TU Delft | aE Intecture Studio | P4 Presentation

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The popUP SUPERstructure

Manuella Borges | 4521463

Content

In nature...

Keukenhof, the Netherlands
Images: online source

In architecture...

Modern Pentathlon Park, Toronto
Images: by author

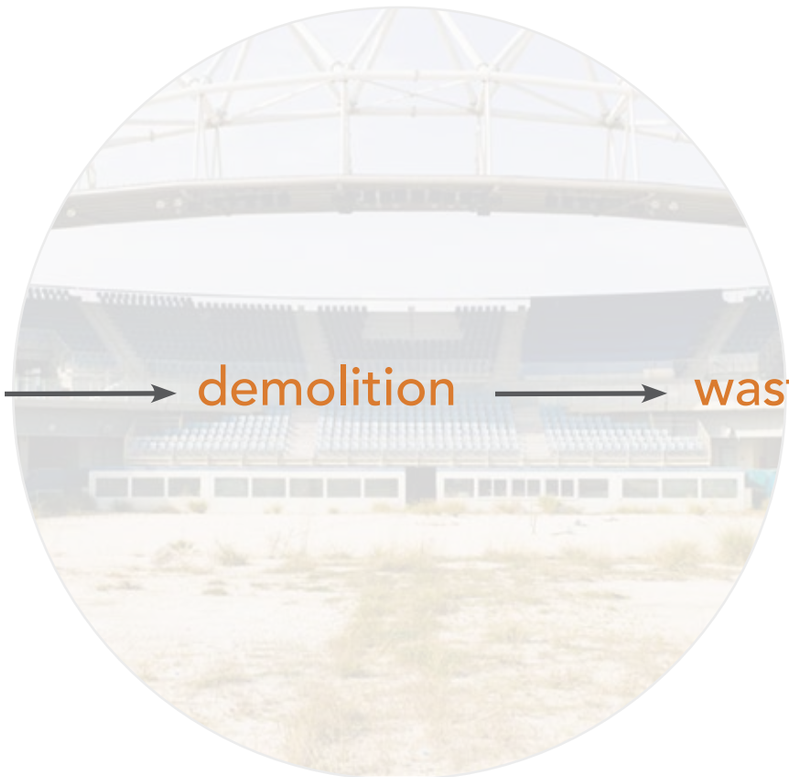
In the world of

events...

Montreal Olympic Stadium, Montreal, Canada
Images: online source

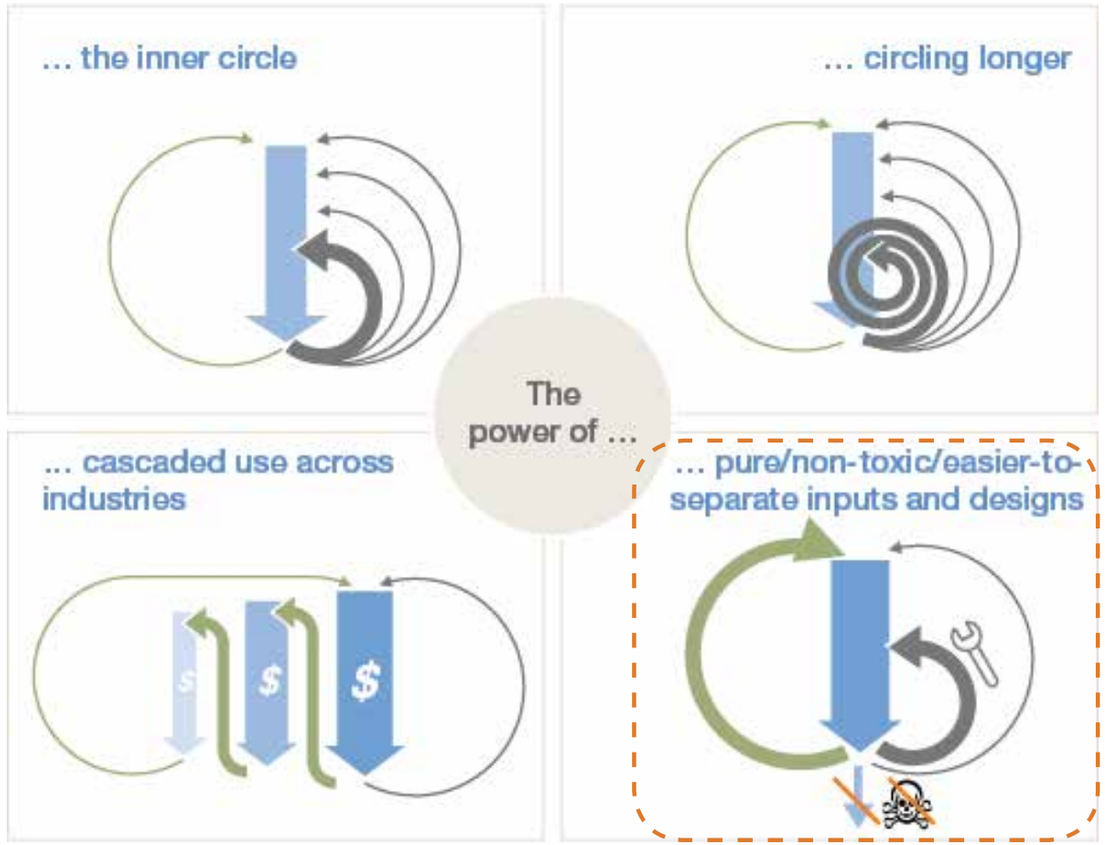
Linear Economy path:

construction → maintenance → renovation → demolition → waste



The Pure Cicle as the Key for Material Re-use & Less Embodied Energy

Circular Economy path:



Design for Disassembly

Modular

Lightweight

Temporary

Four Principles for Circular Economy

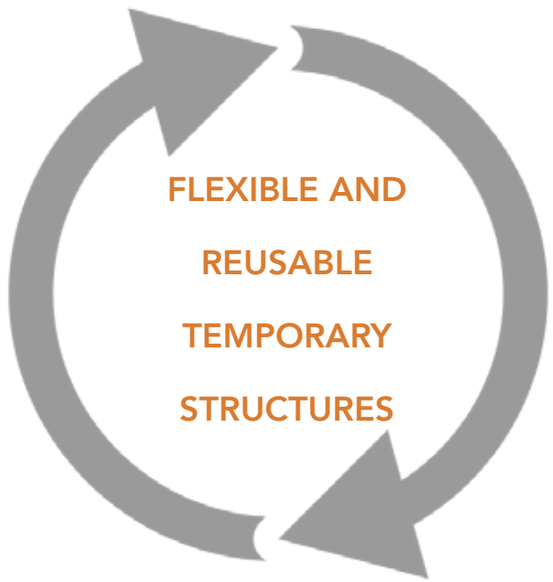
Source: Ellen MacArthur Foundation

"However, portable (moveable) buildings, though temporary in location, are not temporary in use. Their portability is precisely what makes them not disposable. The fact that they can be re-used means that they can represent an efficient use of materials and resources, and should therefore be designed with care. They are high-quality products tuned to a specific need if not a specific location."

Kronenburg, Robert. Architecture in Motion. : Taylor and Francis, 2013. ProQuest Ebook Central. Web. 24 October 2016.

Design Goal: Folly/ Pavillion → Arena

FLEXIBILITY

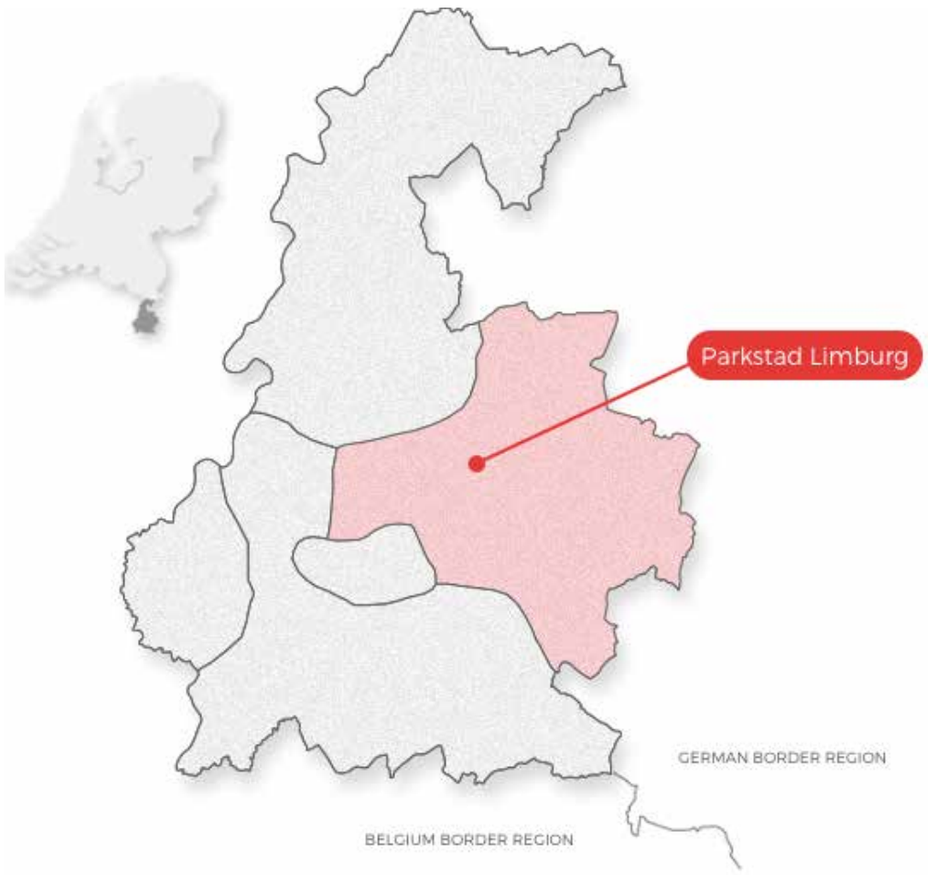


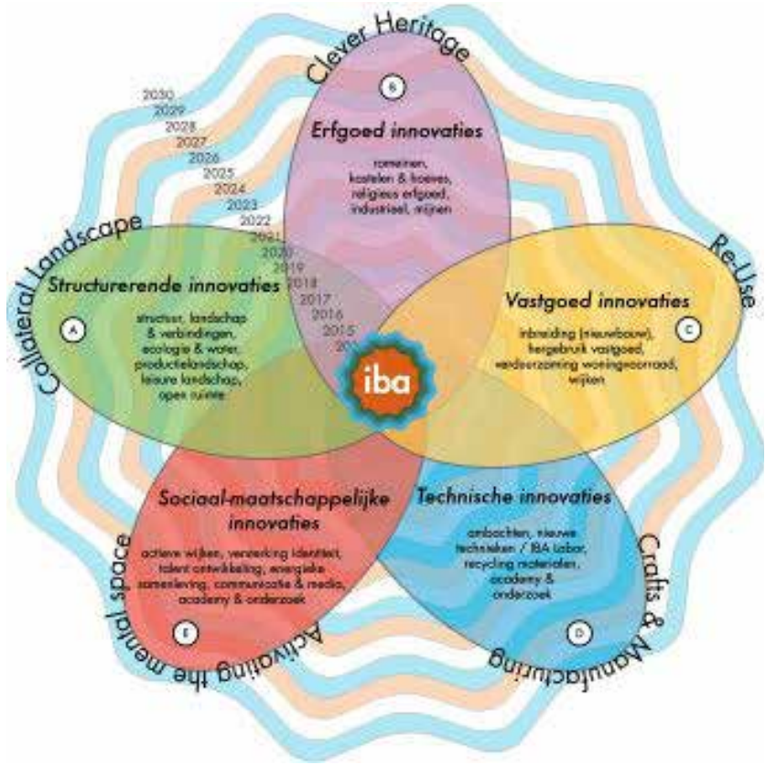
Some causes that drive temporary architecture

Cause:	Natural Disaster	Events	
Purpose:	Shelter	Expo, Exhibit	Games, Concerts
Typology:	Housing	Folly, Pavillion →	Arena

Content

Context - Why IBA Parkstad?

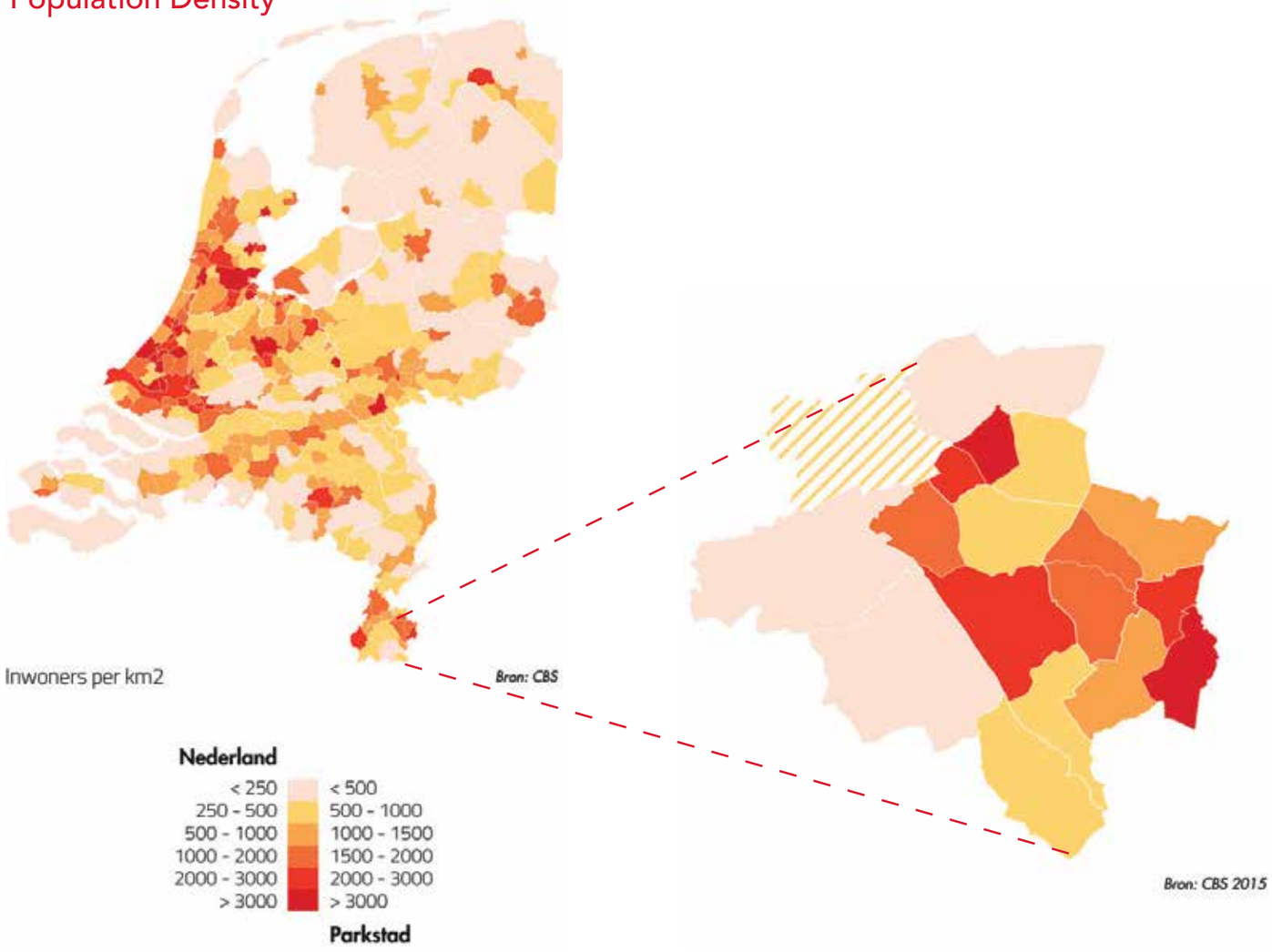




International Event/Expo to be held in 2020 in order to showcase future-proof, innovative and experimental projects that will draw attention to the region and help boost its economy and restore the pride of its citizens.

Context - The Parkstad Region Challenge

Population Density



-875
birth surplus in 2013

9%
unemployment

2,05
average household size

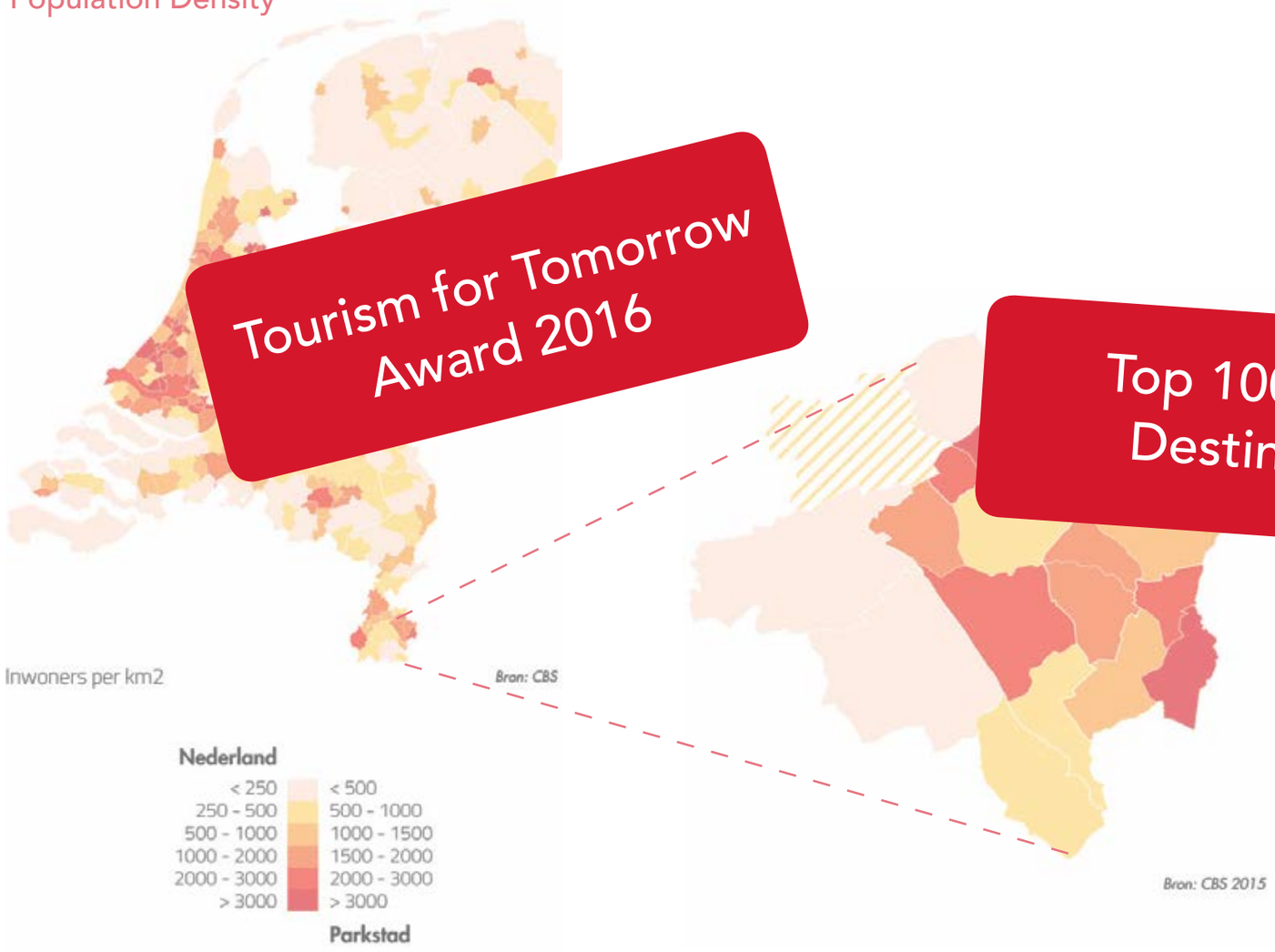
1.180
population density inhabitant per km^2

Shrinking Region

Data Source: Handboek IBA Zomer2015

Context - The Parkstad Region Challenge

Population Density



Tourism for Tomorrow Award 2016

Top 100 Green Destinations

-875
birth surplus in 2013

9%
unemployment

2,05
household size

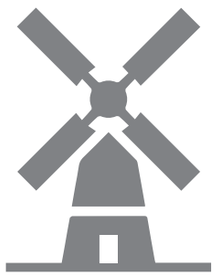
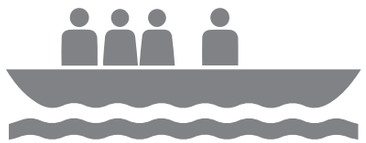
1.180
population density inhabitant per km^2

Shrinking Region

Context - Dutch nature as seen by Tourists




Data Source:
(source: https://www.mooistenatuurgebied.nl/over-de-natuur)
Images: online source

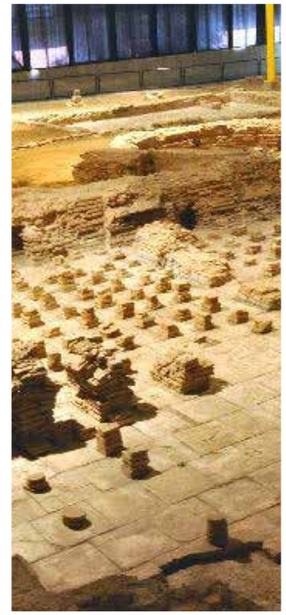

as seen by the Americans, British and Chinese

as seen by Belgians and Germans

Context - What makes the Parkstad Region unique?

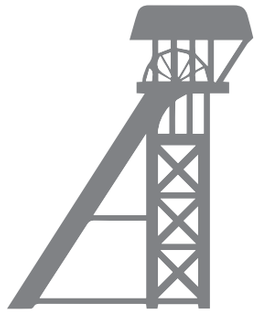






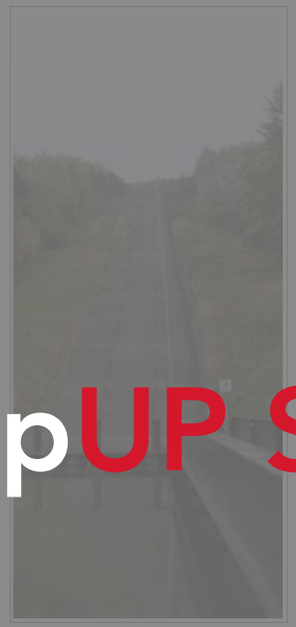
Images: by author

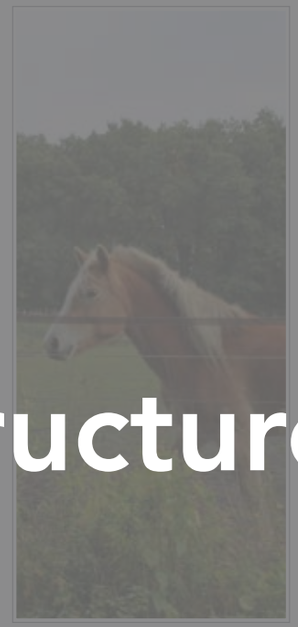
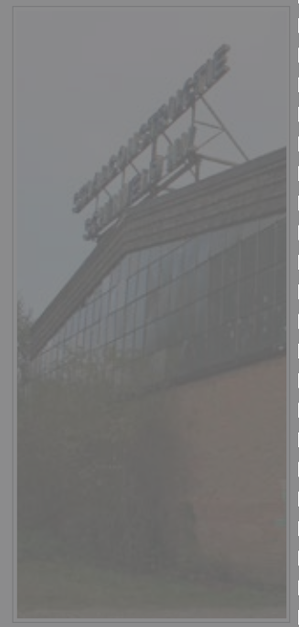



The cultural and historic heritage of the Parkstad Region

popUP SUPERstructure



series of interventions

promote the region

showcase innovation

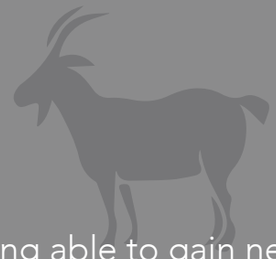
showcase sustainability

increase tourism

create jobs

restore pride of citizens





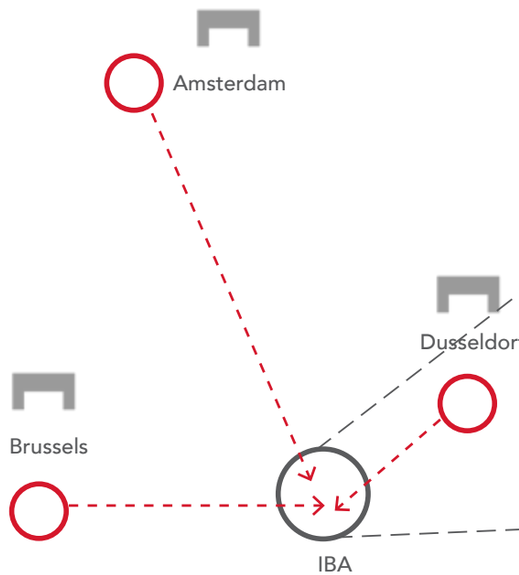

popUP responds to the needs of the present, while being able to gain new life in the future

SUPERstructure: capacity of structure to be flexible and adapt to various scales and programs

Project Phasing

PHASE 1

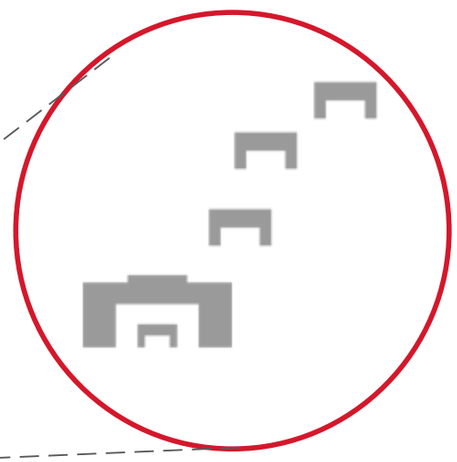
Before IBA 2020



popUP URBANescapes

PHASE 2

IBA 2020

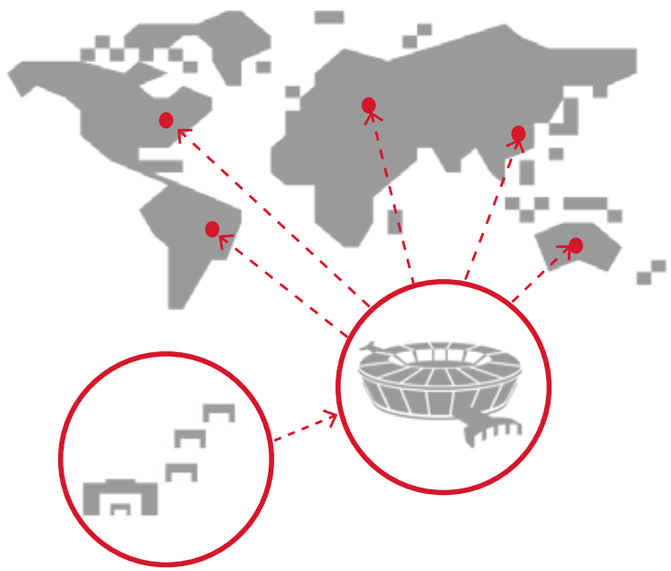


popUP LANDescapes

popUP URBANescapes

PHASE 3 (future vision)

After IBA 2020

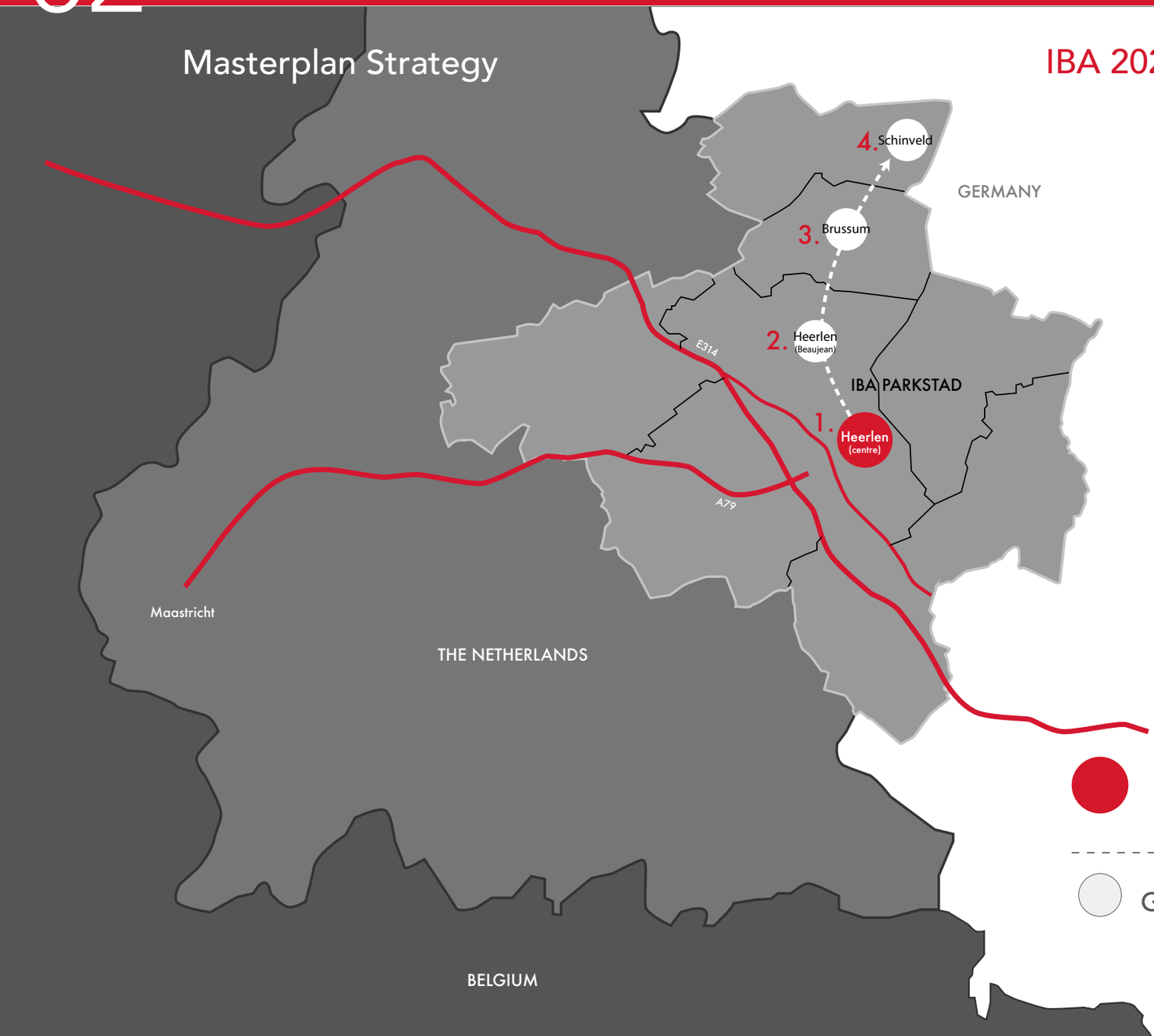


Folly/ Pavillion → Arena

FLEXIBILITY

Masterplan Strategy

IBA 2020 - Meet IBA & Get Connected



Meet IBA

Get connected

popUP URBANescapes

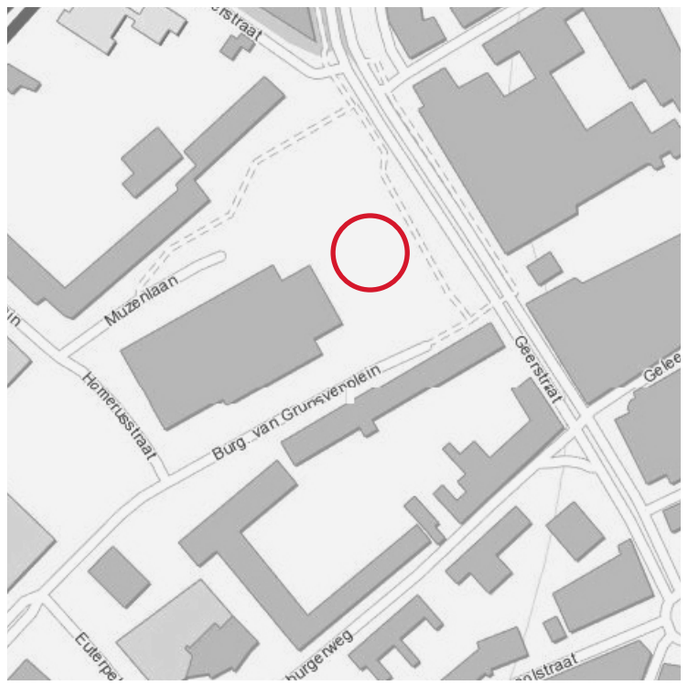
Welcome Centre

popUP LANDescapes

Follies to attract people to certain regions

Heerlen

Grunsvenplein - Welcome Centre

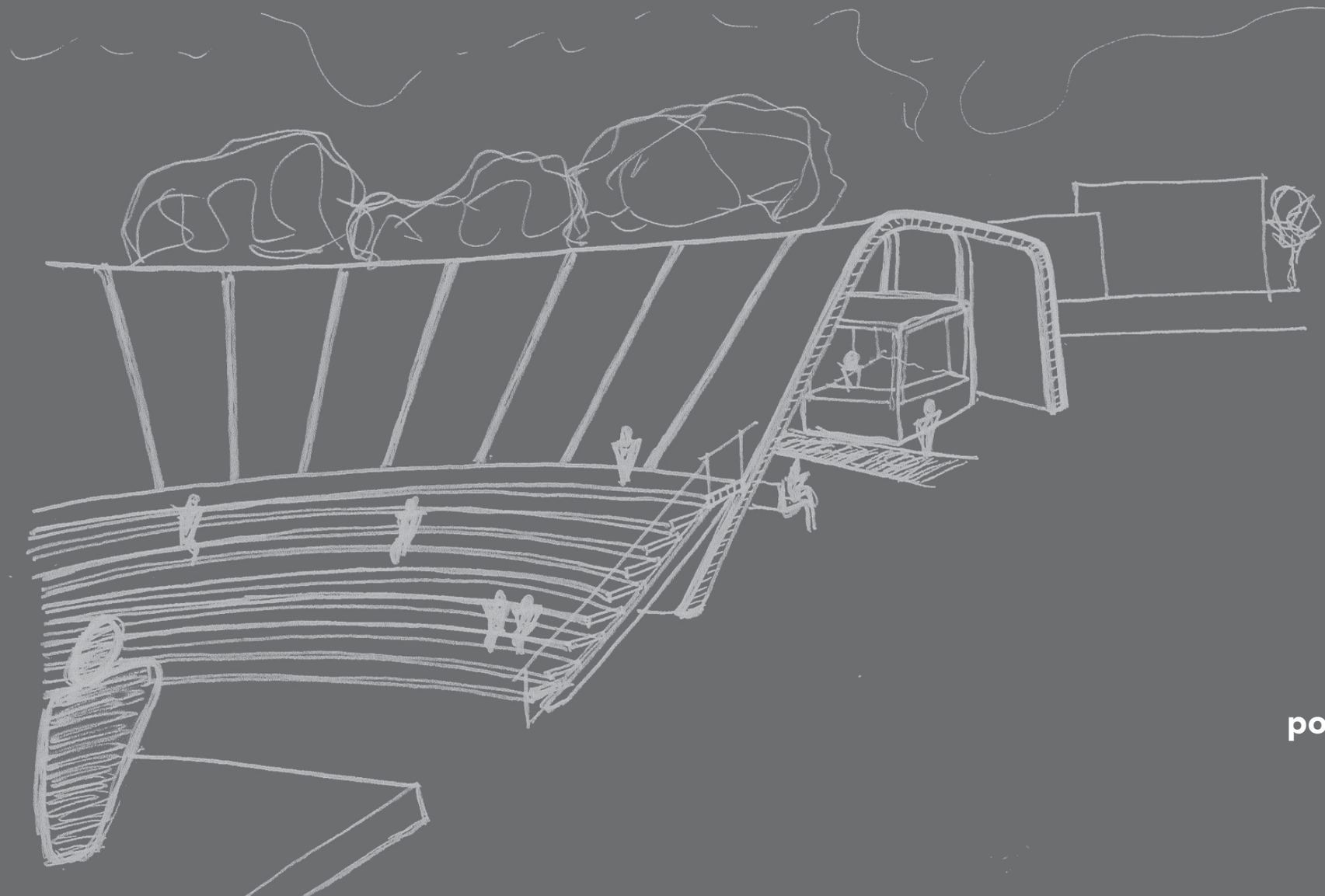


popUP URBANescapes

Welcome Centre

Grunsvenplein - Welcome Centre

Heerlen



popUP URBANescapes

Beaujean

Beaujean Quarry - Folly (Floating Platform)

popUP LANDescapes

Follies to attract people to certain regions

Beaujean Quarry - Folly (Floating Platform)

Beaujean

Brussum

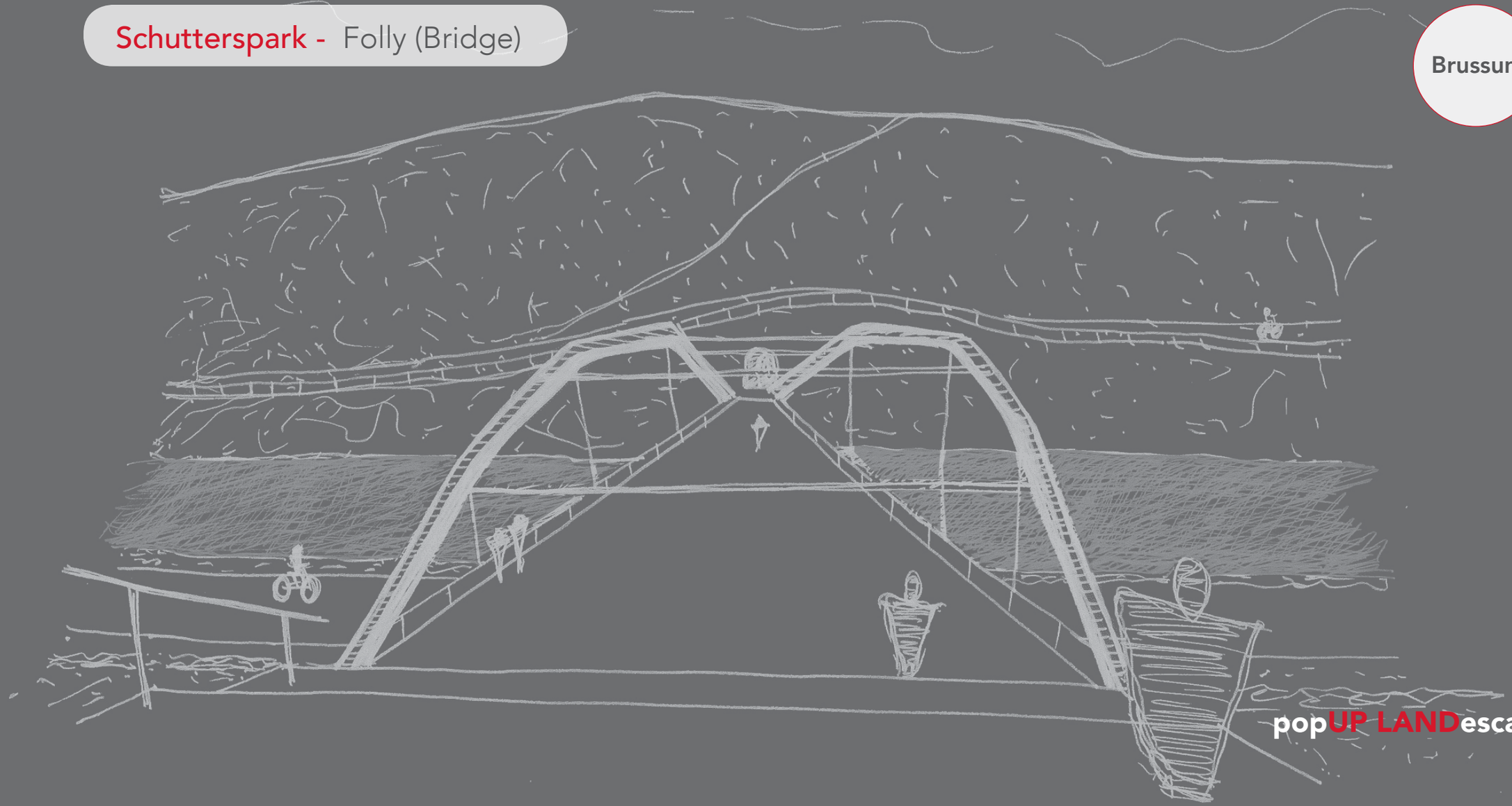
Schutterspark - Folly (Bridge)

popUP LANDescapes

Follies to attract people to certain regions

Schutterspark - Folly (Bridge)

Brussum



popUP LANDescapes

Schinveld

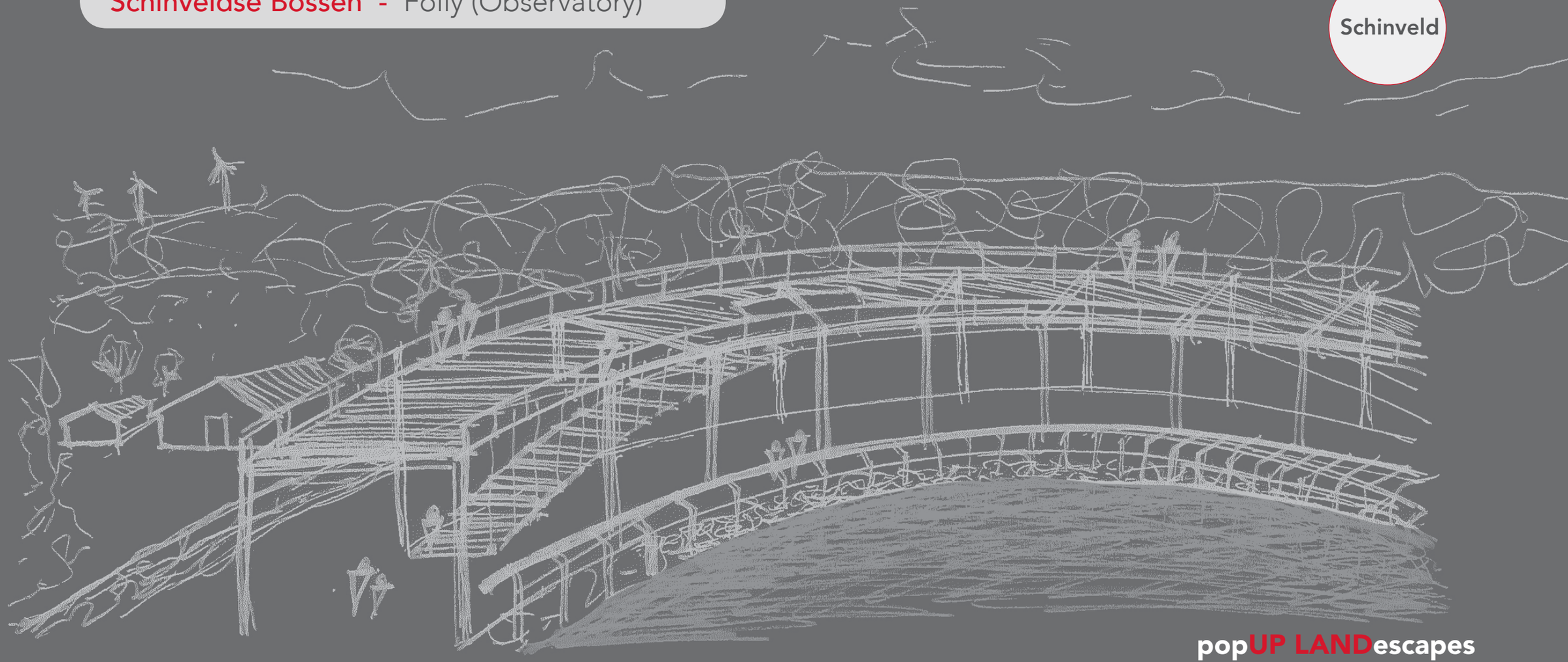
Schinveldse Bossen - Folly (Observatory)

popUP LANDescapes

Follies to attract people to certain regions

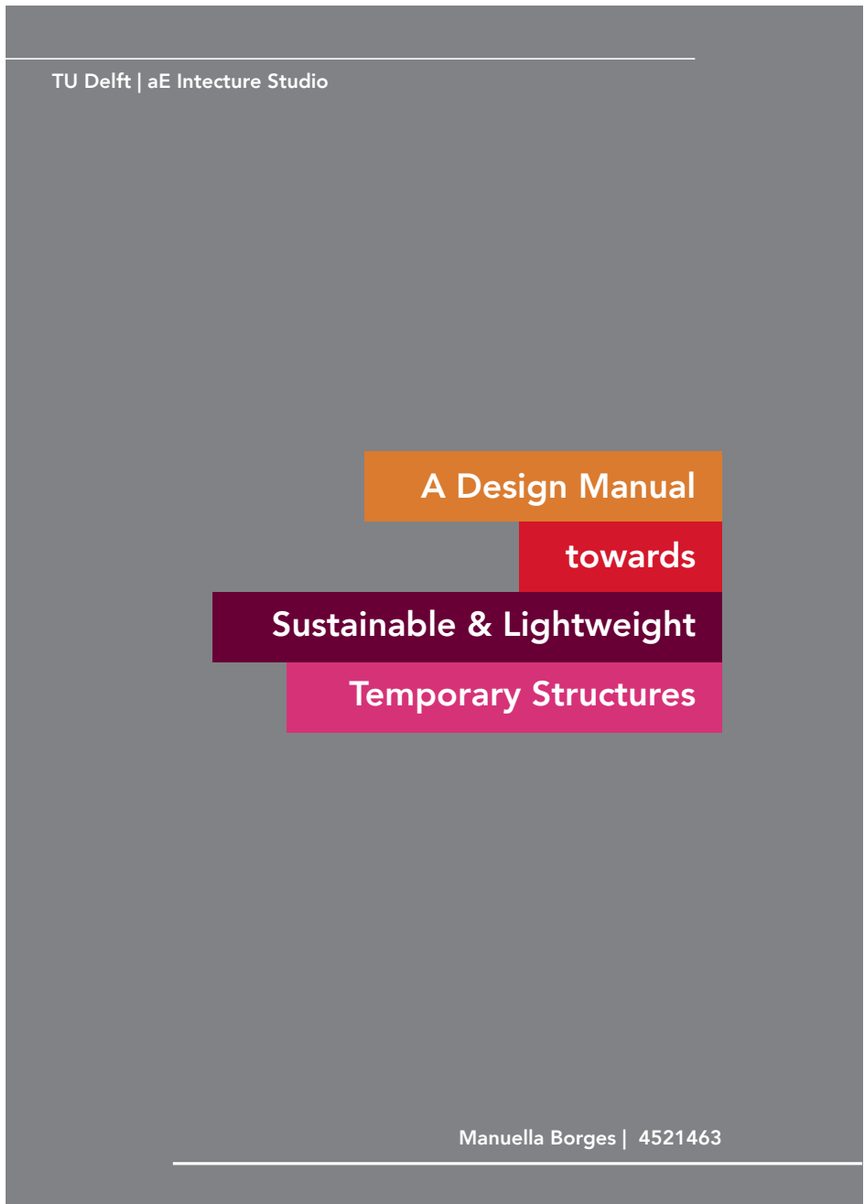
Schinveldse Bossen - Folly (Observatory)

Schinveld



popUP LANDescapes

Content



Technical Research Question

Which techniques will allow for the creation of a more sustainable and flexible temporary architecture?

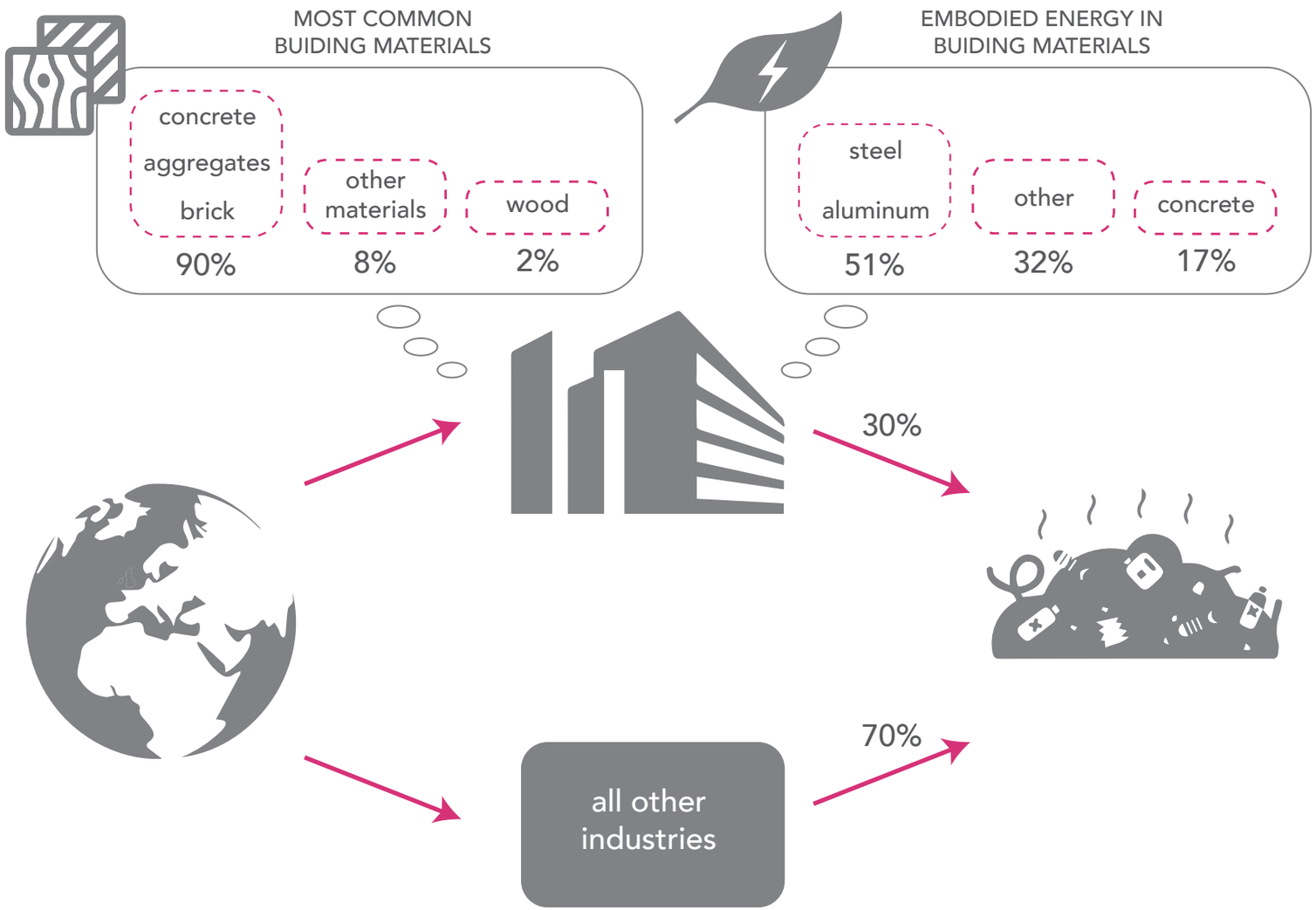
Sub-questions

What **materials** will be most suitable for the creation of lightweight and demountable structures that have low environmental impact?

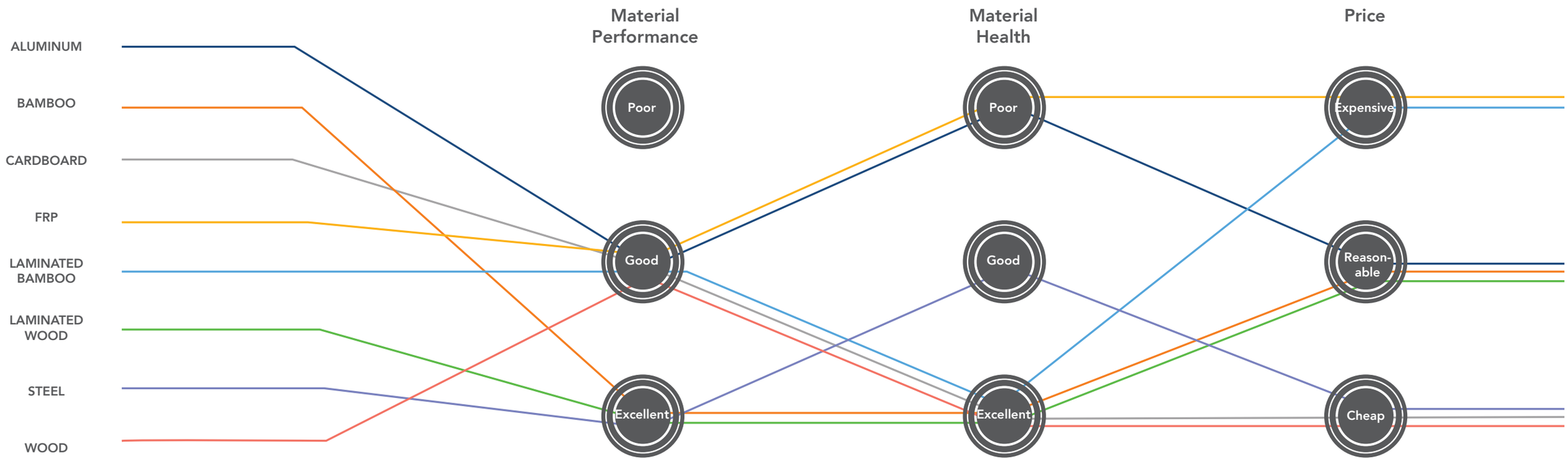
What would be the optimal **sizes** for ease of handling and transportation?

What assembly/disassembly methods and **connections** will be most suitable?

Problem statement concerning building materials

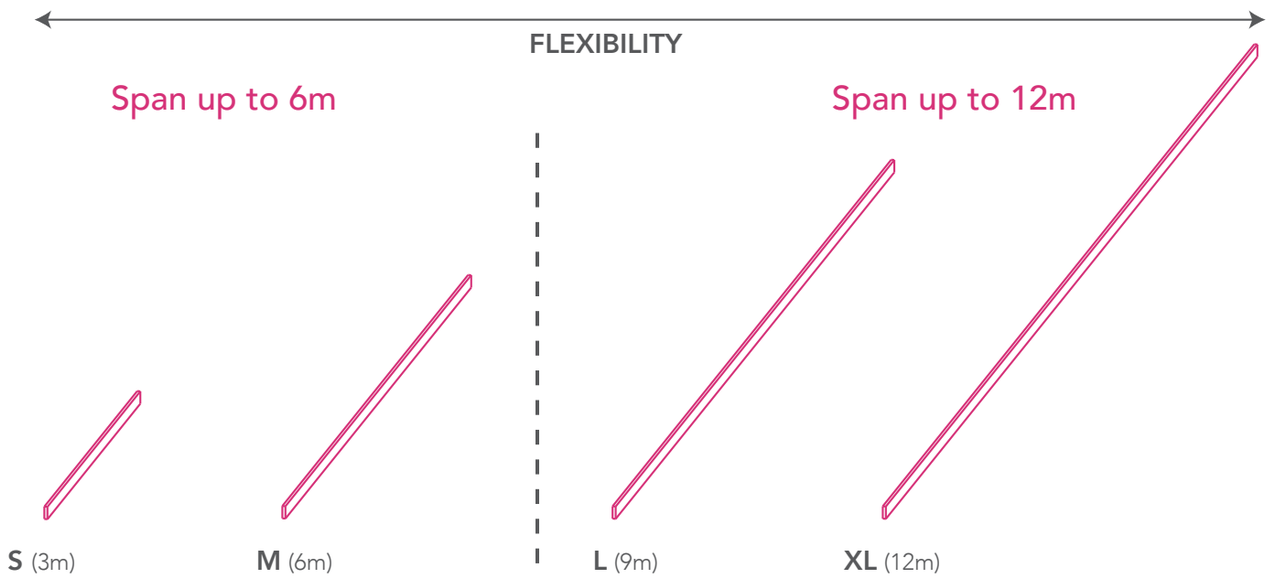


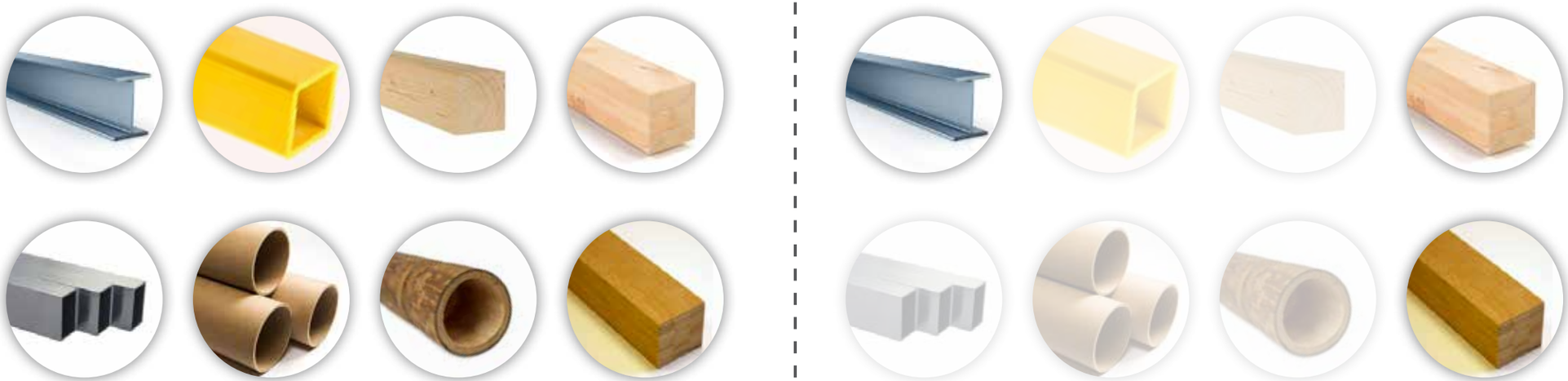
Final results per material & possible scenarios



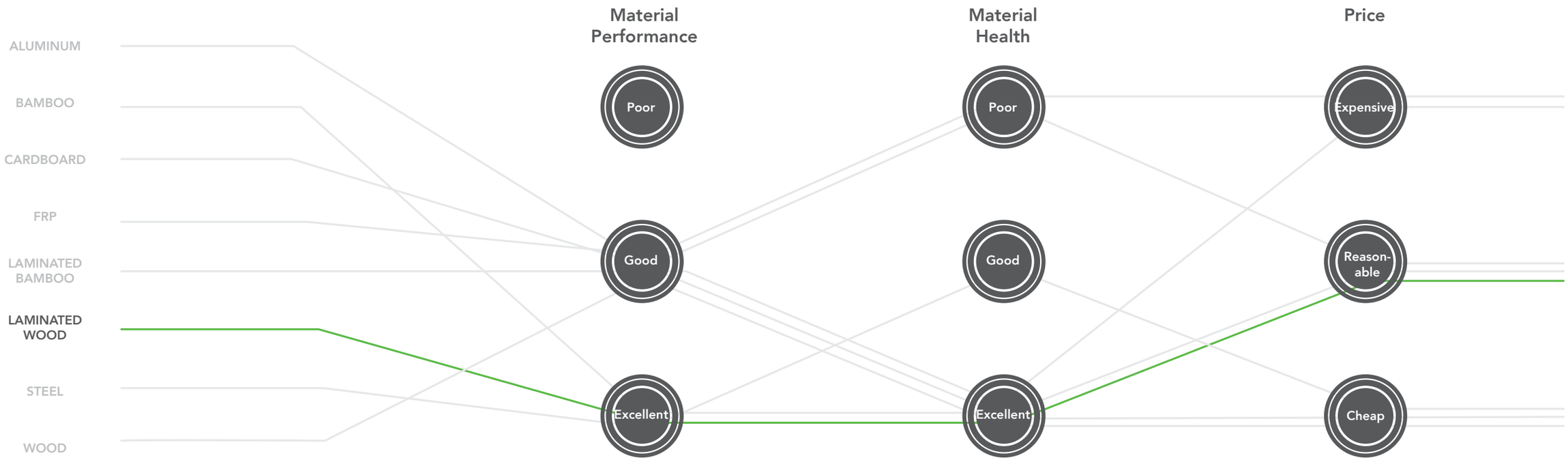
Criteria I: Material Performance	Criteria II: Material Health	Criteria III: Cost
Poor: 1 – 18 points	Poor: 1 – 18 points	Expensive: 1 – 18 points
Good: 19 – 36 points	Good: 19 – 36 points	Reasonable: 19–36 points
Excellent: 37 – 56 points	Excellent: 37 – 56 points	Cheap: 37 – 56 points

Material choice influenced by transportation methods and span sizes





Chosen scenario



Design Principles

FLEXIBLE AND
REUSABLE
TEMPORARY
STRUCTURES

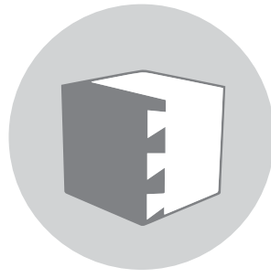
01

Lightweight
Durable
Sustainable
Affordable

02

Flexible
Modular
Easy to transport
Easy to handle on site

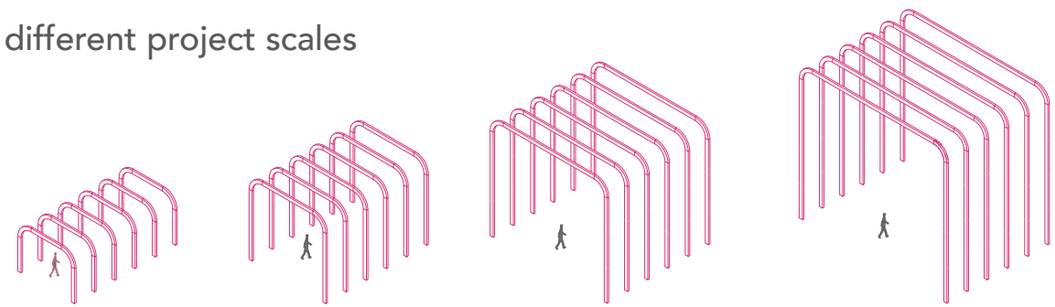
03



Easy to Assemble
Easy to Disassemble
Few parts
Simplified design

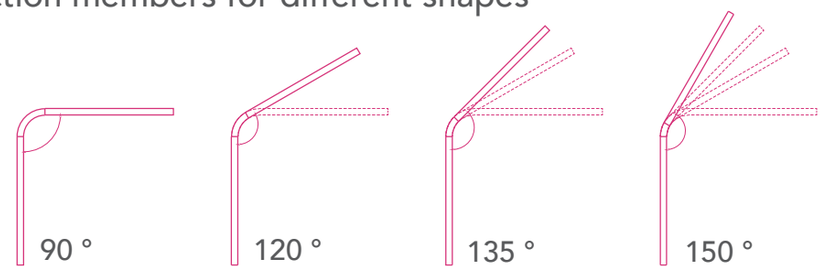
Modularity

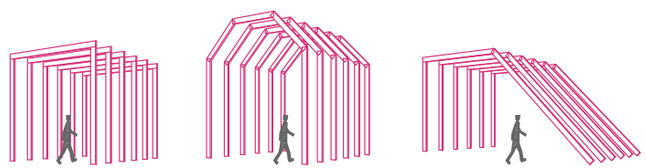
Modular sizes for different project scales



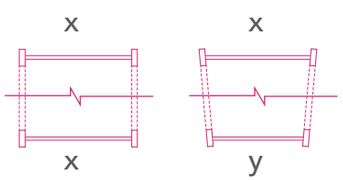
Flexibility

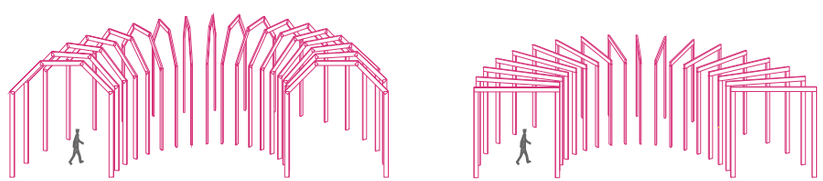
Curved connection members for different shapes





Bracing of different sizes to add curvature to designs





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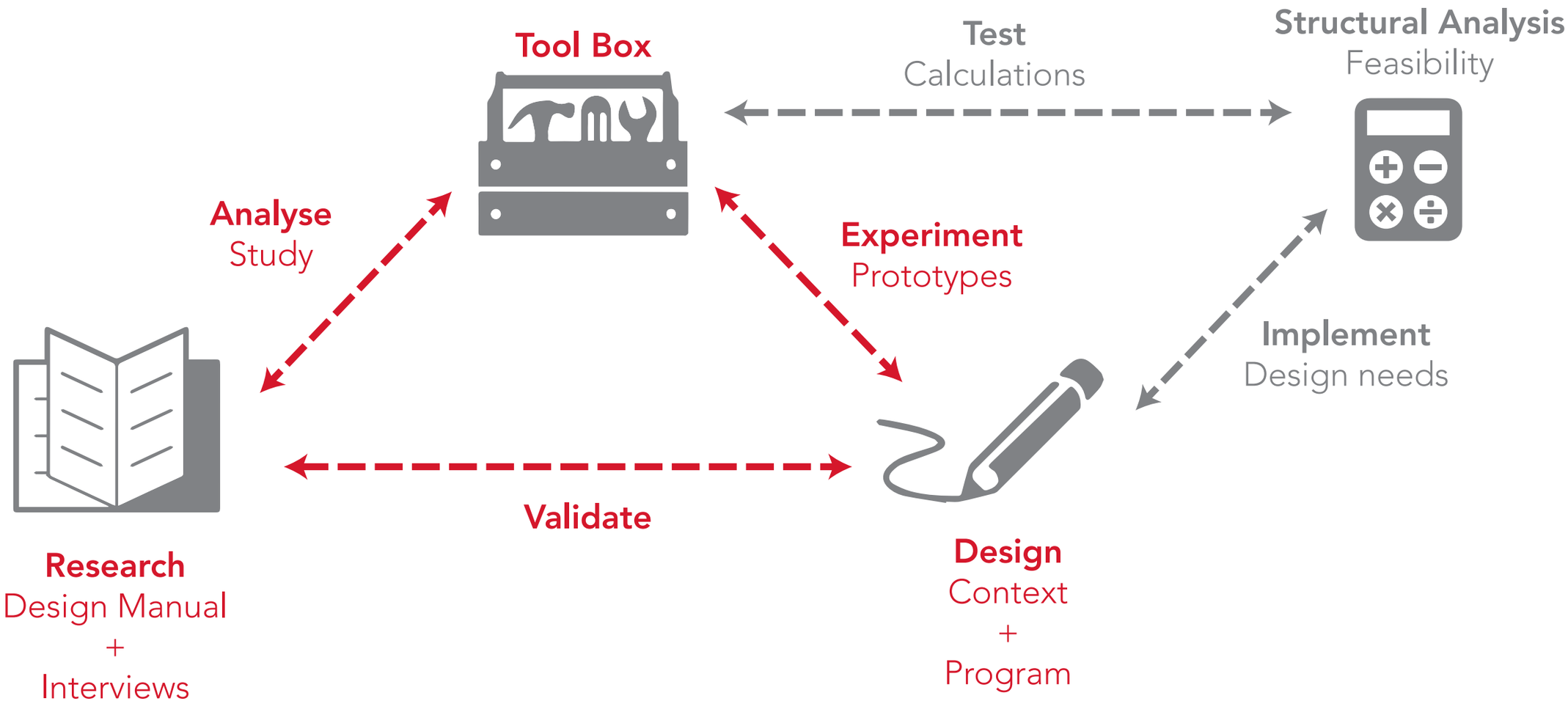
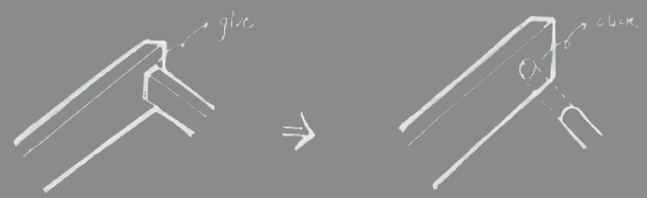

Tool Box
Test
Calculations
Structural Analysis
Feasibility
Analyse
Study
Experiment
Prototypes
Implement
Design needs
Validate
Research
Design Manual
+
Interviews
Design
Context
+
Program

Toolbox Goal

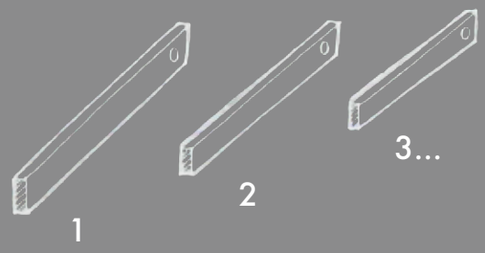
FLEXIBLE

EASY ASSEMBLE / DISASSEMBLE

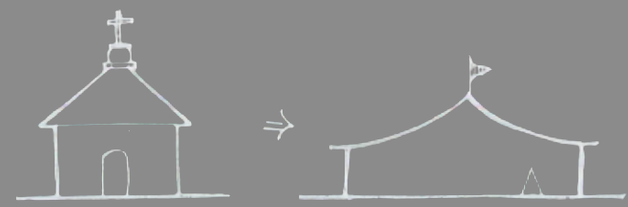


LIGHTWEIGHT

MODULAR

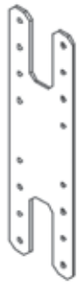


TEMPORARY



Toolbox Parts

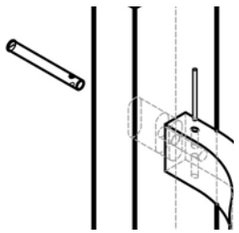
1. PRIMARY STRUCTURE



2. PRIMARY CONNECTION

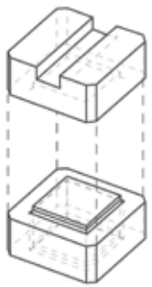
3. EXPANDABLE BOLT

4. SECONDARY STRUCTURE

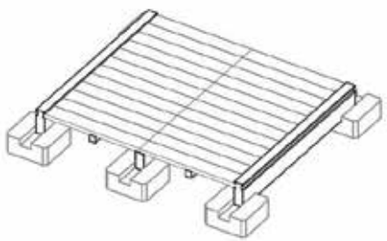


5. SECONDARY CONNECTION

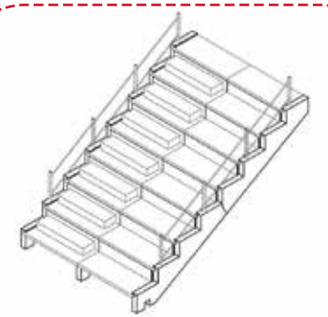
6. FACADE



7. STACKABLE FOUNDATION



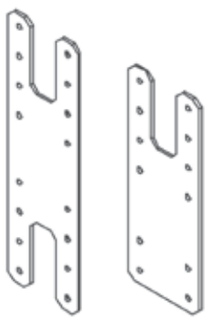
8. FLOORING



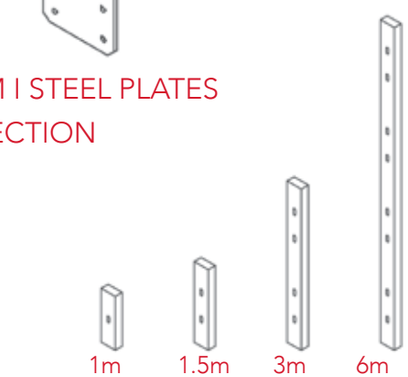
9. STAIRS

Primary Structure - Main members and connections

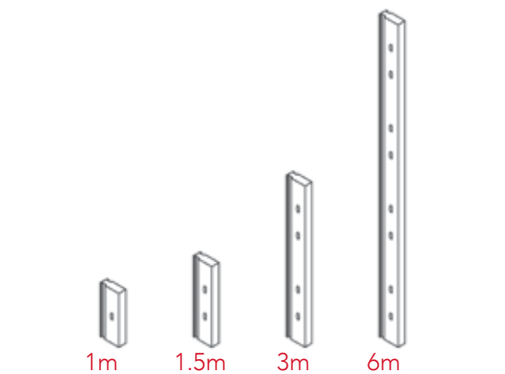
SYSTEM I:
sectional profile 300x150mm



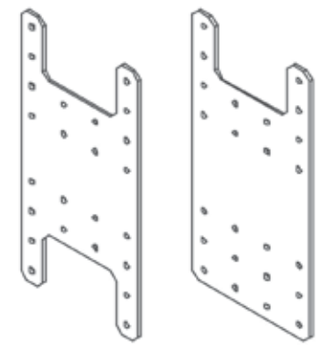
SYSTEM I STEEL PLATES CONNECTION



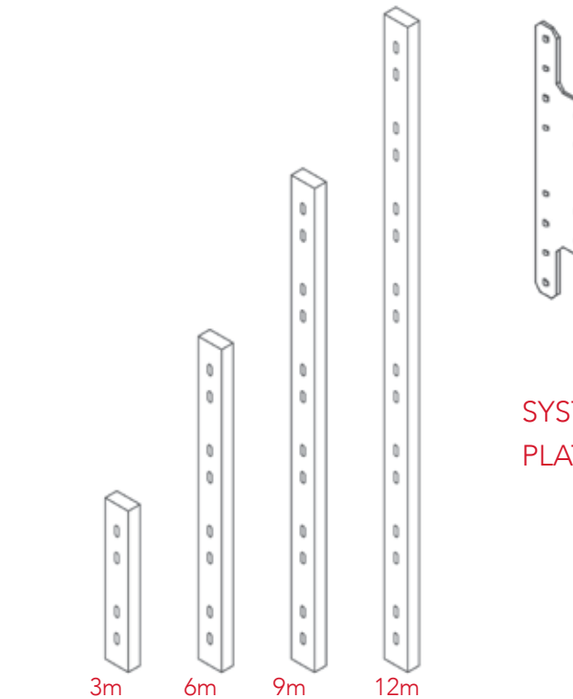
sectional profile 400x150mm



SYSTEM II:
sectional profile 500x250mm

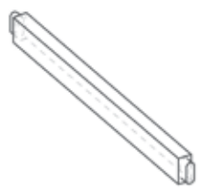


SYSTEM II STEEL PLATES CONNECTION



Secondary Structure - Bracing

BRACING TYPE I



TOP VIEW

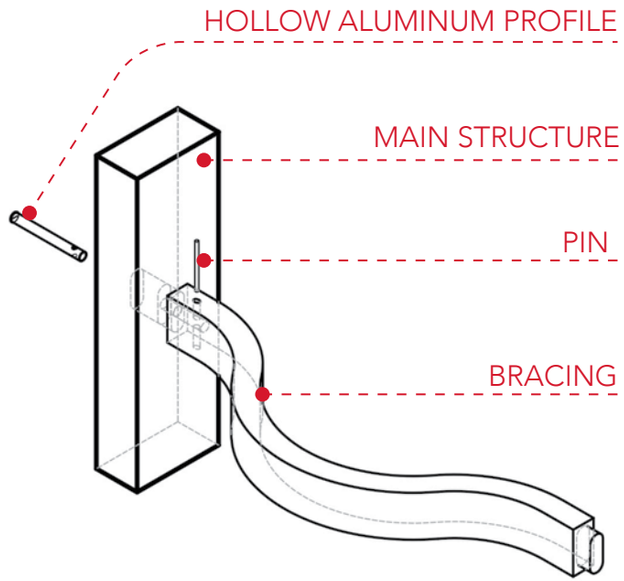
BRACING TYPE II

TOP VIEW

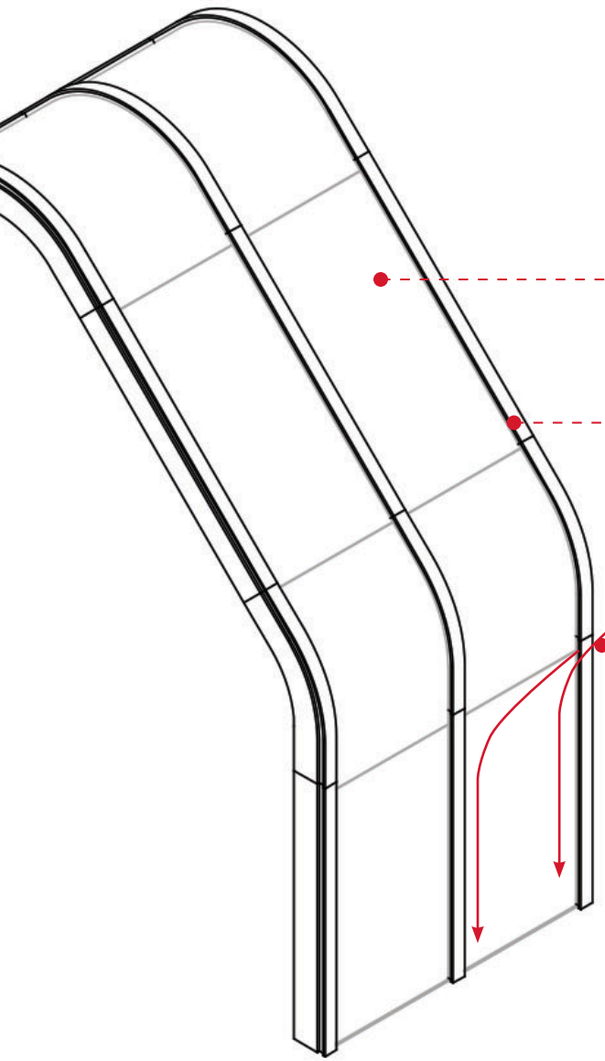
BRACING TYPE III

TOP VIEW

CONNECTION PRINCIPLE



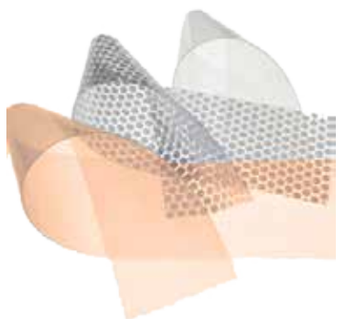
Facade - Concept

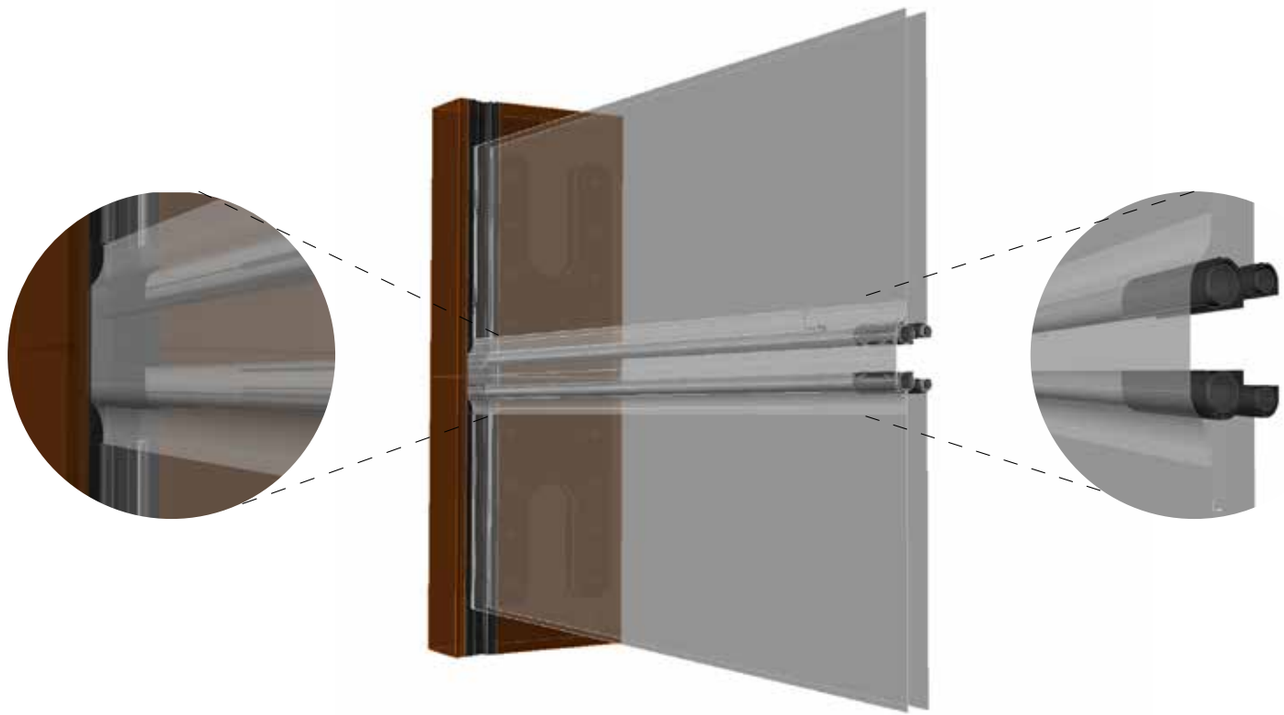


MODULAR PANELS W/
ETFE MEMBRANE

RAIL SYSTEM EMBEDDED
INTO WOOD

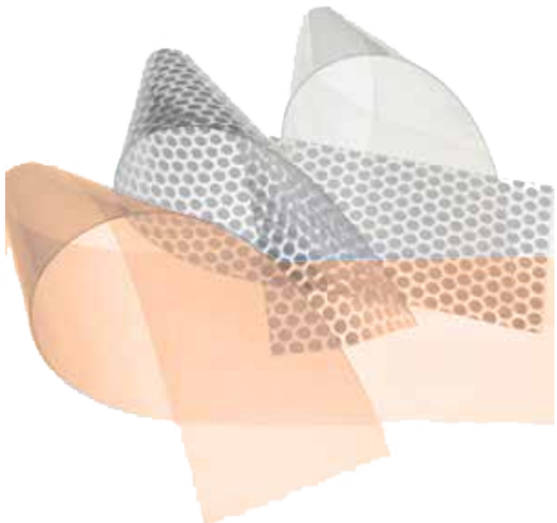
ETFE MEMBRANE
PANELS SLIDES DOWN





CREATION OF DOUBLE FACADE SYSTEM ON
KEDER RAIL PROFILES

Advanatges of Facade system:

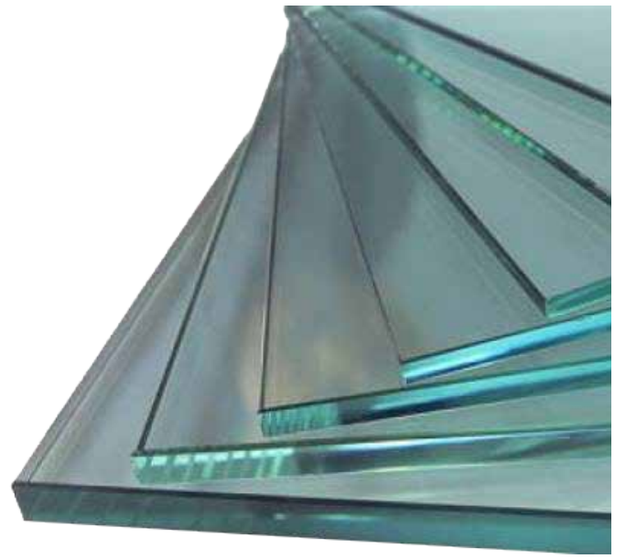


ETFE MEMBRANE

* 20x lighter than glass
* 100% recyclable
* high tensile strength
* flexible shapes
* low maintenance
* high light transmission
* high thermal performance
  up to **U-Value 2.6W/m2K**

PVC FABRIC

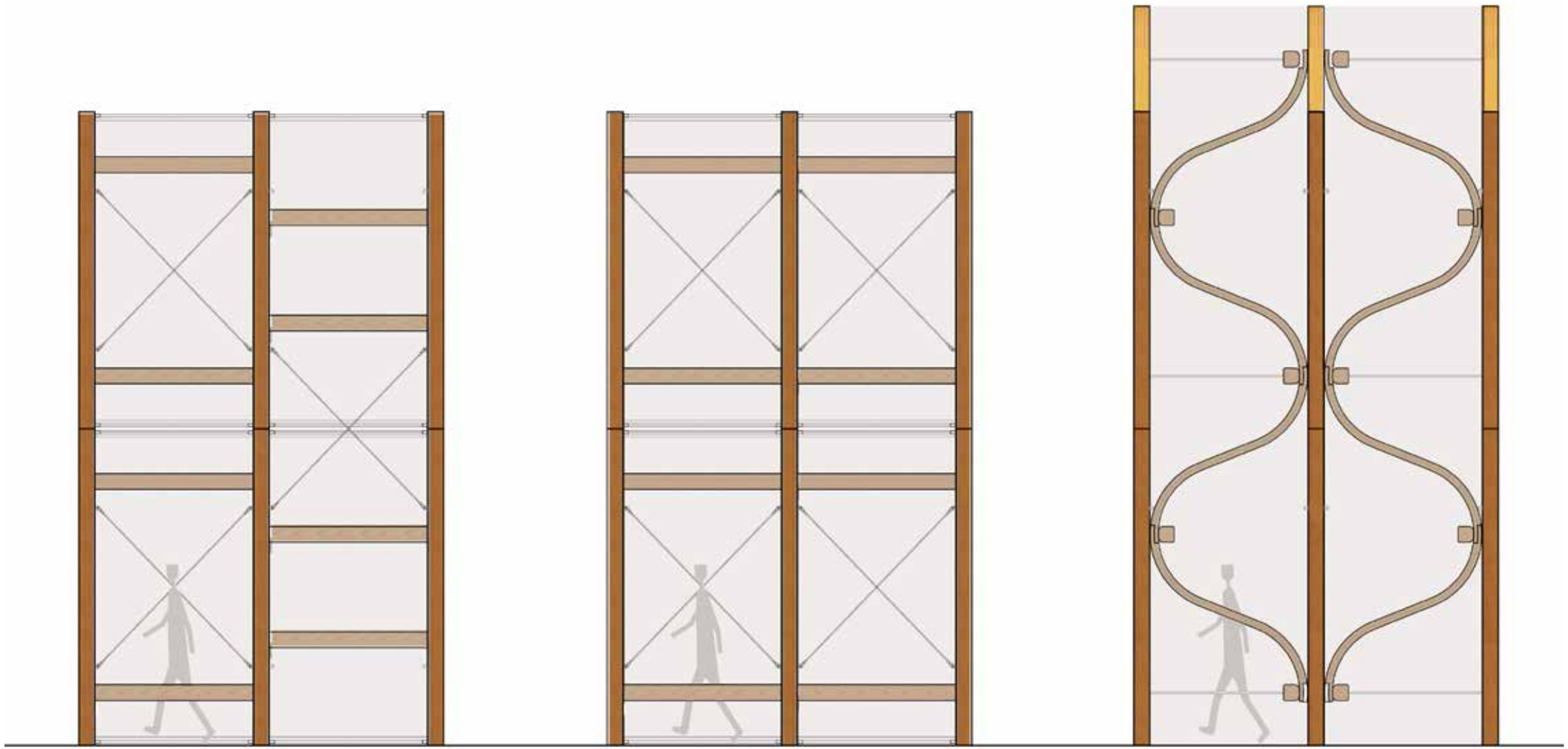
* only 1% recyclable
* toxic components
* flexible shapes
* low thermal performance
  U-Value 4.4W/m2K



GLASS

* not as light
* recyclable
* not flexible shapes
* high thermal performance
  up to U-Value 0.25W/m2K

Facade - possible arrangements

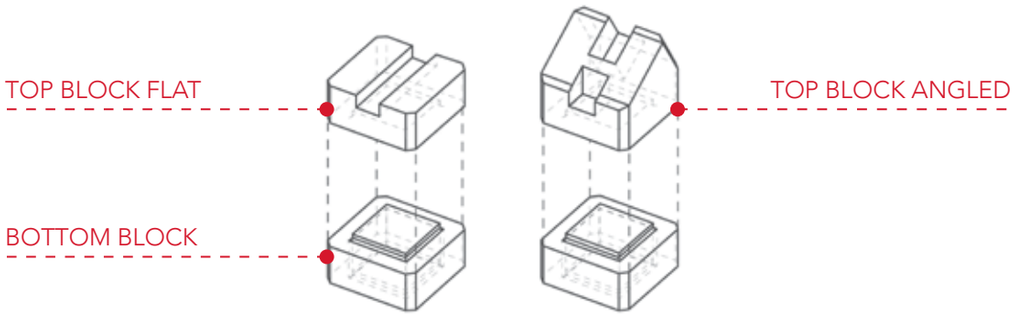


FACADE WITH BRACING TYPE I OR TYPE II

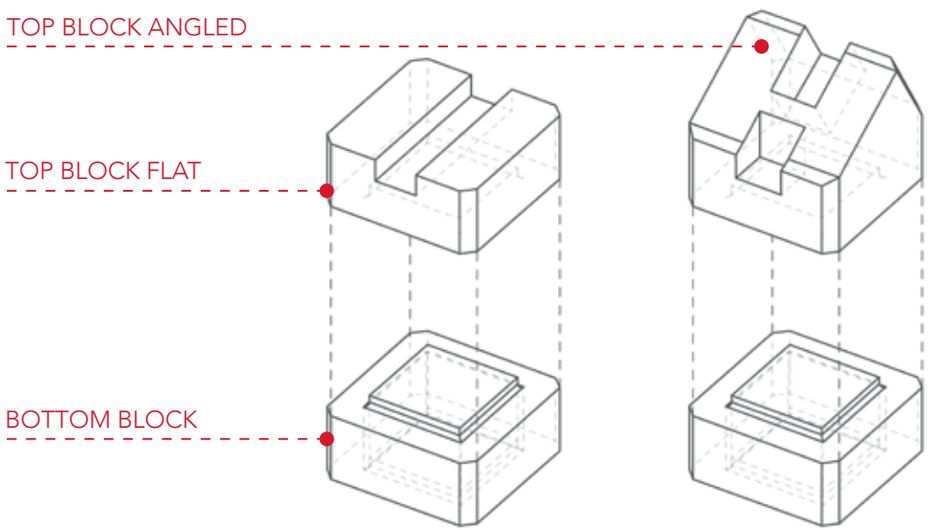
FACADE WITH BRACING TYPE I OR TYPE II

FACADE WITH BRACING TYPE III

Stackable Foundation

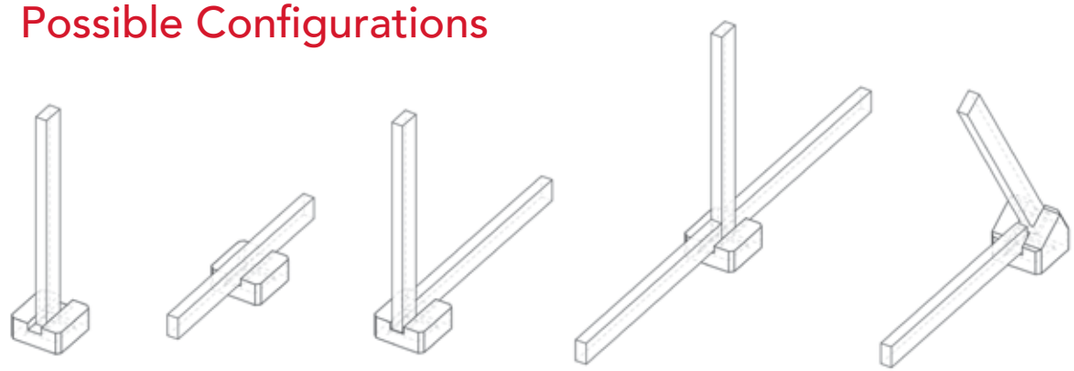


SYSTEM I
Lightweight concrete footing (700 x 700mm)



SYSTEM II
Lightweight concrete footing (1200 x 1200mm)

Possible Configurations

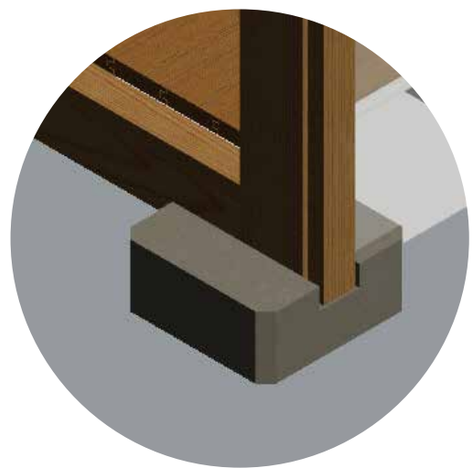


Advanatges of the system:

CURRENT SYSTEMS

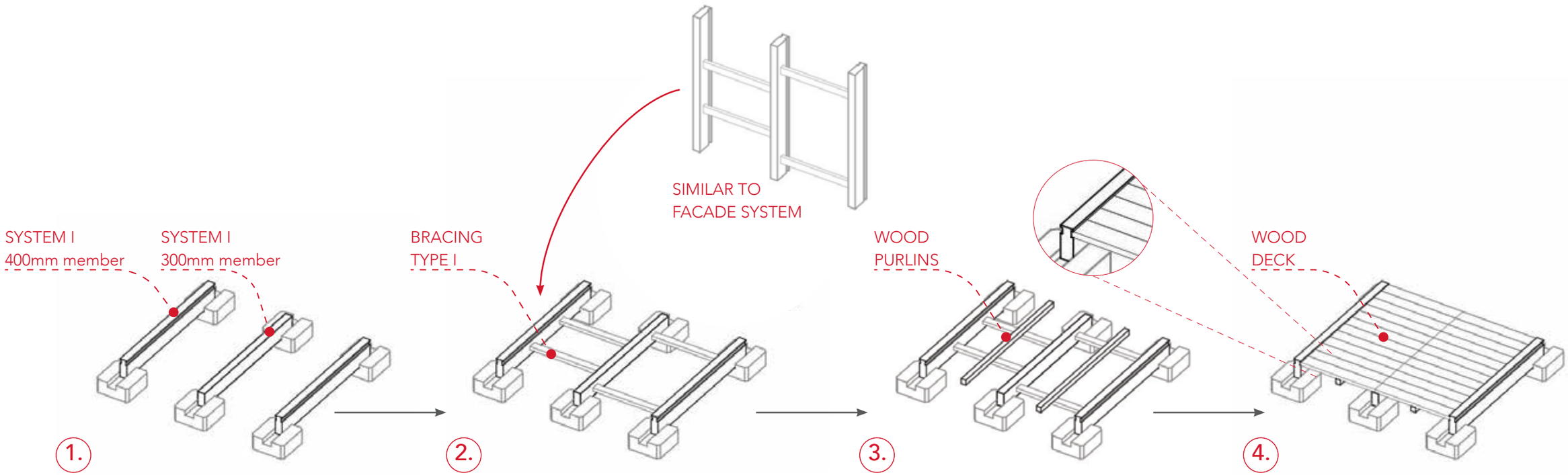
DAMAGE

PROPOSED SYSTEM

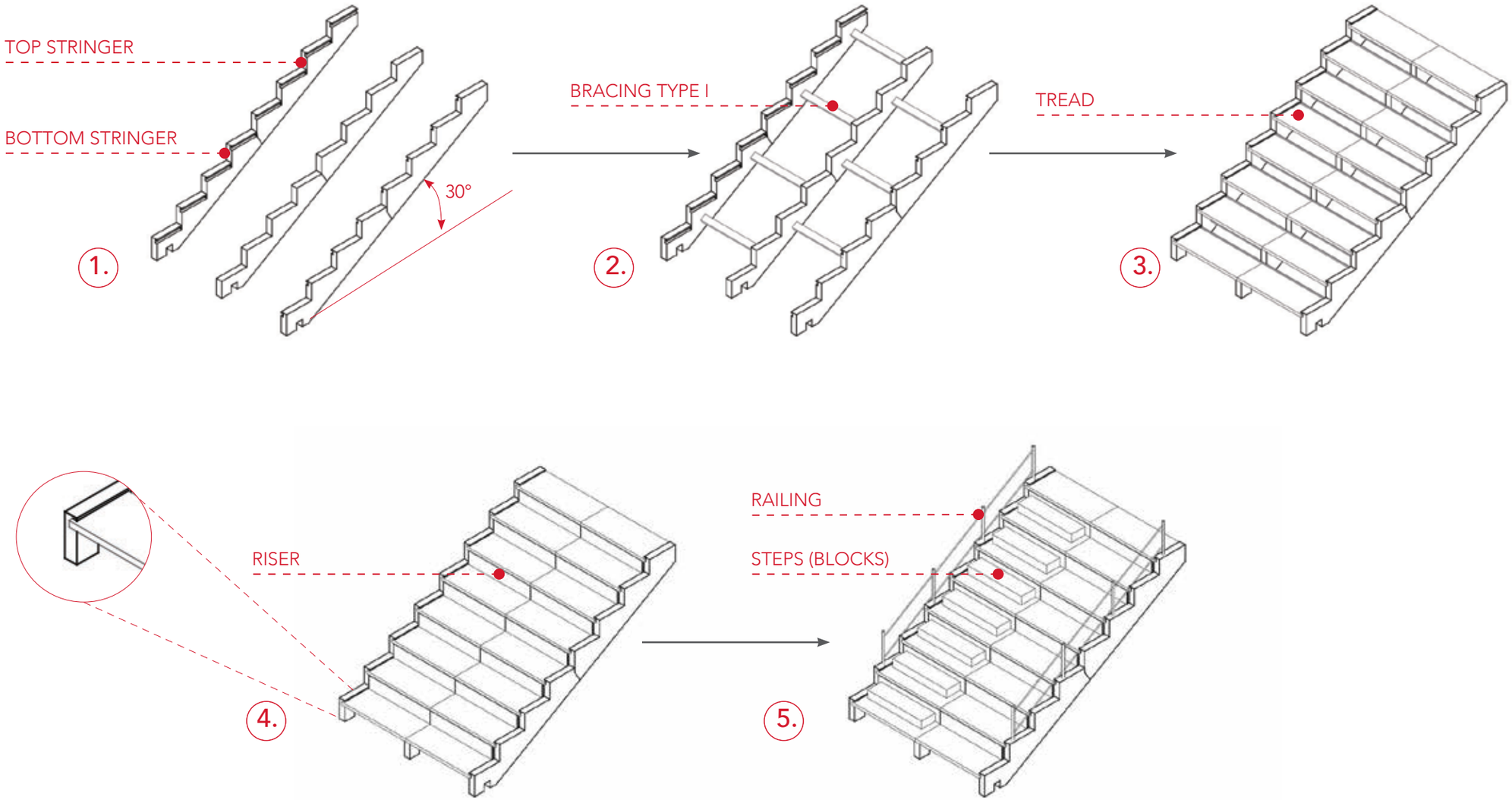


NO DAMAGE

Flooring


SIMILAR TO
FACADE SYSTEM
SYSTEM I
400mm member
SYSTEM I
300mm member
BRACING
TYPE I
WOOD
PURLINS
WOOD
DECK
1.
2.
3.
4.

Stairs


TOP STRINGER
BOTTOM STRINGER
30°
1.
BRACING TYPE I
2.
TREAD
3.
RISER
4.
RAILING
STEPS (BLOCKS)
5.

VIDEO

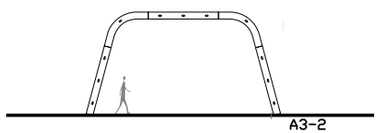
Structural challenge:

1) Determine the limits of toolbox design in terms of possible and structurally sound structures.

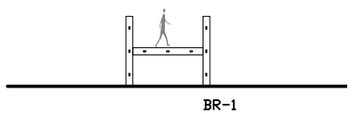
2) Design connections according to stress loads.

Possible typologies

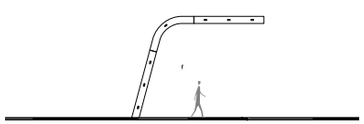
ROOFS



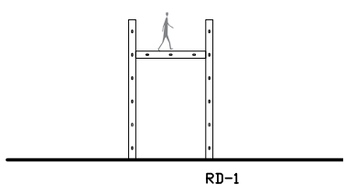
FOOTBRIDGES



CANOPIES



ROOF DECKS



Load Combinations:

Eurocode 1		Canadian Building Code	
H	1KN/m^2	Roofs	1,0 KN/m^2
C1	3KN/m^2	Assembly areas (class b)	2,4 KN/m^2
C5	5KN/m^2	Balconies and Footbridges	4,8 KN/m^2

EUROCODE 5
COMBINATIONS OF ACTIONS (LOADS)

* Characteristic Actions according to EN 1991

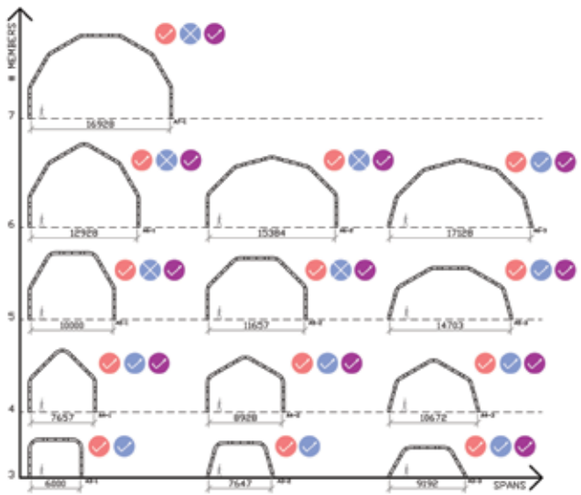
G_k	PERMANENT	e.g.; Self-weight
Q_k	VARIABLE	e.g.: wind, snow, traffic, imposed loads
A_k	ACCIDENTAL	e.g.: impact, fire

DESIGN SITUATION	γ_G	γ_Q
Structural Design Calculation		
favourable effect	1,0	-
unfavourable effect	1,35	1,5
Check at servicability limit state	1,0	1,0

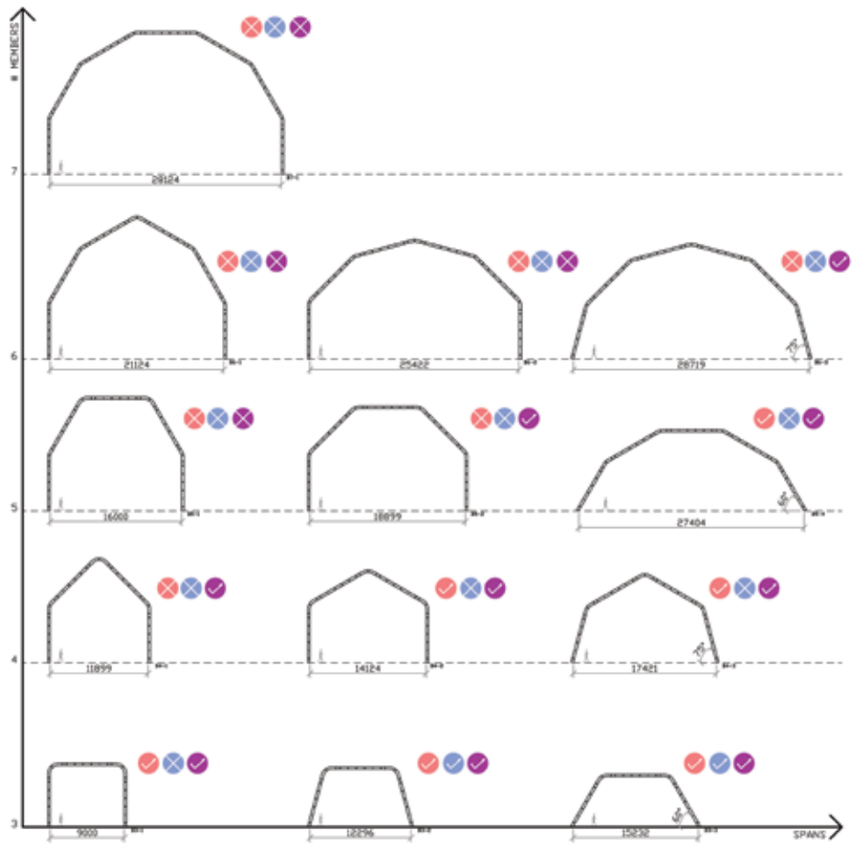
FORMULAS USED :				
(not considering reduction factors Ψ0, Ψ1 and Ψ2 used to factor load reducing it depending on duration exposure)				
ULS	structural design	$1,35*G_k +$	$1,5 * Q_k$	vertical axis for selft weight and imposed load
			$1,5 * Q_k$	horizontal axis for wind load
SLS	sevicability	$1,0 * G_k +$	$1,0 * Q_k$	vertical axis for selft weight and imposed load
			$1,0 * Q_k$	horizontal axis for wind load

Index

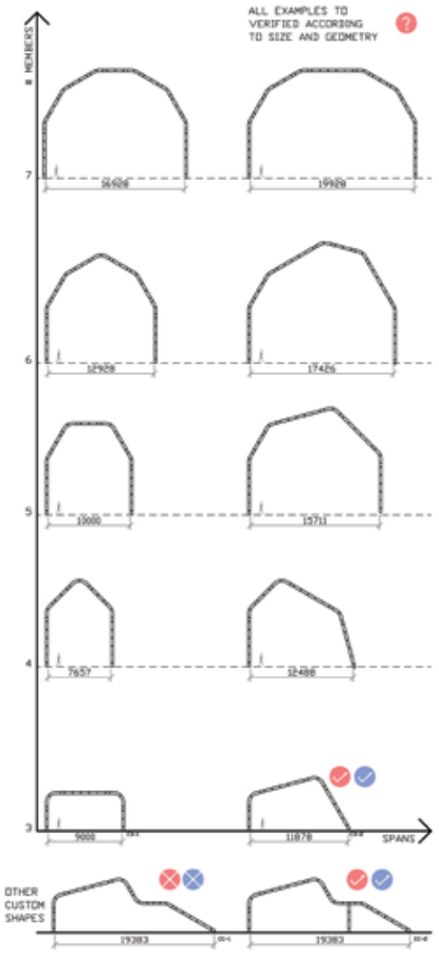
Roofs



3m members



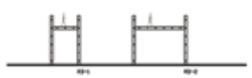
6m members



Hybrid members

Footbridges

Usable Roofs

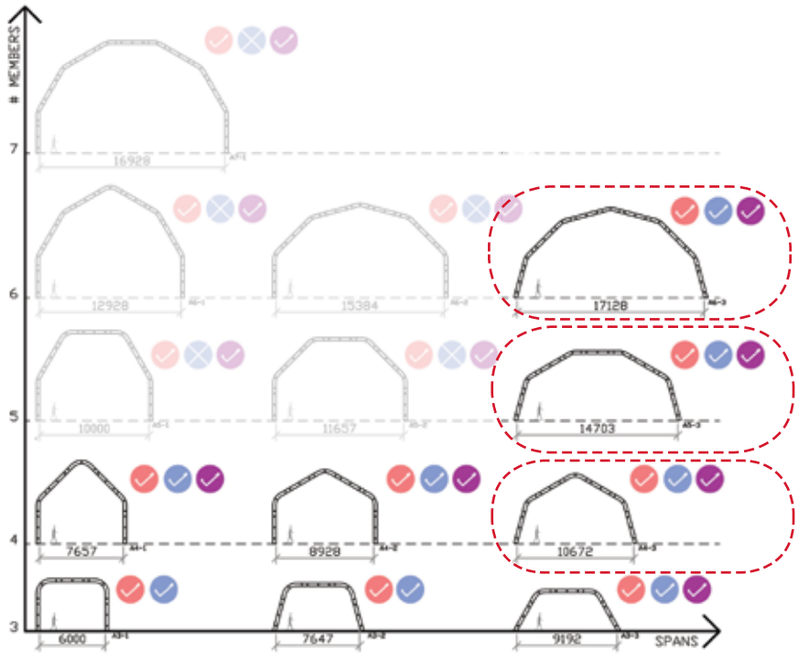


Canopies

3m members hybrid members 6m members

Most critical frames for System I

ROOFS - 3m members



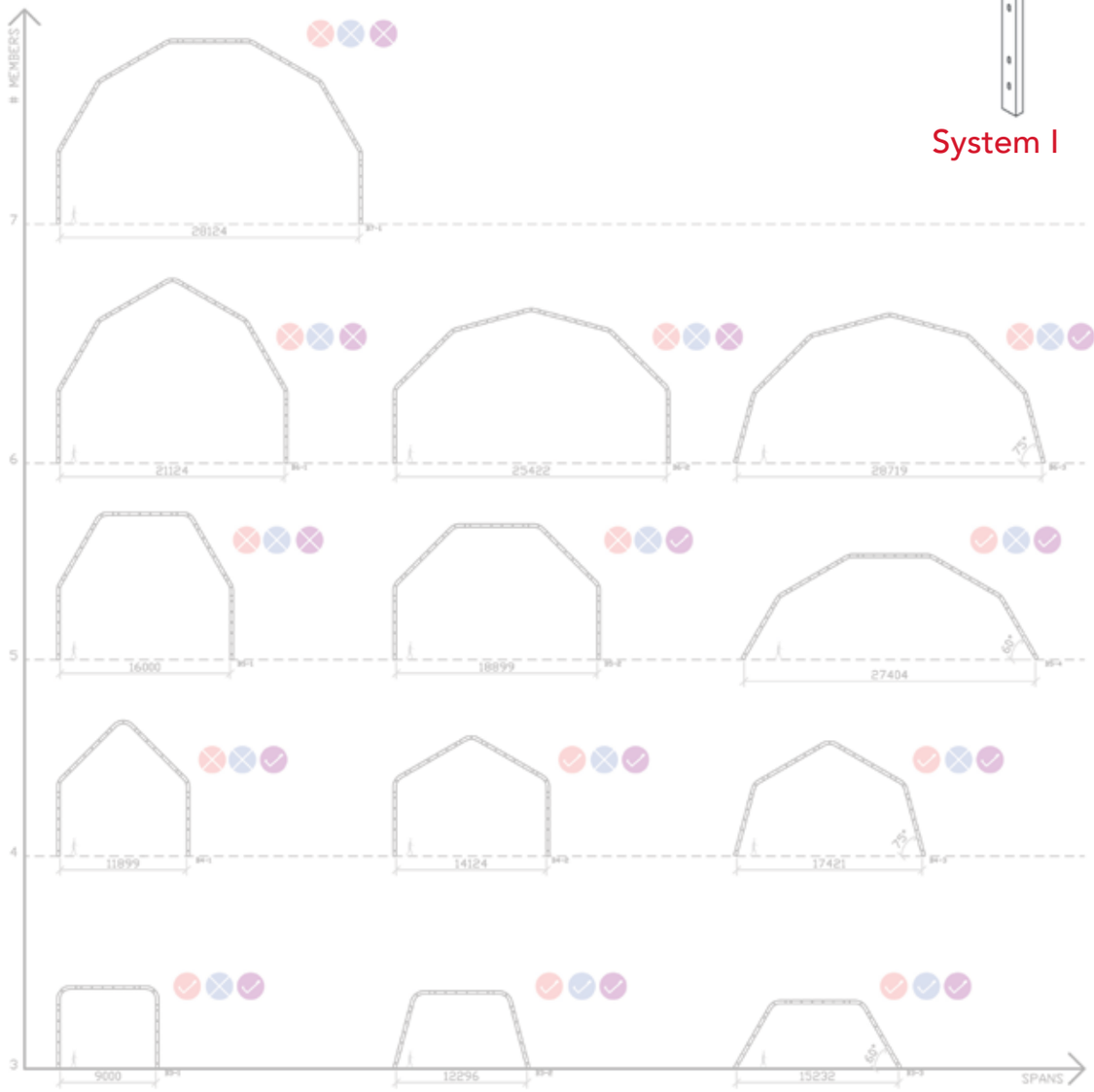
LEGEND SYSTEM I

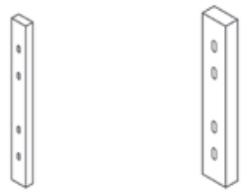
- FIXED SUPPORT CONNECTION FAILED "SLS" CHECK
- FIXED SUPPORT CONNECTION PASSED "SLS" CHECK
- HINGED SUPPORT CONNECTION FAILED "SLS" CHECK
- HINGED SUPPORT CONNECTION PASSED "SLS" CHECK

LEGEND SYSTEM II

- HINGED SUPPORT CONNECTION FAILED "SLS" CHECK
- HINGED SUPPORT CONNECTION PASSED "SLS" CHECK

ROOFS - 6m members

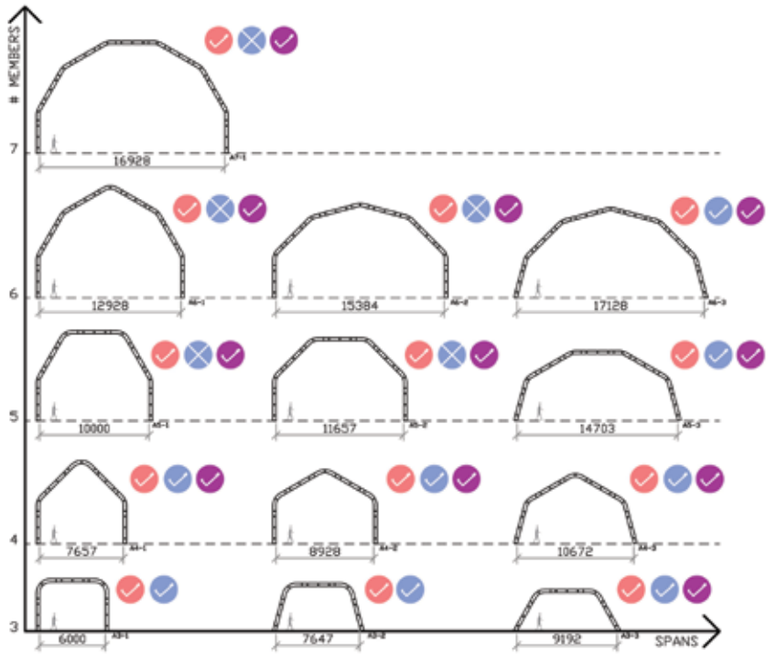




System I System II

Most critical frames for System II

ROOFS - 3m members



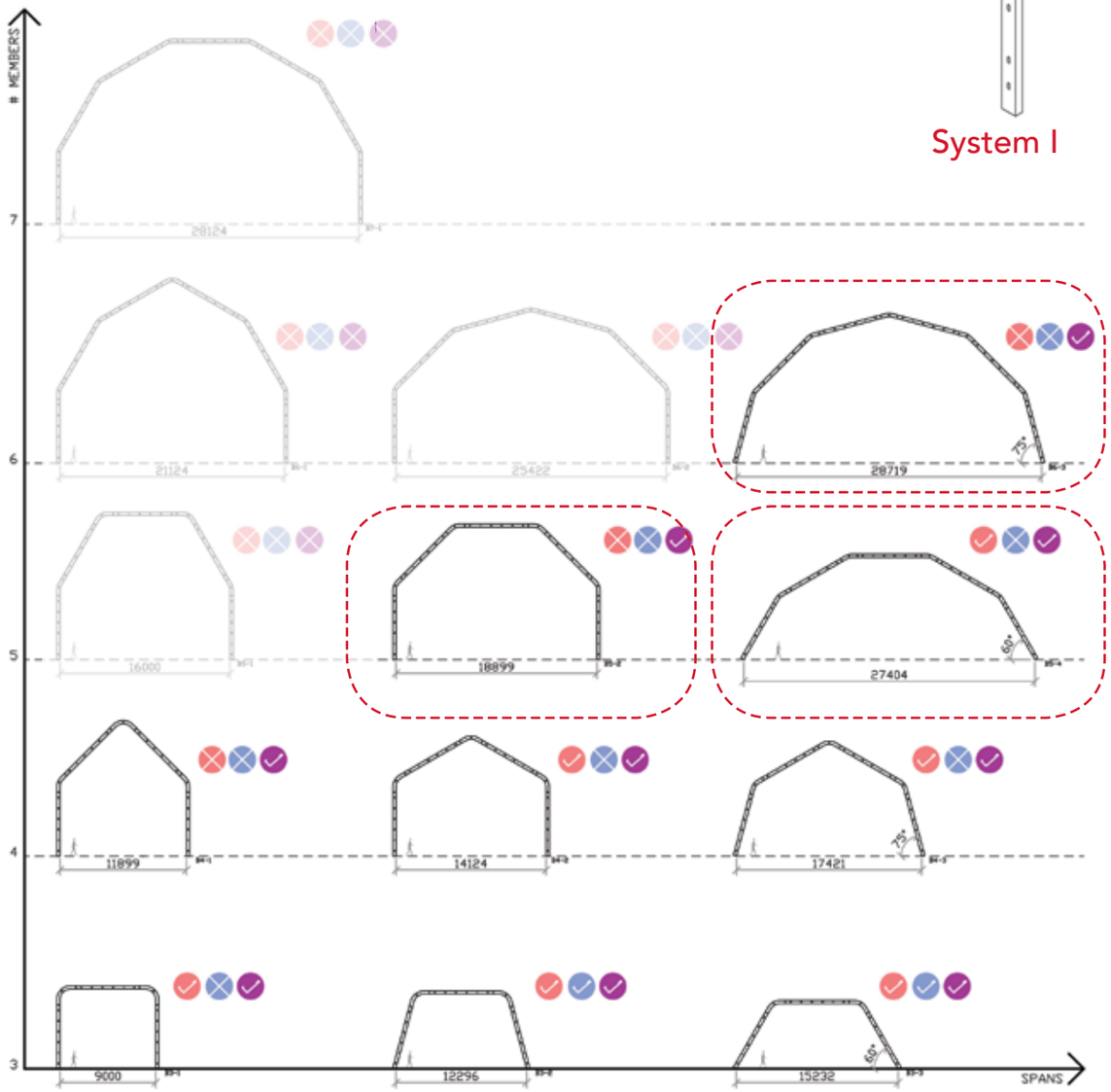
LEGEND SYSTEM I

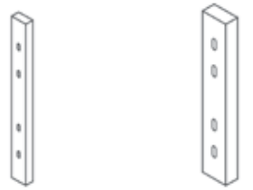
- FIXED SUPPORT CONNECTION FAILED "SLS" CHECK
- FIXED SUPPORT CONNECTION PASSED "SLS" CHECK
- HINGED SUPPORT CONNECTION FAILED "SLS" CHECK
- HINGED SUPPORT CONNECTION PASSED "SLS" CHECK

LEGEND SYSTEM II

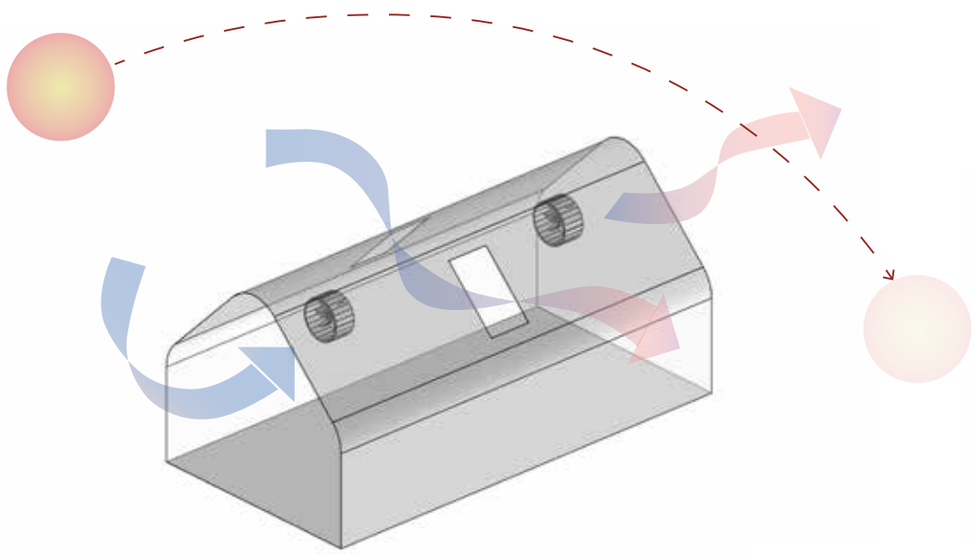
- HINGED SUPPORT CONNECTION FAILED "SLS" CHECK
- HINGED SUPPORT CONNECTION PASSED "SLS" CHECK

ROOFS - 6m members



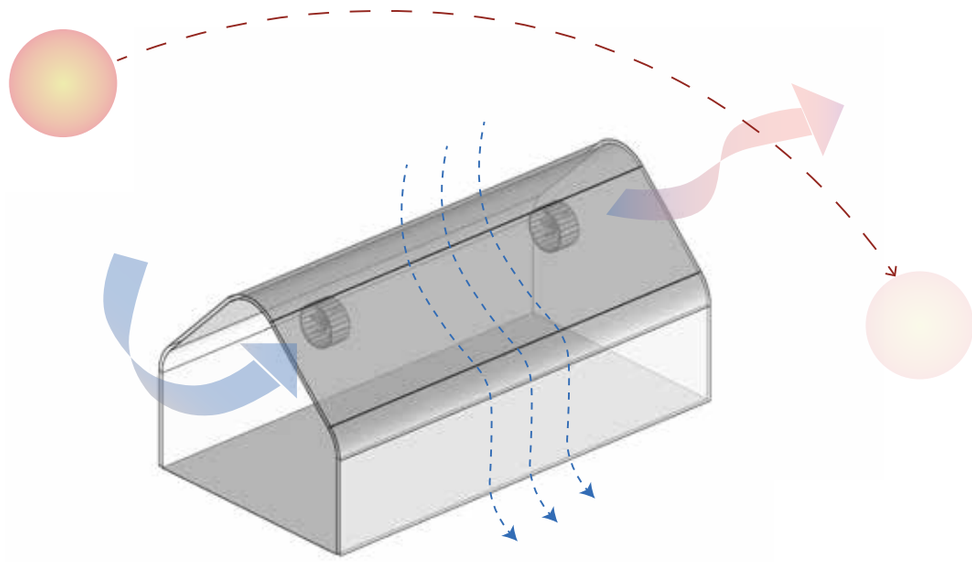


1. TEMPERATE CLIMATE: Single Facade



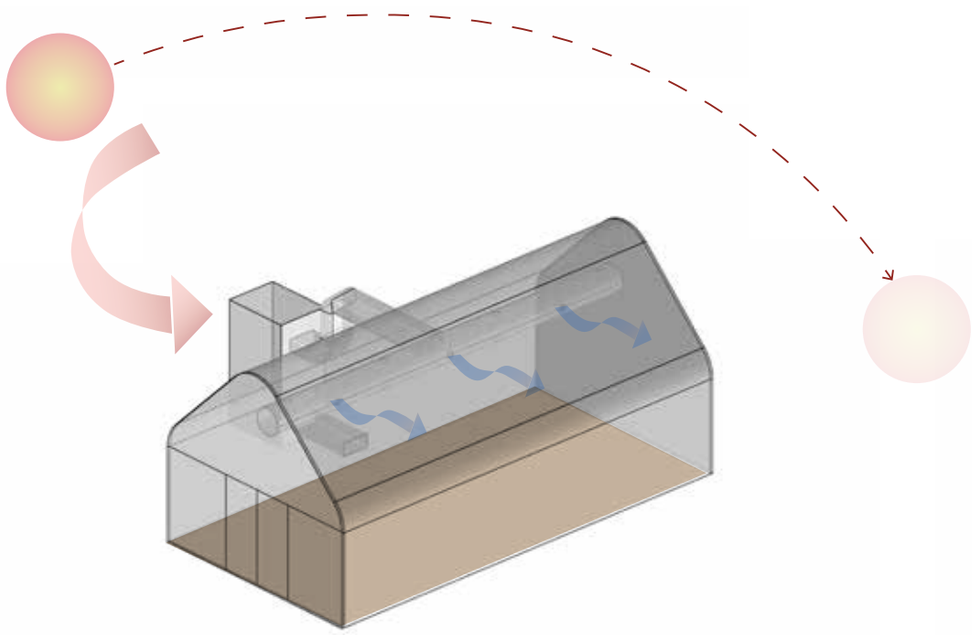
1- open to allow for natural ventilation
2- ventilators to enhance air flow
3- removal of modules for cross ventilation

2. TEMPERATE CLIMATE: Double Facade



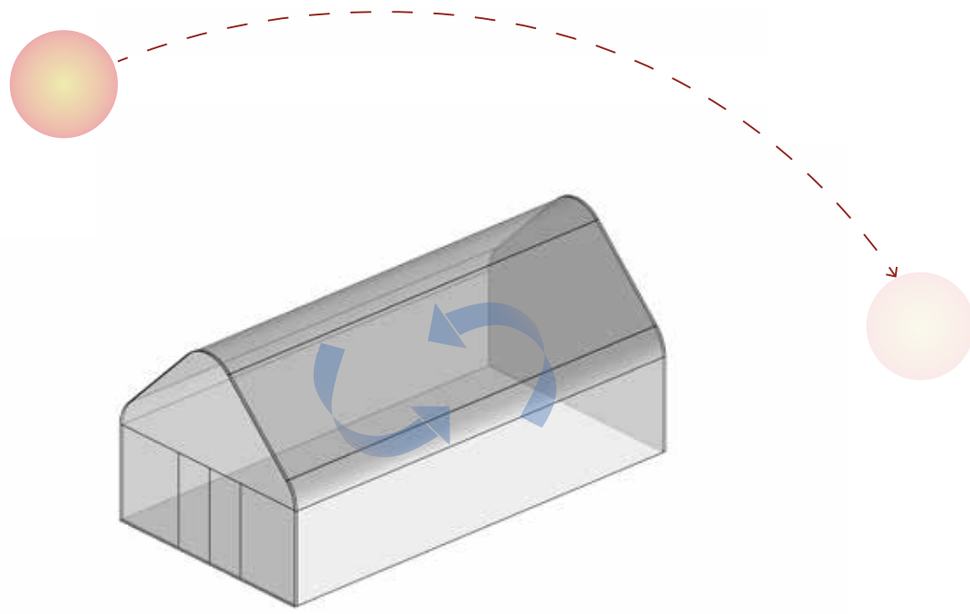
1- open to allow for natural ventilation
2- ventilators to enhance air flow
3- outer layer: rain protection
4- inner layer: shading
5- air gap between layers to prevent from overheating

3. SUMER or WINTER



1- single or double facade
2 - fully enclosed building
2- AHU to control temperature
3- fabric air duct to distrubute air
4- floor insulation added

4. WINTER (no heating needed)



1- fully enclosed building
2- no heating needed (ex: ice skate rink)

Existing Systems:

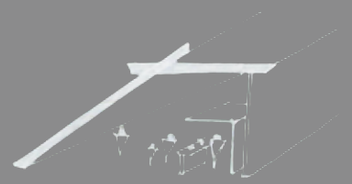



Proposed System:



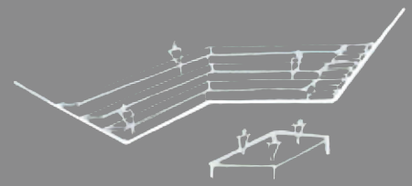

FLEXIBLE INDOOR SPACES

Cultural
Mining & Industrial Heritage
EXHIBITIONS

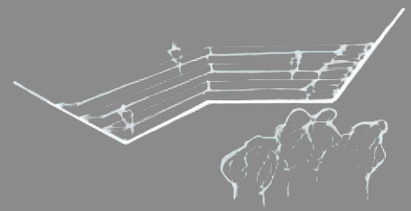


Social & Sustainable
Local Produce
MARKET

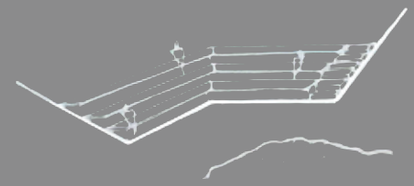
FLEXIBLE OUTDOOR SPACES



Leisure
Recreational Gatherings
FESTIVAL & CONCERT

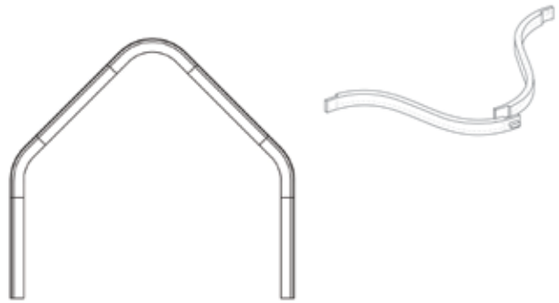


Nature
Interaction with Landscape
BARE NATURE



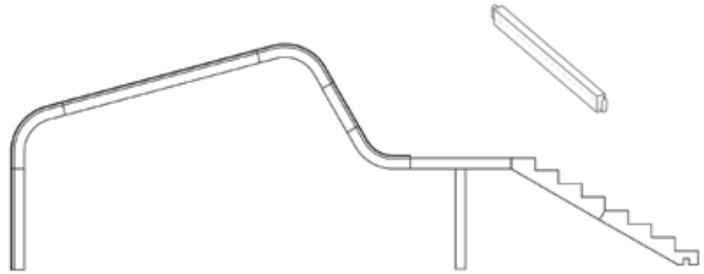
Historic
Interaction with Site History
INSTALLATION

Toolbox use for modules creation

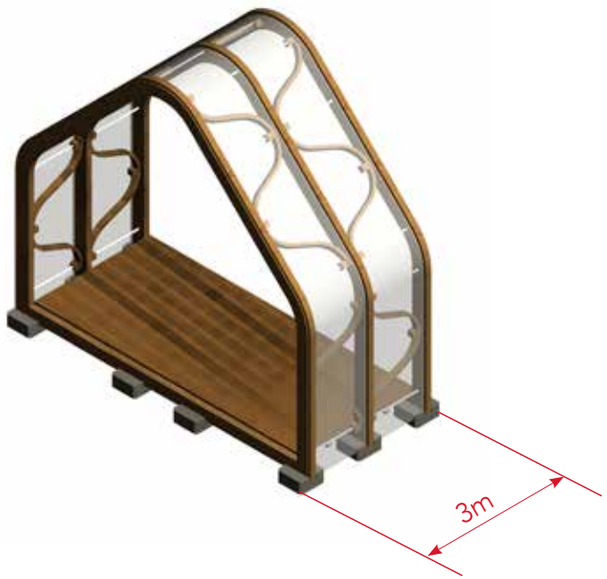


Frame A4-1 + Bracing Type III

Frame C3-2 + Bracing Type I

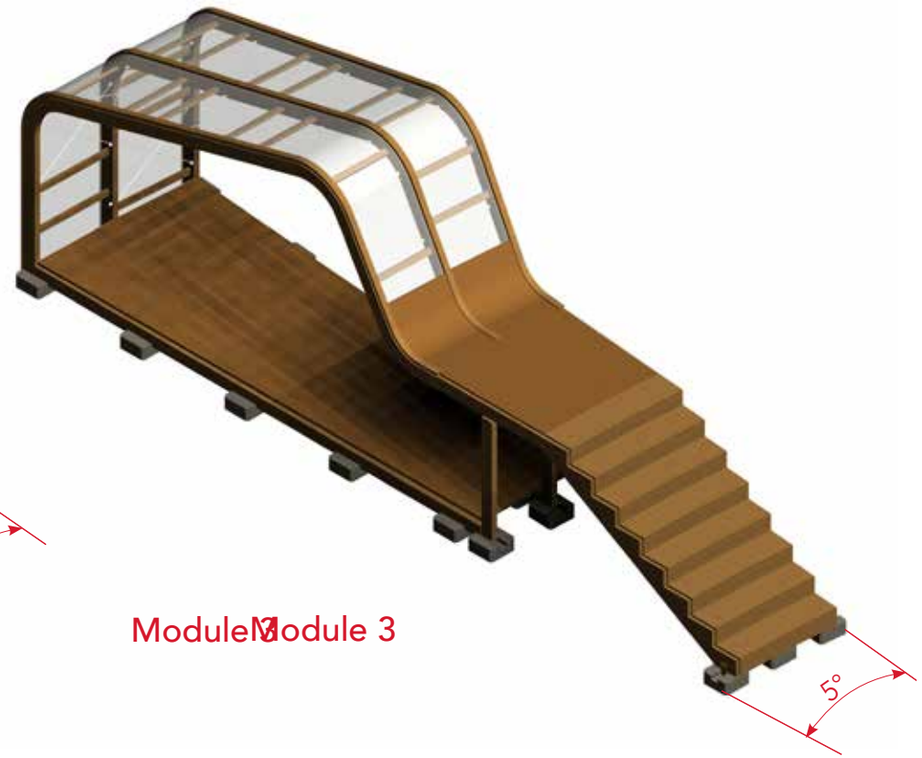


Frame C3-2 + Stairs + Bracing Type I



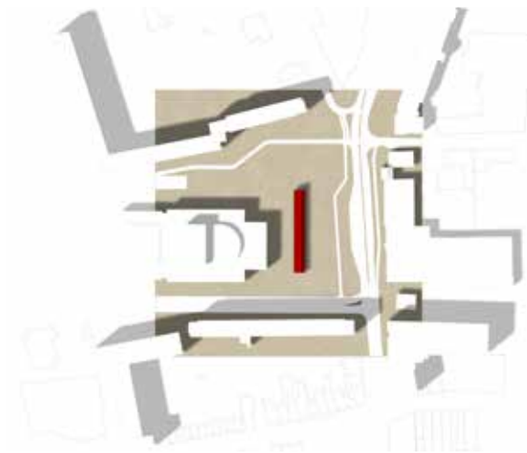
Module 1

Module 2

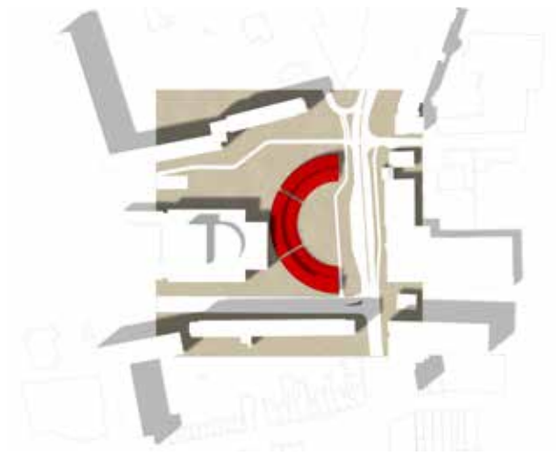


Module 3

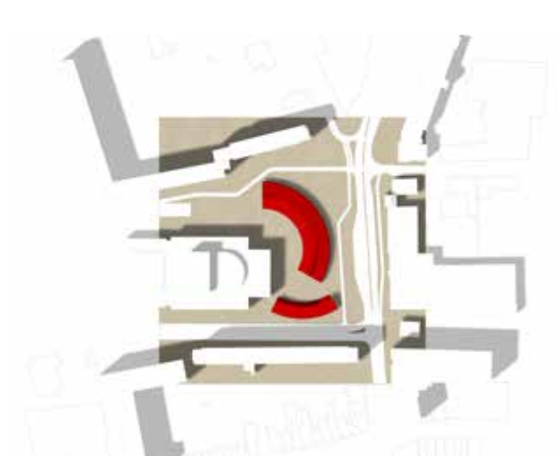
Massing and Urban Study



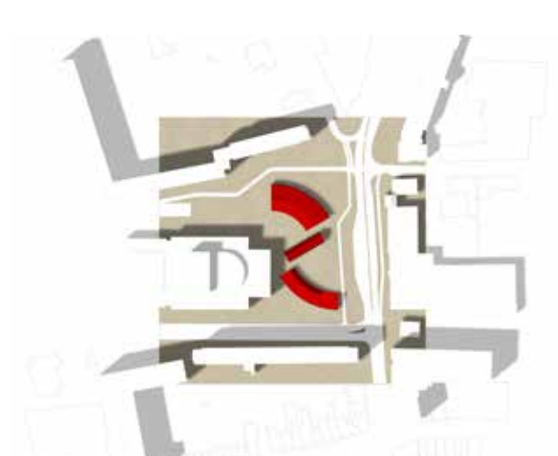
Module 1



Module 3

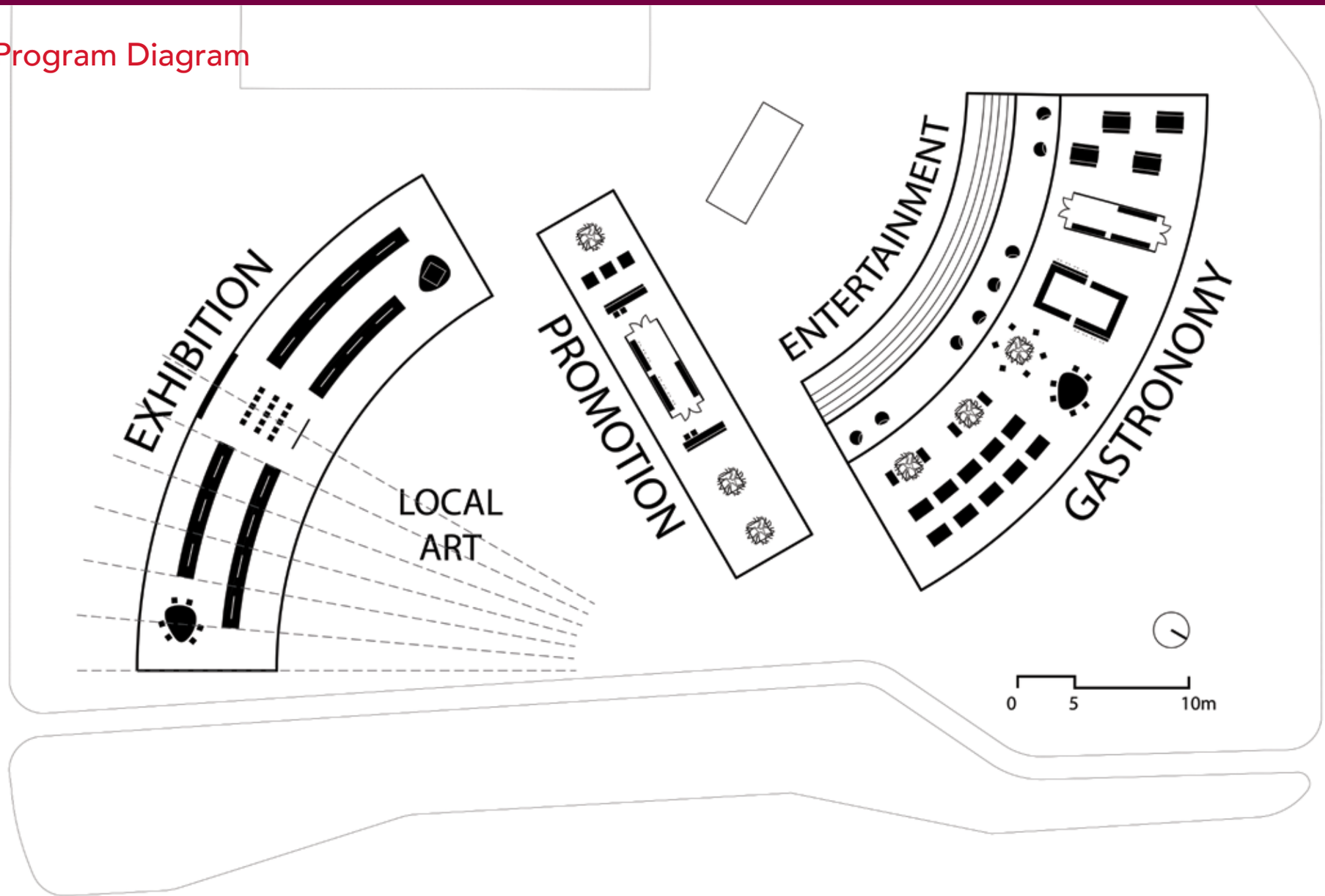


Module 2 + 3



Module 1+ 2 + 3

Program Diagram



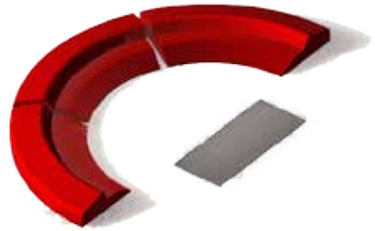
Floor Plan

VIDEO

05 Possible Future Uses

Outdoor Performances

SEATING CAPACITY: 500



Amphitheatre

SEATING CAPACITY: 1500

Arena

SEATING CAPACITY: 3000

MODULE 3

Small Stadium

SEATING CAPACITY: 1600

Medium Stadium

SEATING CAPACITY: 3200

Arena

SEATING CAPACITY: 6200

05 Questions

Thank you!