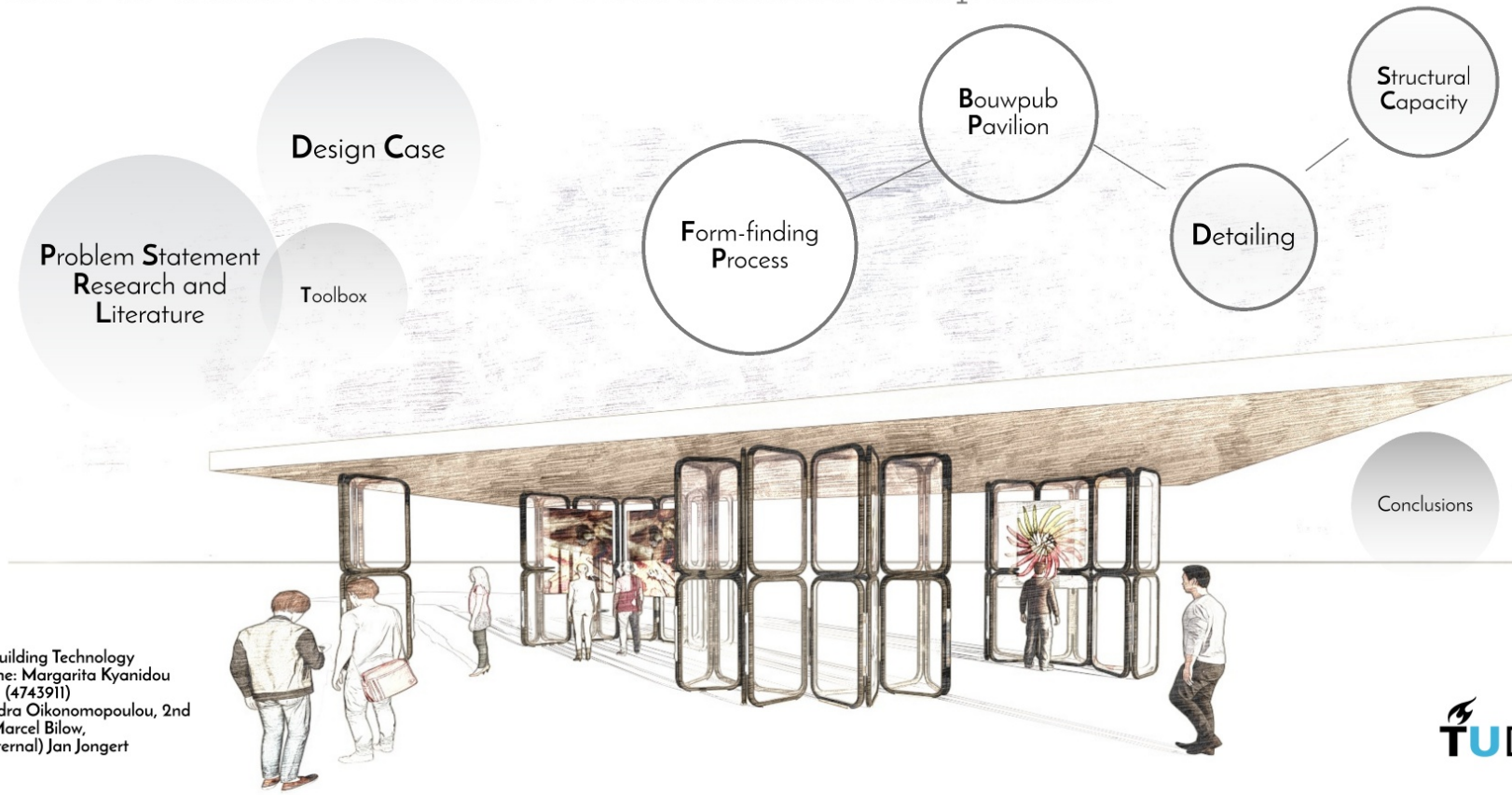
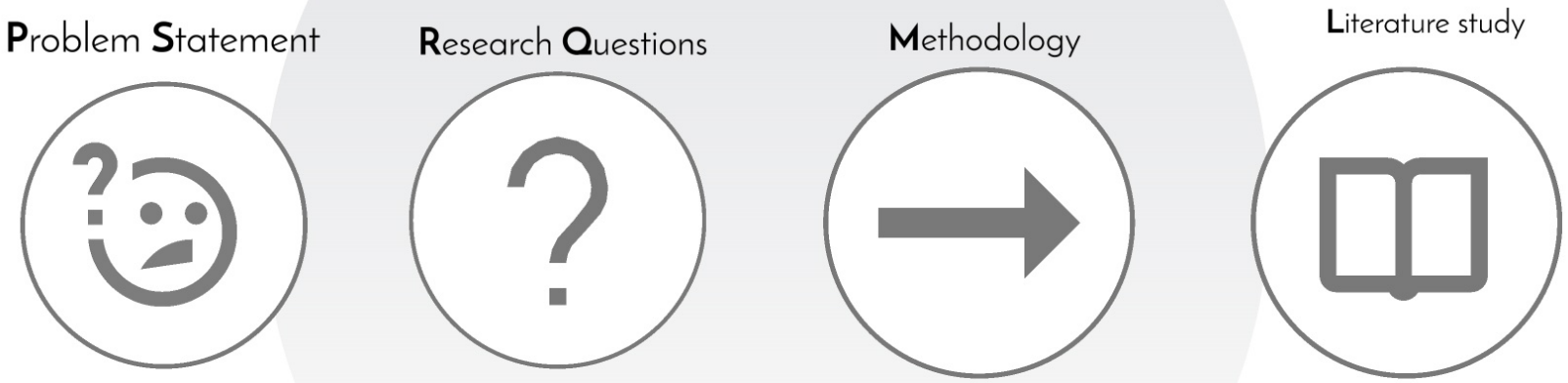
Upcycle in Architecture

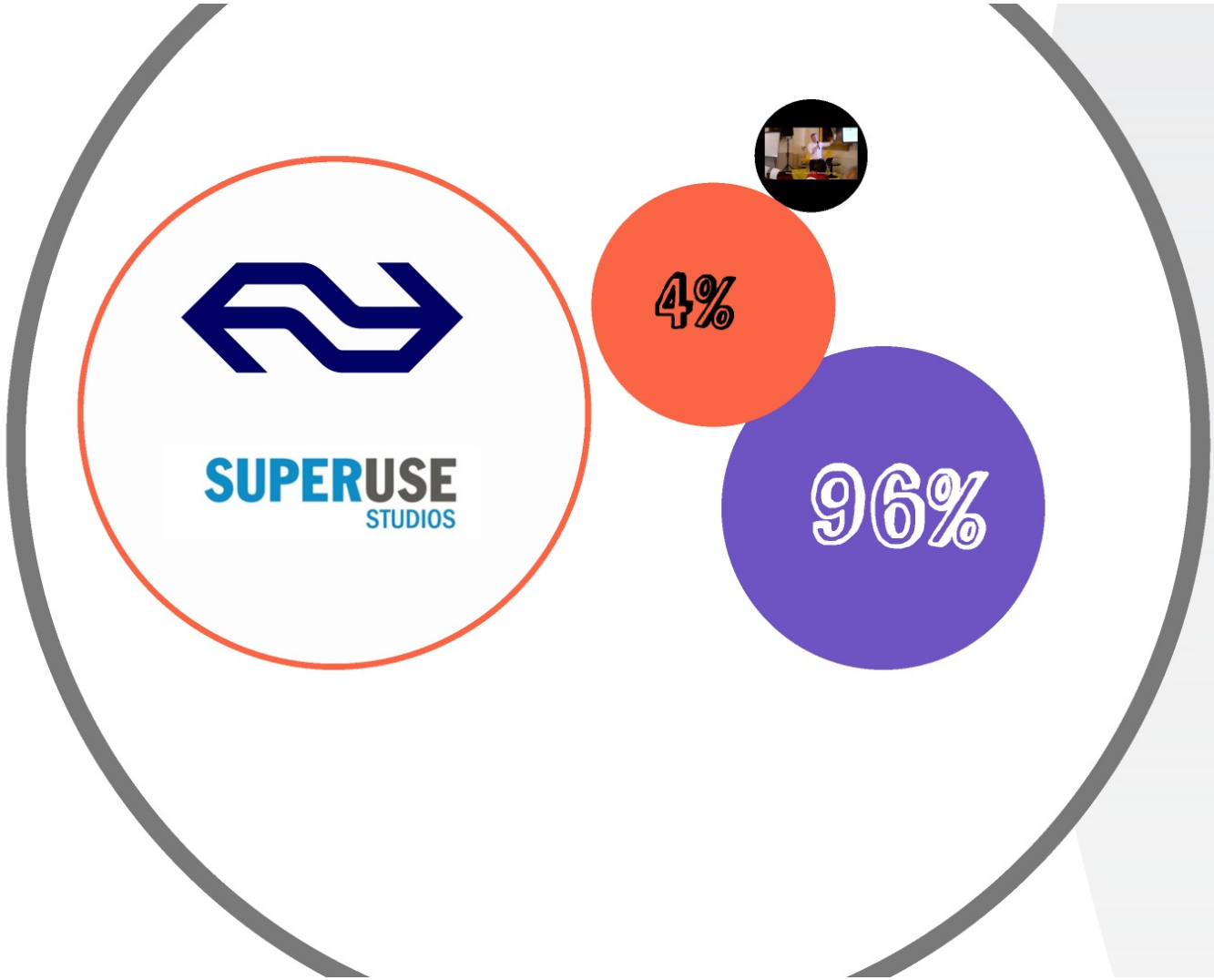
Re-use NS windows as a new construction component



Track: Building Technology
Student name: Margarita Kyanidou
(4743911)
Mentors: 1st Faidra Oikonomopoulou, 2nd
Marcel Bilow,
3rd (external) Jan Jongert

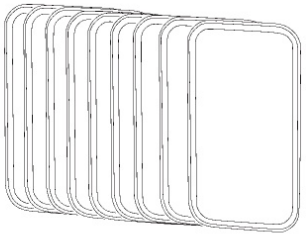
TU Delft


Problem Statement
Research Questions
Methodology
Literature study


SUPERUSE
STUDIOS
4%
96%

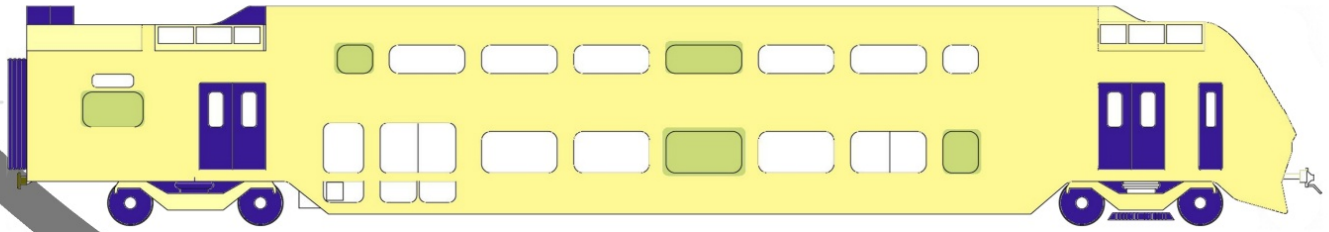

Ninety-six percent is reused in the refurbished train itself.

...around 45 train windows
per week are available...

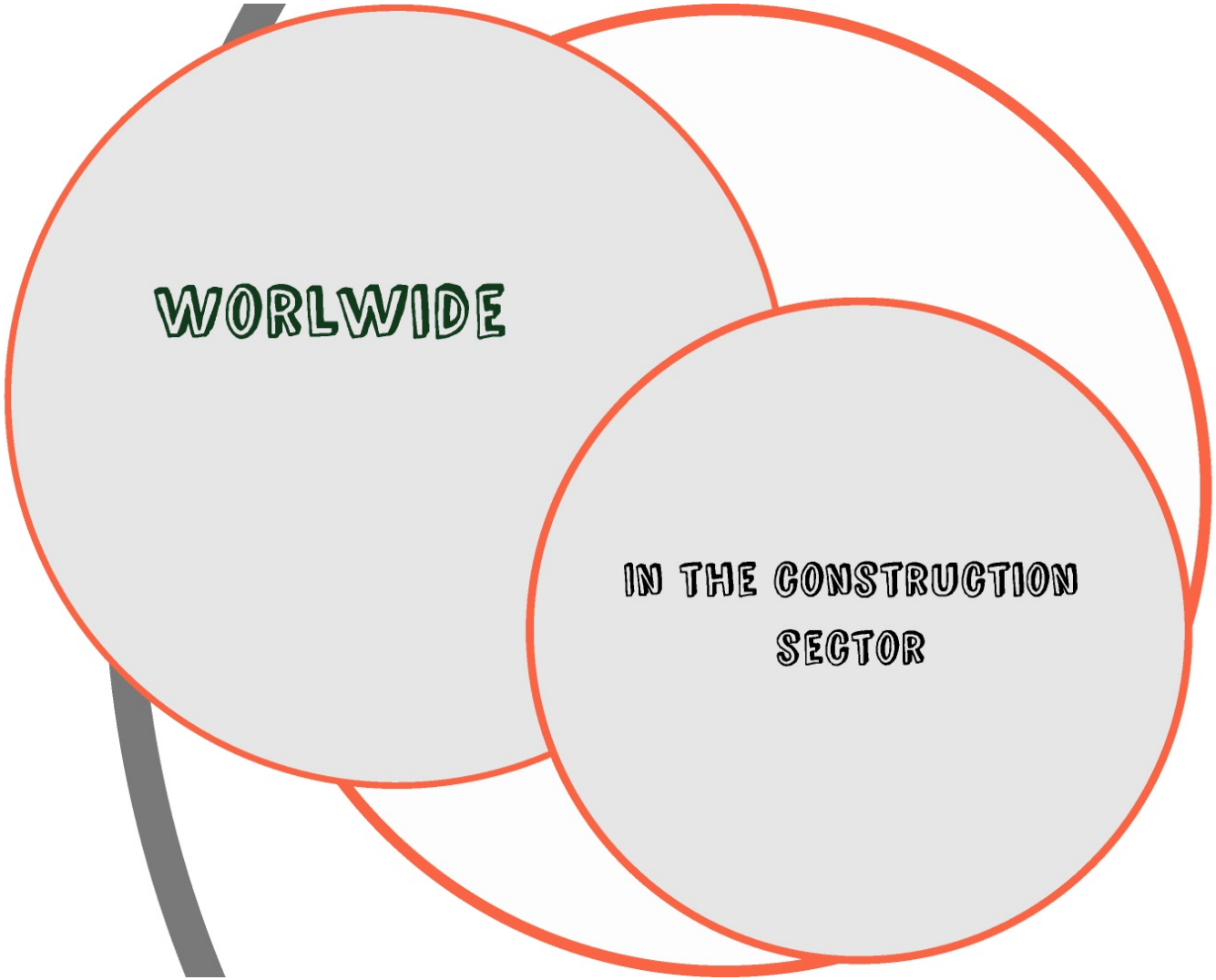


...after appropriate
disassembly
procedure...

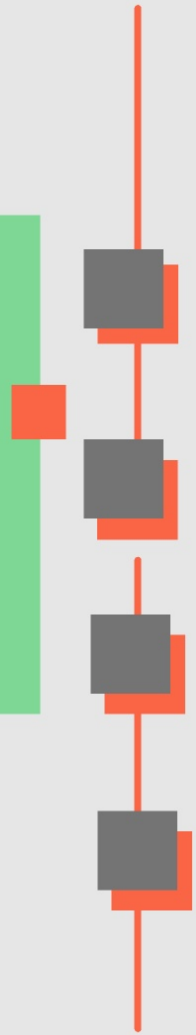
...ready to acquire a second life!



During 2016-2020 Dutch railways re-modernized 81 VIRM train sets...


WORLWIDE
IN THE CONSTRUCTION SECTOR

The request for natural resources will rise three times in 2050 and improving the life quality for many is a case in danger.Since the introduction of the Circular Economy , waste prevention becomes a priority.

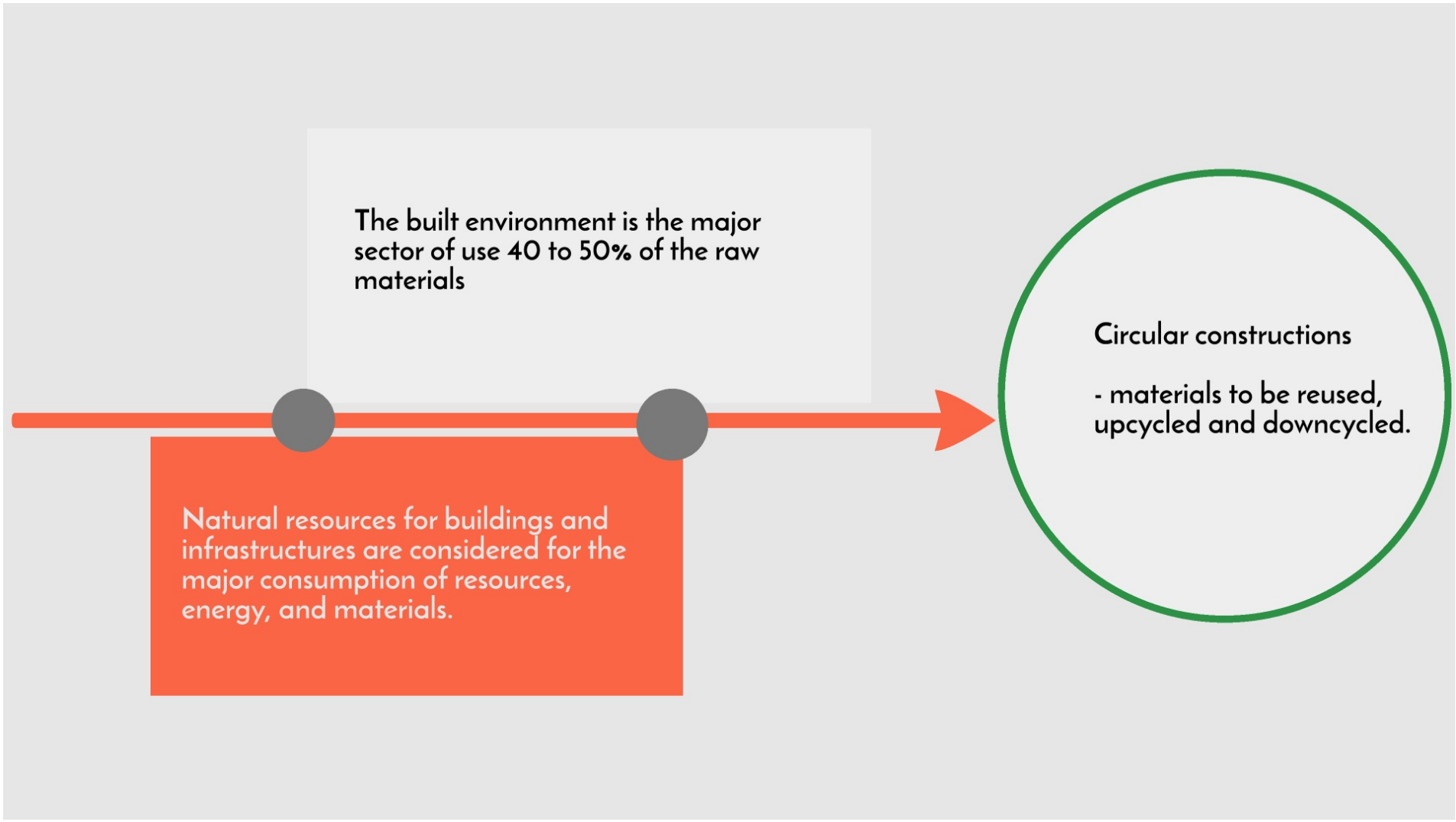


Global economic growth

Increase of the world population

Doubling of consumption per capita.

Waste production is continuously increasing


The built environment is the major sector of use 40 to 50% of the raw materials
Natural resources for buildings and infrastructures are considered for the major consumption of resources, energy, and materials.
Circular constructions
- materials to be reused, upcycled and downcycled.

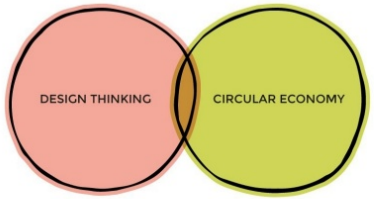
Research Questions

Which component design made from NS reused train windows will allow the creation of a circular, simple, temporary and flexible construction?

Sub-questions

What connections will be most suitable for the creation of a circular, simple, temporary and flexible construction?

Could the component be loadbearing??



Pre-design Questions

Design Questions

Design Questions:

Pre-design:

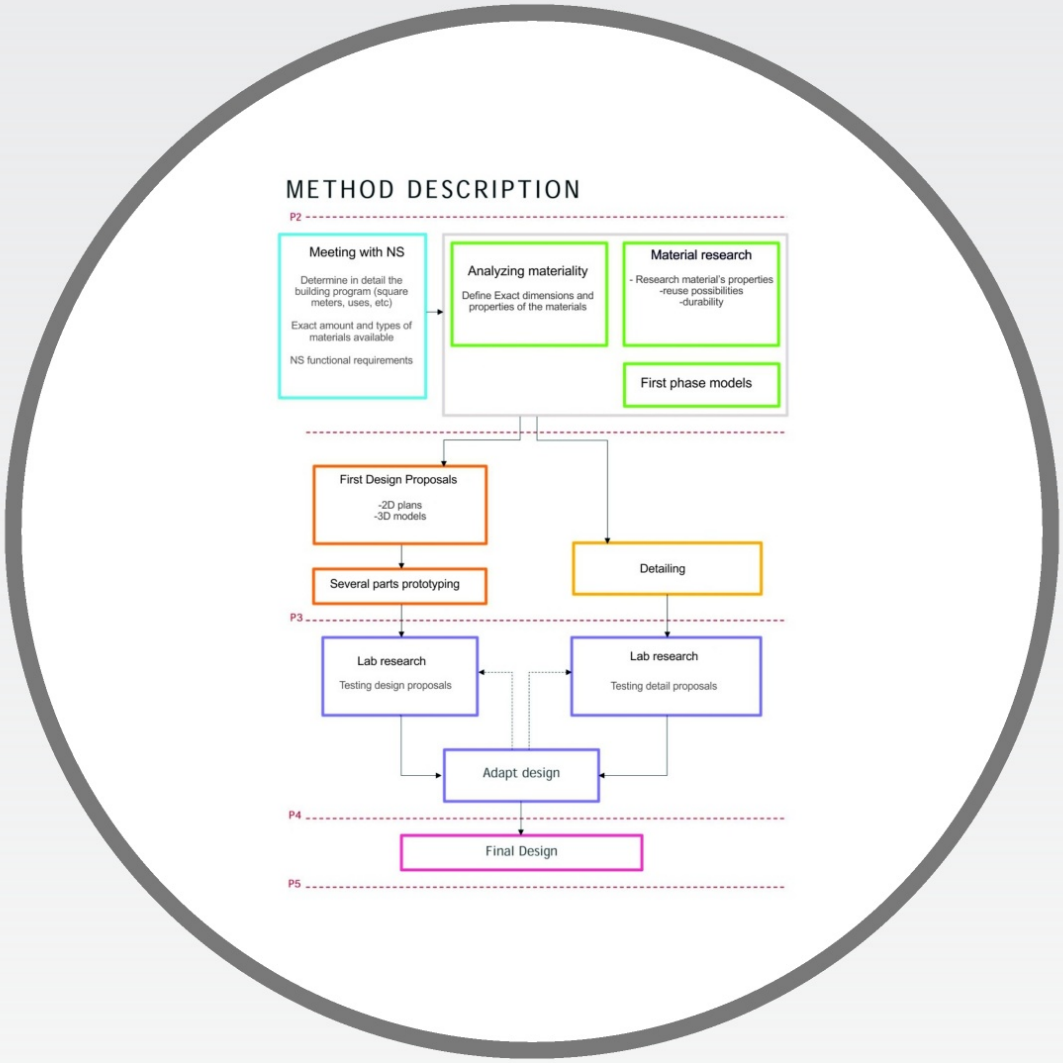
-Which design typologies could be possibly achieved with the use of the train windows?

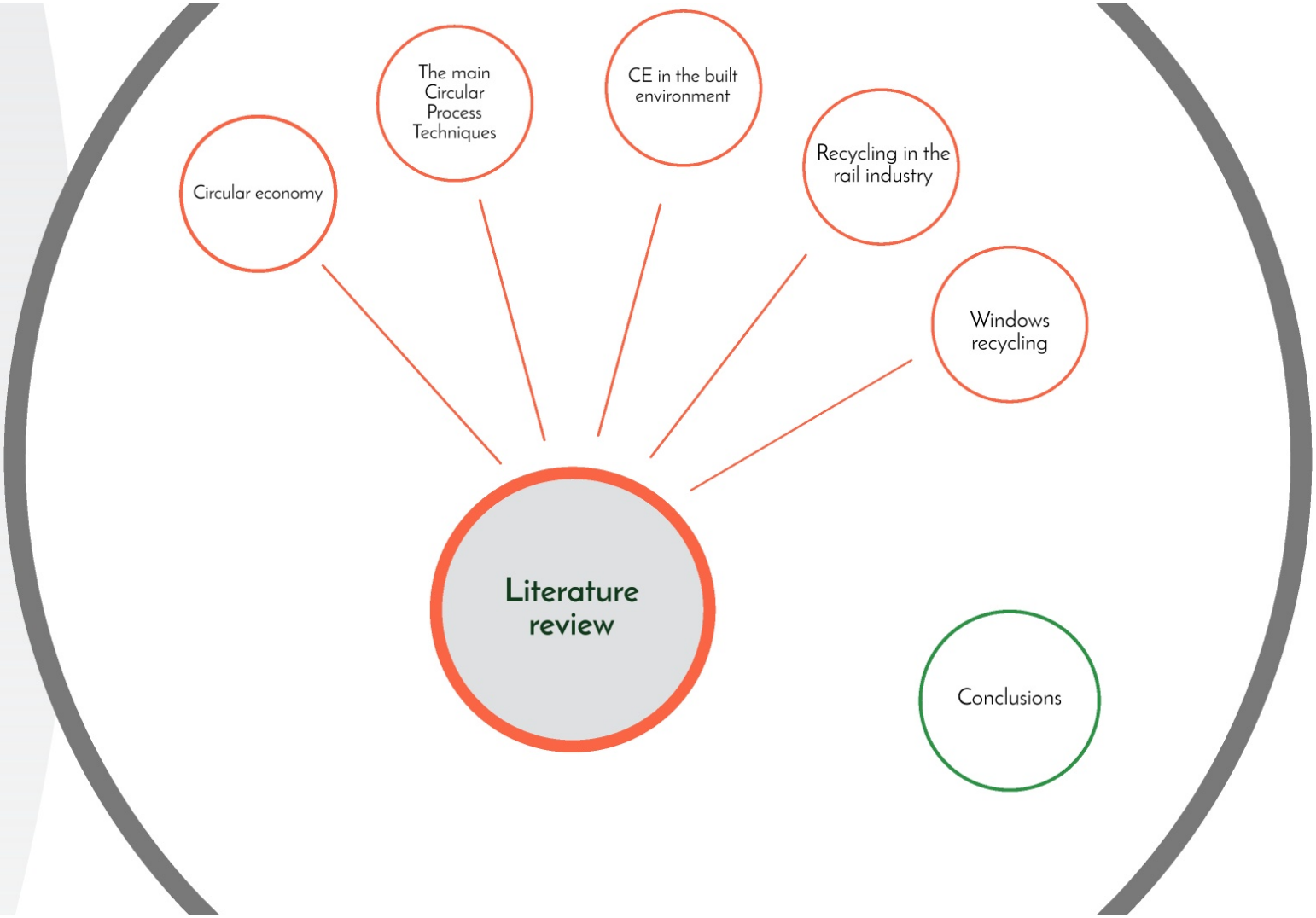
-Which of them allow the creation of a circular, simple, and flexible temporary and flexible construction?

Design

-Which connections could lead to a circular, simple , temporary and flexible construction?

-How can the component proposal be assembled?


METHOD DESCRIPTION
P2
Meeting with NS
Determine in detail the building program (square meters, uses, etc)
Exact amount and types of materials available
NS functional requirements
Analyzing materiality
Define Exact dimensions and properties of the materials
Material research
- Research material's properties
-reuse possibilities
-durability
First phase models
First Design Proposals
-2D plans
-3D models
Several parts prototyping
Detailing
P3
Lab research
Testing design proposals
Lab research
Testing detail proposals
Adapt design
P4
Final Design
P5


Circular economy
The main Circular Process Techniques
CE in the built environment
Recycling in the rail industry
Windows recycling
Literature review
Conclusions

Circular Economy

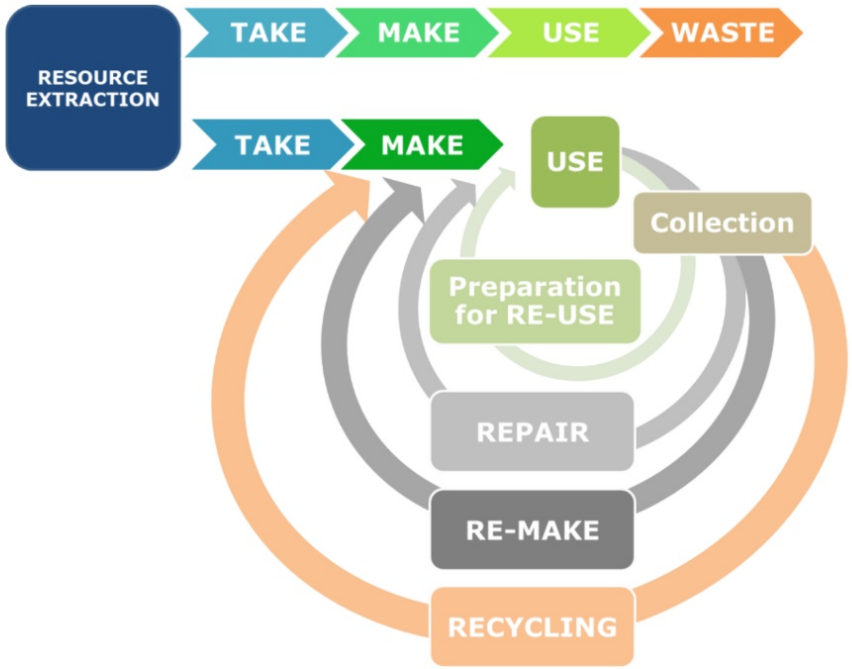
-How much resource, energy and manpower are flowing in and out of every system.

-Most of it comes out as 'waste'. Consequently, by connecting different parts in the system an effective use of the waste flows could be made.

-The circular economy seems to be a systematic approach towards the confrontation of the above-described issue of modern society.

- "Circular economy means many different things to different people."

-Most frequently depicted a result of the 3R's reduce, reuse and recycle approaches although often is highlighting that Circular Economy is not necessary a strong systemic approach.

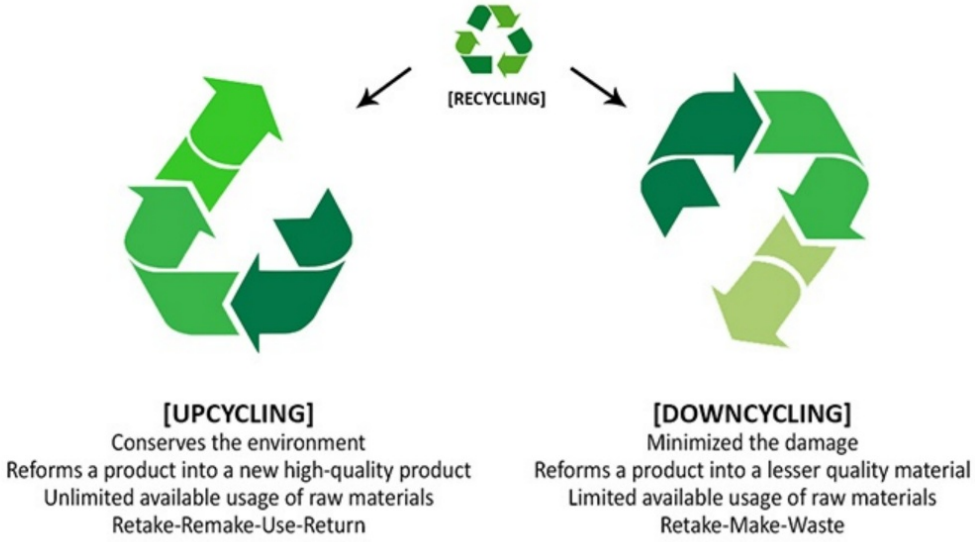


Upcycling

Upcycling(or creative reuse) gives a discarded item a new life with a higher quality and keeps it out of the waste system for long. Upcycle gives a new purpose in the product therefore could be also refer as "repurpose" them.

Down-cycling

Down-cycling is the recycling process that recycled resources are turned into things that cannot be recycled further.



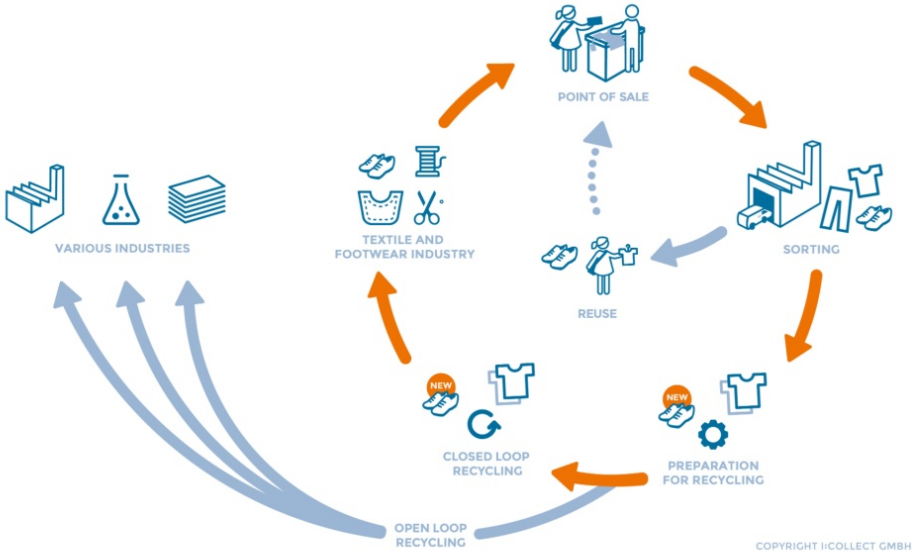
Open and Closed Loop

Open-loop Recycling

Open-loop recycling means that a material is not recycled endlessly but it is excluded from the the loop and ends as waste. The diagram shows the material flow through a linear or open-loop approach.

Closed-loop Recycling

Closed-loop recycling means that the recycling process of a material can continue indefinitely avoiding the degradation of its properties.



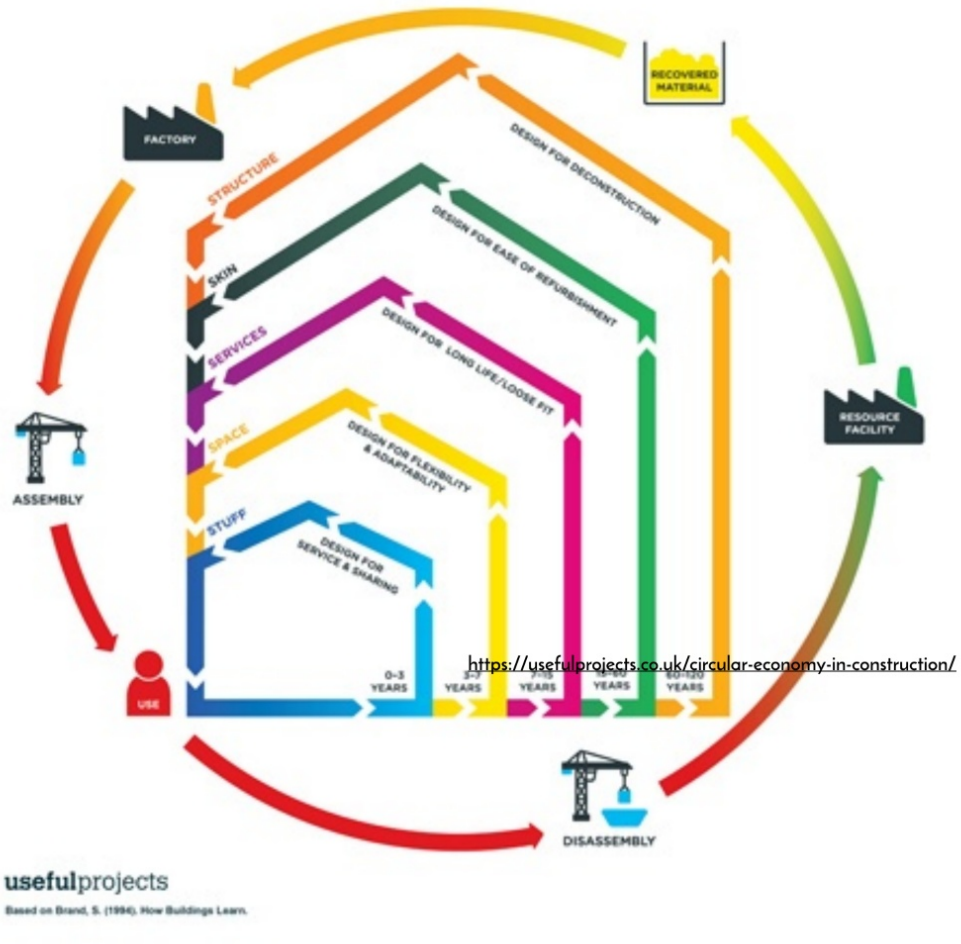
https://www.ico-spirit.com/en/services/

Circular Economy in the Construction Sector

-Research of circular economy in the build environment are detaily dealing with construction and demolition waste.

-Traditionally C&DW (construction and demolition waste) has been landfilled. Because of the disposed of material volume, proper management, and space availability, landfills are gradually becoming more complex to work efficiently..

- The main principles of the circular economy in construction concern the better management of resources



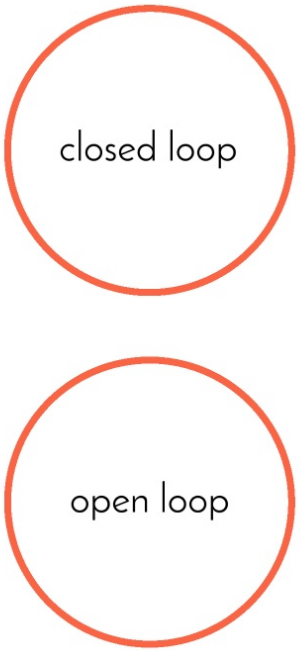
https://usefulprojects.co.uk/circular-economy-in-construction/

Recycling in the Rail industry

-Currently there are no regulations related to the recovery and recycling in the rail industry.

-Some European member states, are forced by local regulations to solve the disposal problem by issuing a product technical documentation.

-The materials from rail vehicles ready to be reused are classified into several categories.



Closed loop recycling

NS.nl

Review of European Renewal and Maintenance Methodologies Technical Appendix Number 2"

Stockpile of old motors awaiting refurbishment

Old point motors waiting to be cleaned and

Open Loop recycling

1) Hotel in Amsterdam by Frank and Irma Appel

Controversy Tram Inn Retrieved from https://www.controversy.nl/

Controversy Tram Inn Retrieved from https://www.controversy.nl/

Retrieved from https://www.flickr.com/photos/42876347@N00/3654494795

3) Church

Retrieved from *English Russia http://englishrussia.com/2009/01/29/railway-car-churches/*

Retrieved fromEnglishRussiahttp://englishrussia.com/2009/01/29/railway-car-churches/

4) Bookstore *La Caverne aux Livres,*

By Alexandre Duret-Lutz, Retrieved from https://www.flickr.com/photos/gadl/395

Image: Alexandre Duret-Lutz Retrieved from https://www.flickr.com/photos/gadl/394370122

5) Restaurant in Brownwood, TX

Image: J.D. Page

Windows Upcycle Reference Projects

Quirky, Superuse Studios

Superuse Studios used 350 car windshields out of Audi100 , to create the interior of a store in the Hague.

100% SALVAGED CAR SHED Leger Wanaselia Architecture

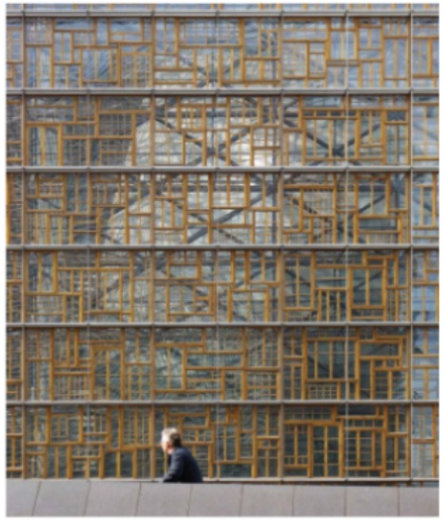
Made out of 100% salvaged car parts, this is a temporary b

MASONS BEND COMMUNITY CENTER Forrest Fulton Architecture

Retrieved from :https://archello.com/project/masons-bend-community-center

The construction ,executed and designed by Auburn University Rural Studio, is an open-air space on a privately owned site.

EUROPA BUILDING IN BRUSSELS BY PHILIPPE SAMYN

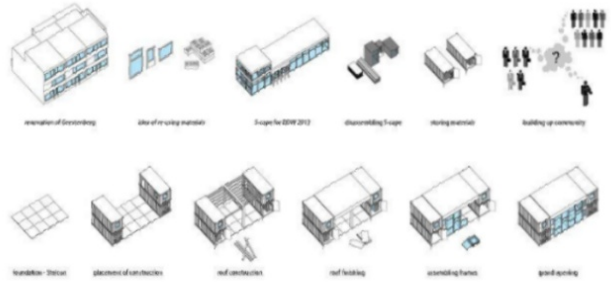


Retrieved from :
https://samynandpartners.com/portfolio/europa-new-headquarters-of-the-council-of-the-european-union/

Salvaged wooden window frames are mounted across two facades of the Europa building. Image Credit: Thierry Henrard

Retrieved from:
https://samynandpartners.com/portfolio/europa-new-headquarters-of-the-council-of-the-european-union/

Het Glaspaviljoen



Retrieved from : http://www.pluginpaviljoen.nl/

The Glass pavilion is an community project of the residents of Strijp-S (Eindhoven), who constructed a temporary, multifunctional building with reused materials, such as a number of window frames and disbanded shipping containers.

Two Different cases:

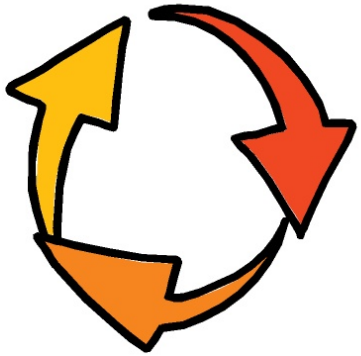
Common Characteristics:

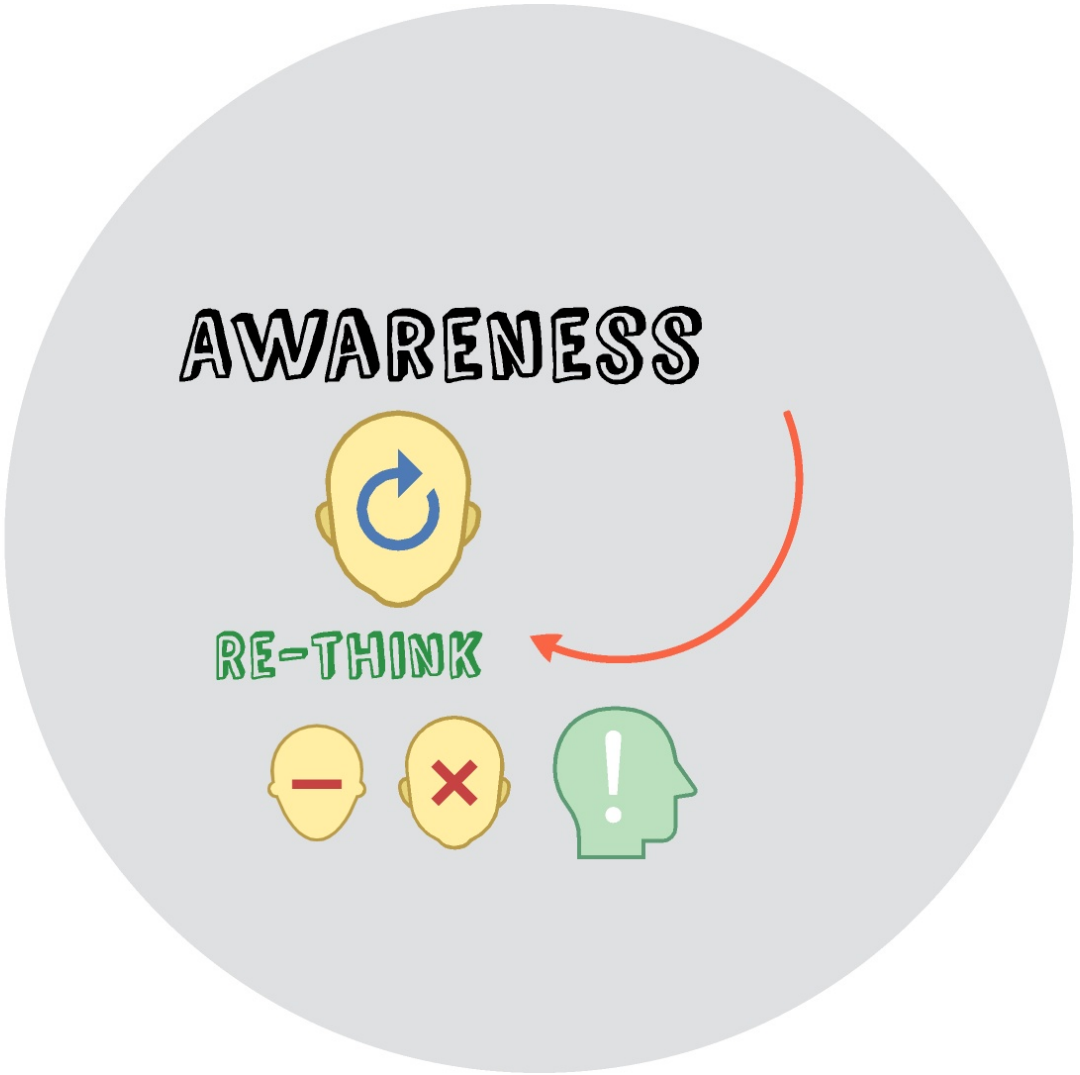
External main construction

Differences:

Frame/No frame
Edge Contact/Cover

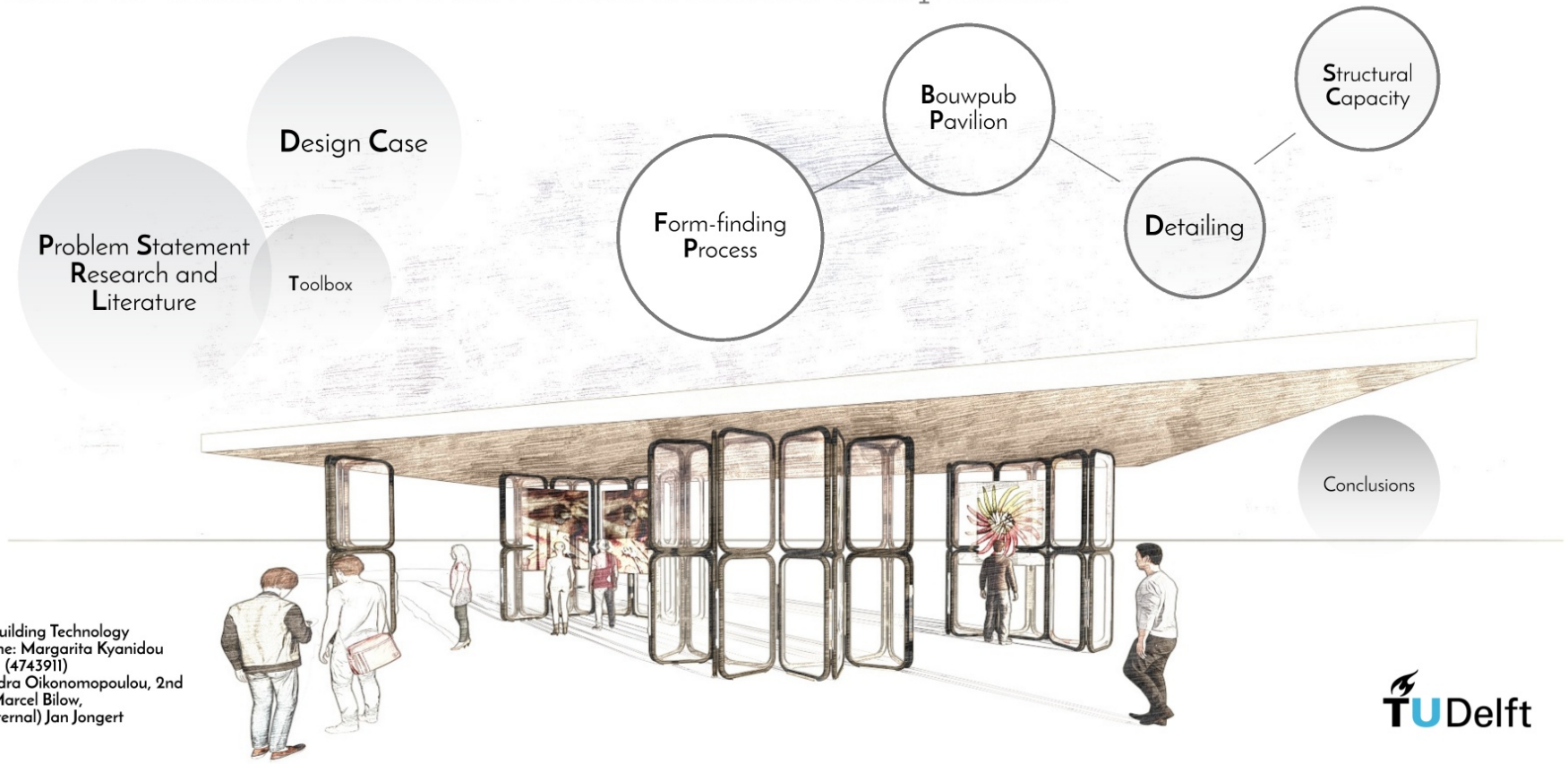
Best strategy?




AWARENESS
RE-THINK

Upcycle in Architecture

Re-use NS windows as a new construction component



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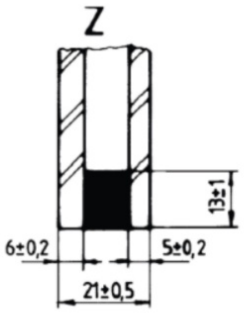
TU Delft

TRAIN WINDOW GLASS SPECIFICATIONS

VLT Visible Light Transmission %	36	U U Value	3,00
VLR Visible Light Reflectance %	8	R R Value	0.33
UV UV Elimination %	83	SHGC Solar Heat Gain Coefficient	0,74



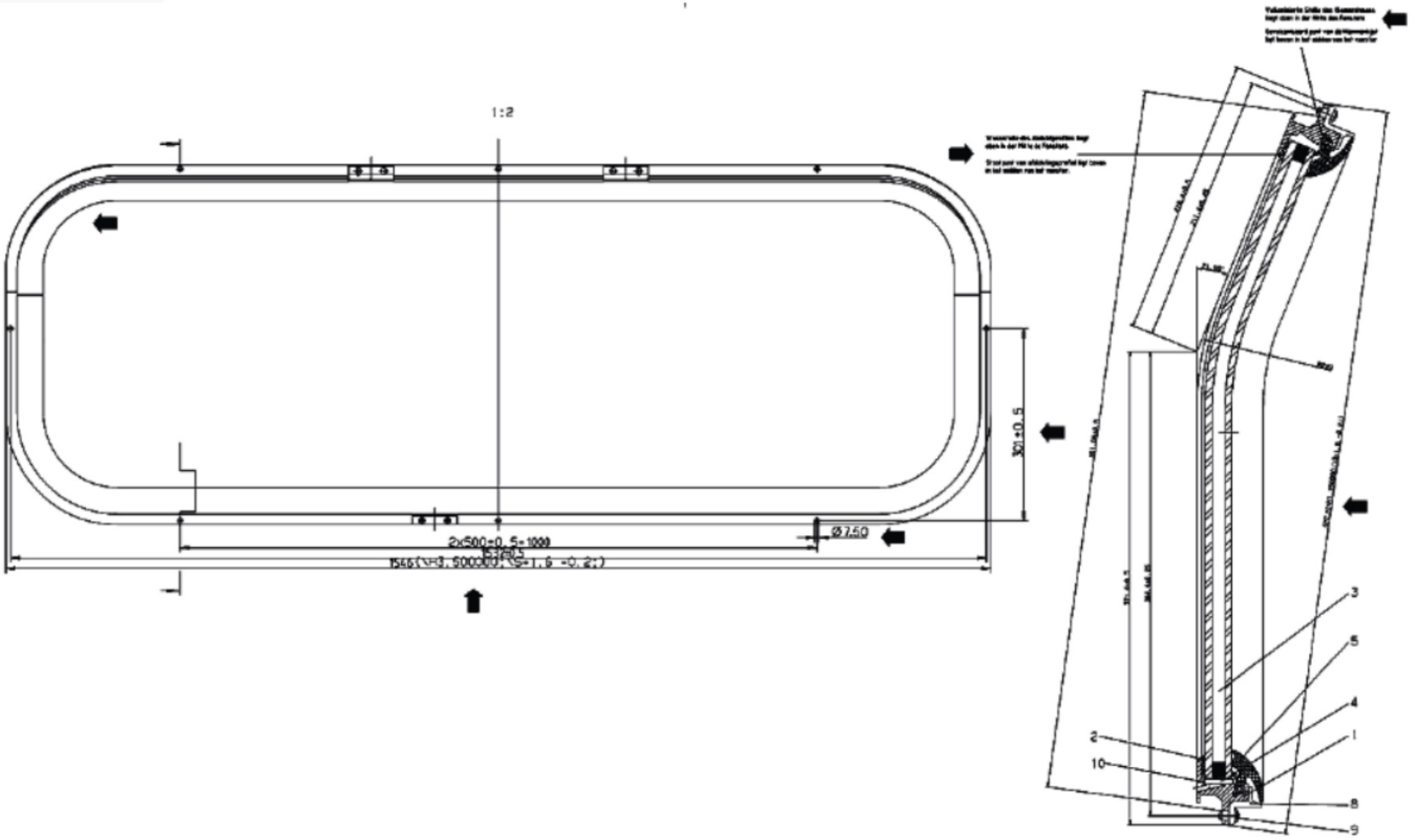
Description of the window system:

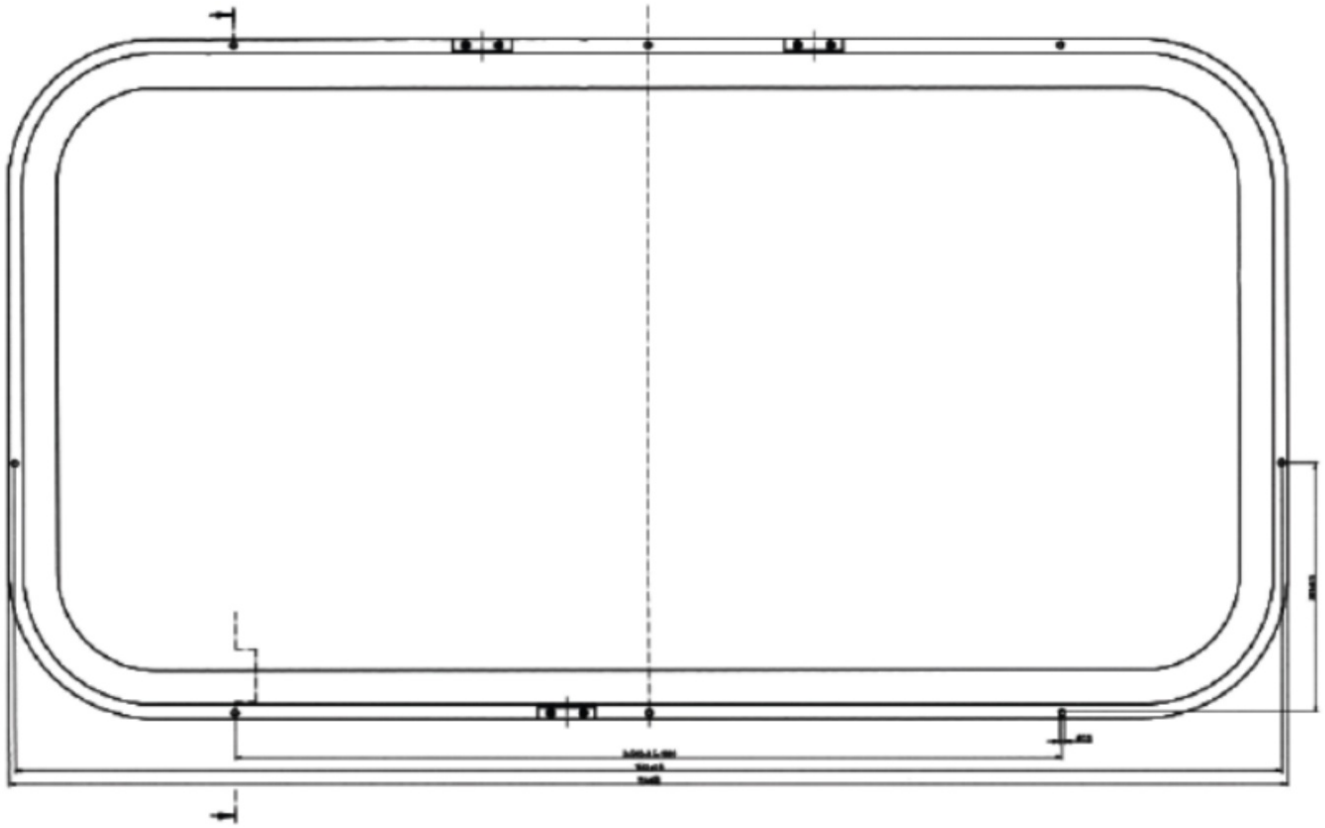
Frame:

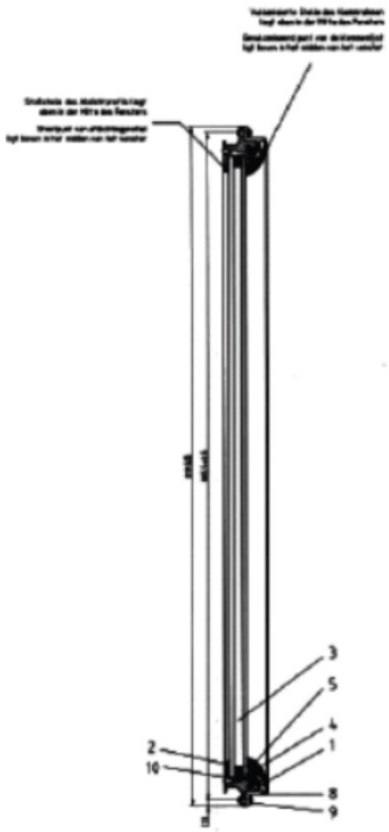
- aluminum frame
- powder-coated color RAL 7021 black-gray, polyester powder according to KVNS 6.201 A.
- Execution curved and straight, geometry according to drawings M1080-M1086
- Quantity according to the number of windows according to the parts list
- Mounting holes available, number and position identical to those in the IRM multiple units used window frames
- When installed, the outer surface of the window frame is flush with the Side wall of the car body
- Replacement of the insulating glass packages is possible from inside the vehicle

Glass:

- Insulating glass package: total thickness according to the IRM multiple unit design 21 mm
- sun-repellent glass with a light transmission of approx. 36%
- Outer pane toughened safety glass, Parsol gray, thickness 6 mm
- Inner pane toughened safety glass, clear glass, 5 mm thick
- Glass edge design according to DIN 1249, part 11 - Edges hemmed
- Execution curved and straight, geometry according to drawings M1080-M1086
- Quantity according to the number of windows according to the parts list
- Labeling according to technical delivery conditions DB, TL 918 511 on the
- Outside of the inner pane, arrangement on the top right, readable from the inside


1:2
301±0.5
Ø7.50
2x500±0.5=1000
3
5
4
1
2
10
8
9




3
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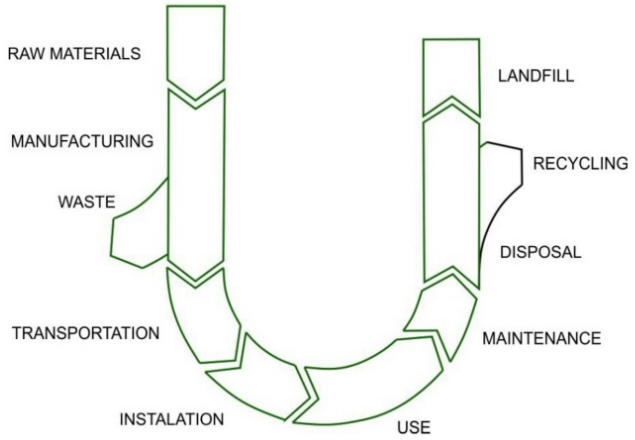
LIFE CYCLE ASSESSMENT (LCA)

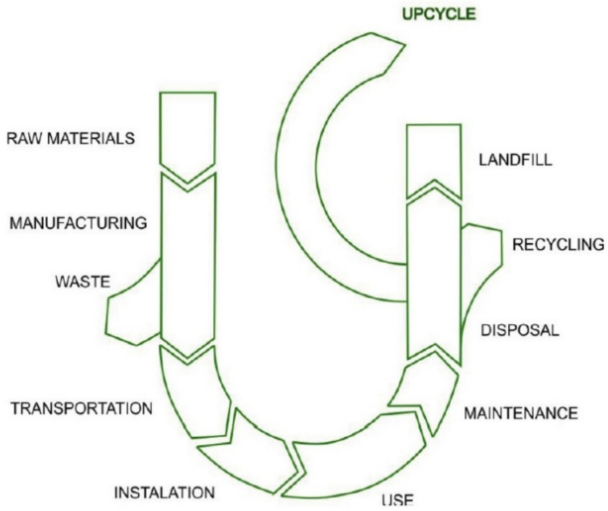
VIRM'S WINDOWS

LCA

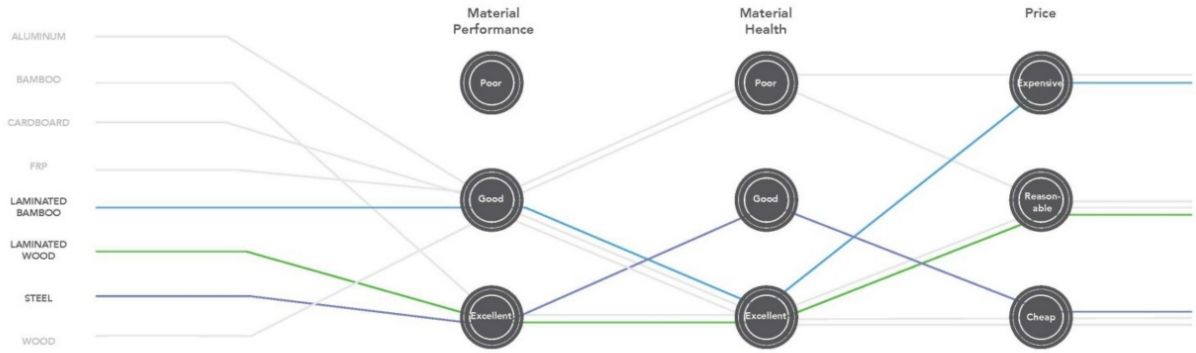


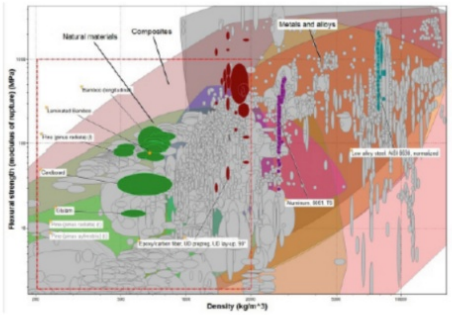
VIRM'S WINDOWS

LCA

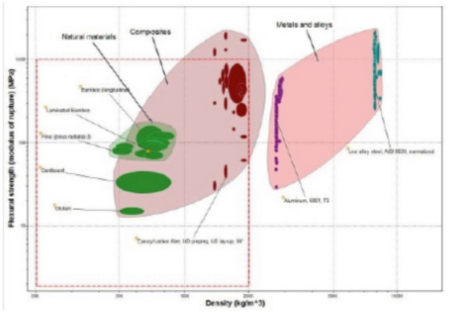


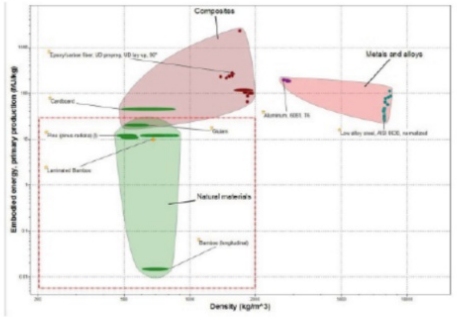
MATERIAL (FLOW) ANALYSIS



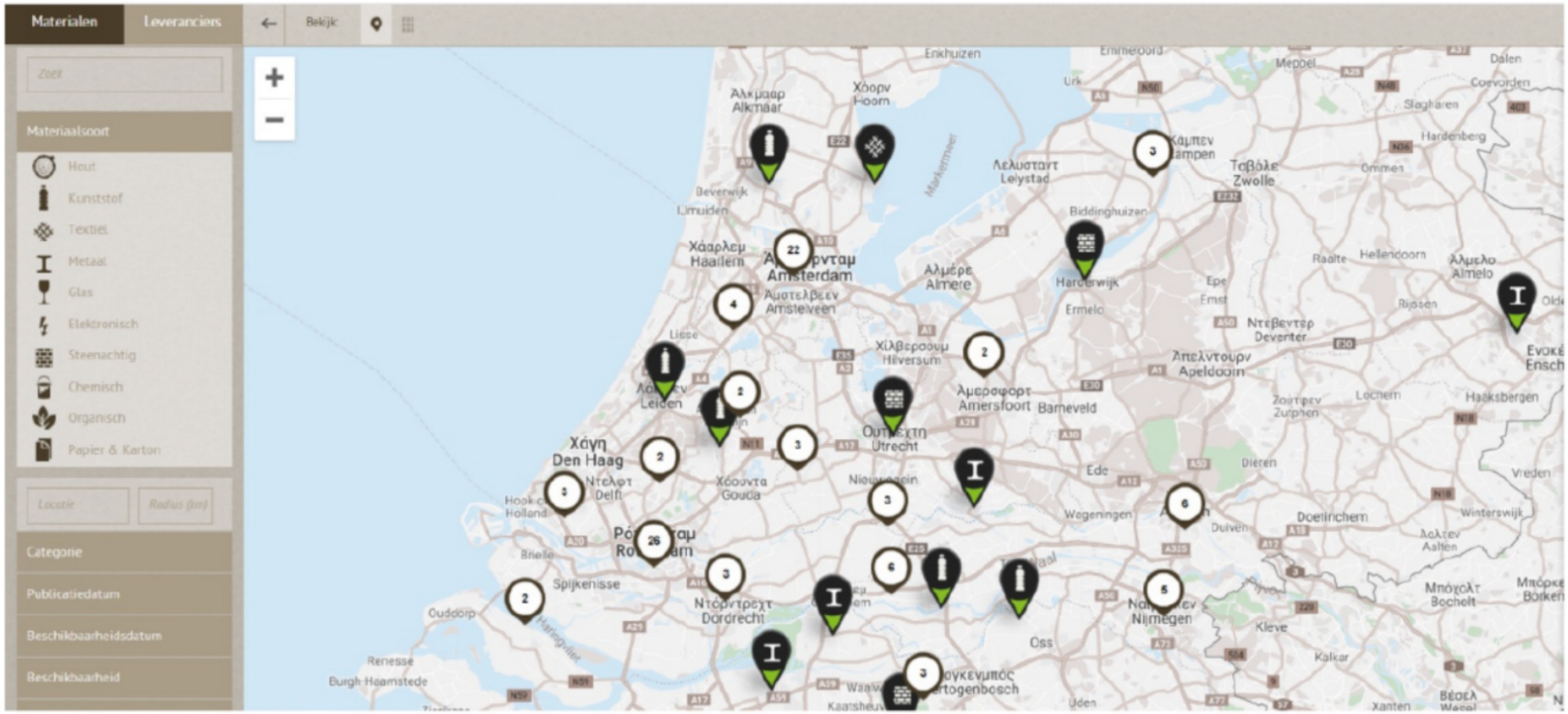


Most Used Materials	Alternative Materials
1) Metals & Alloys - Steel (AISI 8630) - Aluminum (Al 6061)	**2) Composites** - Fiber Reinforced Composite (EP-CF70) - Cardboard (CES Edupack standard)
	3) Natural Materials - Wood (Radiata Pine) - Bamboo (CES Edupack standard)
	4) Engineered Materials - Laminated Wood (acetylated Radiata Pine) - Laminated Bamboo (Moso)





HARVESTMAP.ORG



Circular Design Criteria :

Design causing the less possible harm to the materials,in order to be reuse again in different future projects, "looping again" .

Design using as main design component the reused train windows.

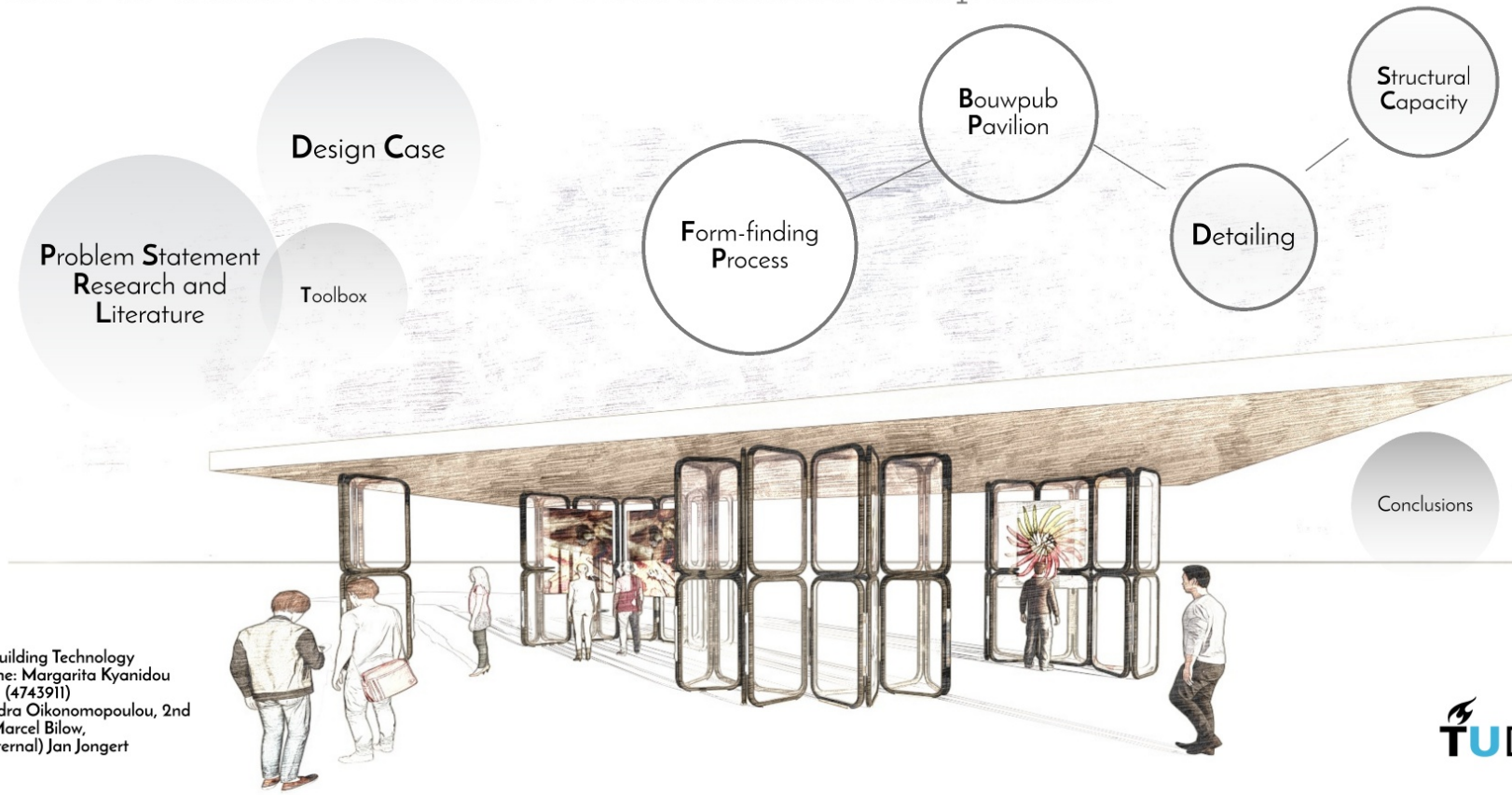
Design for Disassembly

The main design criteria are influenced from the materiality considerations.In this case, starting from the most important the following criteria are formulated:

Keeping everything modular. Having in mind the multi-adaptable nature of the modulus.

Upcycle in Architecture

Re-use NS windows as a new construction component



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TU Delft

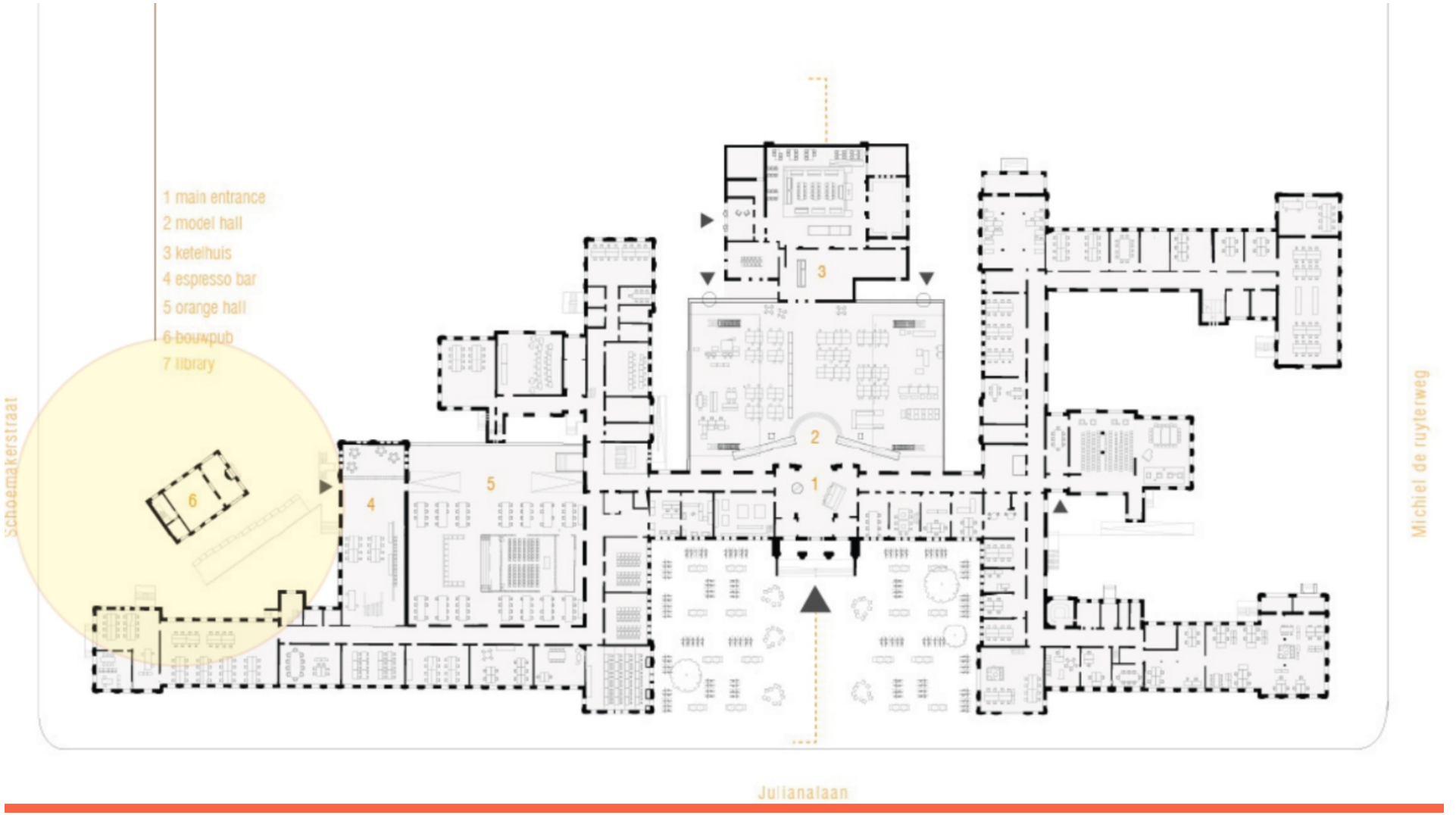
- The **Bouwpub** is the "soul" of the Architecture School of TU Delft.

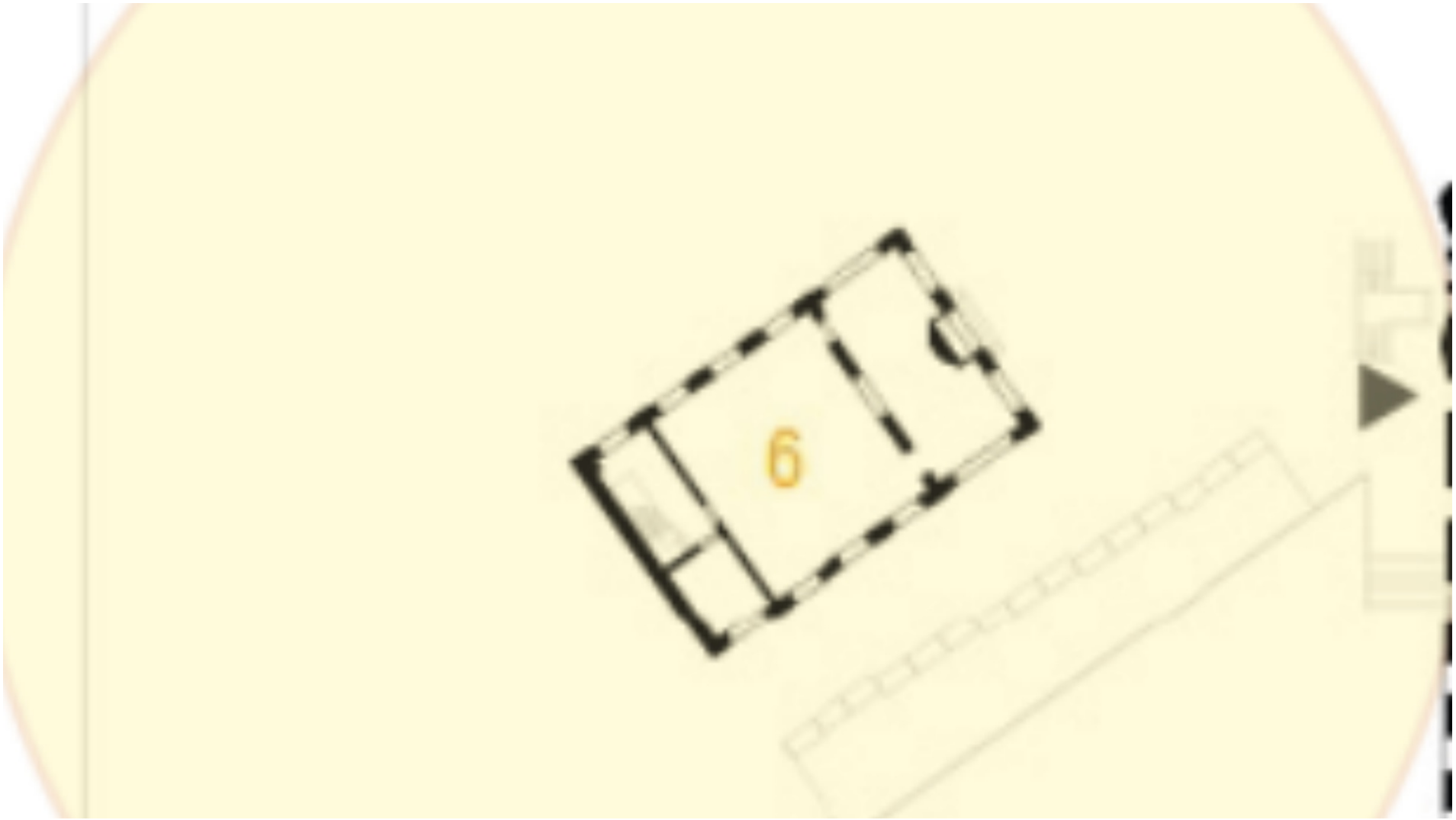
- It is a perfect place for a small pavilion that could host information and stats about the Circular economy during the events of the **Circular Economy week** 2020 (3-7 February 2020).

- A **small, cosy** space with a roof on top to **protect** the exhibition and its host from the rainy Dutch February. .

- Made from **reused materials from the VIRM intercity** trains o f NS

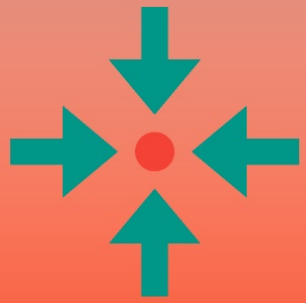
Design Plot


1 main entrance
2 model hall
3 ketelhuis
4 espresso bar
5 orange hall
6 bouwpub
7 library
Schoemakerstraat
Michiel de ruyterweg
Julianalaan


6


ENTRANCE
BKCity
Bouwpub

- PLOT : OUTSIDE THE BOUWPUB IN THE ARCHITECTURE SCHOOL OF TUDELFT.
- CONSTRUCTION AREA OF THE PROPOSAL: 60 -80 S QM
- USES: EXHIBITION AREA
- RAIN PROTECTION
- INFO POINT
- MAIN MATERIALS: TRAIN WINDOWS



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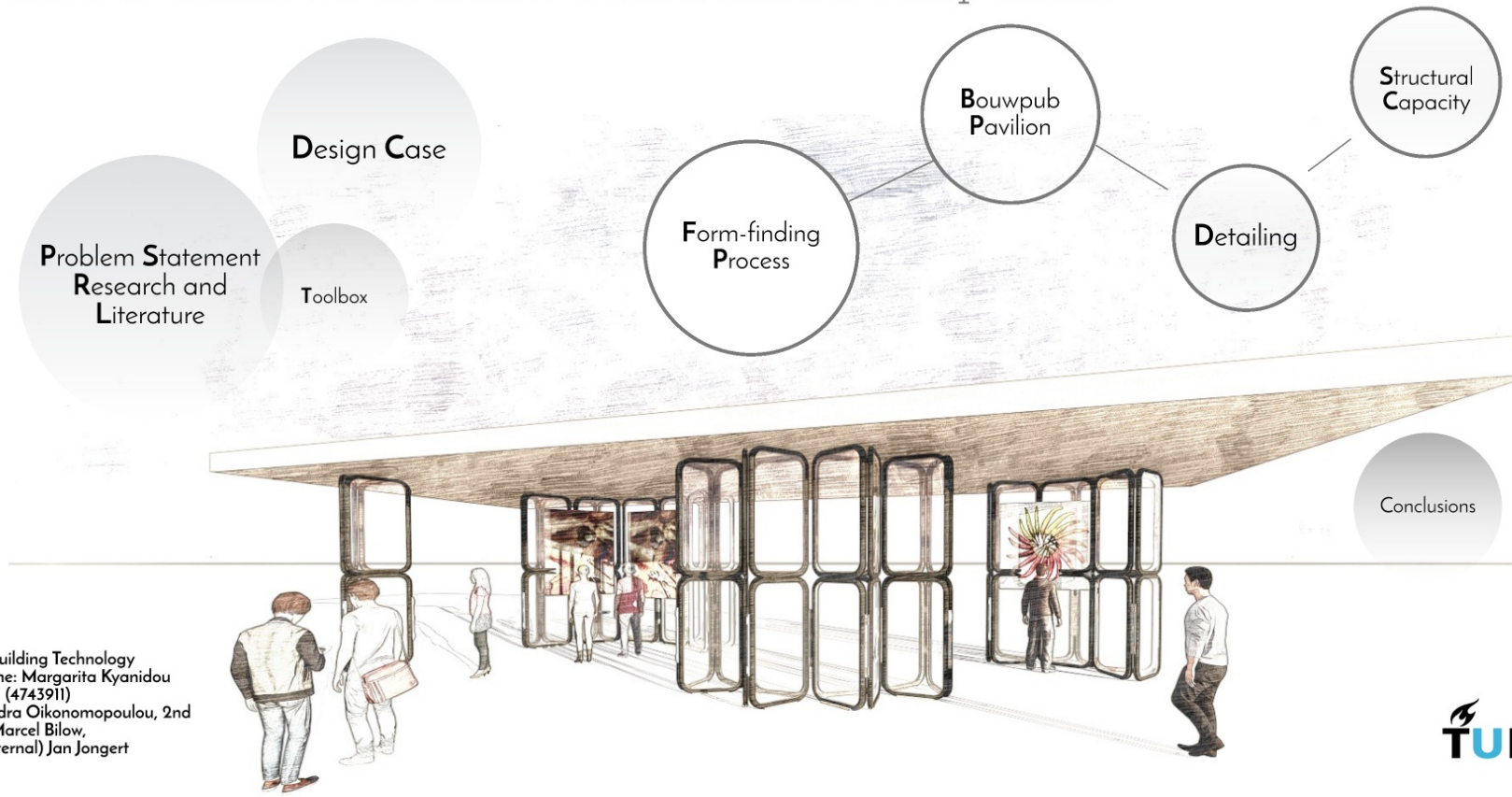

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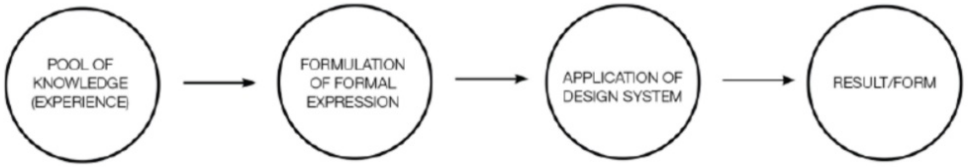


Figure 1. Conventional design approach

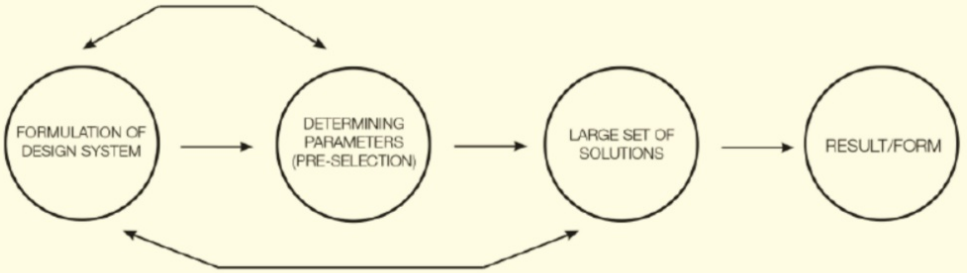
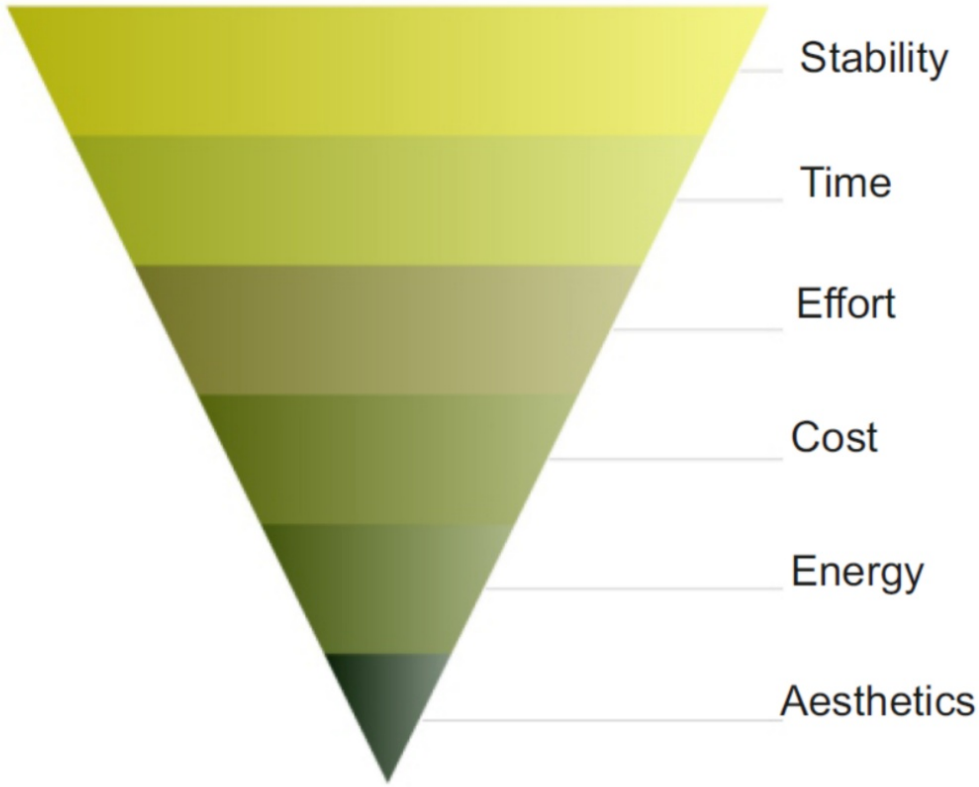
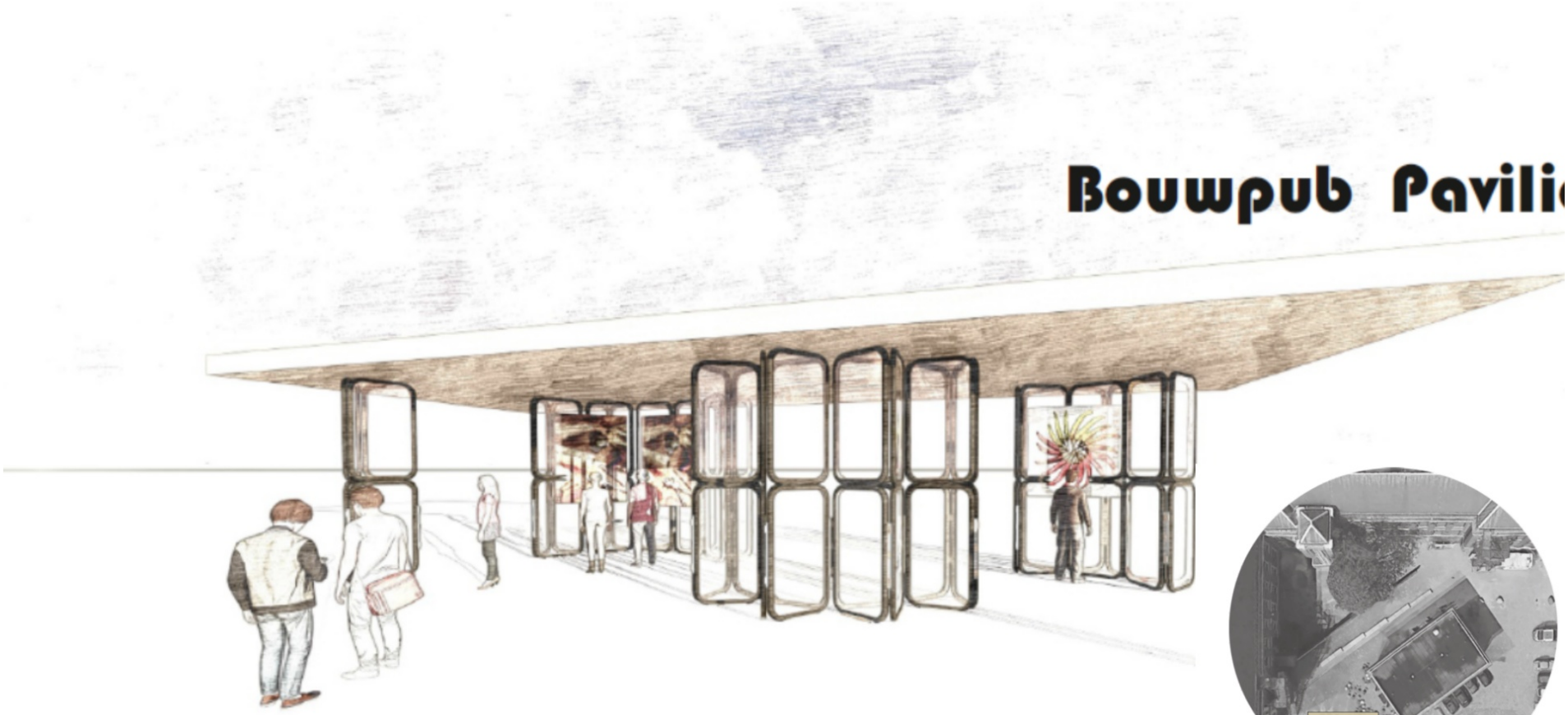
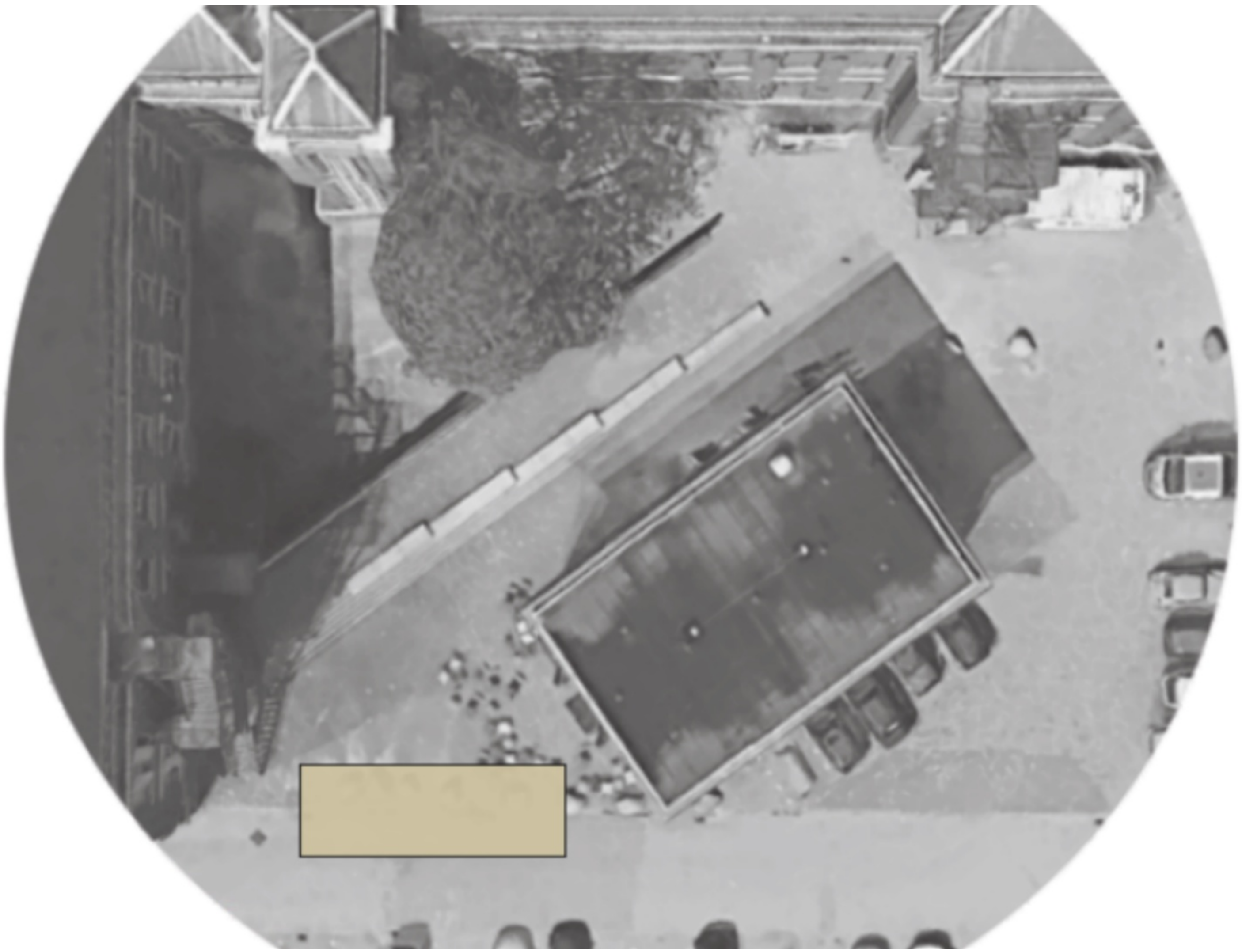


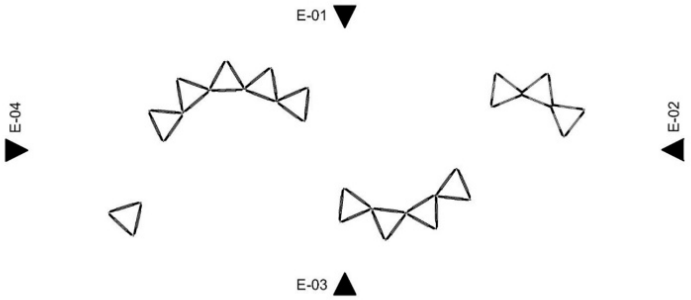
Figure 2. Form-finding process based approach


Stability
Time
Effort
Cost
Energy
Aesthetics

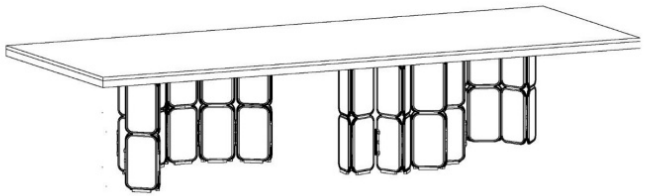
Bouwpub Pavili



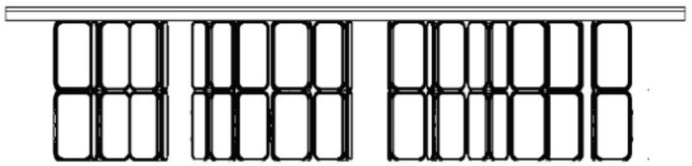




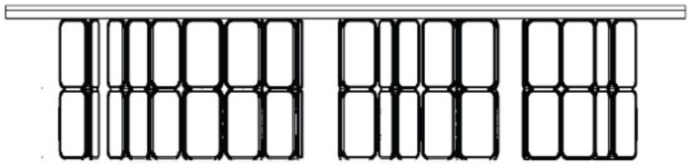
0. Ground Floor 1:100



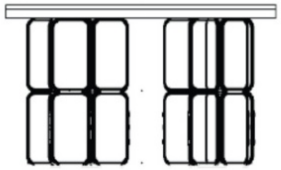
3D-02 Axonometry 1:100



E-01 Elevation 1:100



E-03 Elevation 1:100

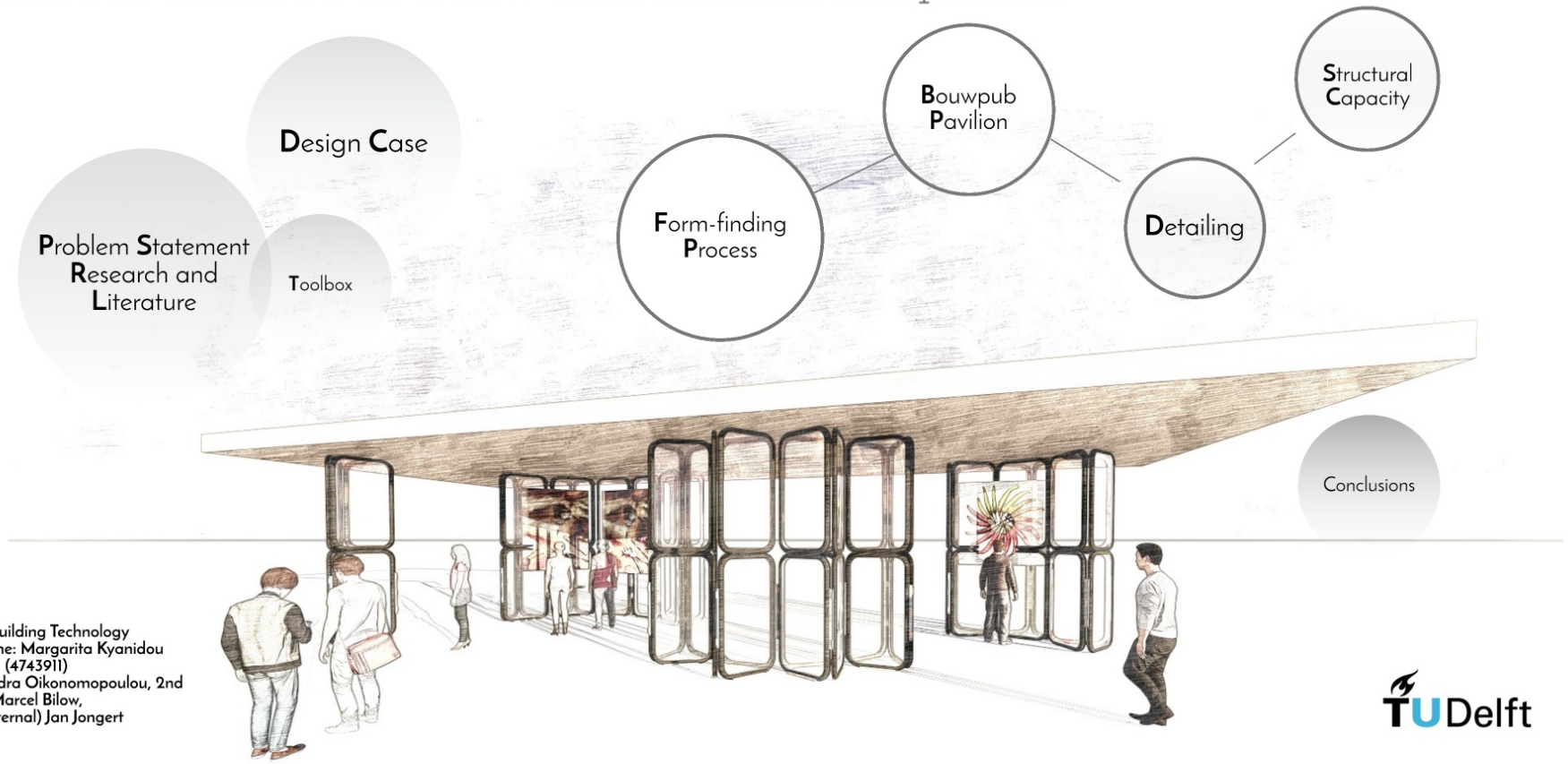


E-04 Elevation 1:100

Bouwpub Pavilion

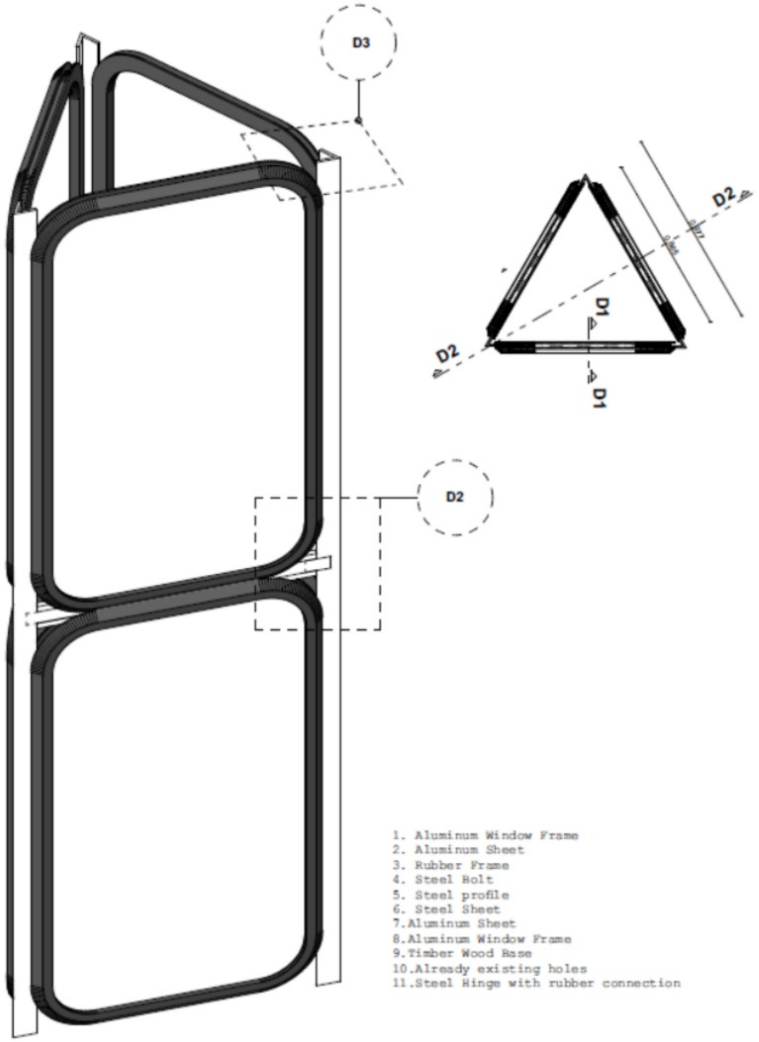
Upcycle in Architecture

Re-use NS windows as a new construction component

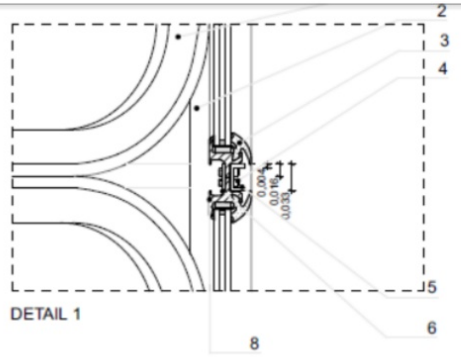


Track: Building Technology
Student name: Margarita Kyanidou
(4743911)
Mentors: 1st Faidra Oikonomopoulou, 2nd
Marcel Bilow,
3rd (external) Jan Jongert

TU Delft



1. Aluminum Window Frame
2. Aluminum Sheet
3. Rubber Frame
4. Steel Bolt
5. Steel profile
6. Steel Sheet
7. Aluminum Sheet
8. Aluminum Window Frame
9. Timber Wood Base
10. Already existing holes
11. Steel Hinge with rubber connection



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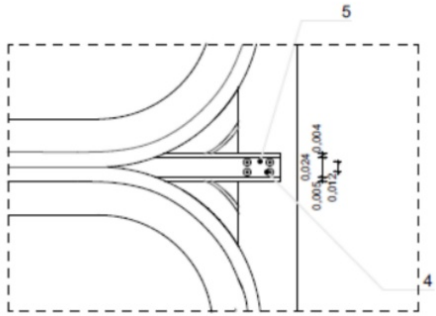

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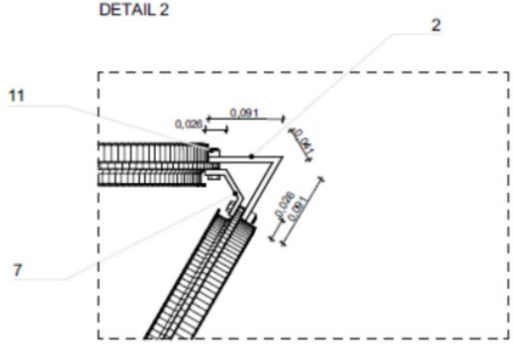

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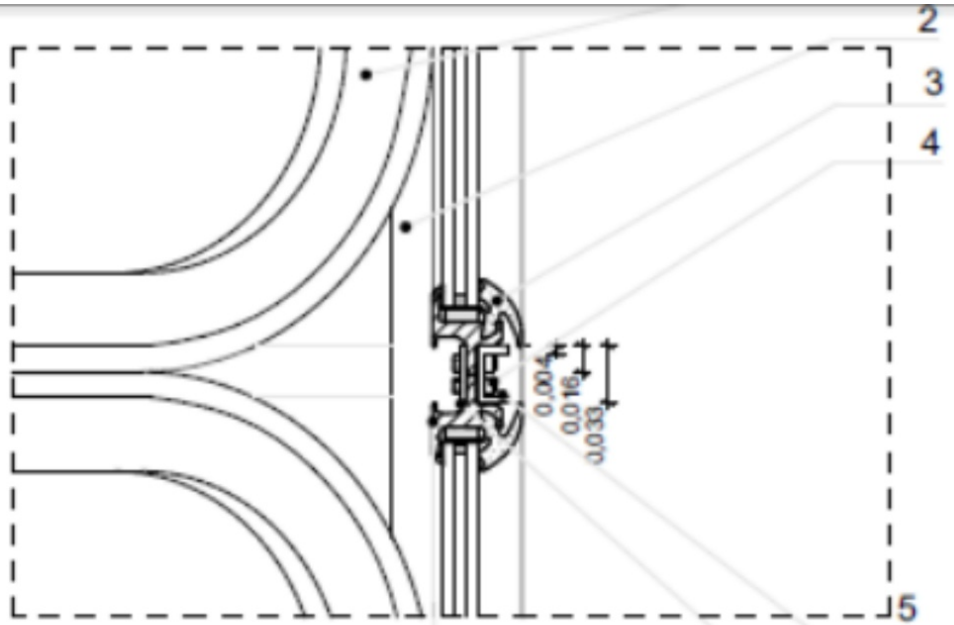

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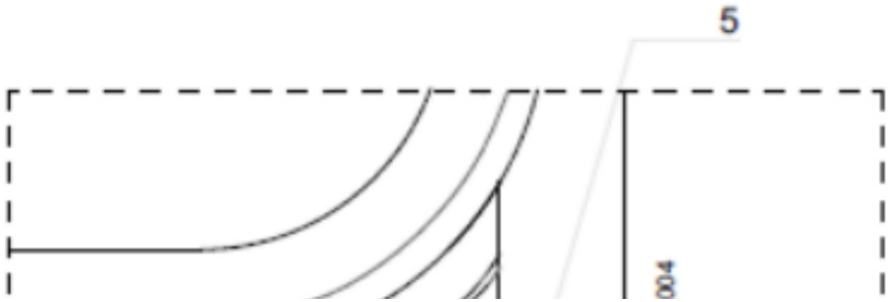

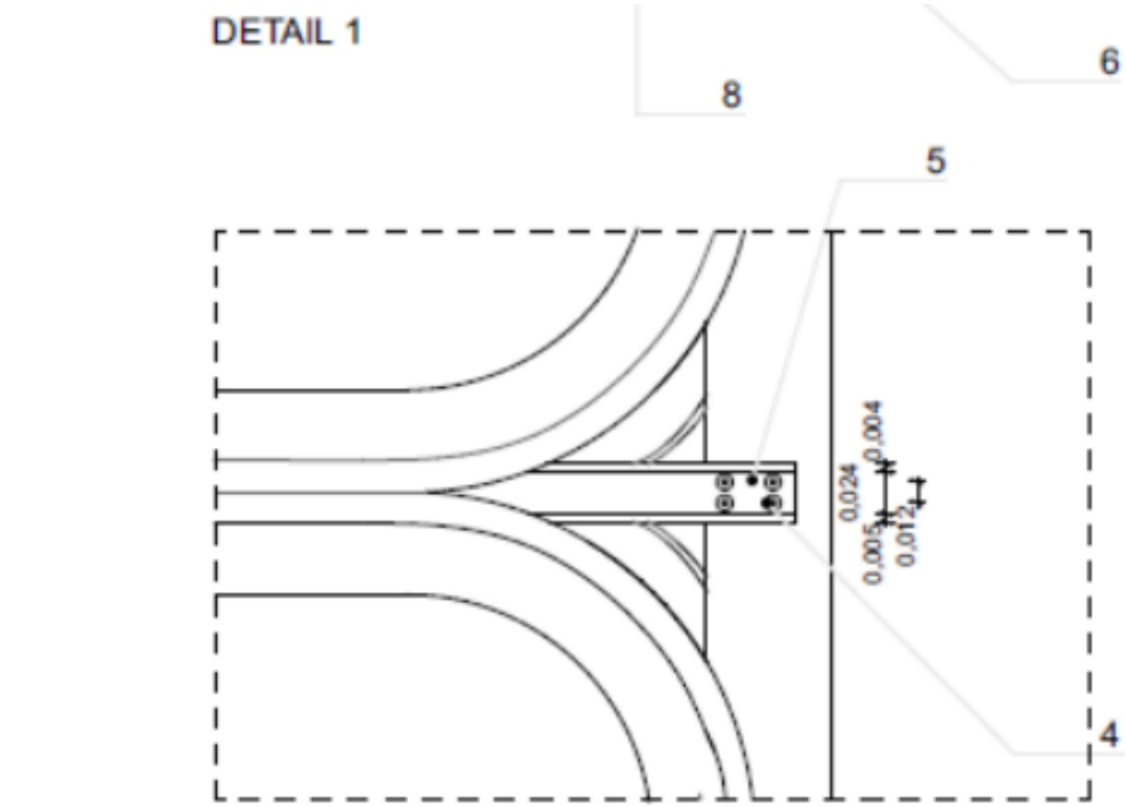
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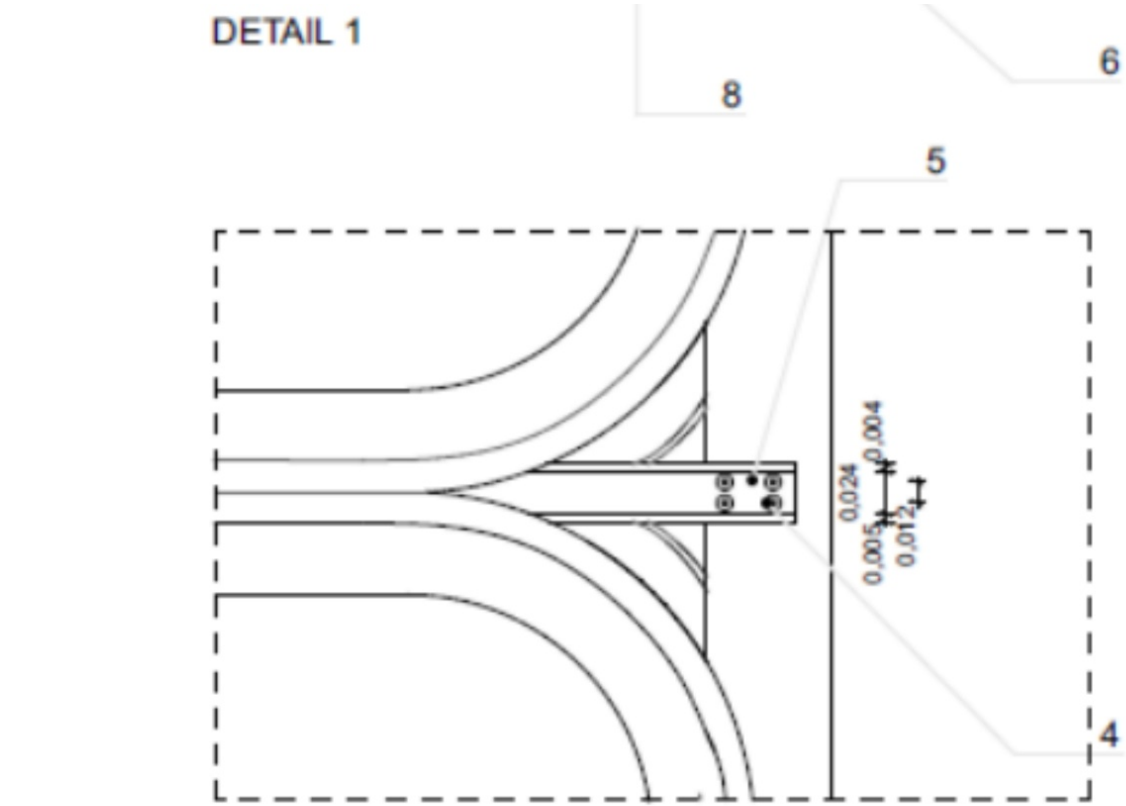
DETAIL 2
2
11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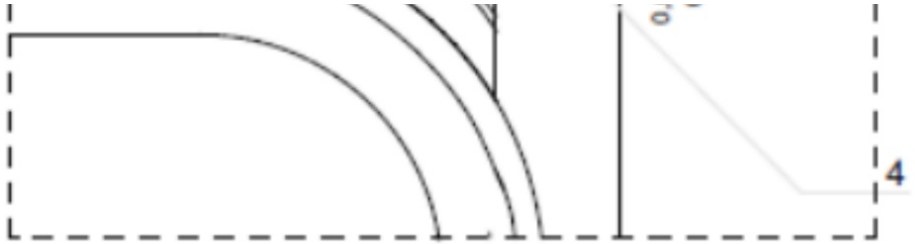
DETAIL 2
2
11



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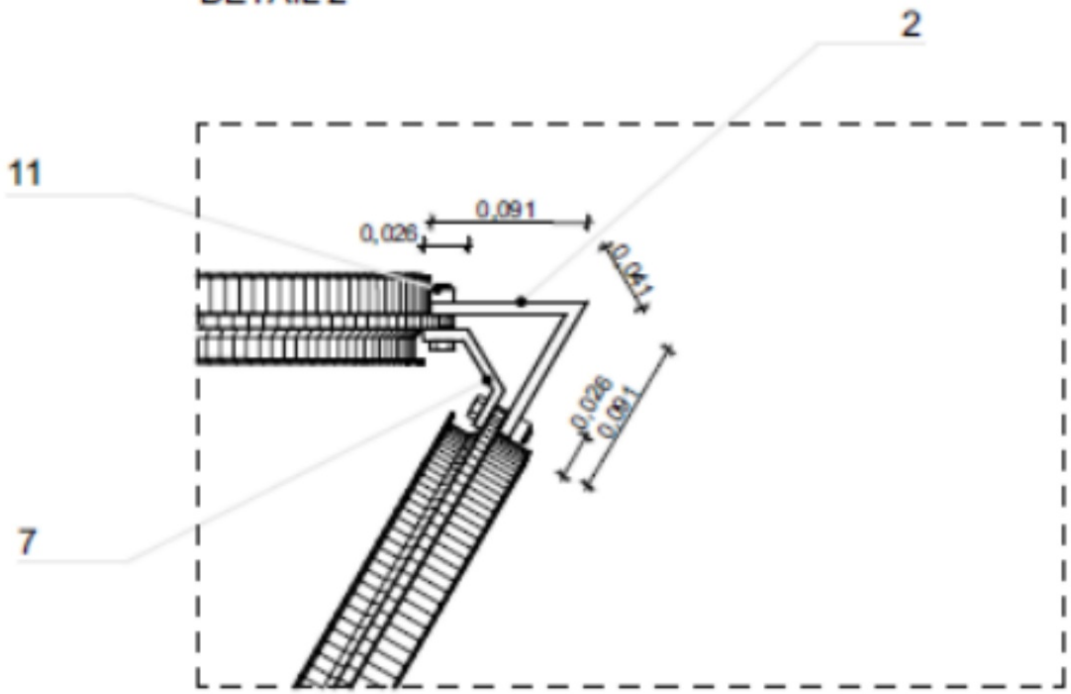

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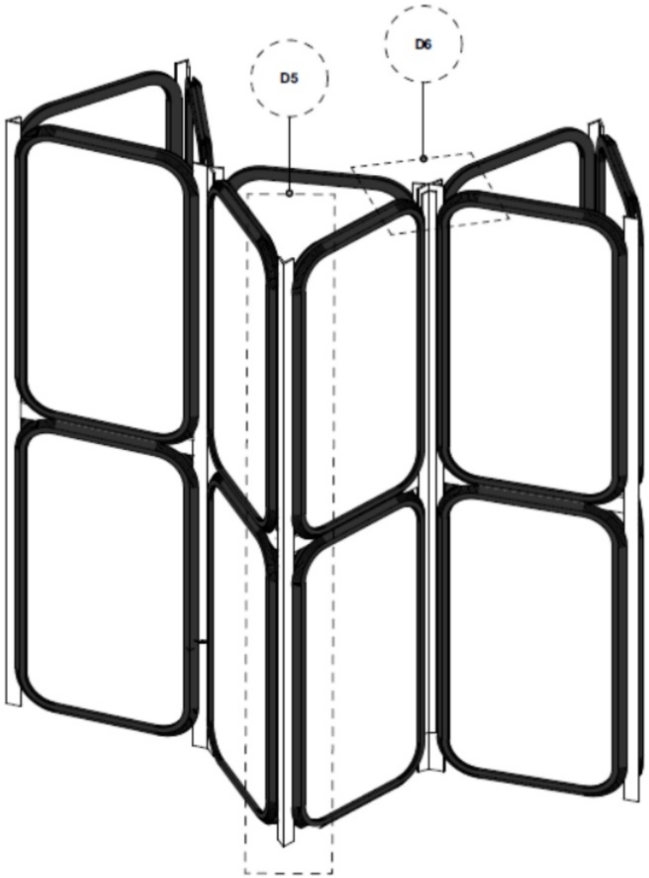
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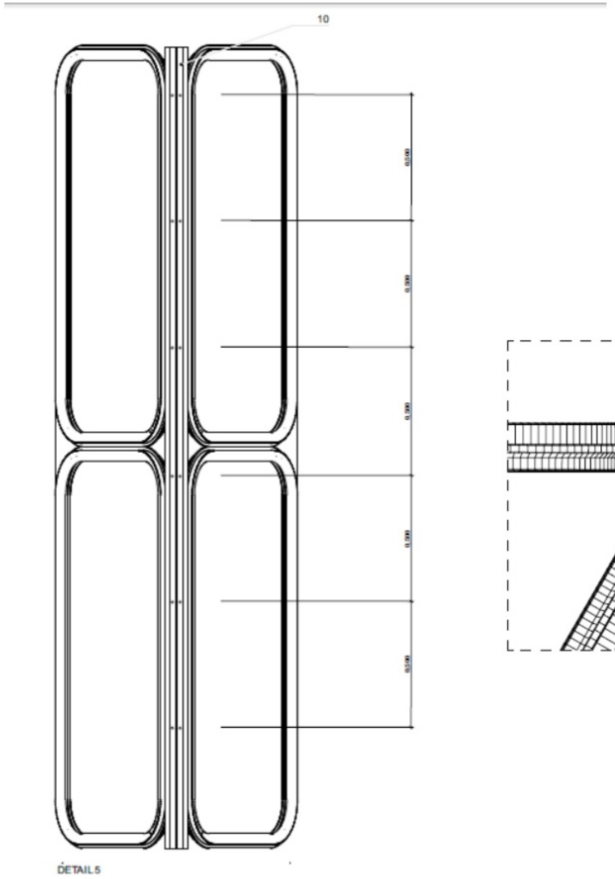
D6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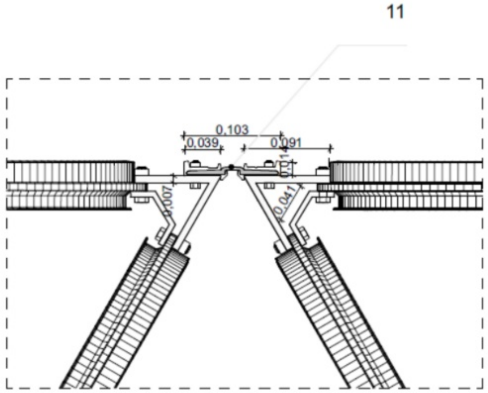
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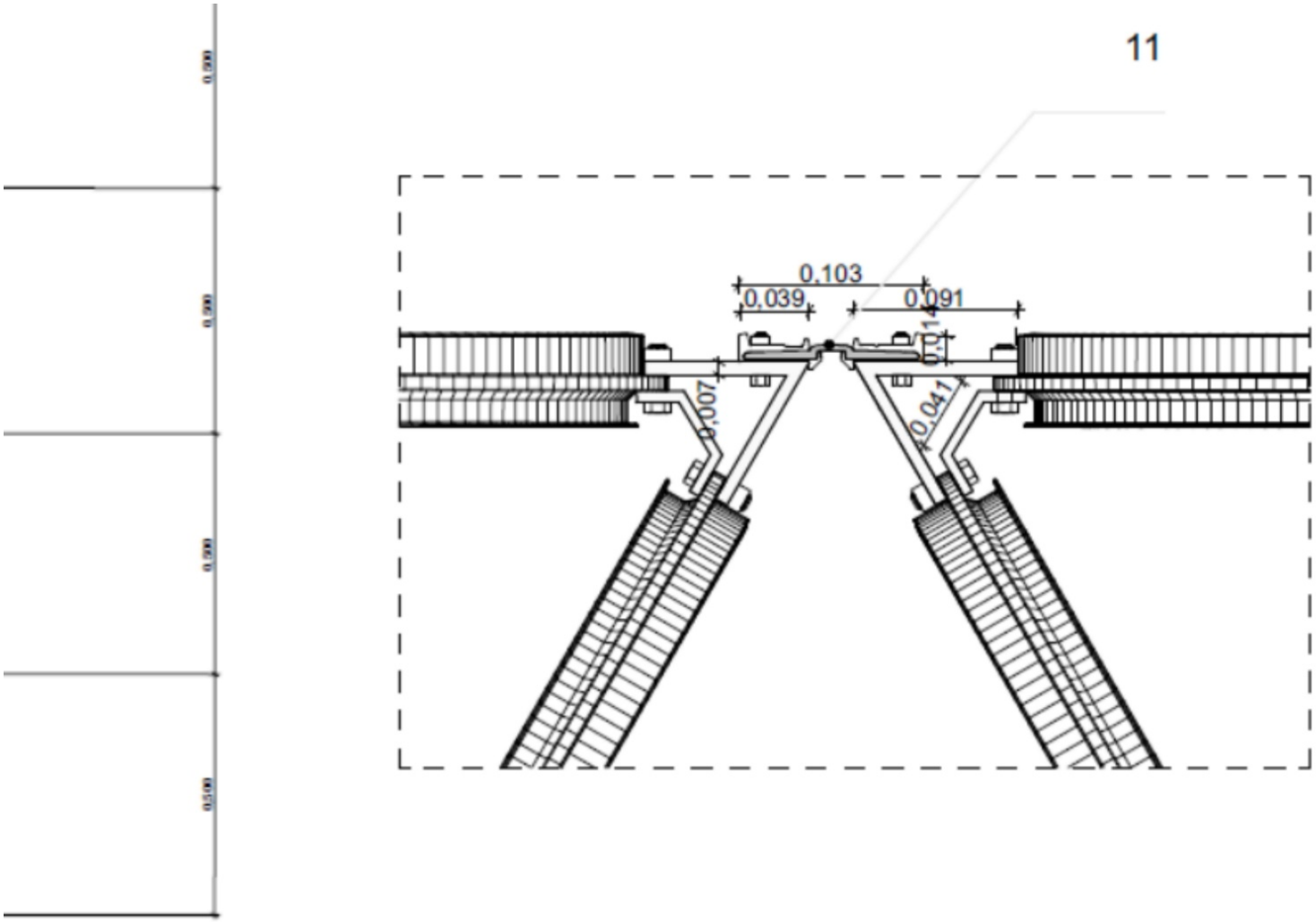
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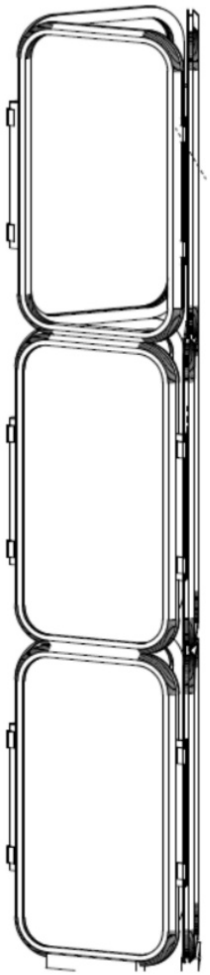

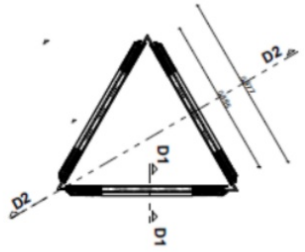

1. Aluminum Window Frame
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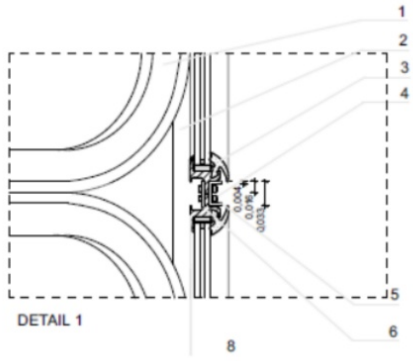
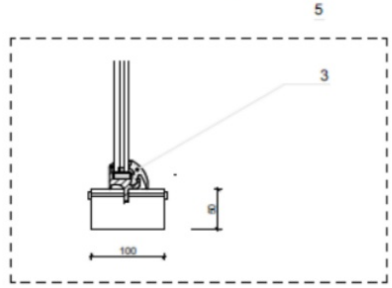
3. Rubber Frame
4. Steel Bolt
5. Steel profile
6. Steel Sheet
7.Aluminum Sheet
8.Aluminum Window Frame
9.Timber Wood Base
10.Already existing holes
11.Steel Hinge 45X45mm



DETAIL 1



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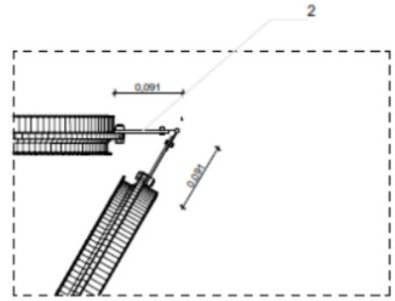
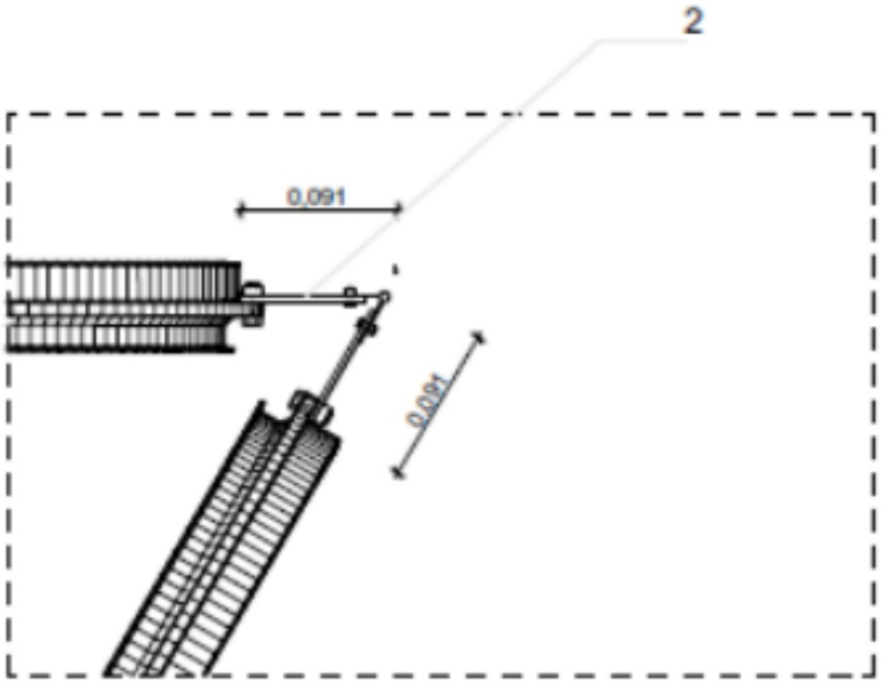


DETAIL 3

DETAIL 2



DETAIL 3

DETAIL 1

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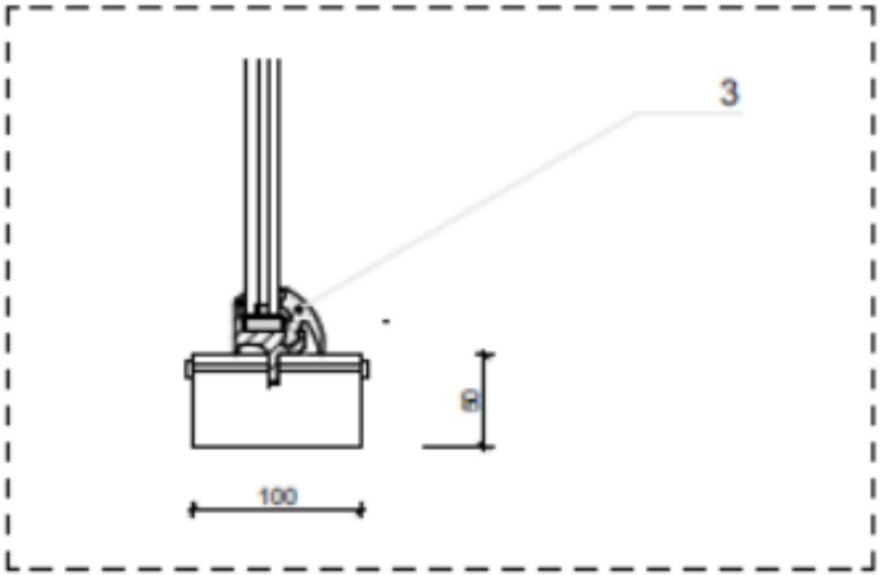

DETAIL 2

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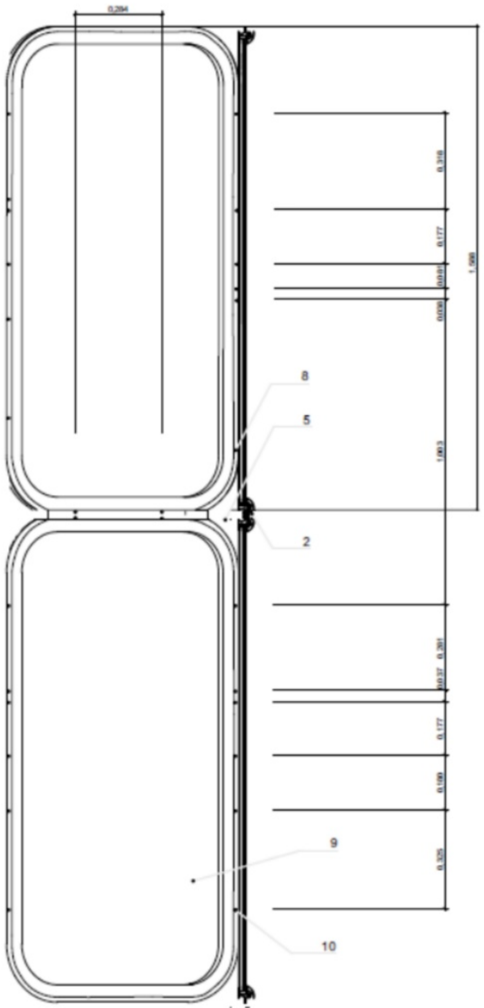

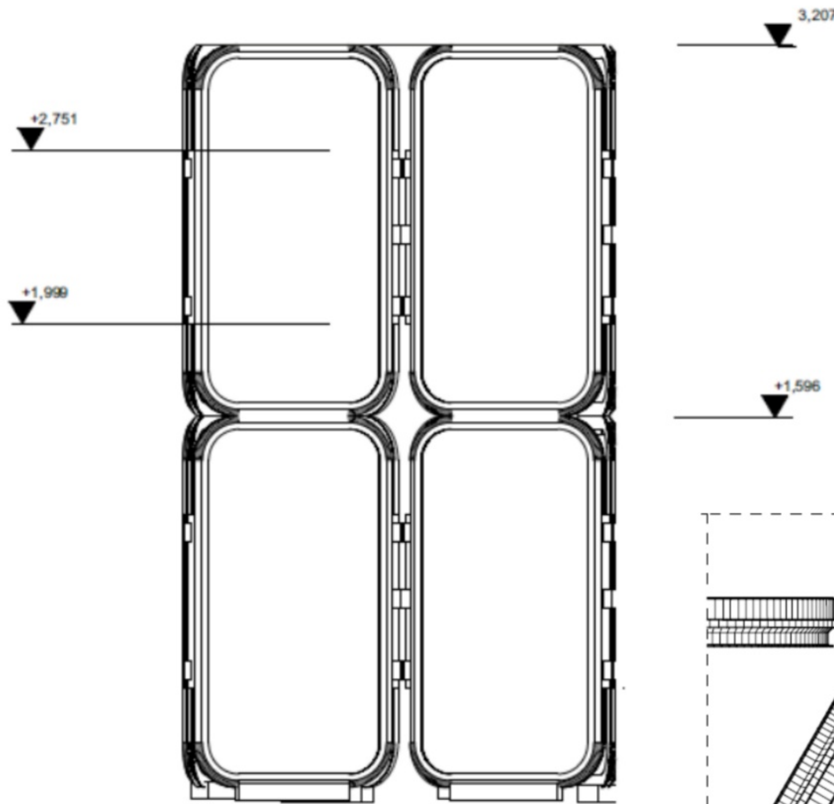

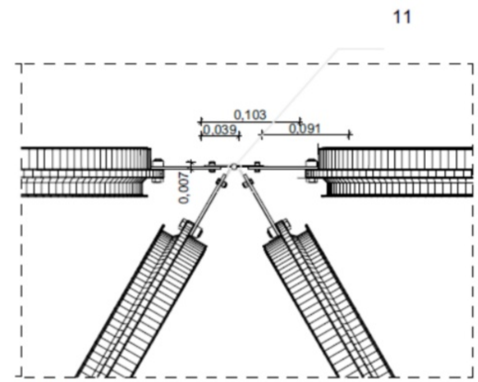

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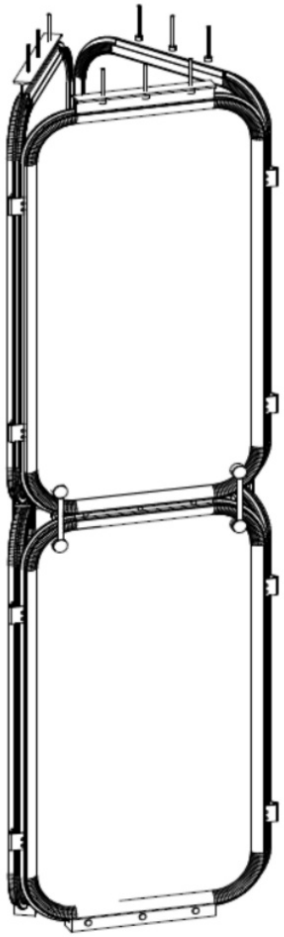

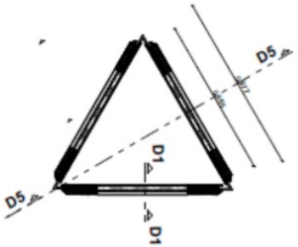

1. Aluminum Window Frame
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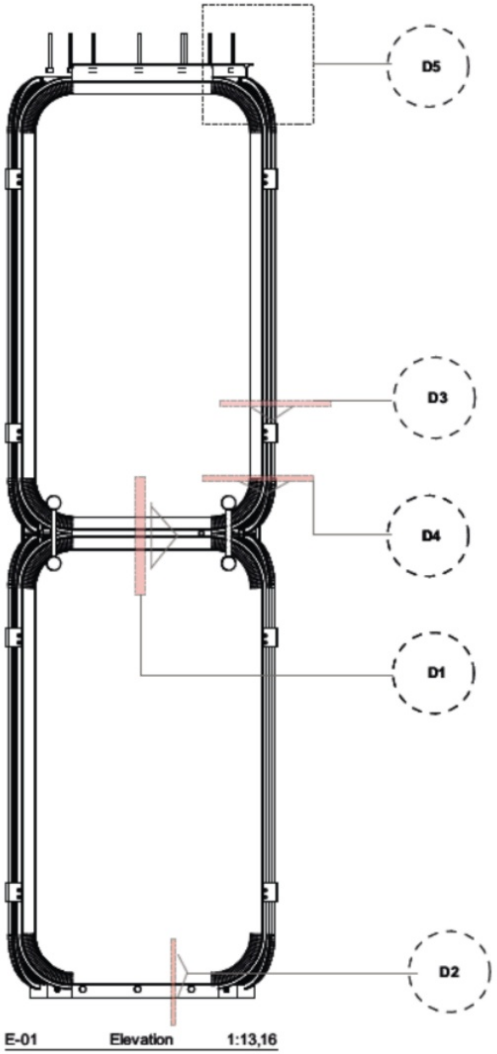
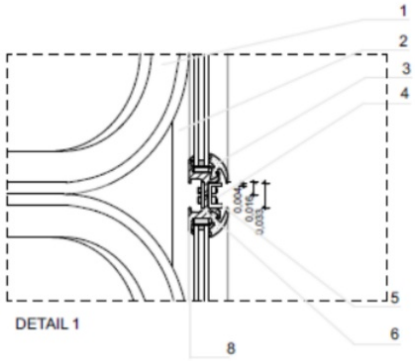
3. Rubber Frame
4. Steel Bolt
5. Steel profile
6. Steel Sheet
7.Aluminum Sheet
8.Aluminum Window Frame
9.Timber Wood Base
10.Already existing holes
11.Steel Hinge 49x88mm
12.Steel bolt shaped connection thickness 8mm
13.Lindapter type SW fixing
14.Steel connection profile
15.Neopreen rubber
16.Anchor bolt SFIX 7, M10 x 120 mm
17.Stel St80 beam

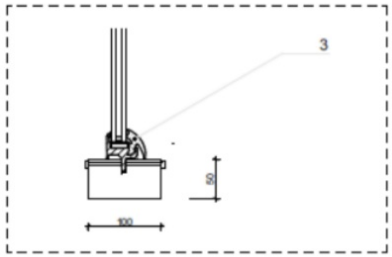
3D-01 Axonometry 1:13,13



E-01 Elevation 1:13,16



DETAIL 1



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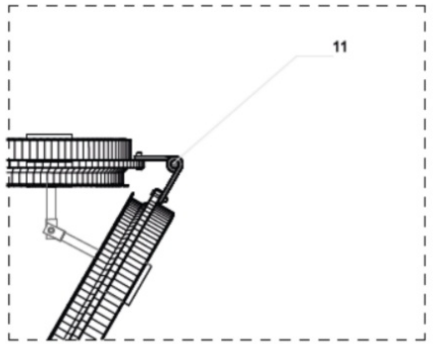
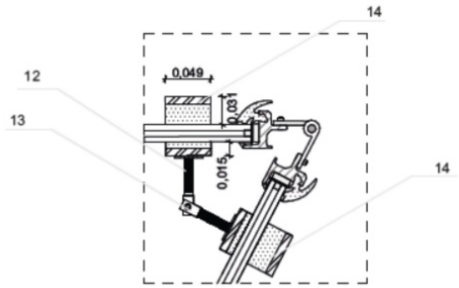


DETAIL 3



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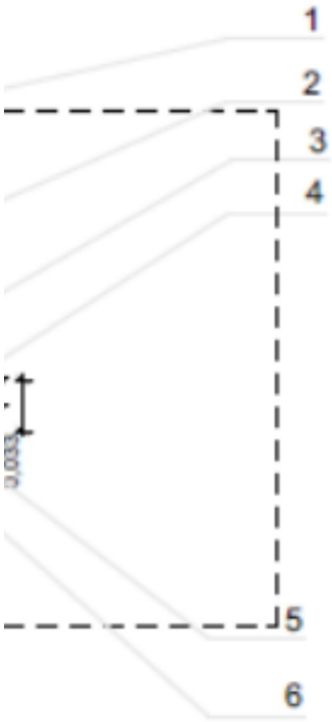

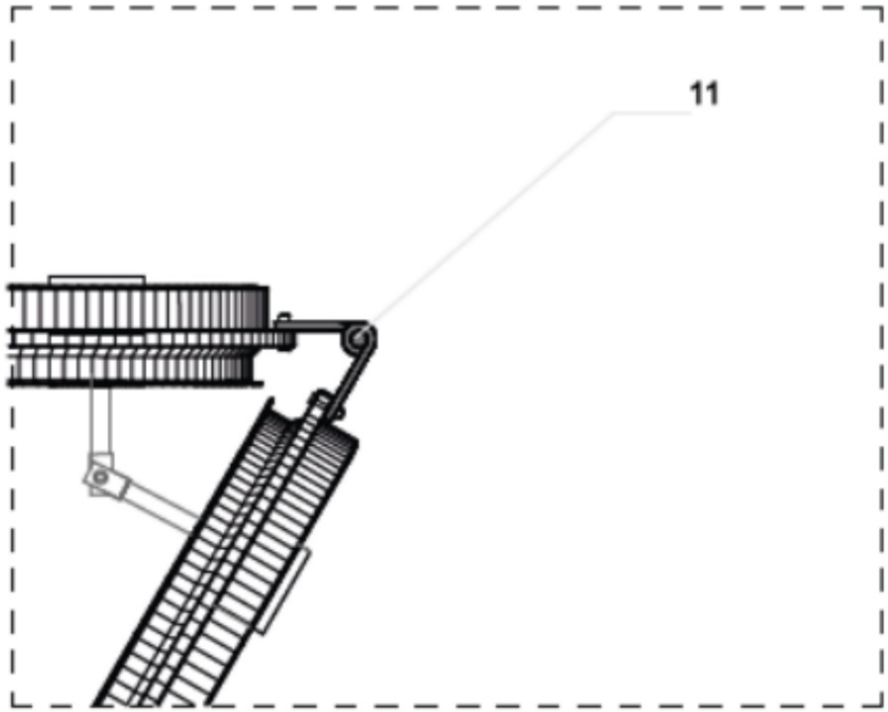

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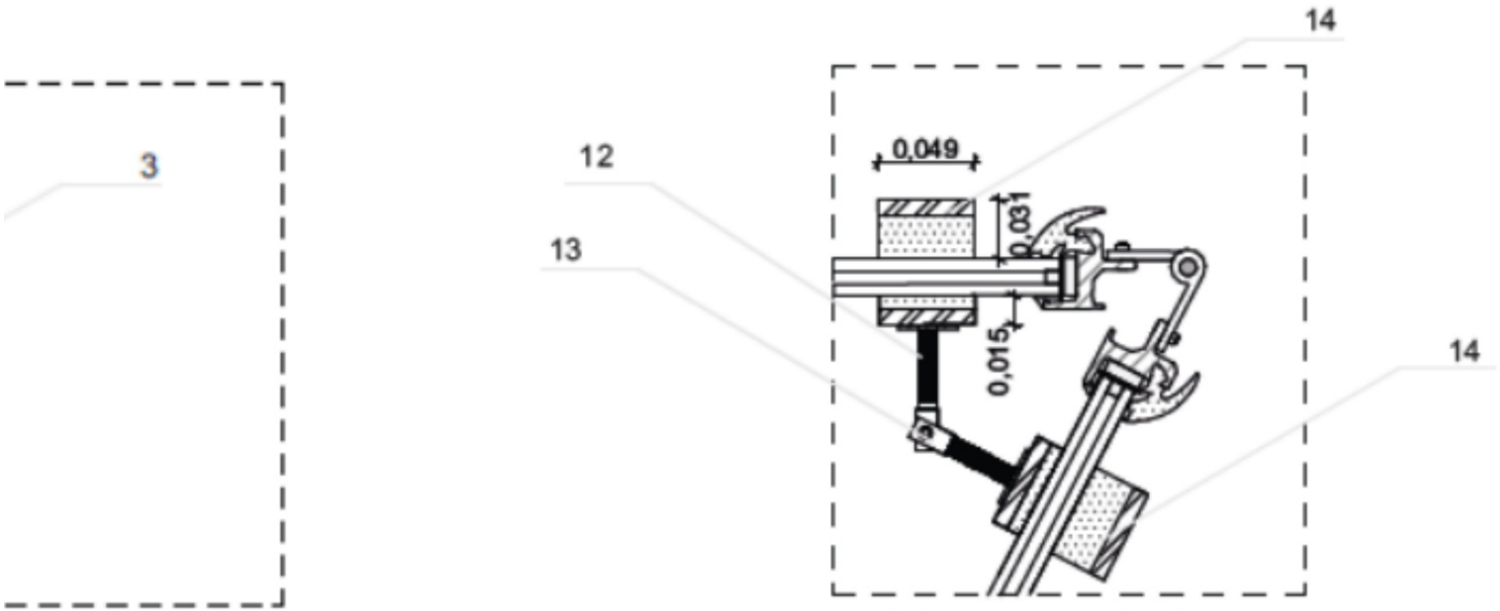

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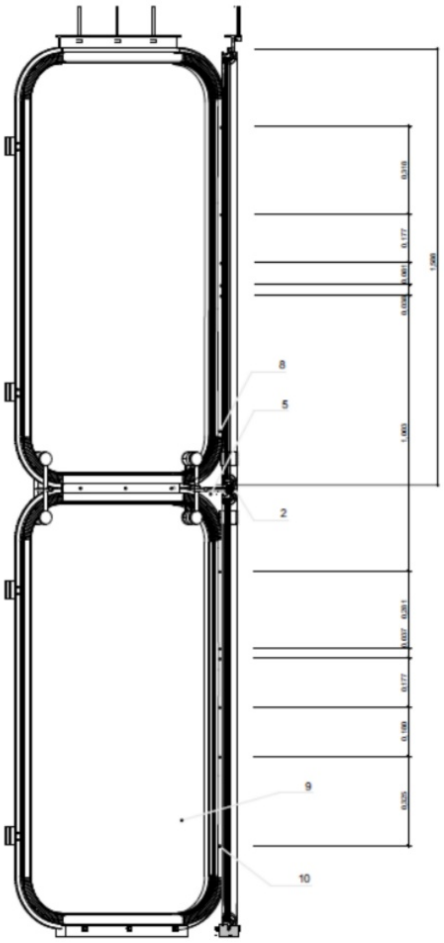
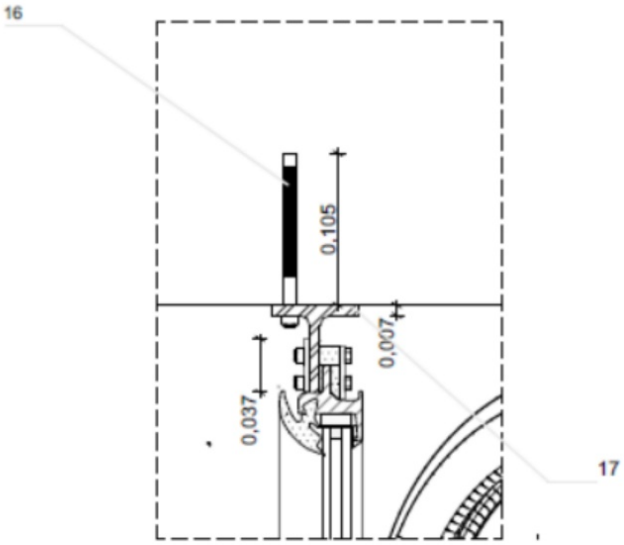
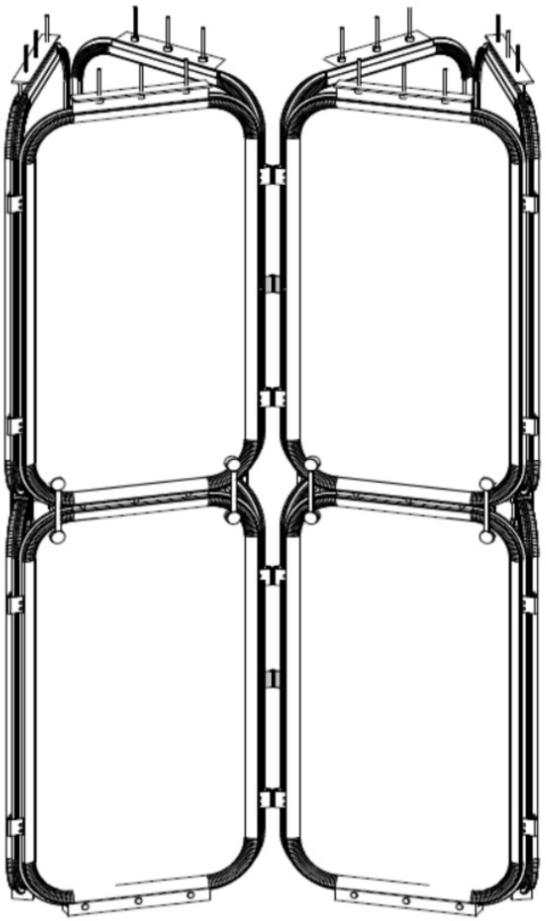


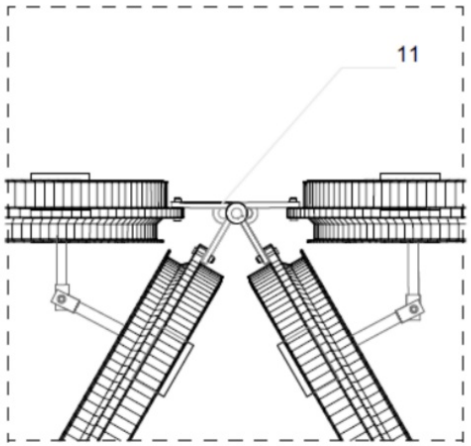
D-05 Detail 1:13



DETAIL 6



D-10 1:13,33



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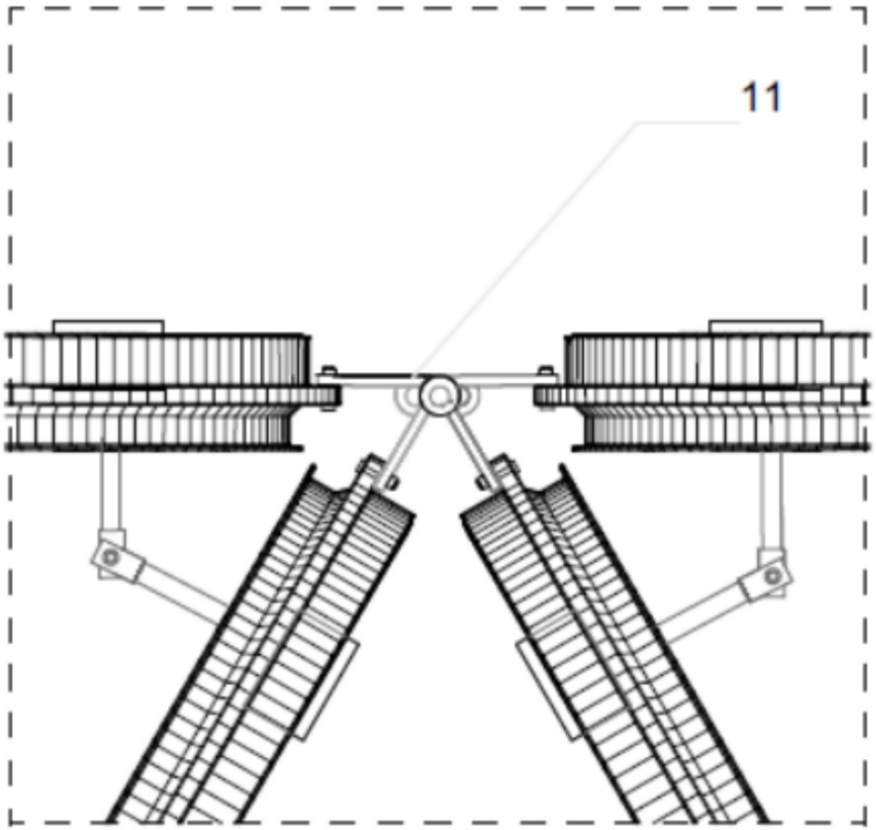
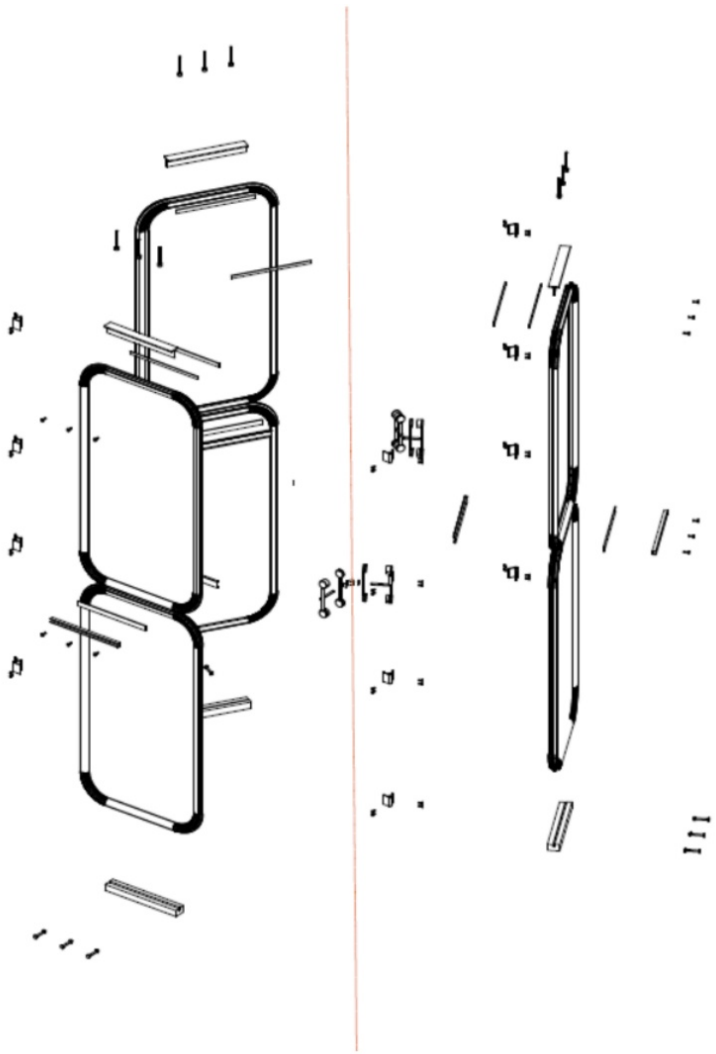
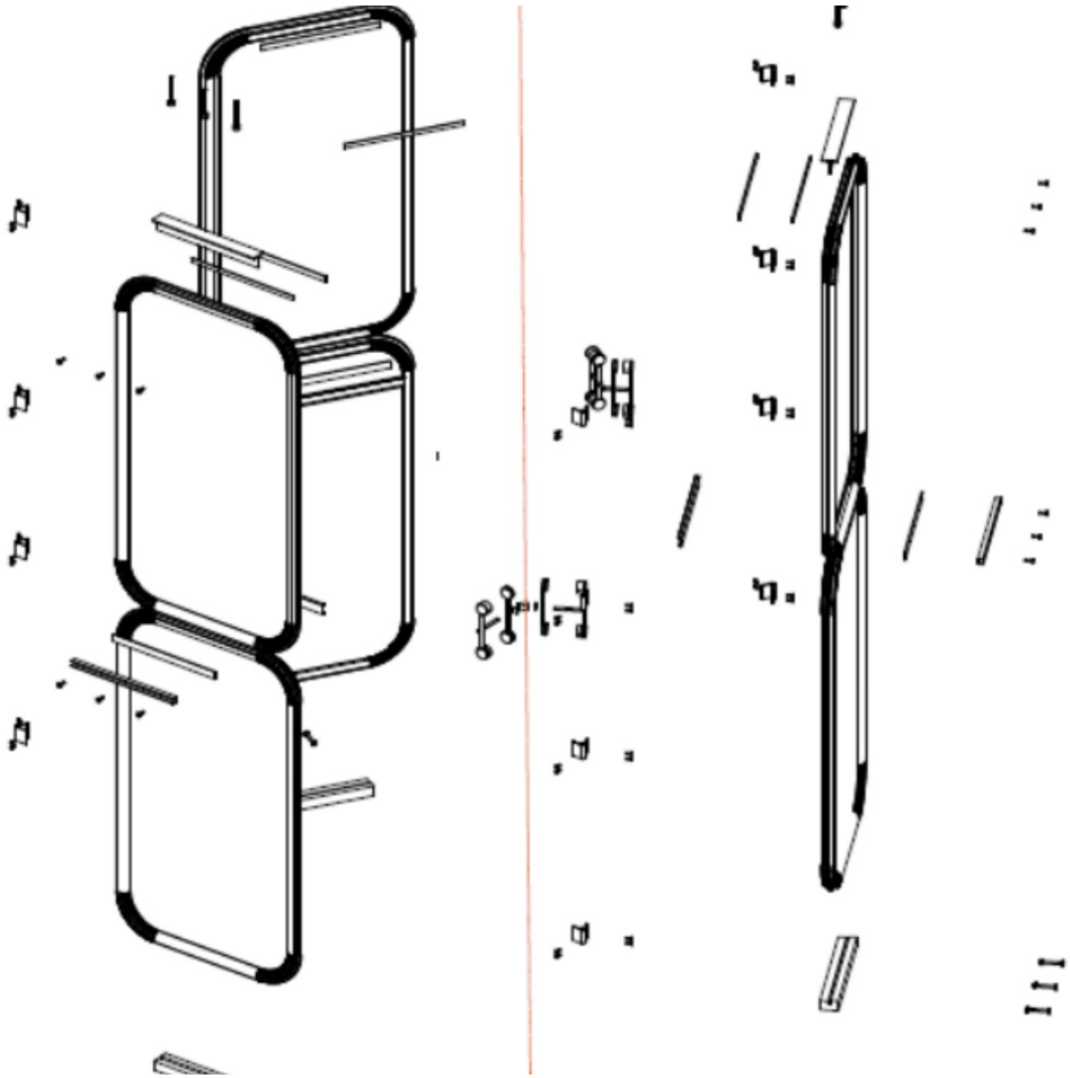
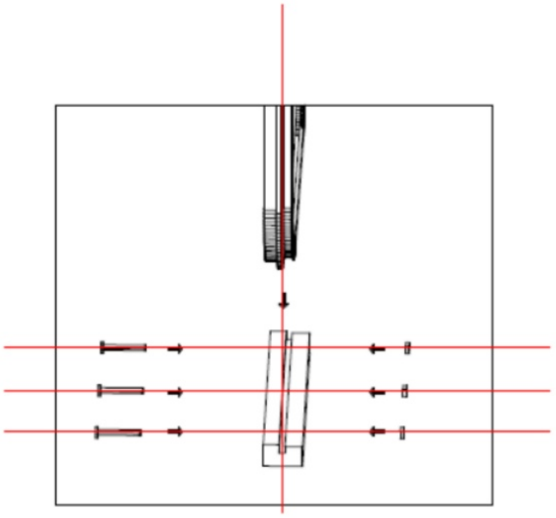


DETAIL 6







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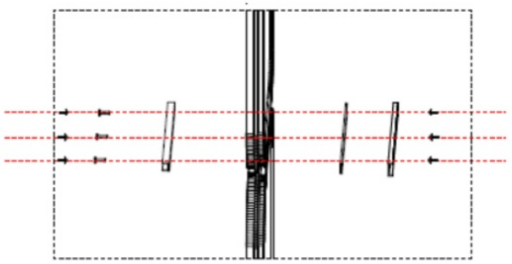

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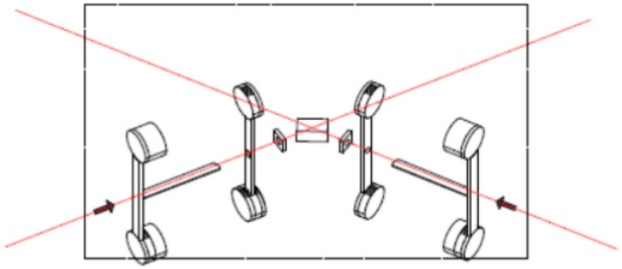

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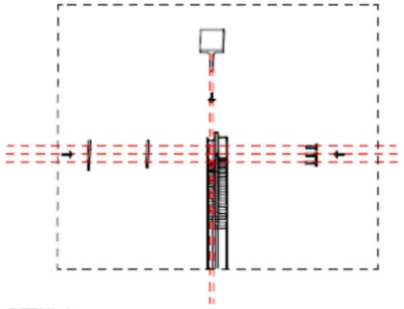

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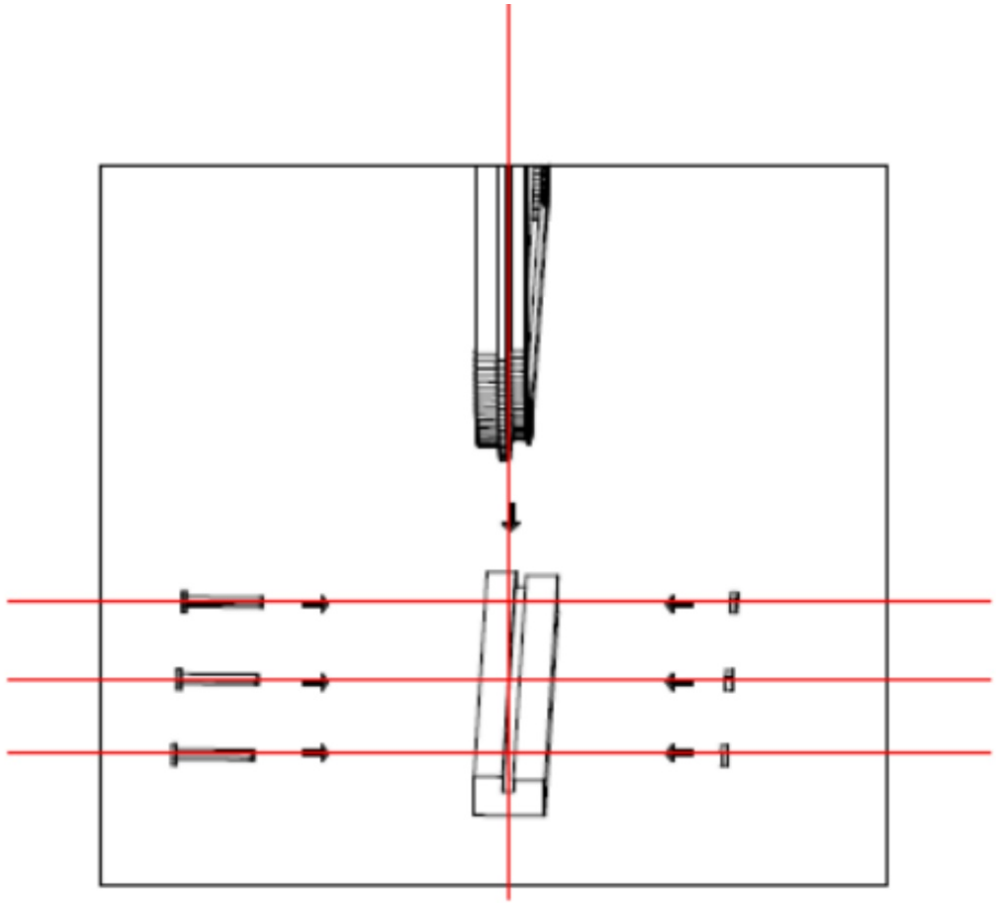
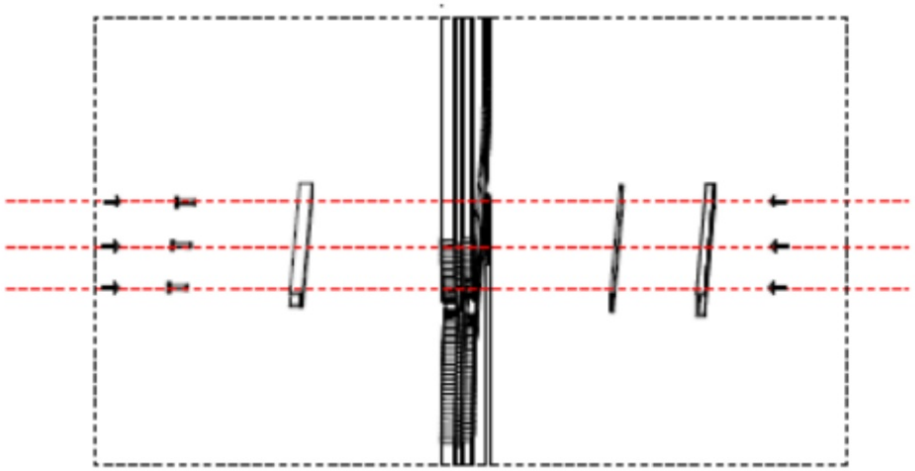
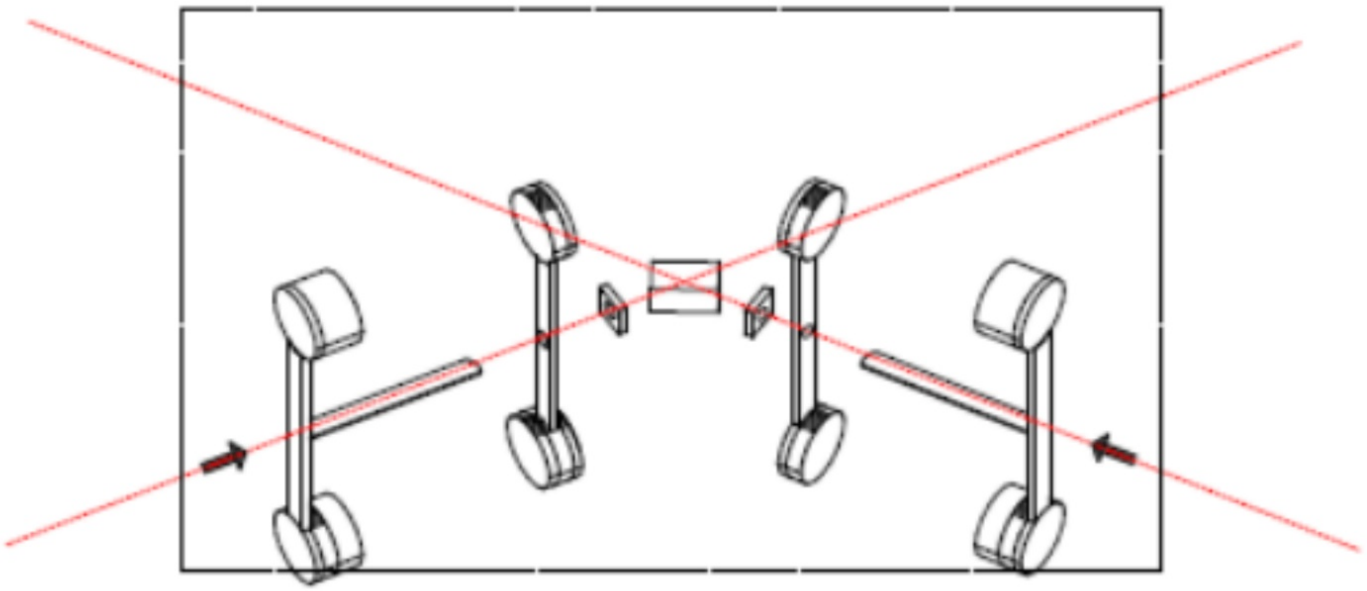


DETAIL 1

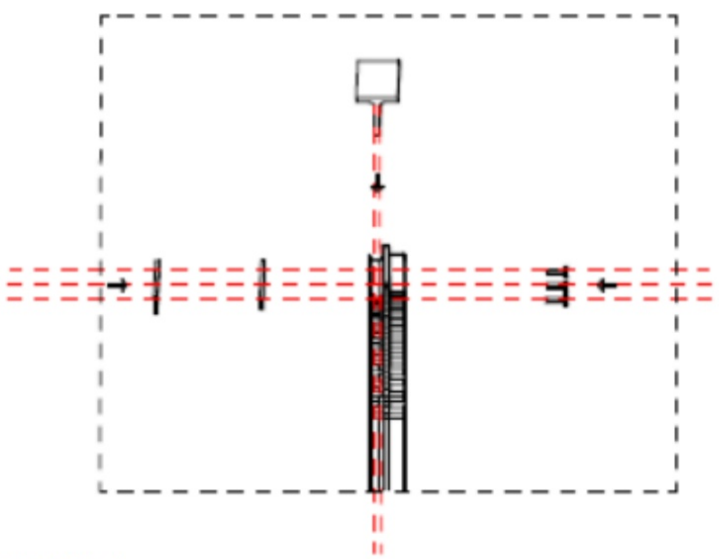


DETAIL 3



DETAIL 2

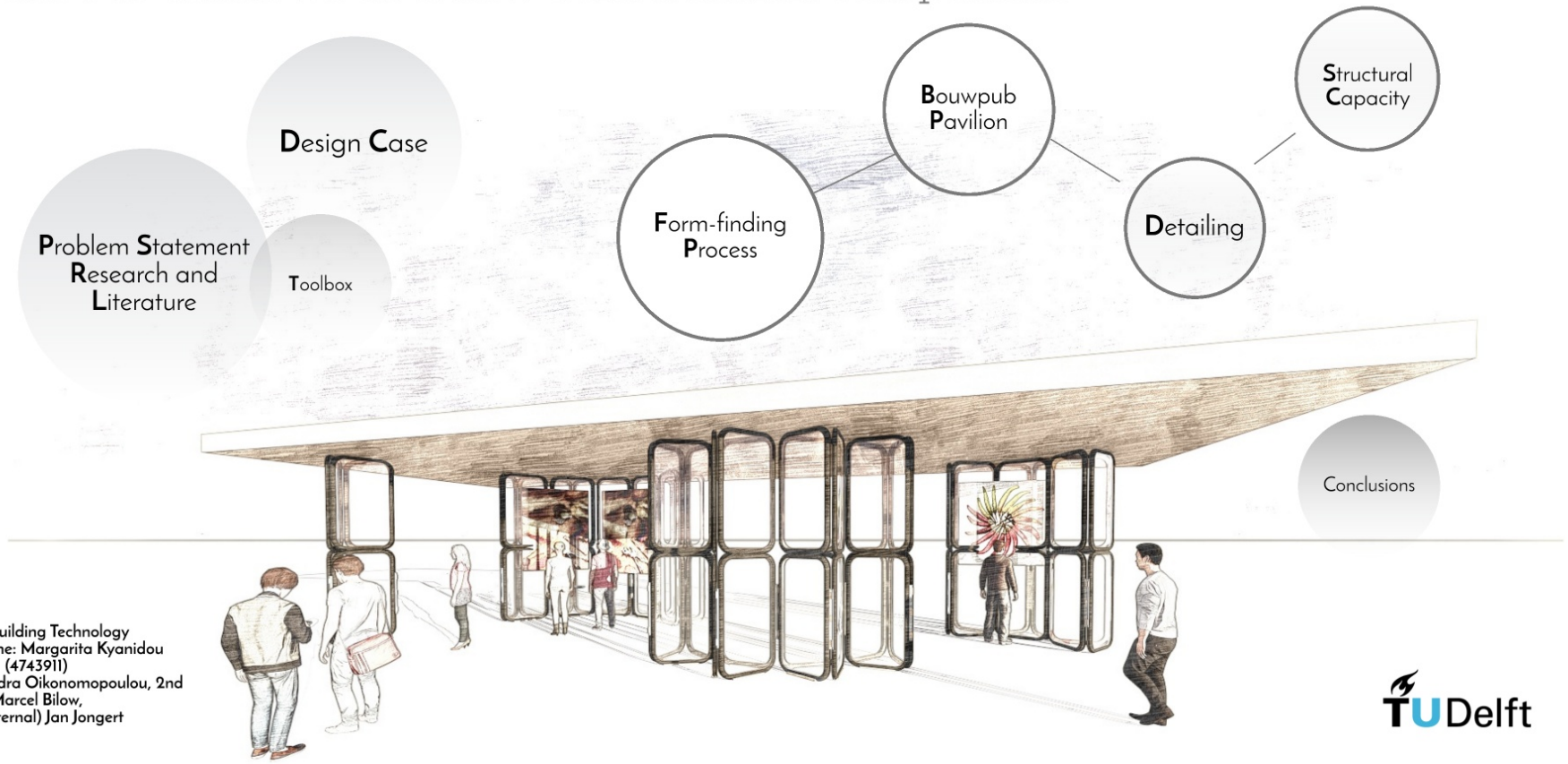
DETAIL 3



DETAIL 4

Upcycle in Architecture

Re-use NS windows as a new construction component



Track: Building Technology
Student name: Margarita Kyanidou
(4743911)
Mentors: 1st Faidra Oikonomopoulou, 2nd
Marcel Bilow,
3rd (external) Jan Jongert

TU Delft

IS IT LOAD BEARING?

As the designed module is column,its role is to bare loads.

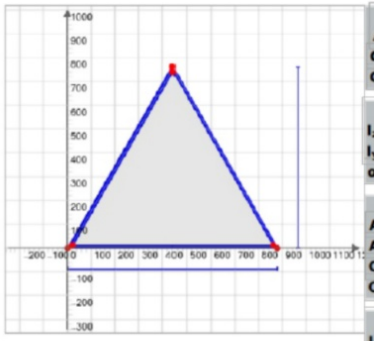
- *But could a triangle column of reuse train windows bare loads?*

- *Could it bare 2 Tones? Could series of columns bare a CLT slab without extra support?*

FEM
Analysis

Data

The tonne (metric ton, abbreviation: t) is the unit of mass in the metric system. 1 tonne-force (tf) = 9.80665 kilonewtons (kN) = 1000 kilogram-forces (kg). Choosing to load the column with 2 tones, which equals 19,92KN is enough to test its structural abilities to the extreme.
To begin with, assuming that the triangle module is completely made of glass its load bearing capacity would be tested.
A pin connection has been chosen in the base of the column.



Geometric Properties		
A	28411.22068	mm^2
C_z	440	mm
C_y	254.03315	mm

Bending Properties		
I_z	1755787069.93272	mm^4
I_y	1755797922.74803	mm^4
α	0	°

Shear Properties		
A_{sz}	11080.20623	mm^2
A_{sy}	11080.11981	mm^2
Q_z	3138794.79983	mm^3
Q_y	3058069.98934	mm^3

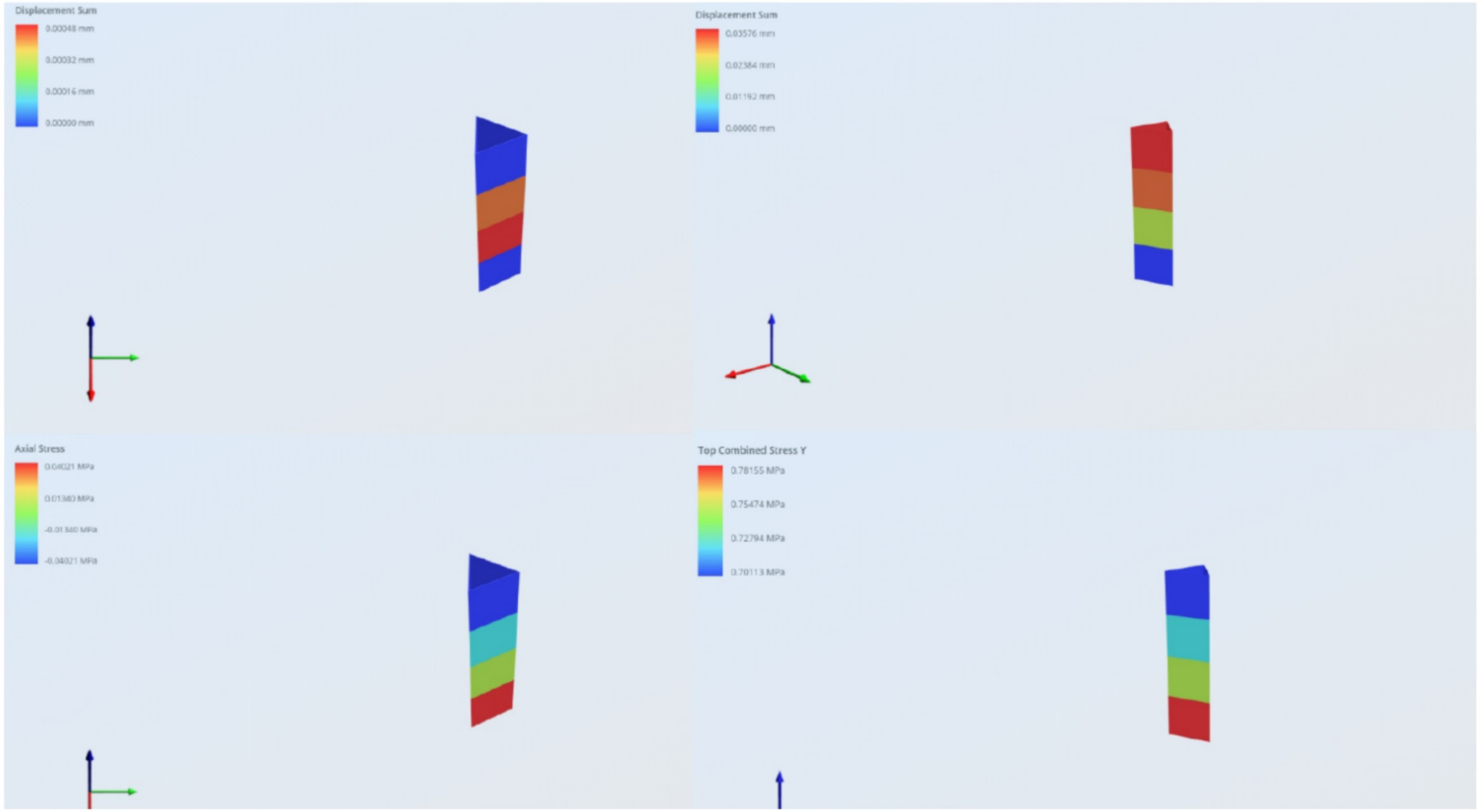
Torsion Properties		
J	1771450000	mm^4
r	292.832	mm

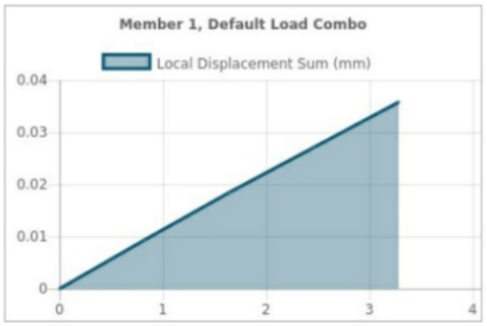
MATERIALS (MPa, kg/m³)

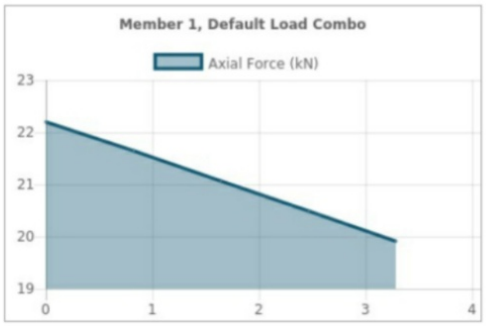
Material	Name	Young's Modulus	Density	Poisson's Ratio
2	Glass	68000.00000	2500.00000	0.24000

Section	Name	Shape	Depth	Width	Shear Area z (STRESS)	Shear Area y (STRESS)	Shear Area z (TIMO)	Shear Area y (TIMO)	Torsion Radius
		-	-	-	-	-	0.00000	0.00000	-
2	equilateral	Hollow Triangular	762.10000	880.00000	11080.20623	11080.11981	-	-	292.83200

Section	Centroid y	Centroid z	Area	y-Axis MoI	z-Axis MoI	Torsion Constant	Principal Angle
2	254.03315	440.00000	28411.22068	1755797922.74803	1755787069.93272	1771450000.00000	0.00000


Displacement Sum
0.00048 mm
0.00032 mm
0.00016 mm
0.00000 mm
Displacement Sum
0.03576 mm
0.02384 mm
0.01192 mm
0.00000 mm
Axial Stress
0.04021 MPa
0.01340 MPa
-0.01340 MPa
-0.04021 MPa
Top Combined Stress Y
0.78155 MPa
0.75474 MPa
0.72794 MPa
0.70113 MPa





MEMBER STRESSES (m, MPa)

Red Cells = Maximum value of a result in the member/plate.
Green Cells = Minimum value of a result in the member/plate.

Member	Station Location	Axial Torsion	Shear Y Shear Z	Top Mom Z Btm Mom Z	Top Mom Y Btm Mom Y	Ax + Top Mom Z Ax + Btm Mom Z	Ax + Top Mom Y Ax + Btm Mom Y
1	0.00000	0.78155	0.00000	0.00000	0.00000	0.78155	0.78155
		0.00000	0.00000	0.00000	0.00000	0.78155	0.78155
1	0.82000	0.76144	0.00000	0.00000	0.00000	0.76144	0.76144
		0.00000	0.00000	0.00000	0.00000	0.76144	0.76144
1	1.64000	0.74134	0.00000	0.00000	0.00000	0.74134	0.74134
		0.00000	0.00000	0.00000	0.00000	0.74134	0.74134
1	2.46000	0.72124	0.00000	0.00000	0.00000	0.72124	0.72124
		0.00000	0.00000	0.00000	0.00000	0.72124	0.72124
1	3.28000	0.70113	0.00000	0.00000	0.00000	0.70113	0.70113
		0.00000	0.00000	0.00000	0.00000	0.70113	0.70113

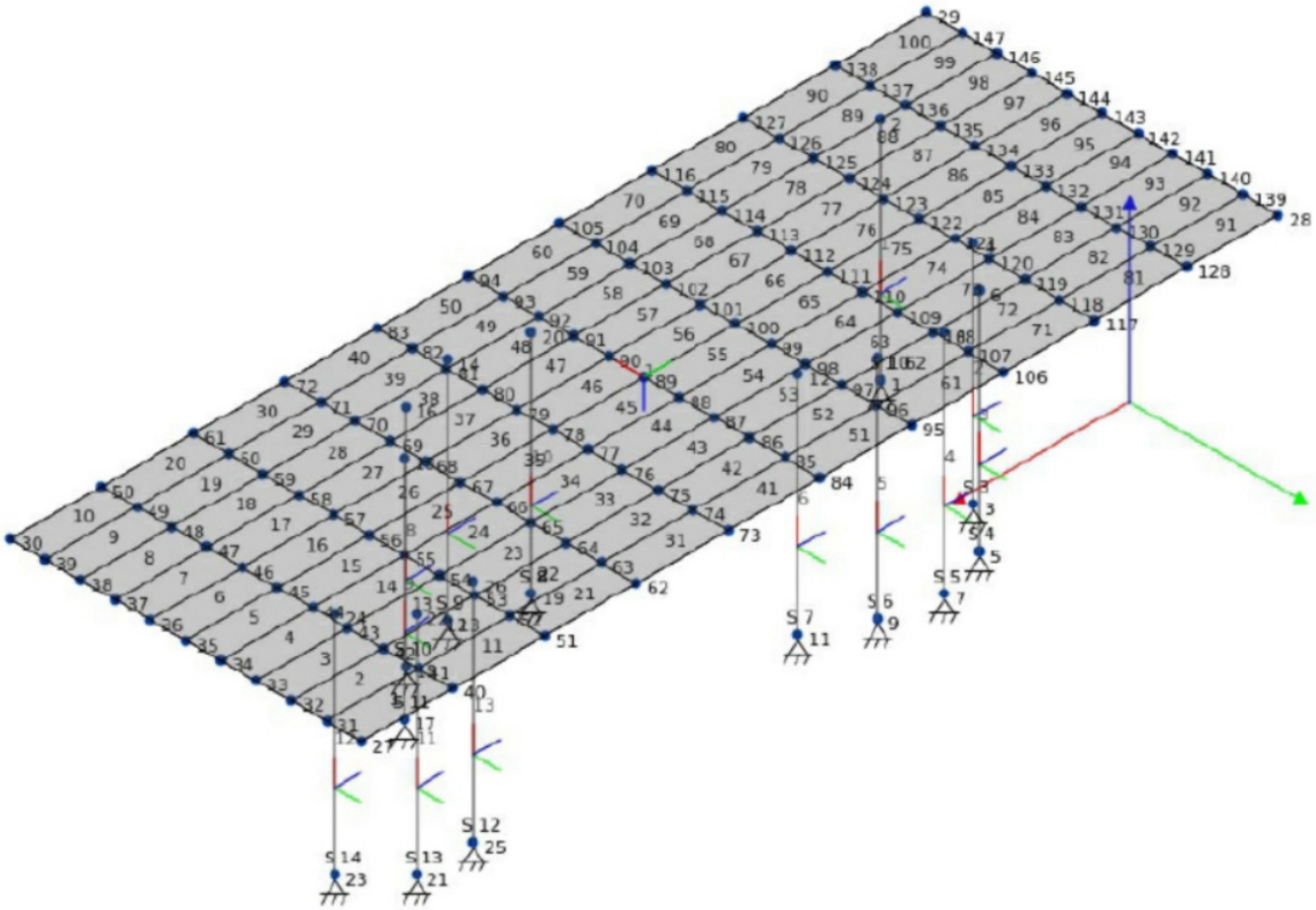
Load Group: 1

INTERNAL MEMBER FORCES AND MOMENTS (m, kN, kN-m)

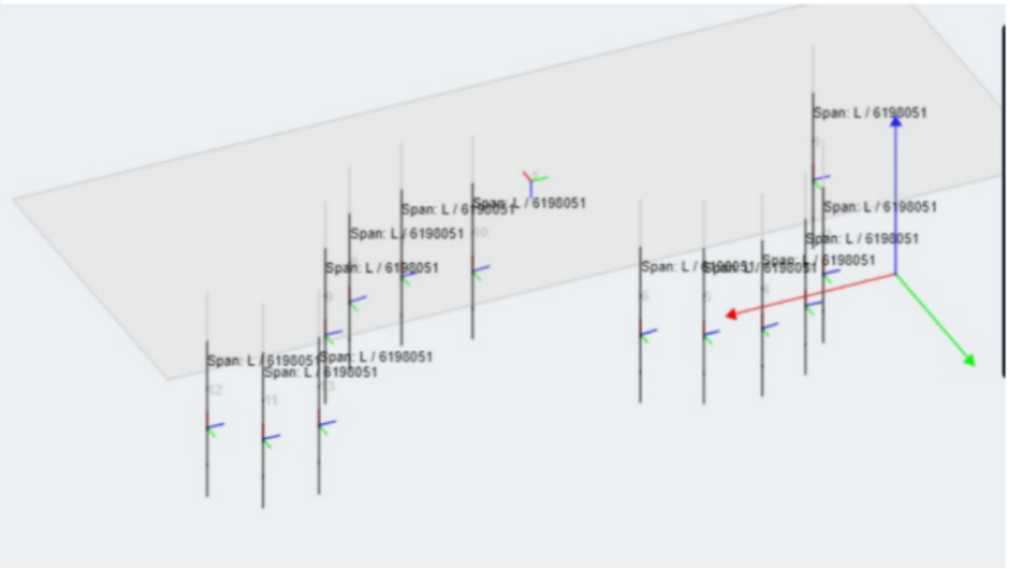
Red Cells = Maximum value of a result in the member/plate.
Green Cells = Minimum value of a result in the member/plate.

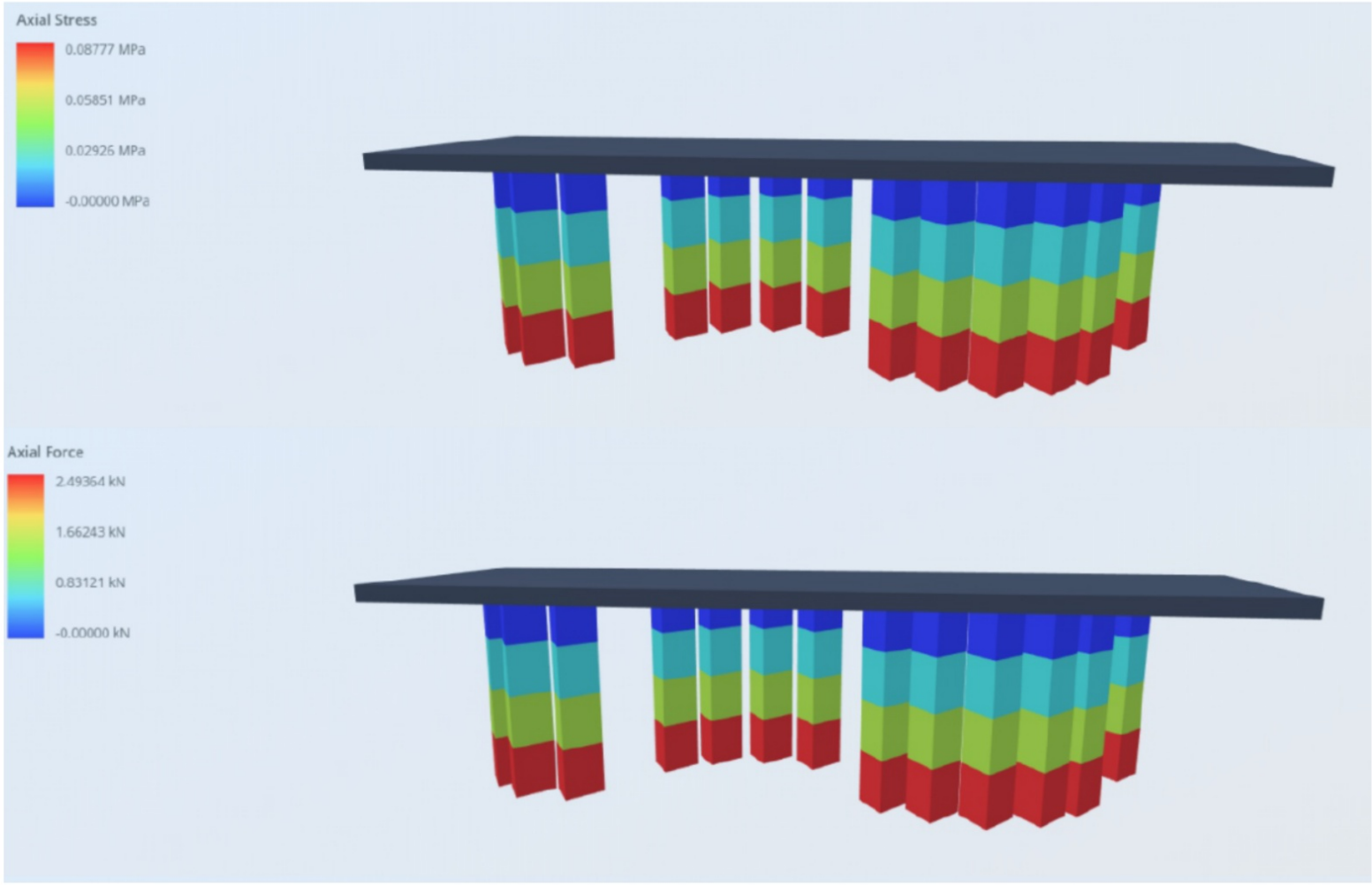
Member	Station Location	Axial Force	Y Shear	Z Shear	X Torsion	Y Moment	Z Moment
1	0.00000	19.92000	0.00000	0.00000	0.00000	0.00000	0.00000
1	0.82000	19.92000	0.00000	0.00000	0.00000	0.00000	0.00000
1	1.64000	19.92000	0.00000	0.00000	0.00000	0.00000	0.00000
1	2.46000	19.92000	0.00000	0.00000	0.00000	0.00000	0.00000
1	3.28000	19.92000	0.00000	0.00000	0.00000	0.00000	0.00000

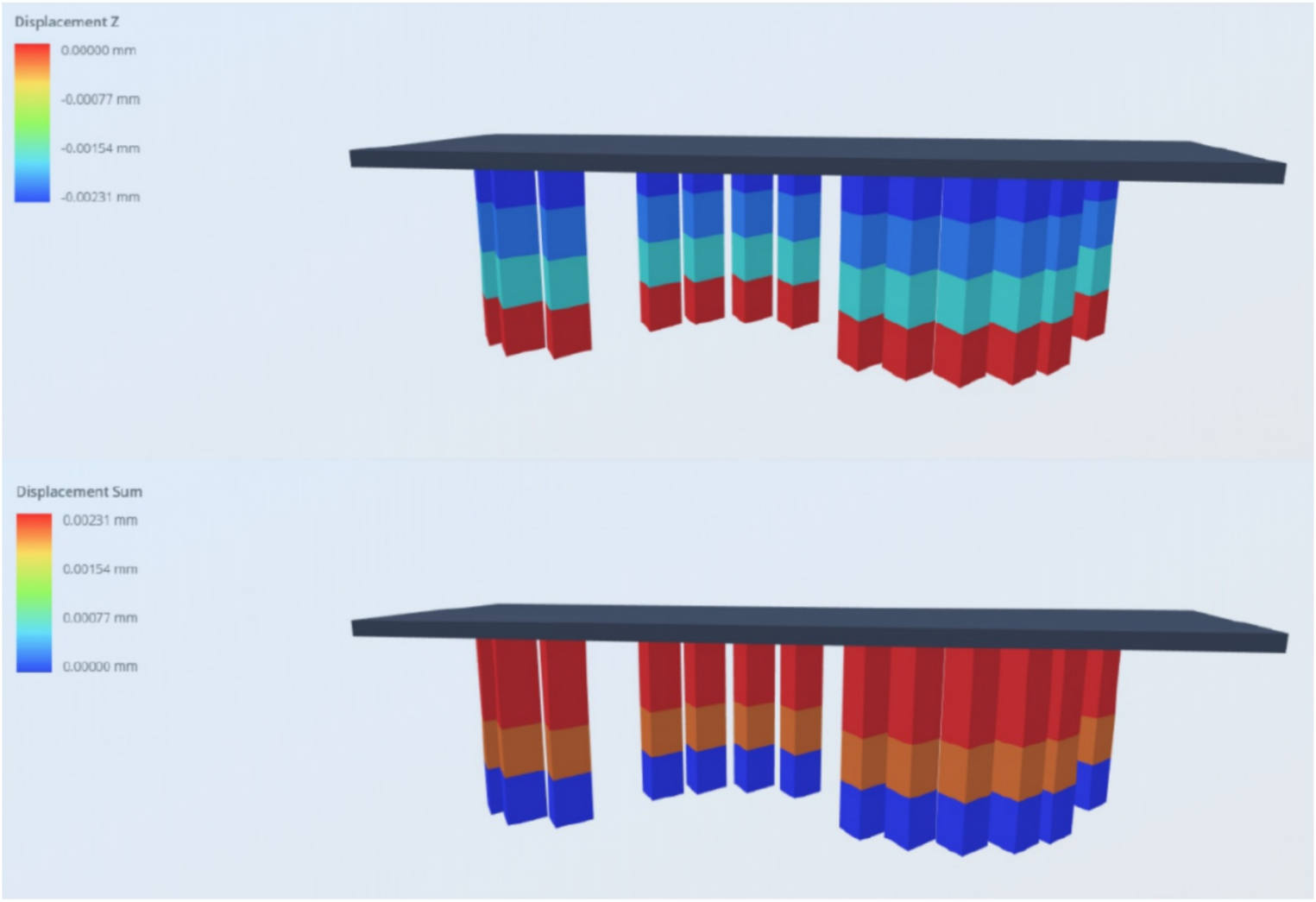
With a combined stress of 0.078Mpa and a tensile strength of tempered glass the σ=80Mpa it is clear that the column can easily bear 2 tones of weight.

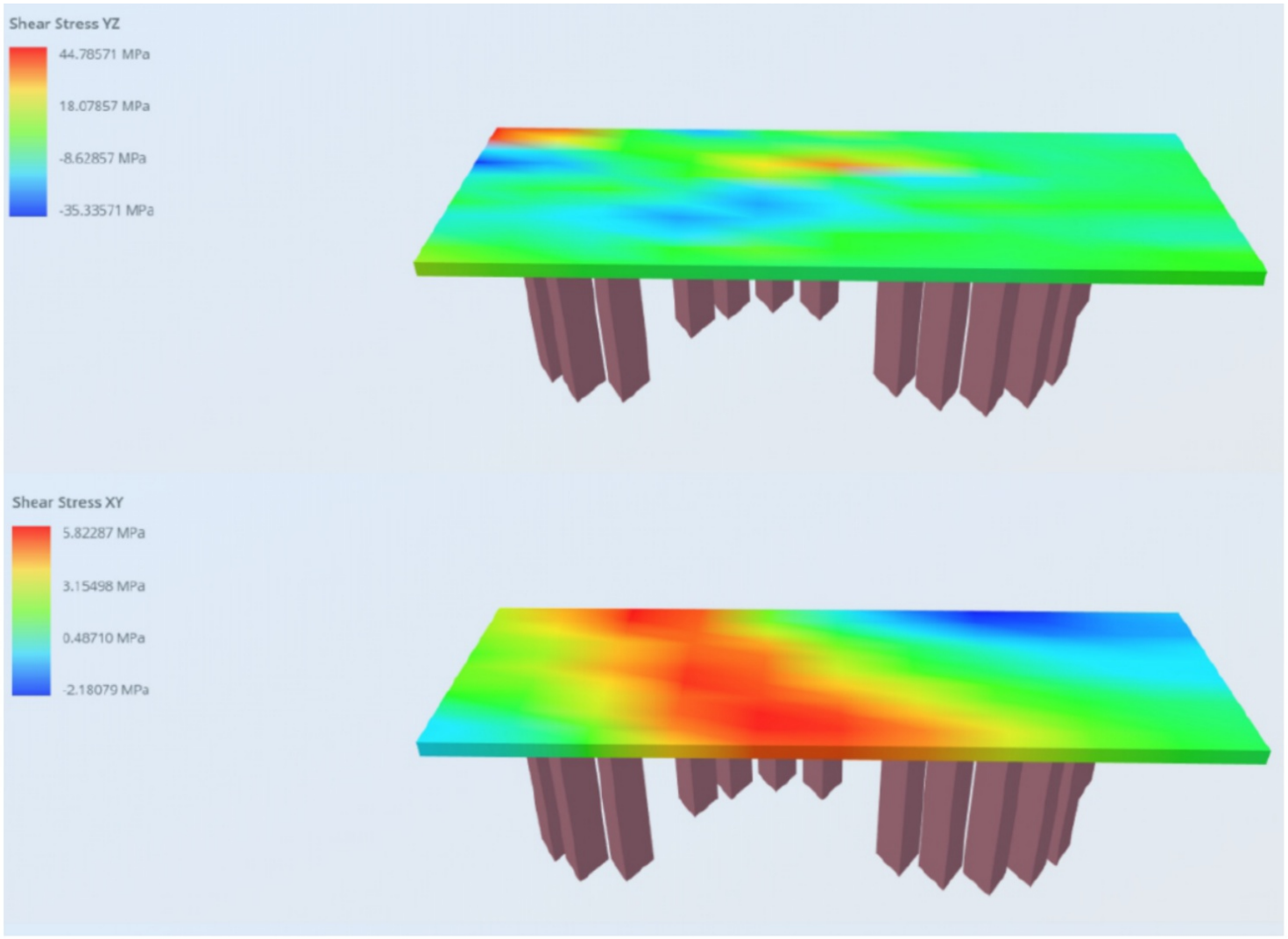


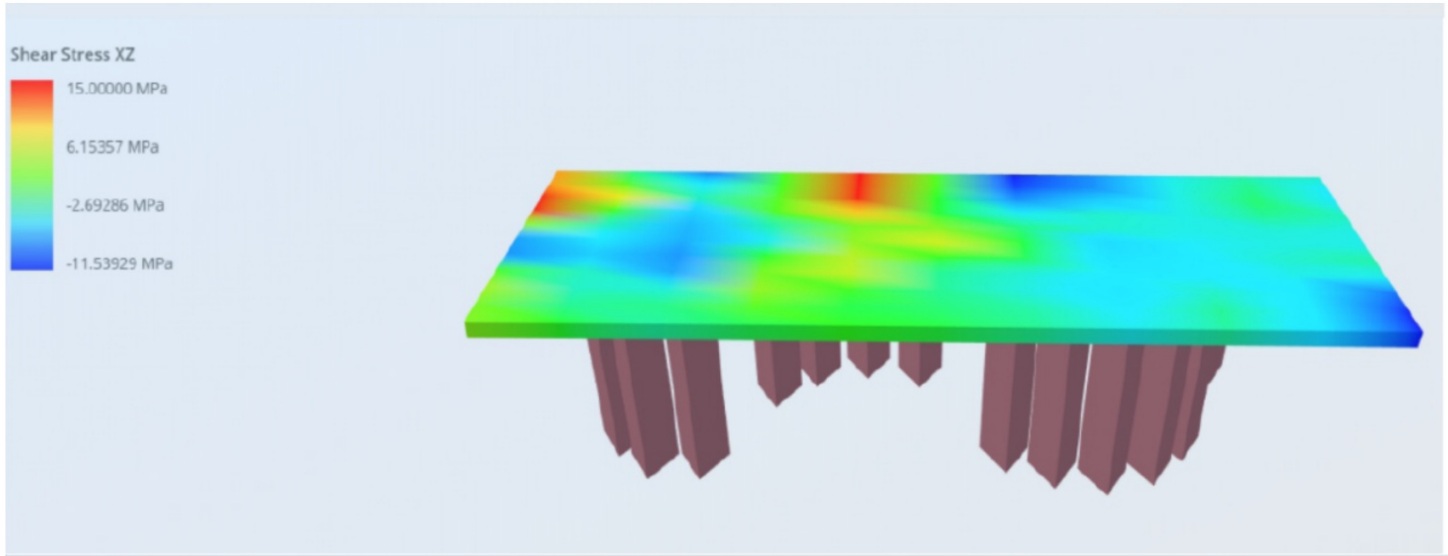

Single Member Analysis
Displacement Sum
for member ID:
1
Member 1, SW1
Local Displacement Sum (mm)
0.003
0.002
0.001
0
0
1
2
3
4
Max Result: 0.00231 mm
Min Result: 0 mm

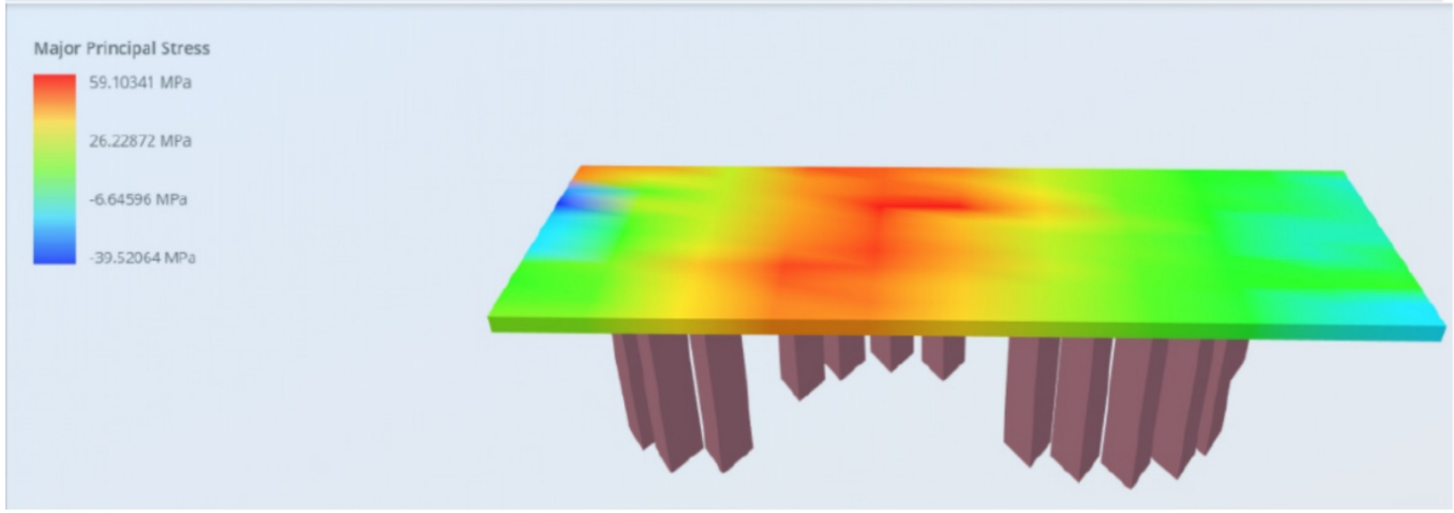

Span: L / 6198051
Span: L / 6198051
Span: L / 6198051
Span: L / 6198051
Span: L / 6198051
Span: L / 6198051
Span: L / 6198051
Span: L / 6198051
Span: L / 6198051
Span: L / 6198051


Axial Stress
0.08777 MPa
0.05851 MPa
0.02926 MPa
-0.00000 MPa
Axial Force
2.49364 kN
1.66243 kN
0.83121 kN
-0.00000 kN

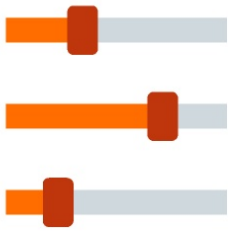

Displacement Z
0.00000 mm
-0.00077 mm
-0.00154 mm
-0.00231 mm
Displacement Sum
0.00231 mm
0.00154 mm
0.00077 mm
0.00000 mm

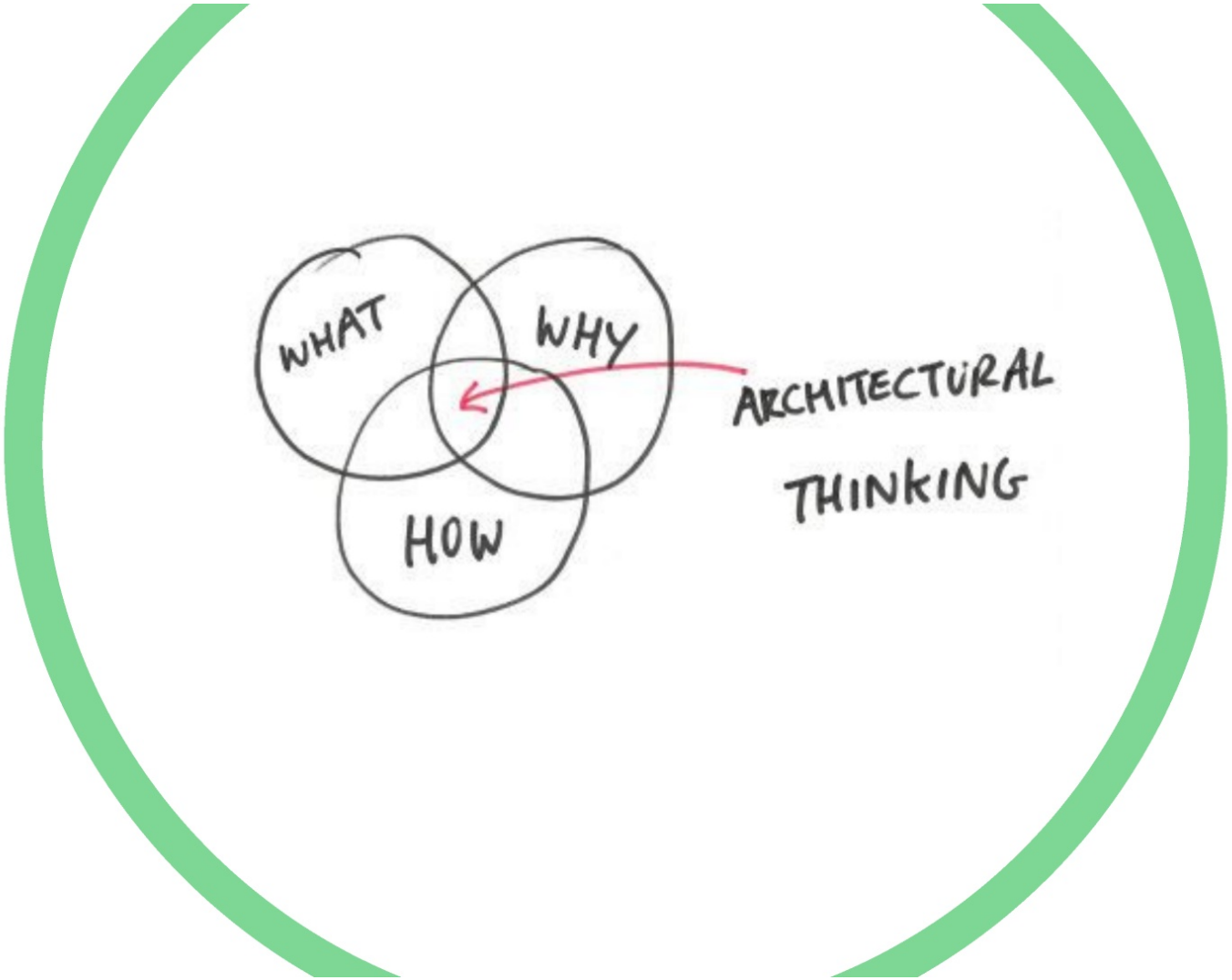

Shear Stress YZ
44.78571 MPa
18.07857 MPa
-8.62857 MPa
-35.33571 MPa
Shear Stress XY
5.82287 MPa
3.15498 MPa
0.48710 MPa
-2.18079 MPa


Shear Stress XZ
15.00000 MPa
6.15357 MPa
-2.69286 MPa
-11.53929 MPa

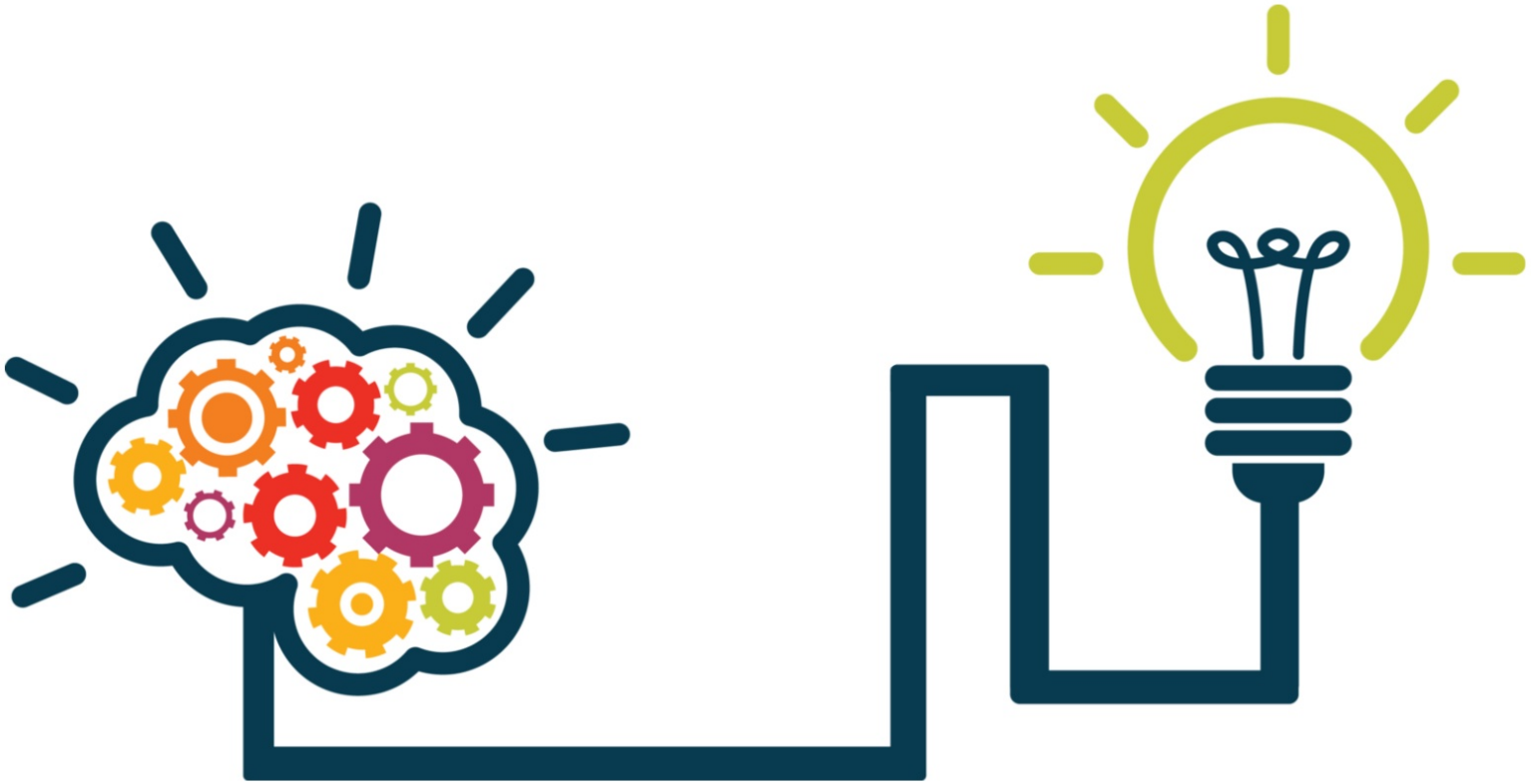

Major Principal Stress
59.10341 MPa
26.22872 MPa
-6.64596 MPa
-39.52064 MPa

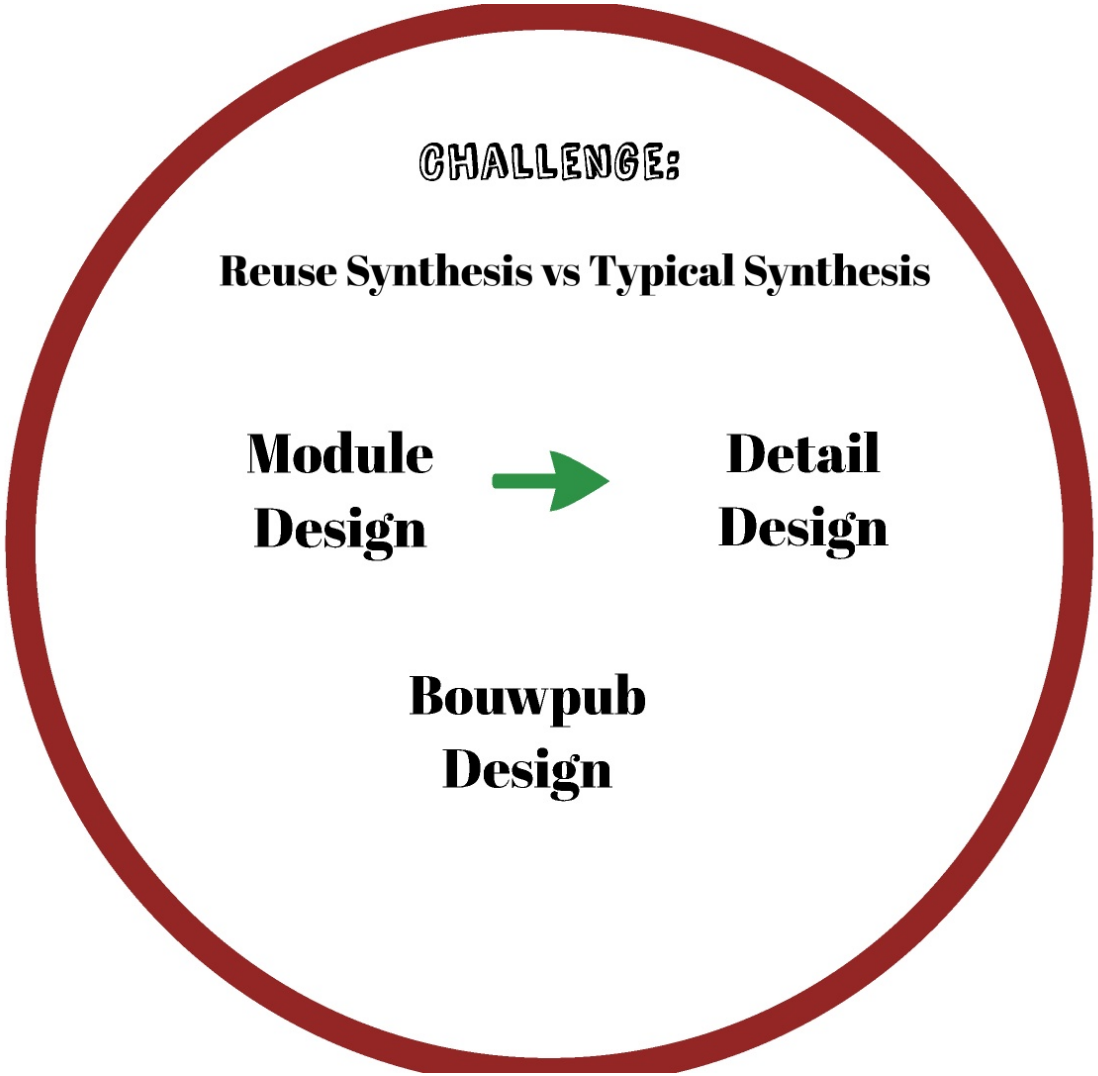
Looking closely to the results for the whole design analysis, we assume that the columns again are staying intact with an axial stress =0,0887 Mpa and a close to zero displacement.




WHAT
WHY
HOW
ARCHITECTURAL
THINKING

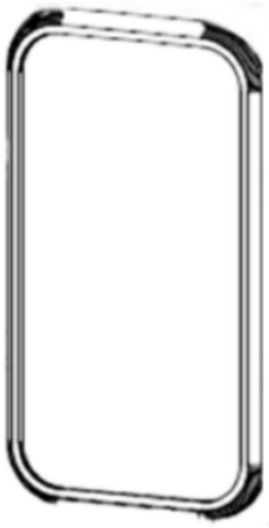
The architectural thinking is based on the problem solving method.




CHALLENGE:
Reuse Synthesis vs Typical Synthesis
Module Design
Detail Design
Bouwpub Design

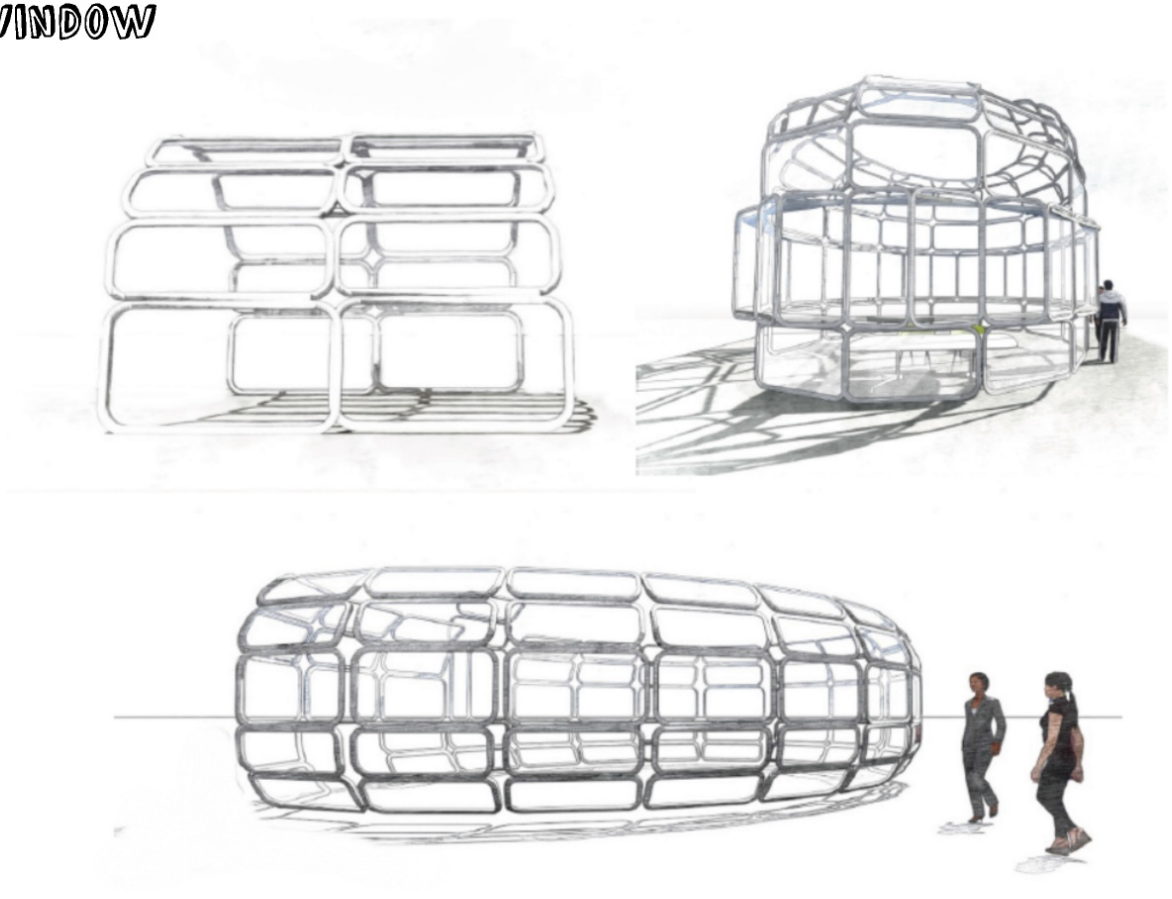
Starting from the module:

One window module



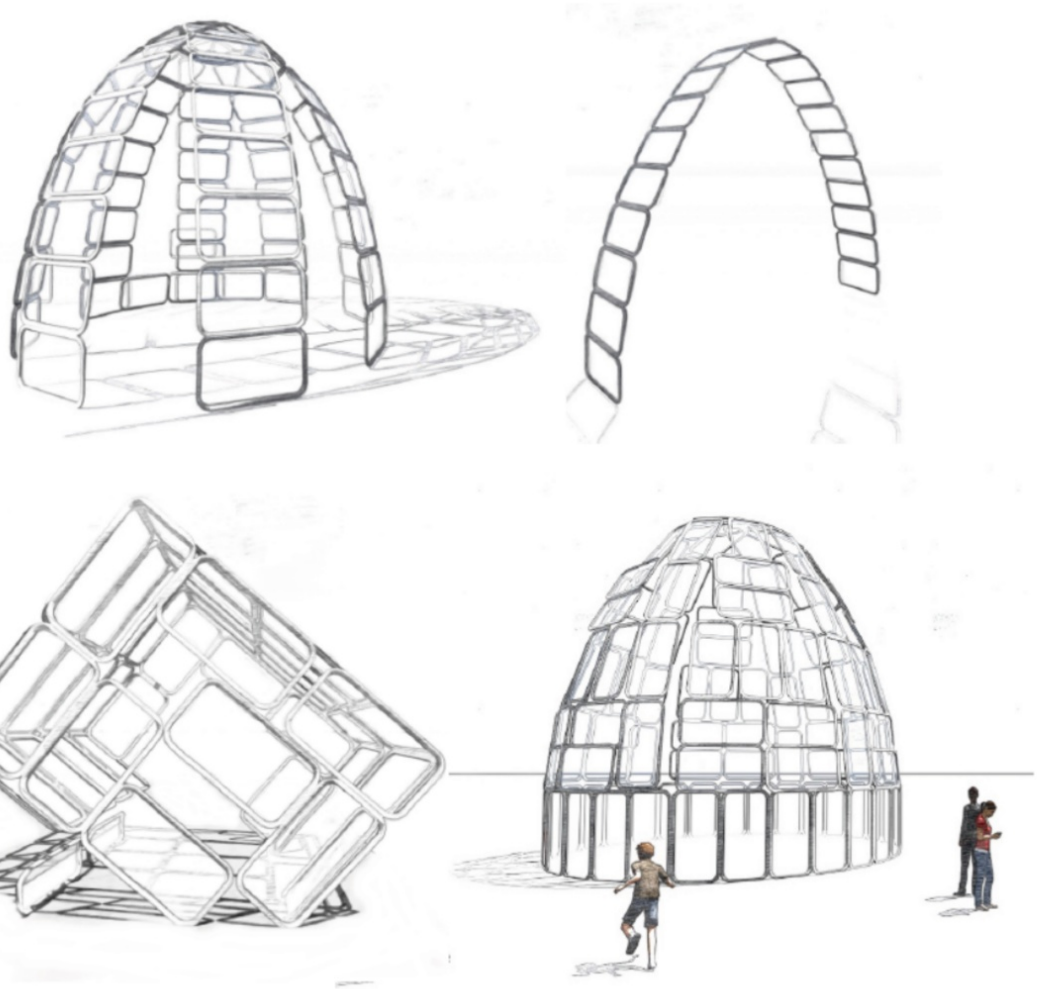
CURVED AND STRAIGHT WINDOW COMBINATION

Time	✗
Effort	✗
Stability	✗
Cost	✗
Energy	✗
Aesthetics	✓
Easy to tranport	✓



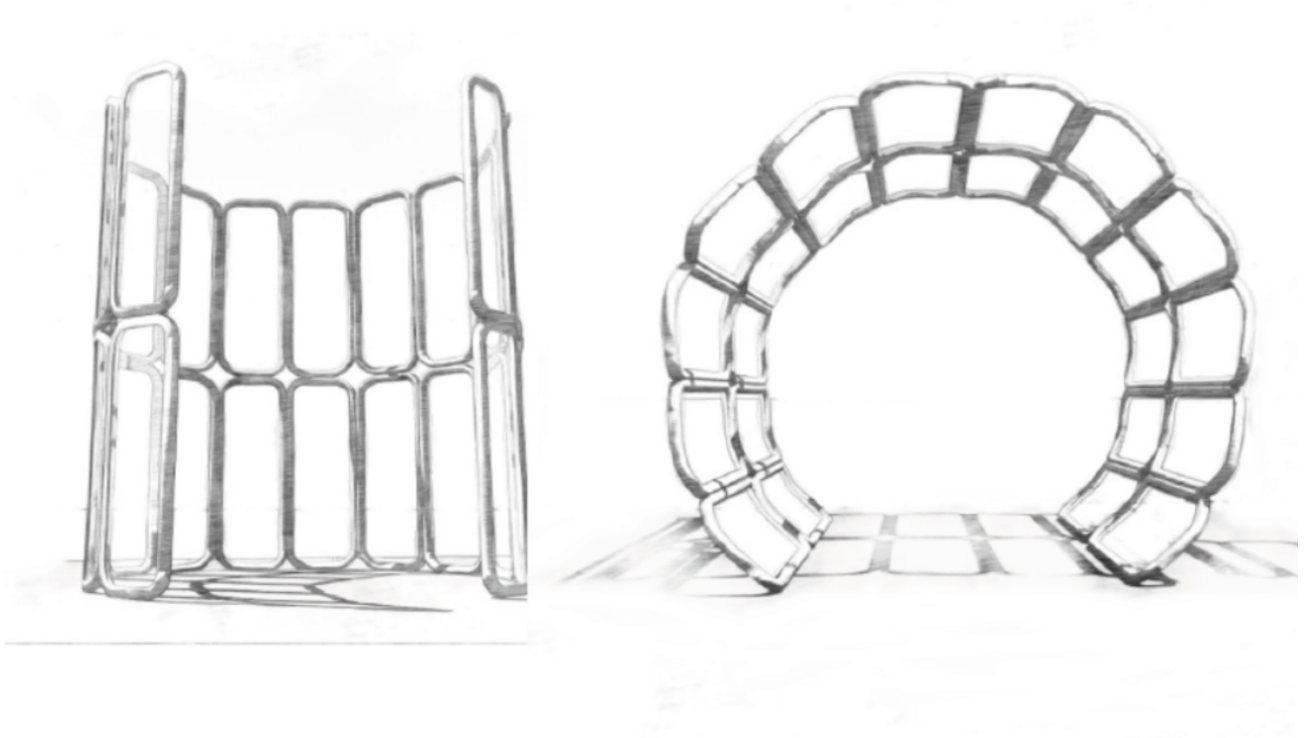
ONLY STRAIGHT WINDOWS

Time	✗
Effort	✗
Stability	✗
Cost	✗
Energy	✗
Aesthetics	✓
Easy to tranport	✓



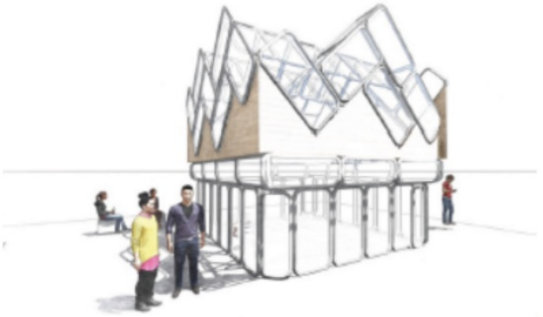
ONLY CURVED WINDOWS

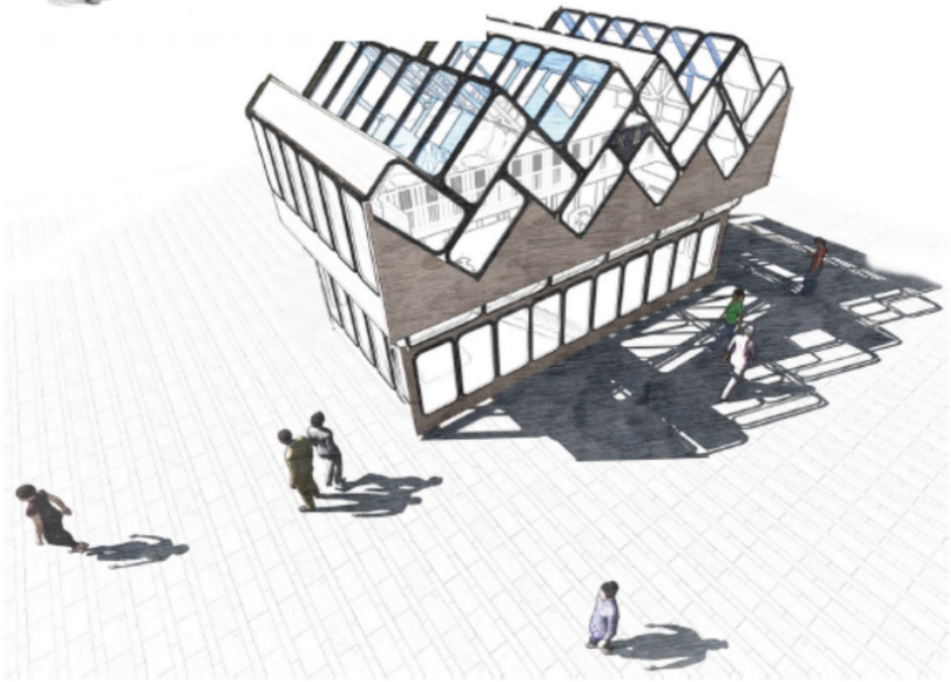
Time	✗
Effort	✓
Stability	✓
Cost	✗
Energy	✓
Aesthetics	✓
Easy to tranport	✓



WINDOWS AND OTHER NS MATERIALS

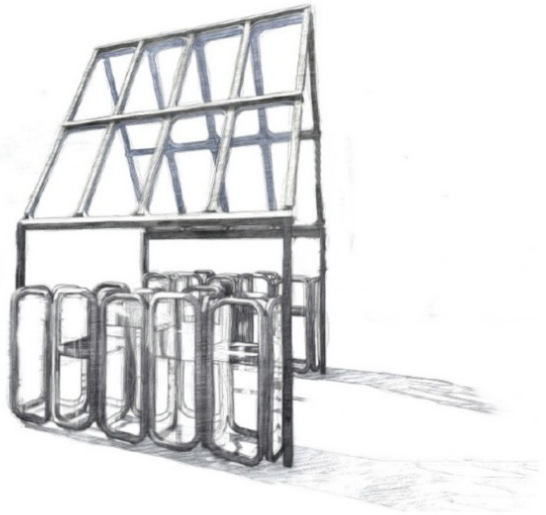
Time	✗
Effort	✓
Stability	✓
Cost	✗
Energy	✓
Aesthetics	✓
Easy to tranport	✓

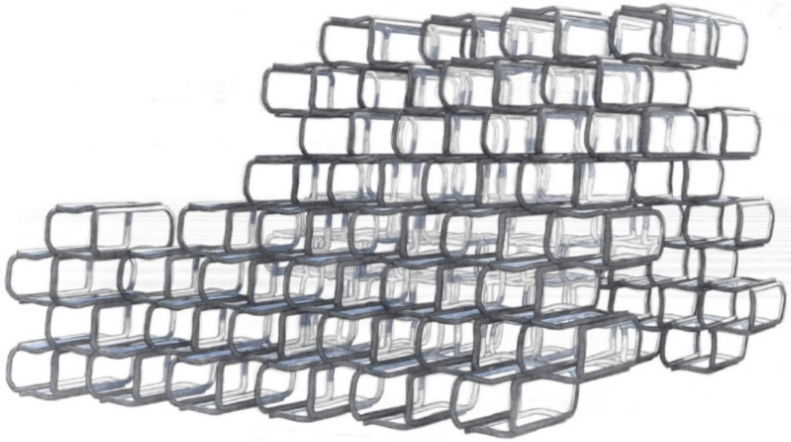


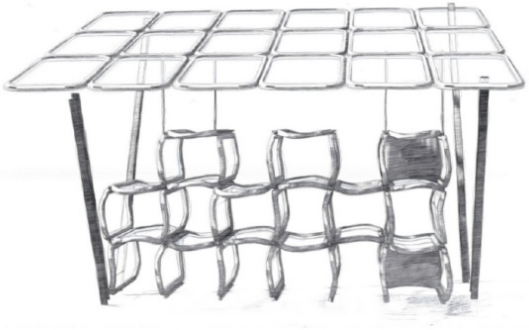


Three or more windows module

BRICK OR COLUMN?

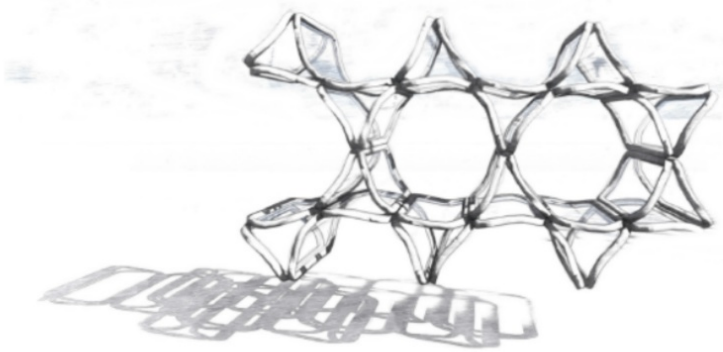






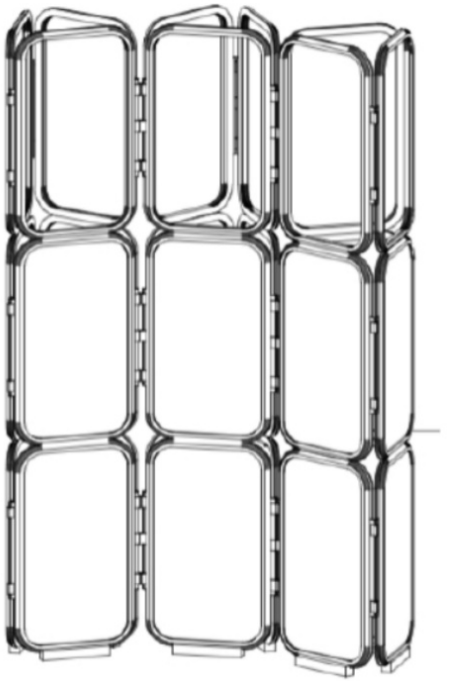
THREE OR FOUR WINDOWS?

CURVED OR STRAIGHT?



TRIANGULAR WINDOW COLUMN

Time	✓
Effort	✓
Stability	✓
Cost	✓
Energy	✓
Aesthetics	✓
Easy to tranport	✓



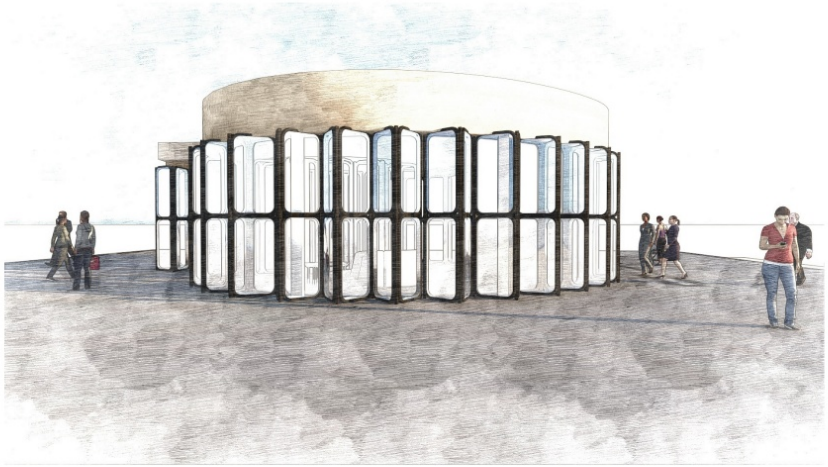
But is it multiadaptable?

Design experiments with the triangle window columns

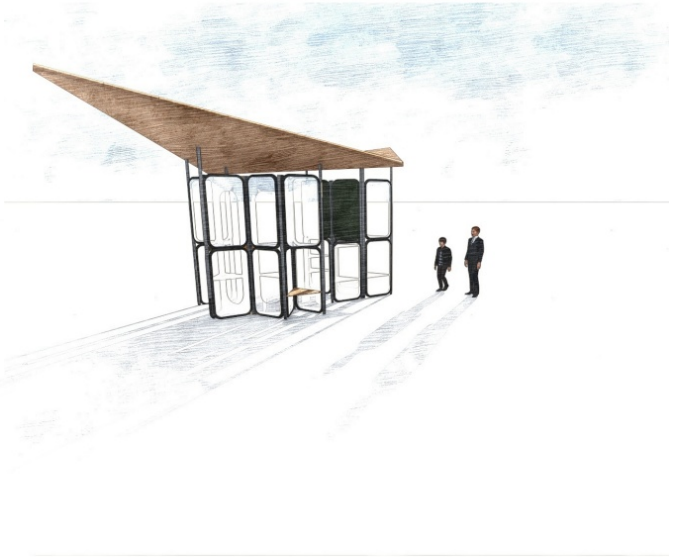
In the following pages several design experiments exist. Every one of them played its own role to the final design decision. All of them are designed in Superuse Studios during my internship.

SUPERUSE STUDIOS

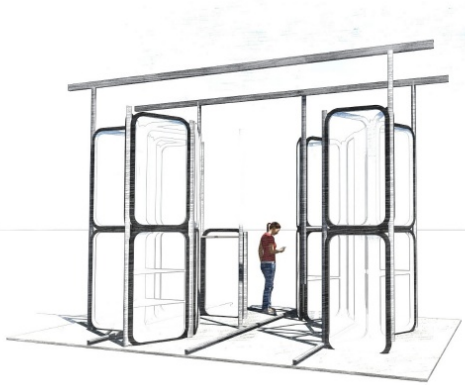
BUILDINGS



PAVILIONS

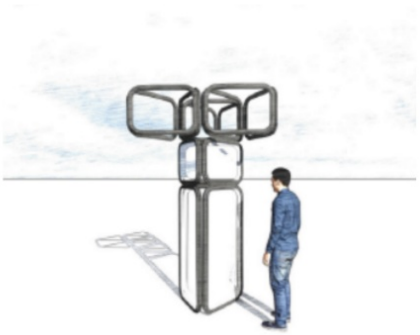


BUS STOPS



INSTALLATIONS

OR INFO KIOSKS

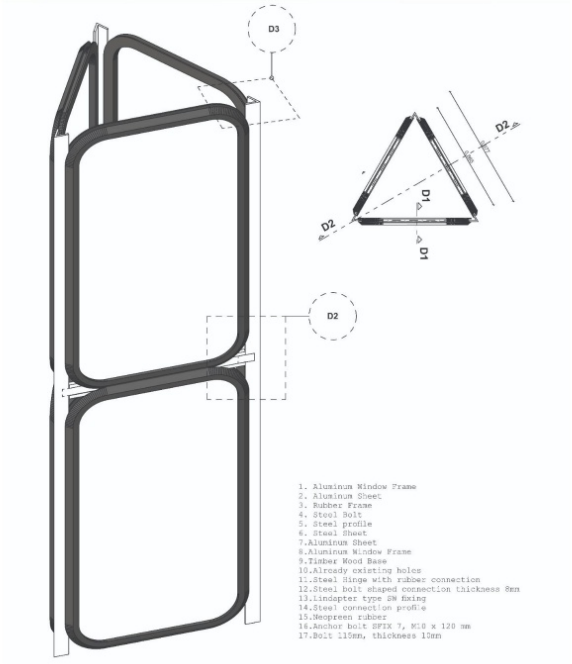


THE CONNECTION DESIGN:

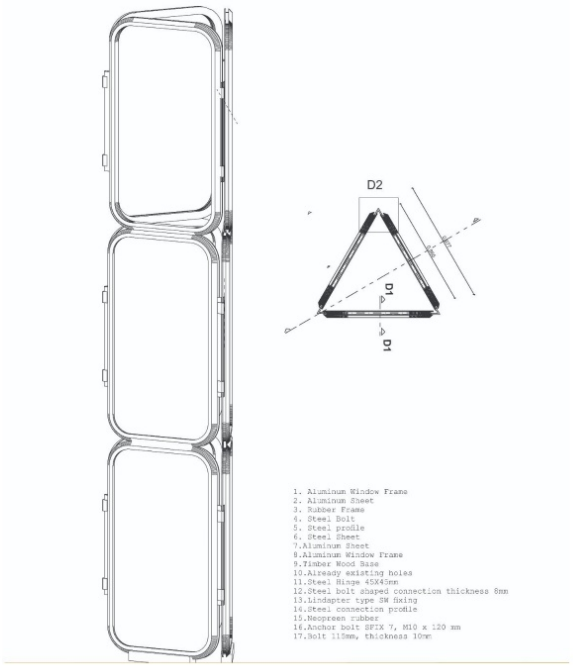
- **Design for disassembly**
- **As simple as possible**

Design for dis-assembly:

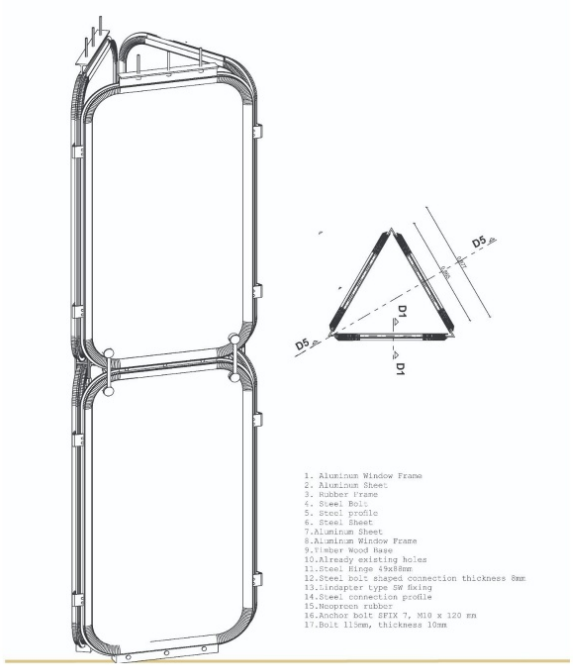
PHASE 1

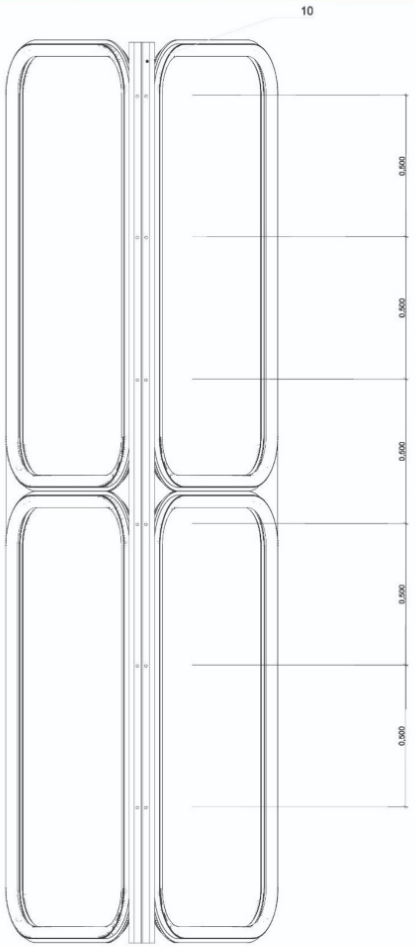


PHASE 2

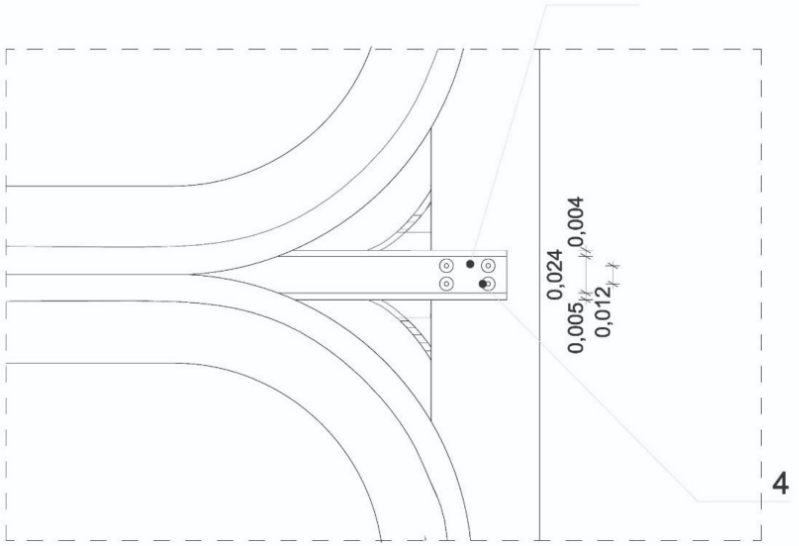


PHASE 3



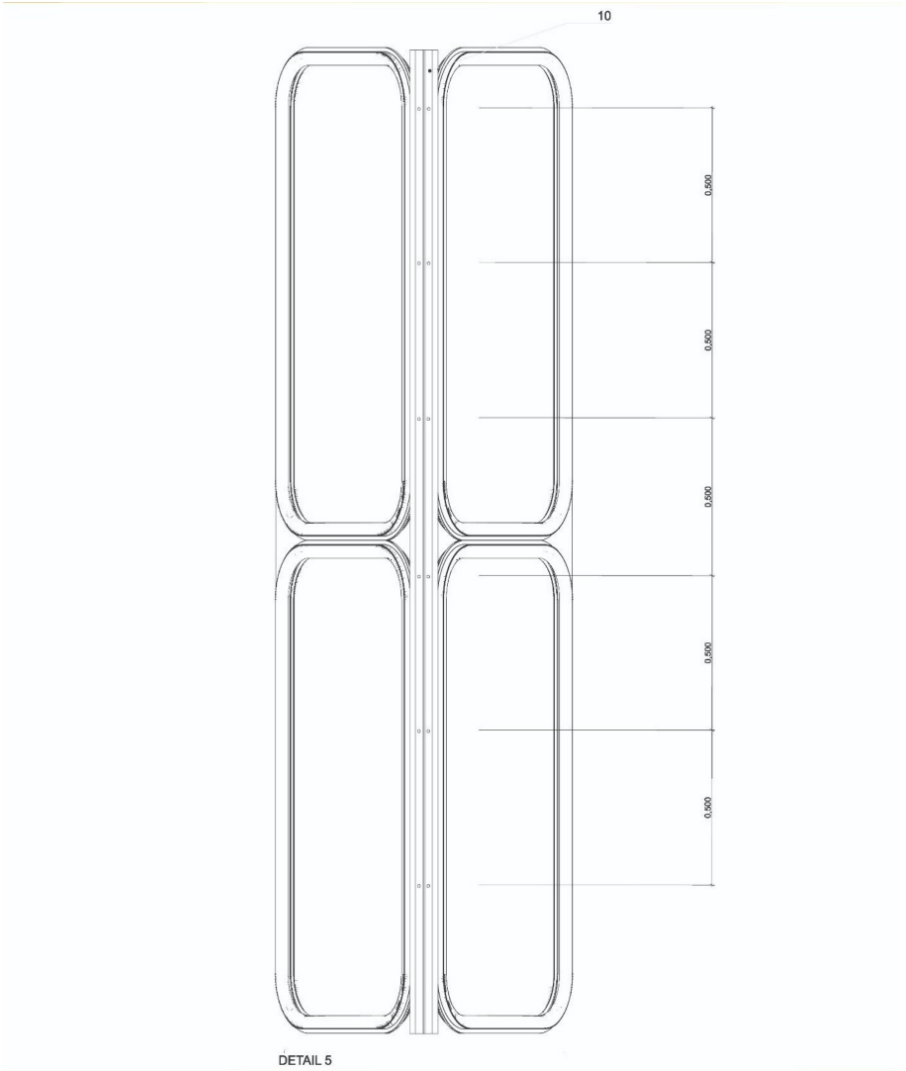


DETAIL 5

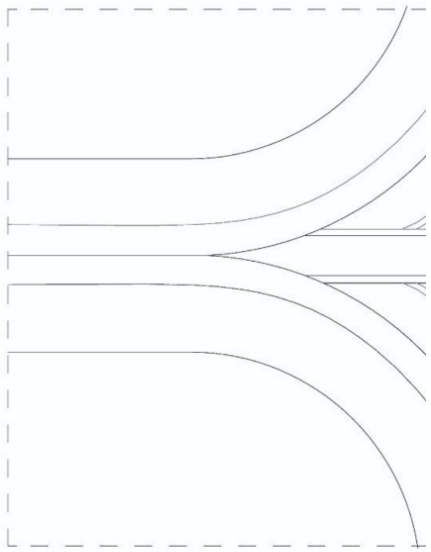


DETAIL 2

1. Aluminum Window Frame
2. Aluminum Sheet
3. Rubber Frame
4. Steel Bolt
5. Steel profile
6. Steel Sheet
7. Aluminum Sheet
8. Aluminum Window Frame
9. Timber Wood Base
10. Already existing holes
11. Steel Hinge with rubber connection
12. Steel bolt shaped connection thickness 8mm
13. Lindapter type SW fixing
14. Steel connection profile
15. Neopreen rubber
16. Anchor bolt SFIX 7, M10 x 120 mm
17. Bolt 115mm, thickness 10mm

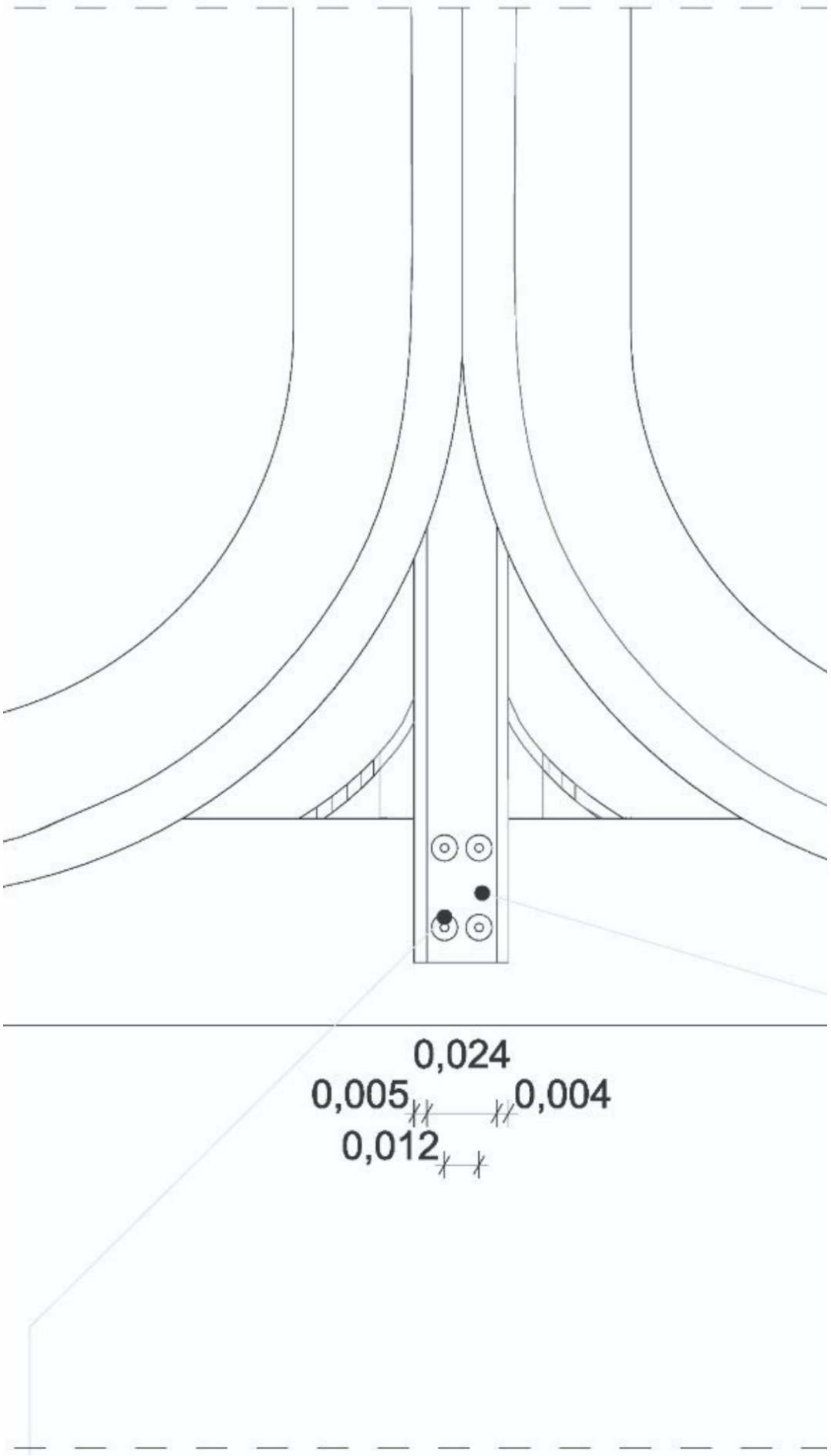


DETAIL 5



DETAIL 2

1. Aluminum Window Frame
2. Aluminum Sheet
3. Rubber Frame
4. Steel Bolt
5. Steel profile
6. Steel Sheet
7. Aluminum Sheet
8. Aluminum Window Frame
9. Timber Wood Base
10. Already existing holes
11. Steel Hinge with rubber connection
12. Steel bolt shaped connection thickness 8mm
13. Lindapter type SW fixing
14. Steel connection profile
15. Neopreen rubber
16. Anchor bolt SFIX 7, M10 x 120 mm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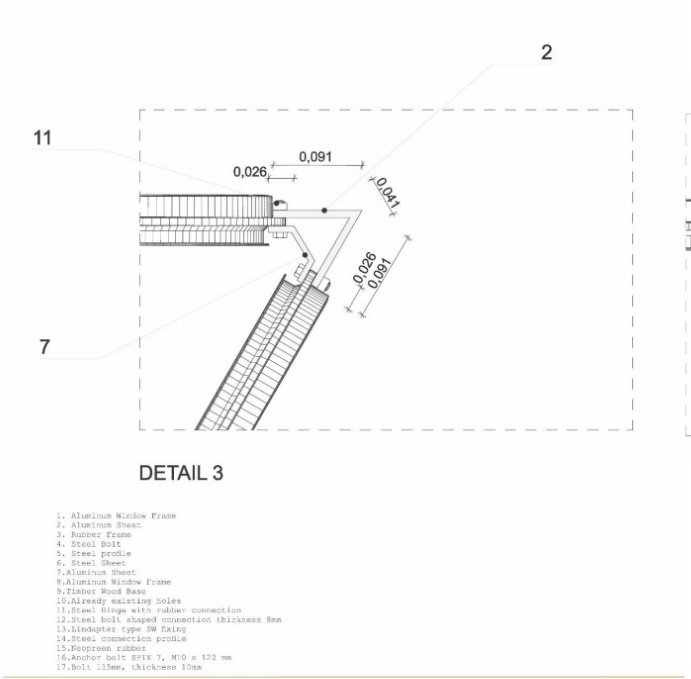
PHASE 1

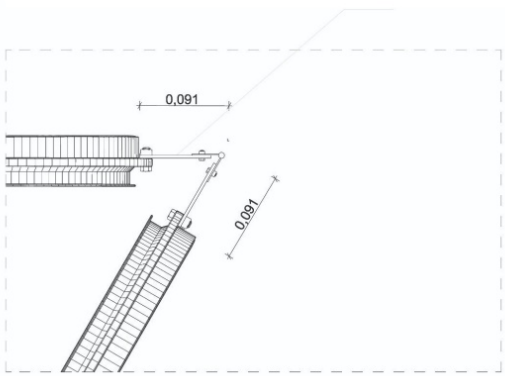
PHASE 2

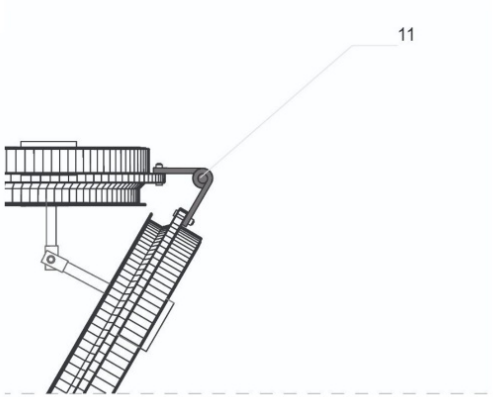
PHASE 3

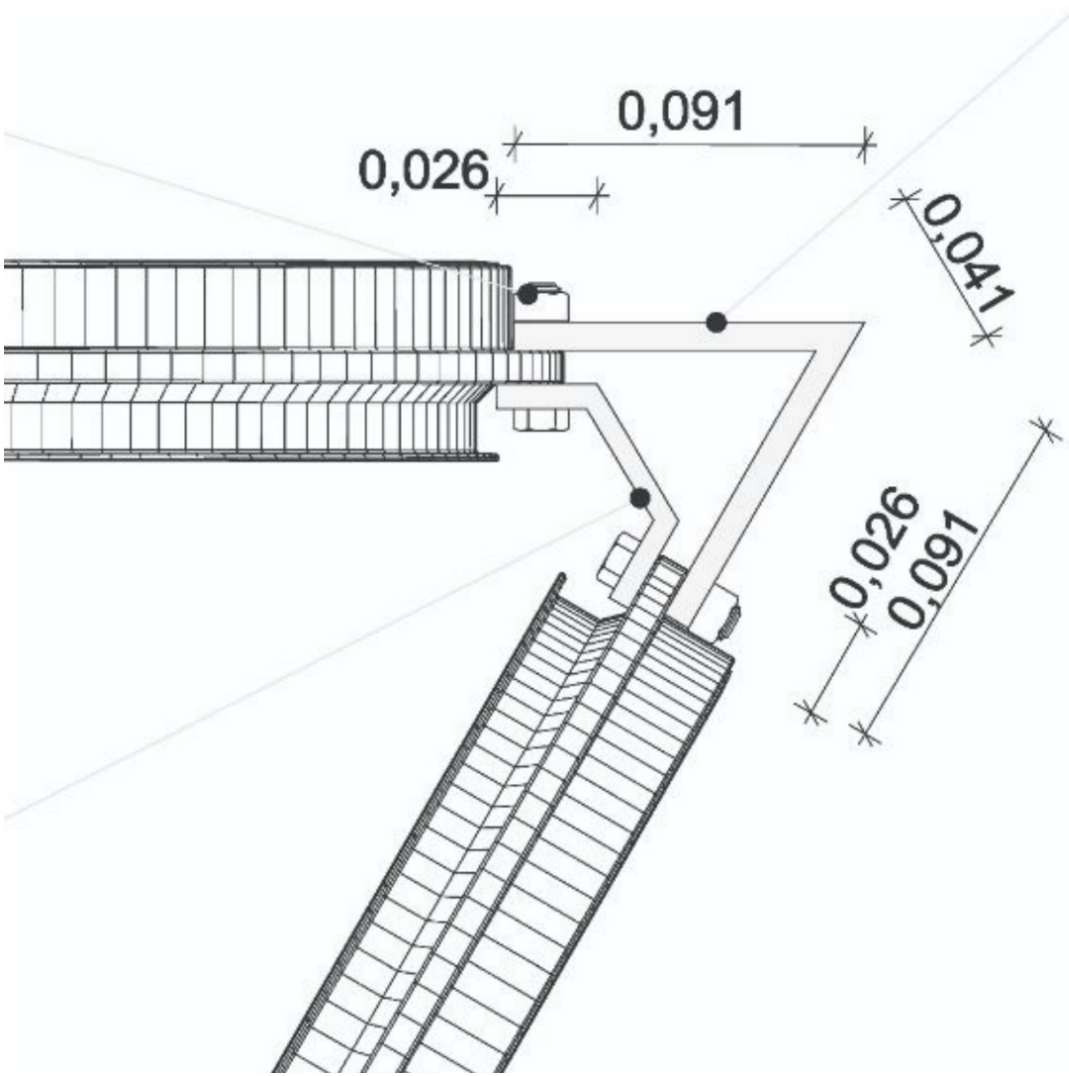


DETAIL 3

1. Aluminum Window Frame
2. Aluminum Sheet
3. Rubber Frame
4. Steel Bolt
5. Steel profile
6. Steel Sheet
7.Aluminum Sheet
8.Aluminum Window Frame
9.Timber Wood Base
10.Already existing holes
11.Steel Hinge with rubber connection
12.Steel bolt shaped connection thickness 8mm
13.Lindapter type SW fxing
14.Steel connection profile
15.Neopreen rubber
16.Anchor bolt SFIX 7, M10 x 120 mm
17.Bolt 115mm, thickness 10mm



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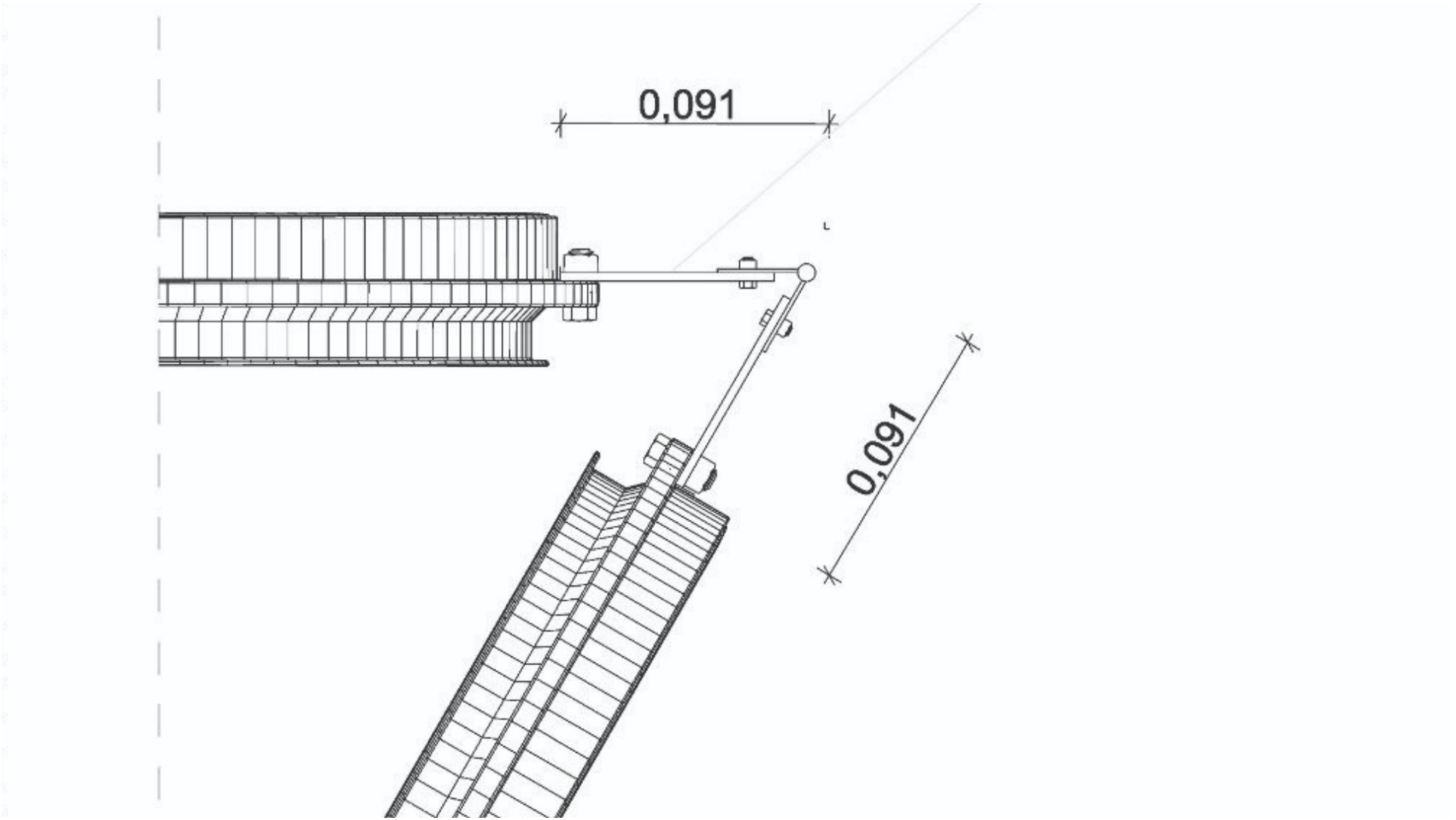
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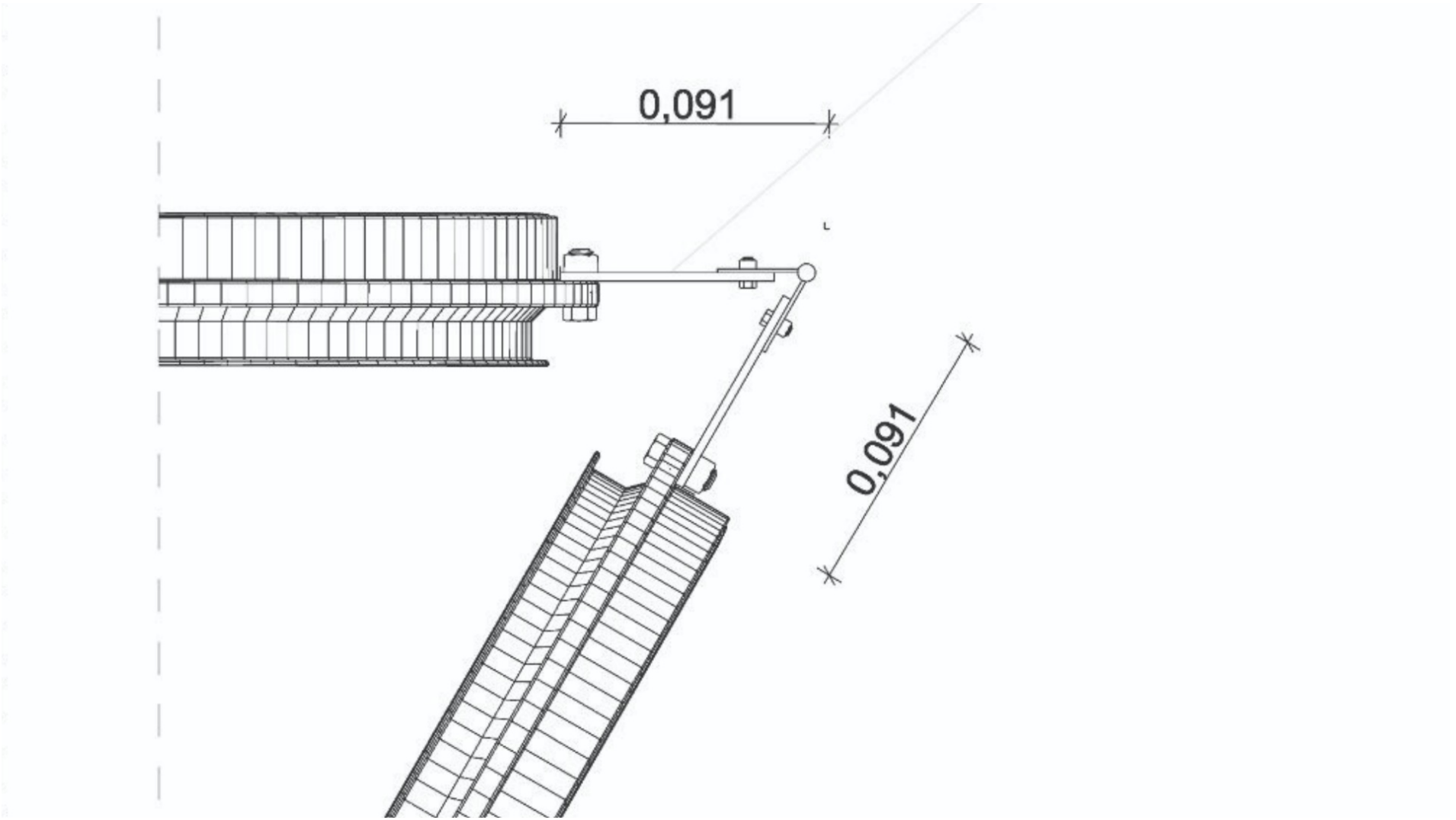
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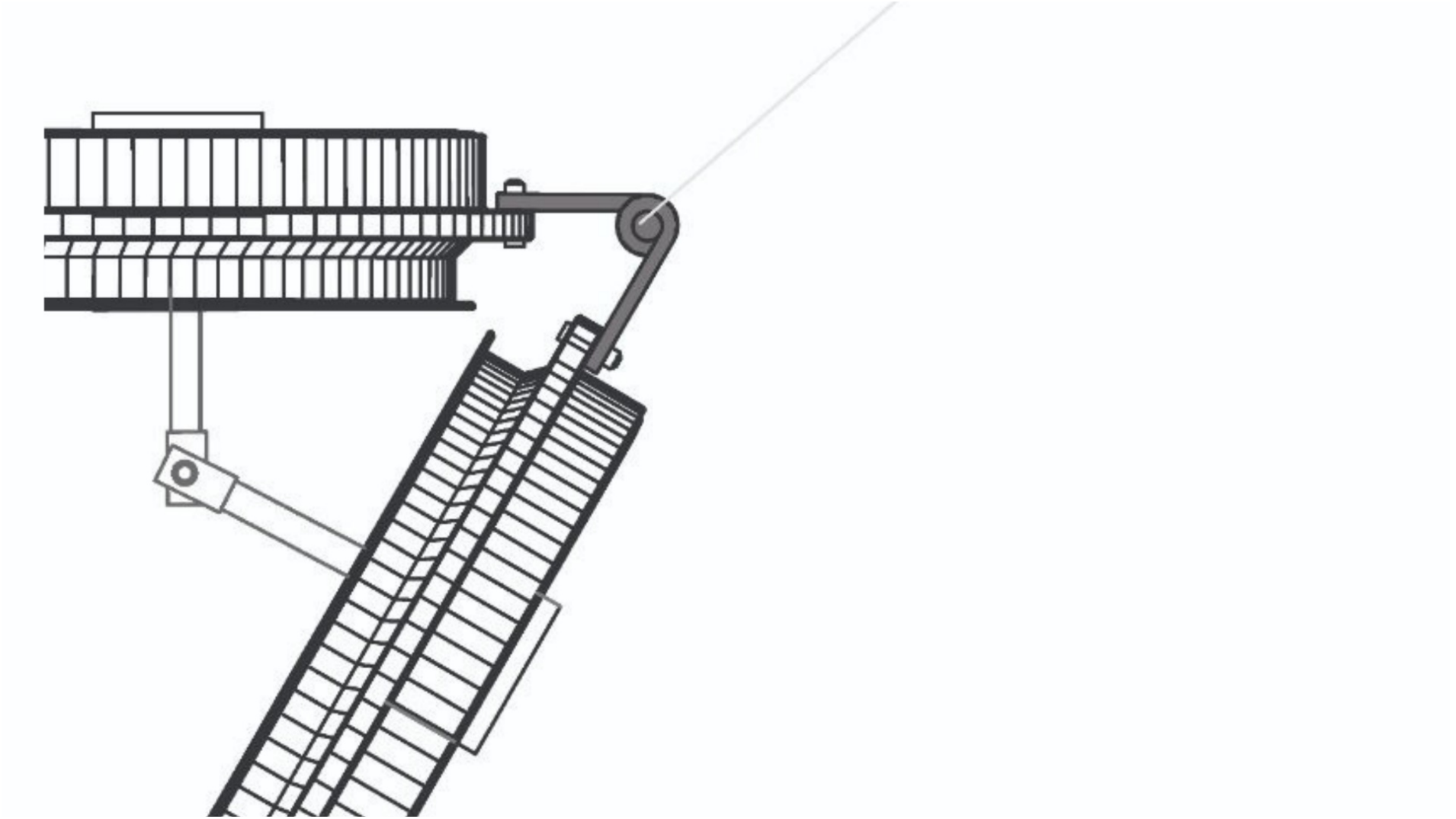
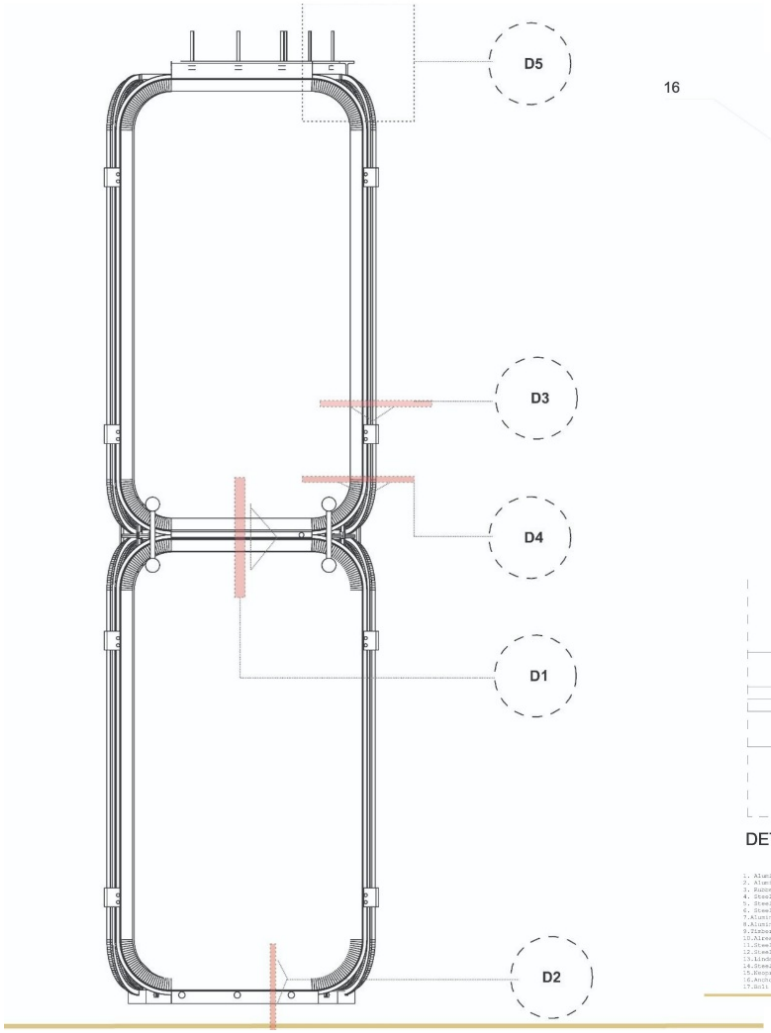
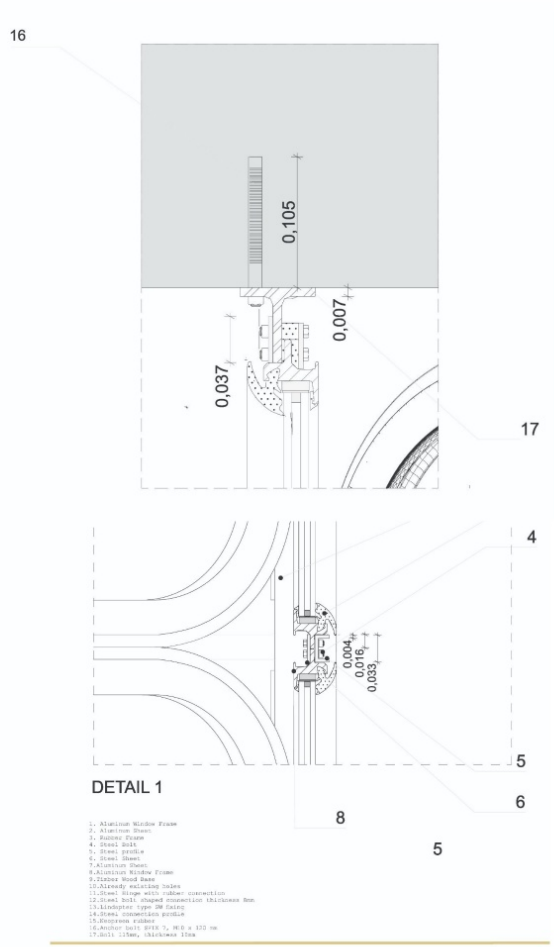
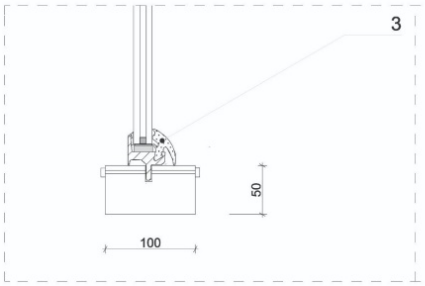


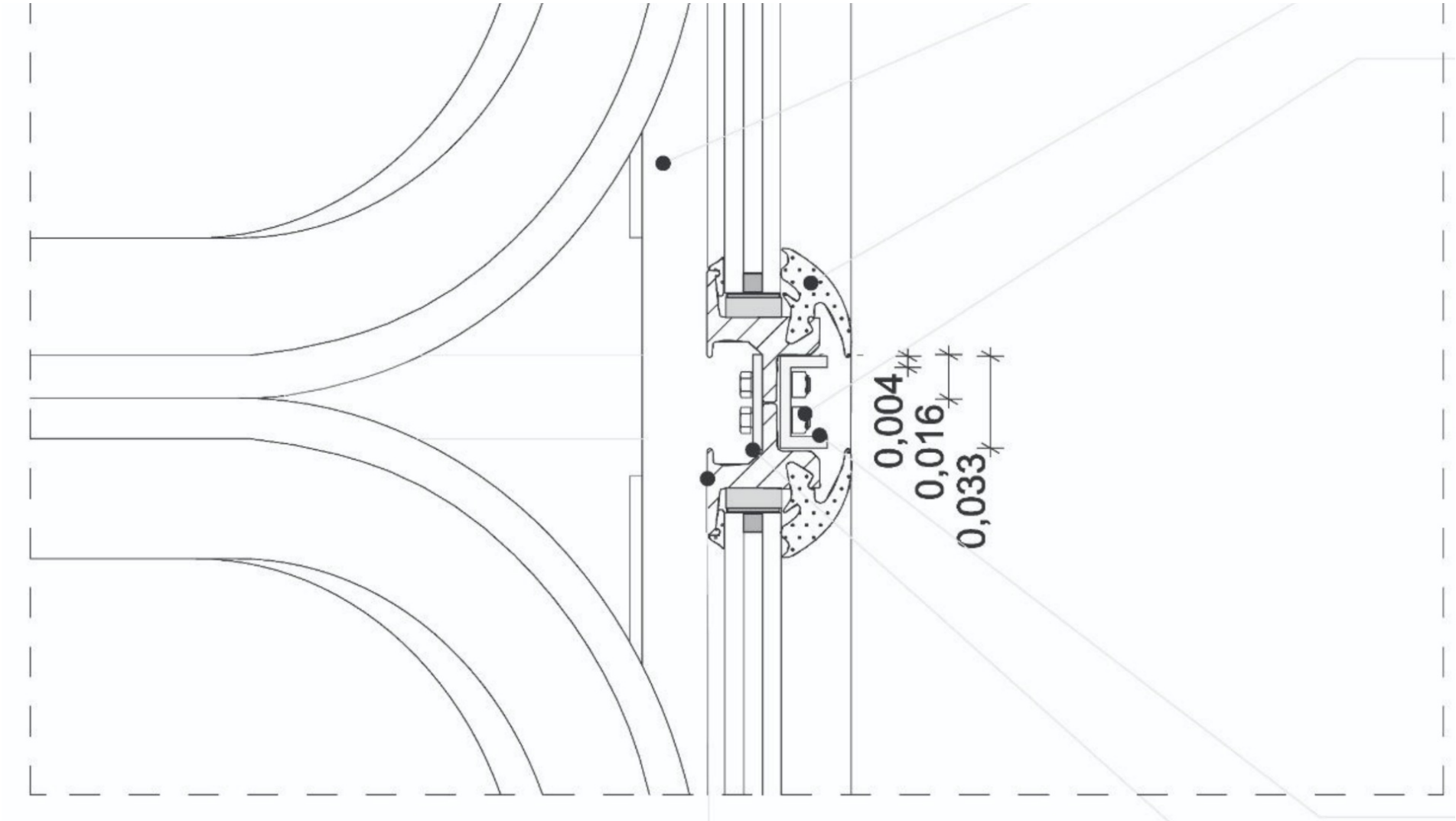




DETAIL 1

1. Aluminum Window Frame
2. Aluminum Sheet
3. Rubber Frame
4. Steel Profile
5. Steel profile
6. Steel Sheet
7.Aluminum Sheet
8.Aluminum Window Frame
9.Timber Wood Base
10.Already existing holes
11.Steel Hinge with rubber connection
12.Steel bolt shaped connection thickness 8mm
13.Windpster type EM fsing
14.Steel connection profile
15.Neoprene rubber
16.Anchor bolt EPFE 5, M10 x 130 ns
17.Bolt 115mm, thickness 15ns

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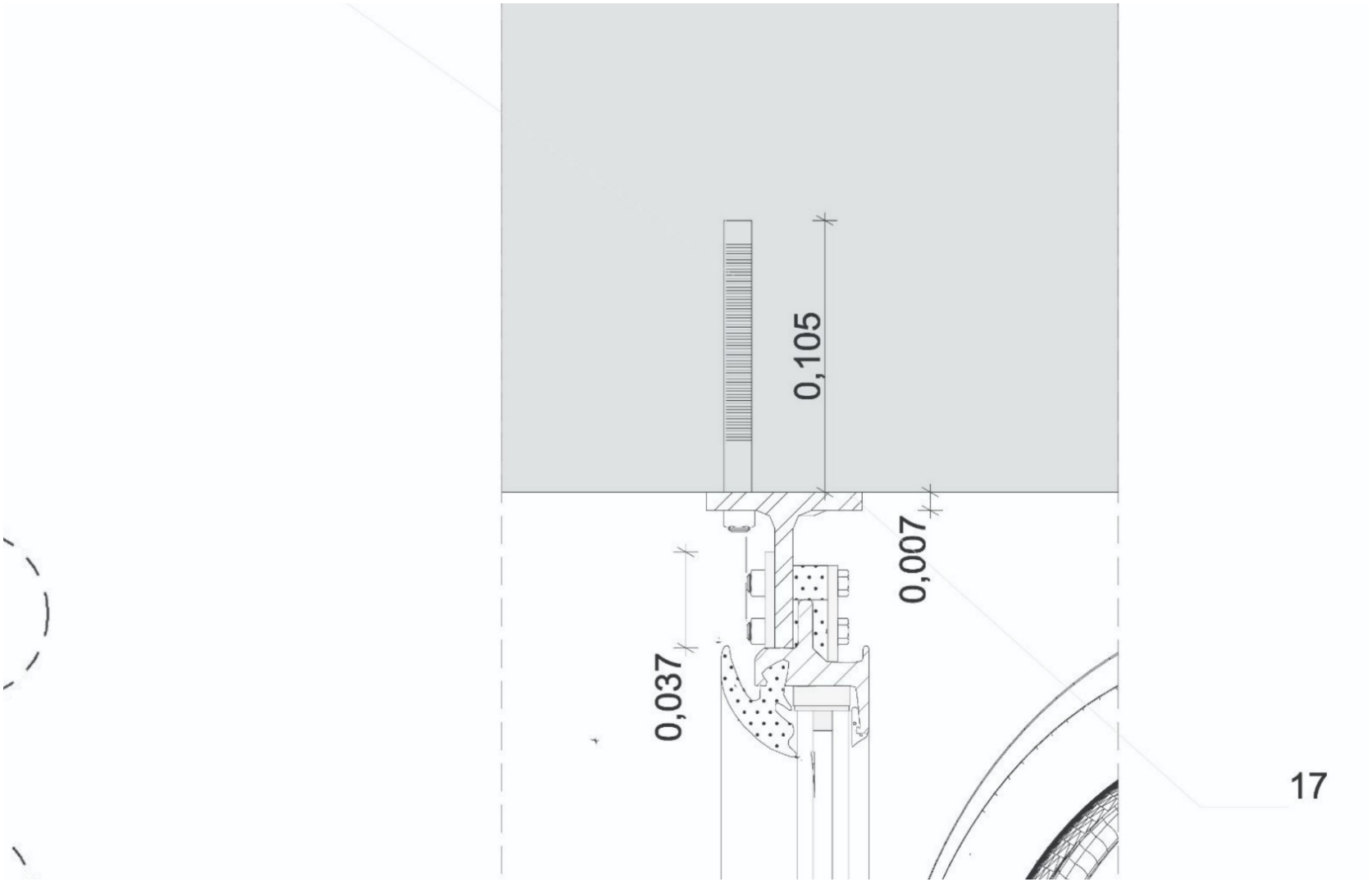
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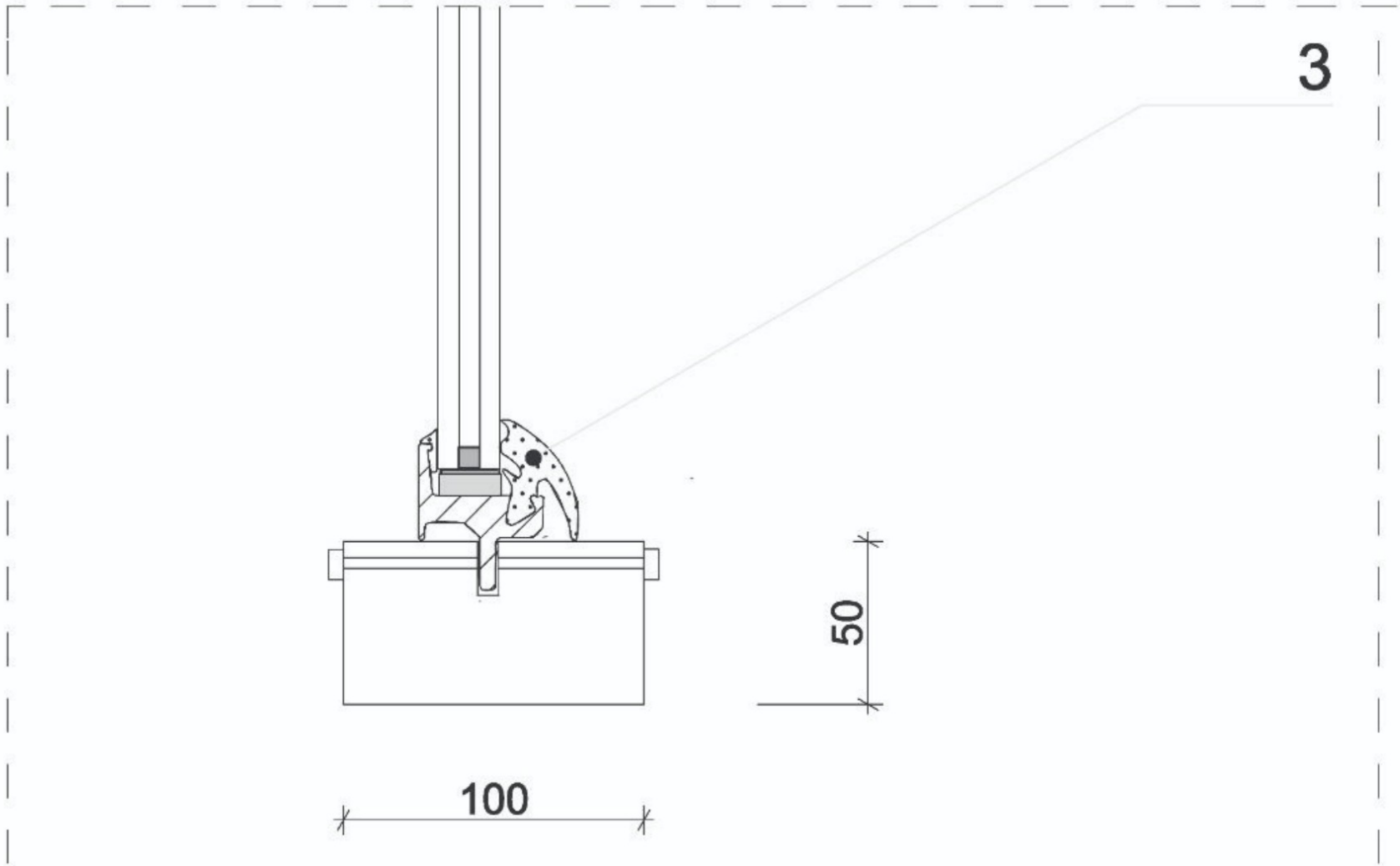
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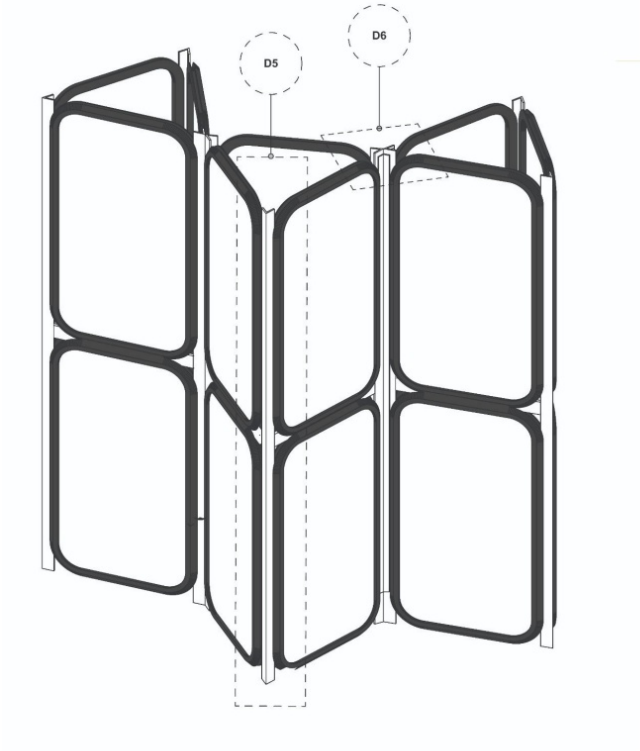
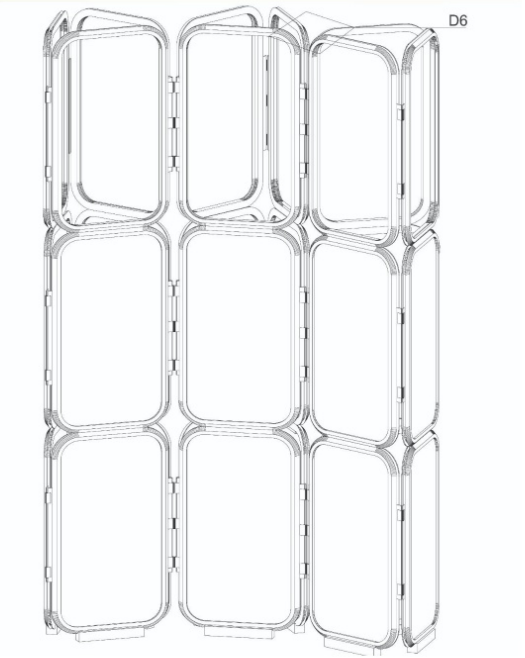
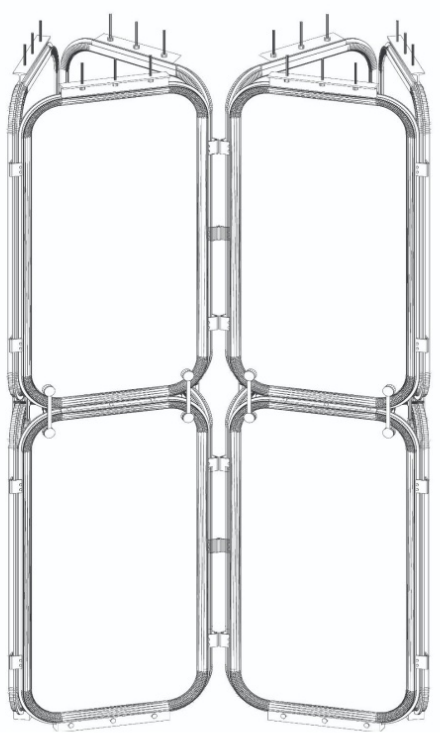
PHASE 1



PHASE 2



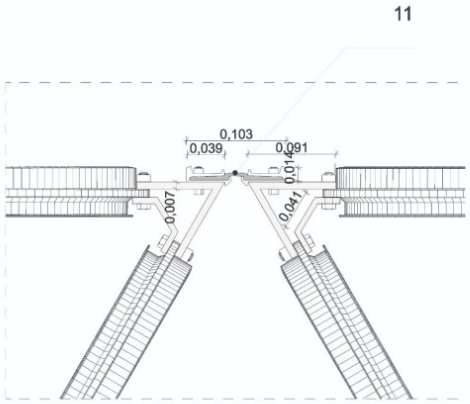
PHASE 3

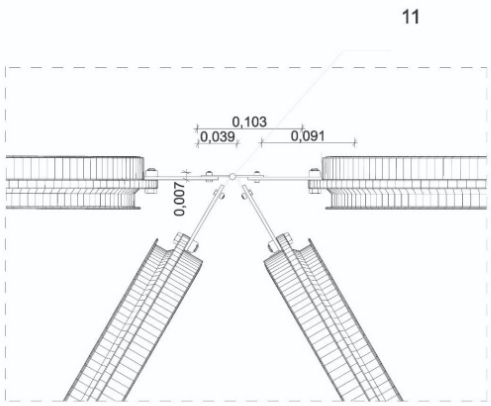


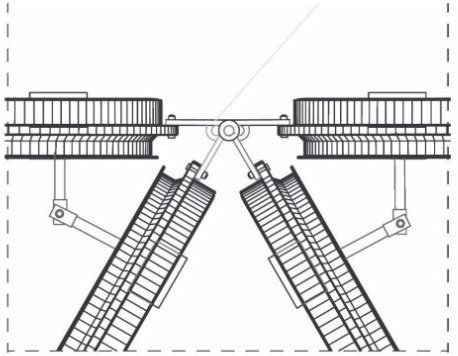
PHASE 1

PHASE 2

PHASE 3

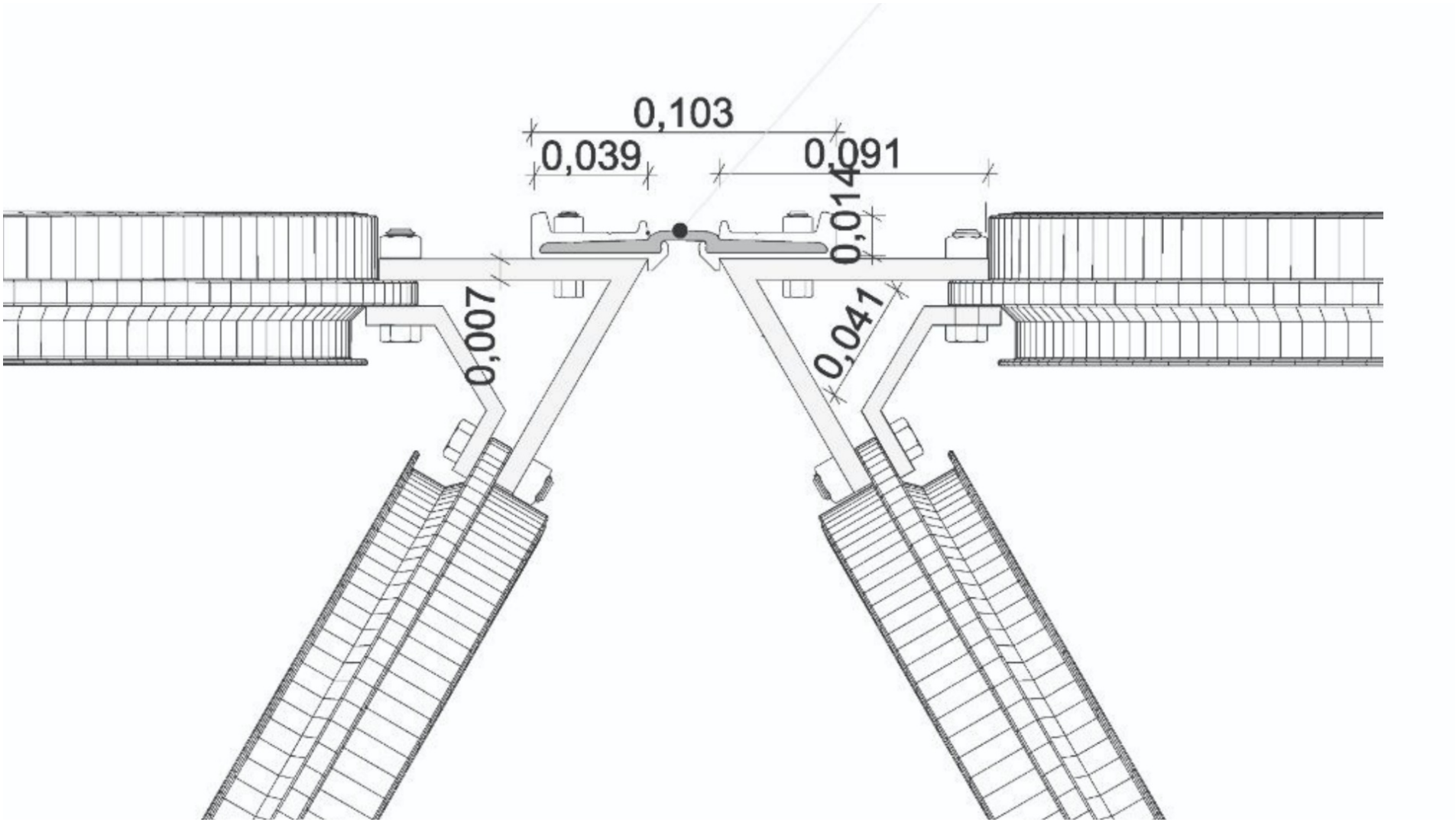






DETAIL 5

1. Aluminum Window Frame
2. Aluminum Sheet
3. Rubber Frame
4. Steel Bolt
5. Steel profile
6. Steel Sheet
7.Aluminum Sheet
8.Aluminum Window Frame
9.Timber Wood Base
10.Already existing holes
11.Steel Hinge 45X45mm
12.Steel bolt shaped connection thickness 8mm
13.Lindapter type SW fixing
14.Steel connection profile
15.Neopreen rubber
16.Anchor bolt SFIX 7, M10 X 120 mm
17.Bolt 115mm, thickness 10mm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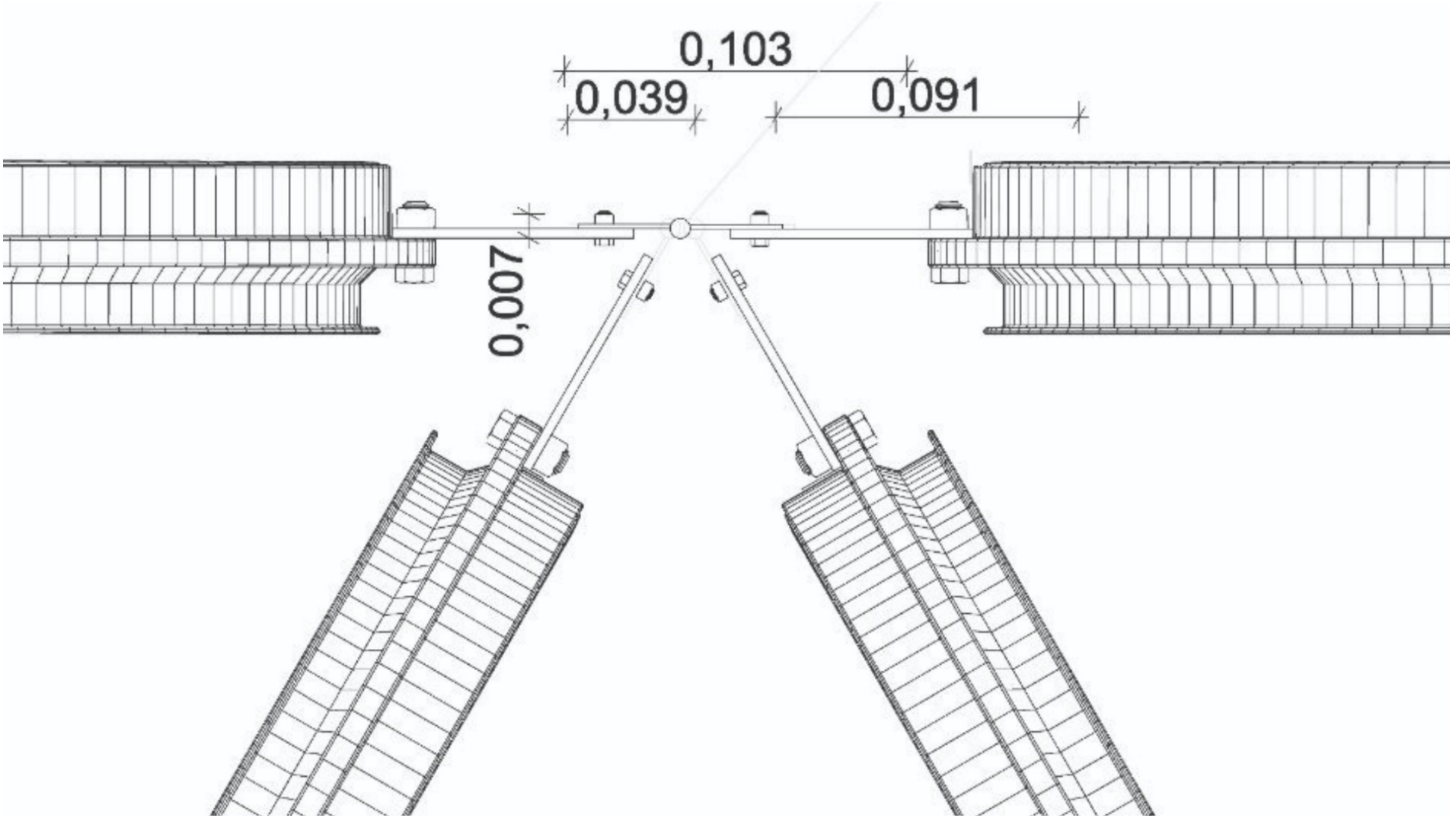
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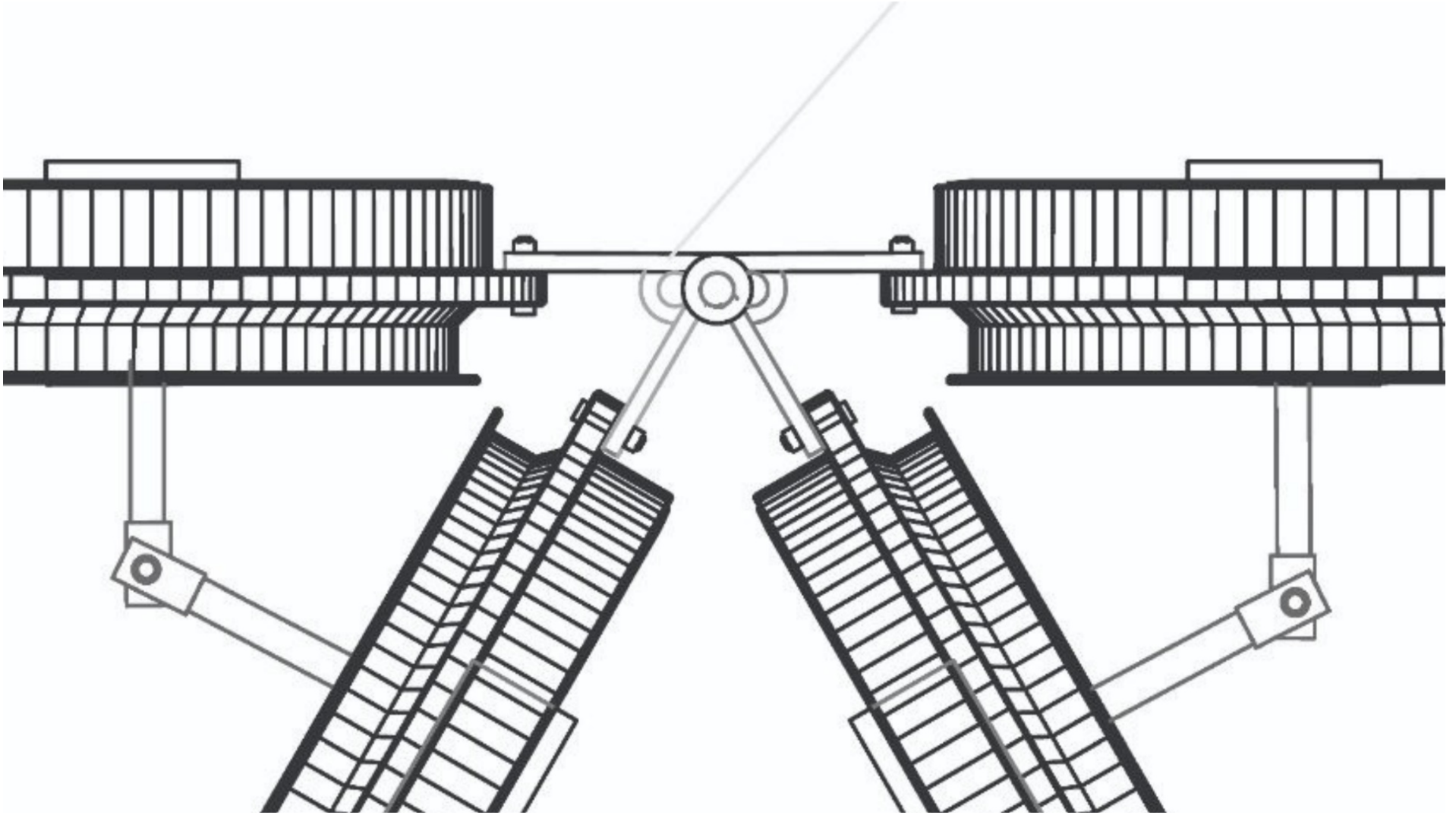
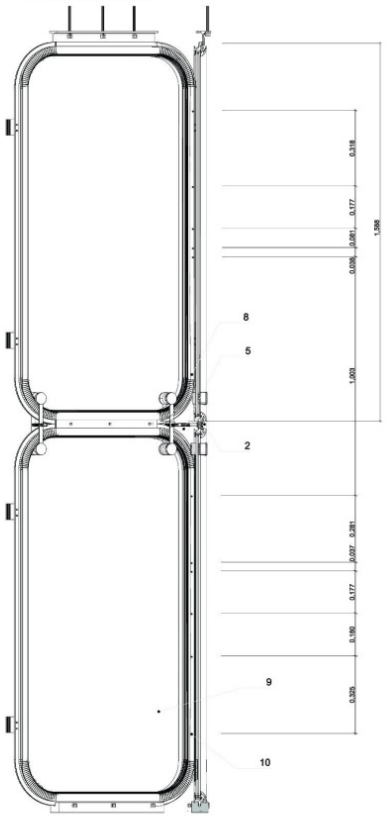
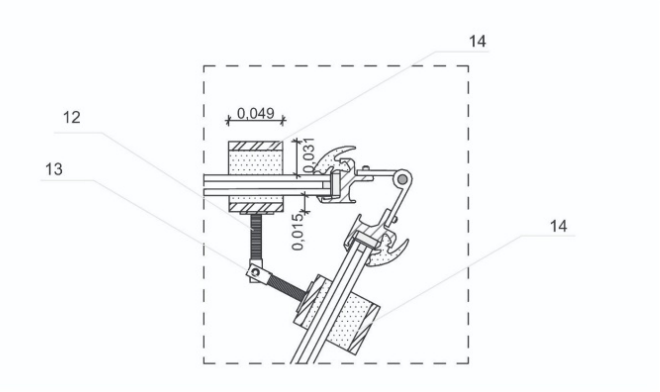
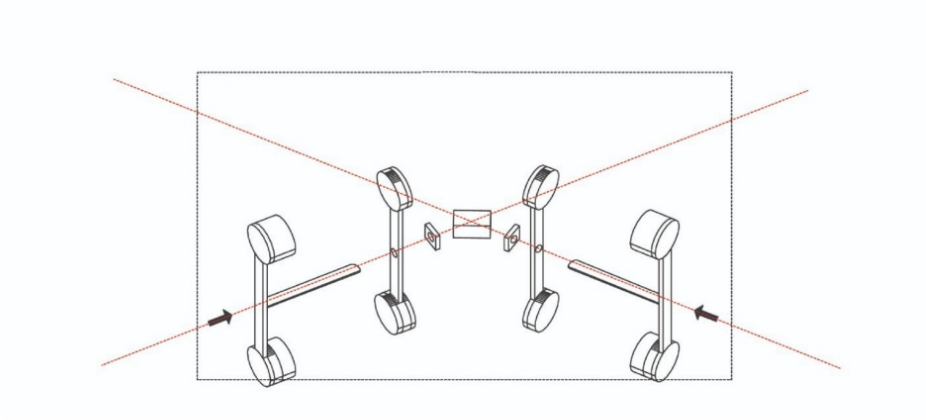
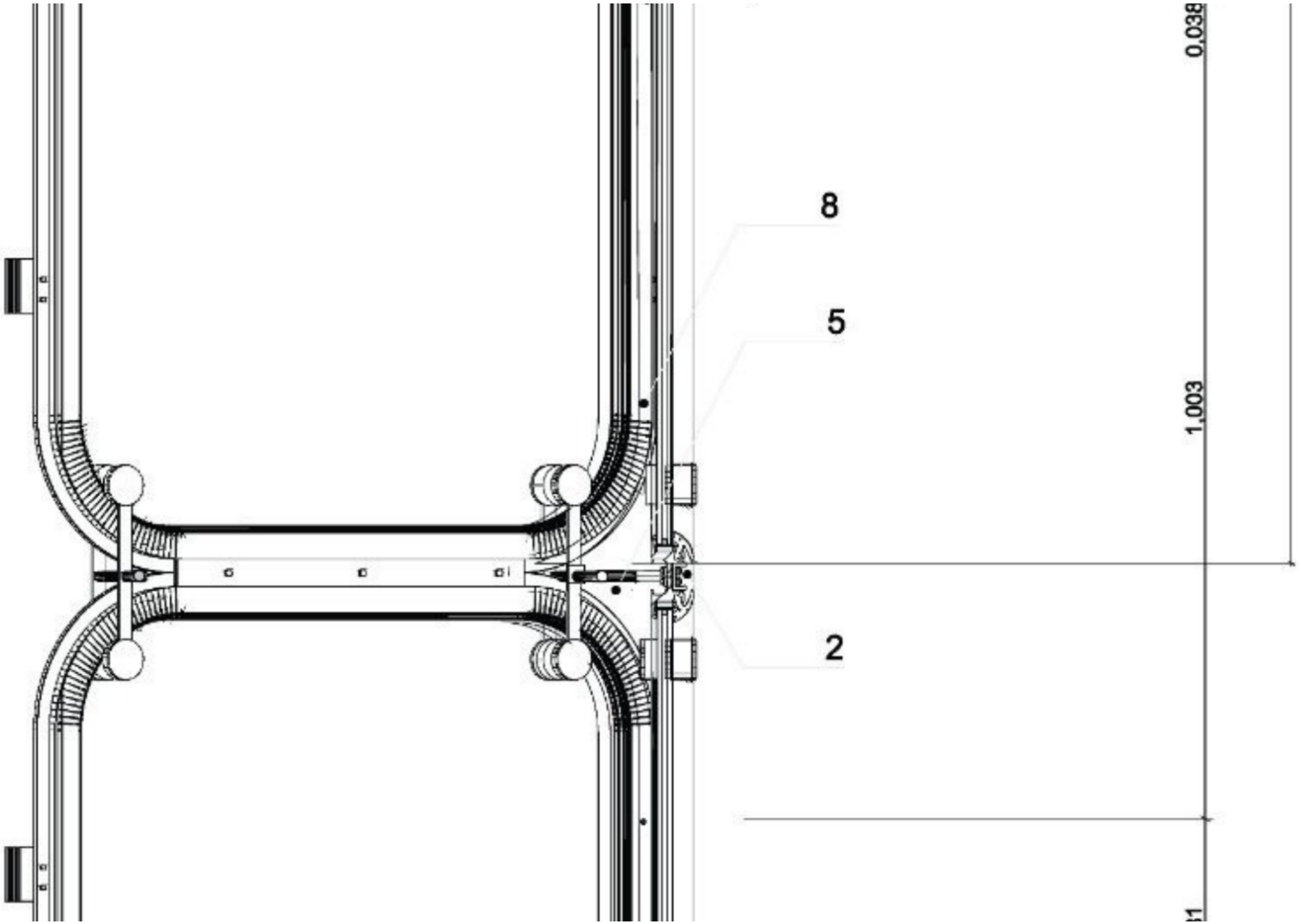


THE MOST CONTROVERSIAL ASPECT DURING DETAILING:





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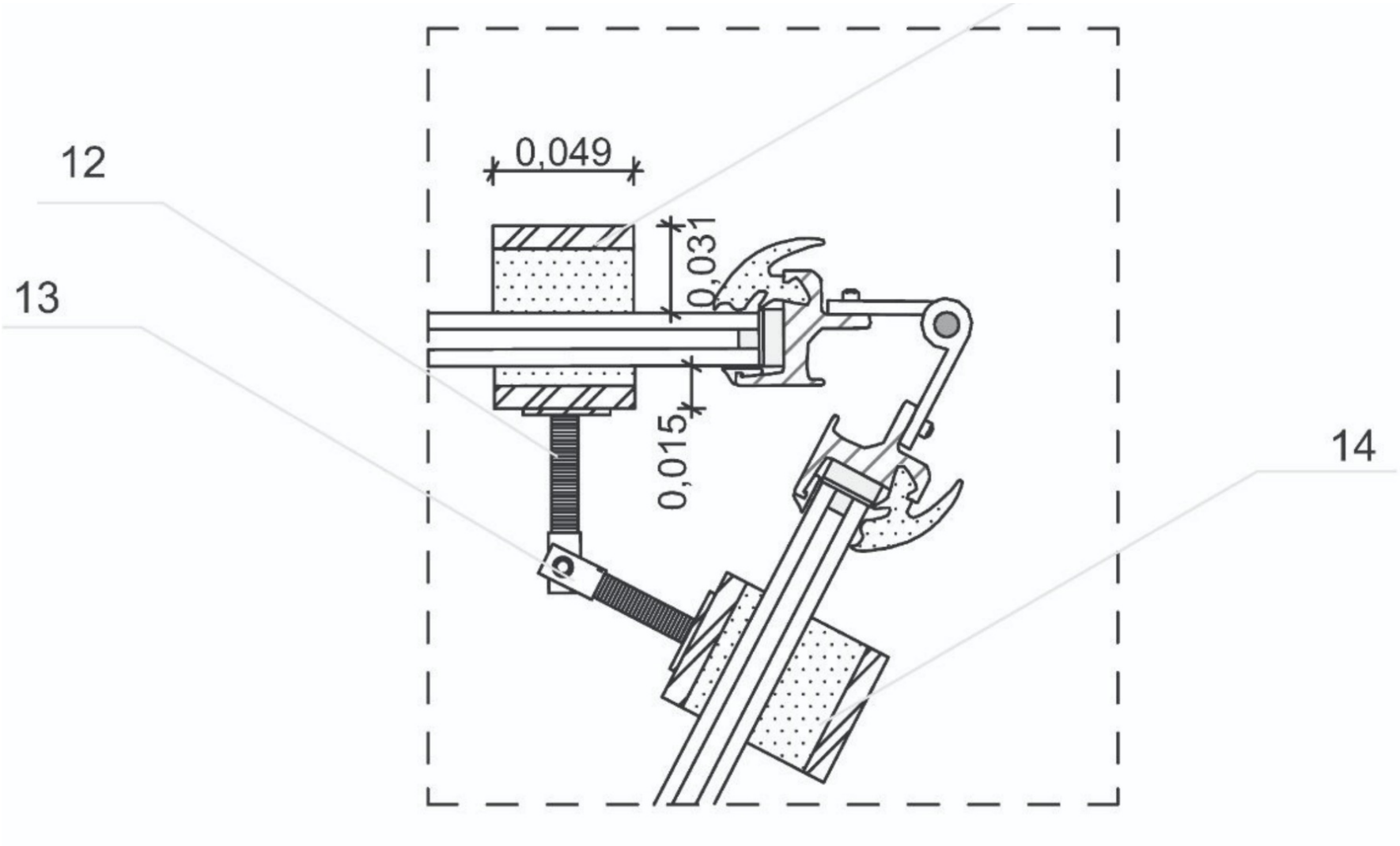
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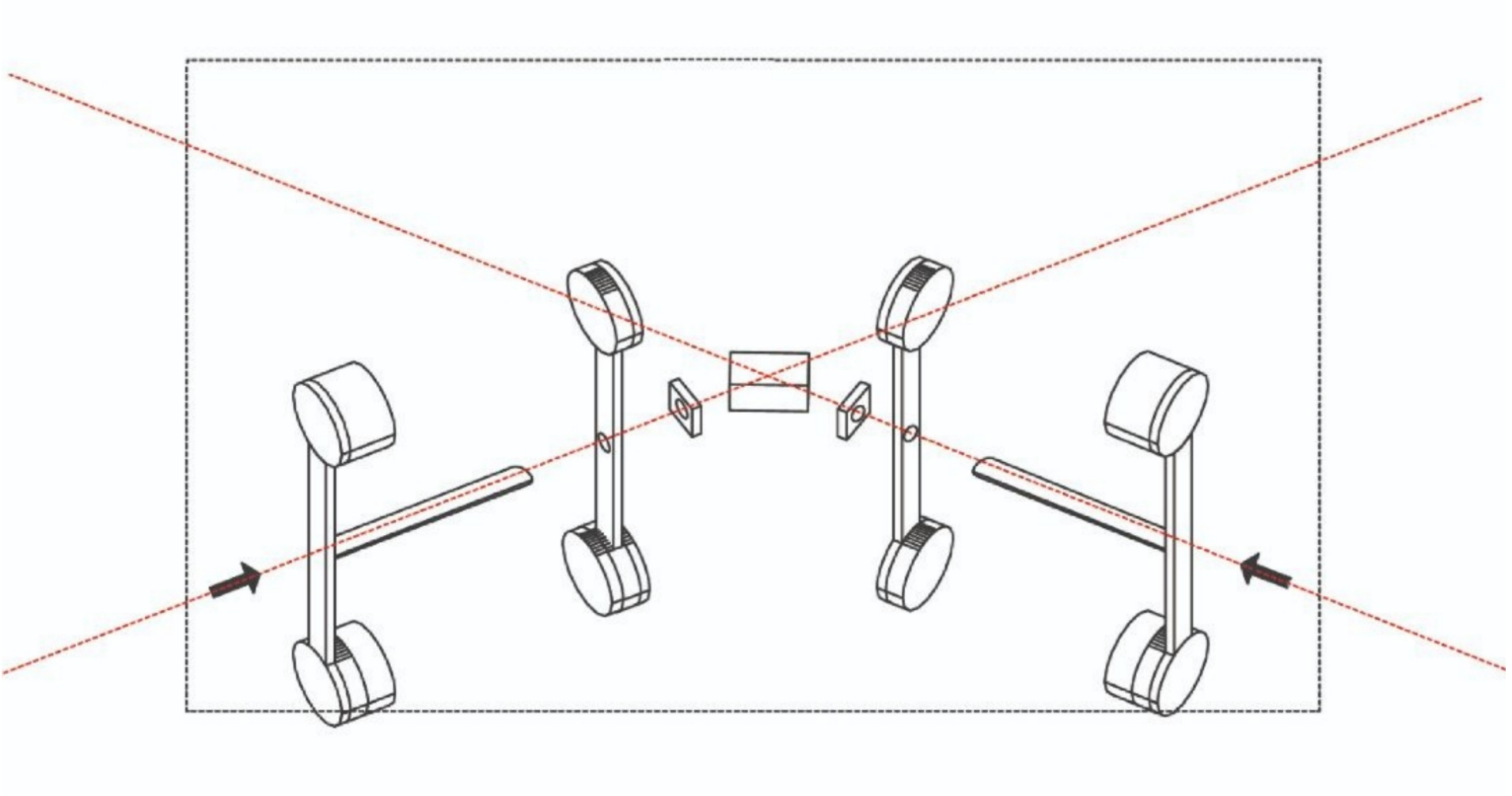
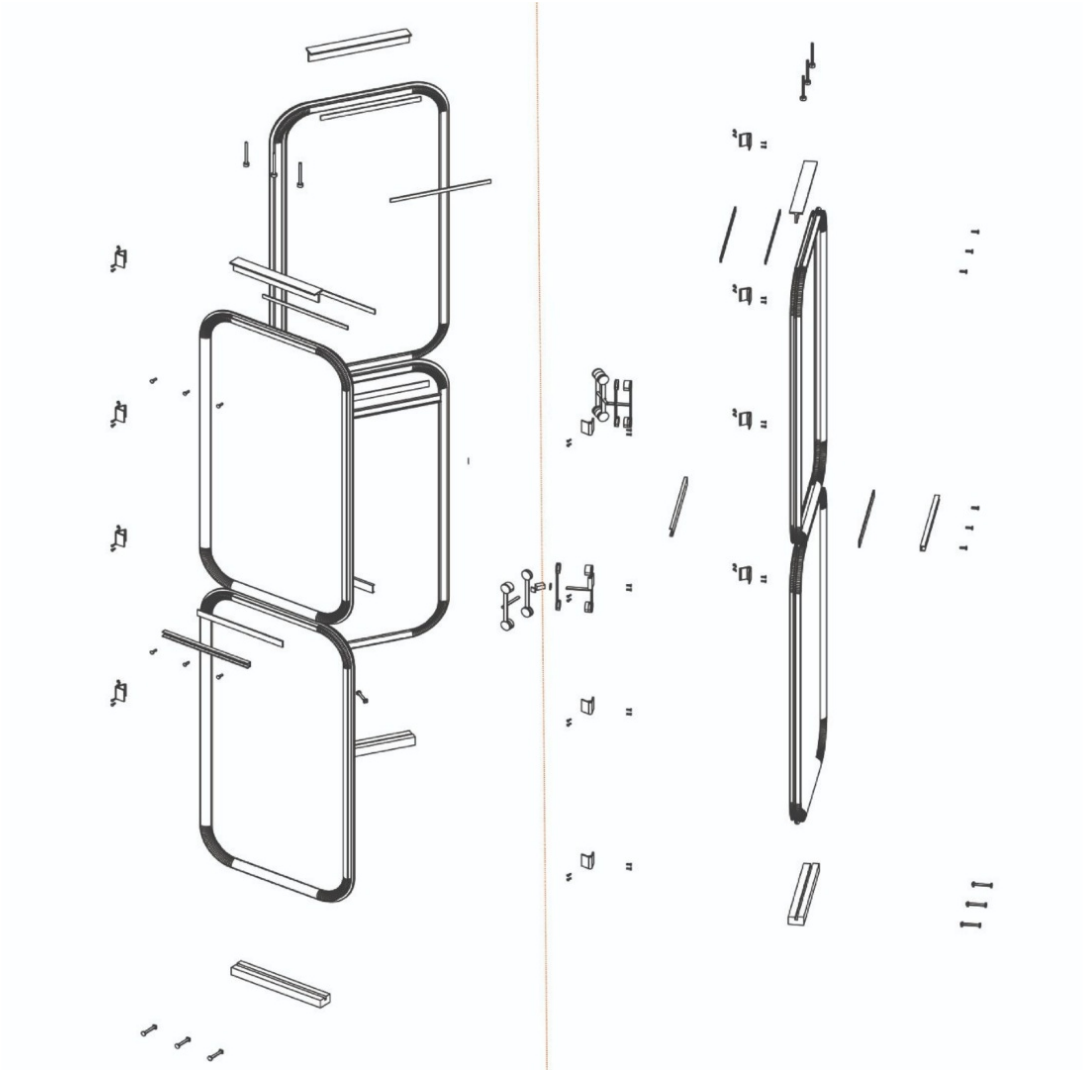
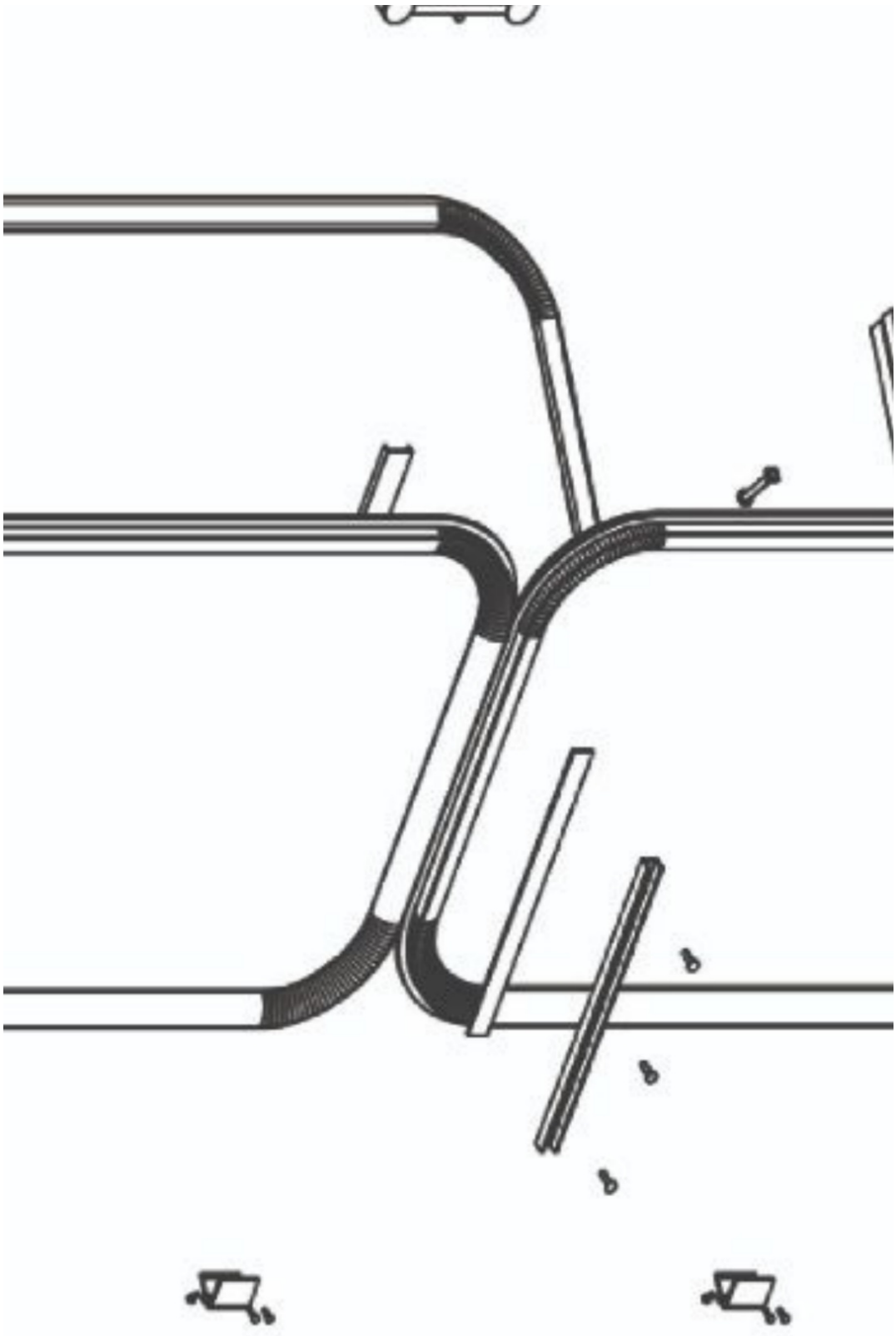
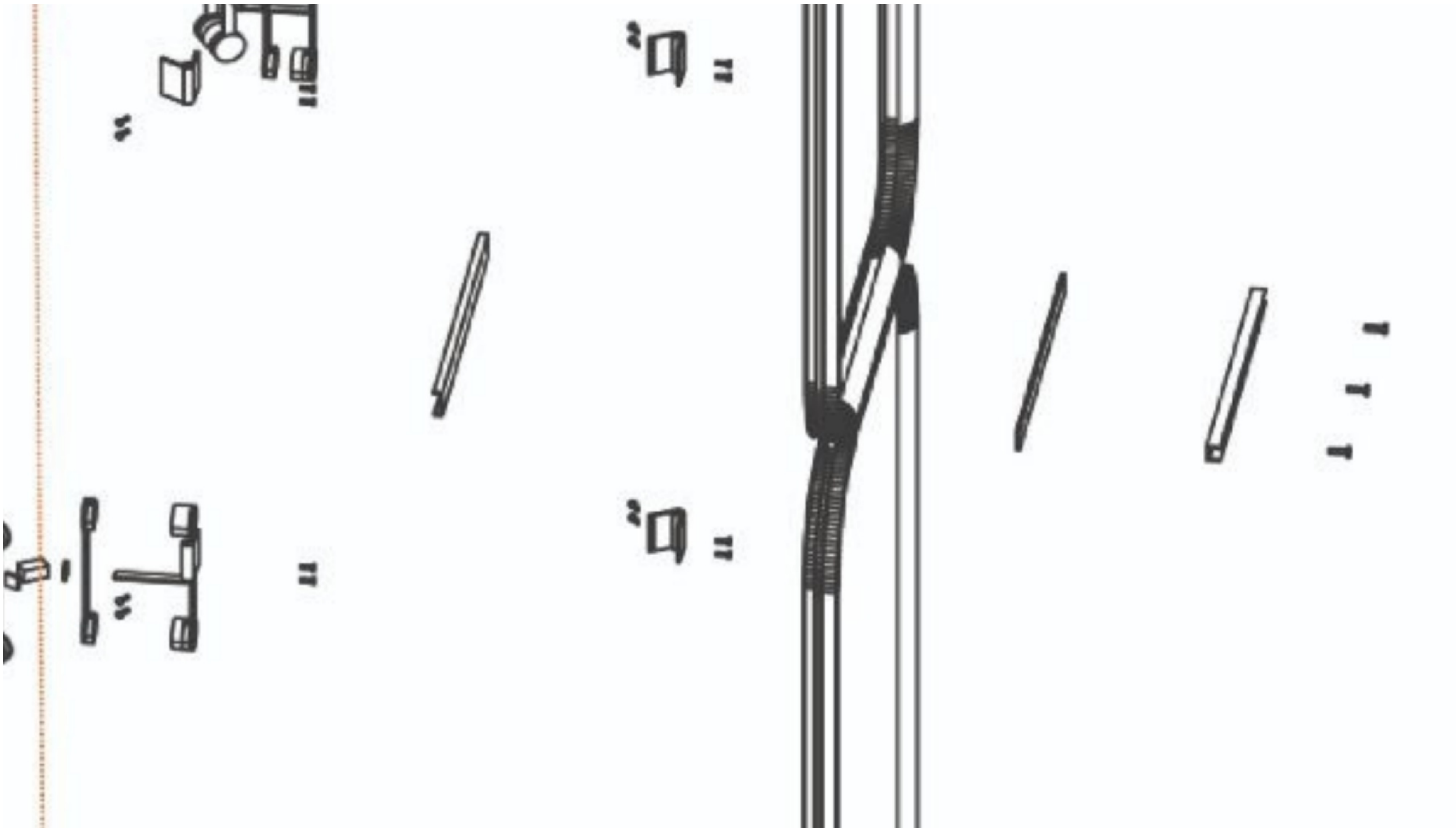
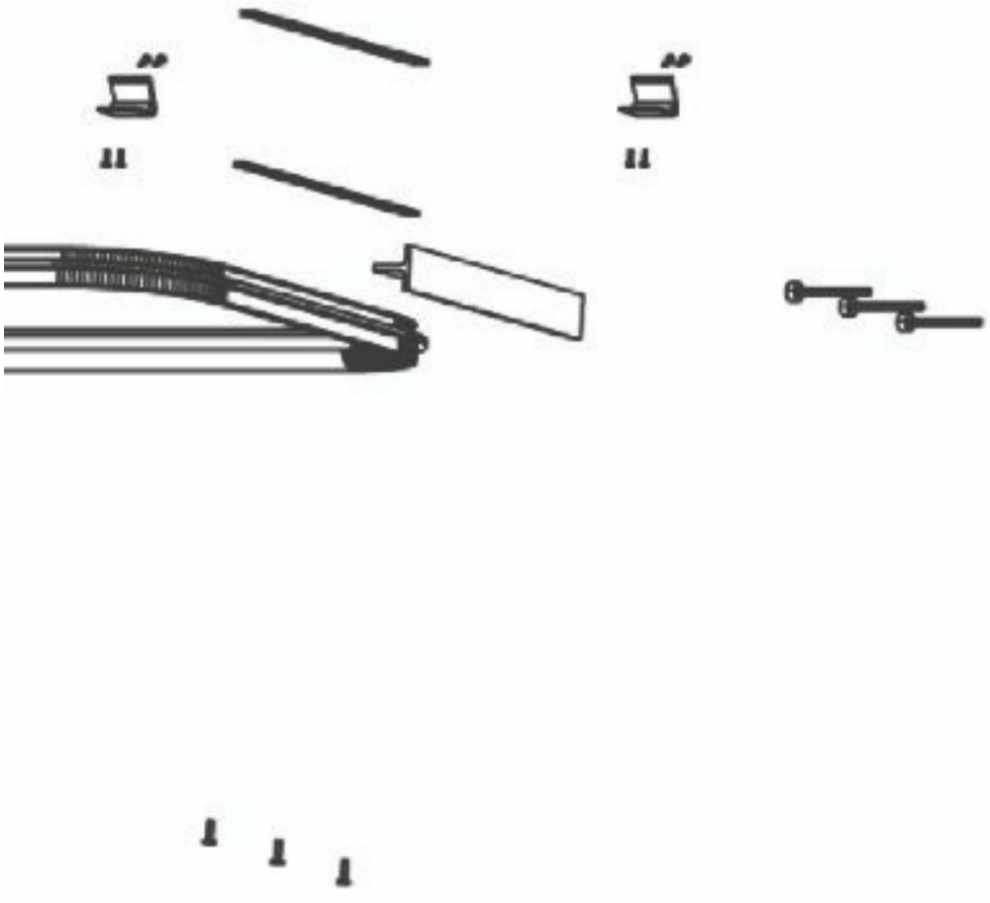


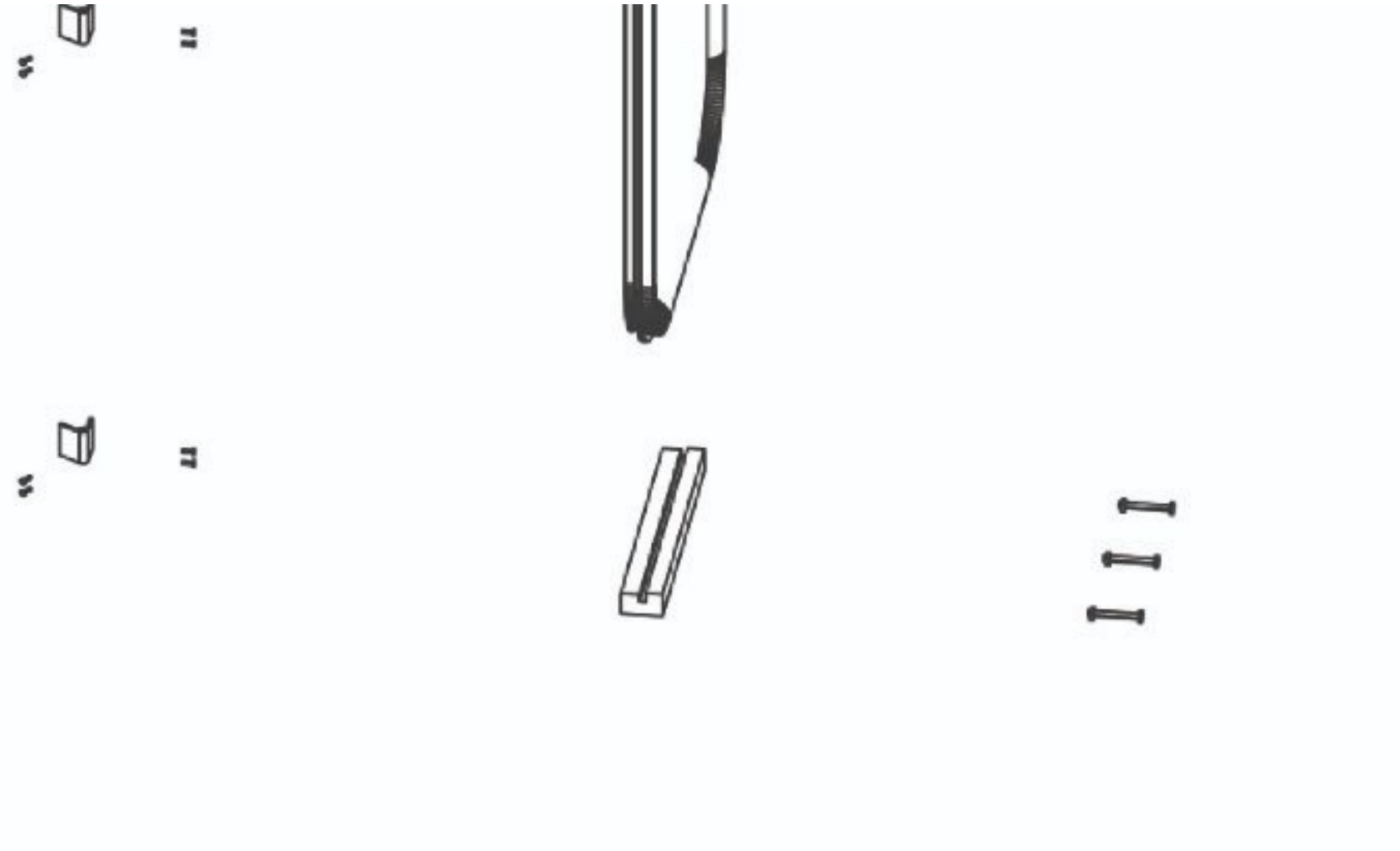
EXPLODED MODULE:

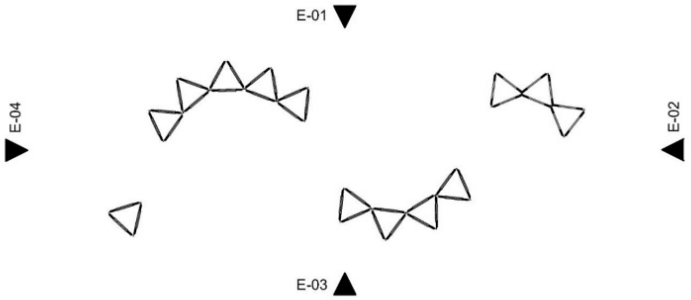




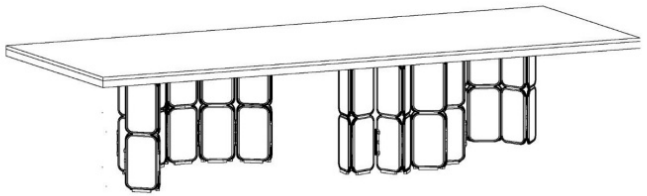




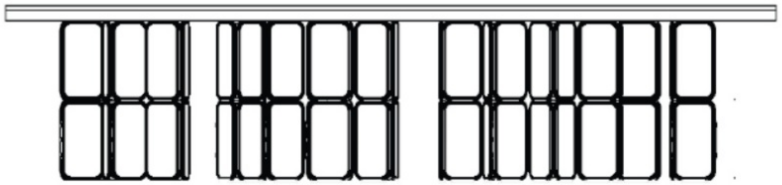




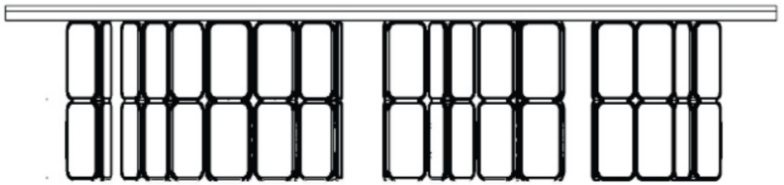
0. Ground Floor 1:100



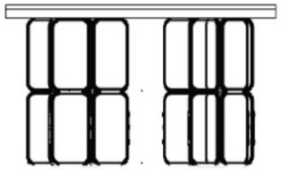
3D-02 Axonometry 1:100



E-01 Elevation 1:100



E-03 Elevation 1:100

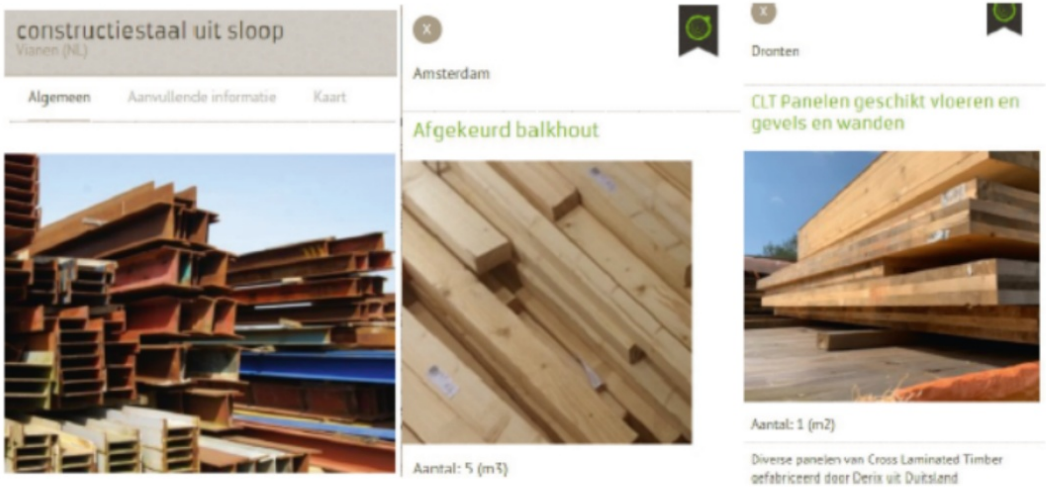


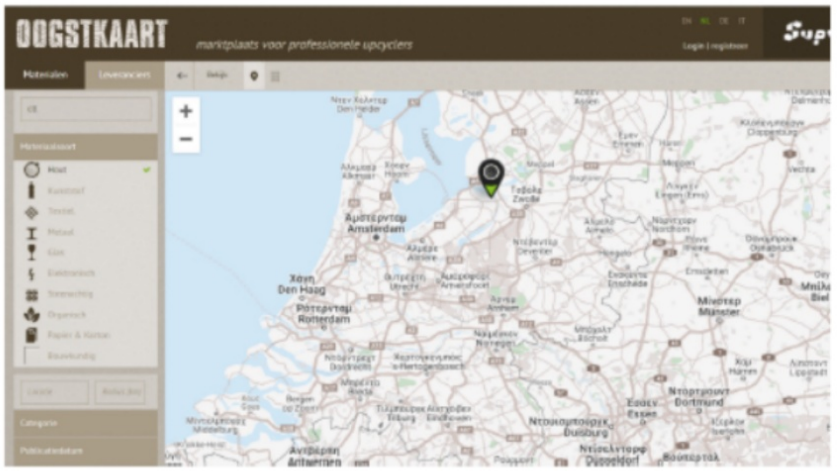
E-04 Elevation 1:100

BOUWPUB
PAVILION

HARVEST MATERIALS:

Lower Embodied Energy





Material selection

-Metal Hinges
-Metal profiles
-Bolts
-Nuts
-Base wood

FIRST PROTOTYPE: FIRST CHANGES:

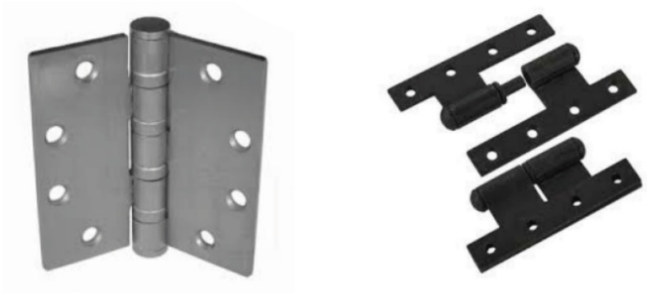
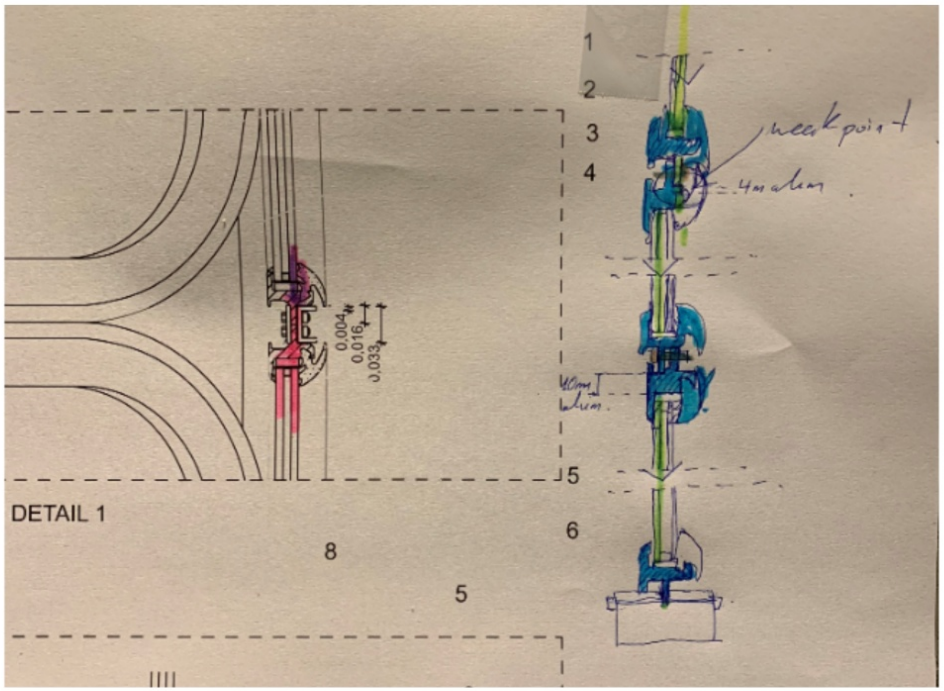
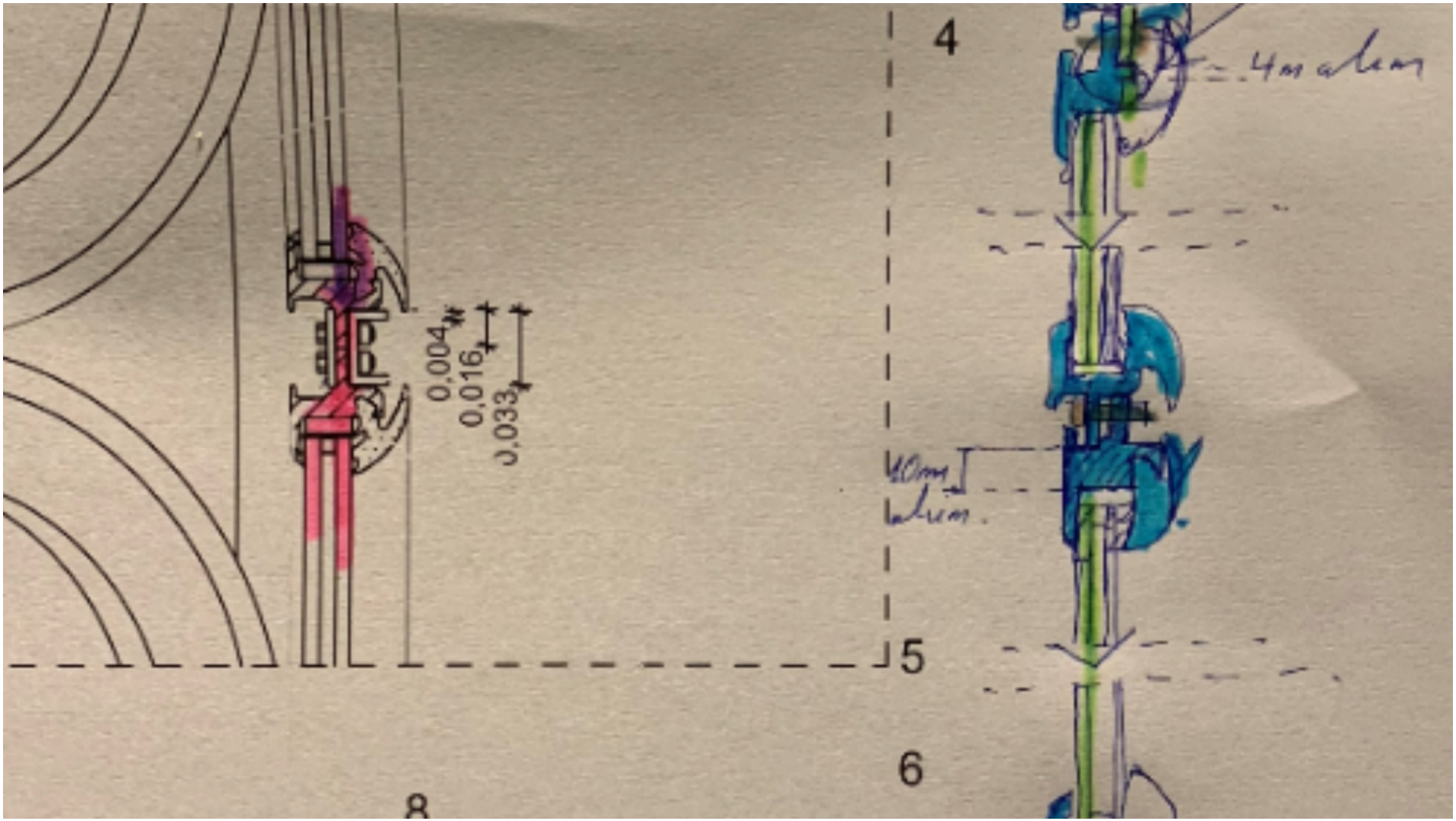


Image 7.2.1:Locked and unlocked hinges
Retrieved from:https://www.natman.com/category/hinges

DO WE NEED THE METAL - STEEL PARTS?




4
5
6
8
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0,016
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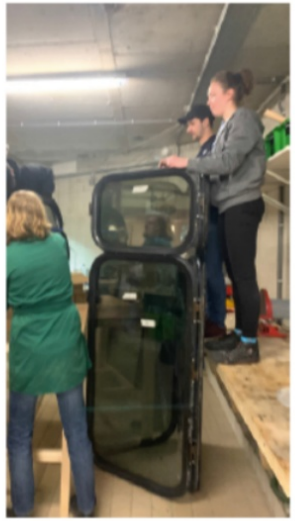
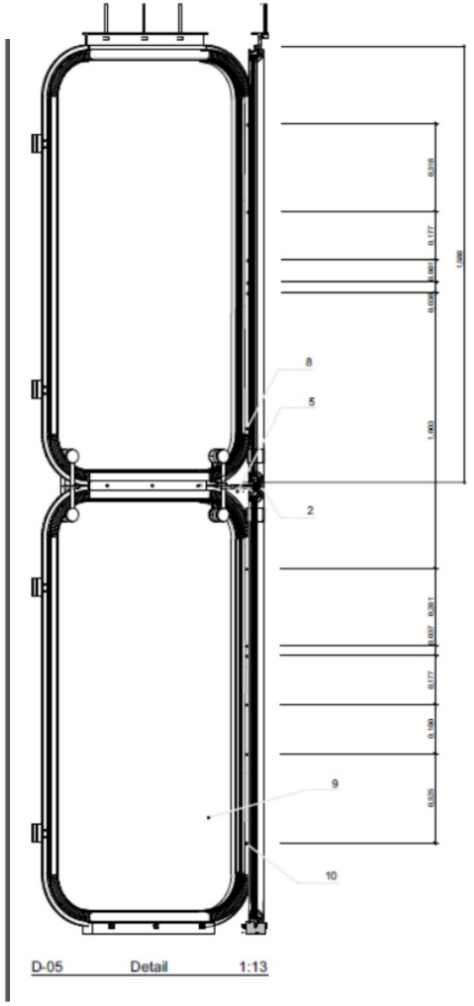
PHASE 2 :

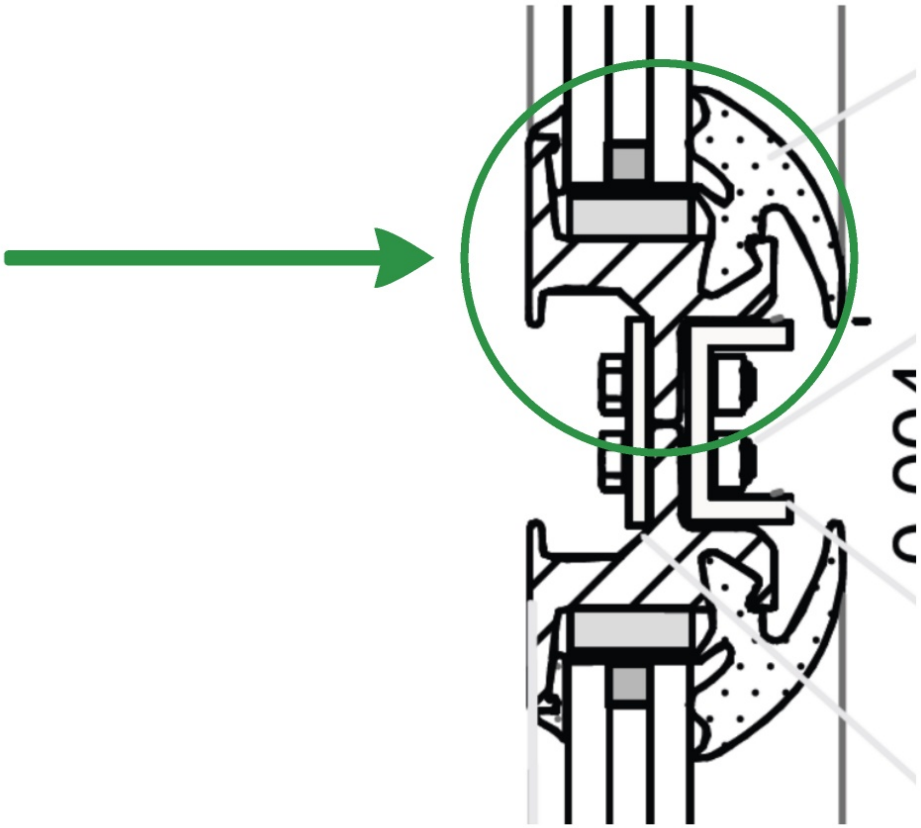
FIRST ASSEMBLY ATTEMPT

Small triangle module





THE CANTILEVER TEST: Overcoming the concerns

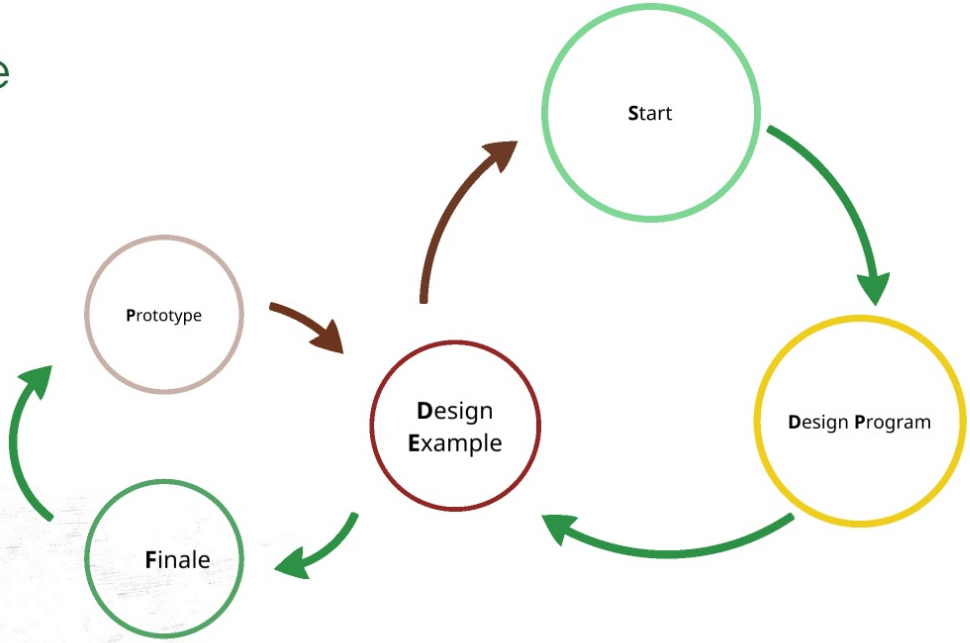


PHASE 4: FINAL ASSEMBLY

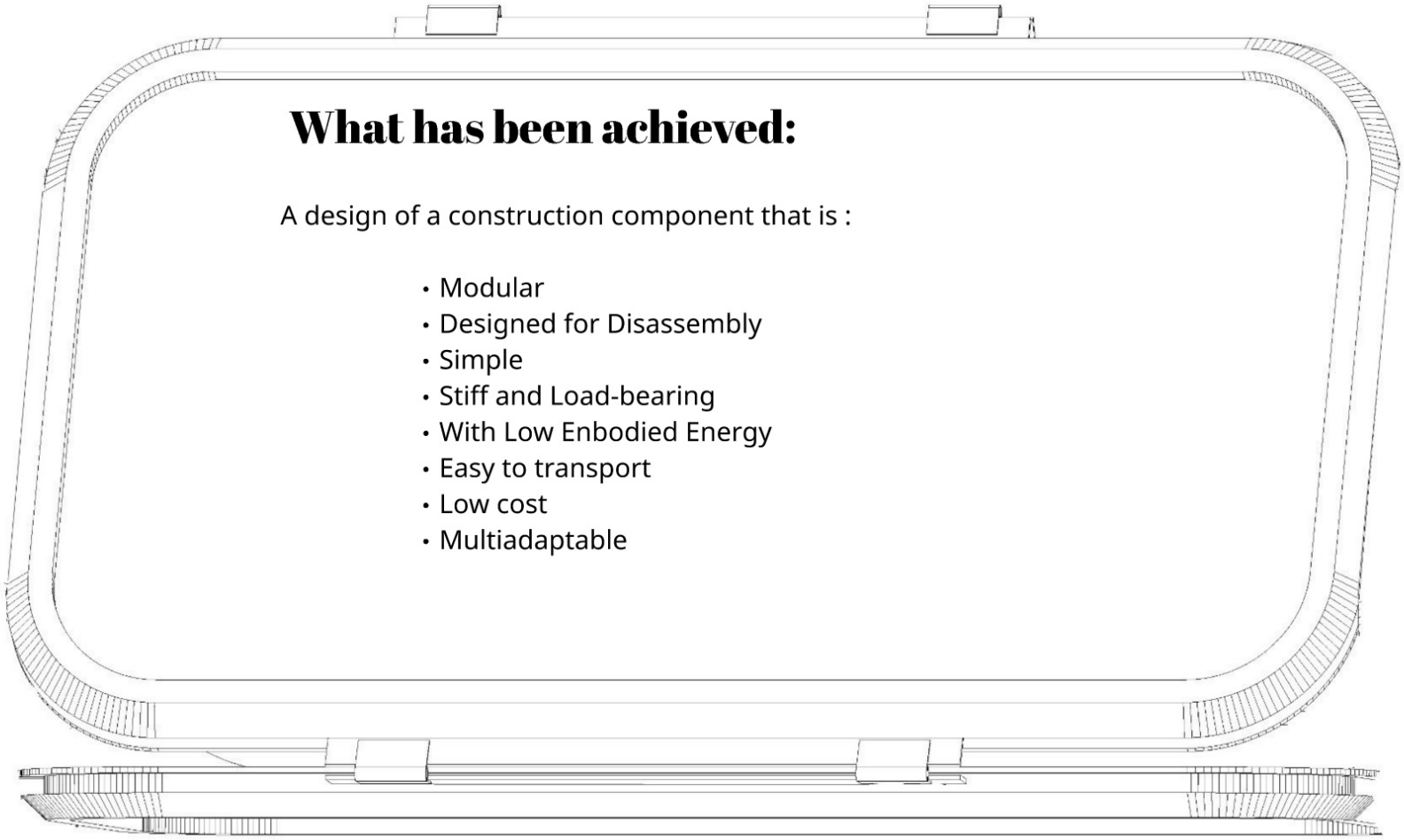
FINAL PROTOTYPE: GEVEL 2020


PASS

Upcycle in Architecture



MULTIADAPTABILITY :



What has been achieved:

A design of a construction component that is :

- Modular
- Designed for Disassembly
- Simple
- Stiff and Load-bearing
- With Low Enbodied Energy
- Easy to transport
- Low cost
- Multiadaptable

GOOD LUCK!


THANK YOU!
Questions?