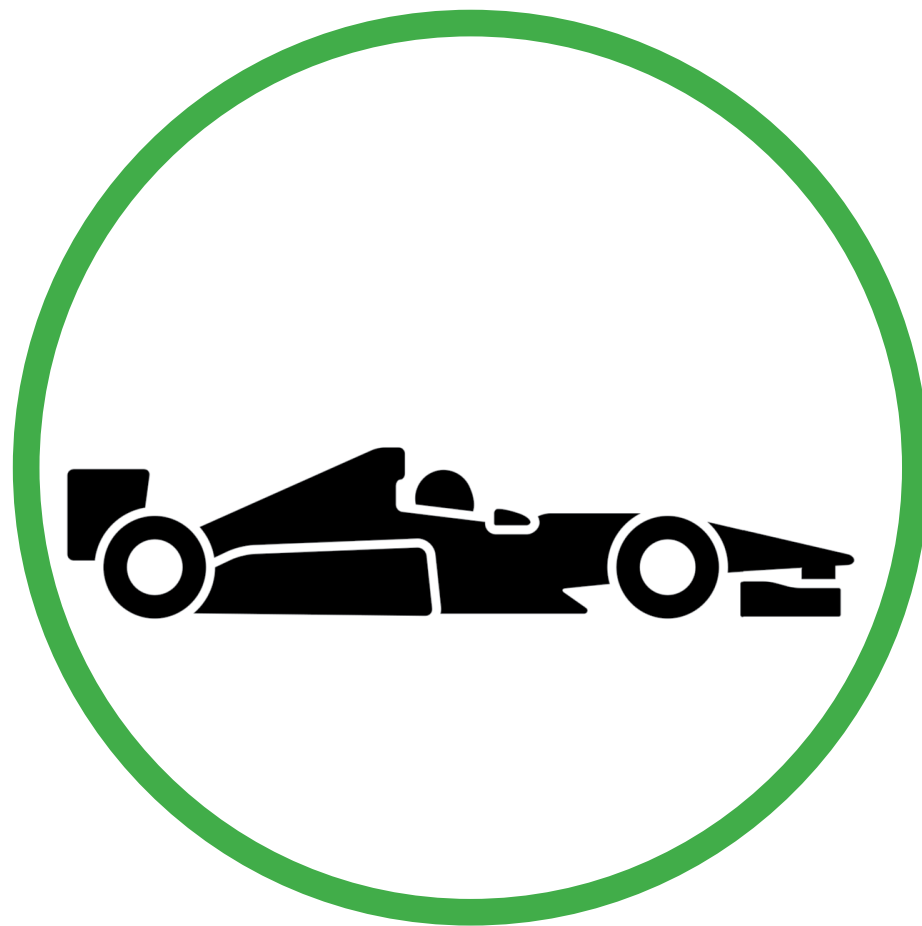
How can the requested visitor capacity for sports events temporarily be provided and also give an added value to these events?

5. Conclusions

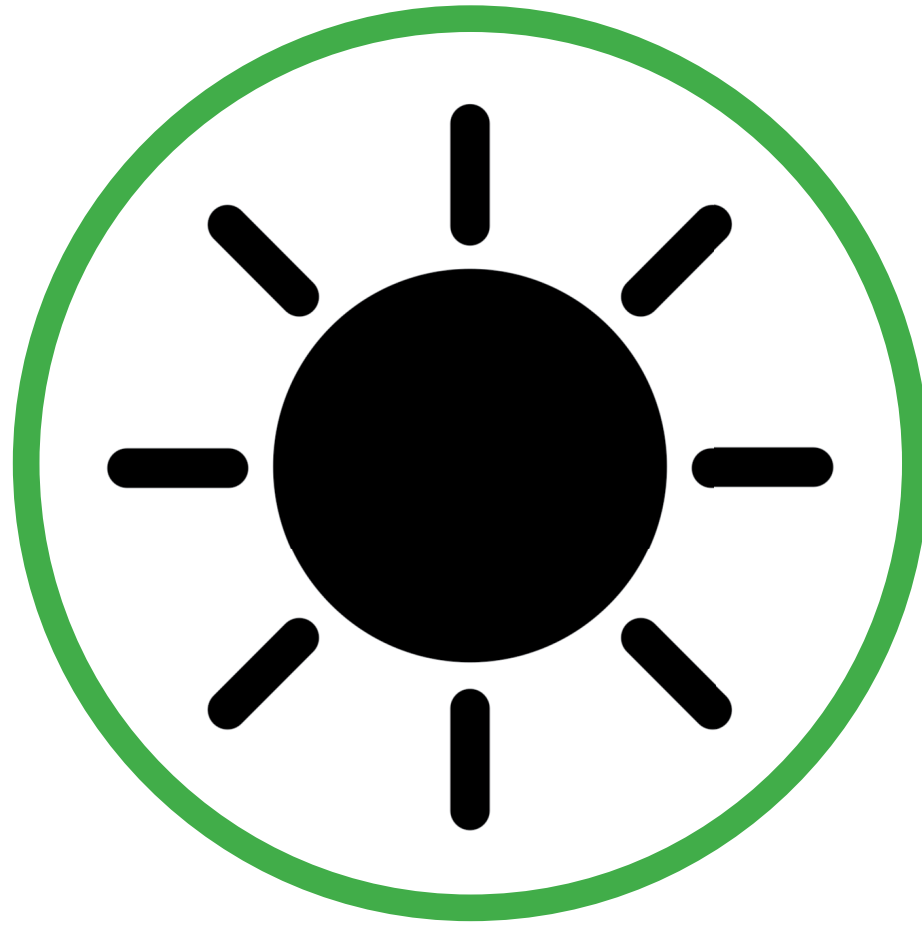
To design a temporary structure



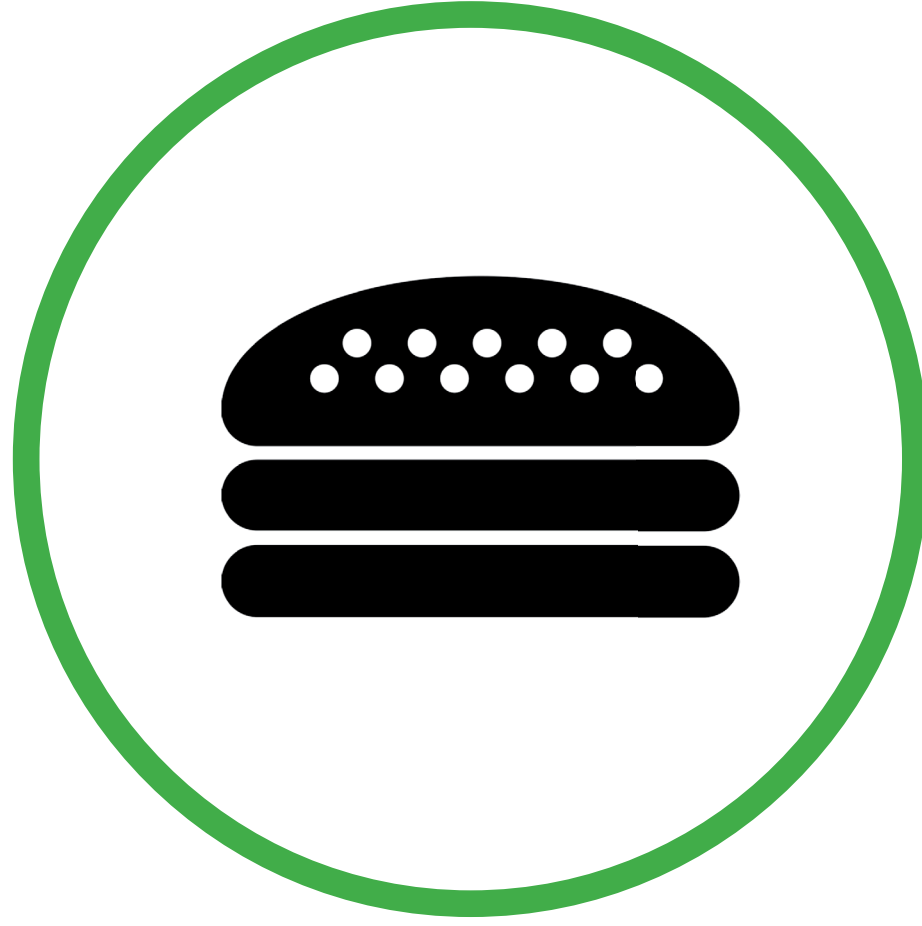
for visitors of all kinds of sports events



on a great variety of locations

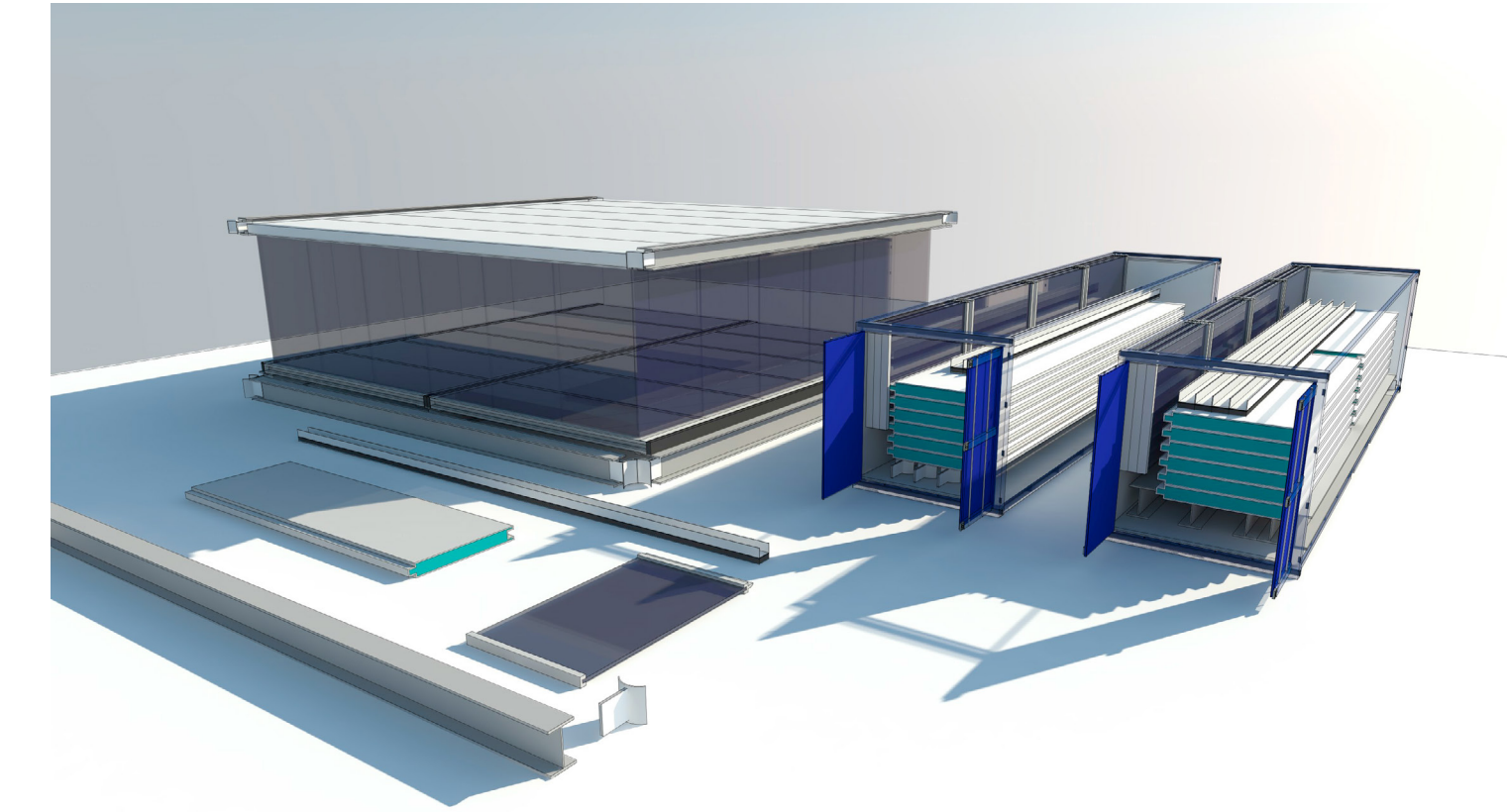
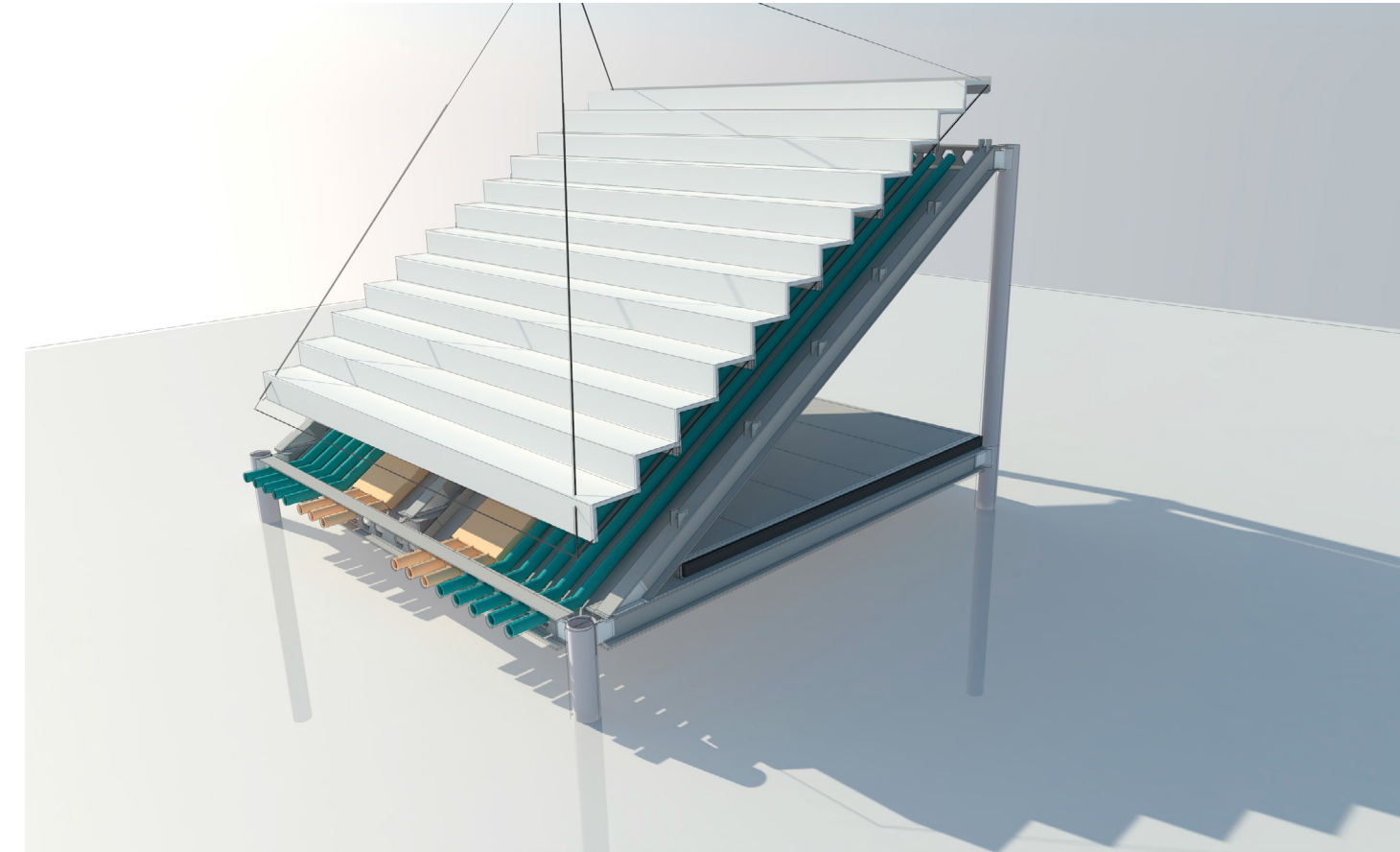


with spaces for all types of functions.

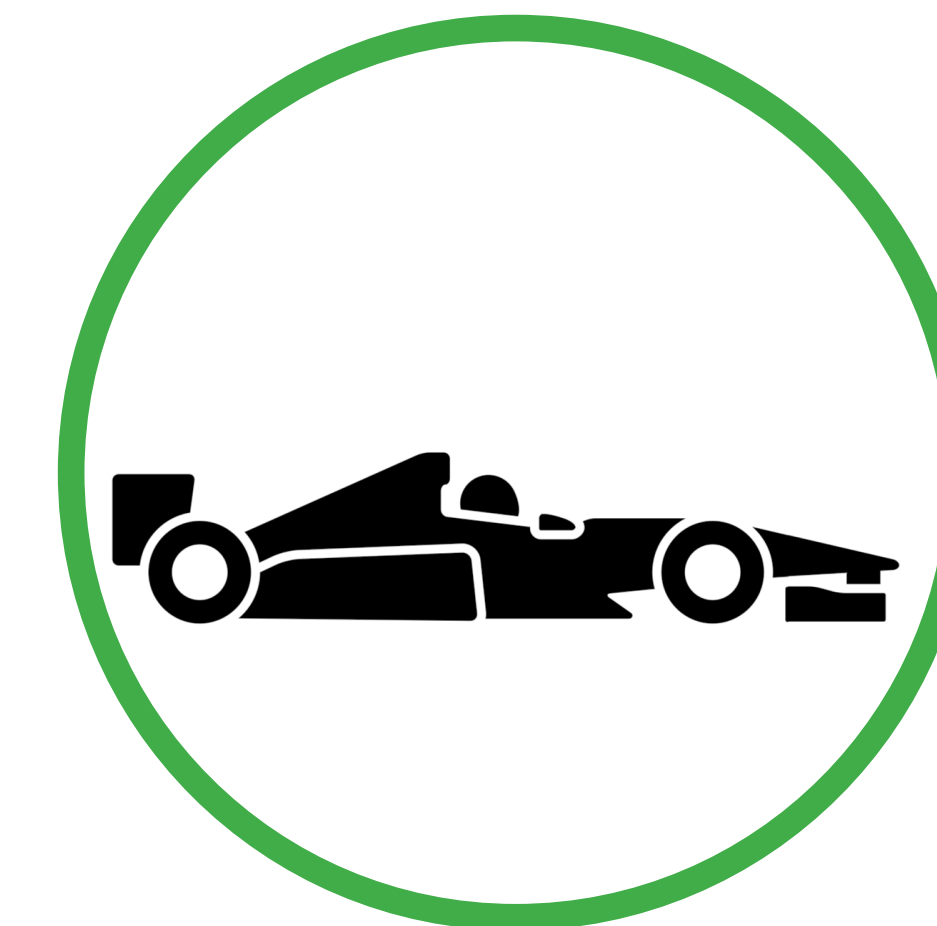


5. Conclusions

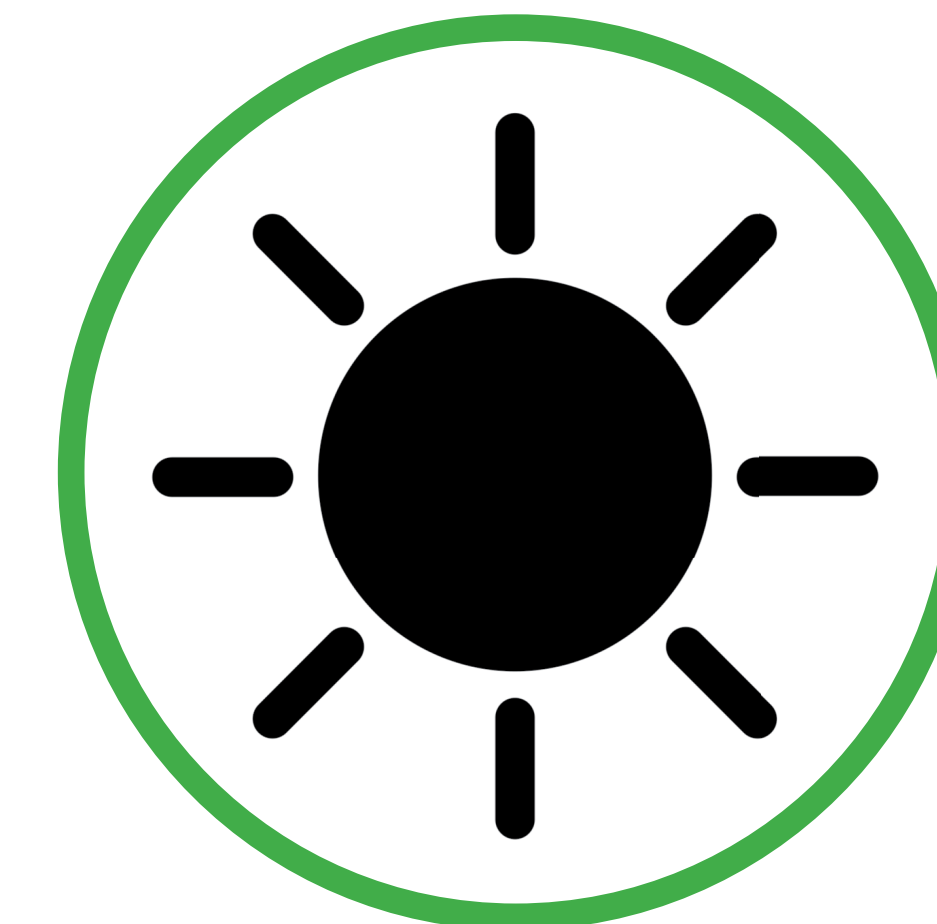
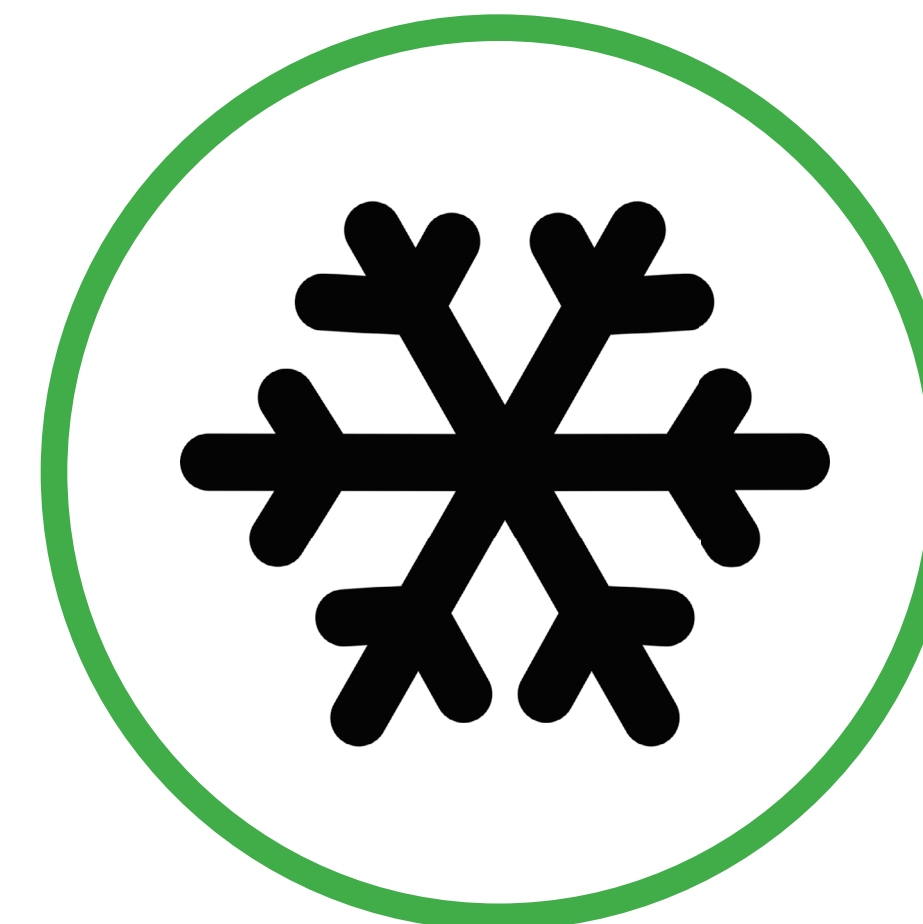
To design a temporary structure



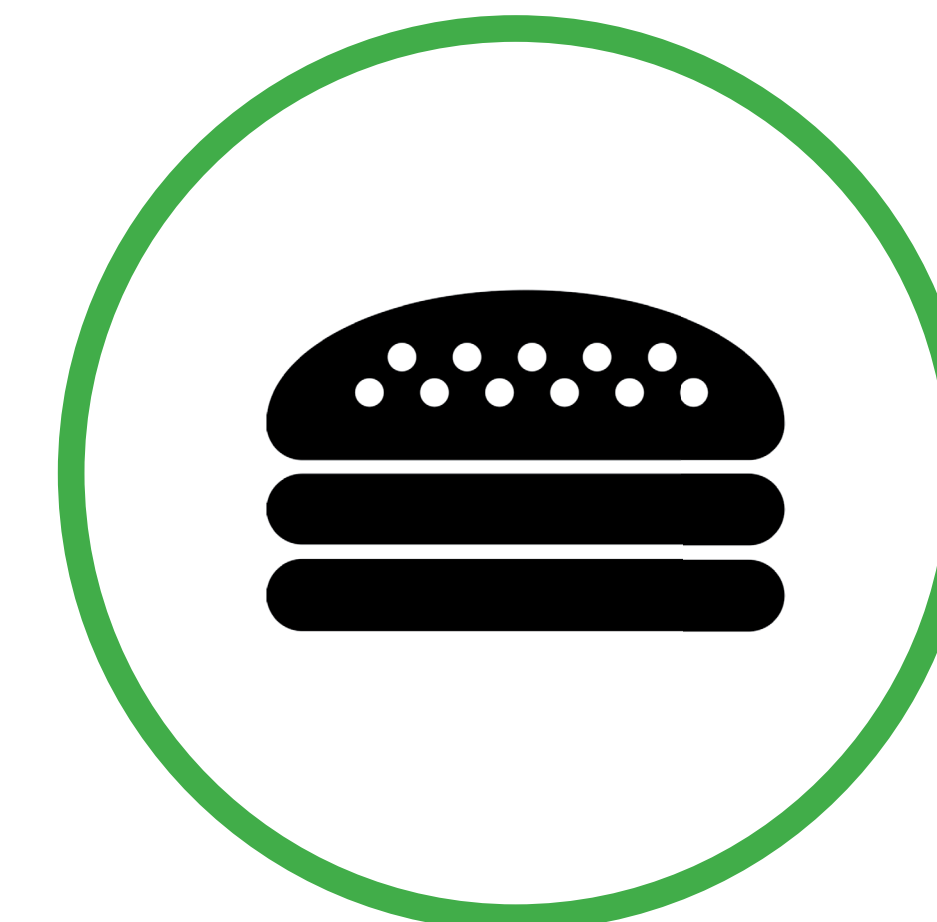
for visitors of all kinds of sports events



on a great variety of locations

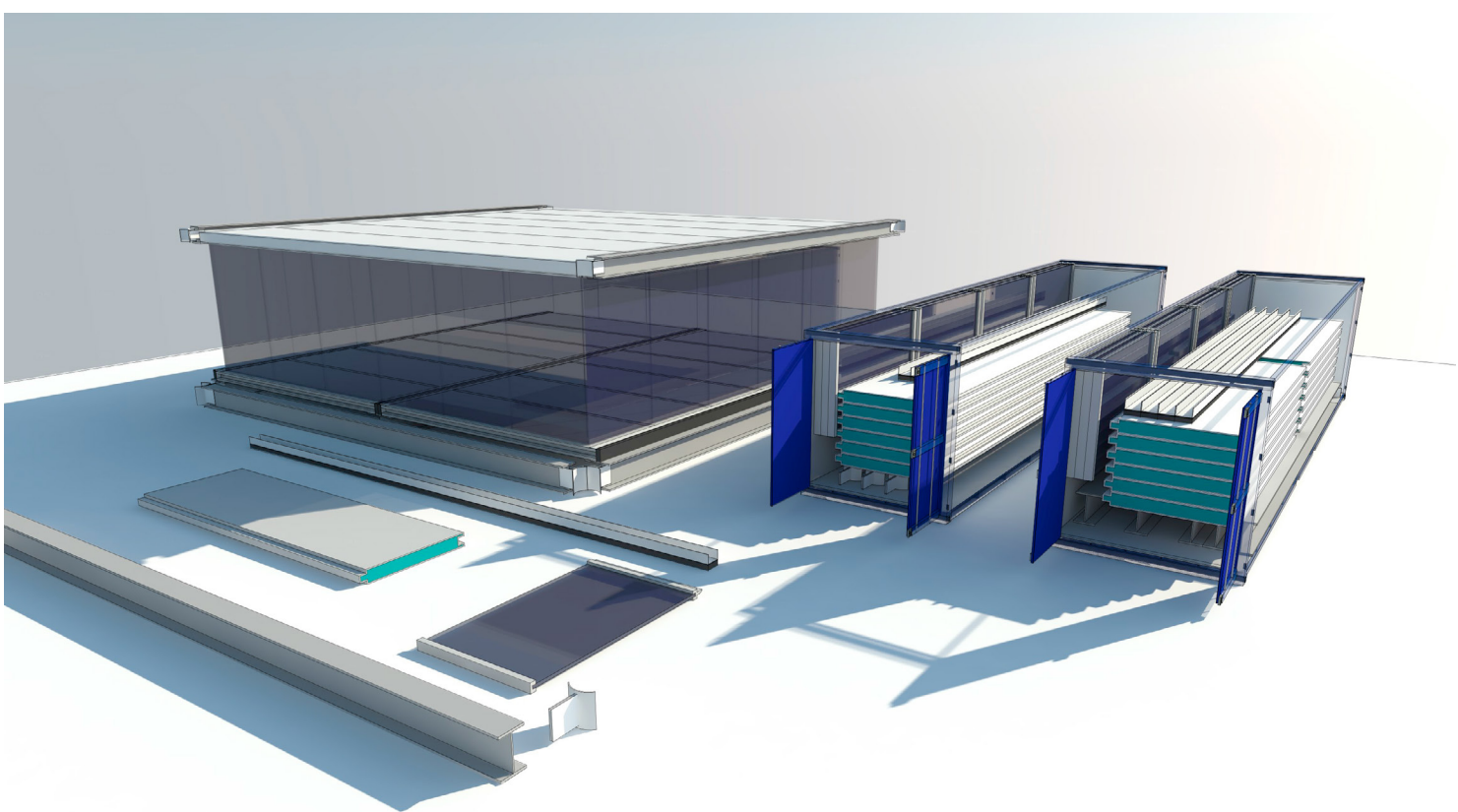
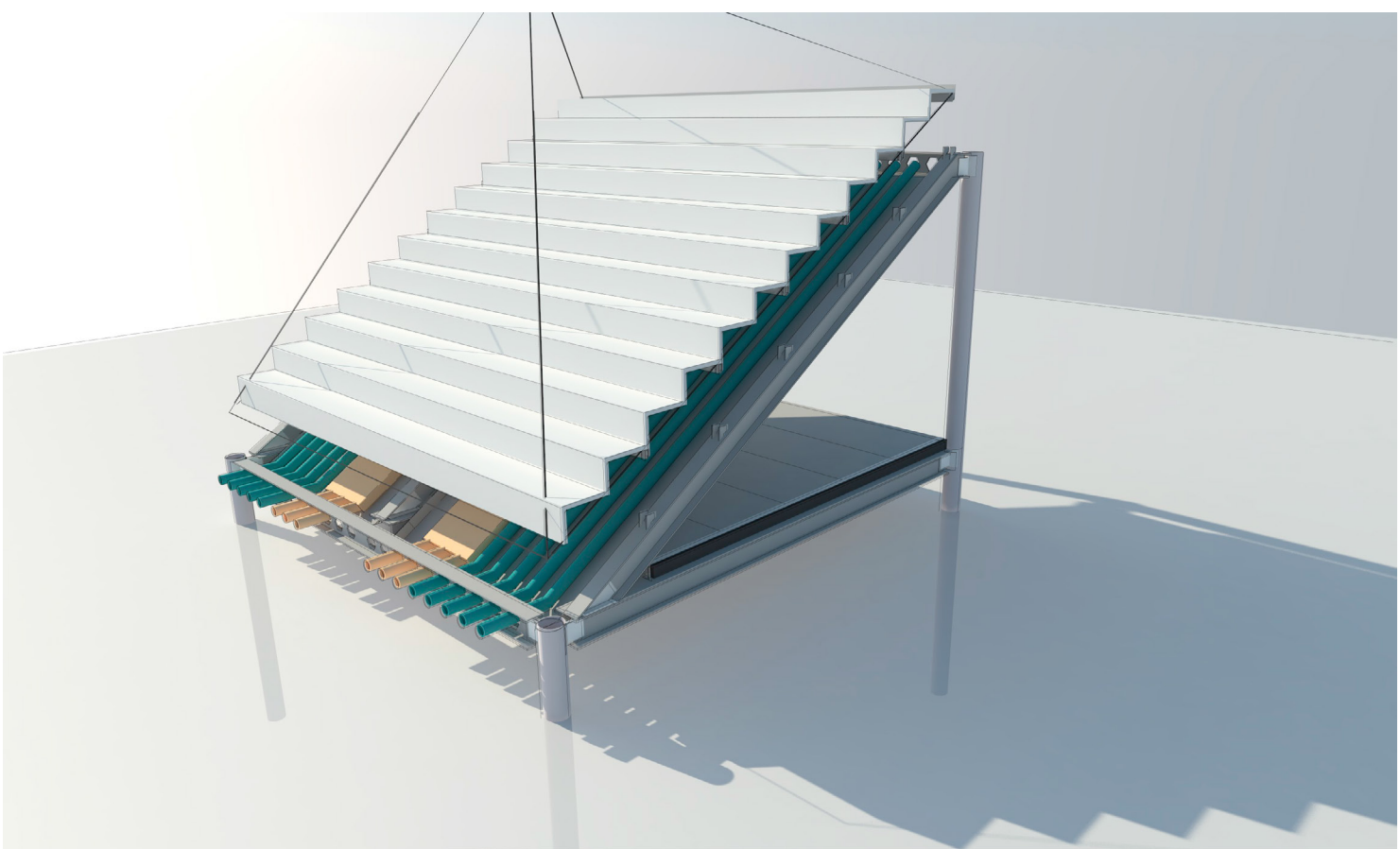


with spaces for all types of functions.



5. Conclusions

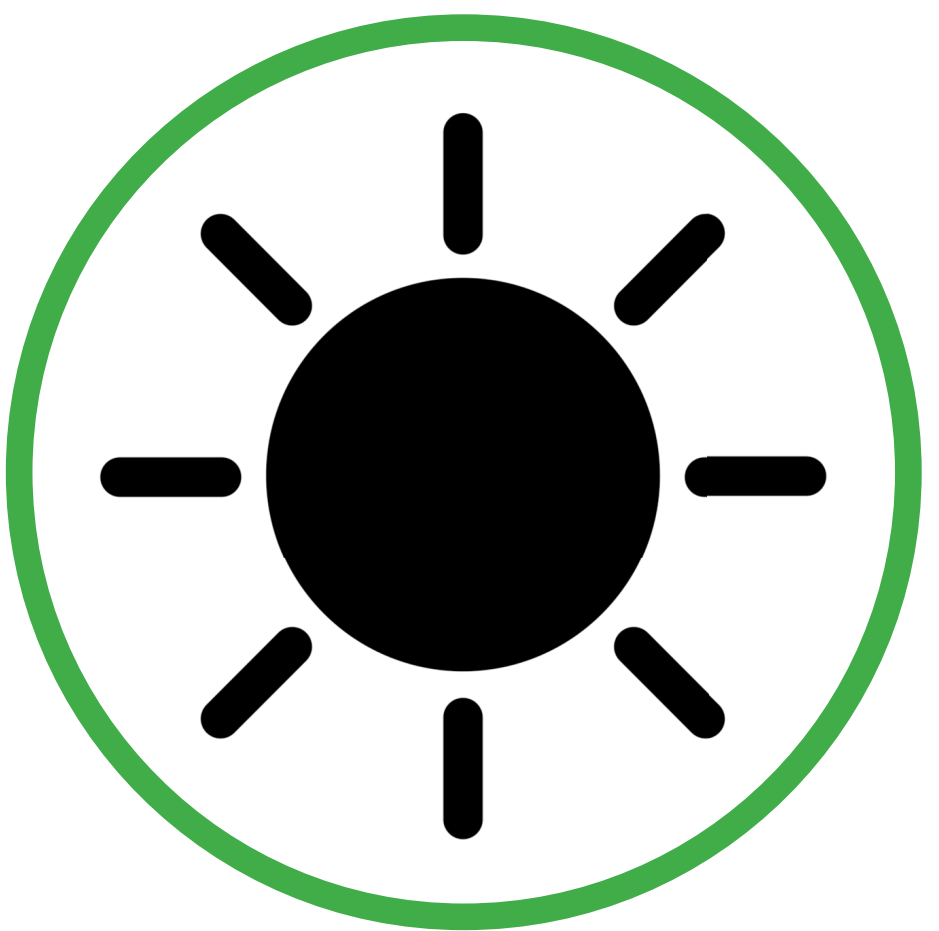
To design a temporary structure



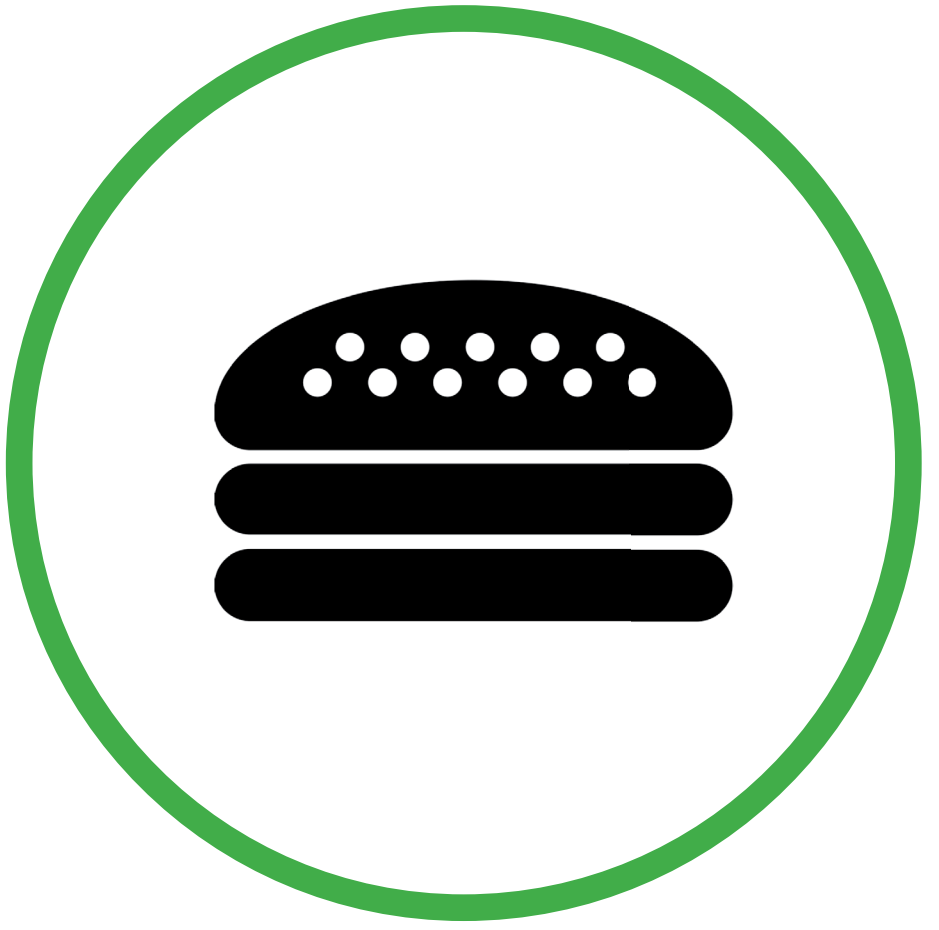
for visitors of all kinds of sports events



on a great variety of locations

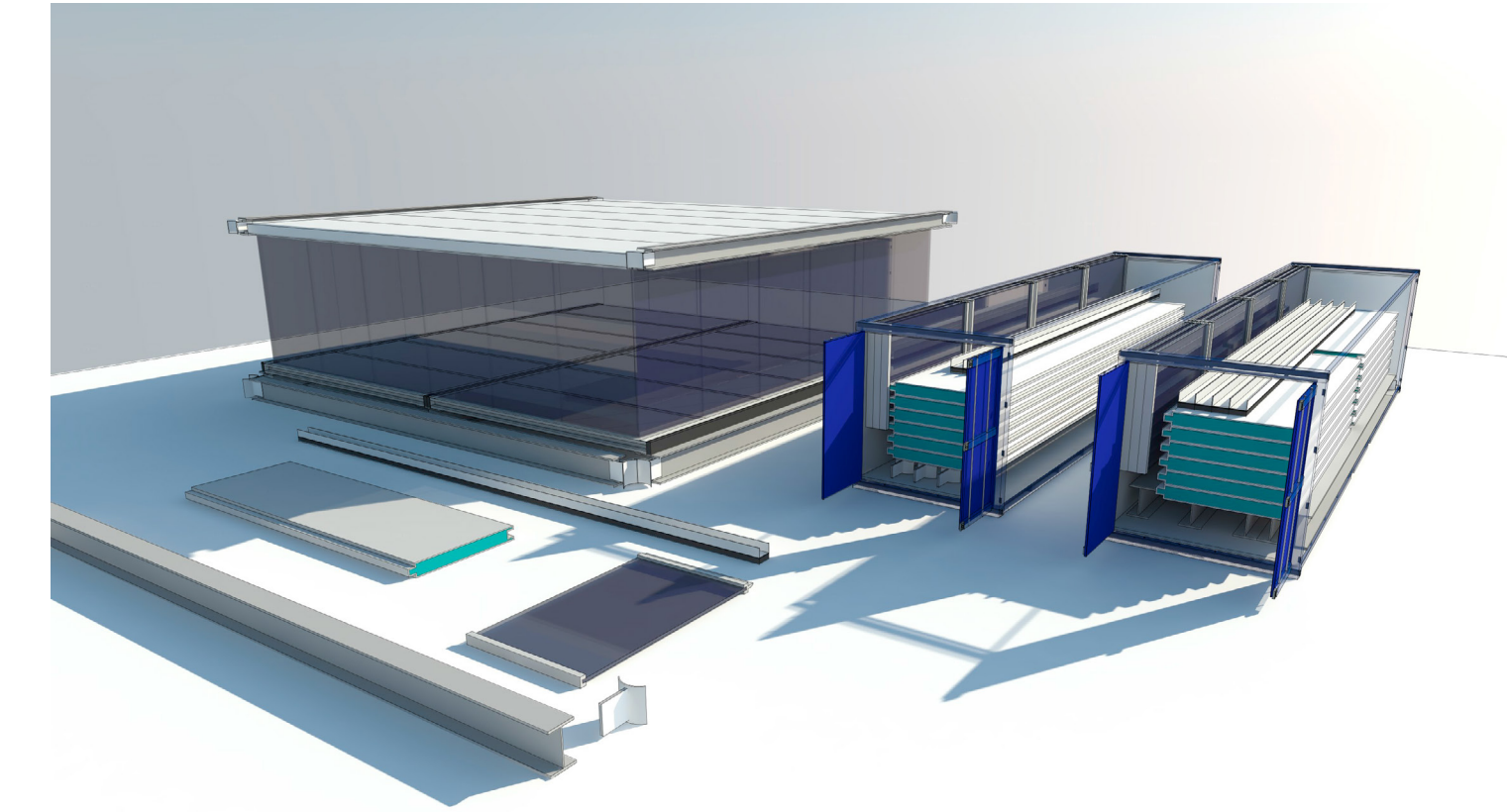
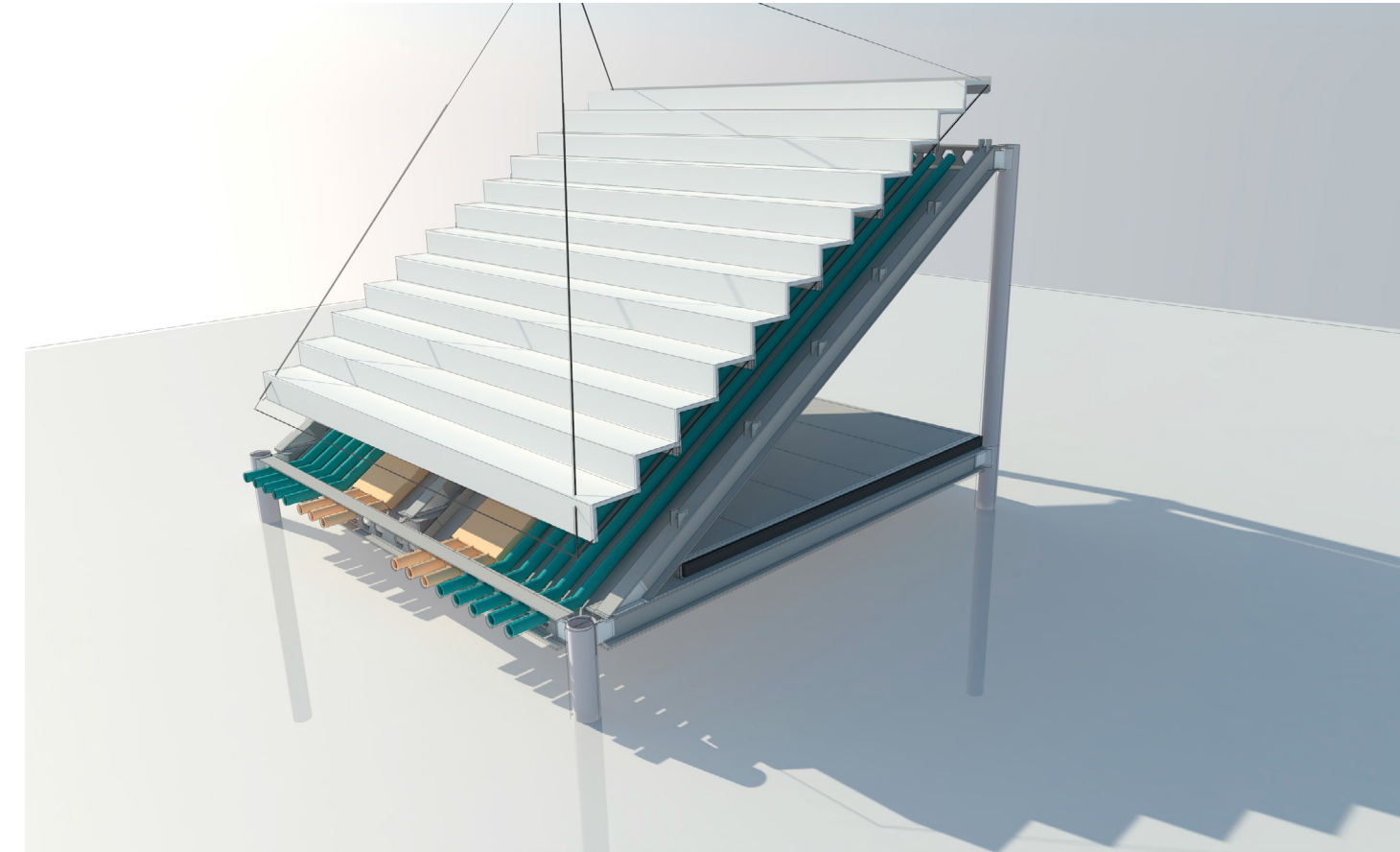


with spaces for all types of functions.



5. Conclusions

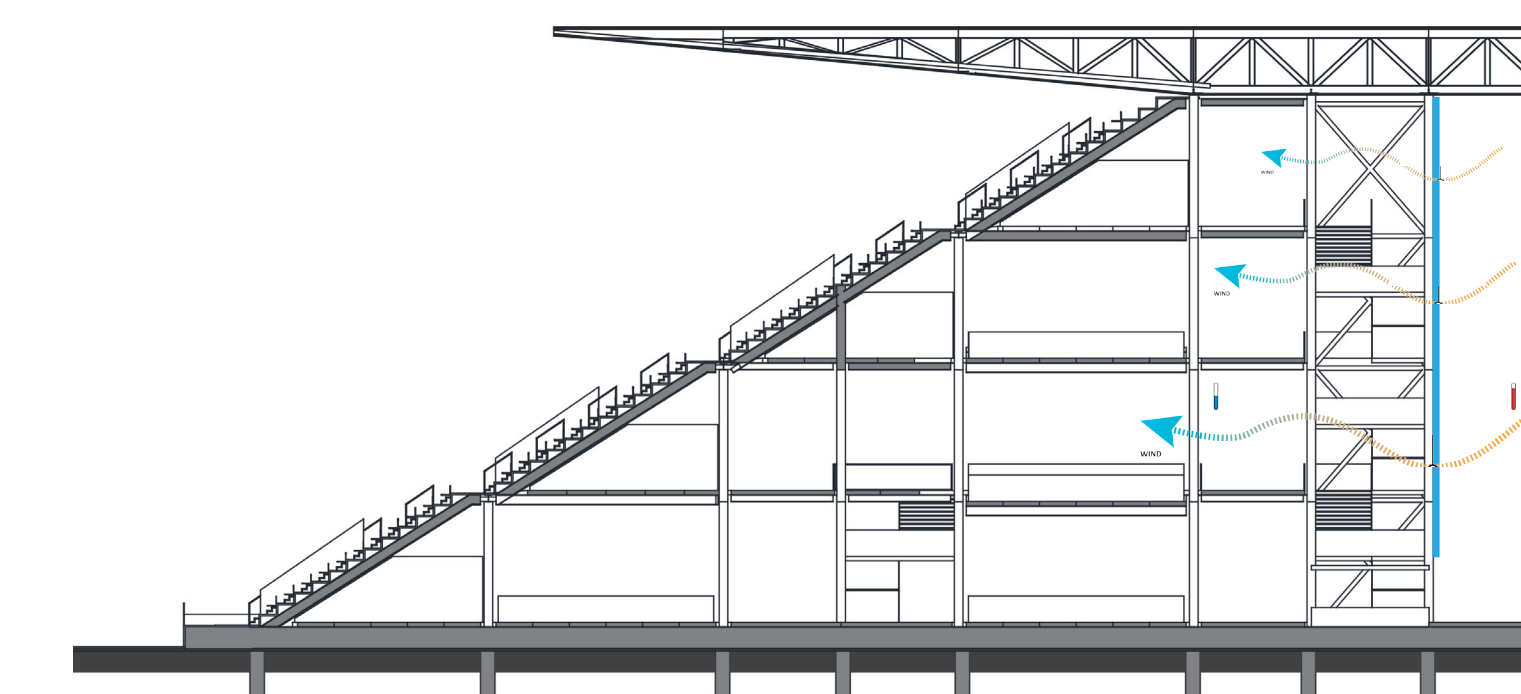
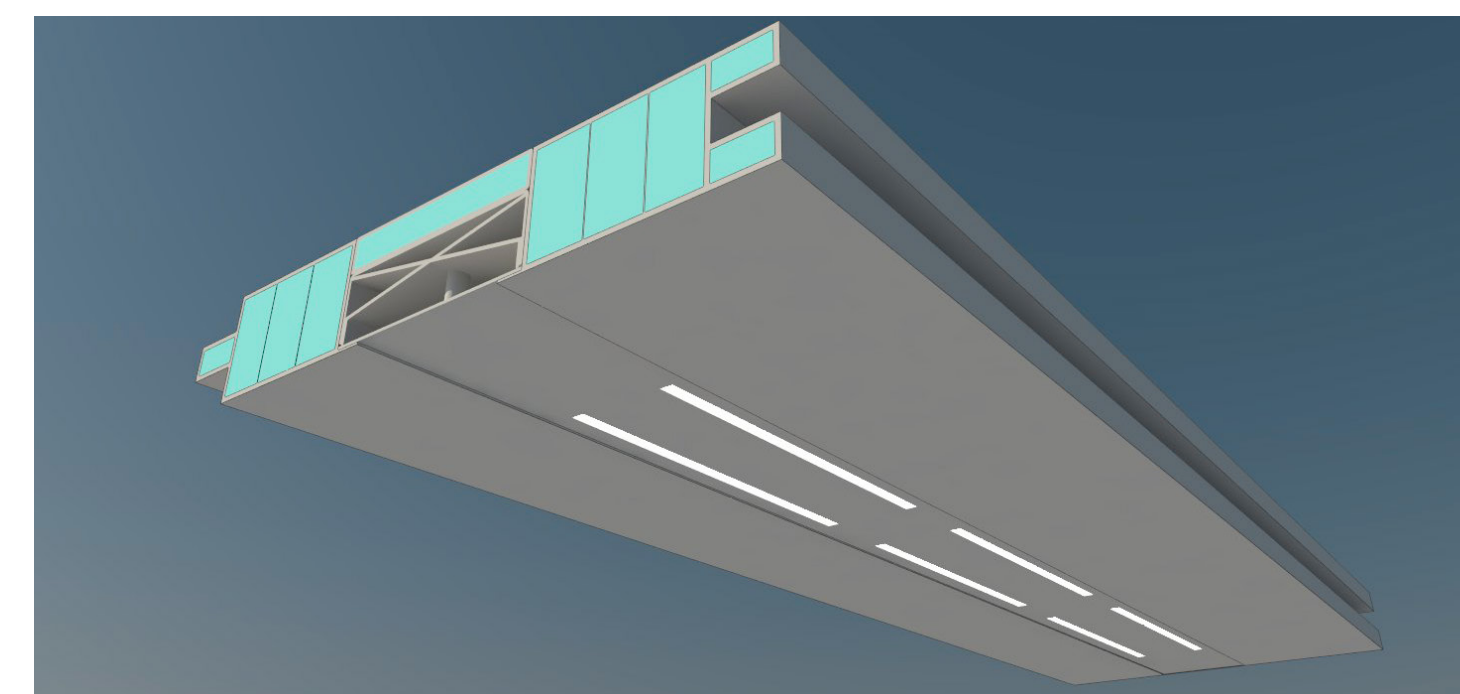
To design a temporary structure



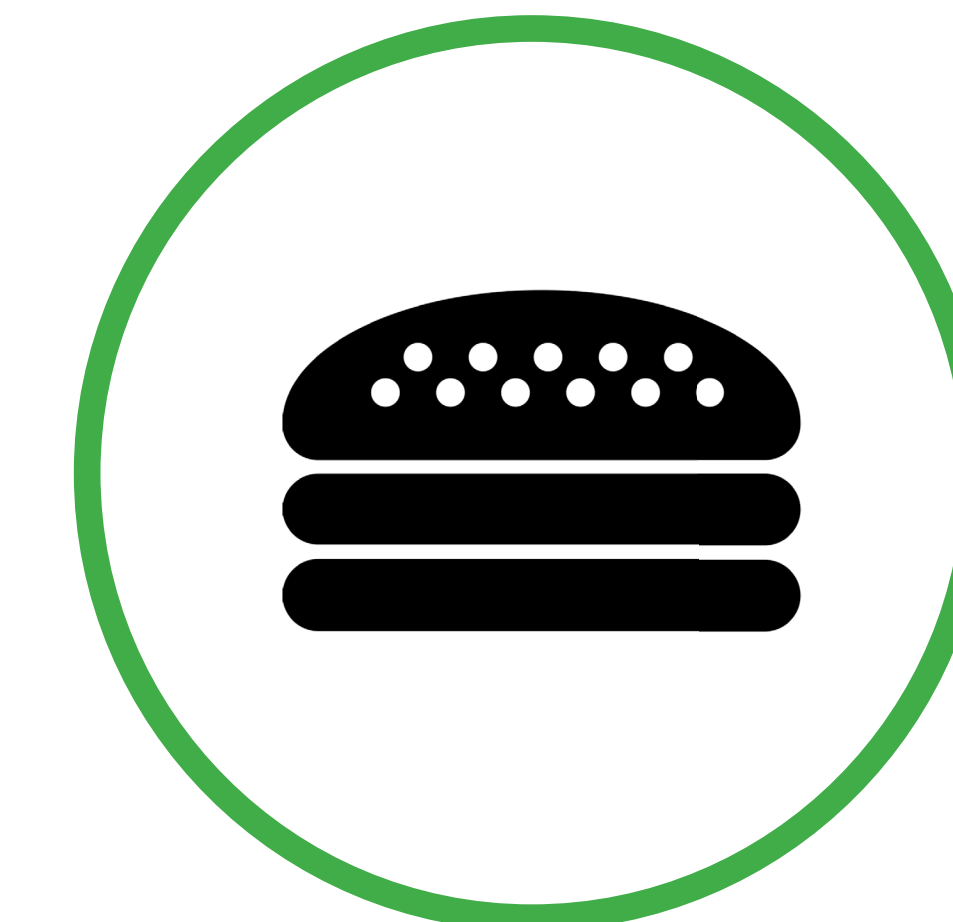
for visitors of all kinds of sports events



on a great variety of locations

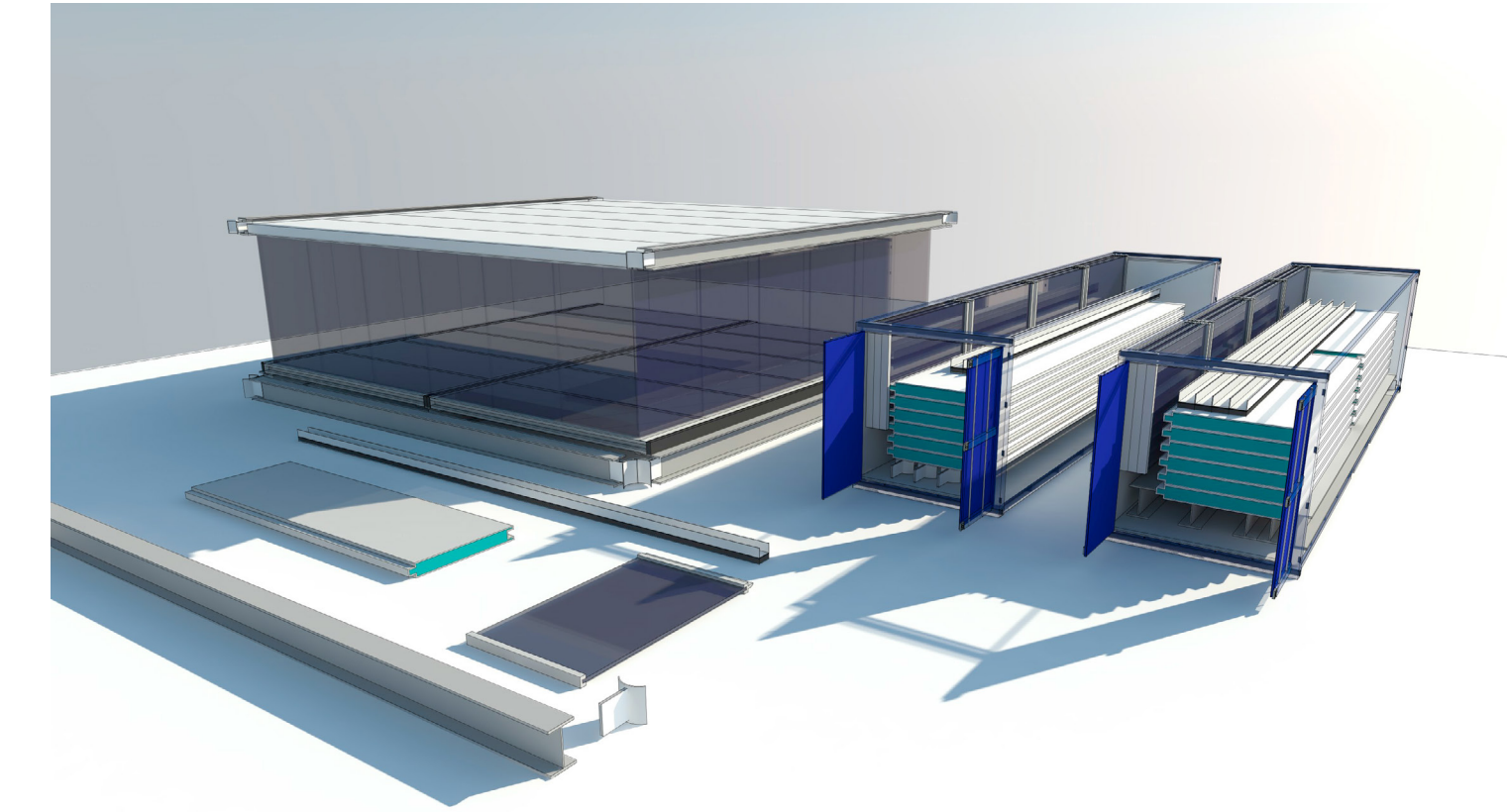
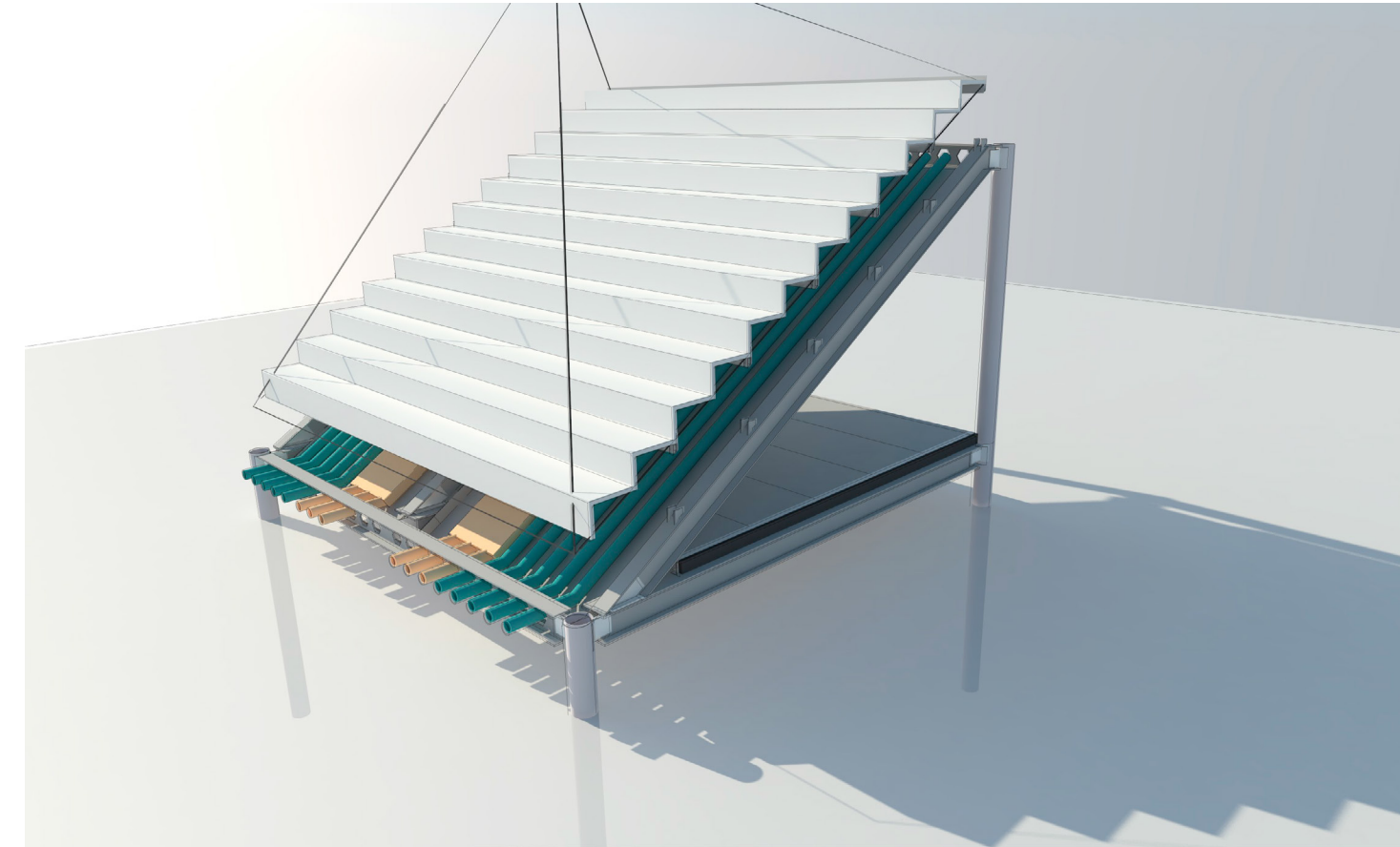


with spaces for all types of functions.



5. Conclusions

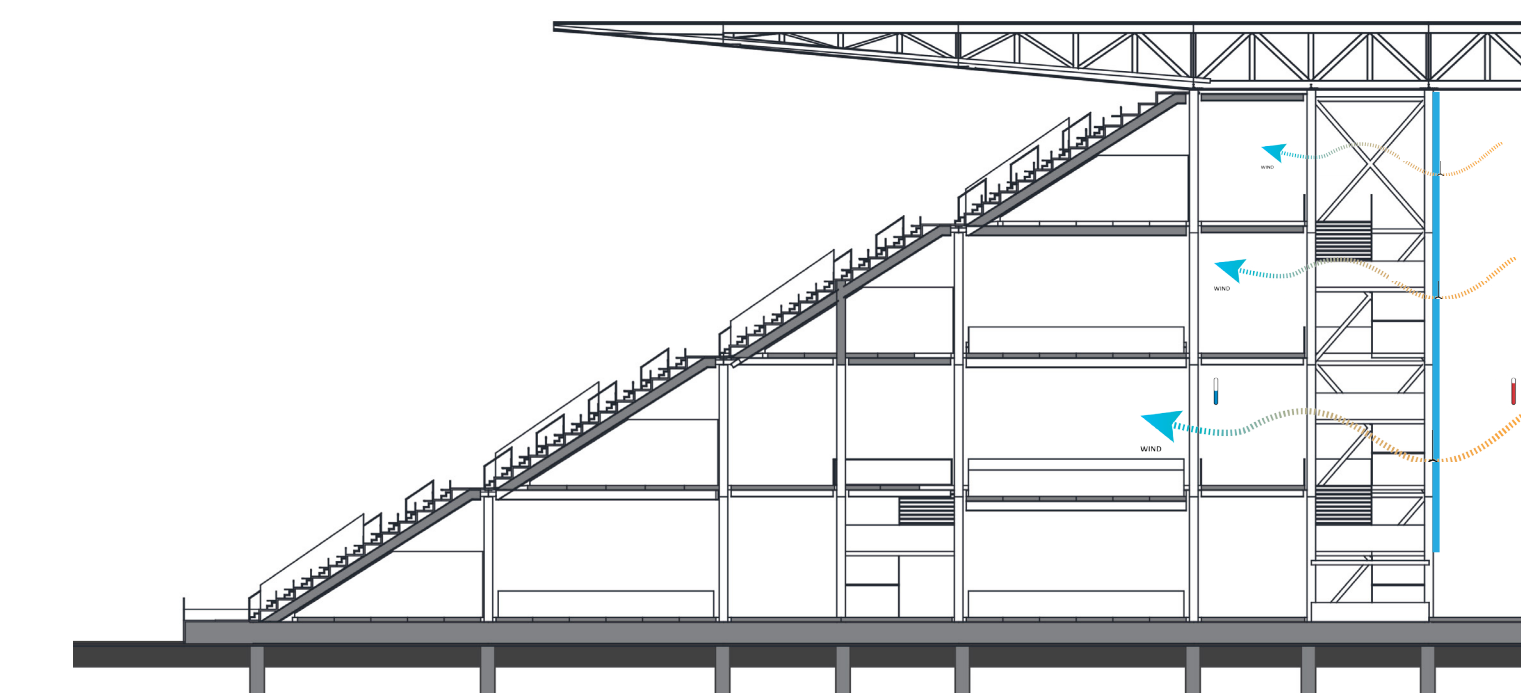
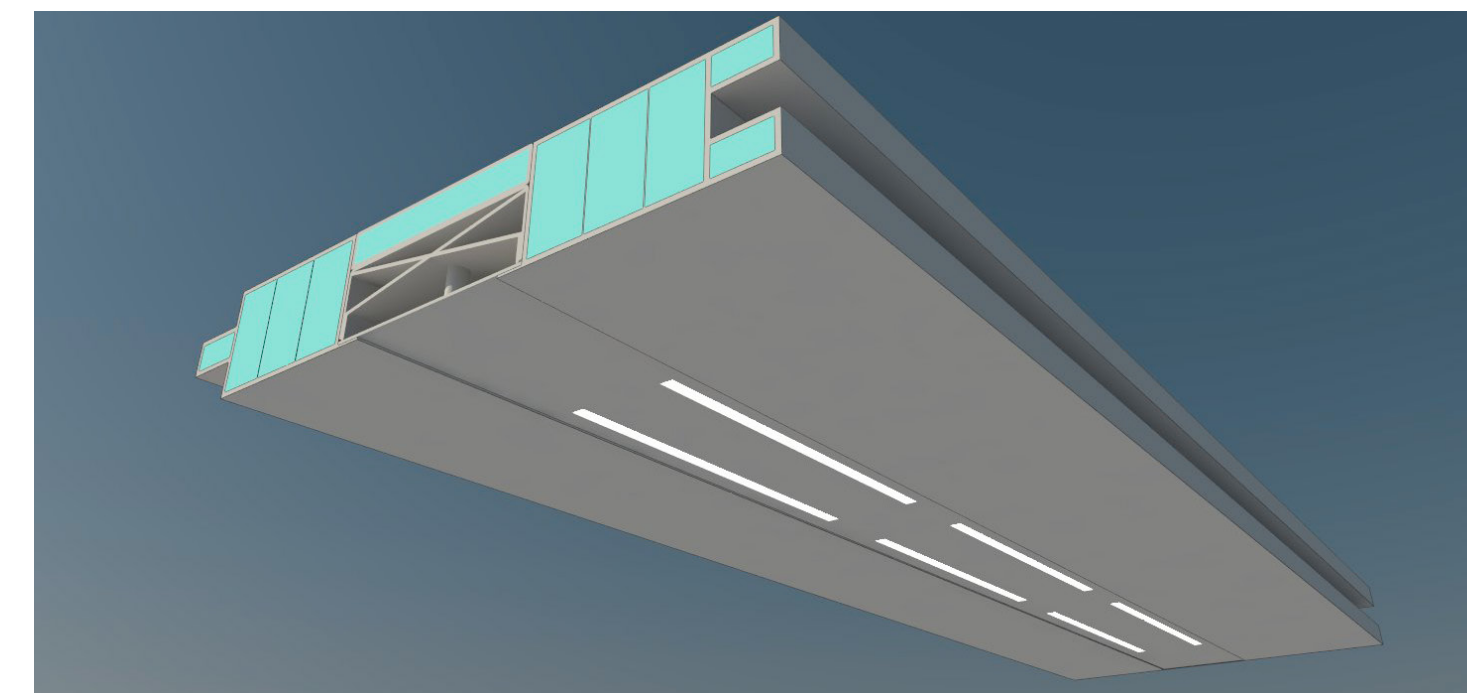
To design a temporary structure



for visitors of all kinds of sports events



on a great variety of locations



with spaces for all types of functions.



With many thanks for the support to:

Ruud Burger

Anouk Busser


Michelle Klerks

Freek van Zeist

Thijs Bennebroek

Anne Schakel



A white mannequin is sitting on a red stadium seat. A speech bubble is positioned above the mannequin, containing the text "Thank you for your attention!". The background consists of many rows of red stadium seats, creating a sense of a large, empty arena.

Thank you for your
attention!