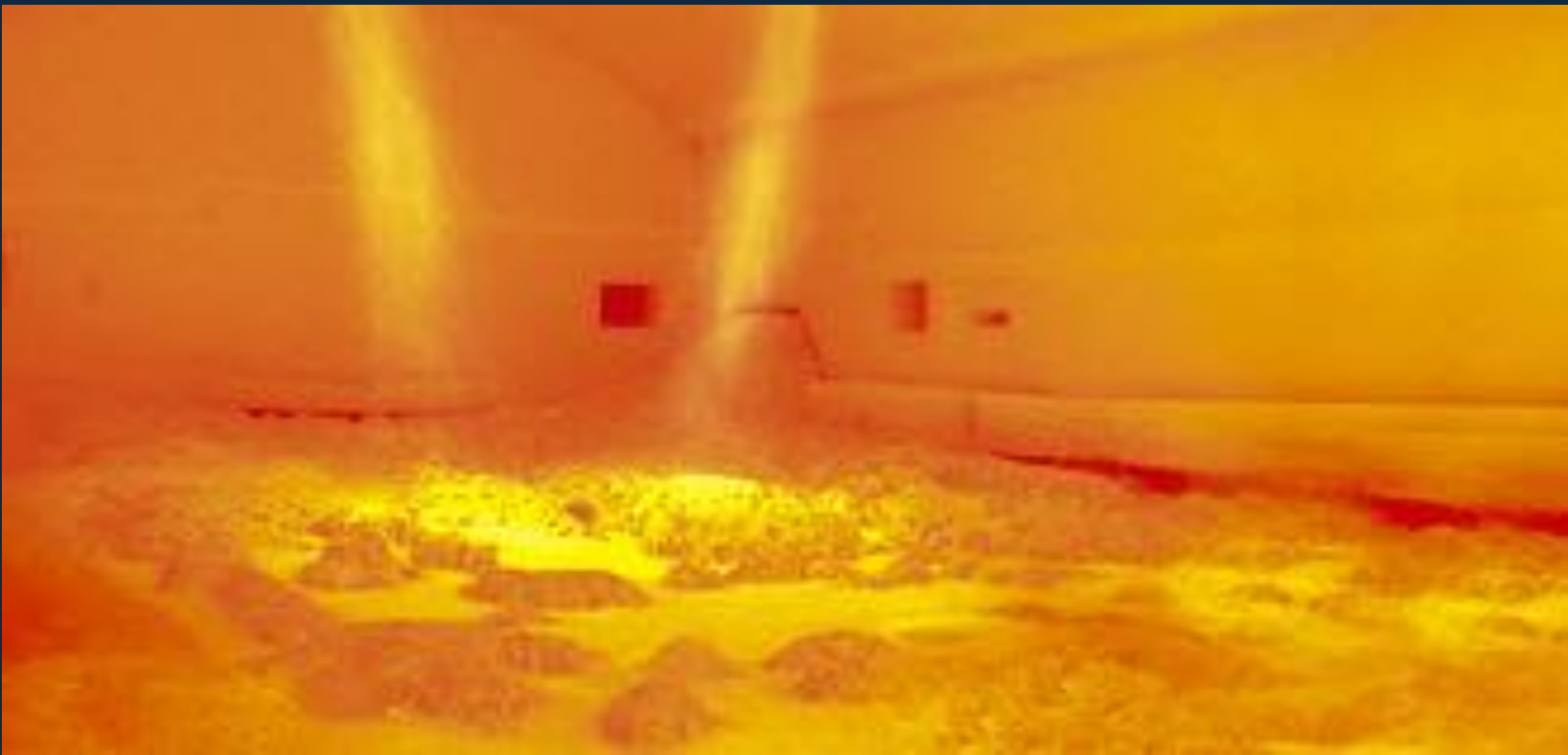
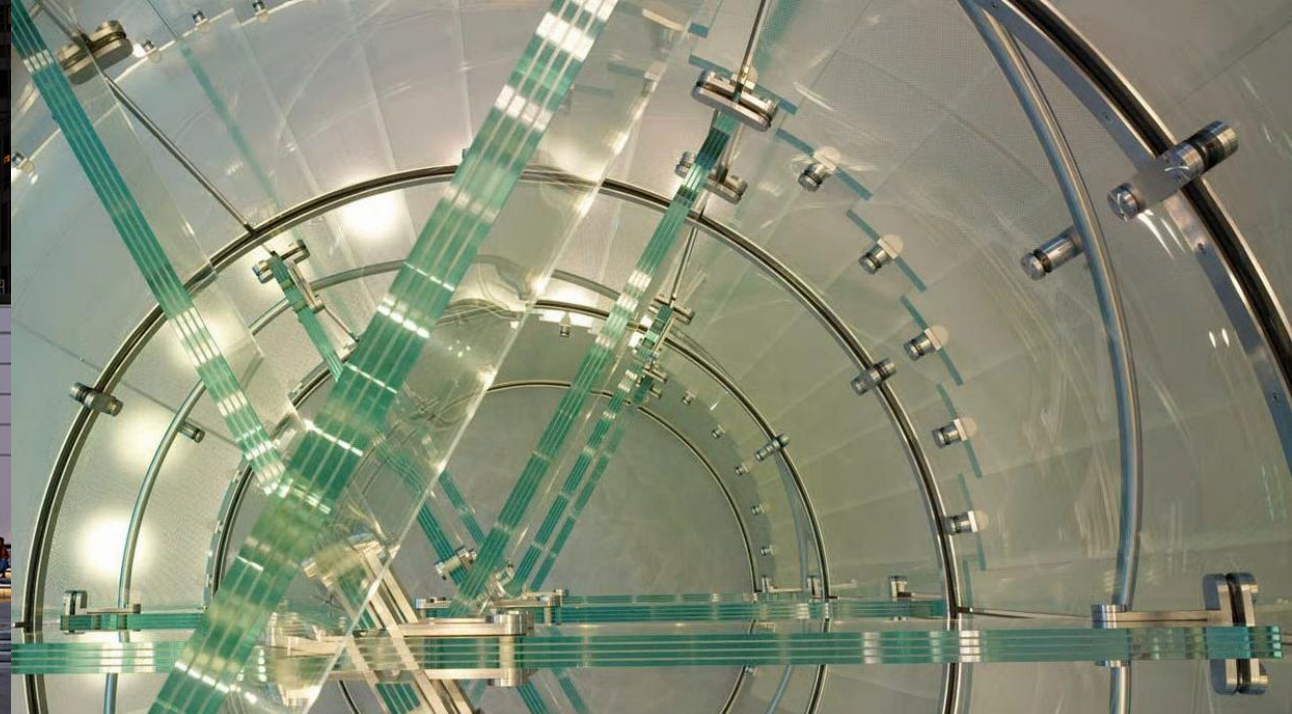


Hi



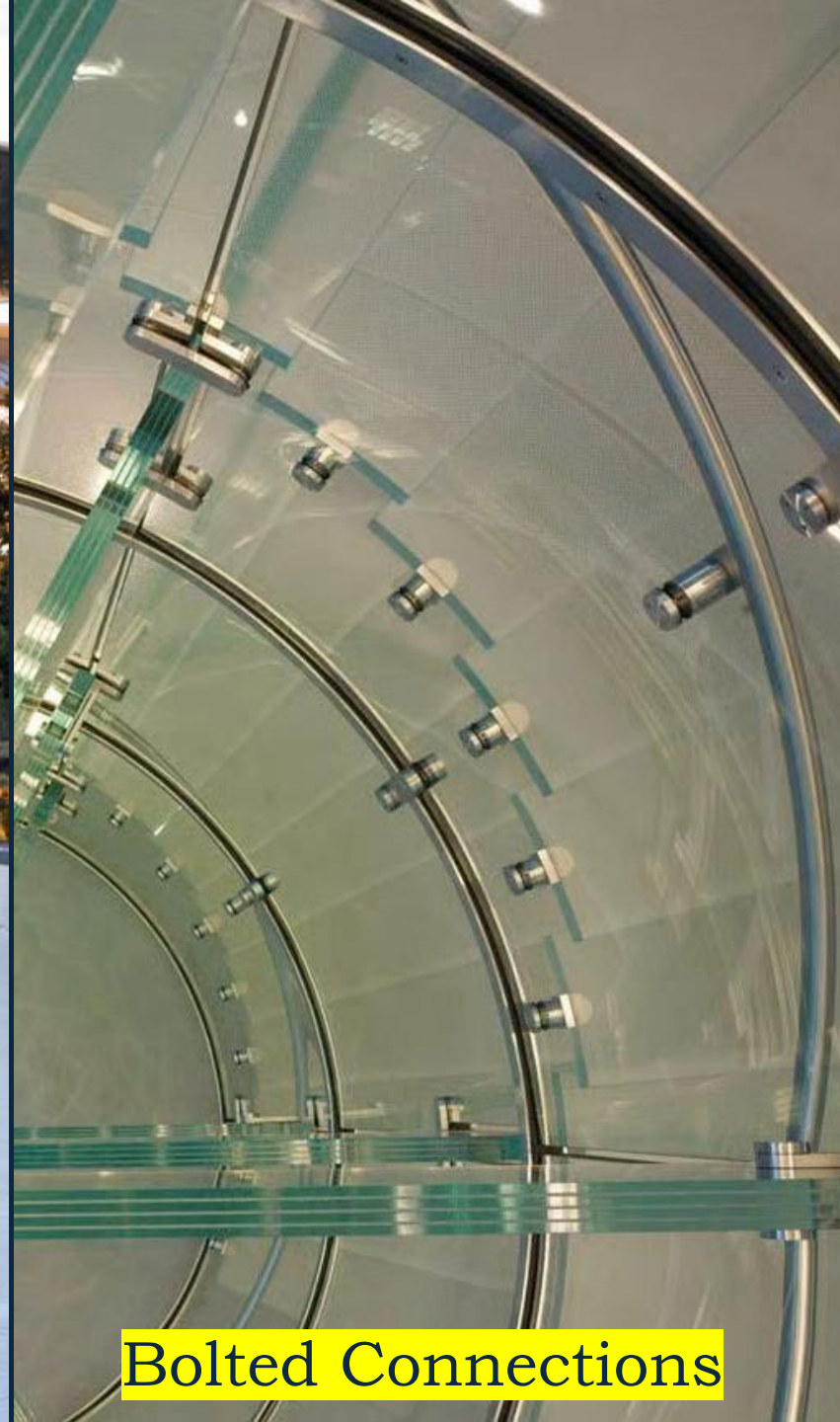








Adhesive based



Bolted Connections

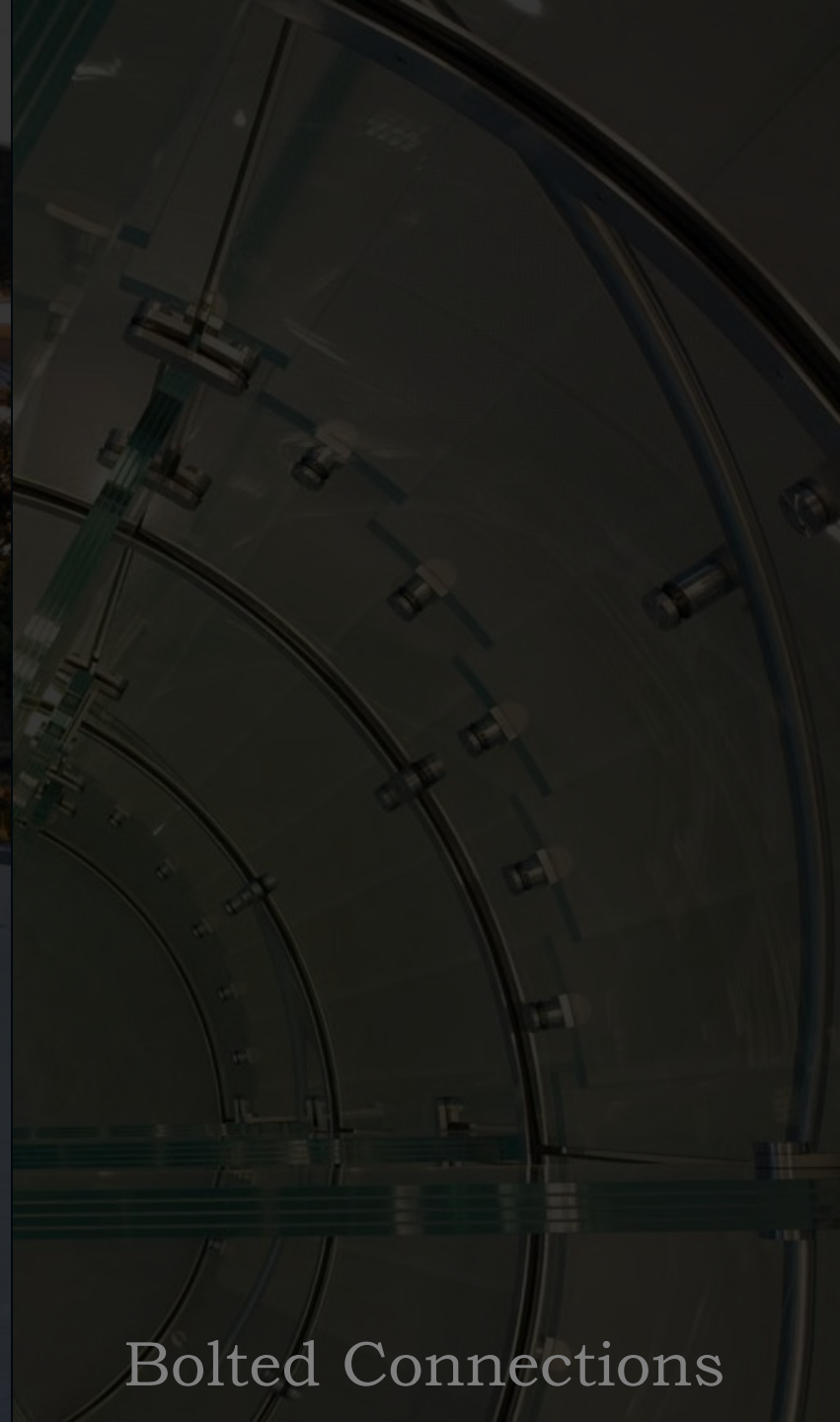


Laminated inserts

- Efficient in load transfer.
- Vibration damping due to elastic behaviour
- Well-established and continuous innovations.

- UV degradation
- Panels are difficult to detach
- Maintenance and removal of sealant is costly and impractical onsite.
- Limits reusability due to bonded interface.

Adhesive based



Bolted Connections



Laminated inserts

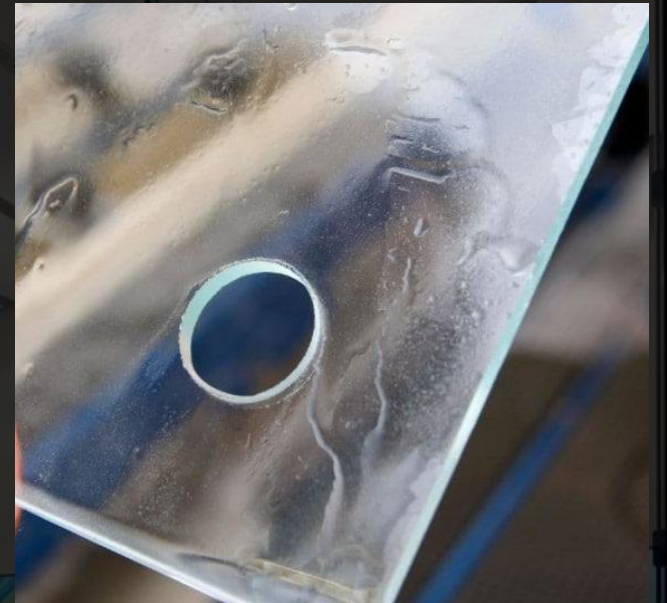


Adhesive based

- Effective and reliable in load transfer.
- Good for replaceability/ maintenance

- Requires drilling holes into glass panels
- Damages glass integrity.
- Significantly limits the panel reusability.

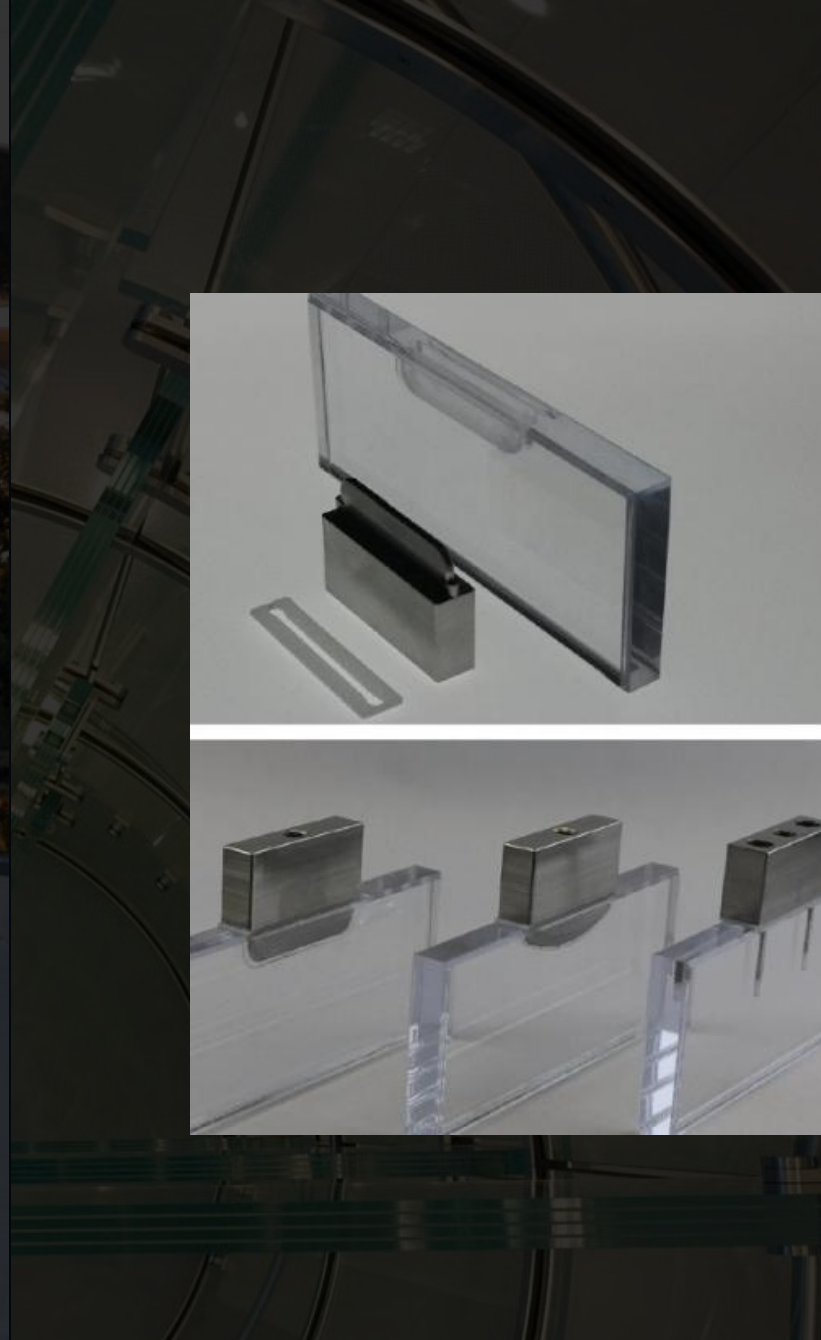
Bolted Connections



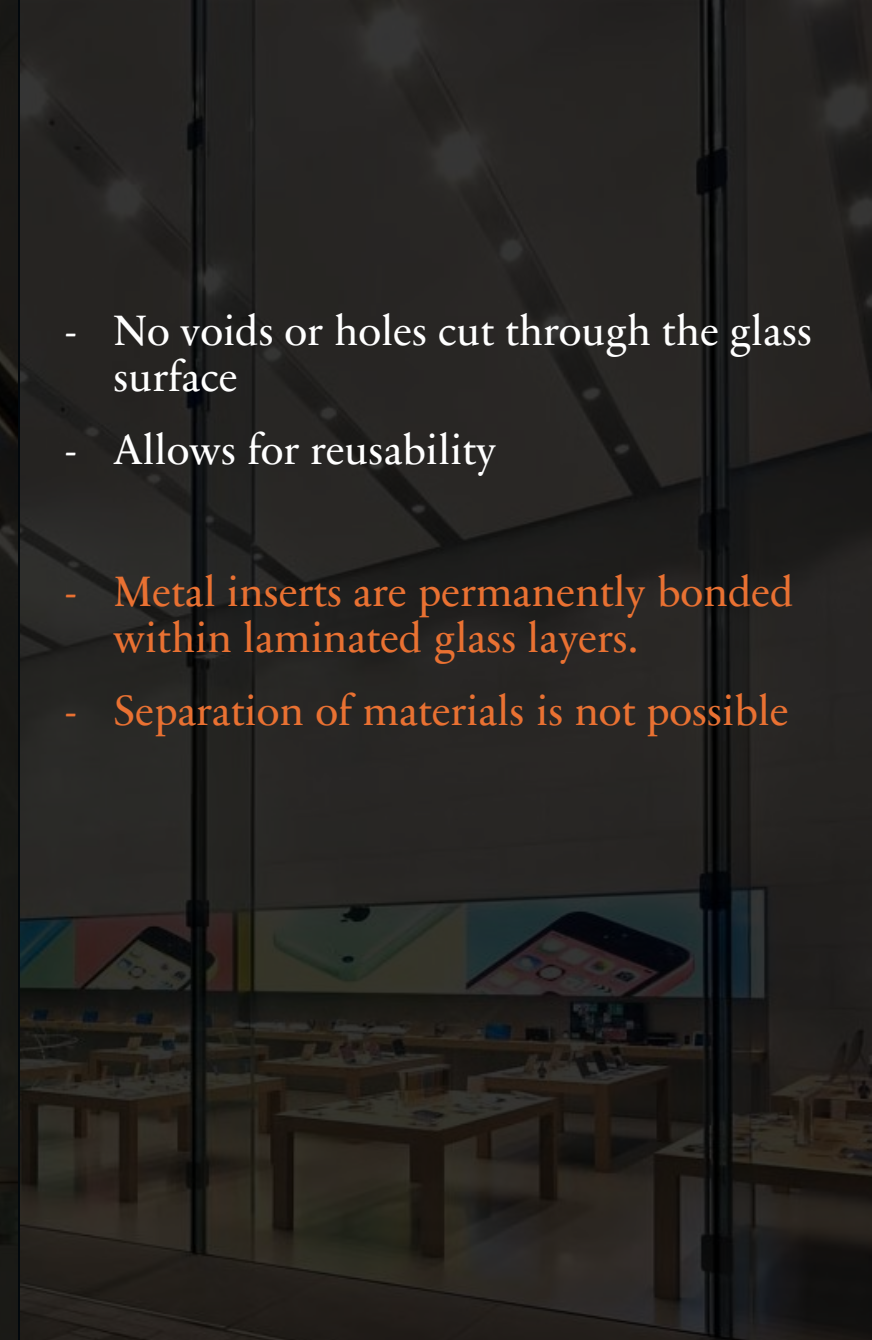
Laminated inserts



Adhesive based



Bolted Connections



Laminated inserts

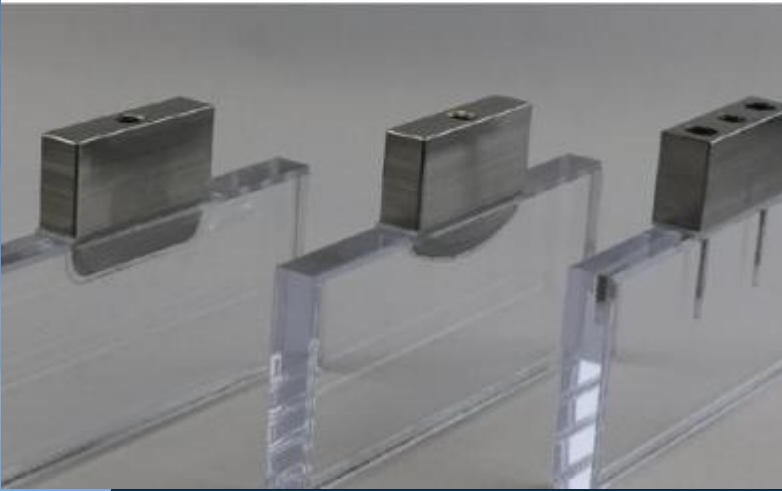
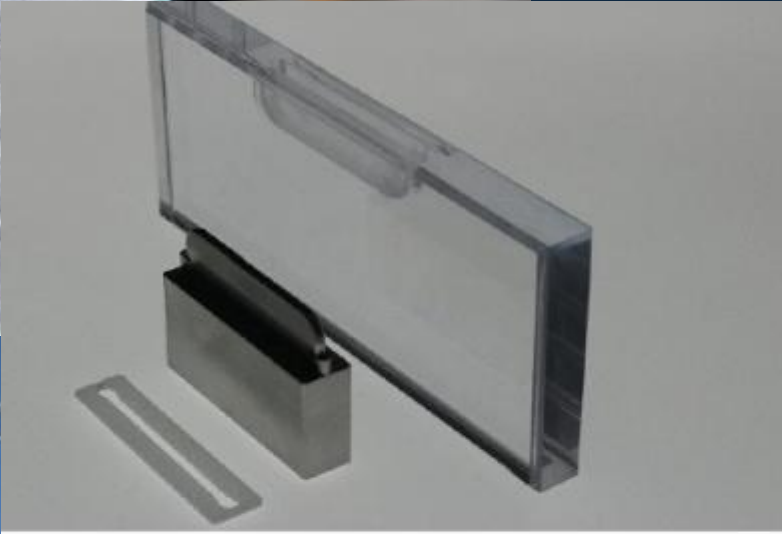
- No voids or holes cut through the glass surface
- Allows for reusability
- Metal inserts are permanently bonded within laminated glass layers.
- Separation of materials is not possible

End of Life?

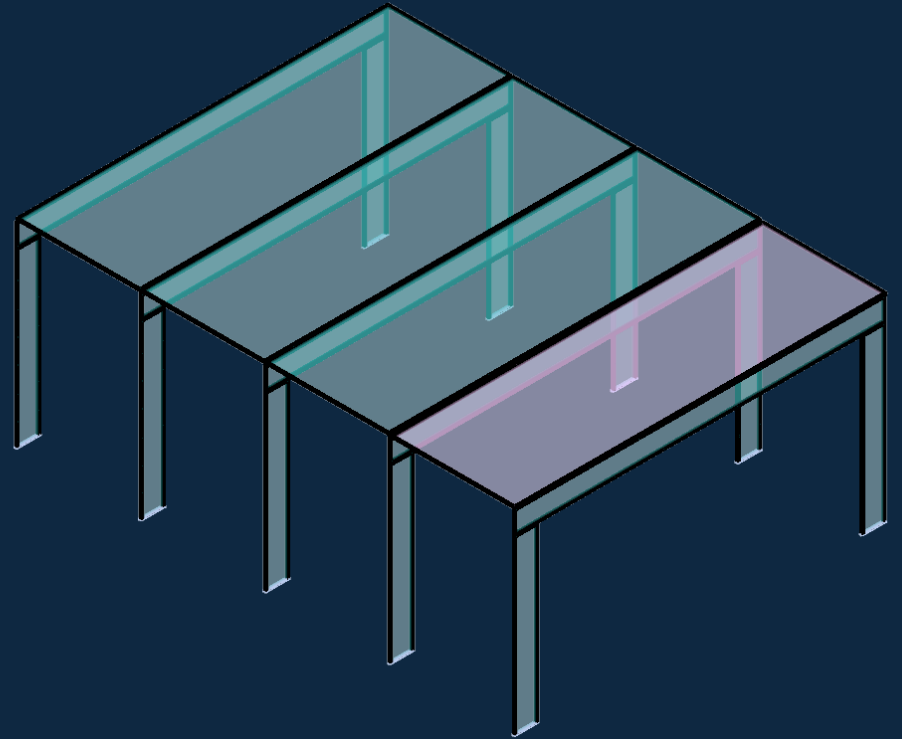
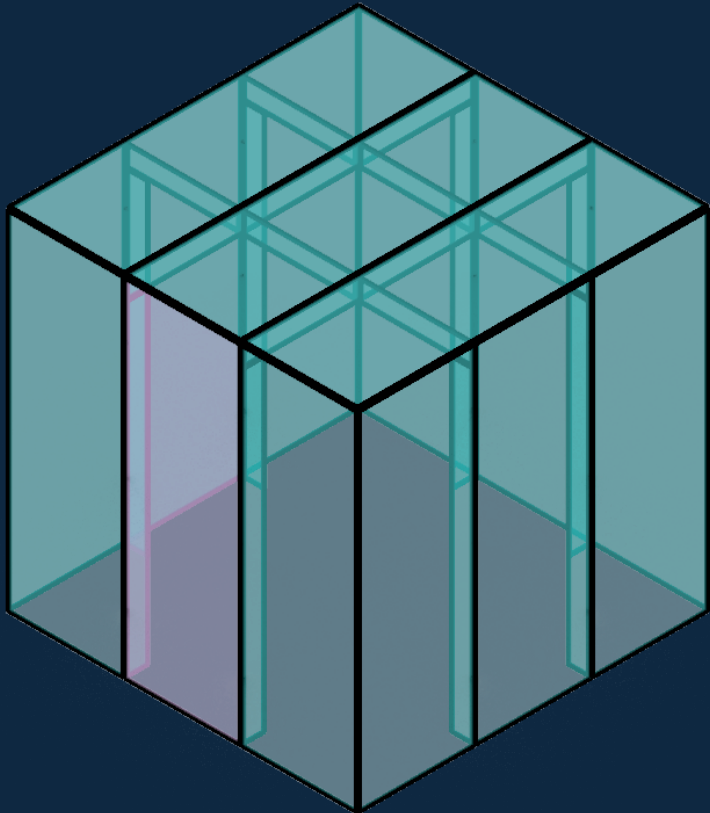
Landfills..



Reuse?



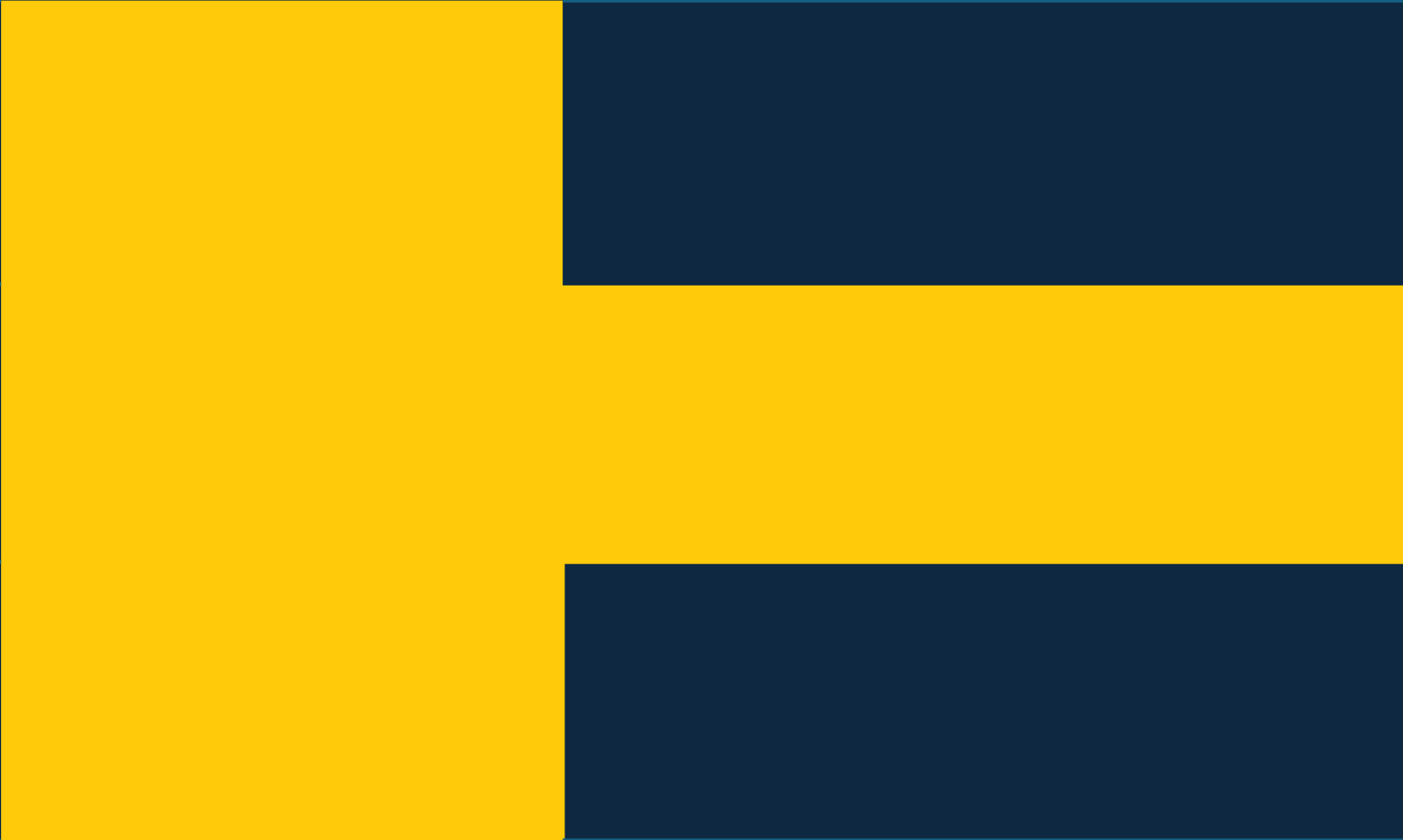
Solution?



Solution?



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Fully Demountable glass Connection
for large-scale structural applications

Master Thesis

22-06-2026

Krishna Koushik Venigalla

6177336

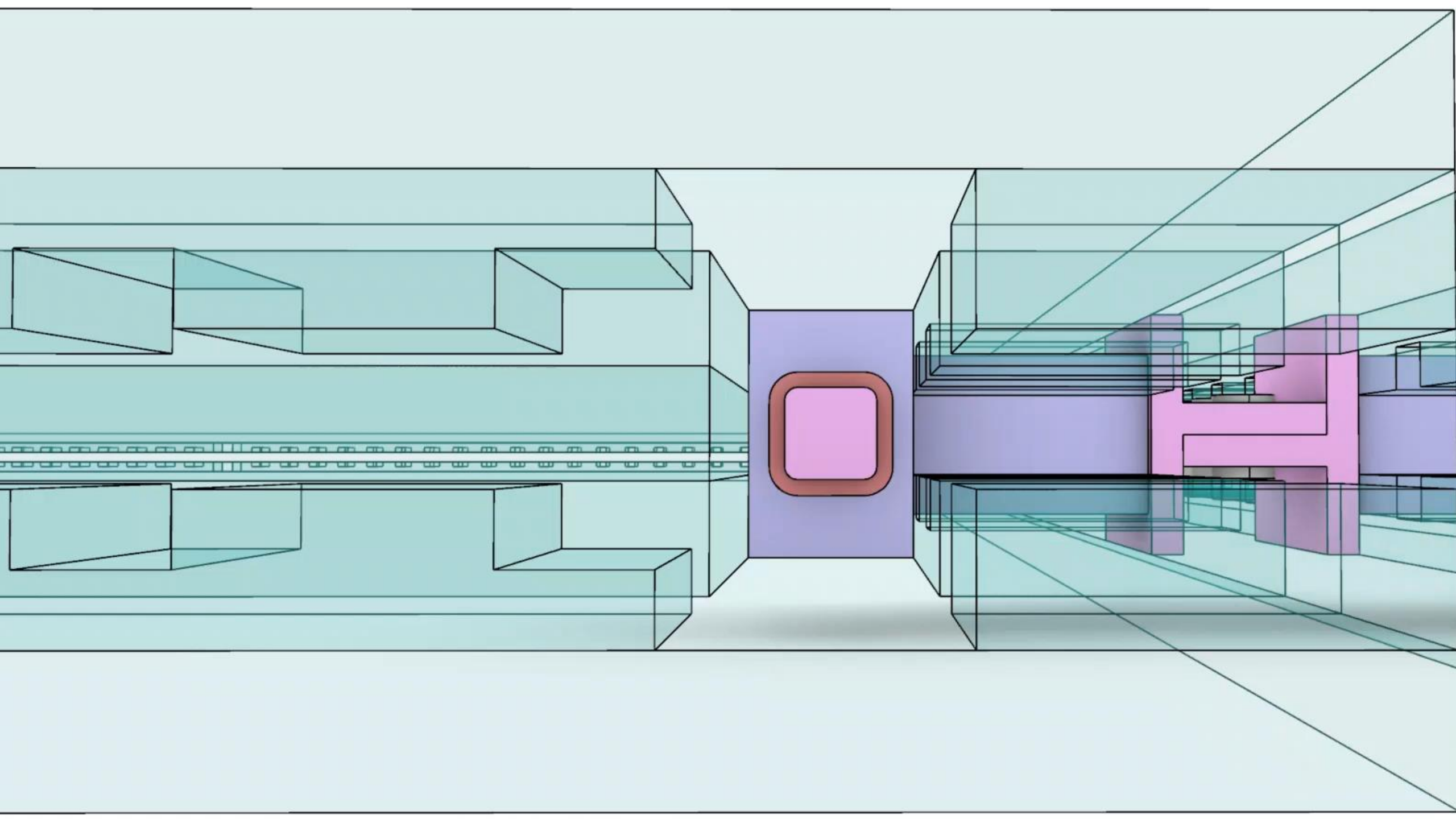
Supervisors

Faidra Oikonomopoulou

Marcel Bilow

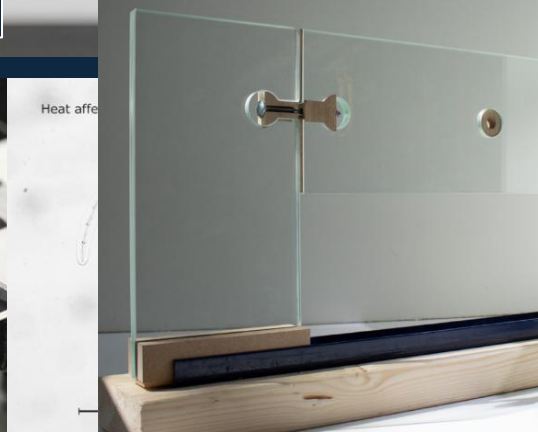
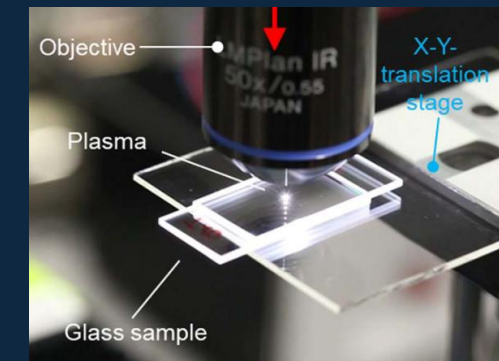
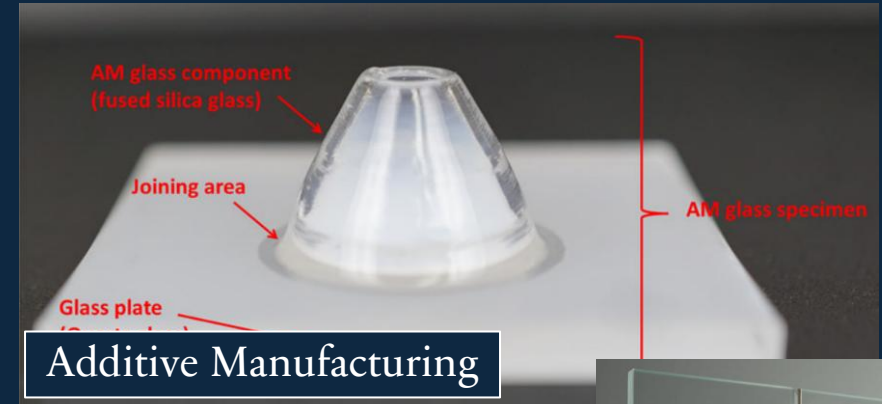
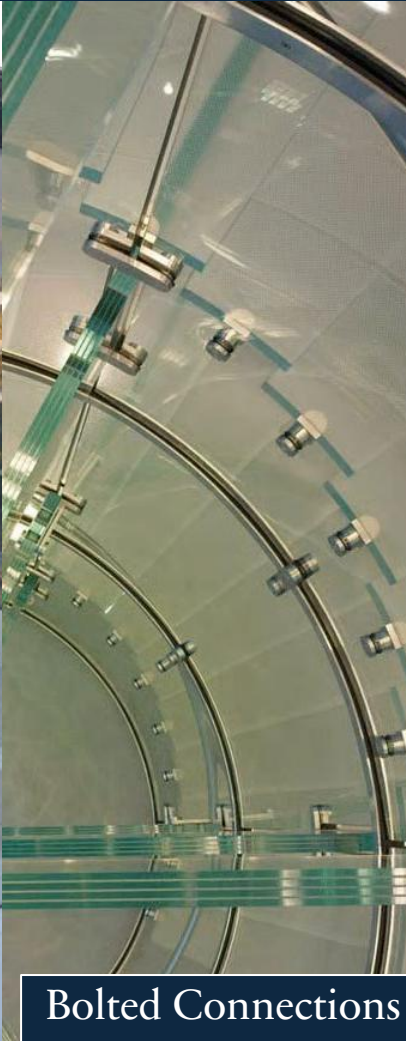
Consultant

James O'Callaghan

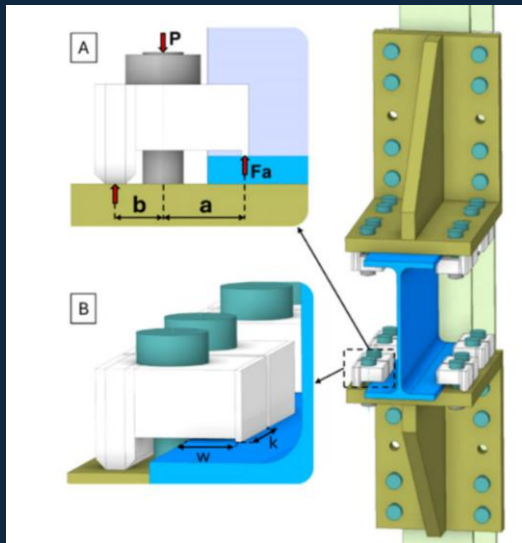
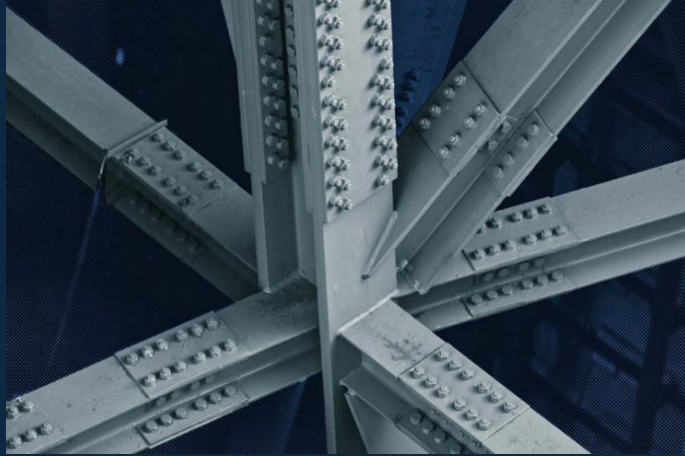


How can a **fully demountable** connection system be developed for **large-scale structural glass panels** without modifying or damaging the glass, while still meeting the necessary structural and durability requirements?

Glass connections



Demountable connections in the industry



Summary

Status of existing and upcoming connections

- Demountability
- Reusability
- Maintenance scope

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Reusability

Interlocking systems

Embedded laminates

Bolted Connections

Additive Manufacturing

Poor

Adhesive-based

Recyclability

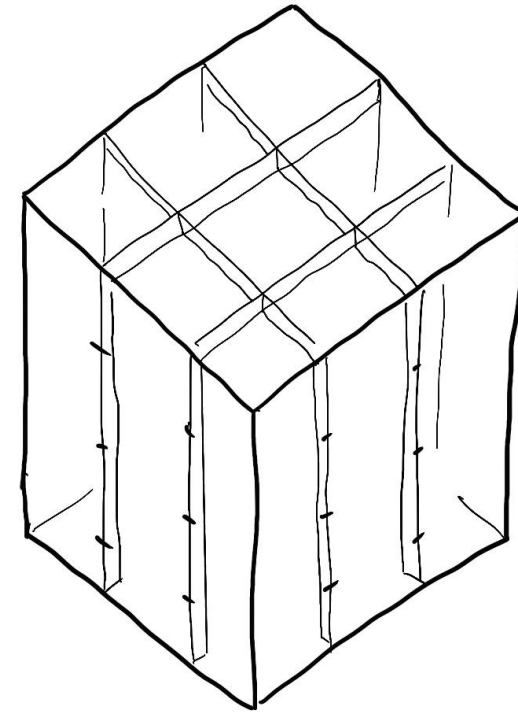
Heat bonding

Design Benchmarks

Design Benchmarks

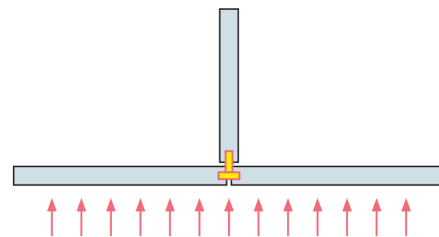
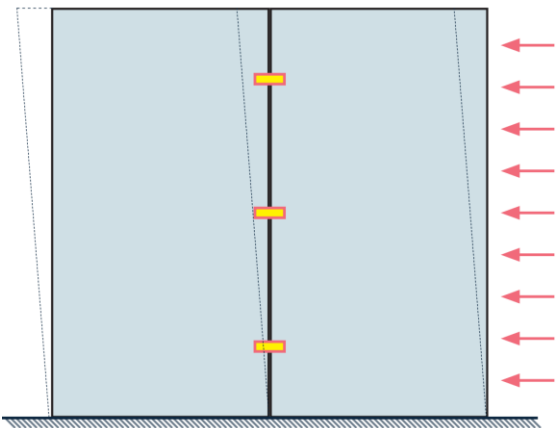
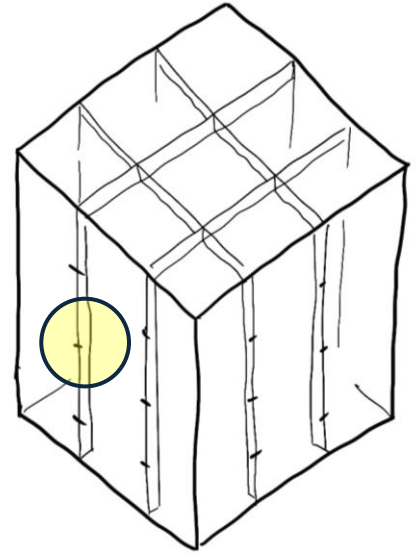


Apple fifth Avenue, version 2



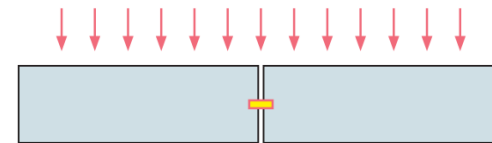
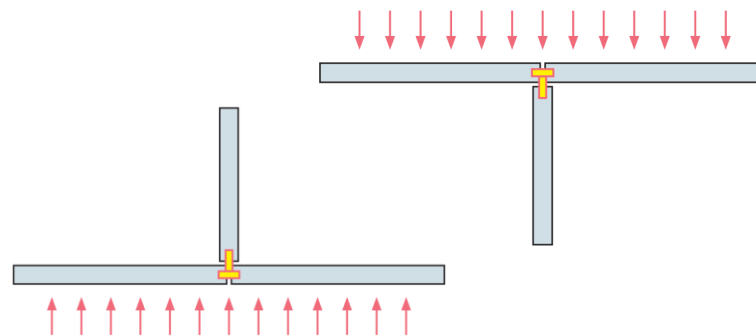
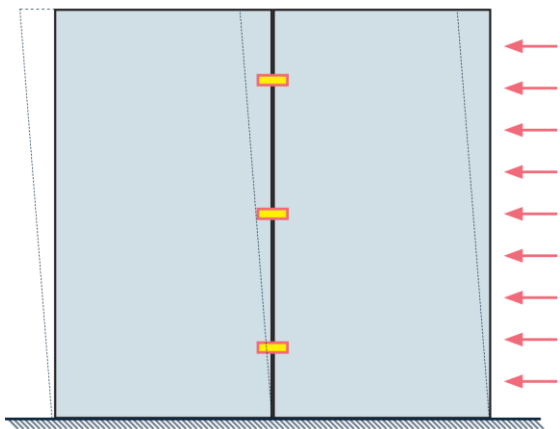
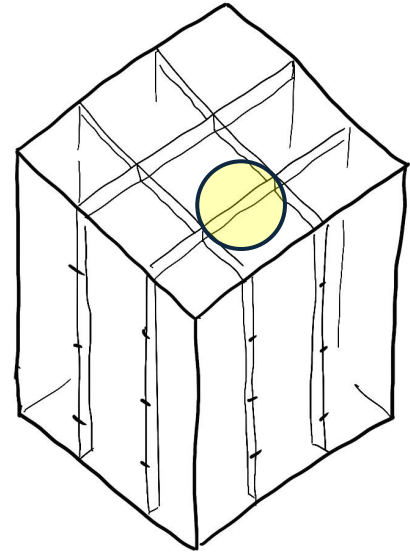
Load cases

- Façade – 2 panels
- Façade T junction



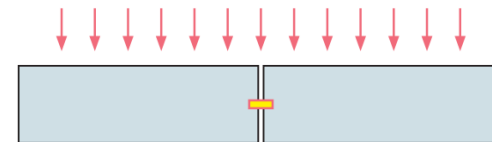
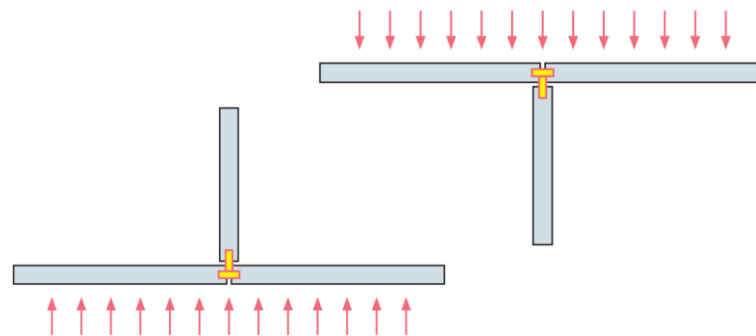
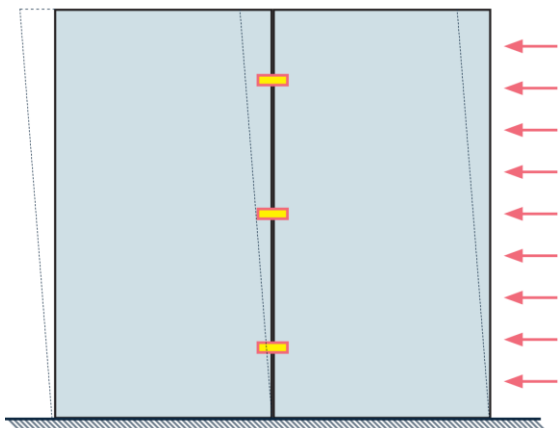
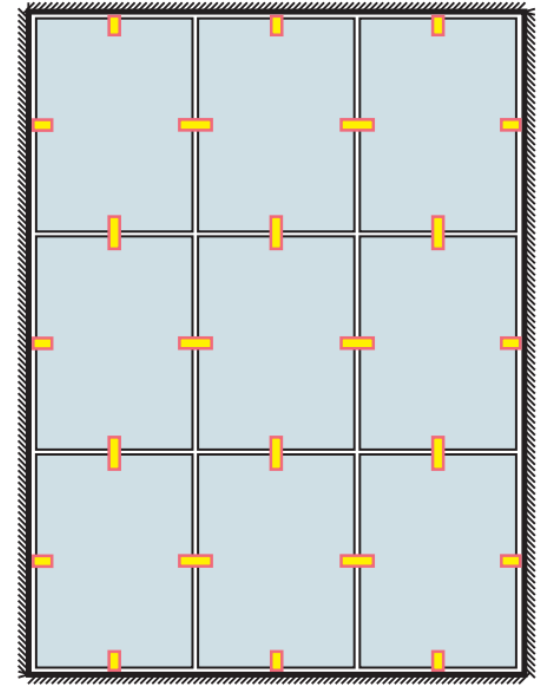
Load cases

- Façade – 2 panels
- Façade T junction
- Roof panels-to-beam: T junction
- Beam-to-beam connection (under roof load)

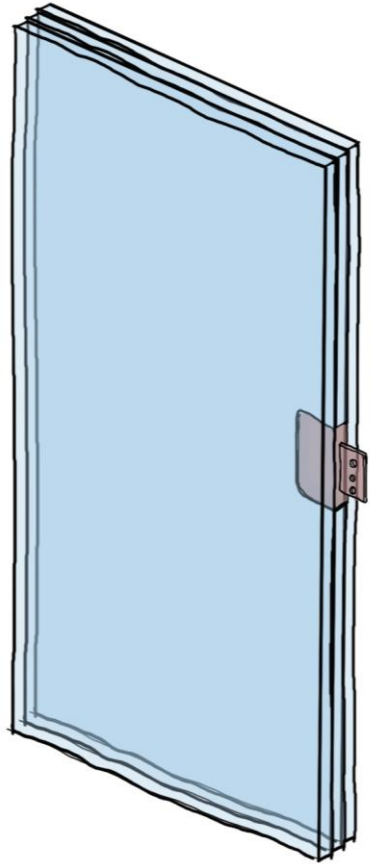


Load cases

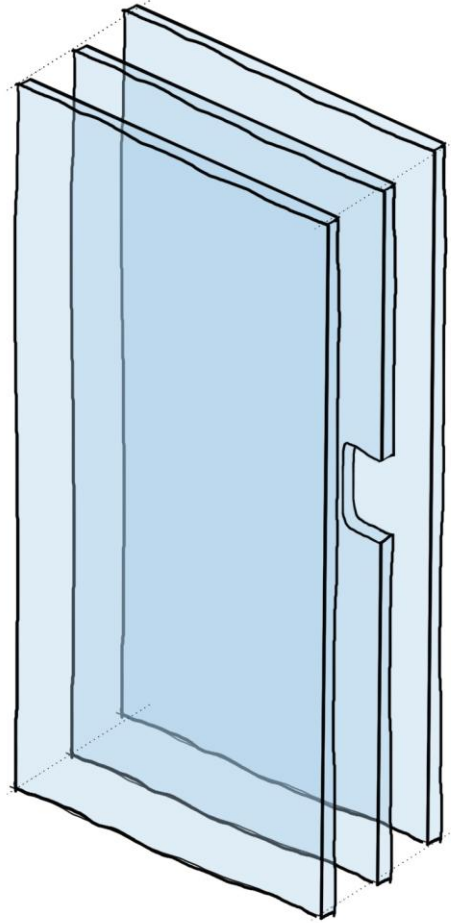
- Façade – 2 panels
- Façade T junction
- Roof panels-to-beam: T junction
- Beam-to-beam connection (under roof load)
- Grid of 3x3 panels – to figure out assembly sequence



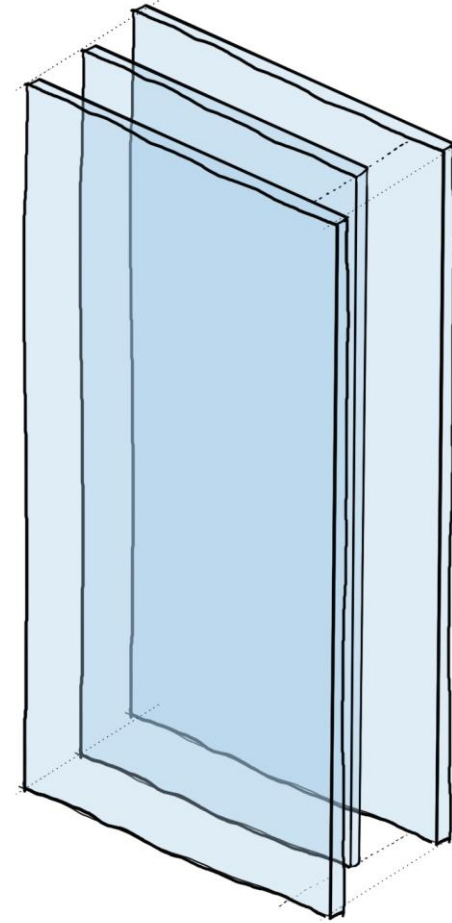
Design Concepts



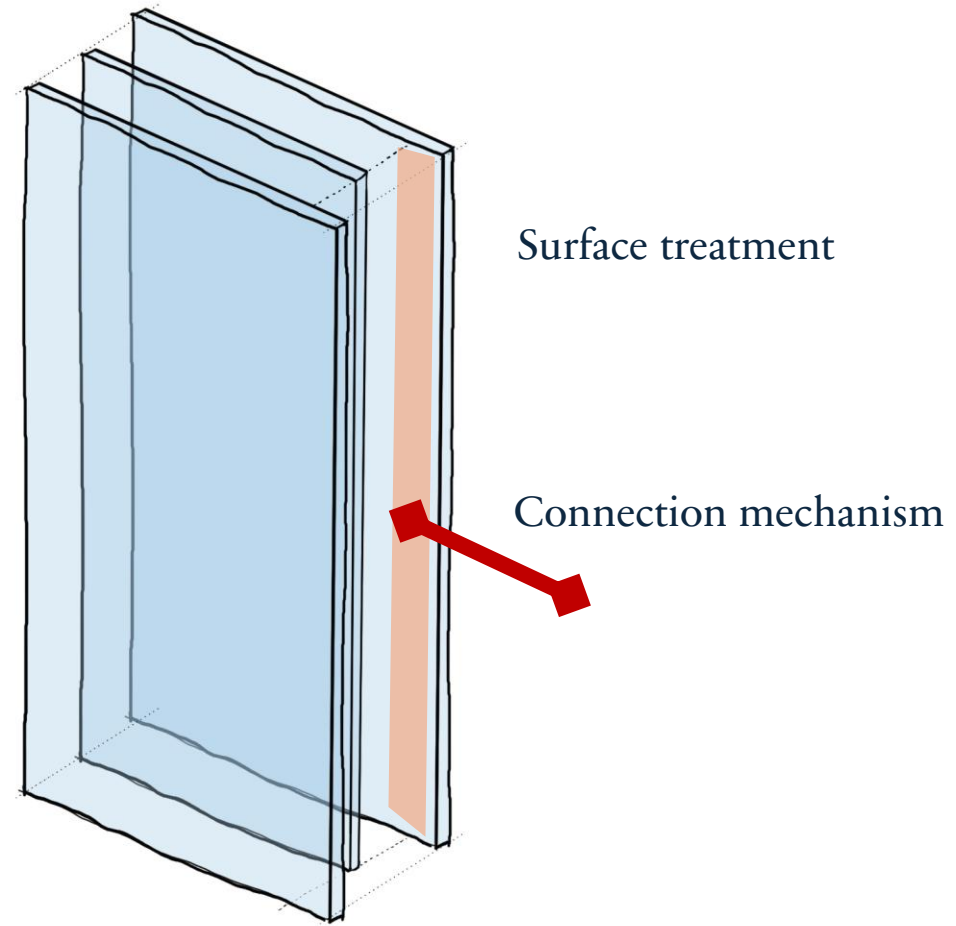
Laminated inserts

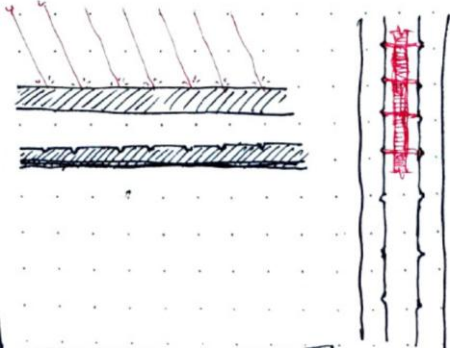
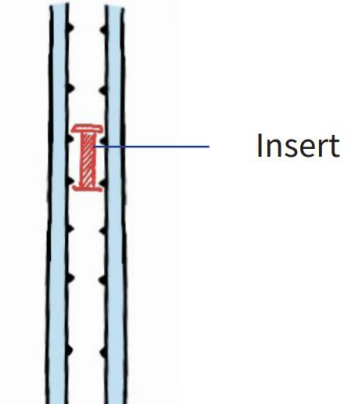
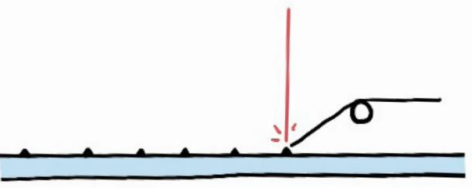
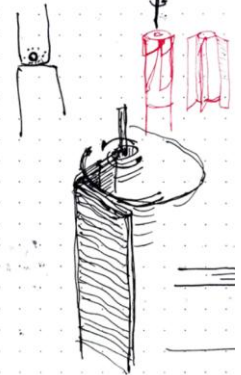
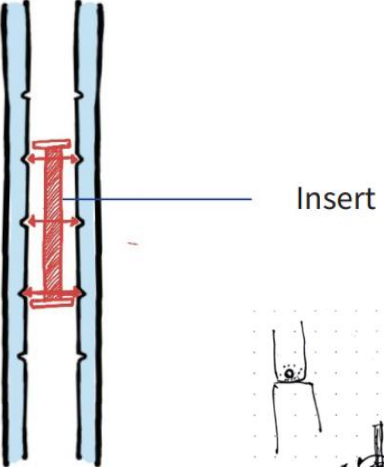
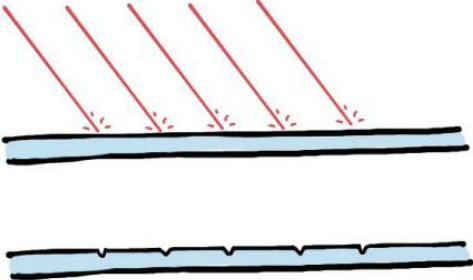
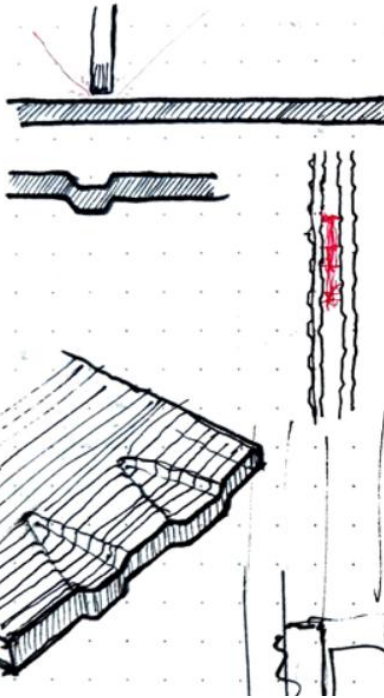
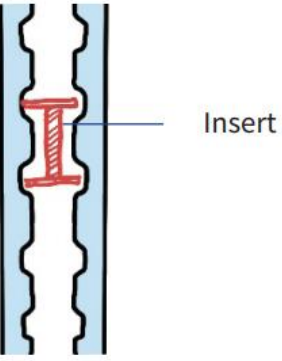
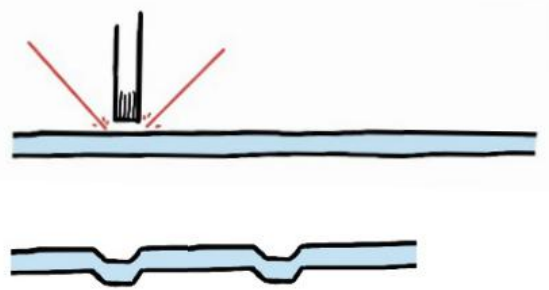
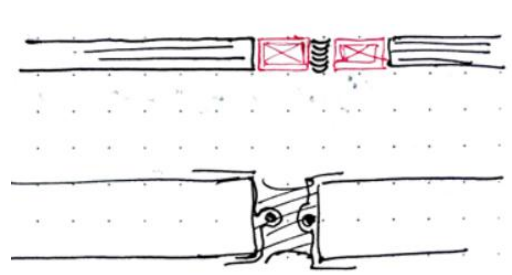
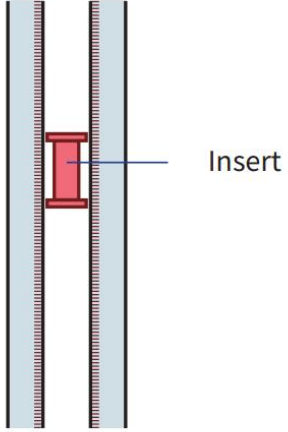
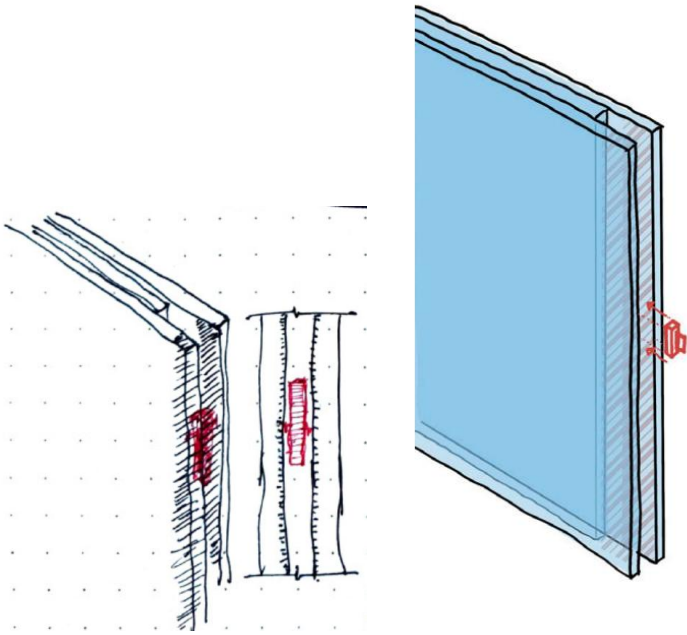


Existing panels

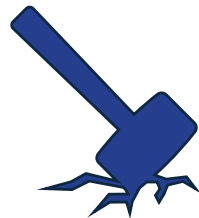


Suggested panel modification





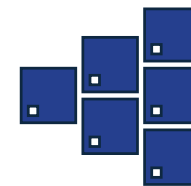
Surface Treatment

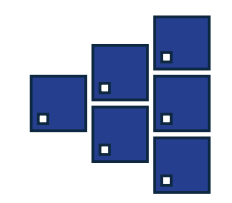
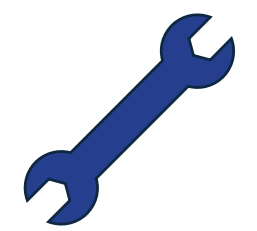
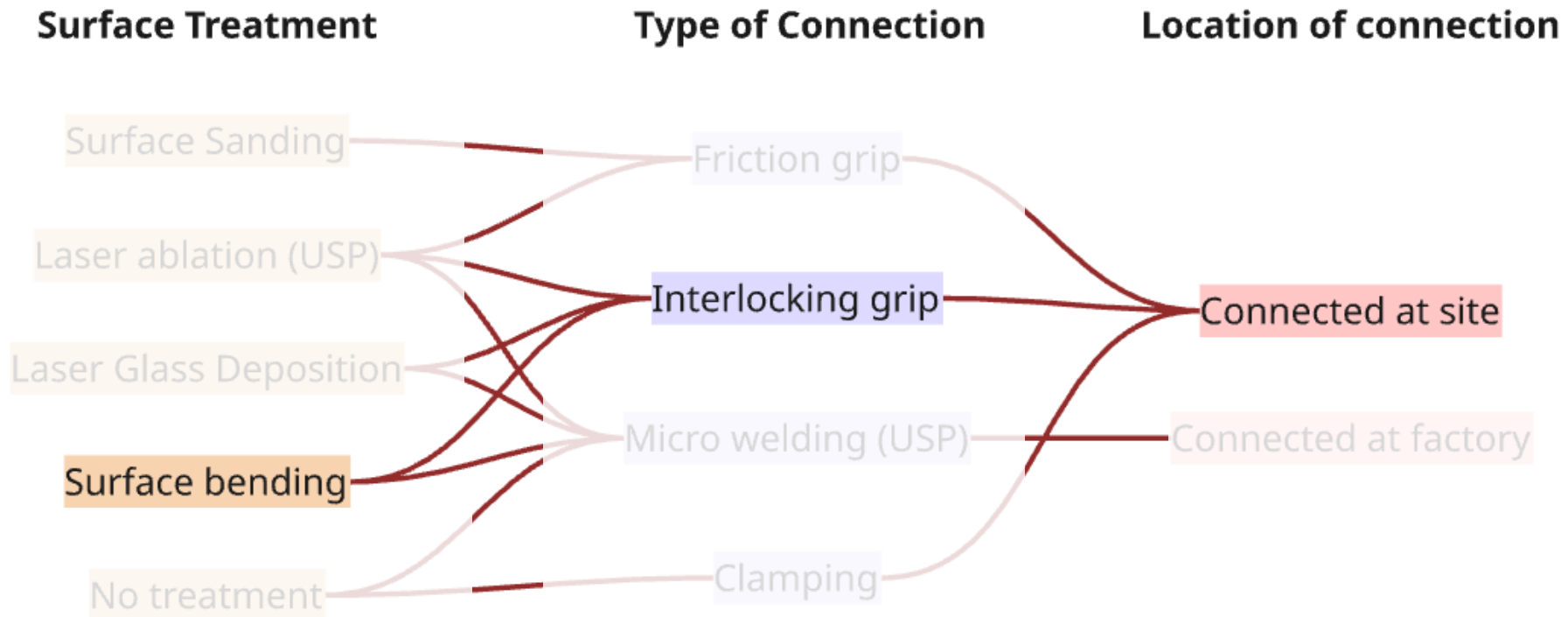


Type of Connection

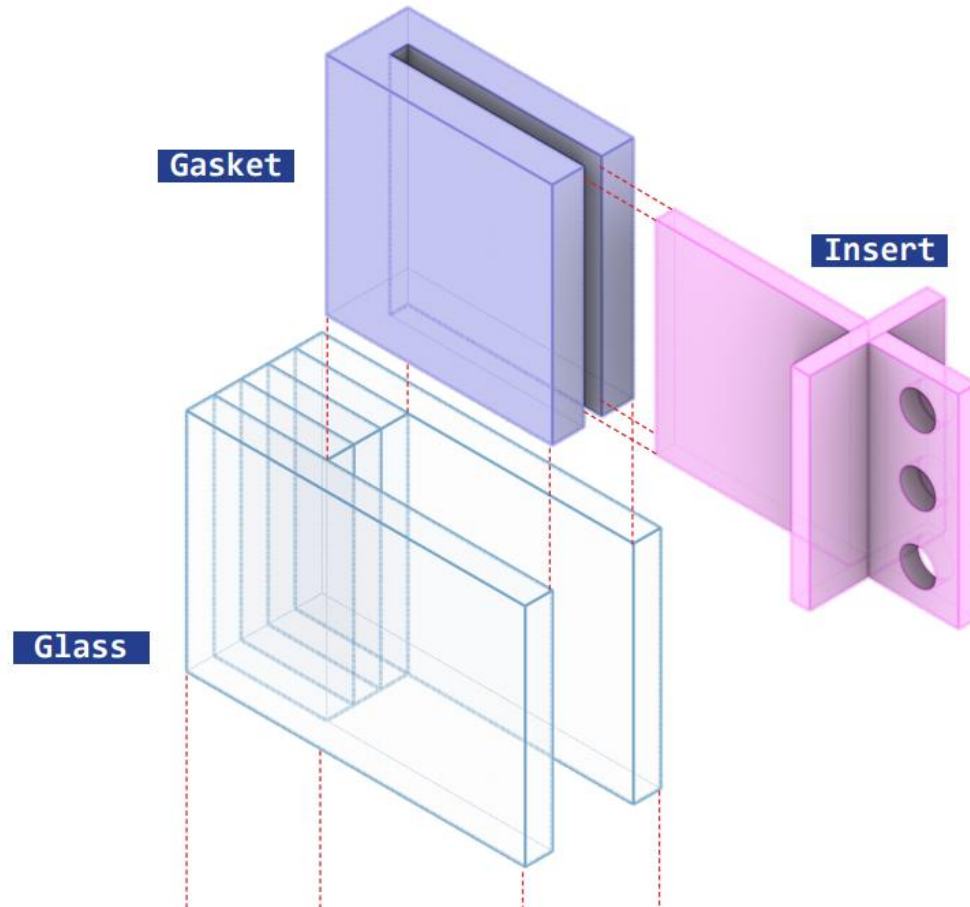


Location of connection

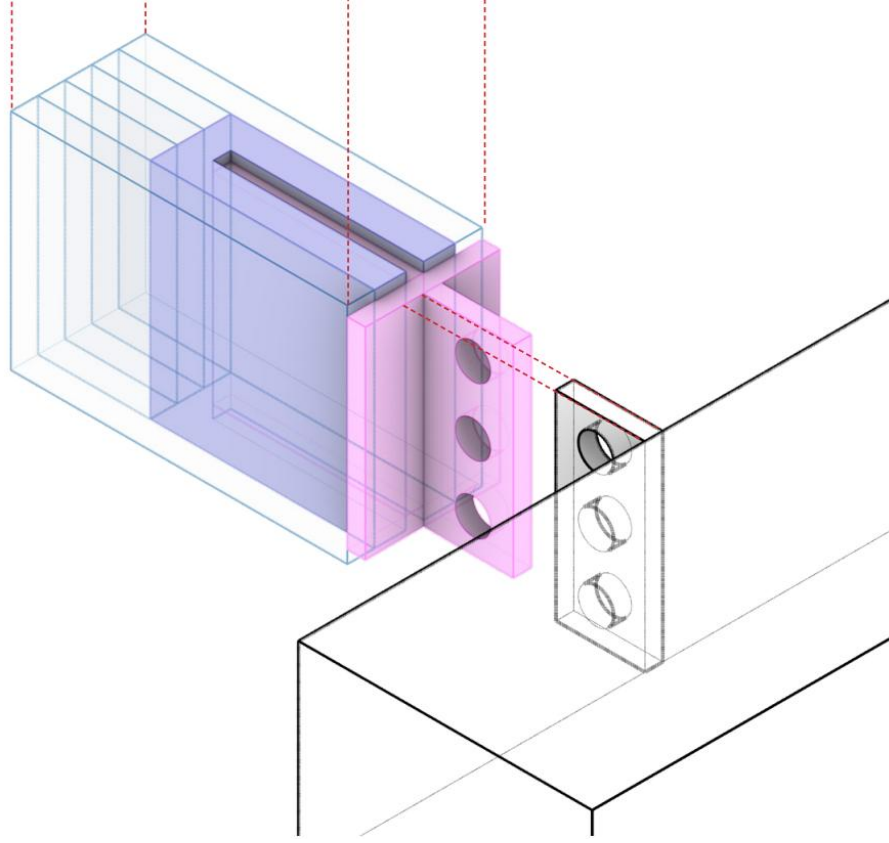




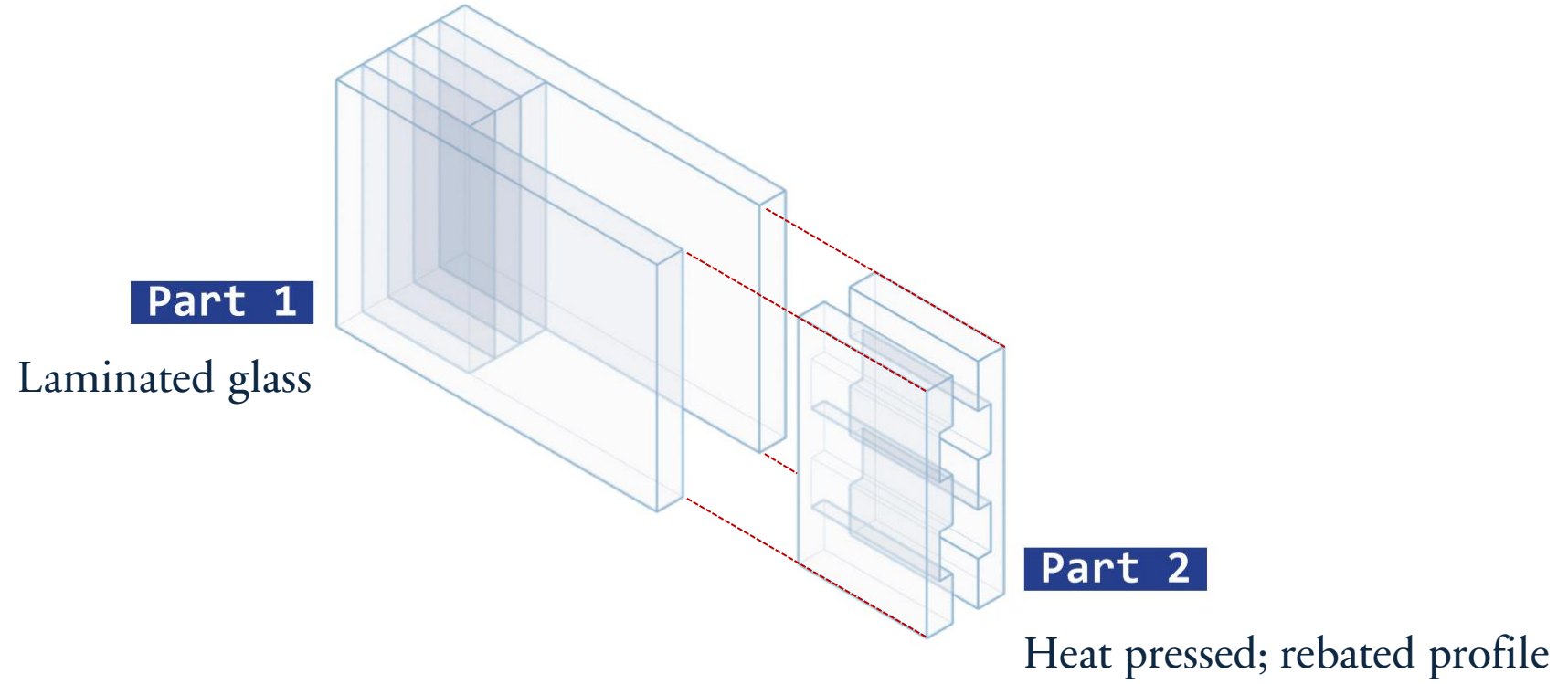
The Uni.conn



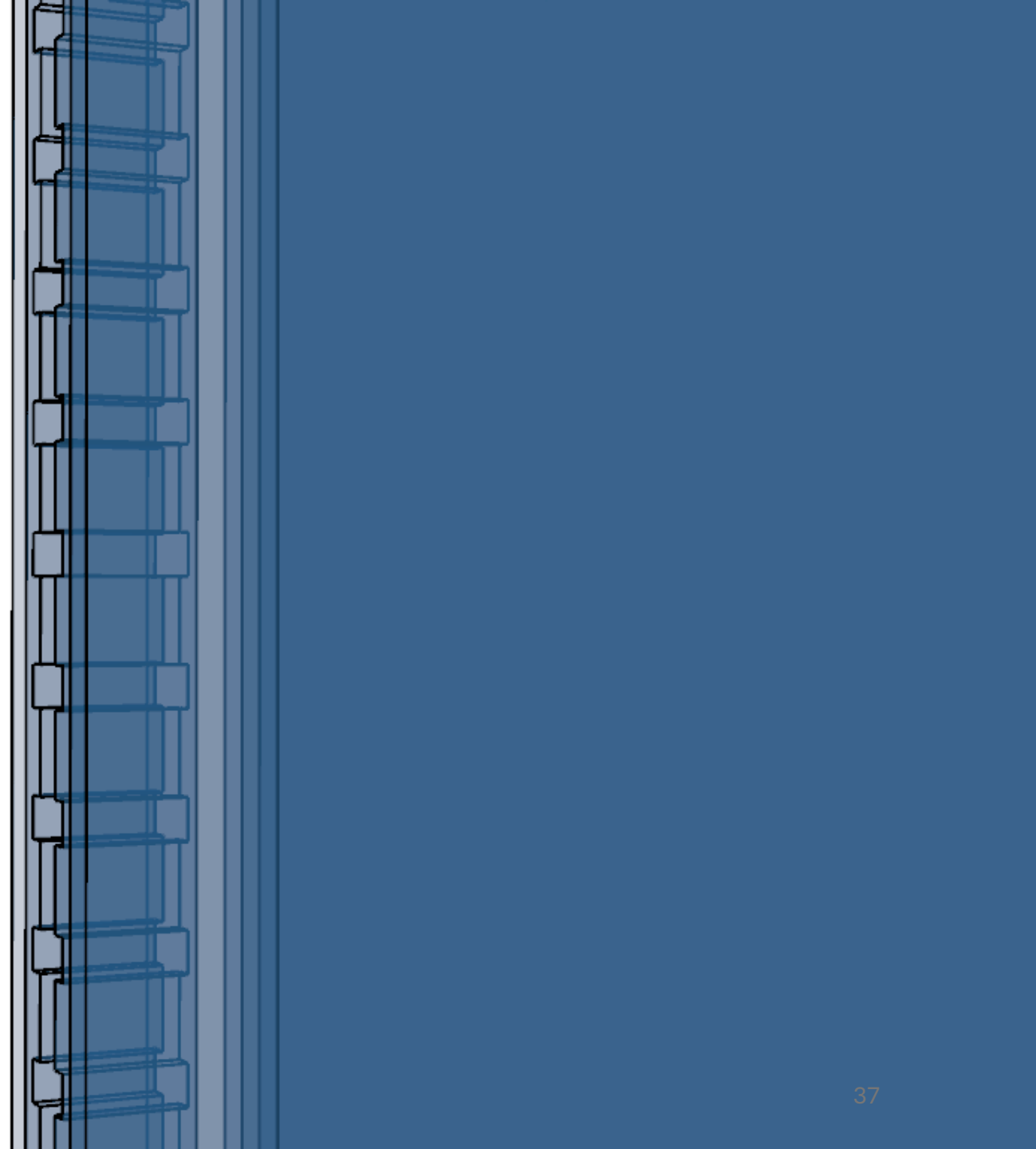
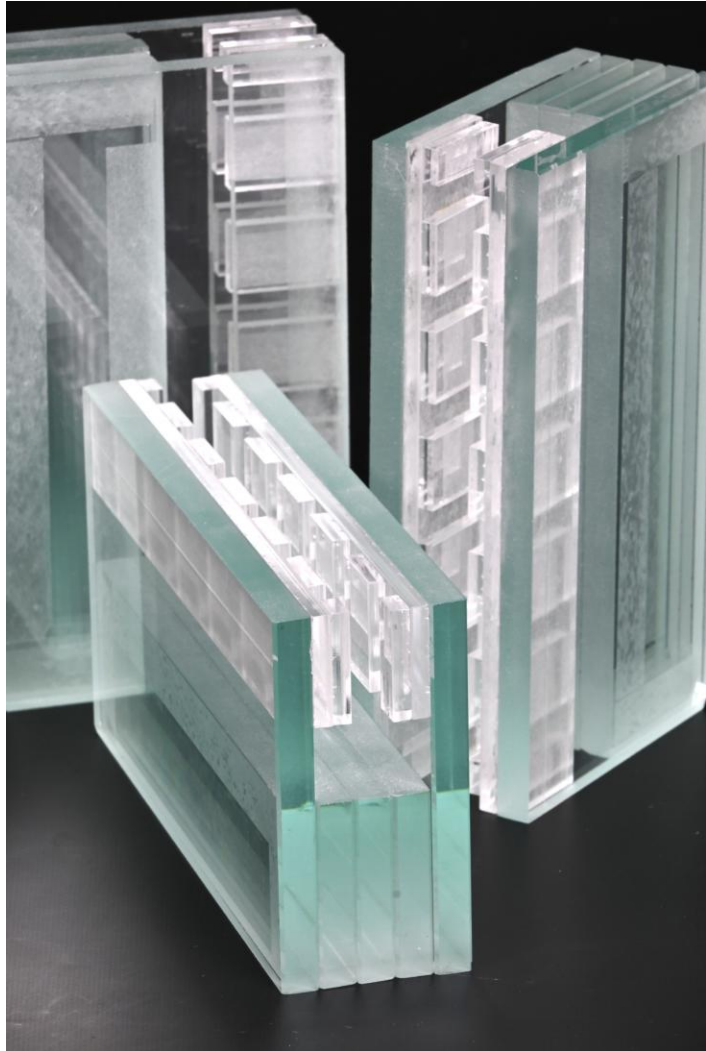
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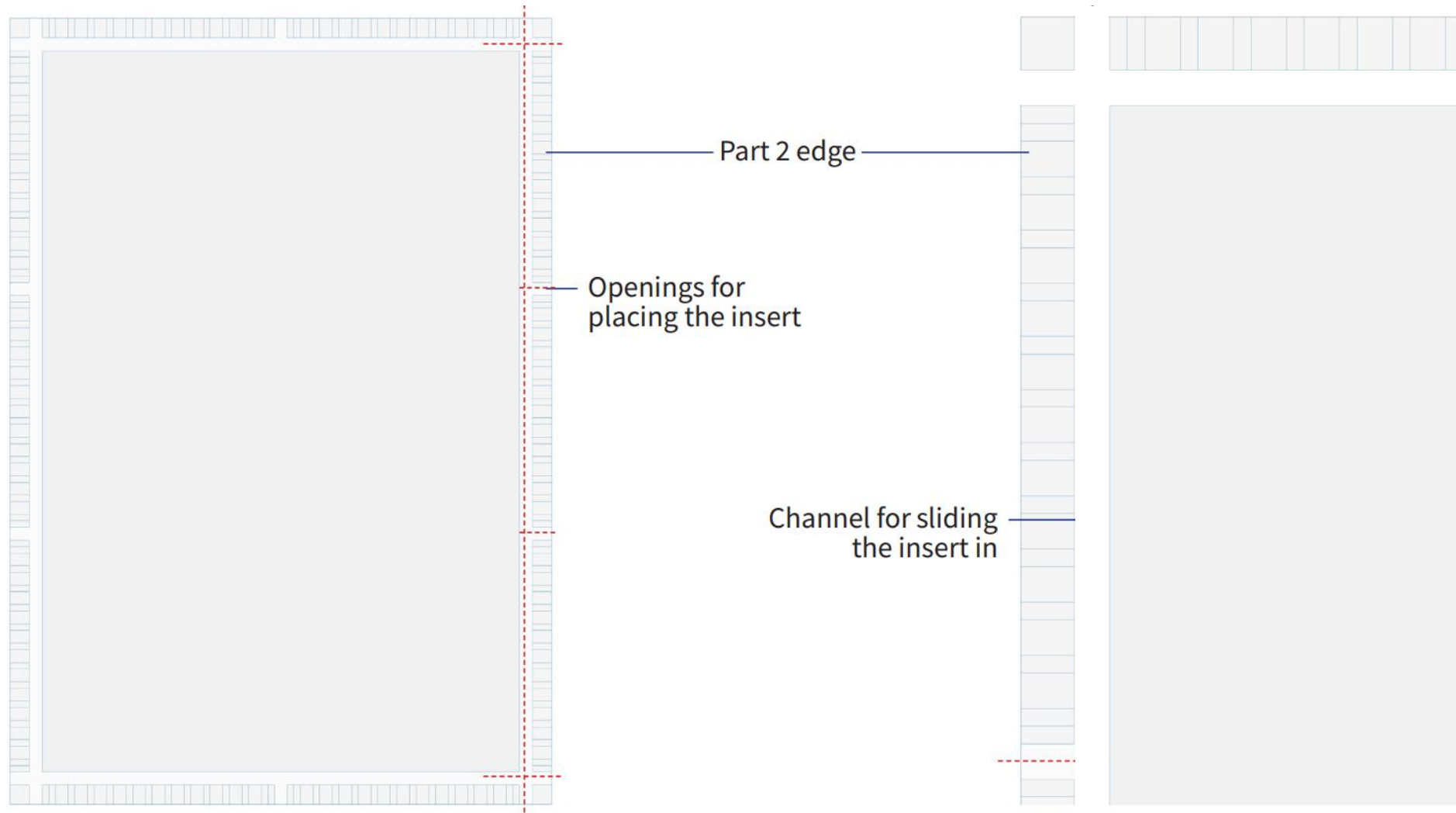
Glass



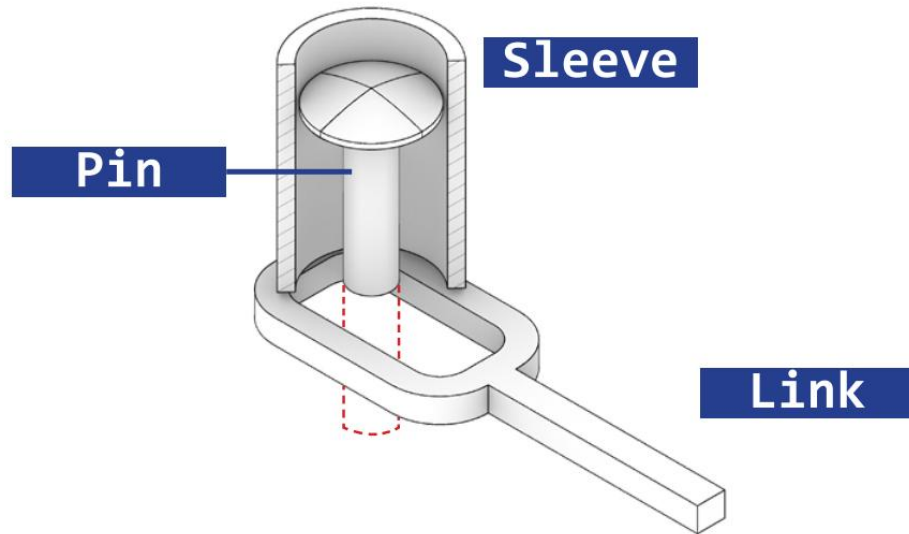
Glass



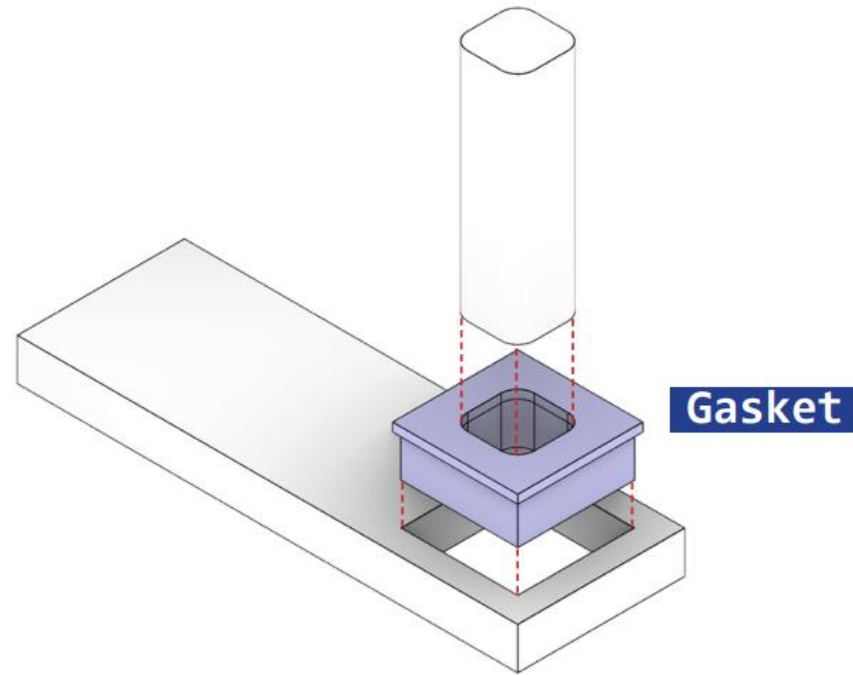
Glass



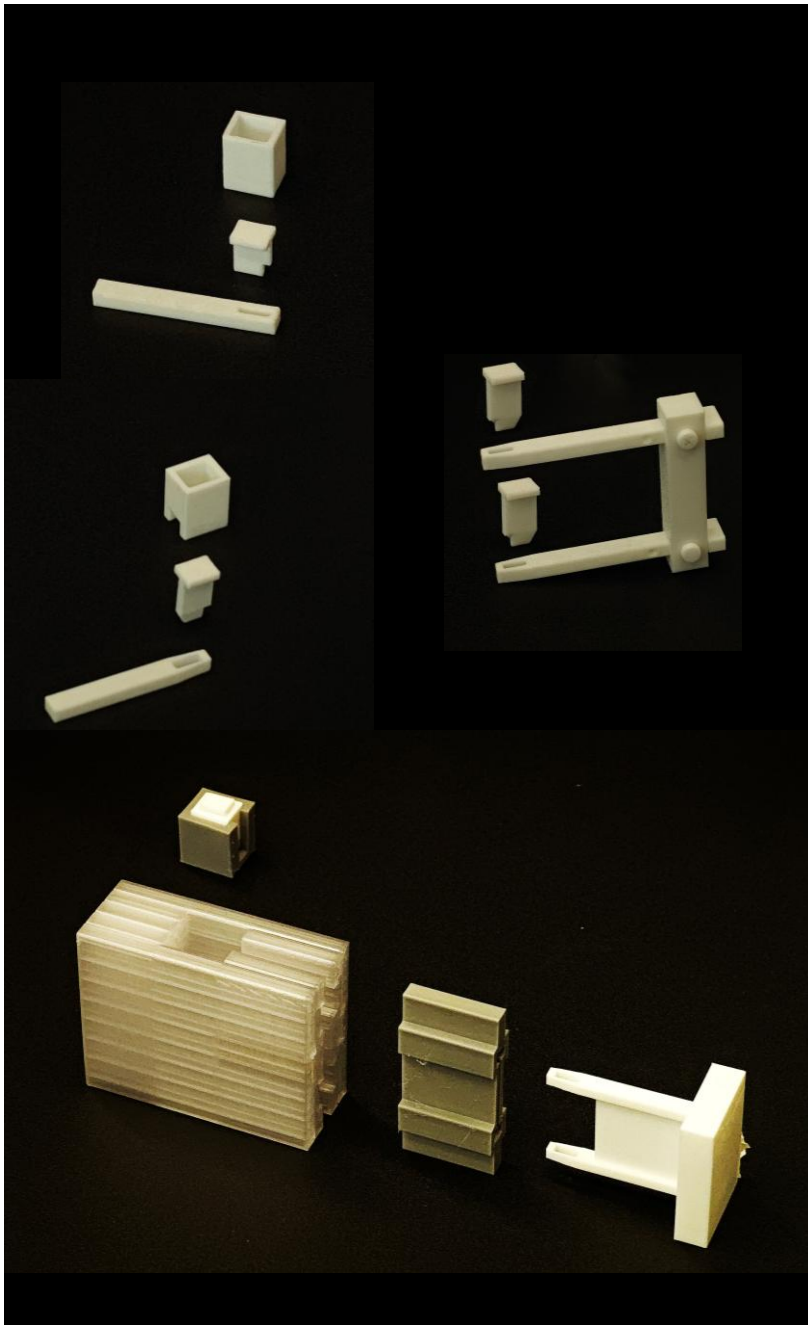
Insert



Gasket

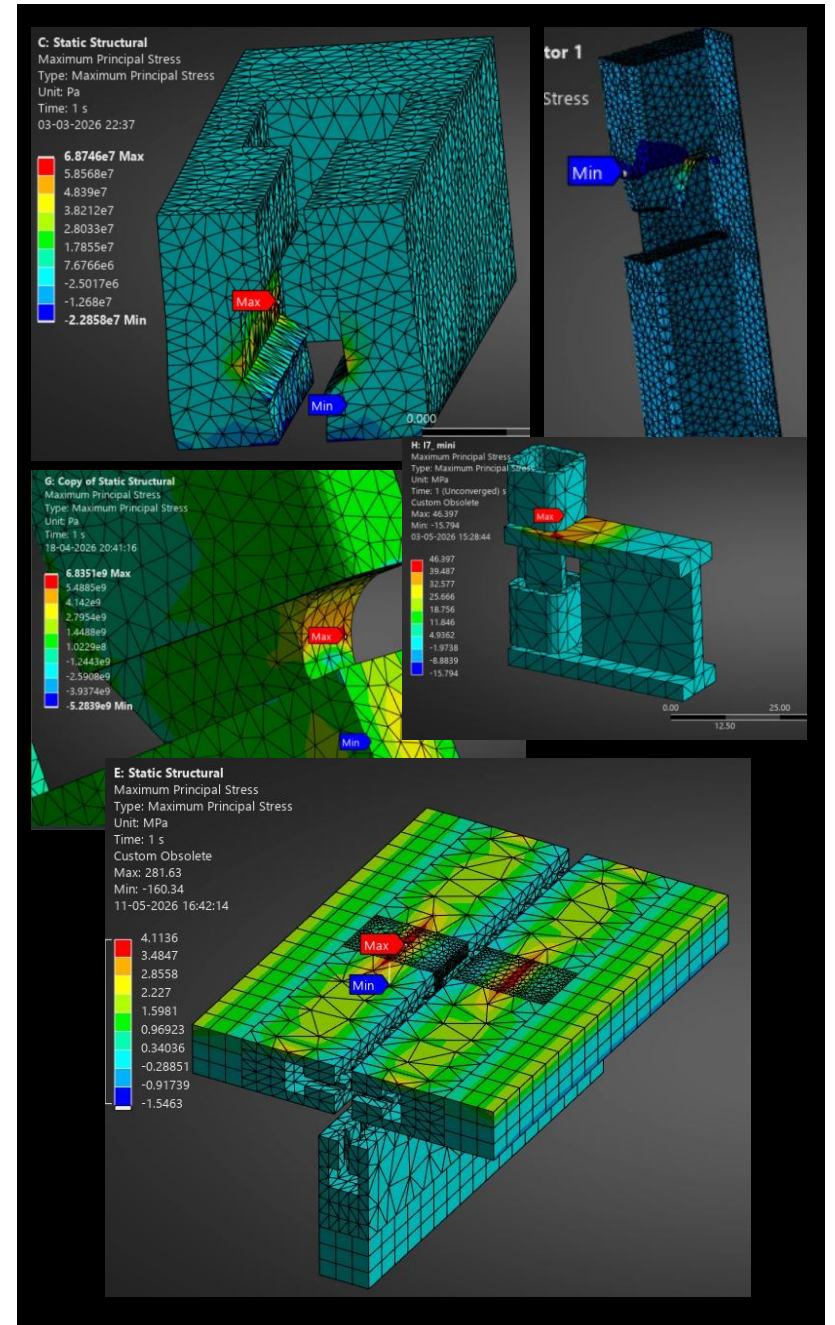


Design iterations

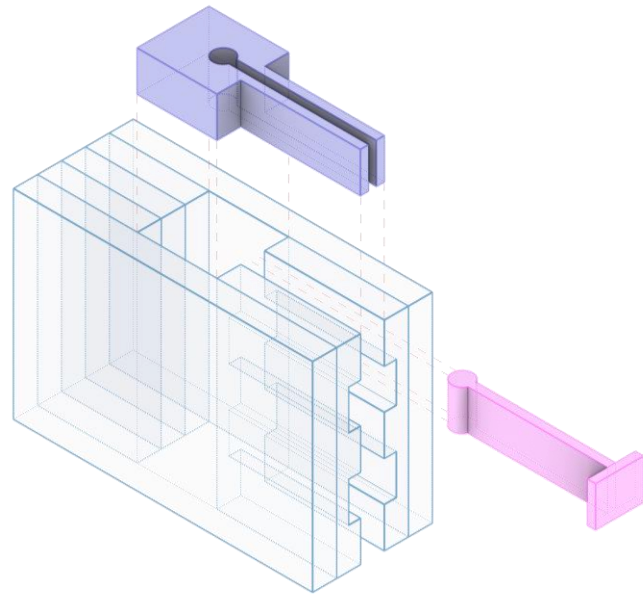


Design iterations

Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1
			G2
Iteration 2	Version 1	I1	G3
		I2	
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4
			G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6	G5
		I6.1	
Iteration 7	Version 3	I7 V	G6 V
		I7 H	G6 H

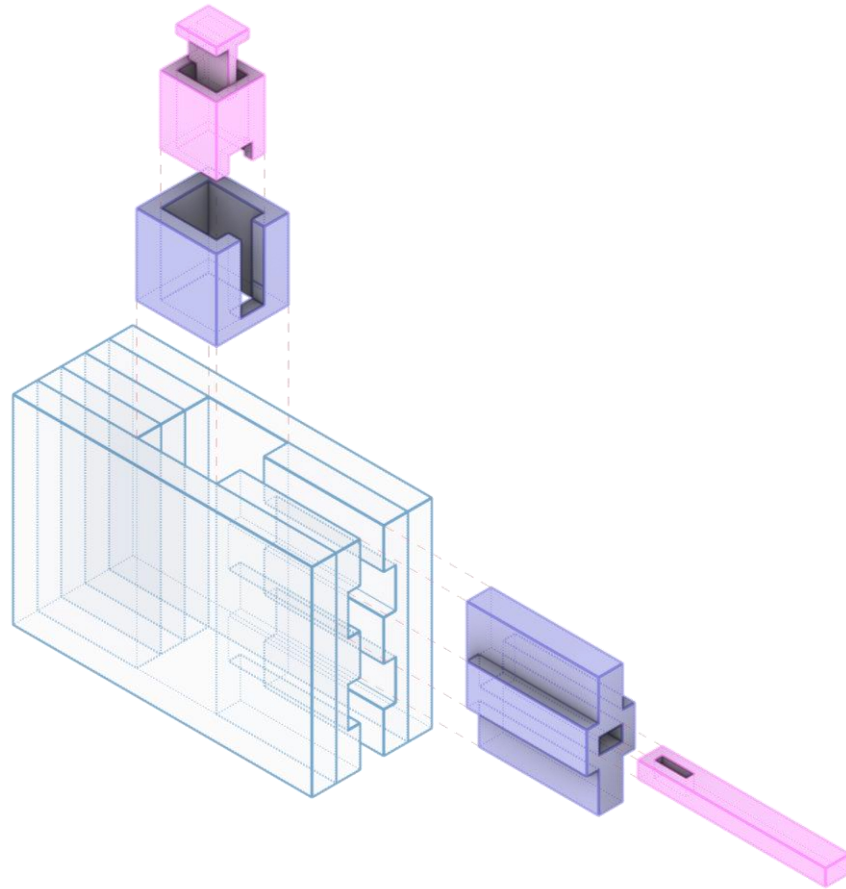


Design iteration 1



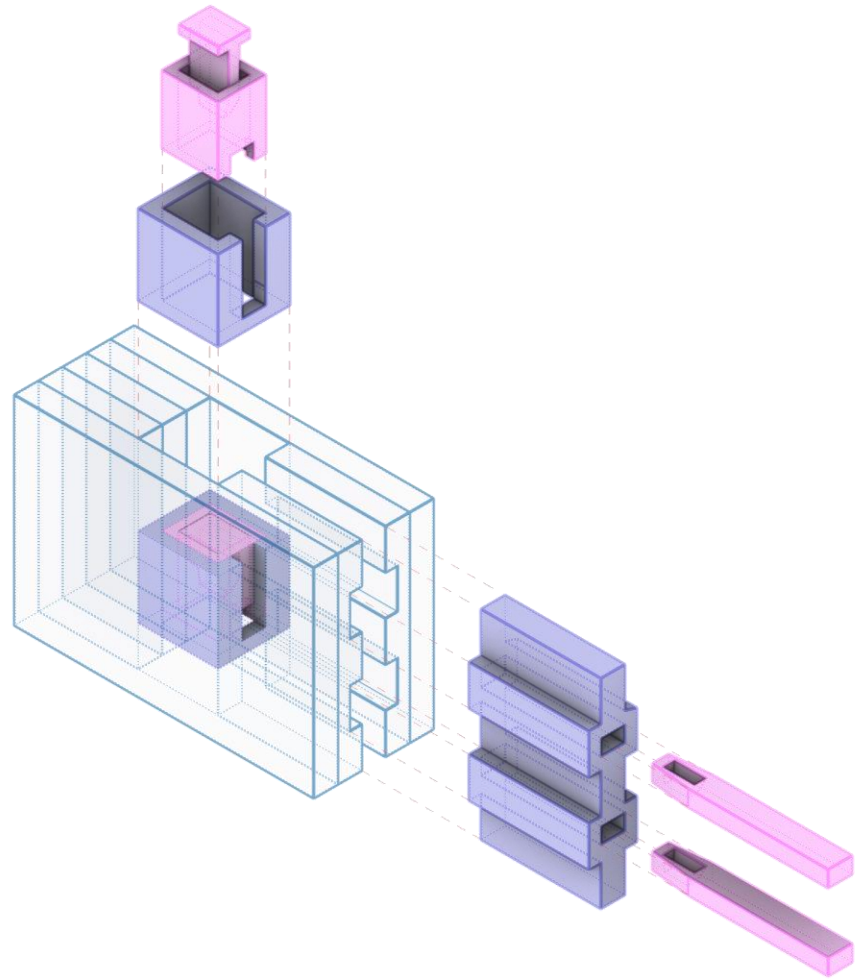
Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1
Iteration 2	Version 1	I1	G2
		I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4
			G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6	G5
		I6.1	
Iteration 7	Version 3	I7 V	G6 V
		I7 H	G6 H

Design iteration 2

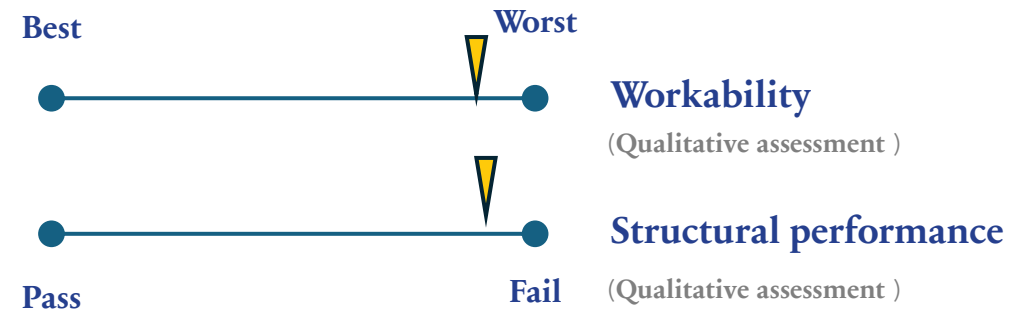


Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1 G2
Iteration 2	Version 1	I1 I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4 G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6 I6.1	G5
Iteration 7	Version 3	I7 V I7 H	G6 V G6 H

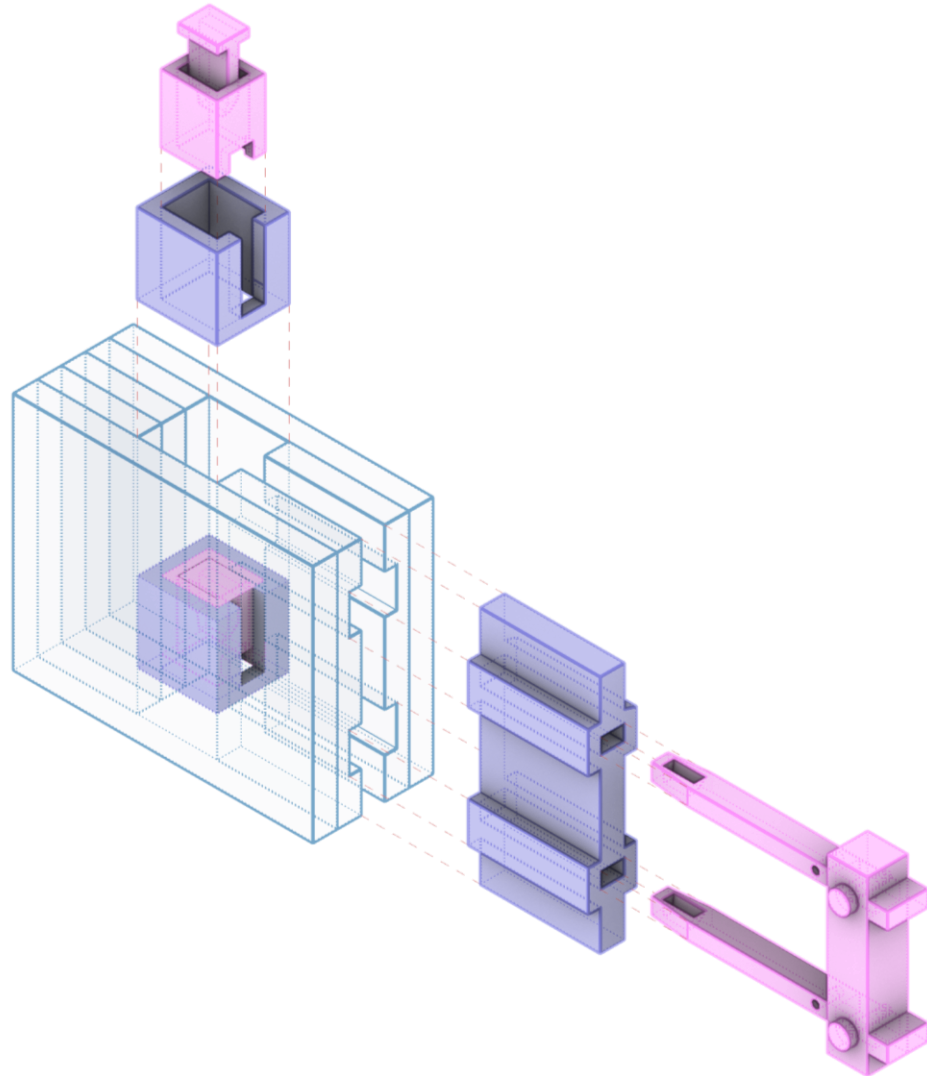
Design iteration 2



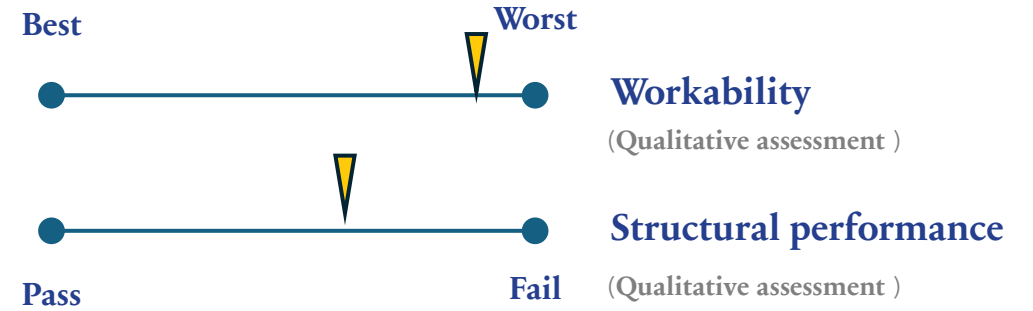
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Iteration 1	Version 1	-	G1 G2
Iteration 2	Version 1	I1 I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4 G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6 I6.1	G5
Iteration 7	Version 3	I7 V I7 H	G6 V G6 H



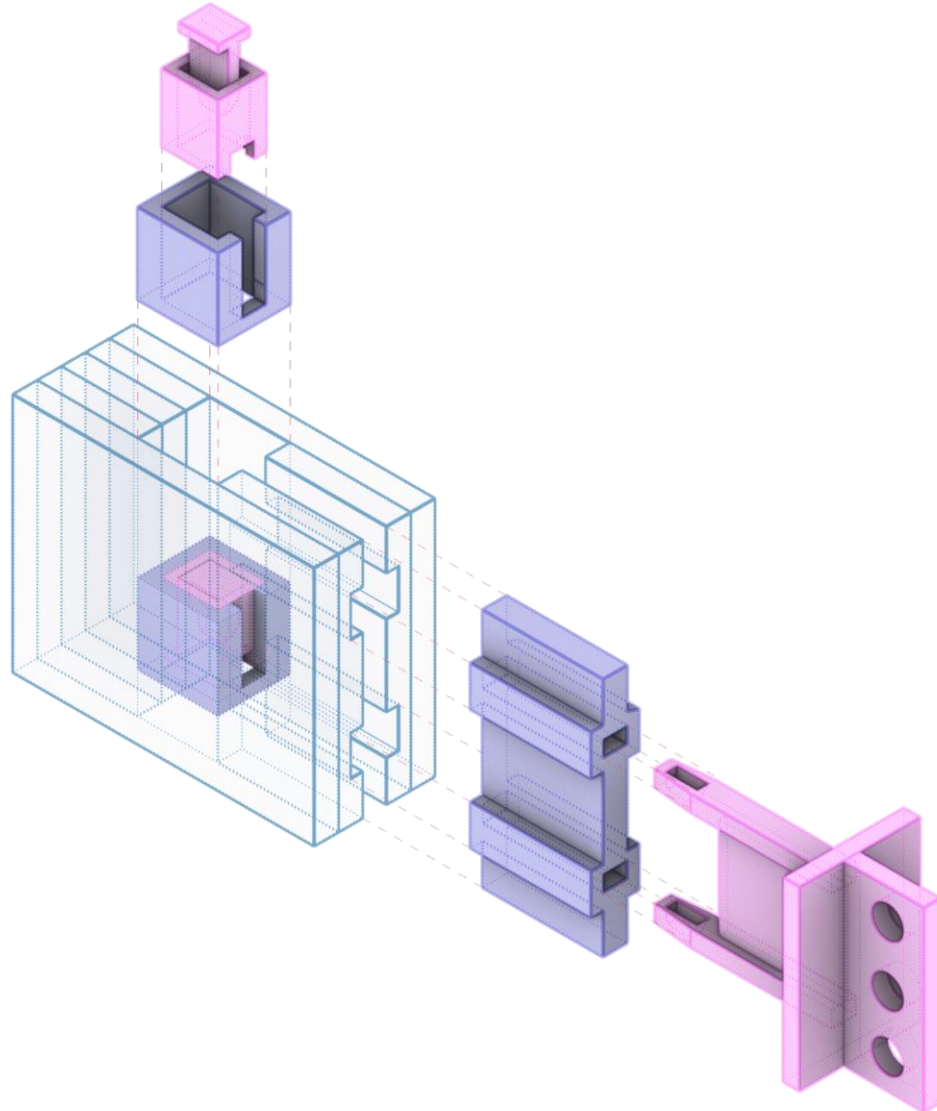
Design iteration 3



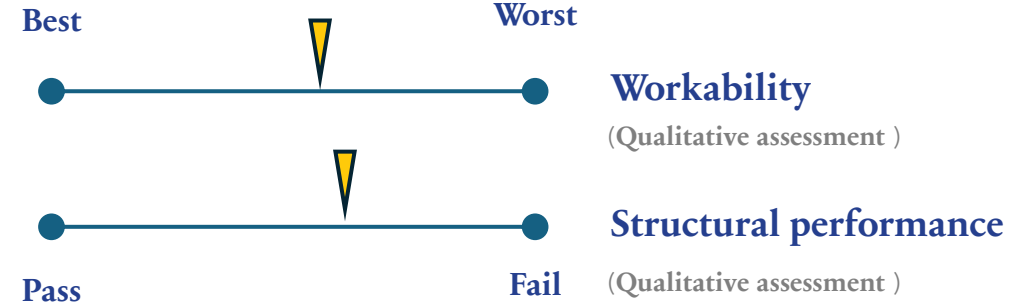
Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1 G2
Iteration 2	Version 1	I1 I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4 G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6 I6.1	G5
Iteration 7	Version 3	I7 V I7 H	G6 V G6 H



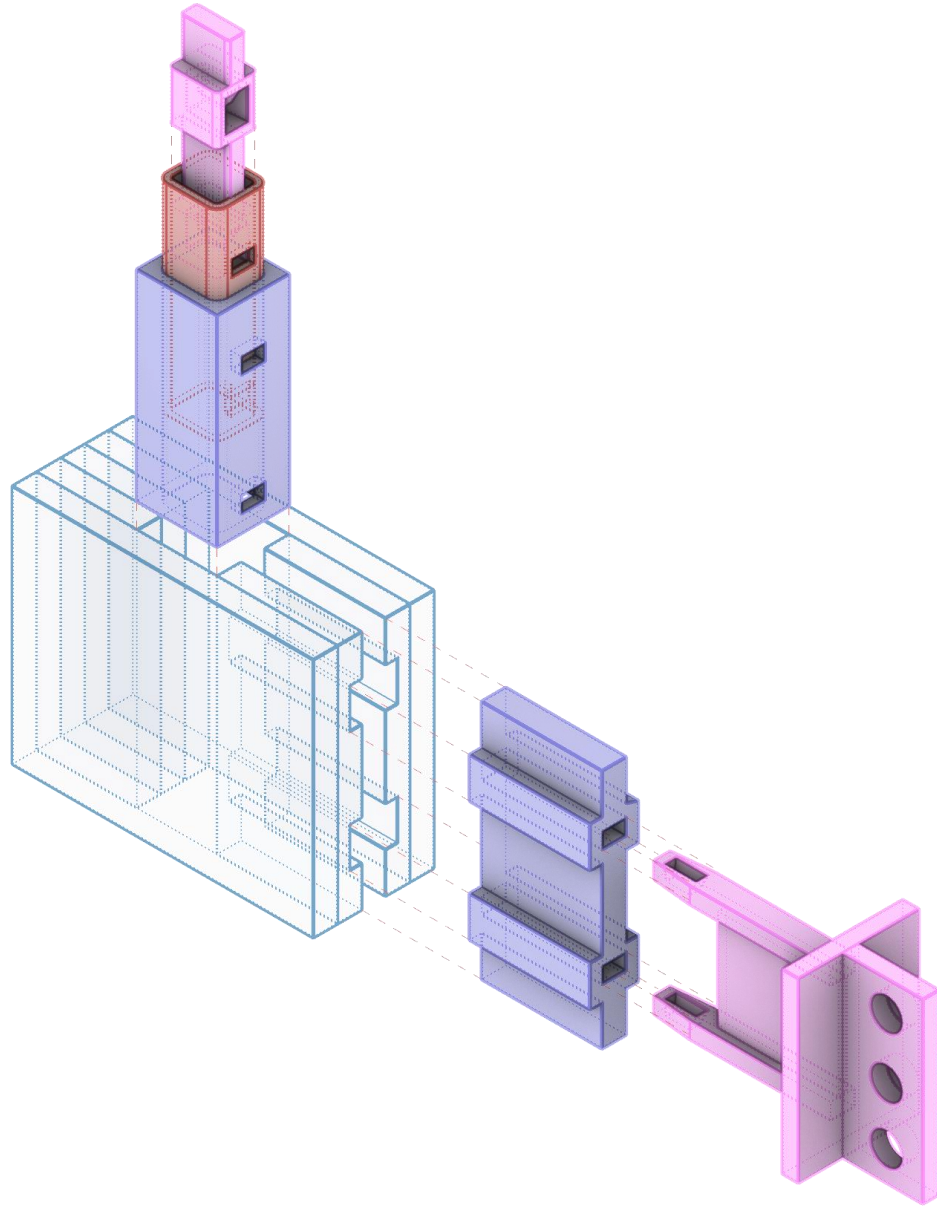
Design iteration 4



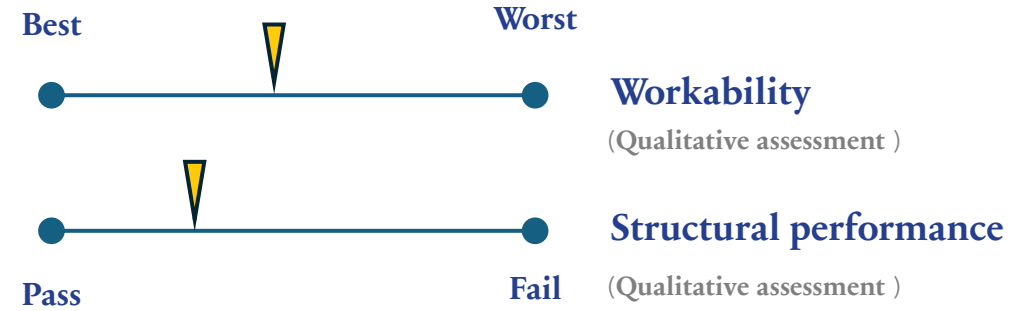
Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1 G2
Iteration 2	Version 1	I1 I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4 G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6 I6.1	G5
Iteration 7	Version 3	I7 V I7 H	G6 V G6 H



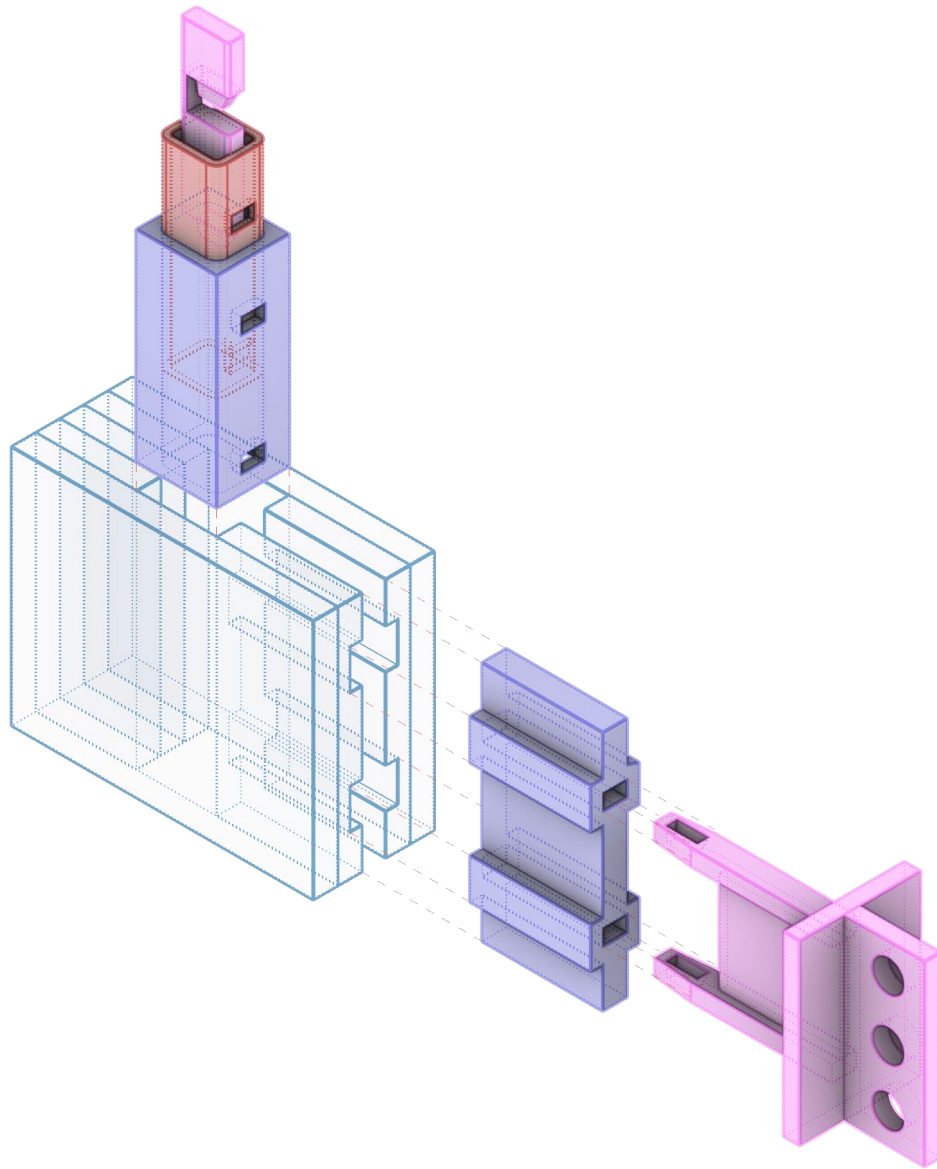
Design iteration 5



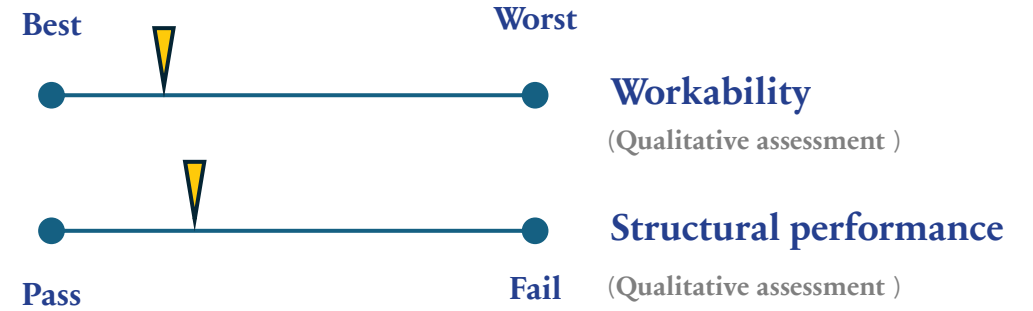
Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1 G2
Iteration 2	Version 1	I1 I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4 G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6 I6.1	G5
Iteration 7	Version 3	I7 V I7 H	G6 V G6 H



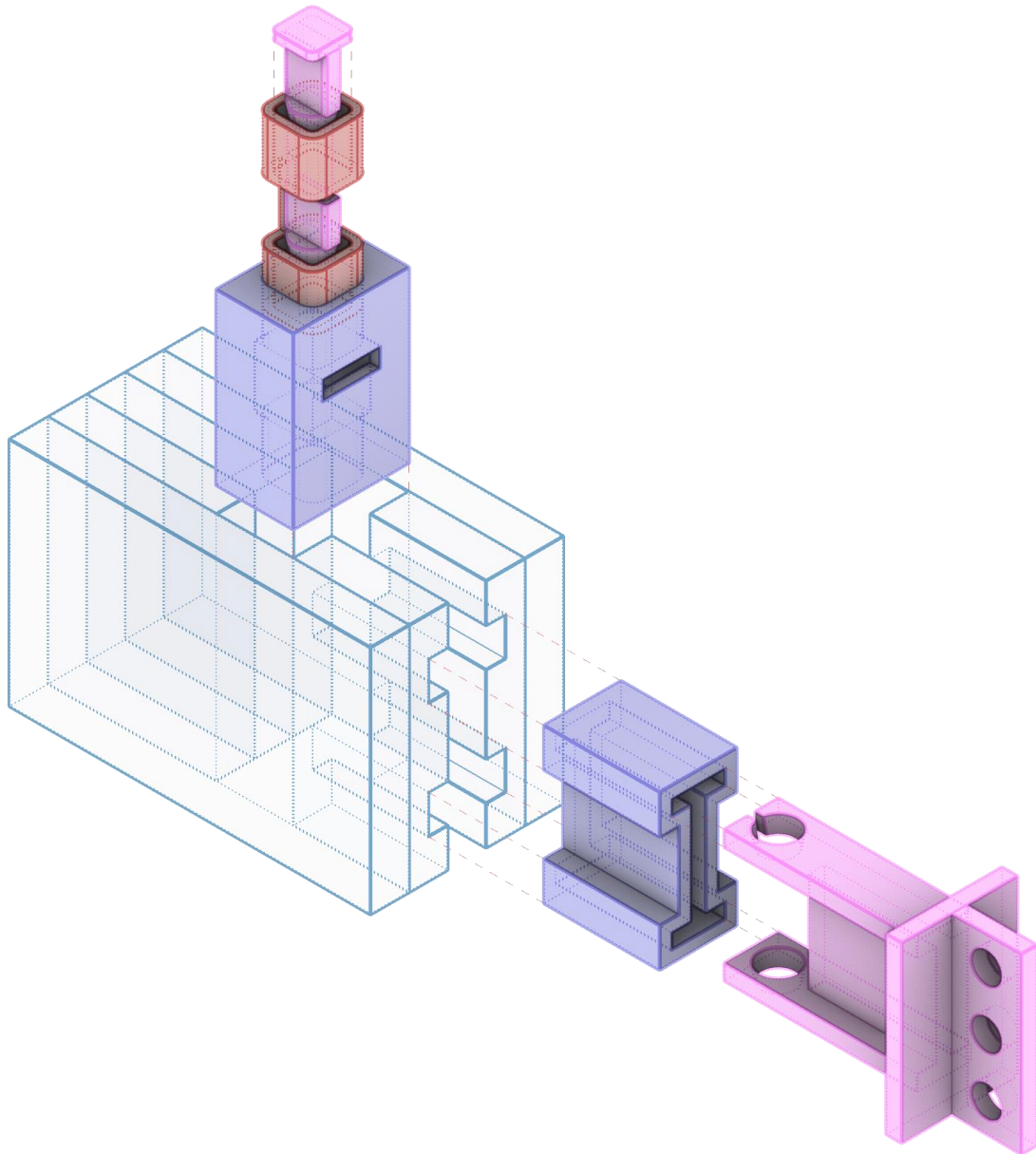
Design iteration 6



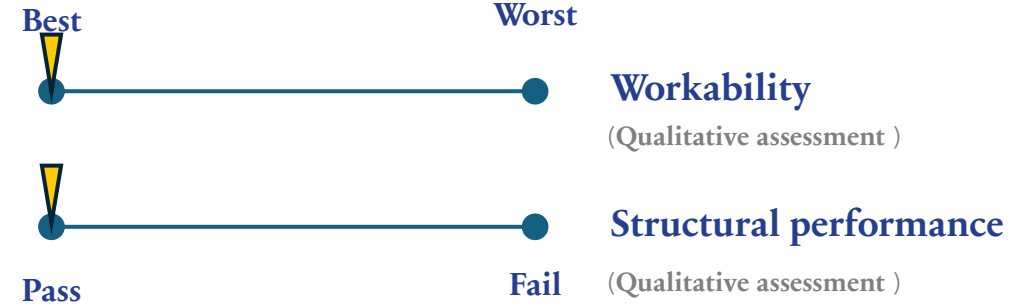
Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1 G2
Iteration 2	Version 1	I1 I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4 G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6 I6.1	G5
Iteration 7	Version 3	I7 V I7 H	G6 V G6 H



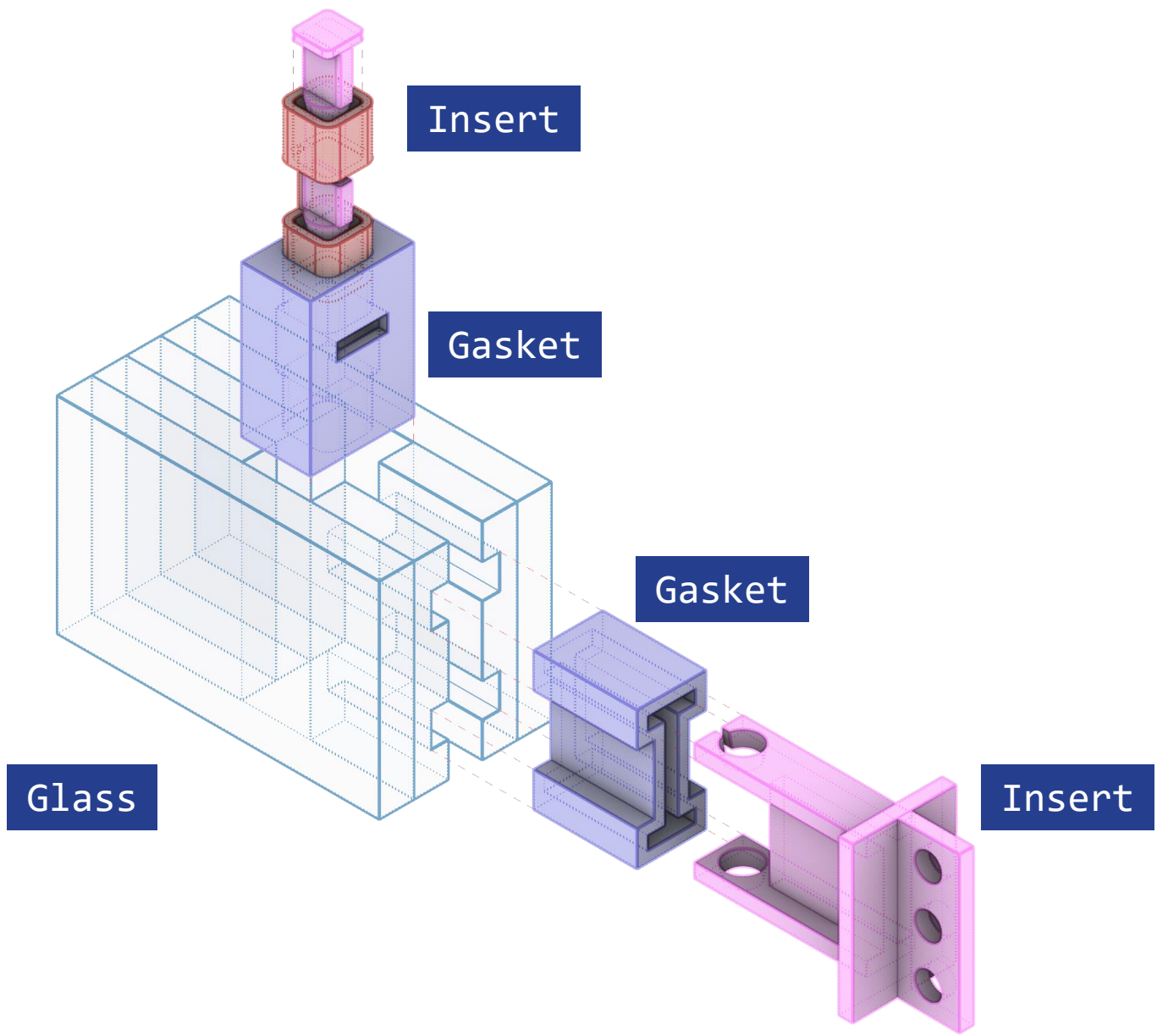
Design iteration 7



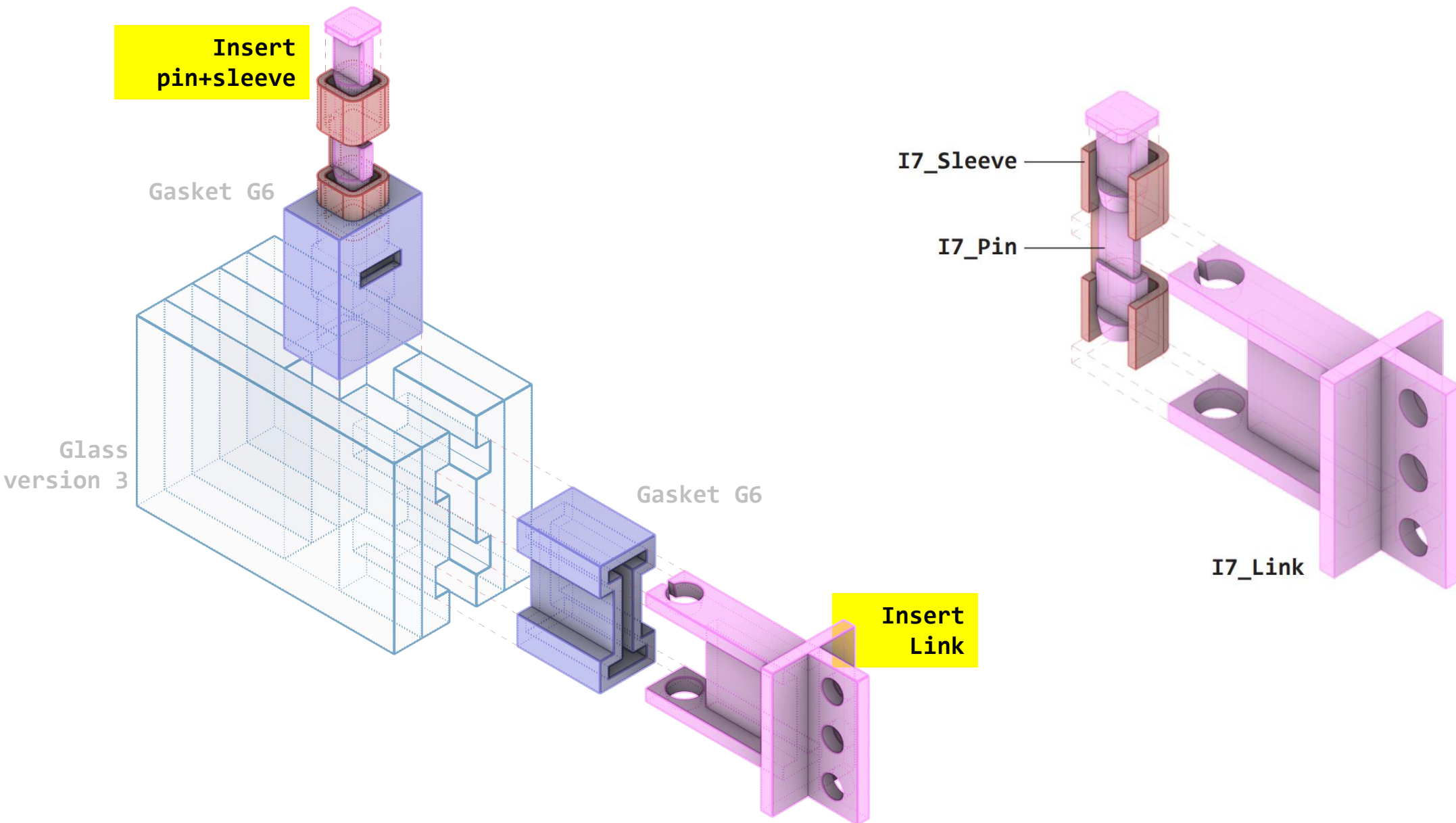
Iterations	Glass Panel version	Insert version	Gasket version
Iteration 1	Version 1	-	G1 G2
Iteration 2	Version 1	I1 I2	G3
Iteration 3	Version 2	I3	G4
Iteration 4	Version 2	I4	G4 G4.1
Iteration 5	Version 2	I5	G5
Iteration 6	Version 2	I6 I6.1	G5
Iteration 7	Version 3	I7 V I7 H	G6 V G6 H

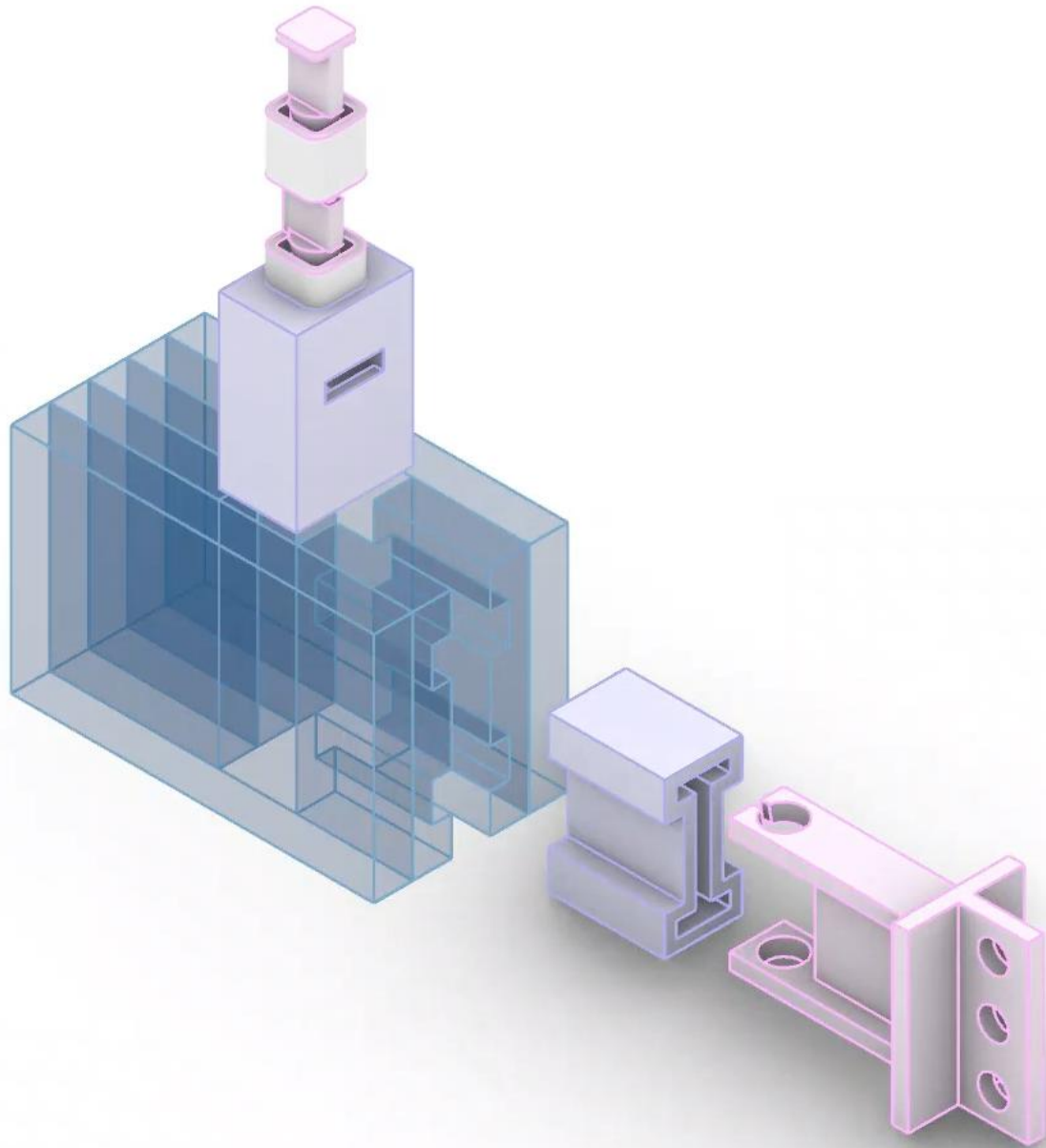


The Uni.conn

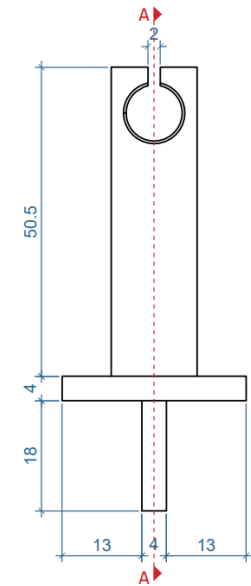
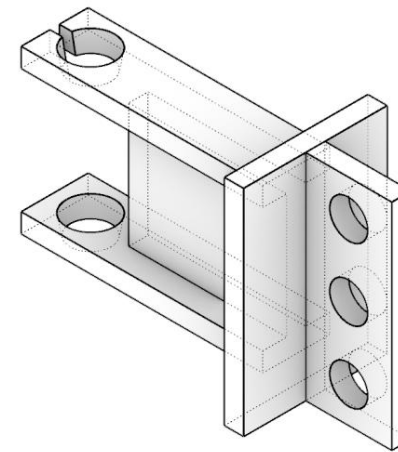
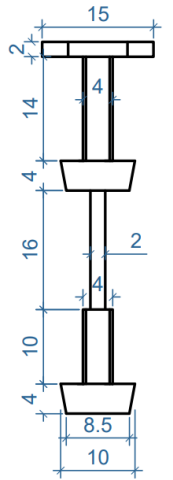
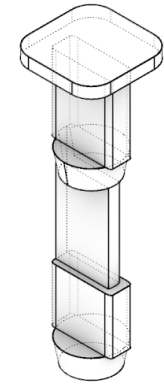
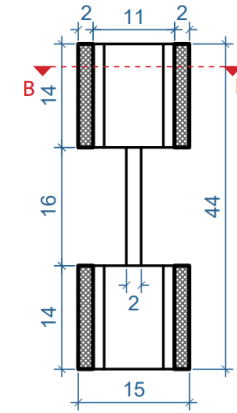
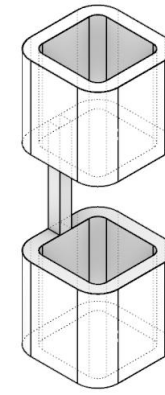
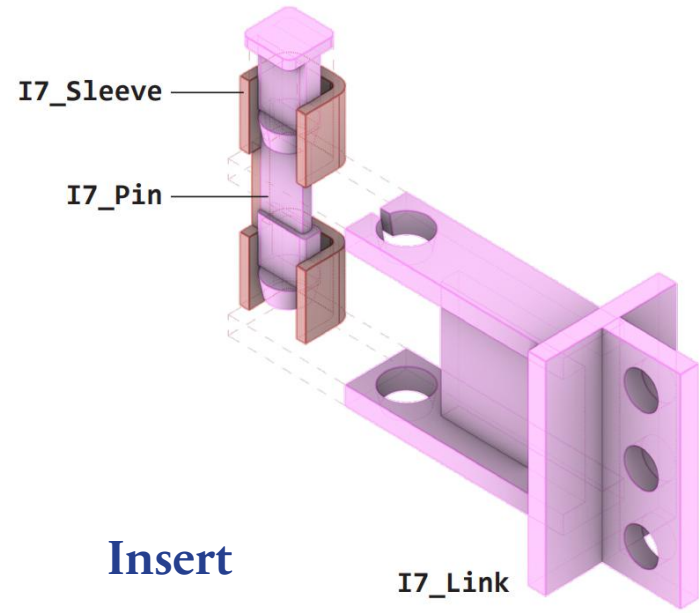


The Uni.conn

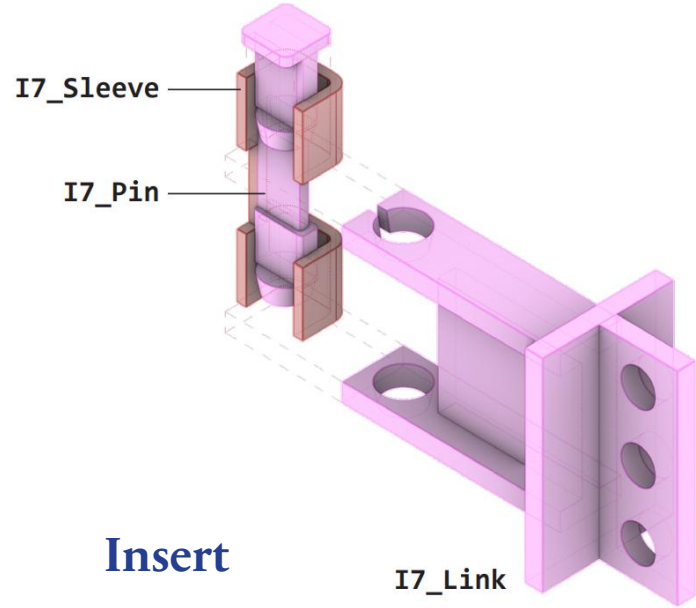




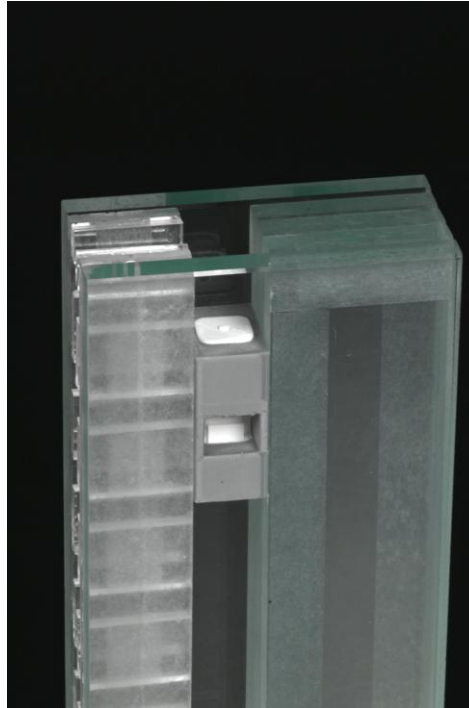
Materiality



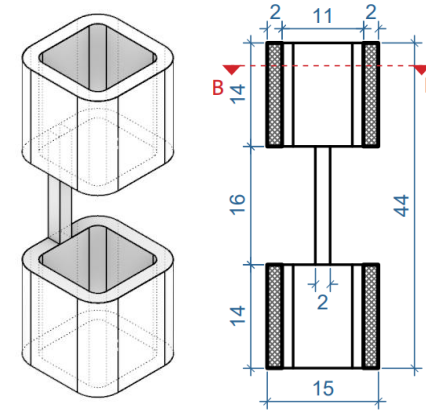
Materiality



Insert

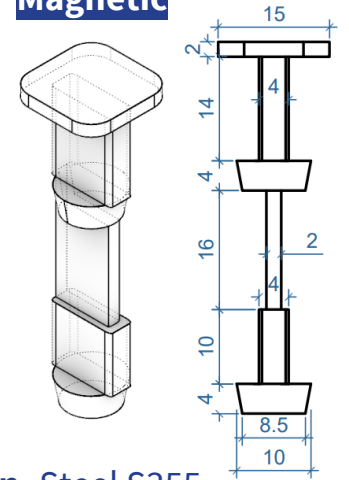


Non-magnetic

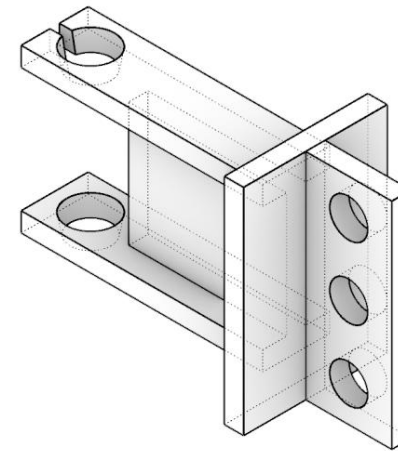


Sleeve- Al 6063
CNC machined

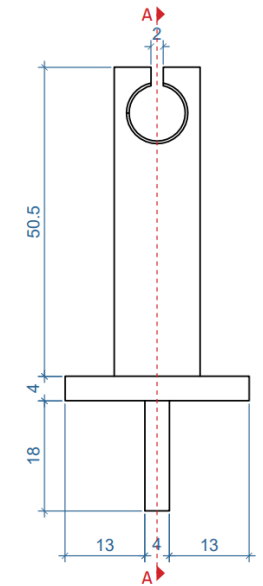
Magnetic



Pin- Steel S355
CNC machined



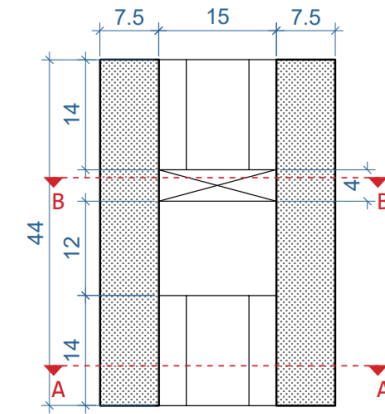
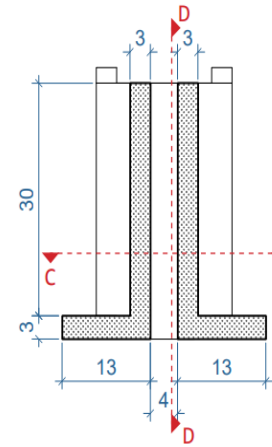
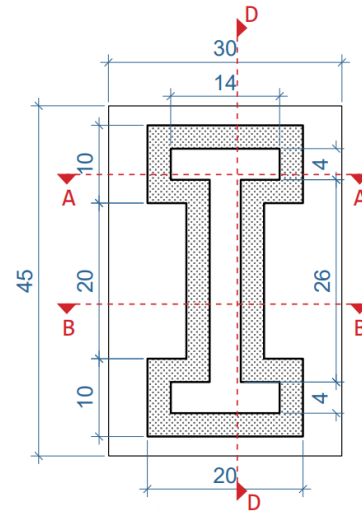
Link- Steel S355
CNC machined



Materiality

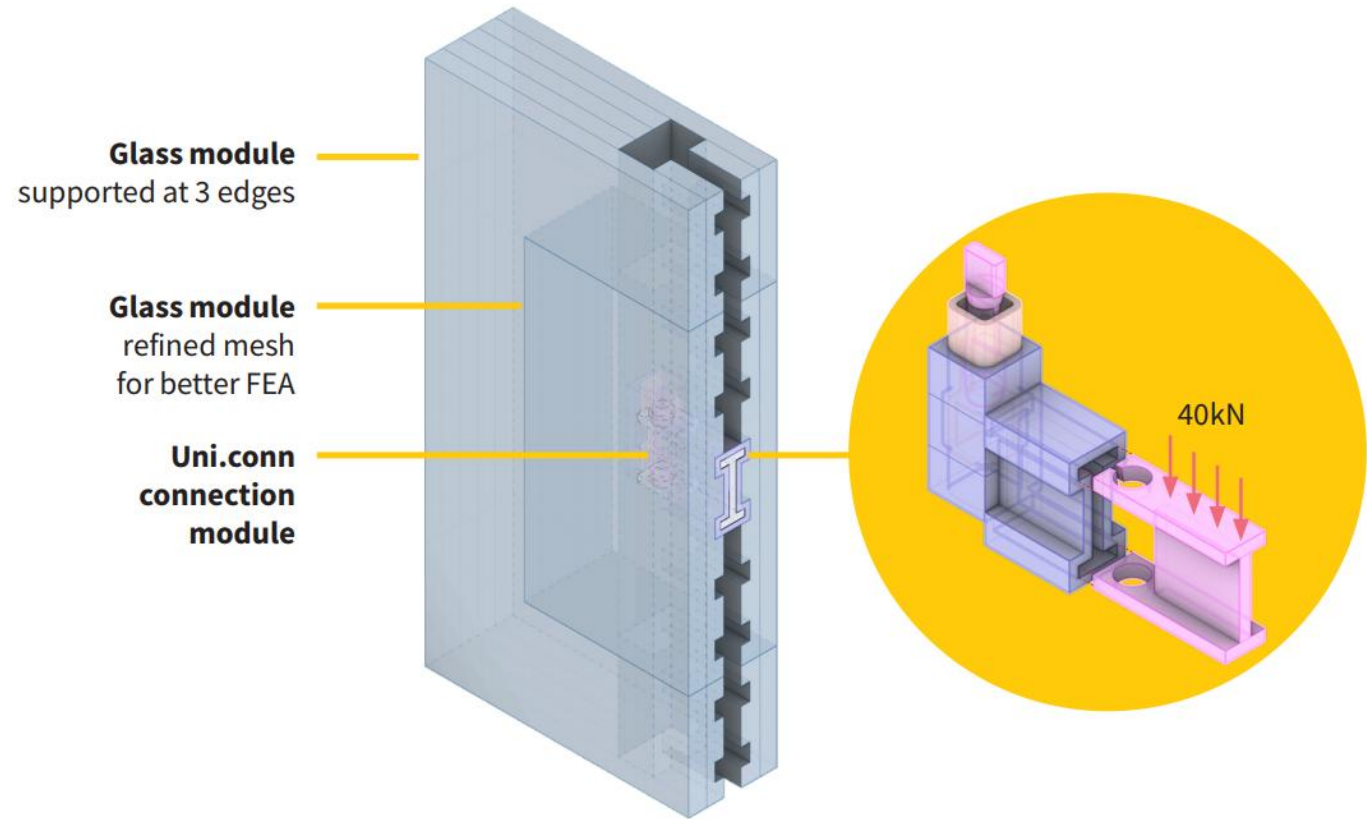
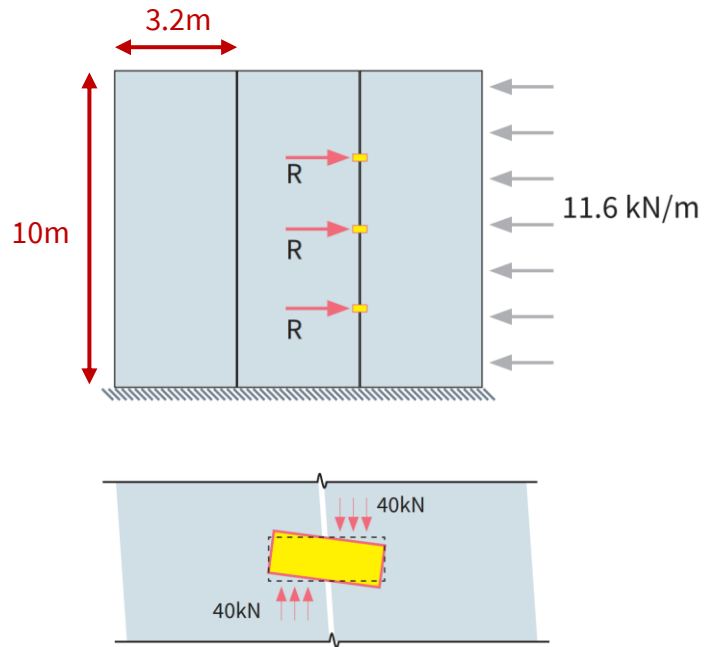


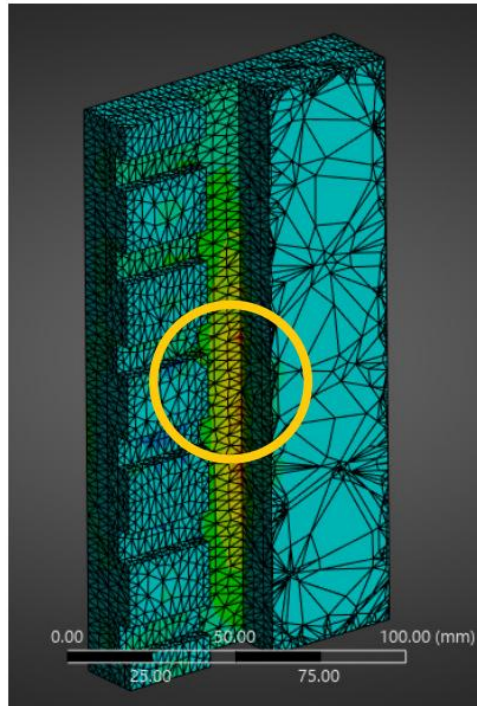
Gasket



TPU Ester (Shore A70)
Injection moulded

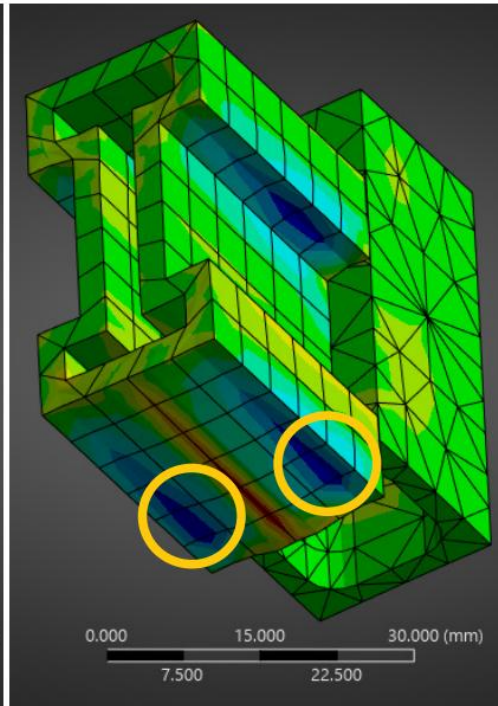
Structural Analysis





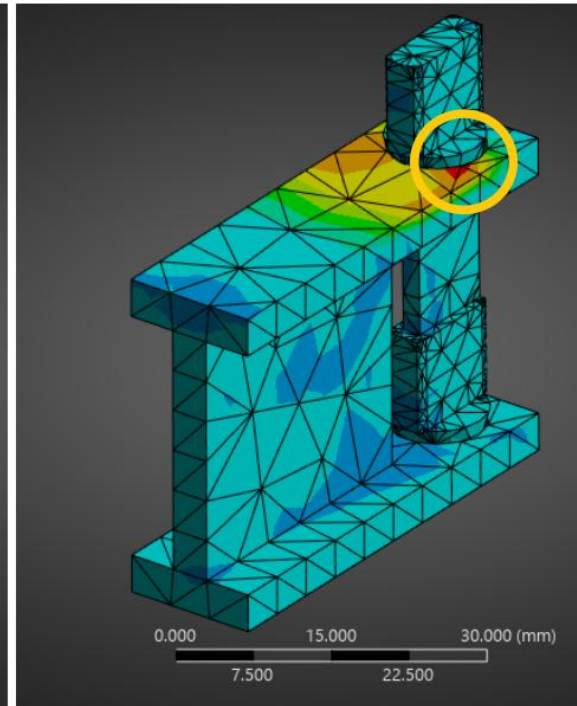
Glass (in section)

Maximum Principle Stress: **8.03 MPa**



Gasket - TPU Shore A70

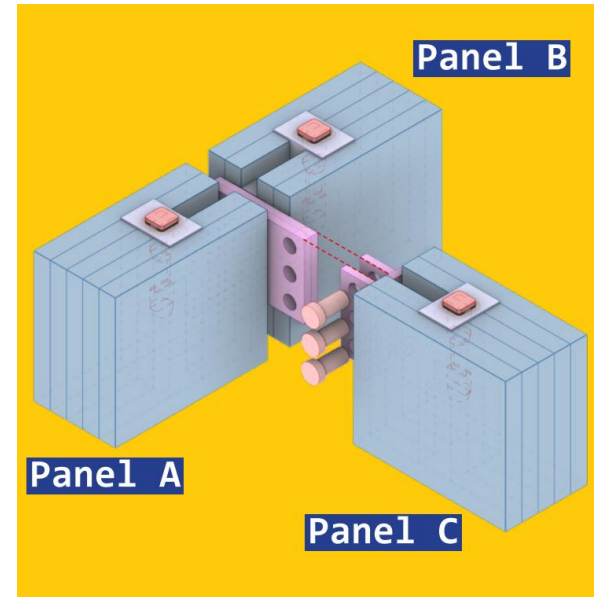
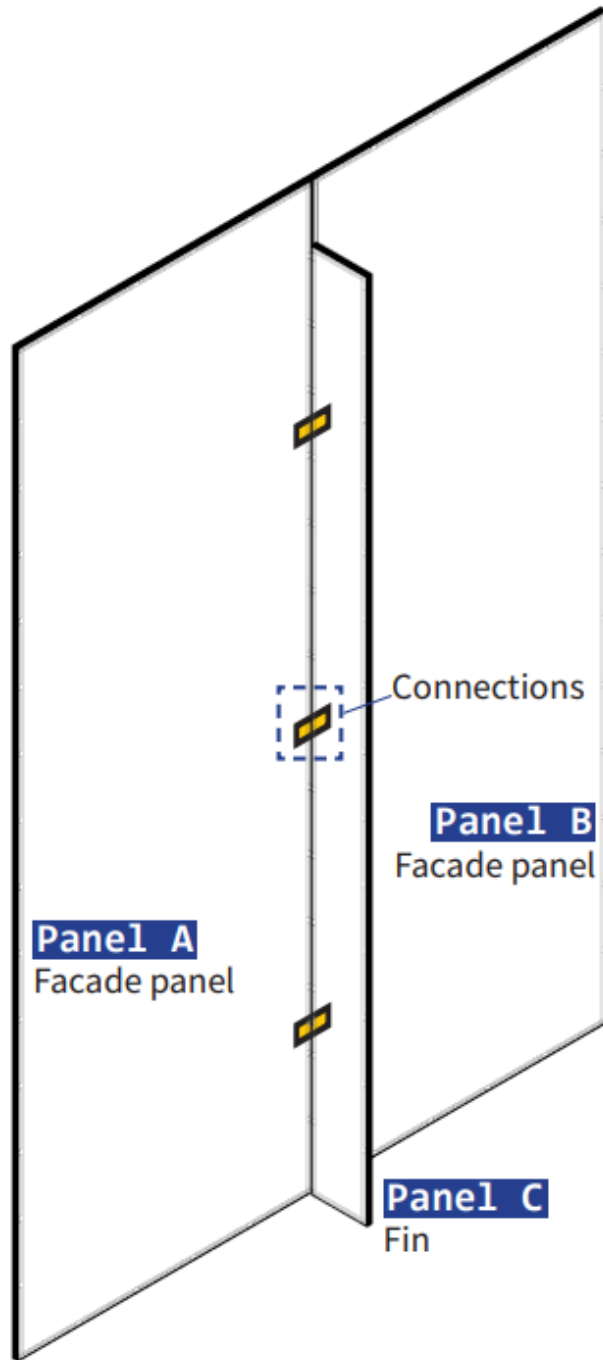
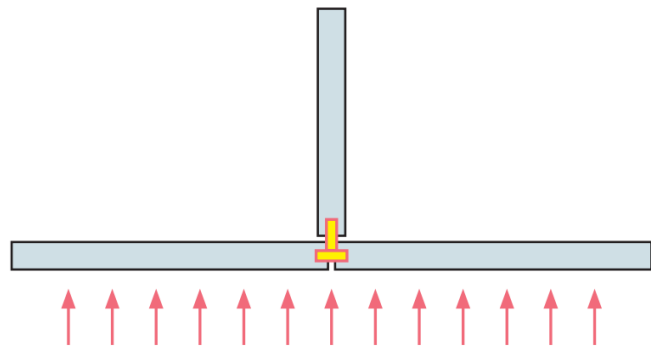
Maximum Principle Stress: **2.04 MPa**
(Compressive forces)



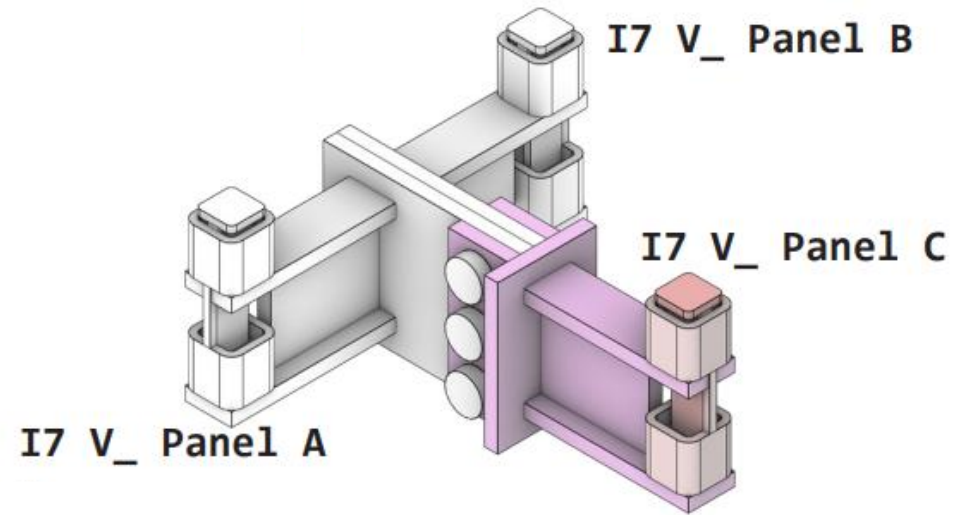
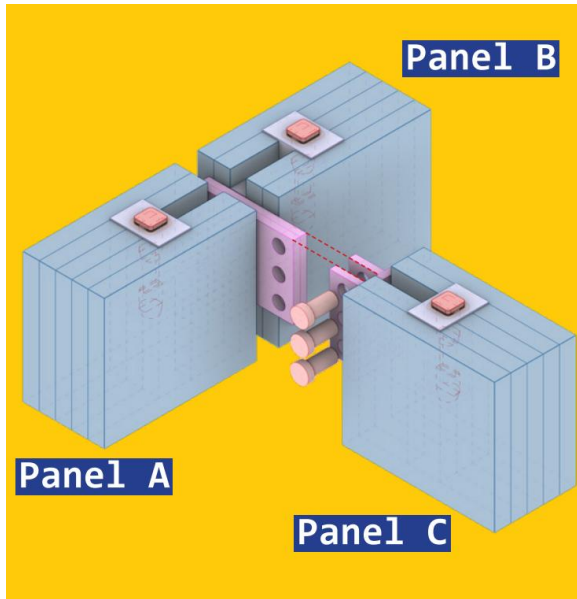
Insert - Stainless steel S355

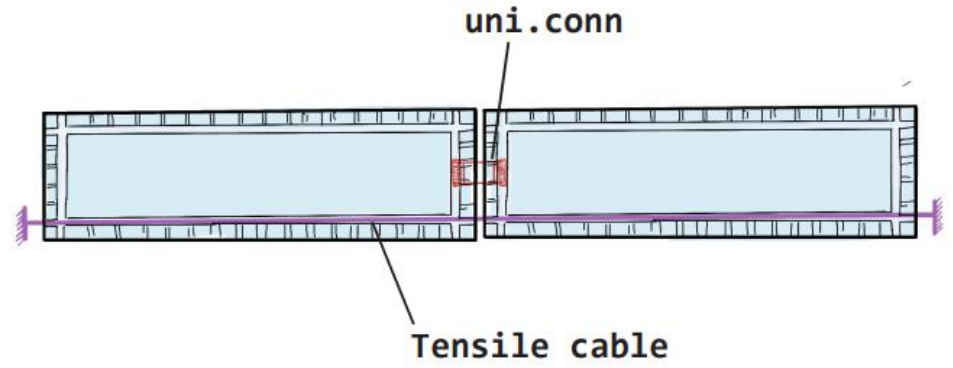
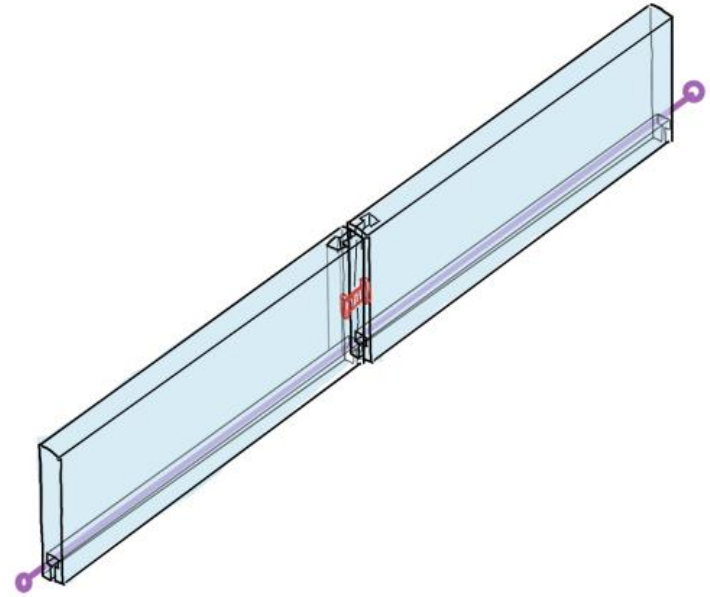
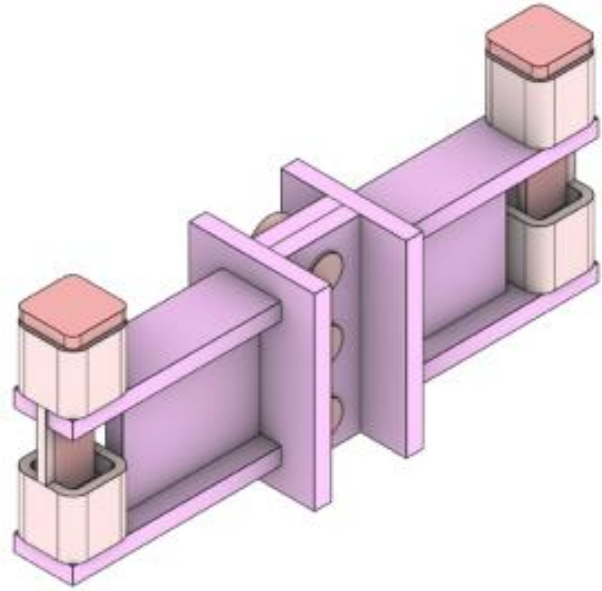
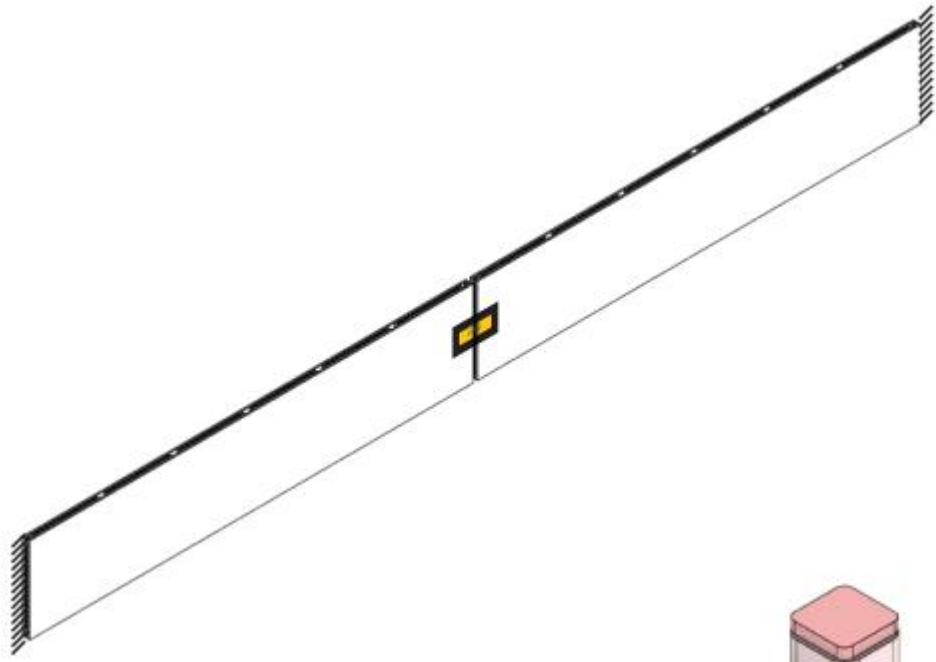
Maximum Principle Stress: **98.46 MPa**

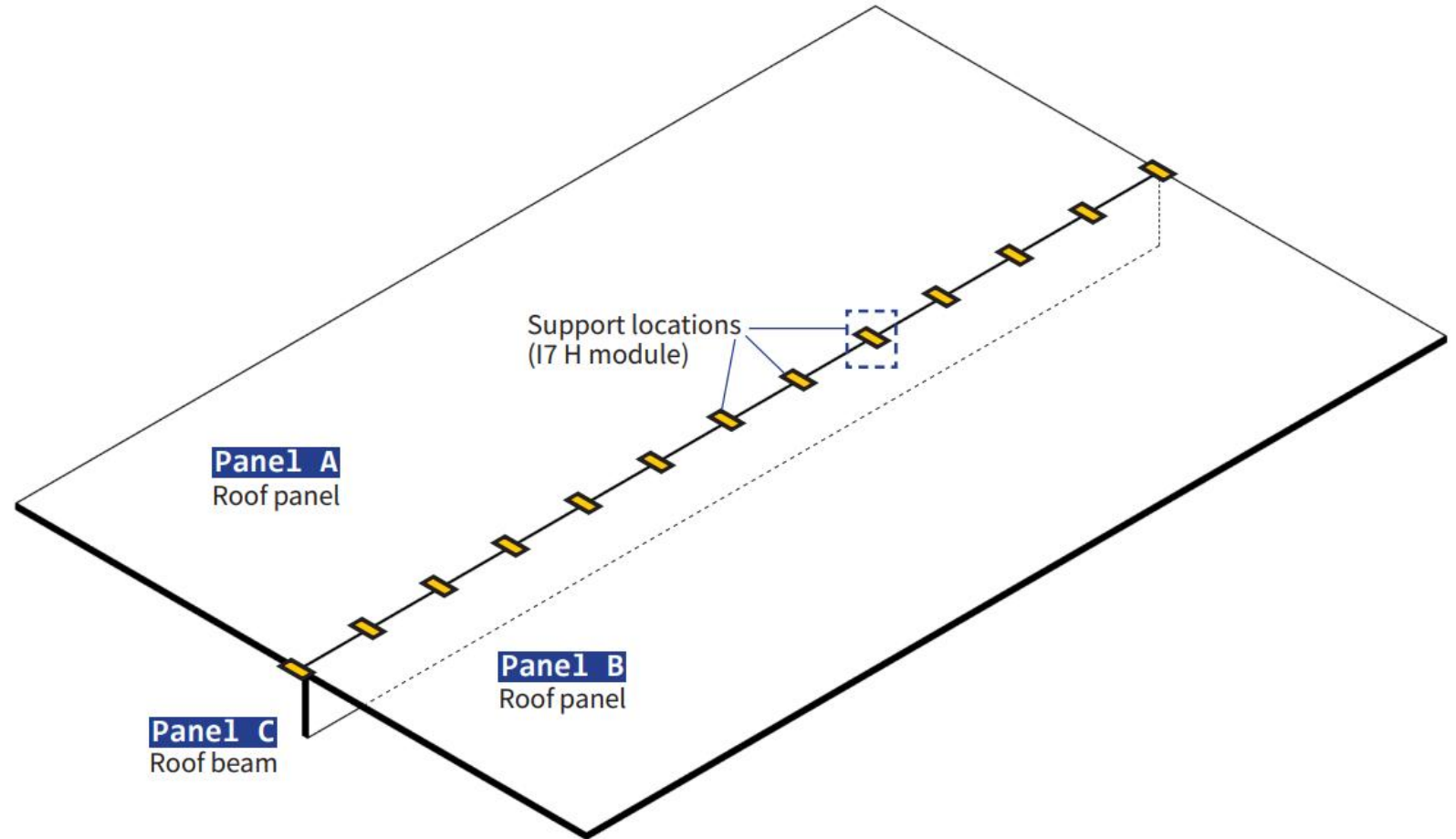
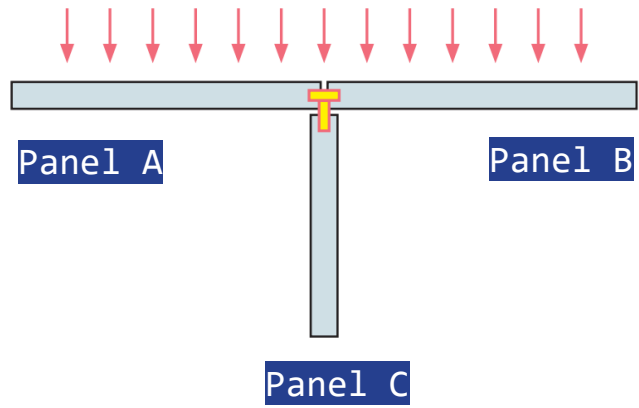
Design Applications



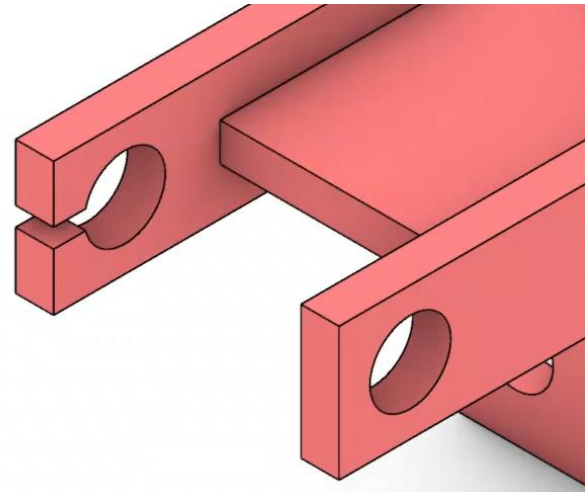
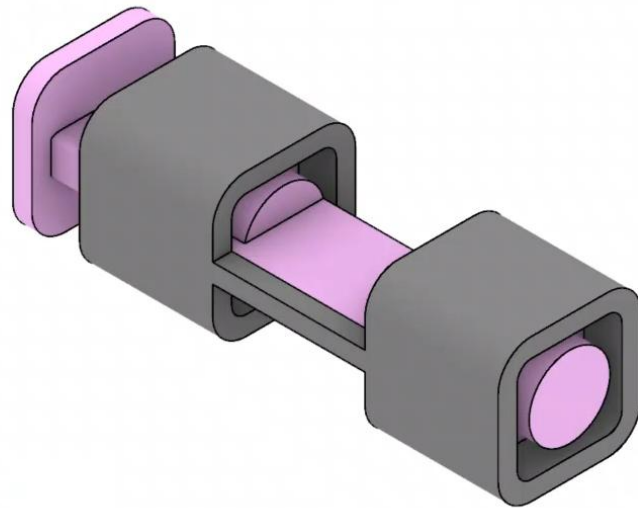
Façade T junction

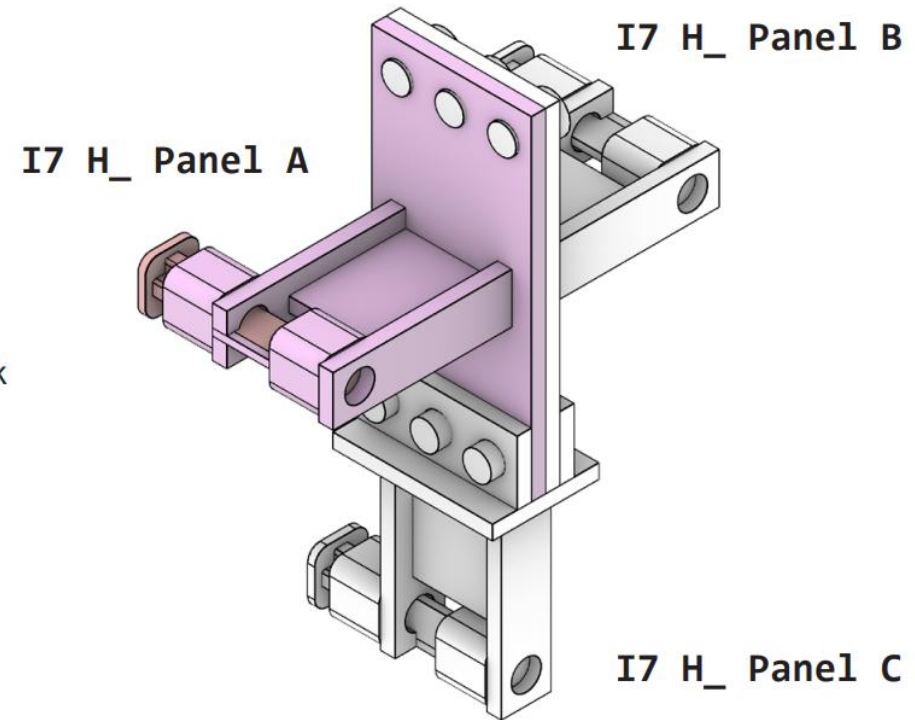
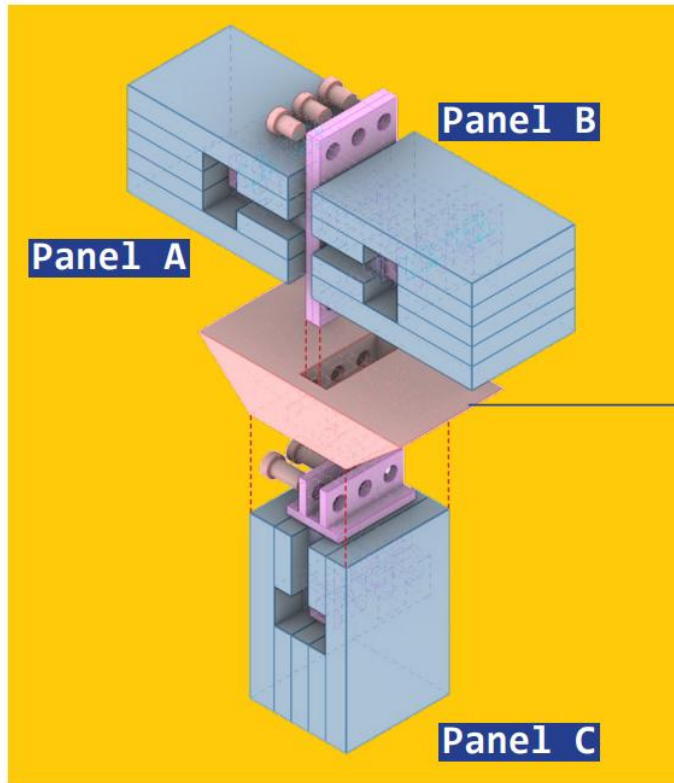


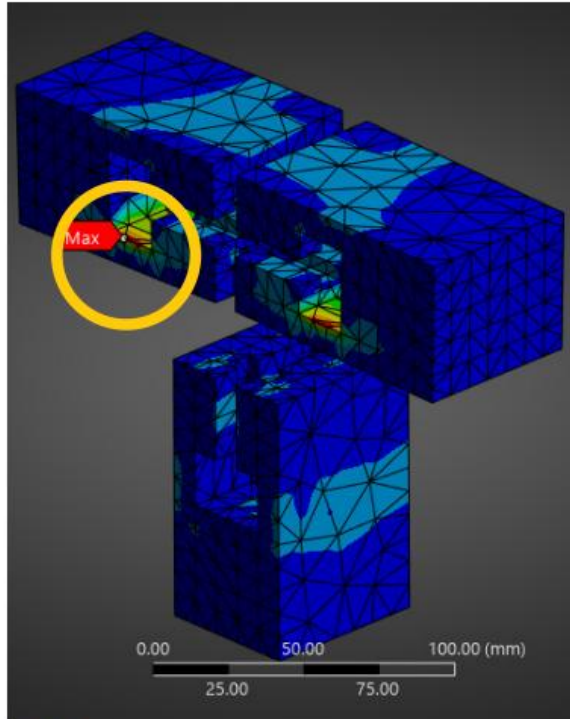




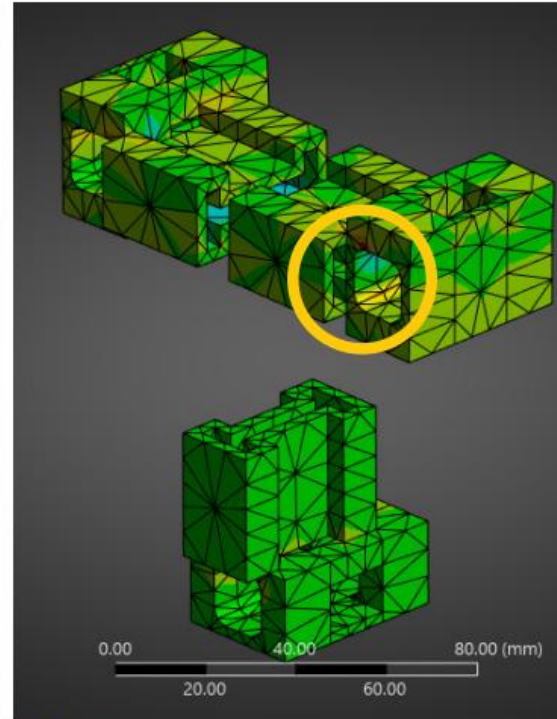
Assembly



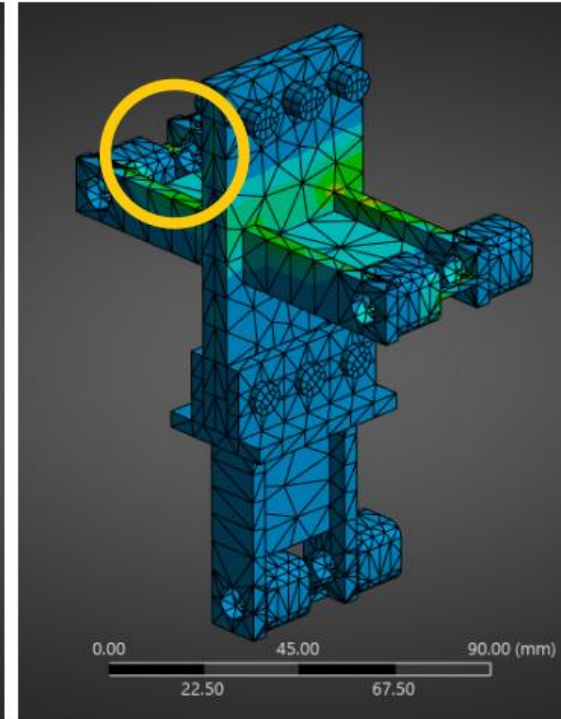




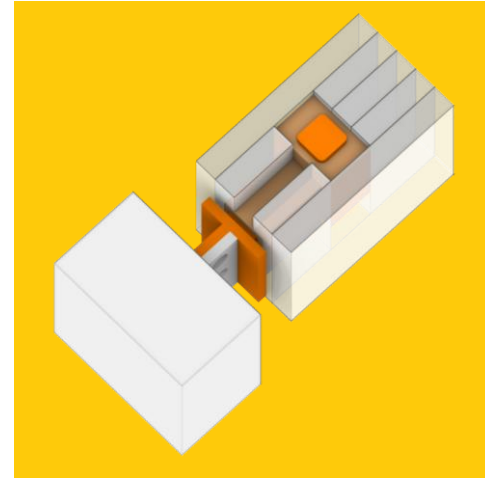
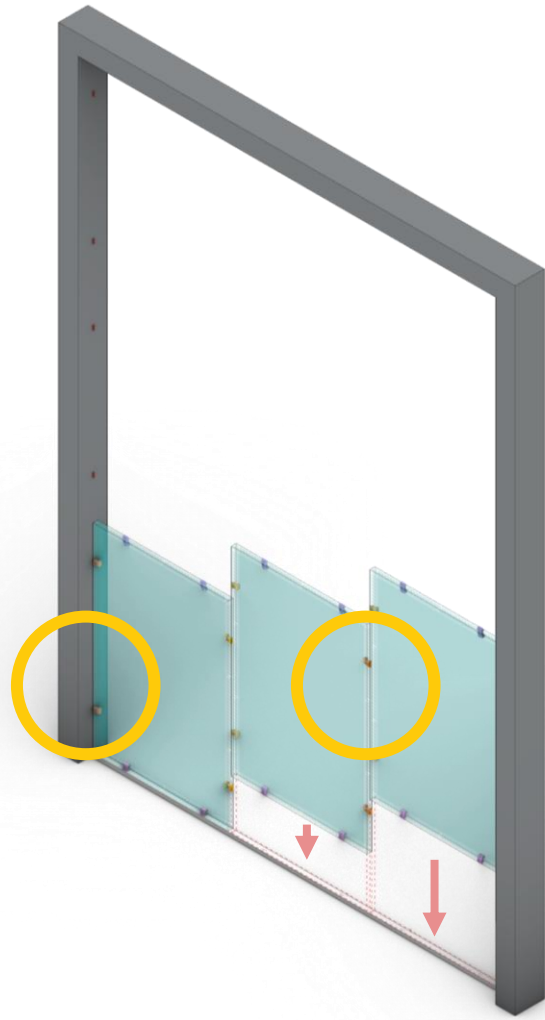
^ Glass
50.1 MPa



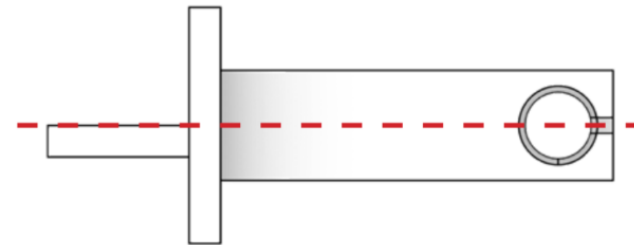
^ Gasket
TPU (Shore A70) | 2.12 MPa

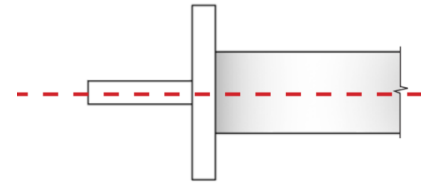
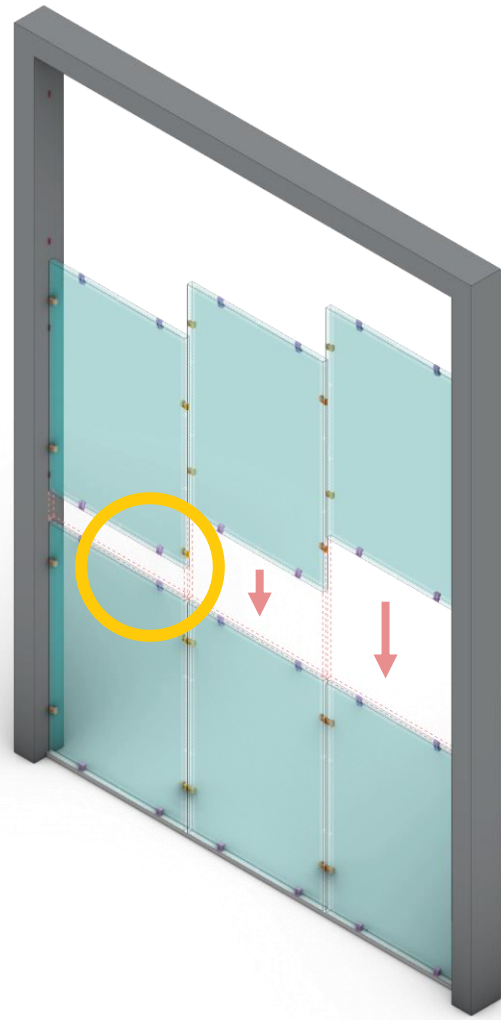


^ I7 H
180.47 MPa

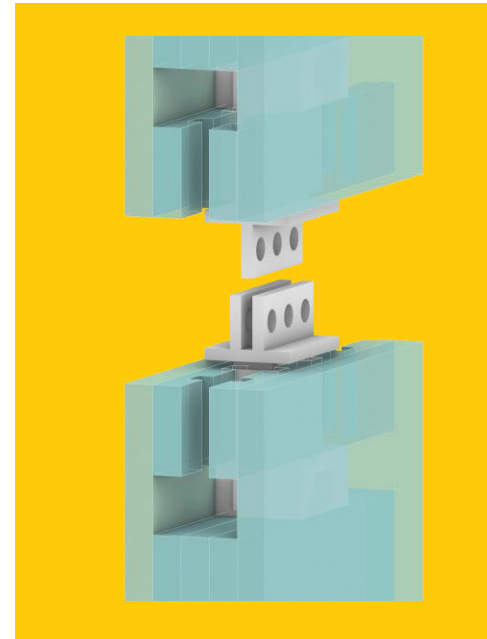


I7 V_ Type C

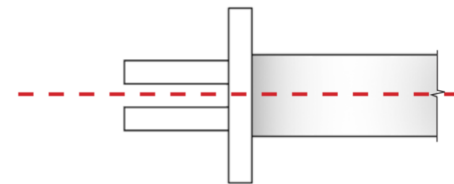


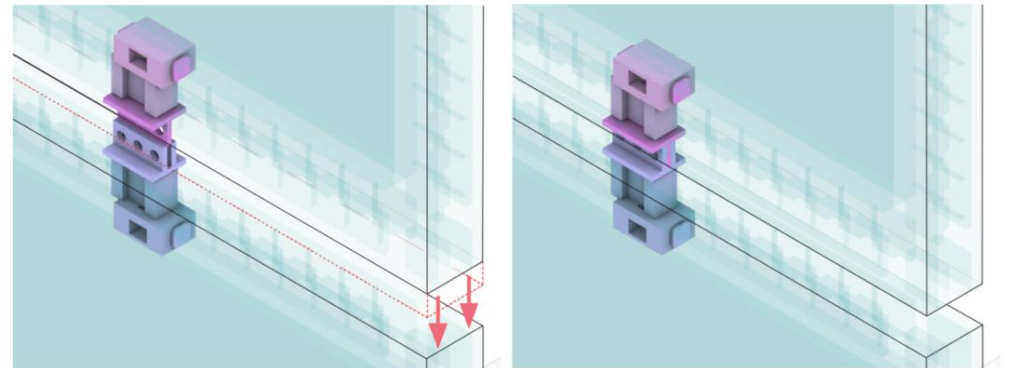
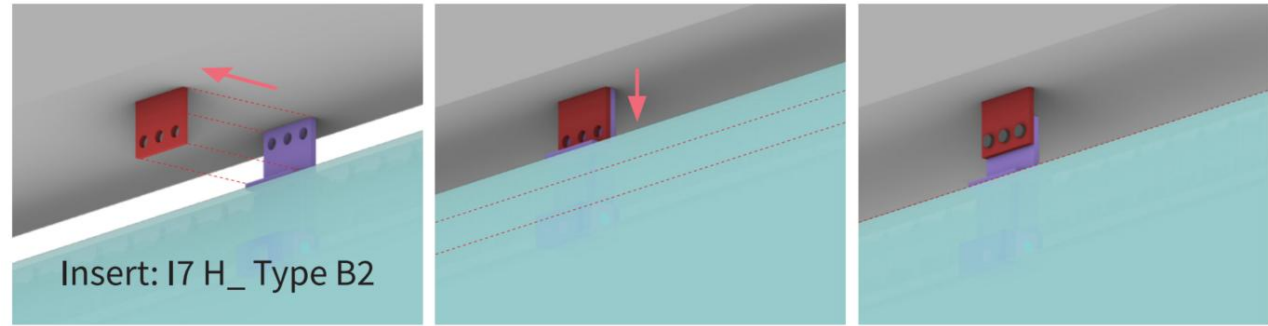
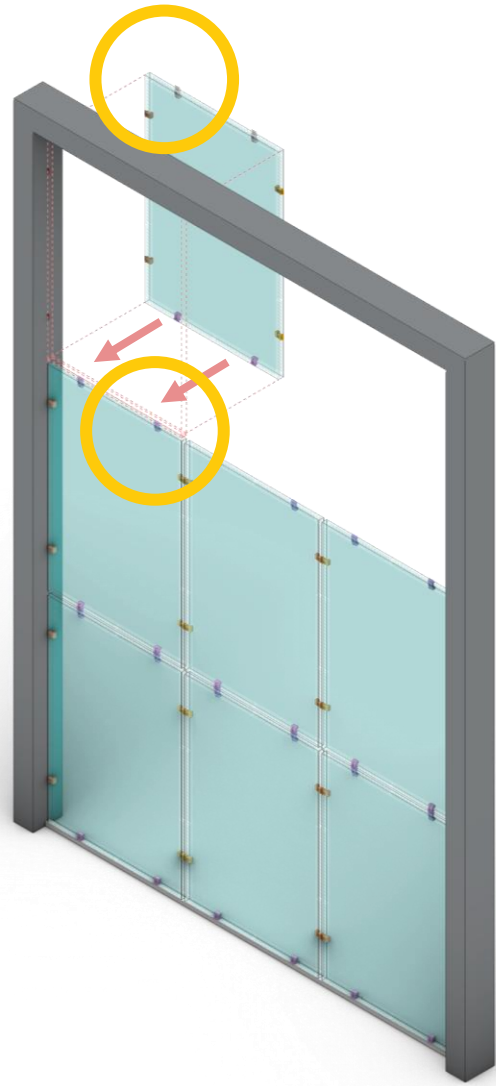


I7 H_ Type A



I7 H_ Type D



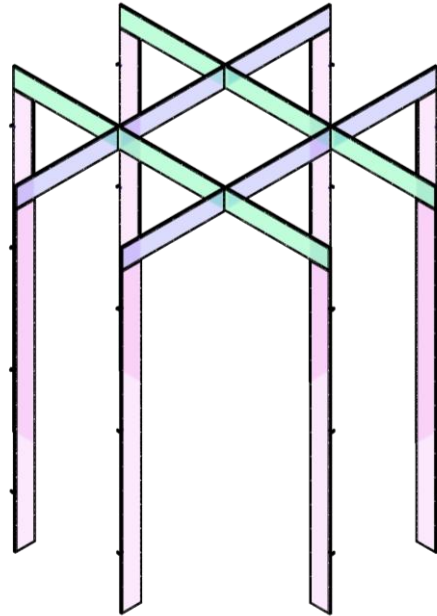
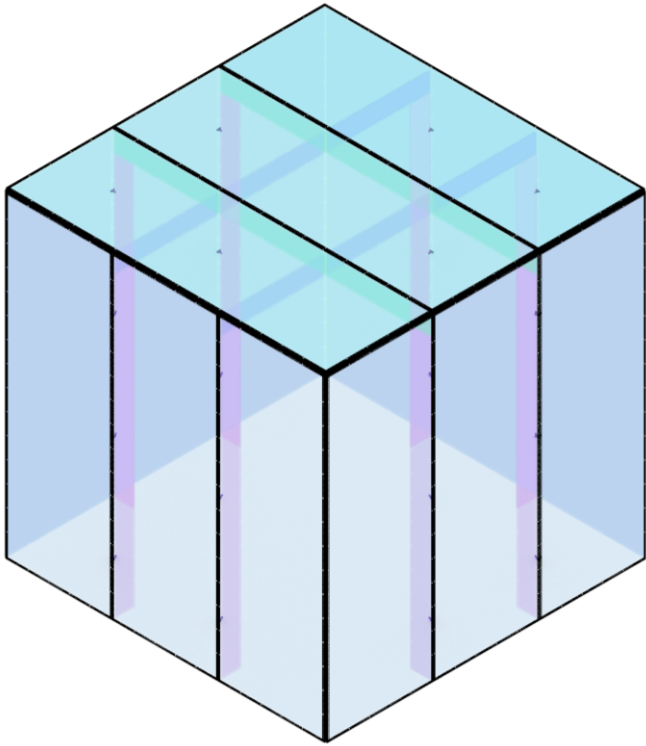




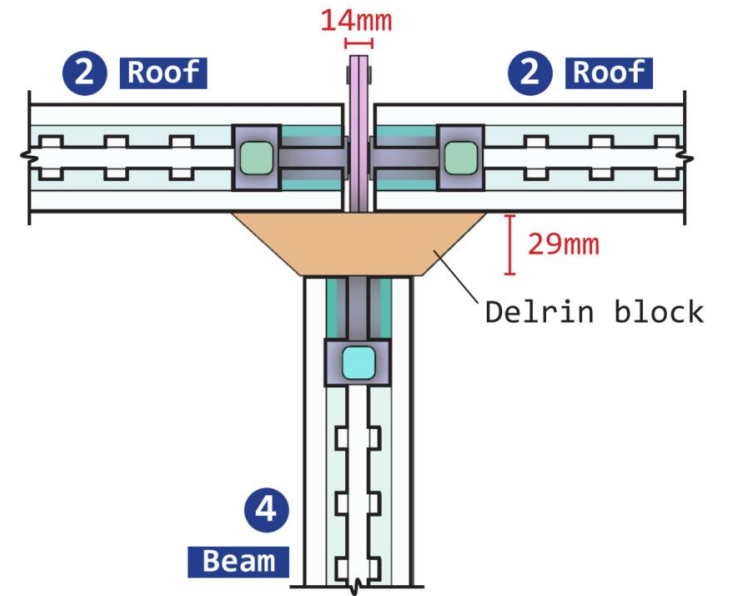
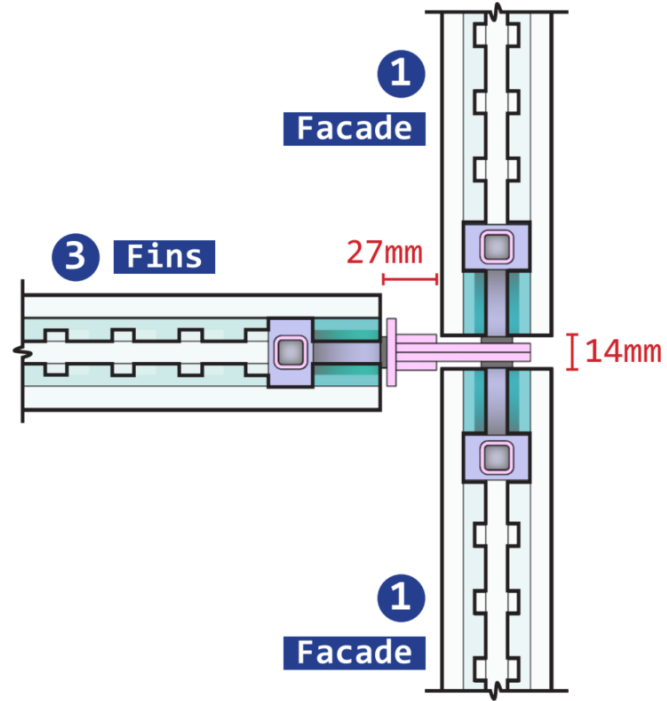
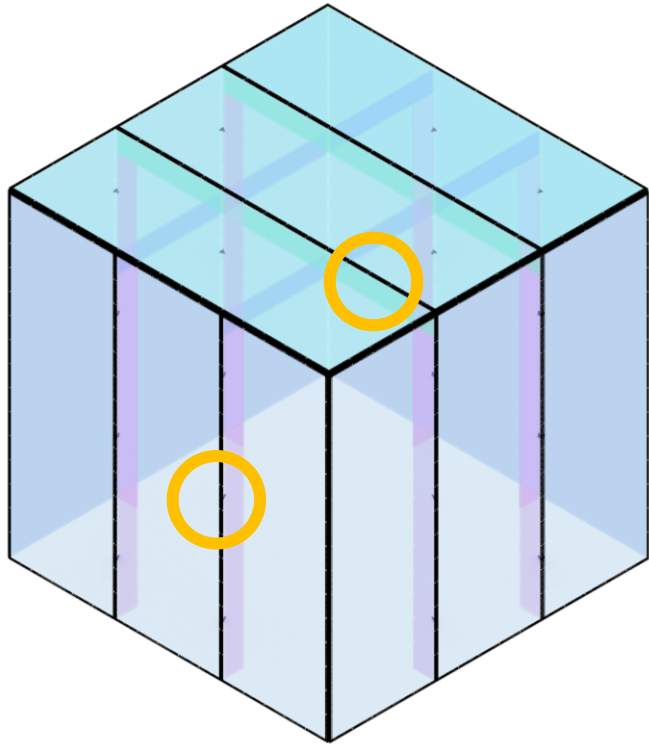
3x3 faade panel grid

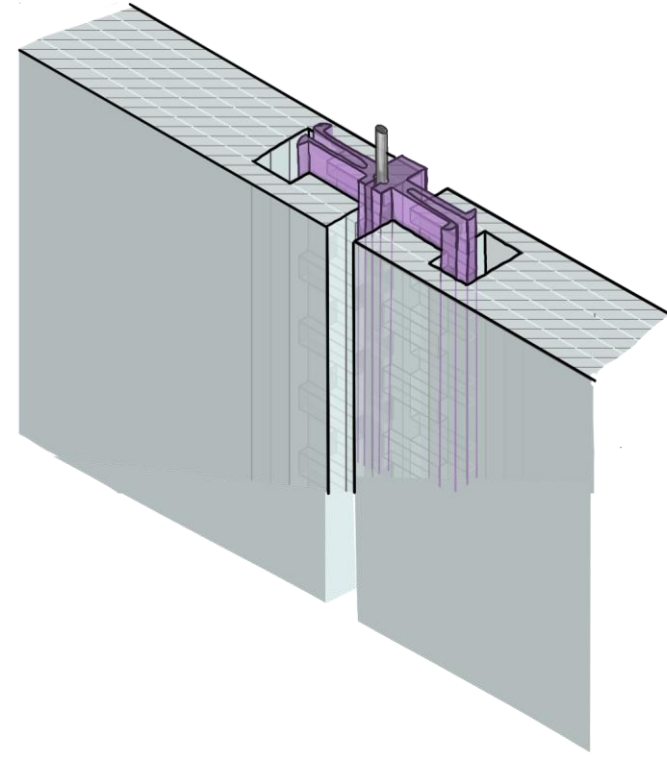
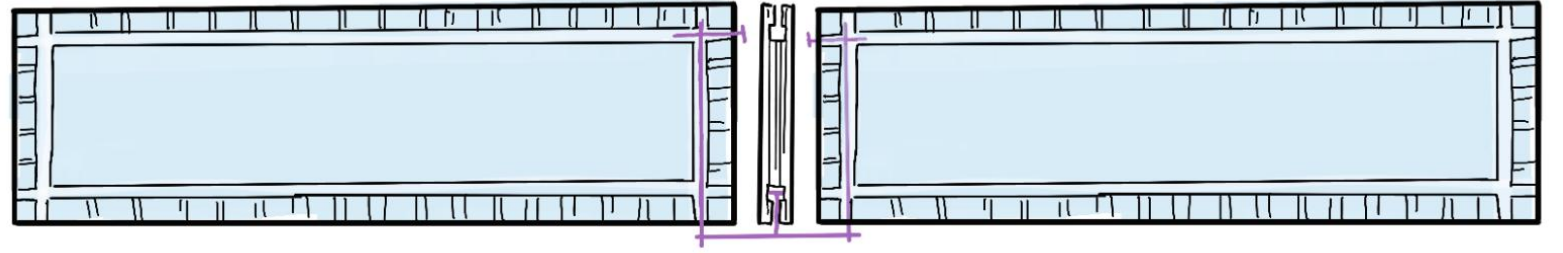
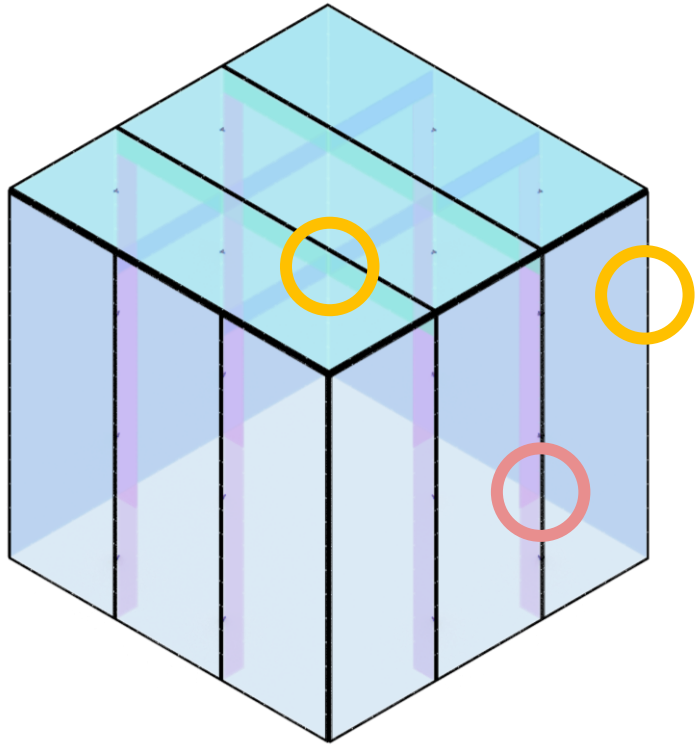


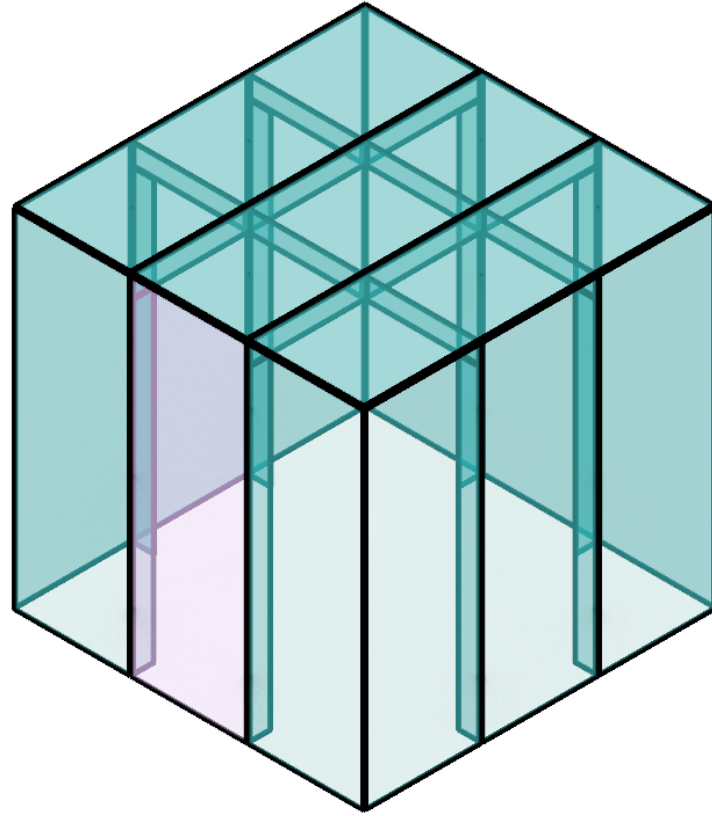
Apple fifth avenue, version 3.0



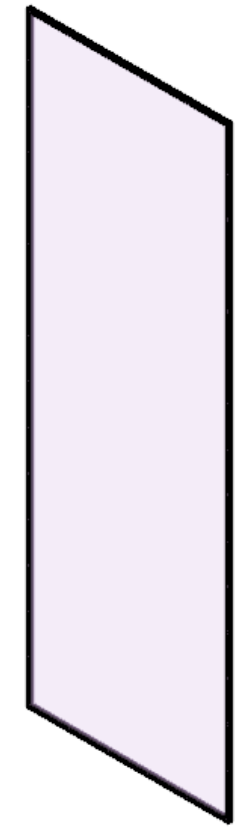
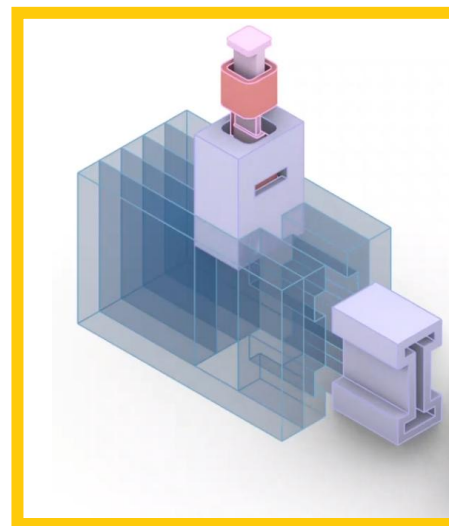
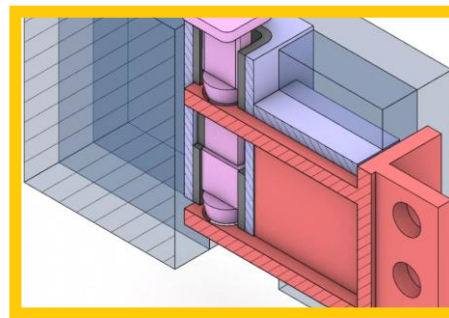
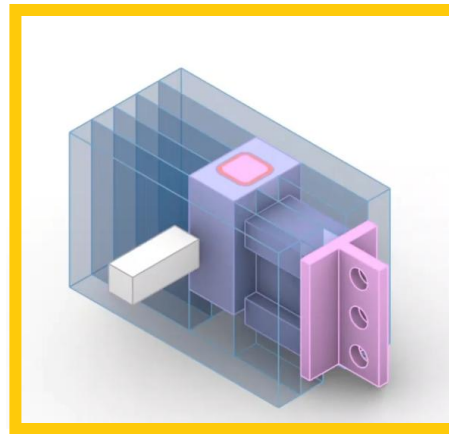
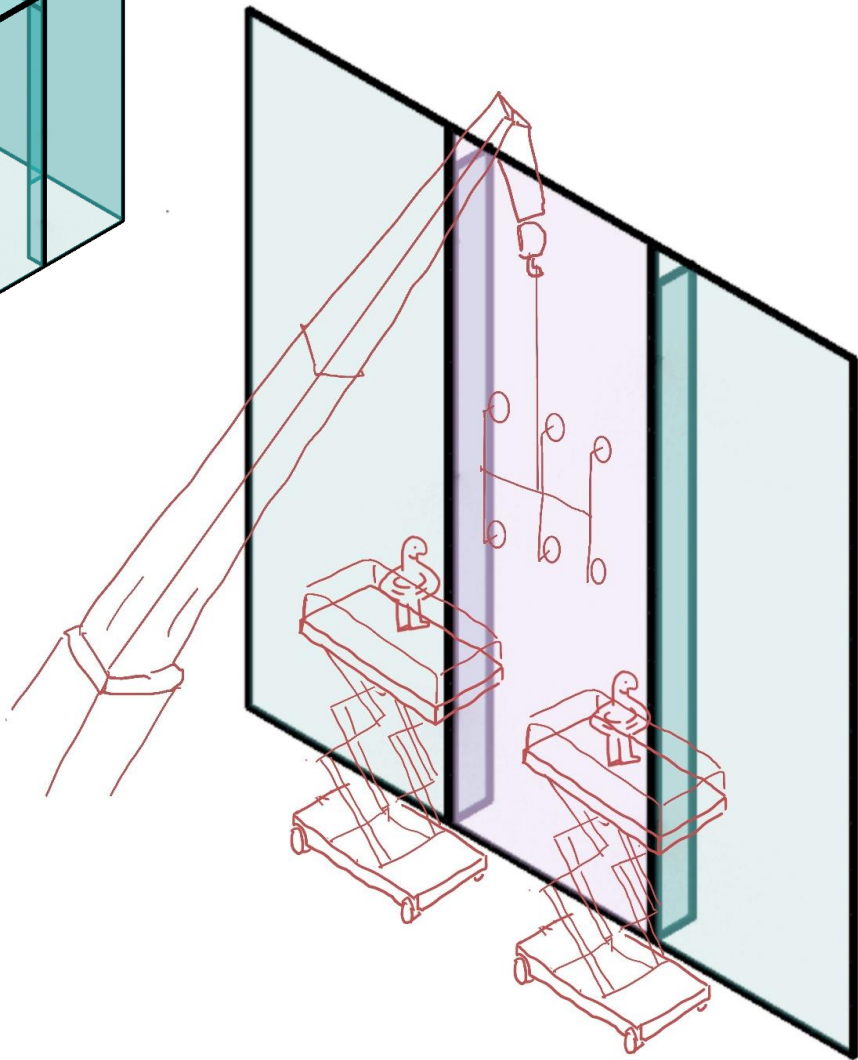
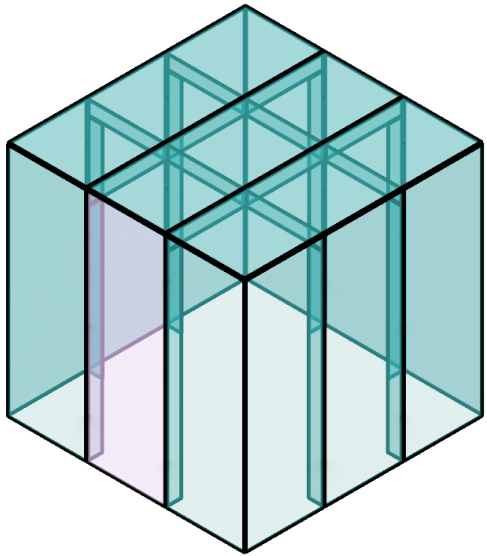
Panel no.	Sizing (m)	Location	Count
①	3.2 x 9.6	Facade panels	12
②	3.2 x 9.66	Roof panels	3
③	0.6 x 9	Facade fins	8
④	0.6 x 9.574	Longitudinal roof beam	2
⑤	0.6 X 3.11	Intermediate, secondary beams	6
Total			29



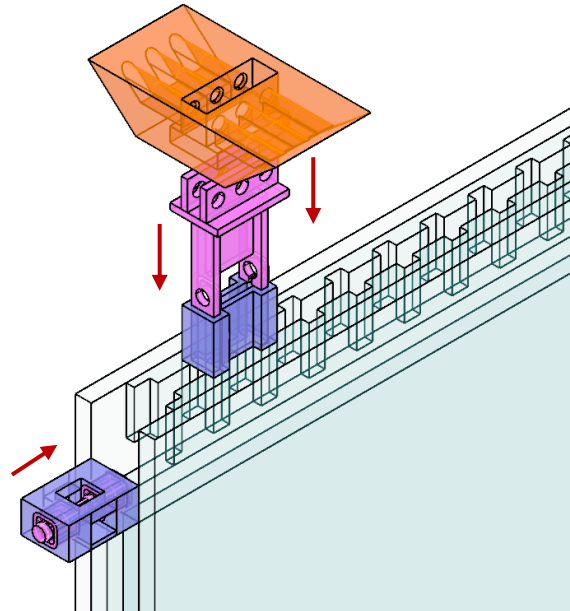
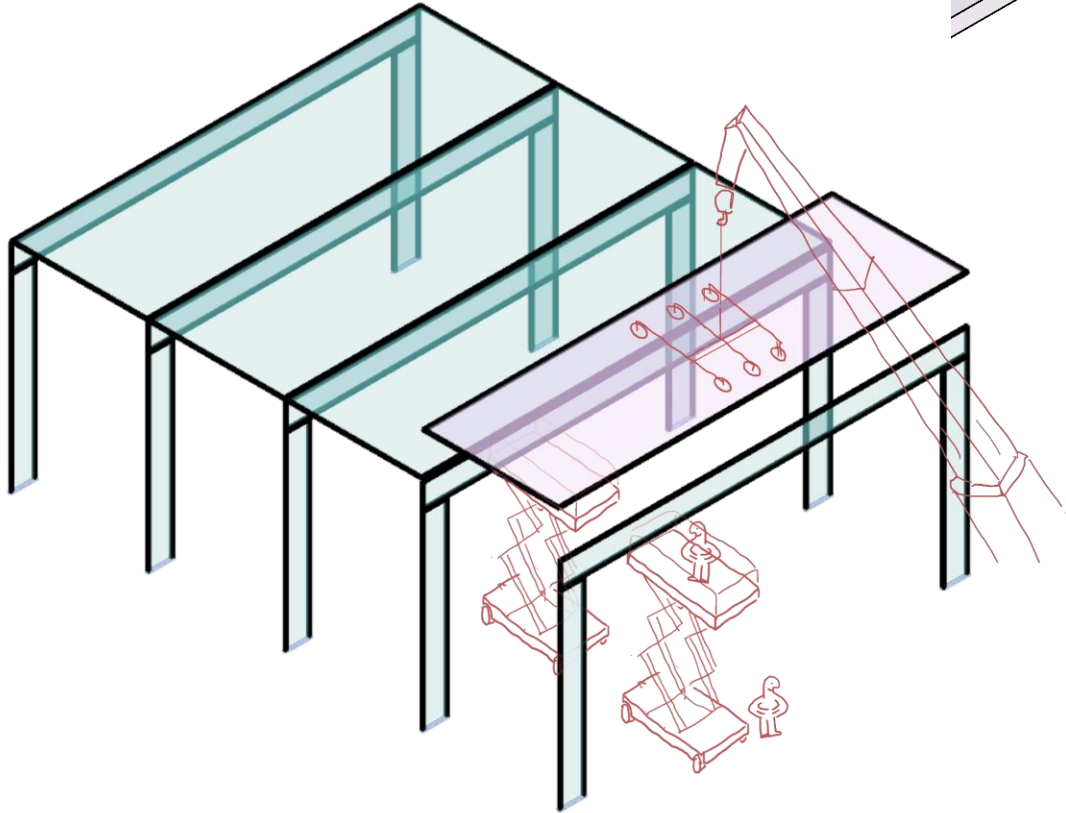
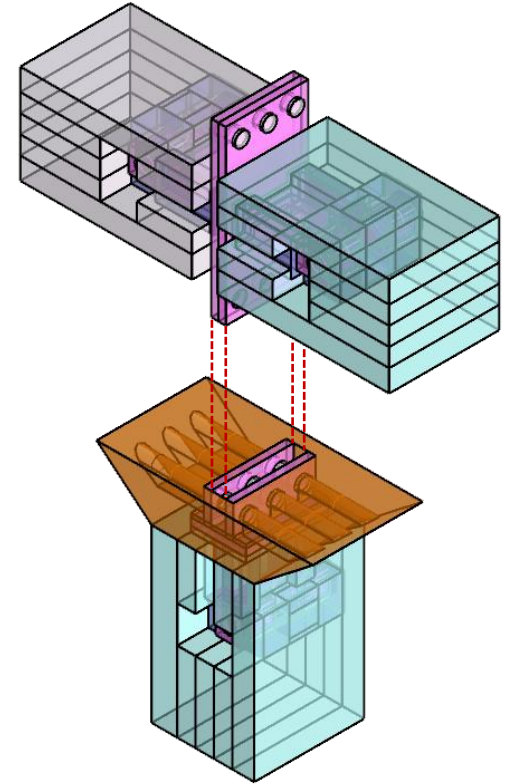
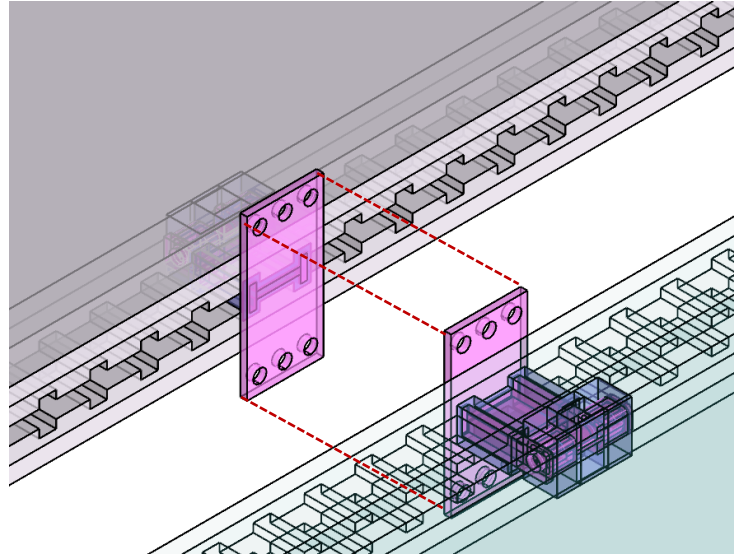
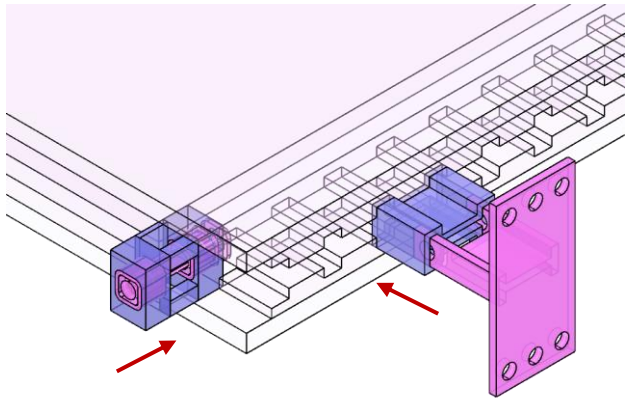


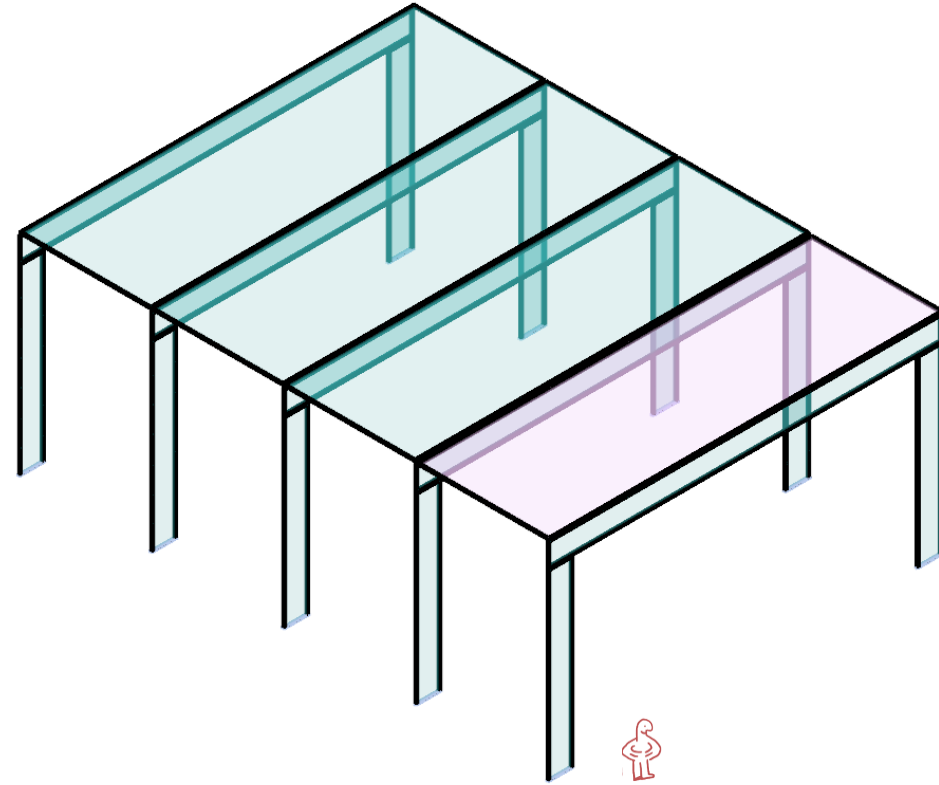


End of Life

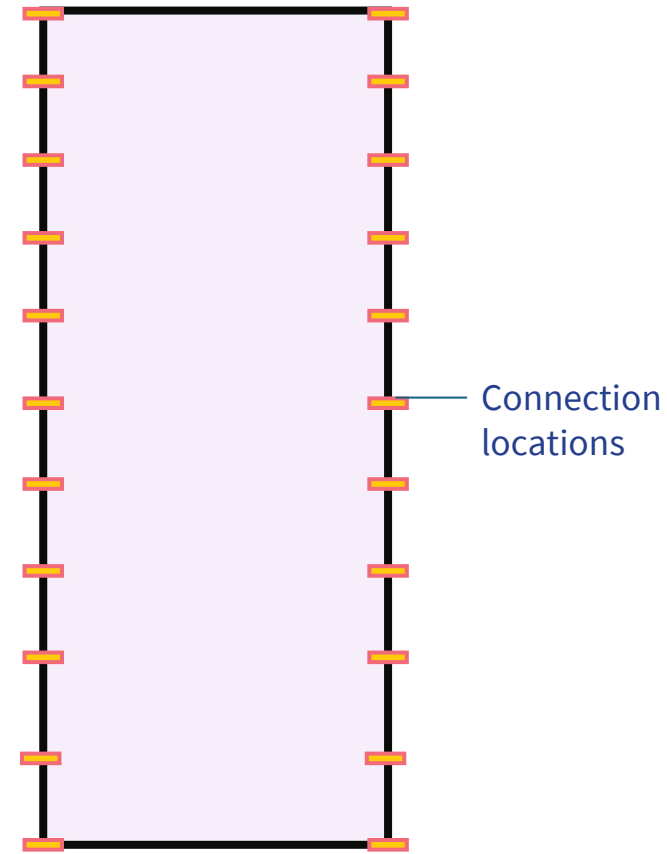
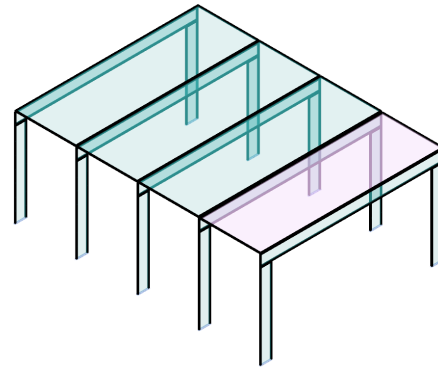
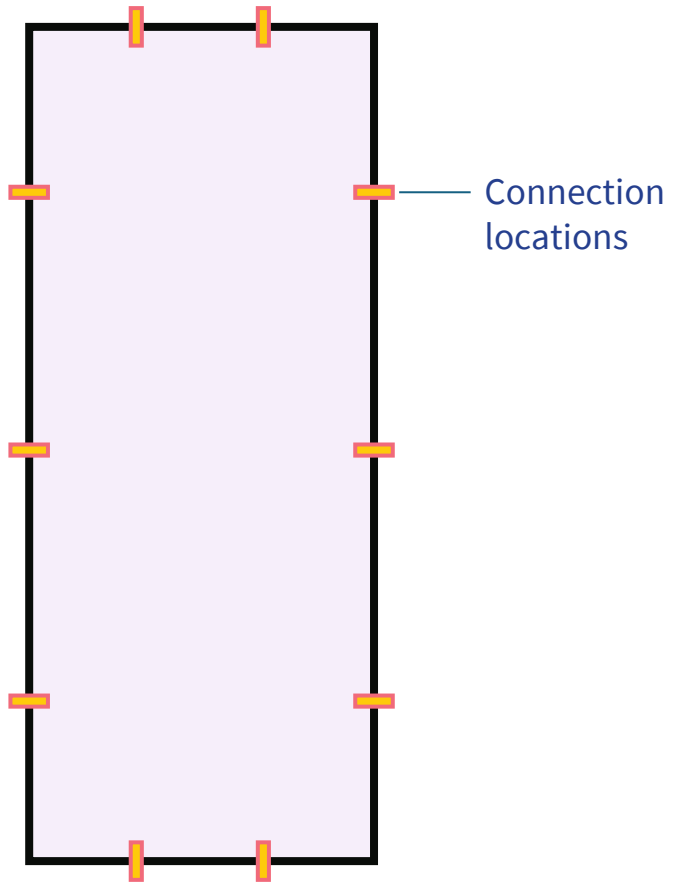
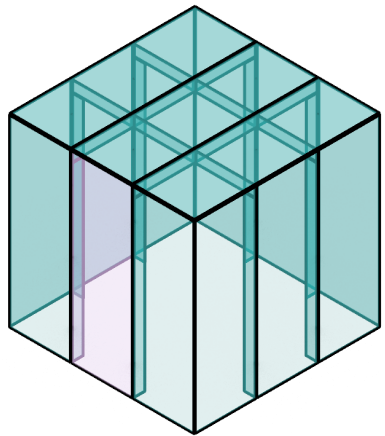


End of Life

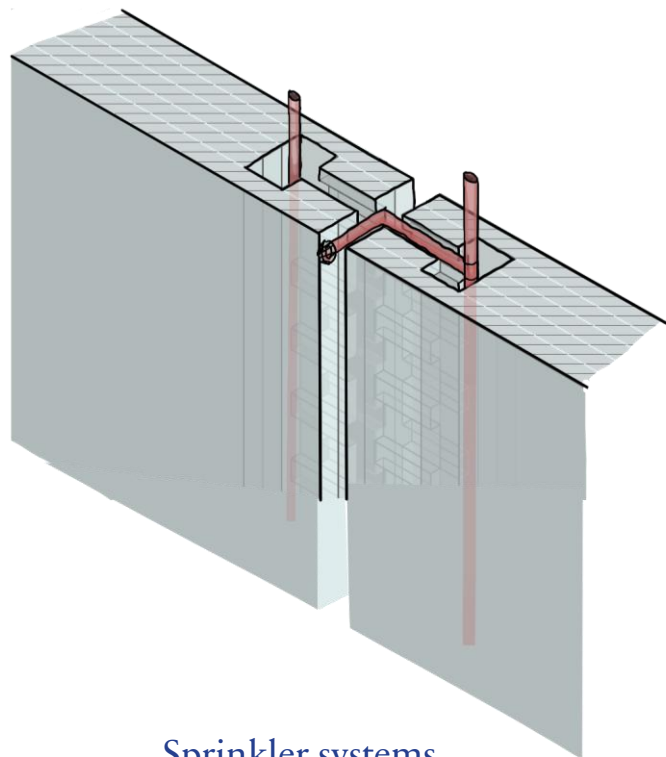




End of New Life

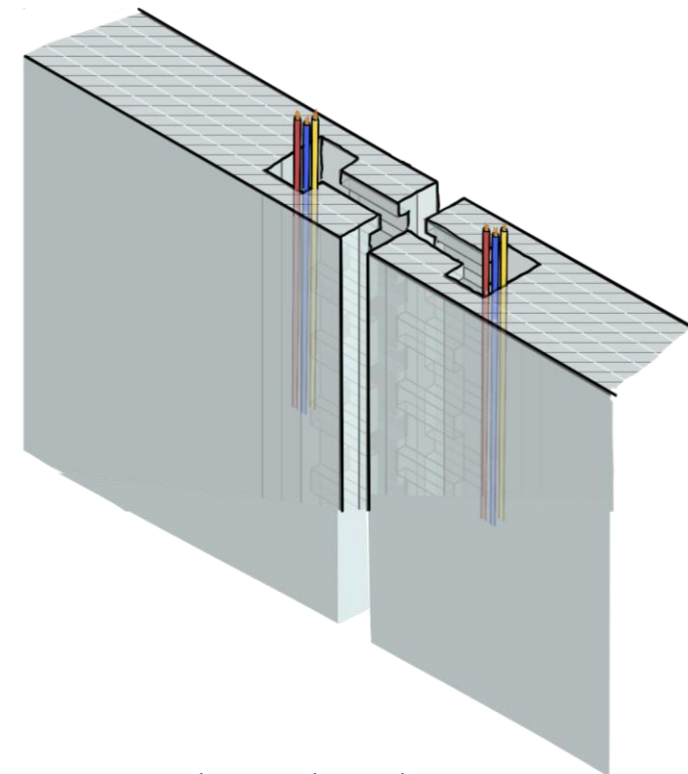
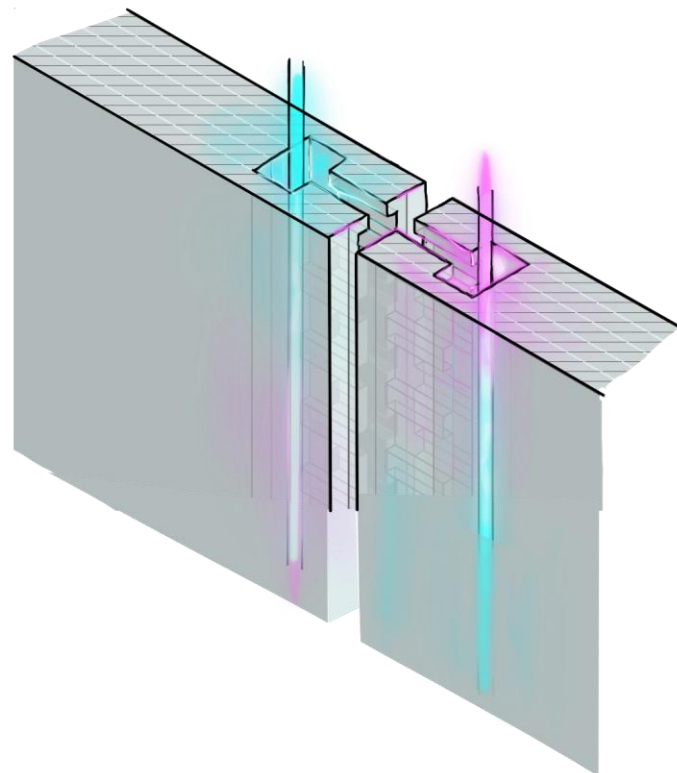


Beyond structure



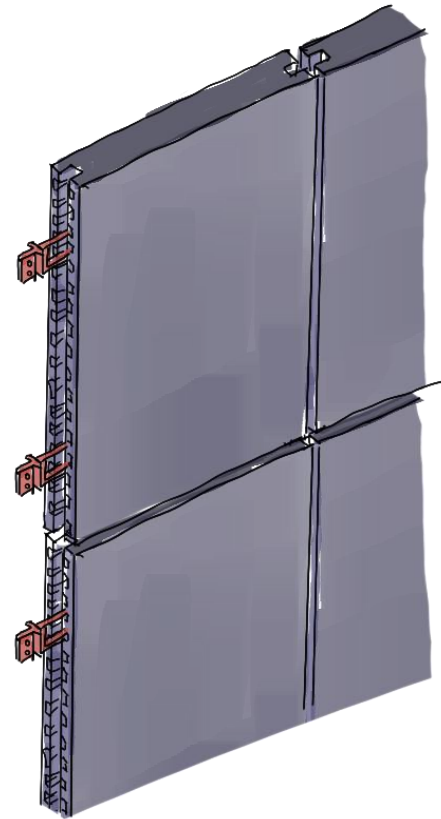
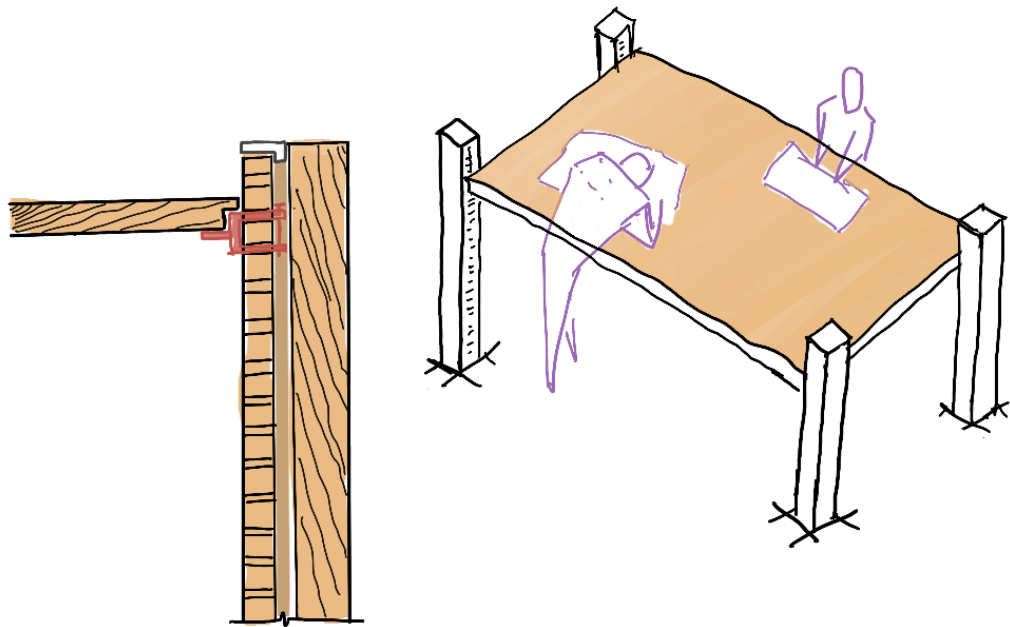
Sprinkler systems

Lighting



Electrical conduits

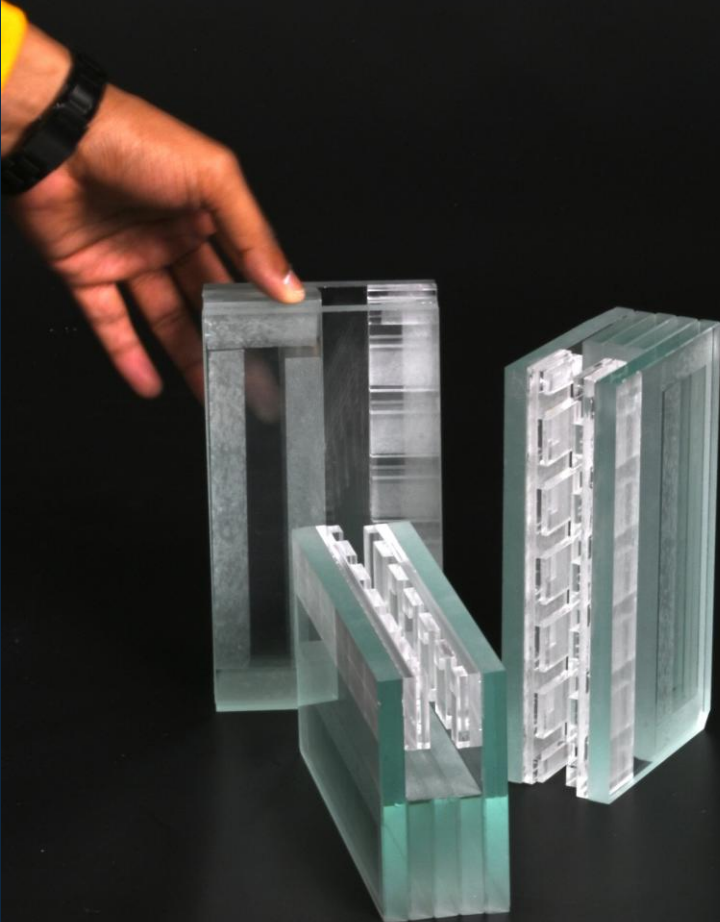
Beyond Glass



Recap

Recap 

Is the unicorn found?





No permanent modification to glass



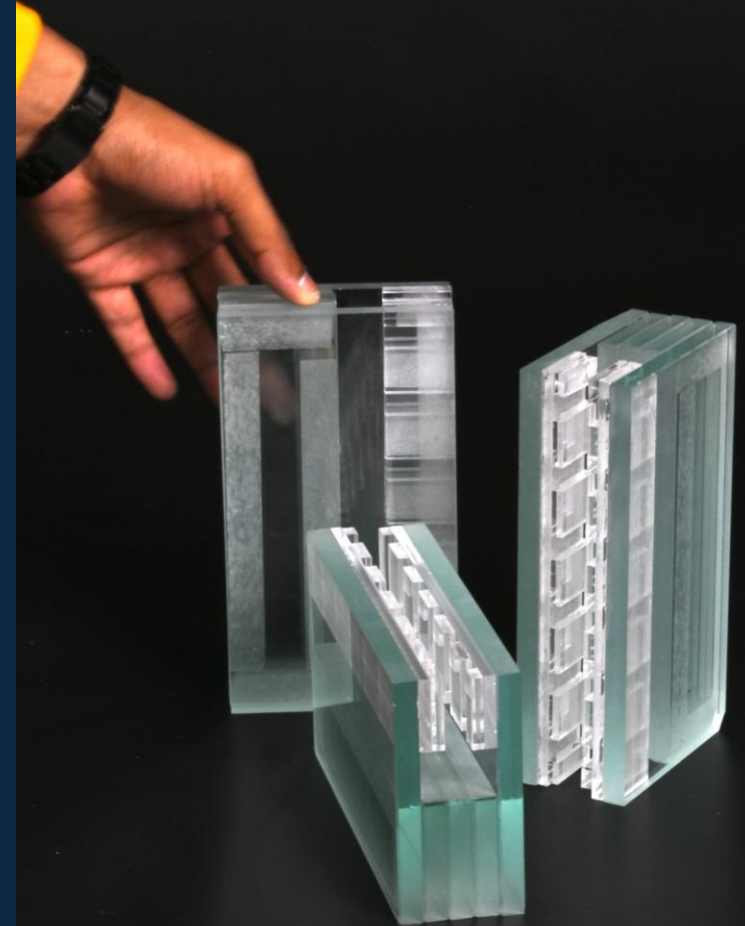
Repositionable and removable

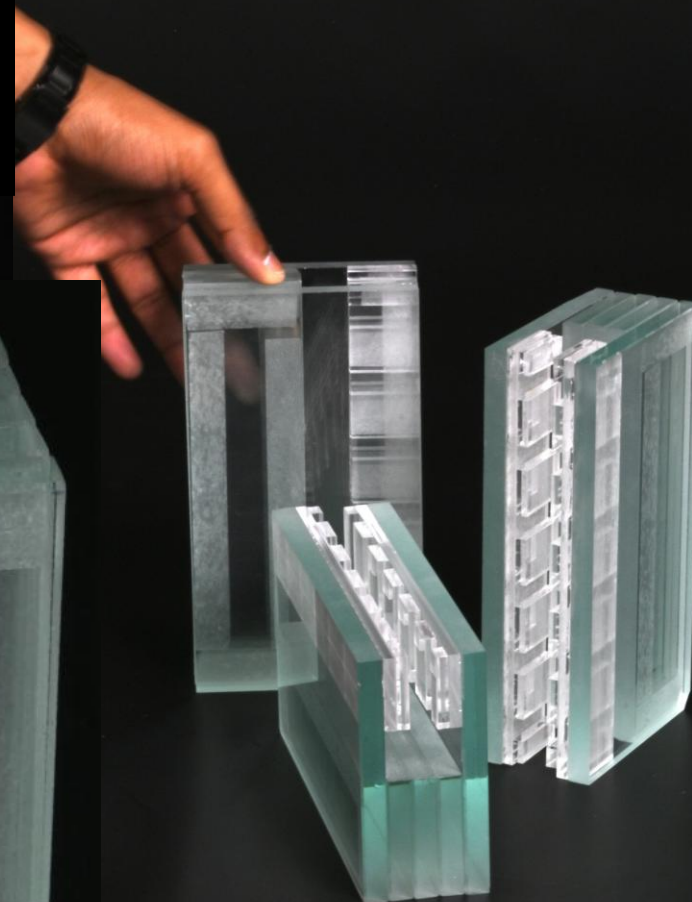
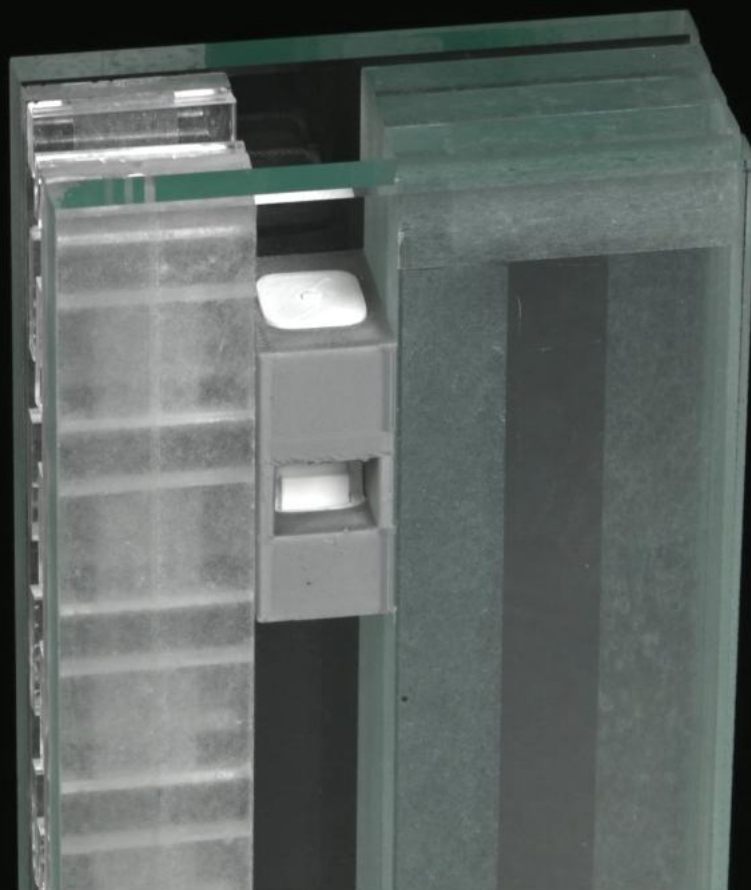
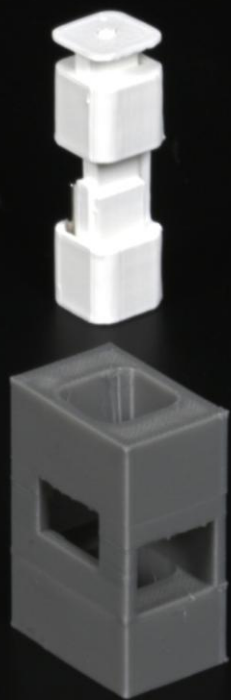


Structural performance

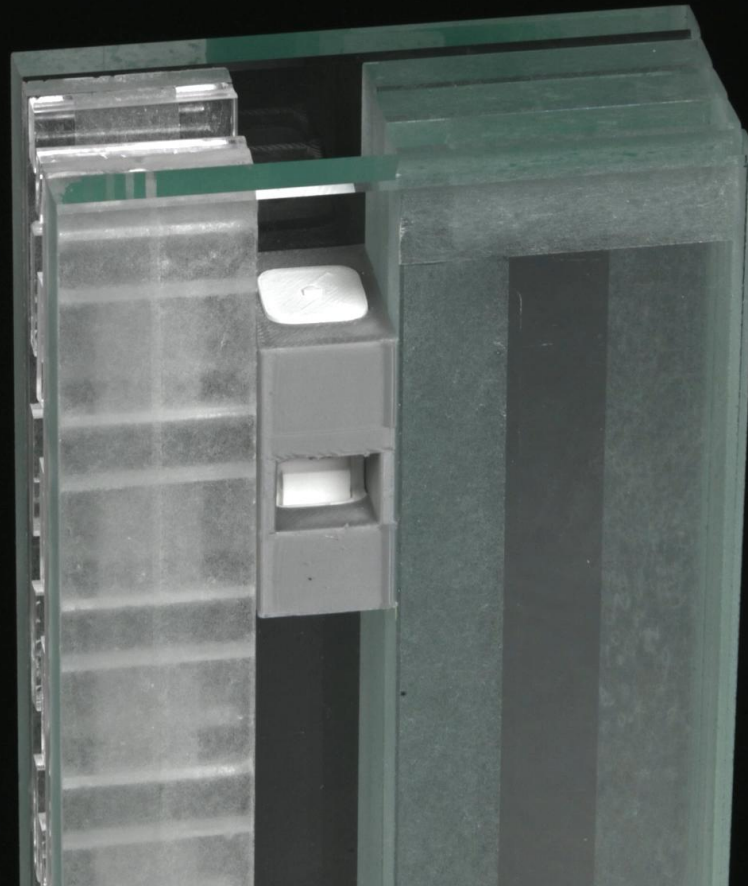


Visual intrusion





Locking sequence



Uni.conn



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6177336

Master Thesis

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