“The design of a modular and reusable biocomposite railway footbridge”

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MSc Graduation Studio
AR3B025

P5
Diederik Jilderda
4096649

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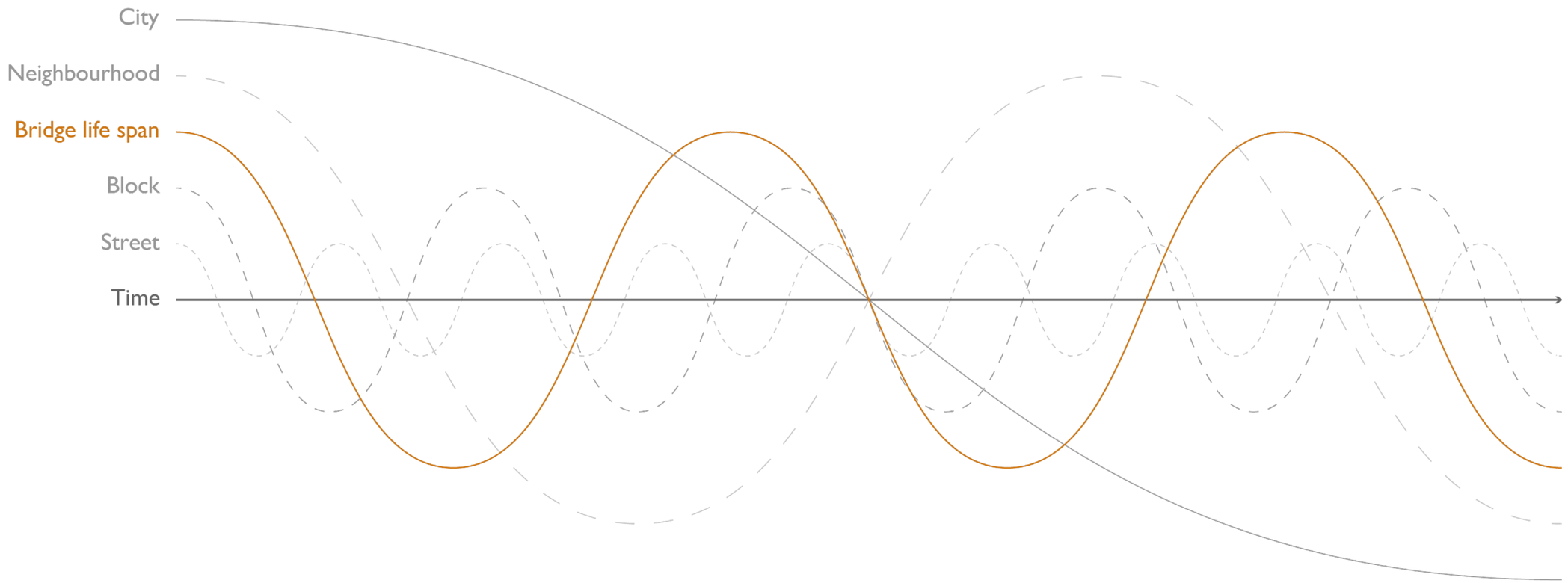
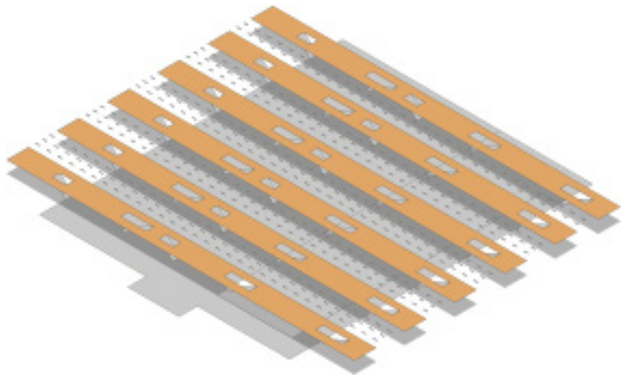
THE PROBLEM

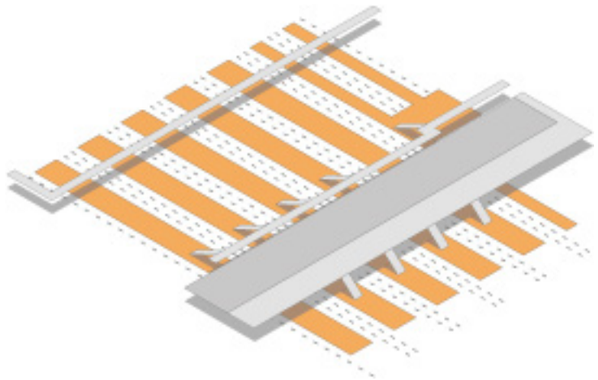
PROBLEM | THE EVOLVING URBAN CONTEXT



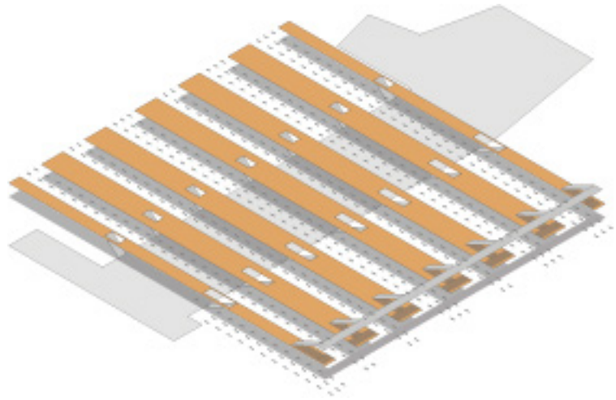
"The design of a modular and reusable footbridge."



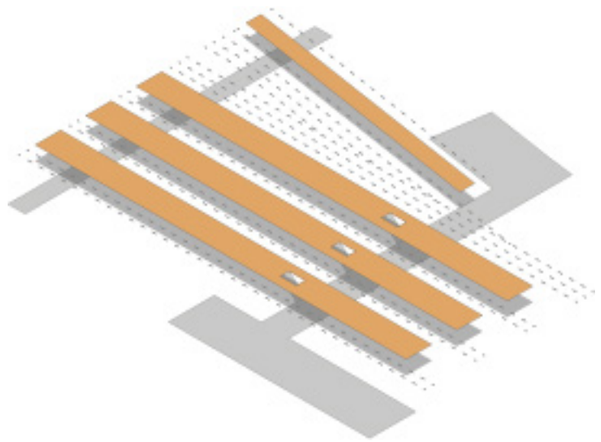
Amsterdam Centraal



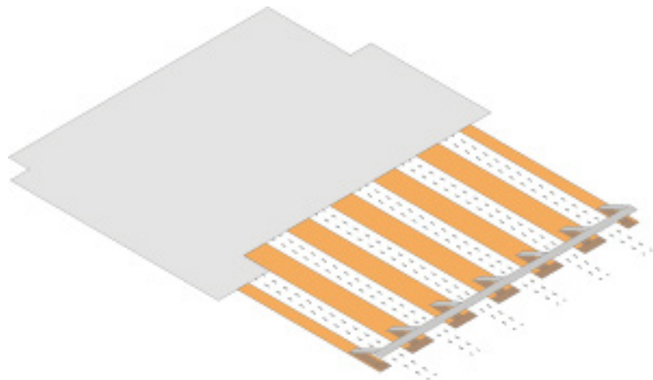
Utrecht Centraal



Rotterdam Centraal



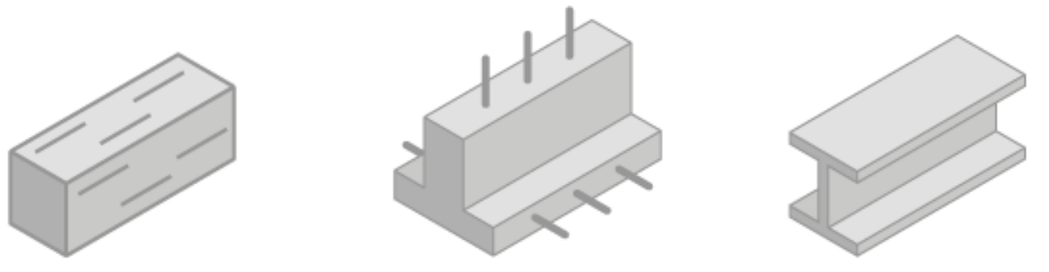
Eindhoven Centraal



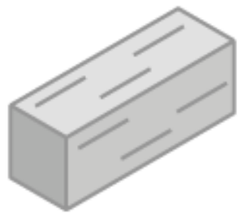
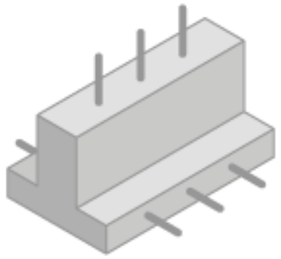
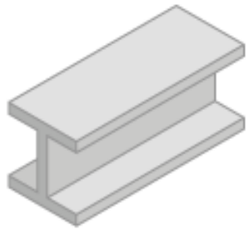
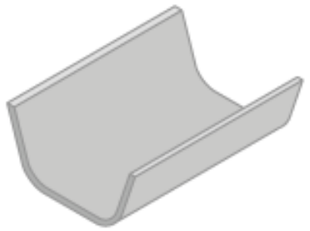
Den Haag Centraal

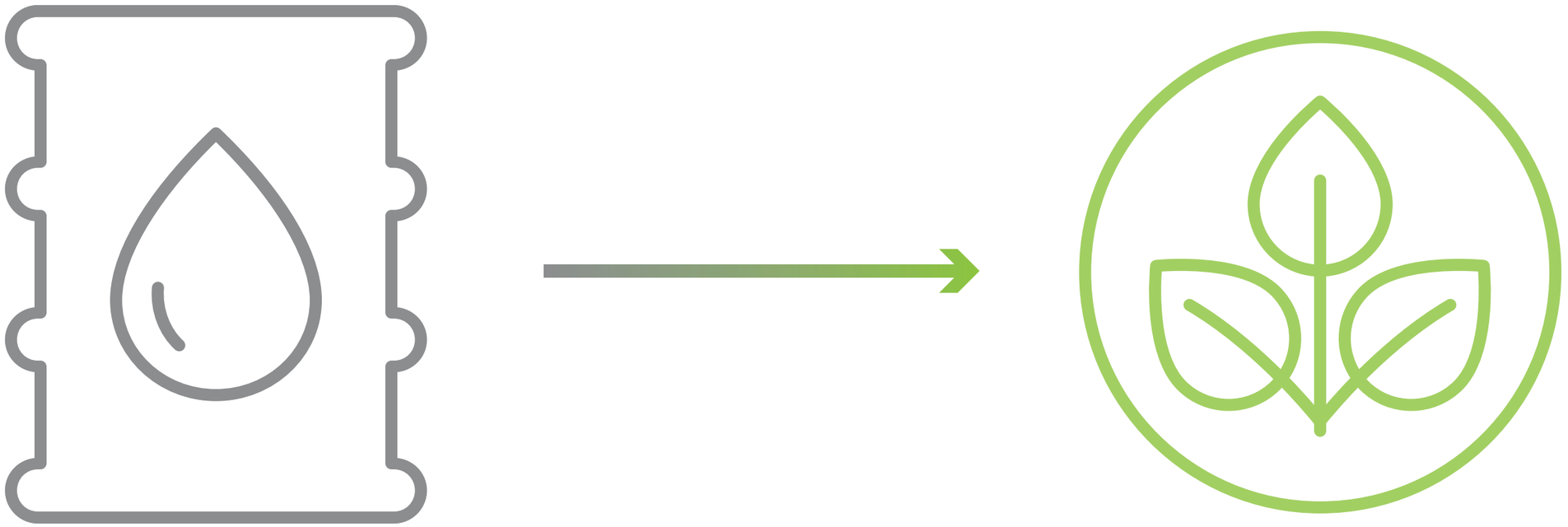
"The design of a modular and reusable railway footbridge."

Conventional



	Timber	Concrete	Steel
Advantages	Natural Light Attractive	Versatile Economic	Very strong Durable Recycleable
Disadvantages	Durability Detailing Maintenance	Heavy Aesthetics	Corrosion Maintenance

	Conventional			Innovative
				
	Timber	Concrete	Steel	Fiber-reinforced plastic (FRP)
Advantages	Natural Light Attractive	Versatile Economic	Very strong Durable Recycleable	Very light Strong Versatile Durable Maintenance
Disadvantages	Durability Detailing Maintenance	Heavy Aesthetics	Corrosion Maintenance	High initial costs Difficult to recycle



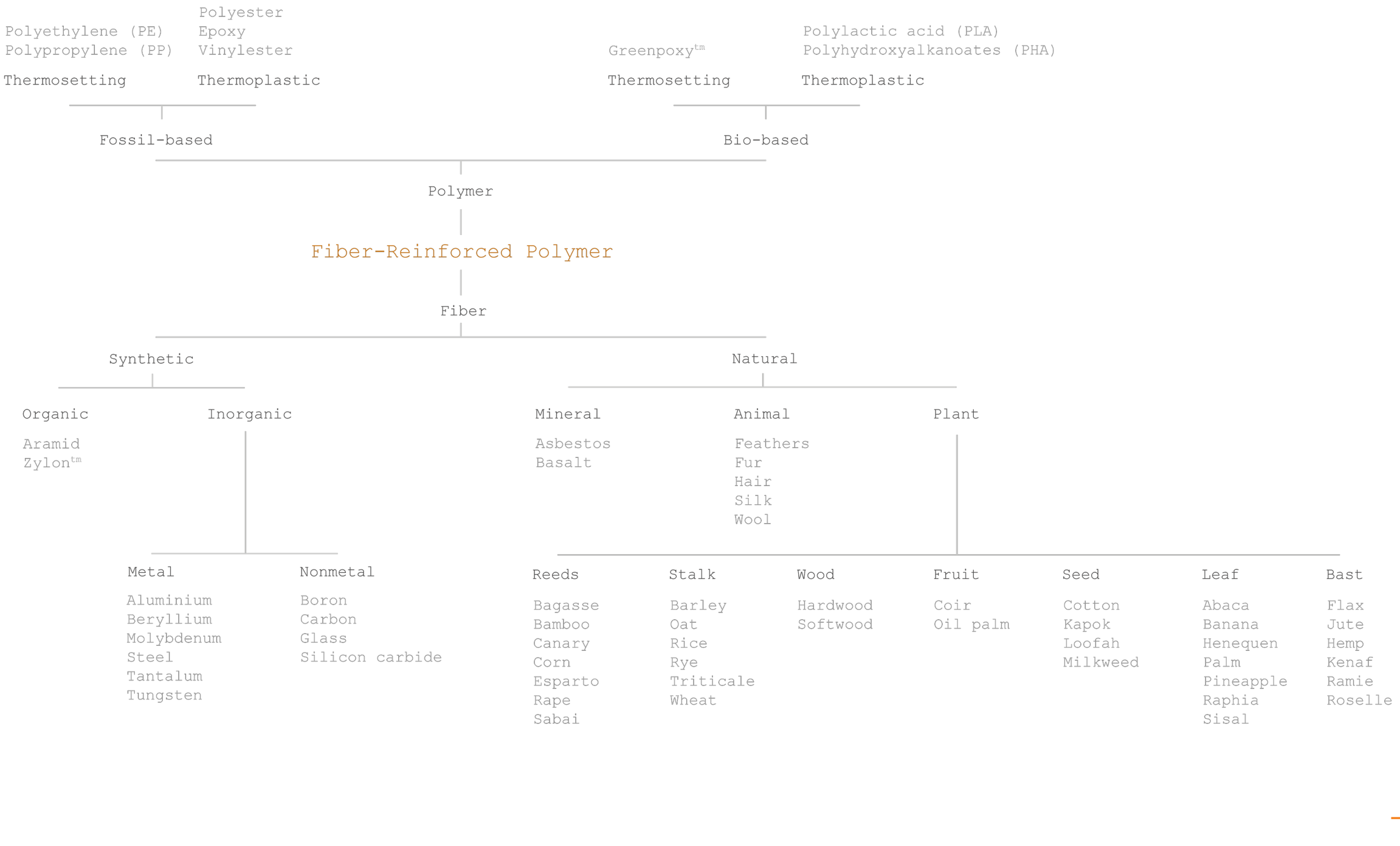
Unsustainable

Sustainable

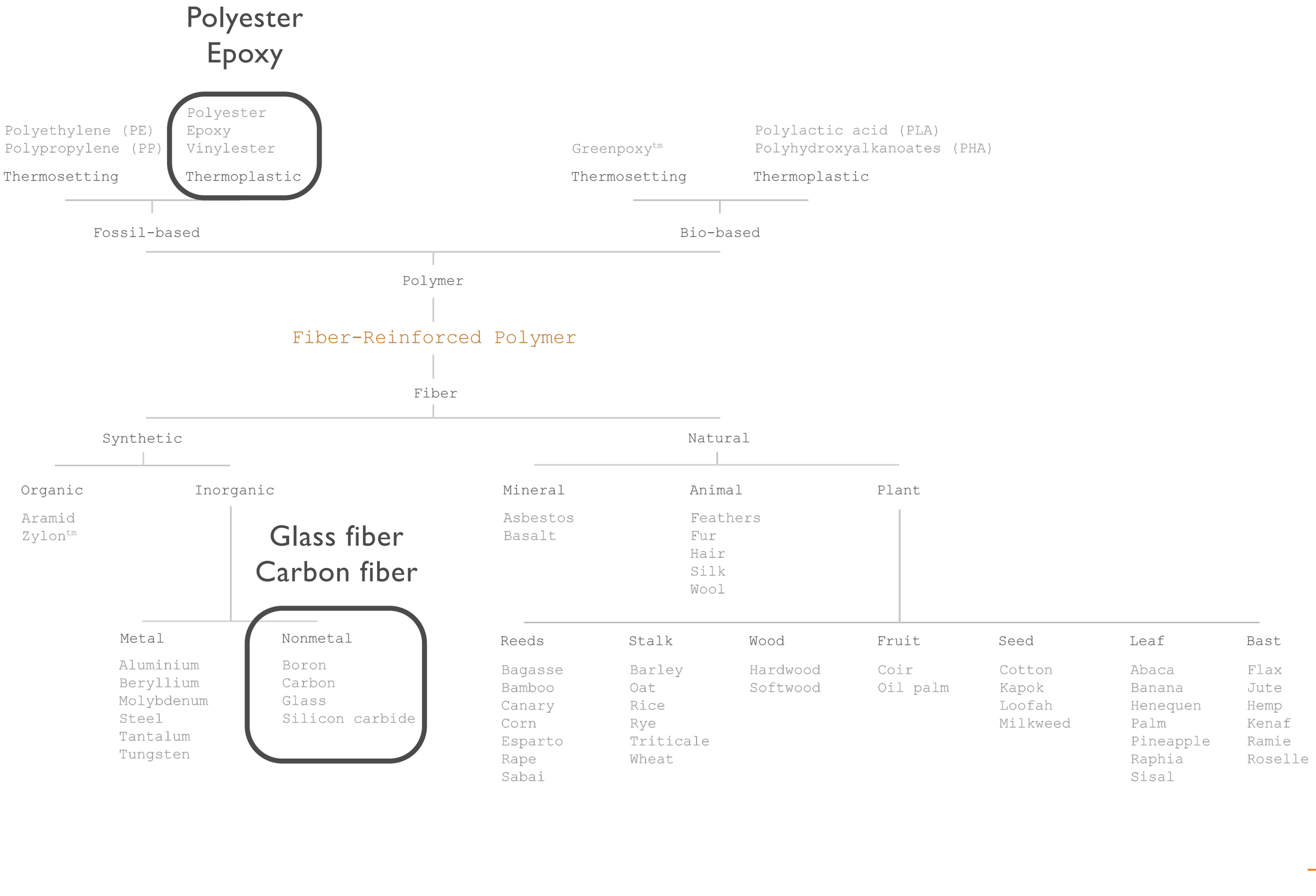
"The design of a modular and reusable biocomposite railway footbridge."

THE MATERIAL

fibers X polymers


Polyethylene (PE)
Polypropylene (PP)
Polyester
Epoxy
Vinylester
Thermosetting
Thermoplastic
Fossil-based
Greenpoxy™
Polylactic acid (PLA)
Polyhydroxyalkanoates (PHA)
Thermosetting
Thermoplastic
Bio-based
Polymer
Fiber-Reinforced Polymer
Fiber
Synthetic
Natural
Organic
Aramid
Zylon™
Inorganic
Metal
Aluminium
Beryllium
Molybdenum
Steel
Tantalum
Tungsten
Nonmetal
Boron
Carbon
Glass
Silicon carbide
Mineral
Asbestos
Basalt
Animal
Feathers
Fur
Hair
Silk
Wool
Plant
Reeds
Bagasse
Bamboo
Canary
Corn
Esparto
Rape
Sabai
Stalk
Barley
Oat
Rice
Rye
Triticale
Wheat
Wood
Hardwood
Softwood
Fruit
Coir
Oil palm
Seed
Cotton
Kapok
Loofah
Milkweed
Leaf
Abaca
Banana
Henequen
Palm
Pineapple
Raphia
Sisal
Bast
Flax
Jute
Hemp
Kenaf
Ramie
Roselle

MATERIAL | INDUSTRY STANDARD



Polylactic acid (PLA)

Polyethylene (PE)
Polypropylene (PP)
Thermosetting

Polyester
Epoxy
Vinylester
Thermoplastic

Fossil-based

Greenpoxy[tm]
Thermosetting

Polylactic acid (PLA)
Polyhydroxyalkanoates (PHA)
Thermoplastic

Bio-based

Polymer

Fiber-Reinforced Polymer

Fiber

Basalt fiber

Synthetic

Organic
Aramid
Zylon[tm]

Inorganic

Metal
Aluminium
Beryllium
Molybdenum
Steel
Tantalum
Tungsten

Nonmetal
Boron
Carbon
Glass
Silicon carbide

Natural

Mineral
Asbestos
Basalt

Animal
Feathers
Fur
Hair
Silk
Wool

Plant

Reeds
Bagasse
Bamboo
Canary
Corn
Esparto
Rape
Sabai

Stalk
Barley
Oat
Rice
Rye
Triticale
Wheat

Wood
Hardwood
Softwood

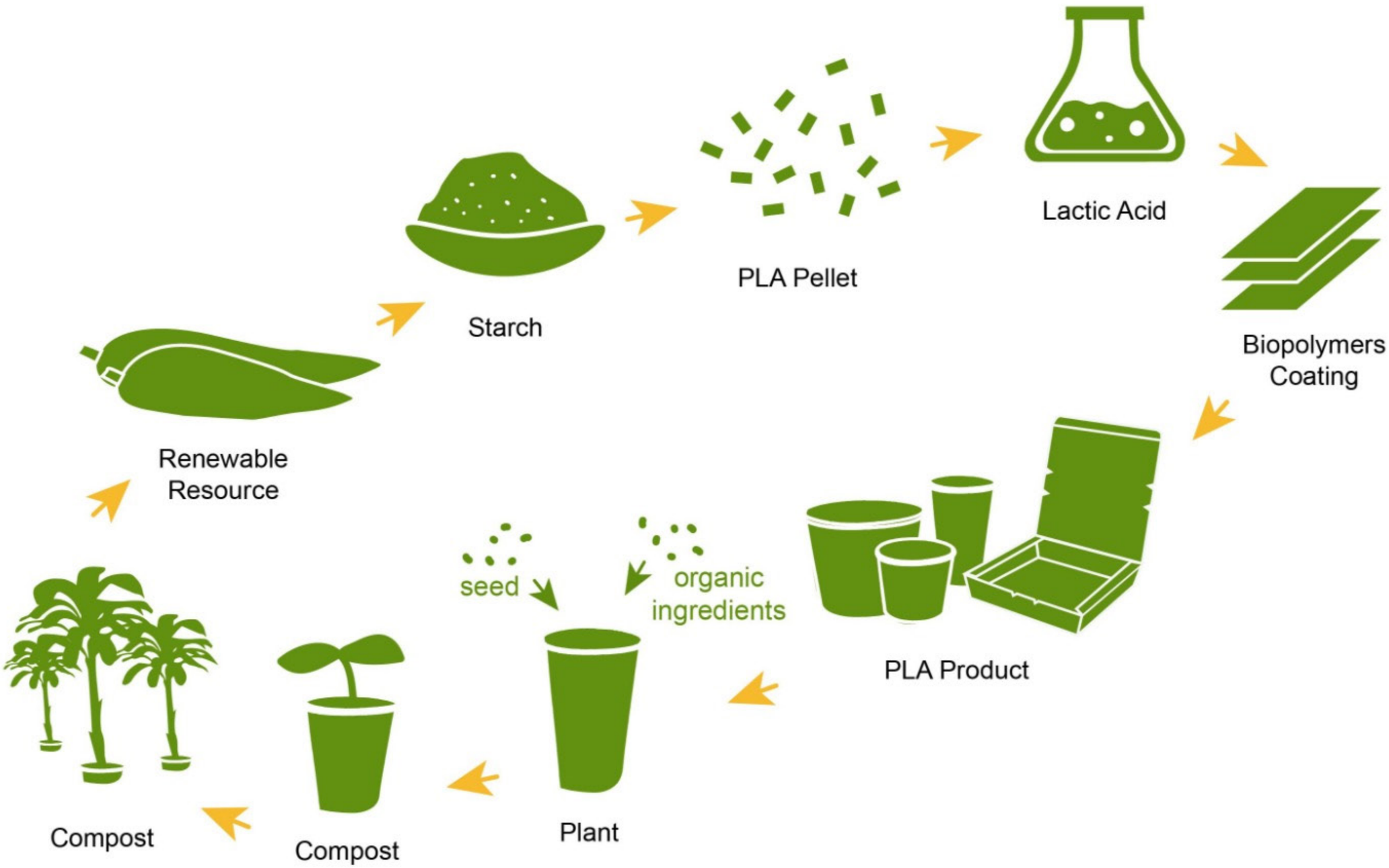
Fruit
Coir
Oil palm

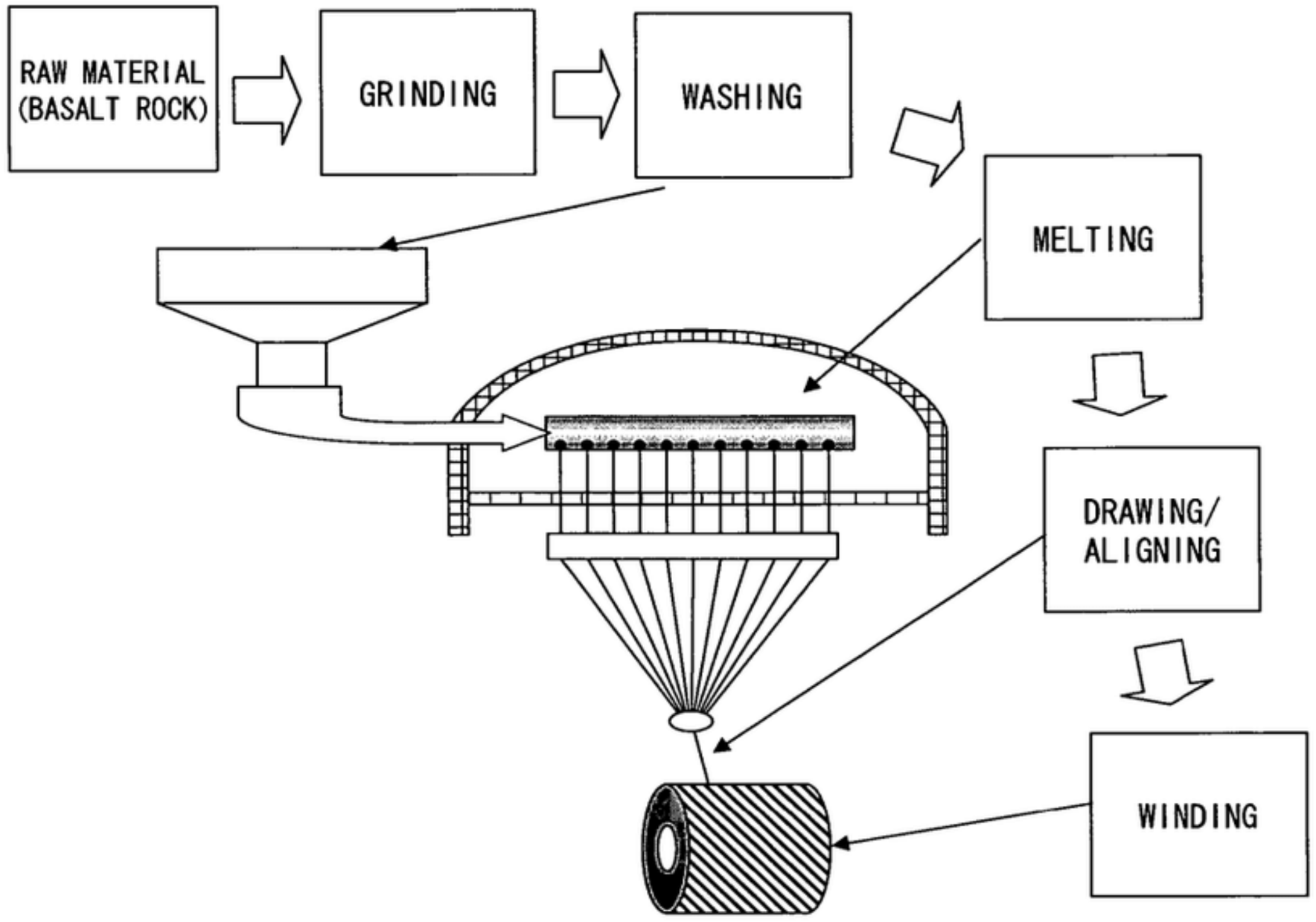
Seed
Cotton
Kapok
Loofah
Milkweed

Leaf
Abaca
Banana
Henequen
Palm
Pineapple
Raphia
Sisal

Bast
Flax
Jute
Hemp
Kenaf
Ramie
Roselle

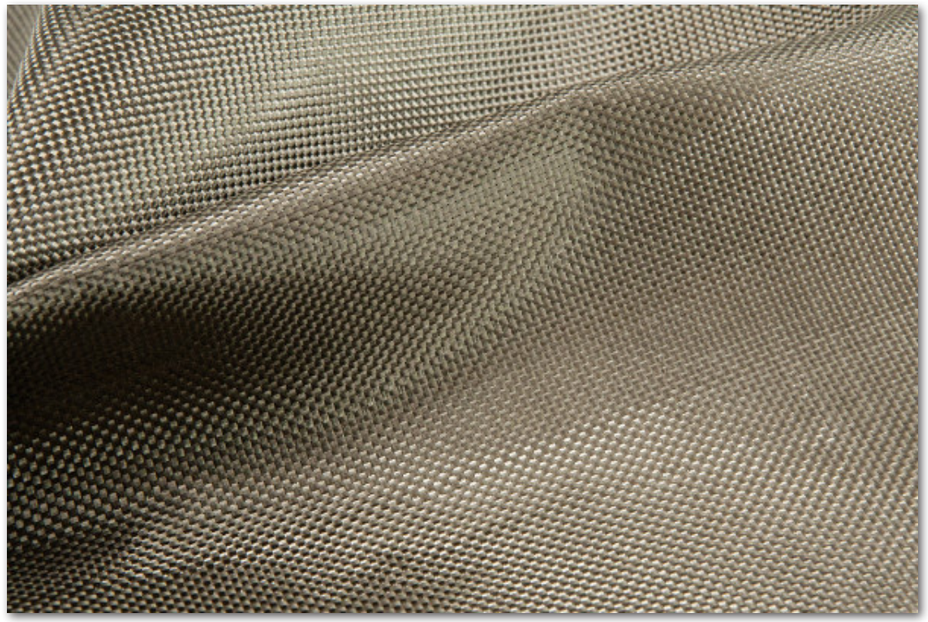
MATERIAL | POLYLACTIC ACID (PLA)




RAW MATERIAL
(BASALT ROCK)
GRINDING
WASHING
MELTING
DRAWING/
ALIGNING
WINDING

PLA

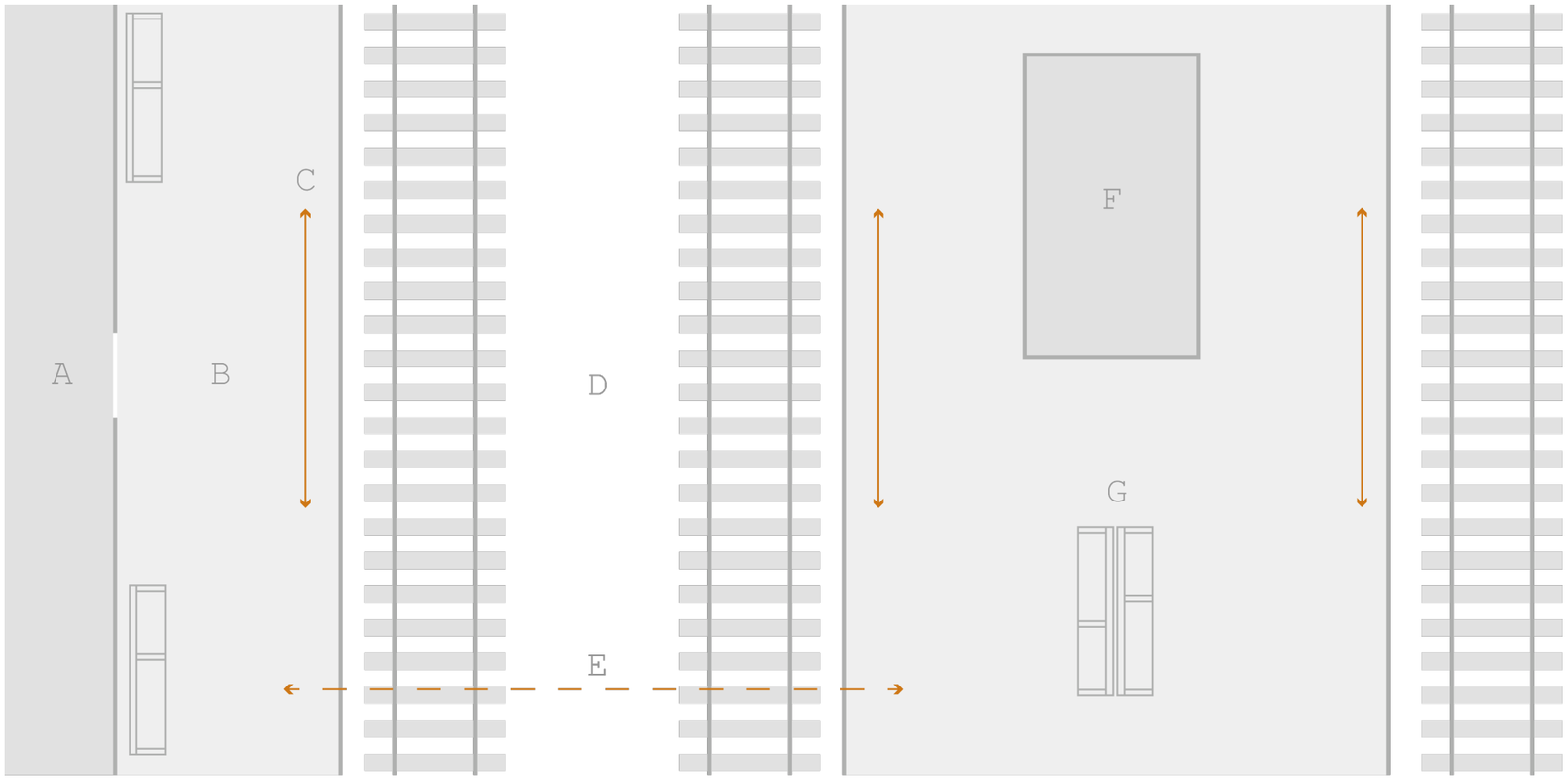
Basalt fiber



assumed properties	composite	steel (S275)
fiber volume fraction V_f:	40 wt%	-
density ρ:	1800 kg/m^3	8000 kg/m^3
young's modulus E:	30 GPa	210 GPa
tensile strength f_t:	120 MPa	275 MPa

THE CONTEXT

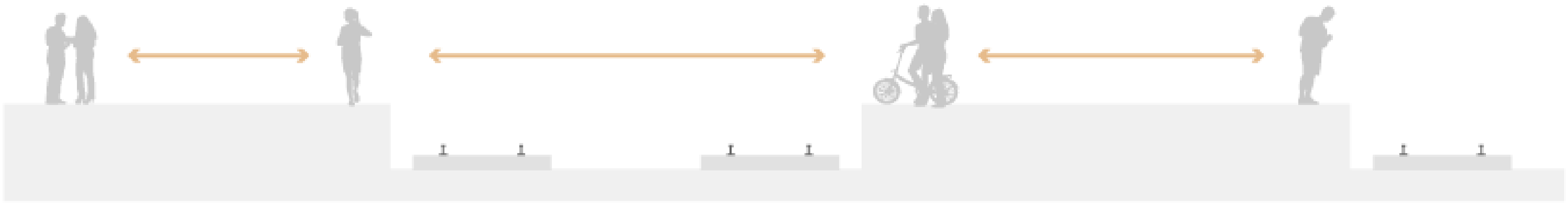
orthogonal | limited lateral space



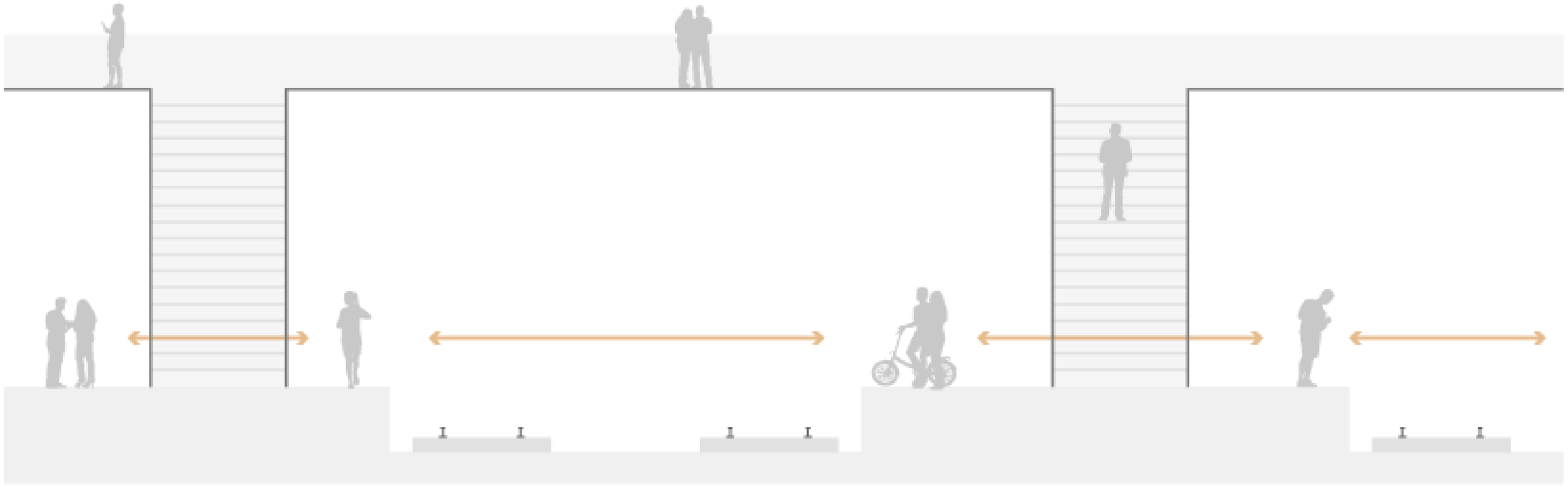
Legend

A Entry domain
B Platform
C Main traffic flow
D Train tracks
E Intended overpass
F Retail
G Furniture

single level | horizontal | transparent



preserve original landscape



CONTEXT | A DYNAMIC HUB

Transparent design

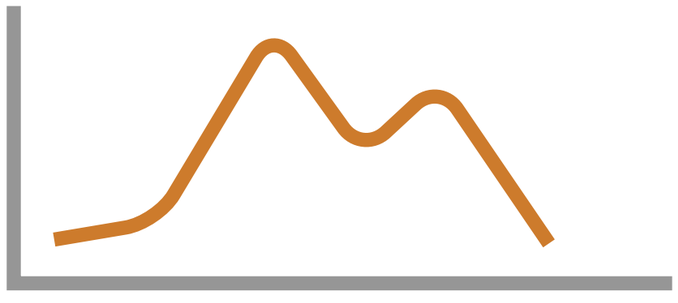
Subdued design

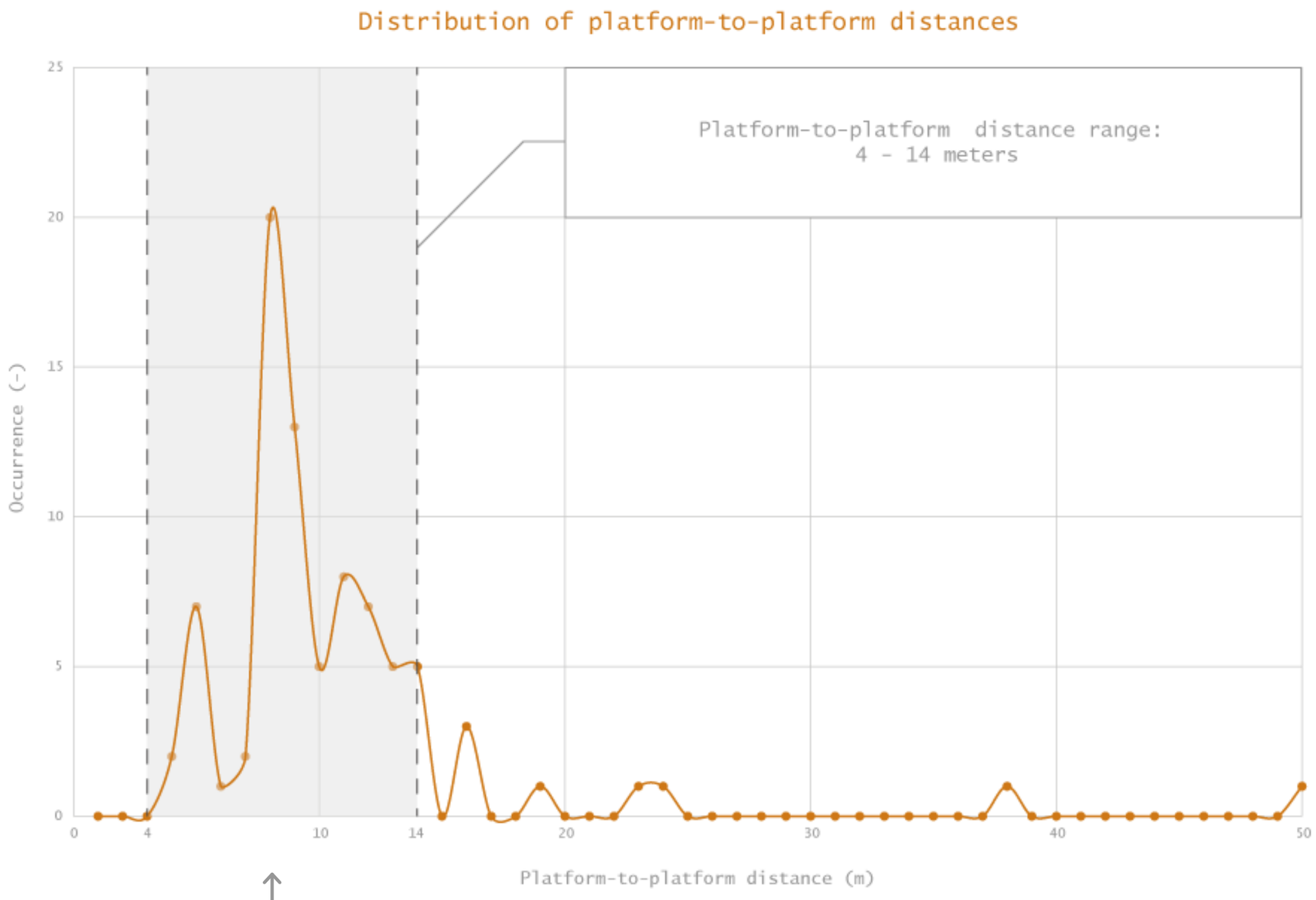
Dynamic design

Measure

Tabulate

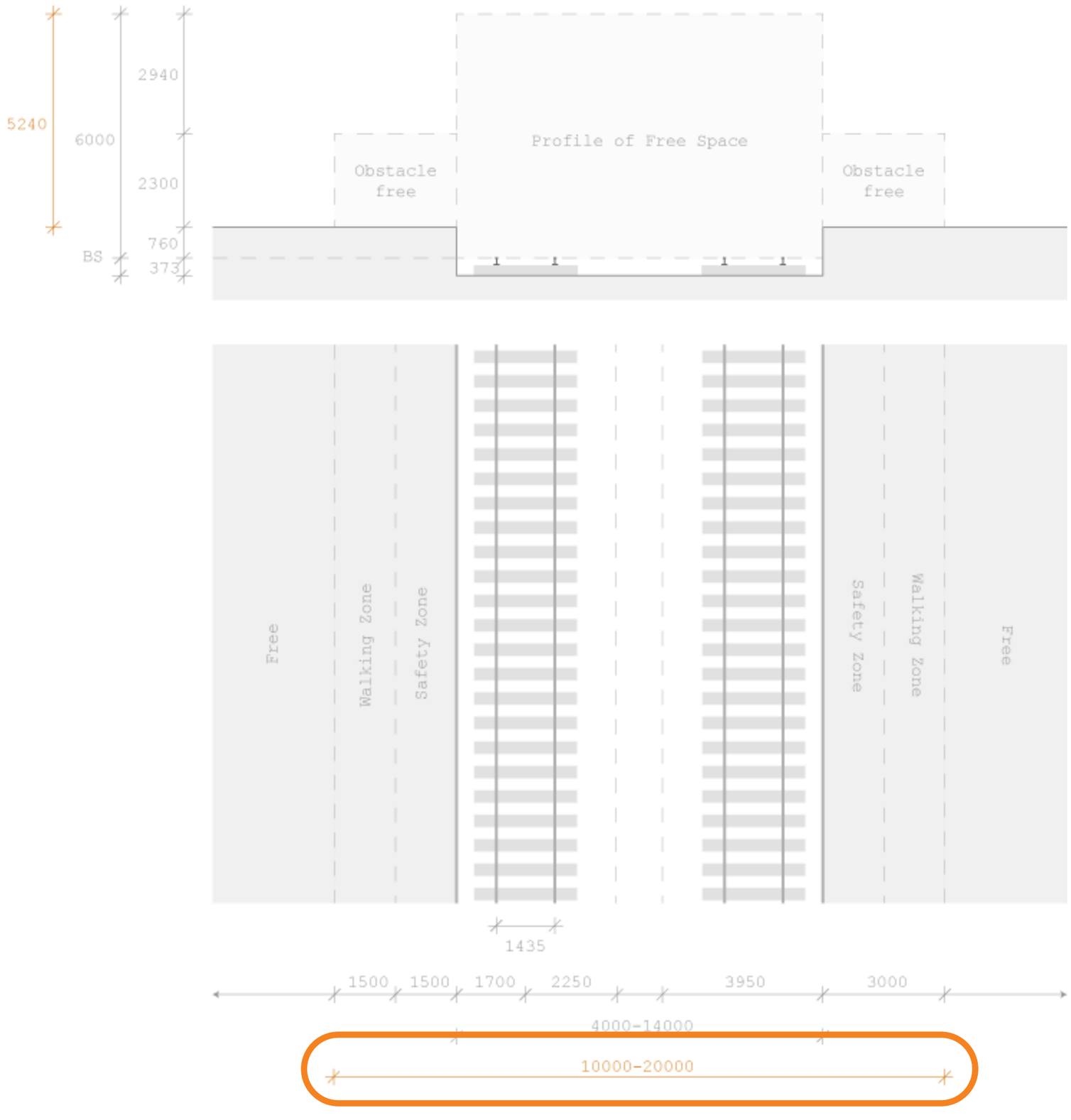
Graph



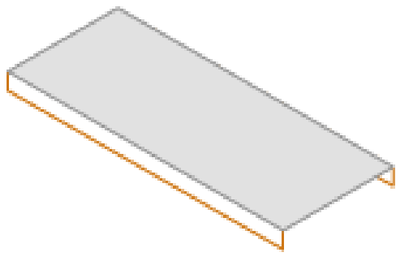


domain: 4 - 14 meters

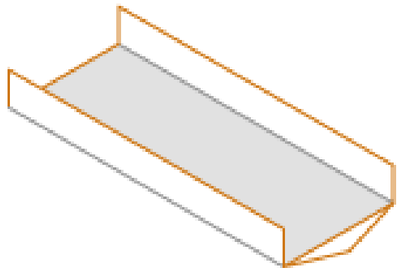
CONTEXT | BOUNDARY CONDITIONS



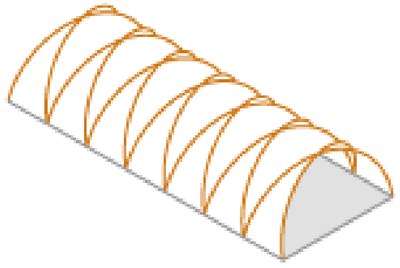
THE PROCESS



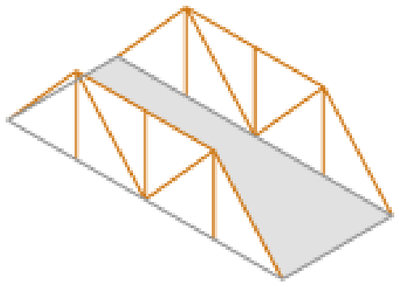
beam



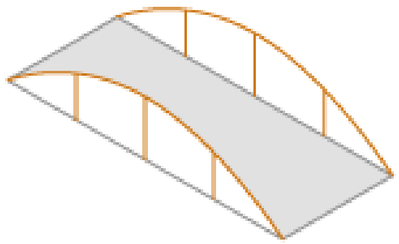
monocoque



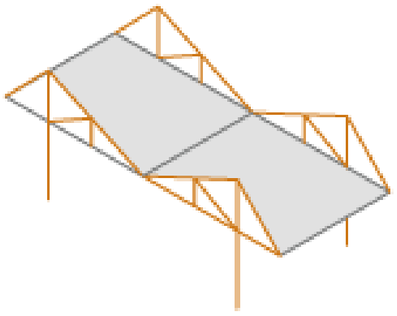
membrane



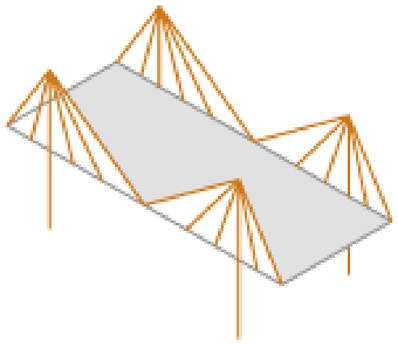
truss



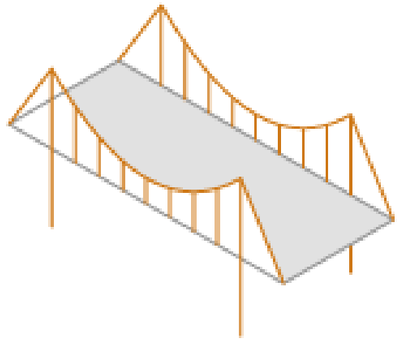
arch



cantilever

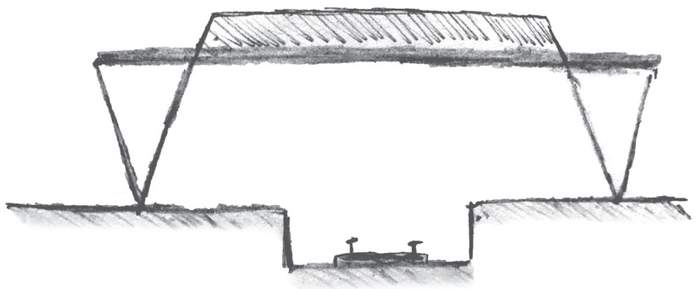


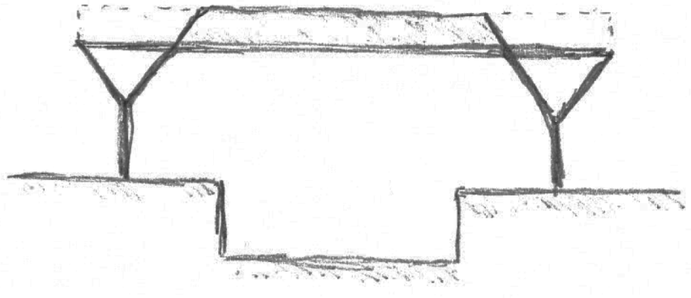
cable-stayed



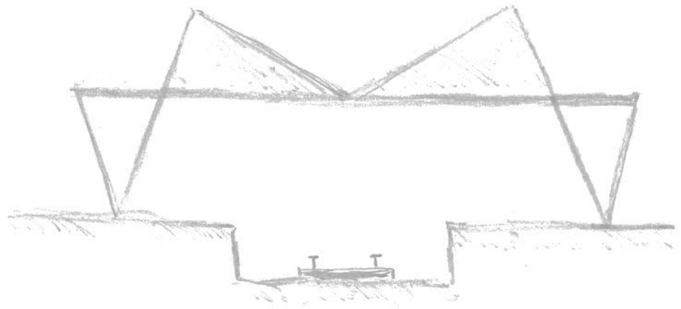
suspension

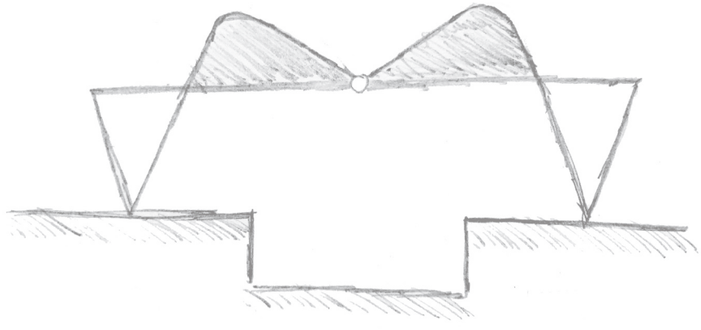
beam



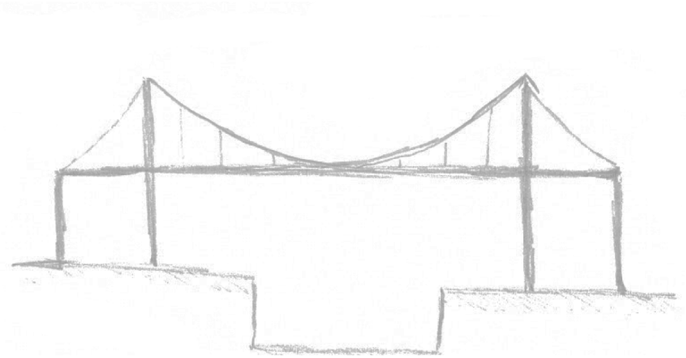


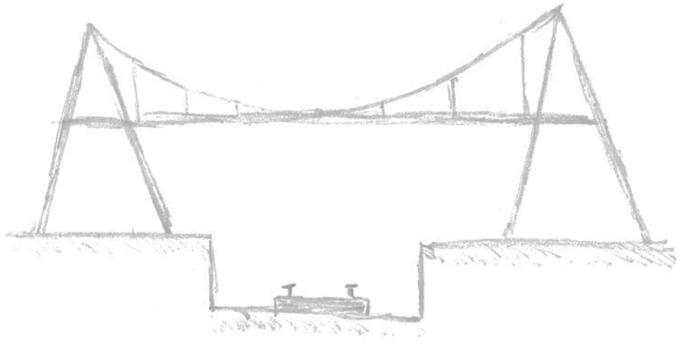
cantilever





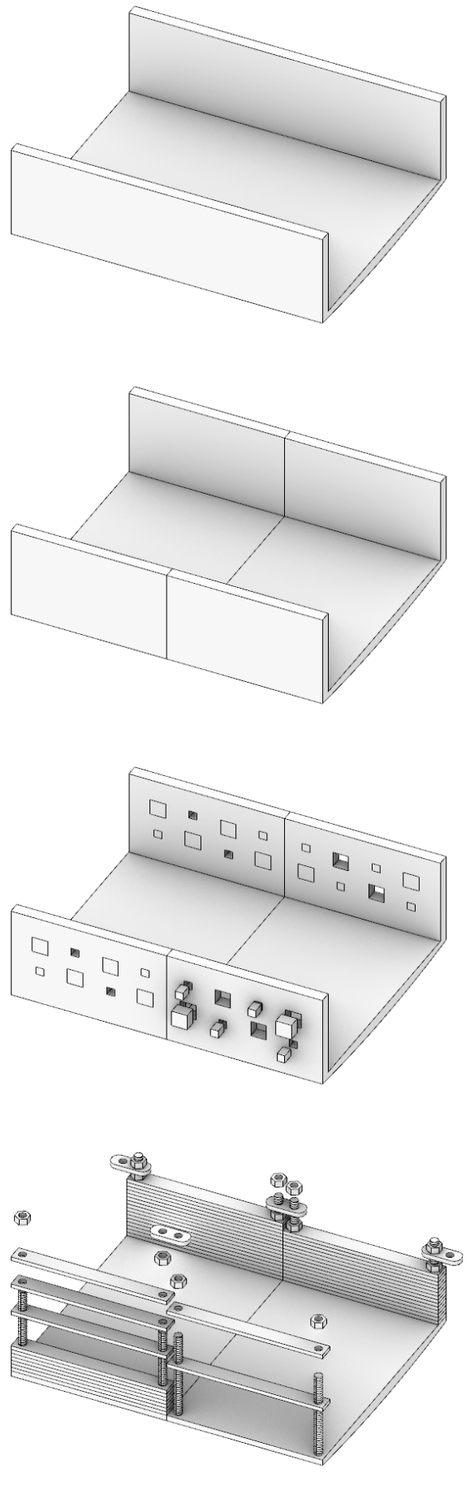
suspension





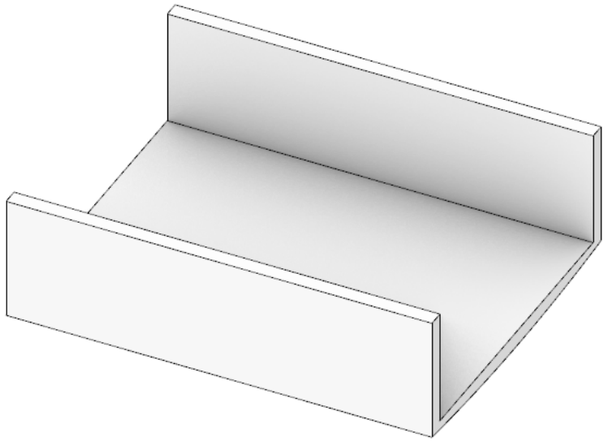
bridge as module

scales of modularity

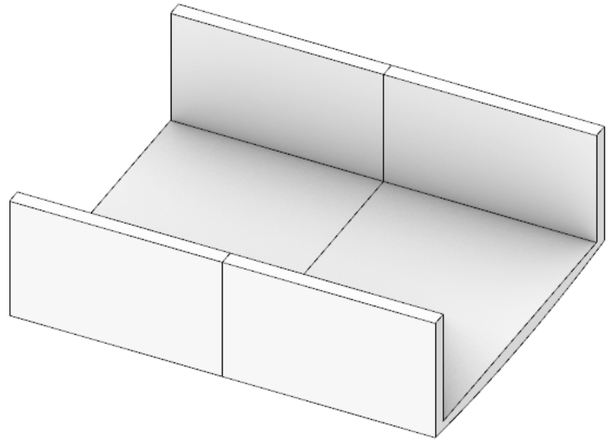


modules within modules

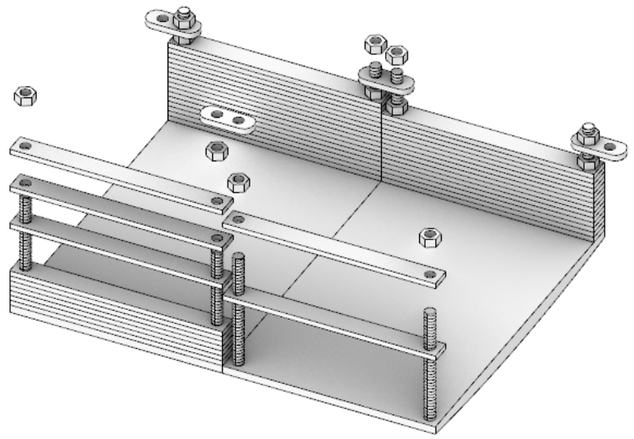
whole span



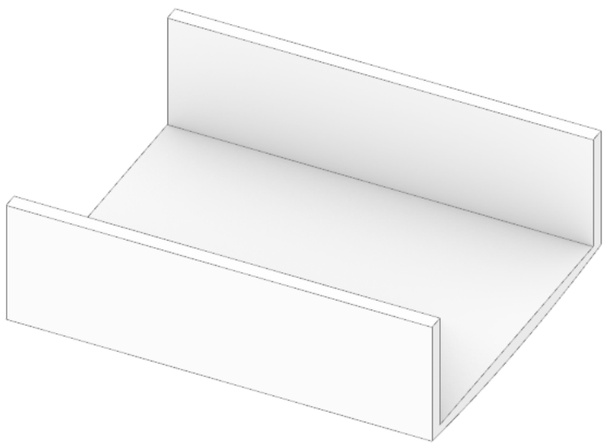
span sections



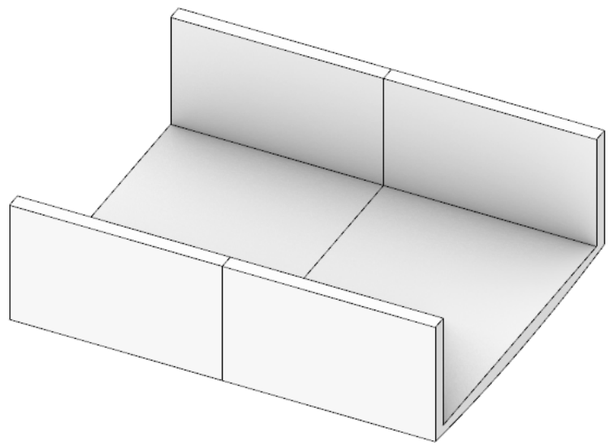
modular parapets



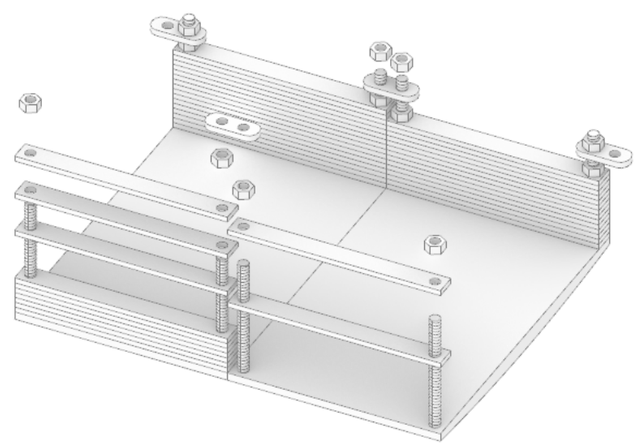
whole span

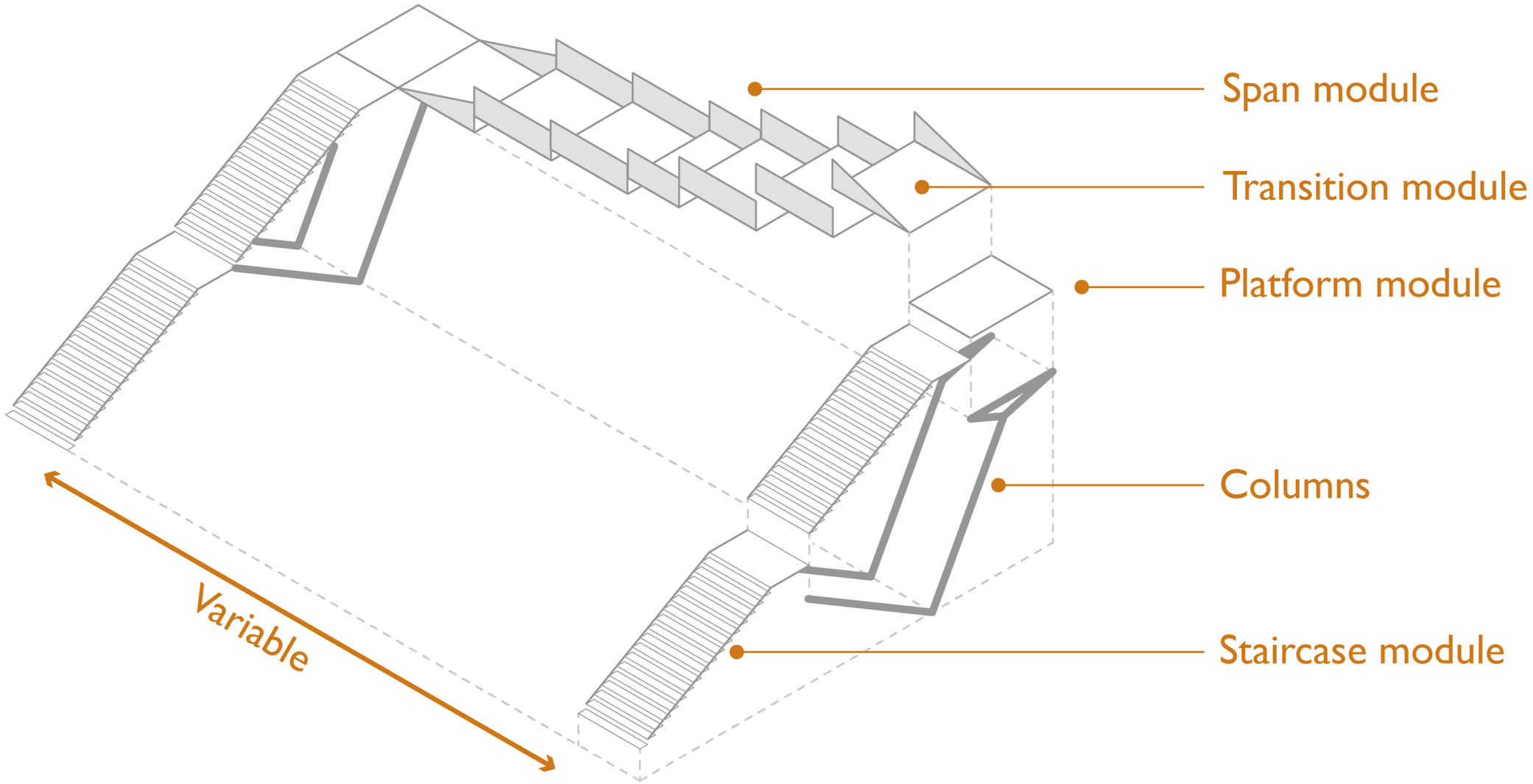


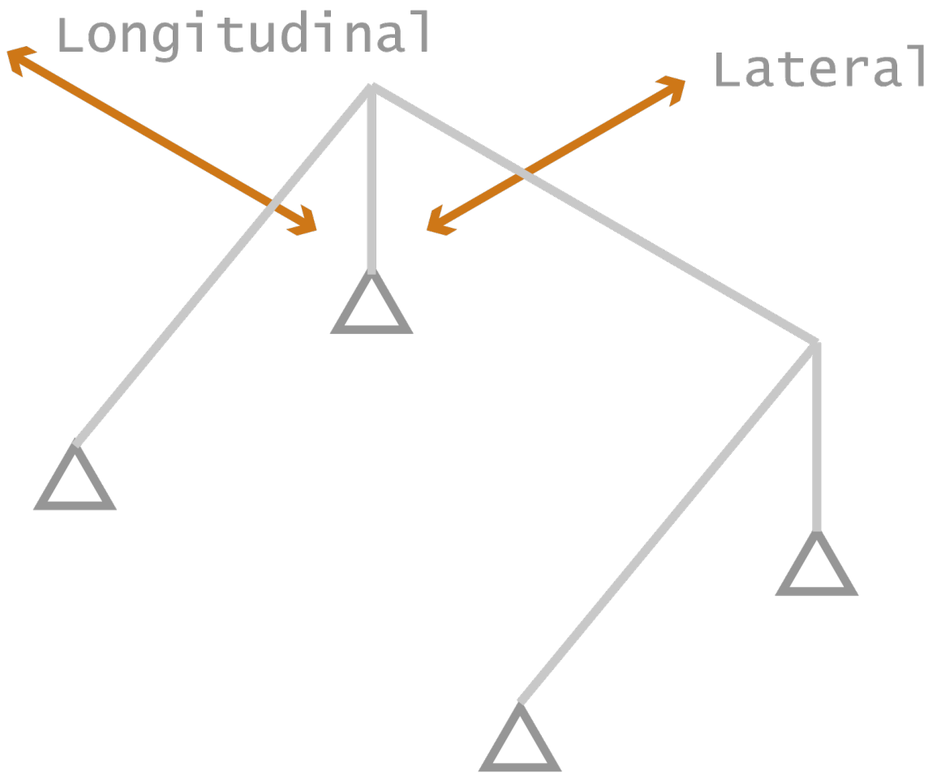
span sections



modular parapets



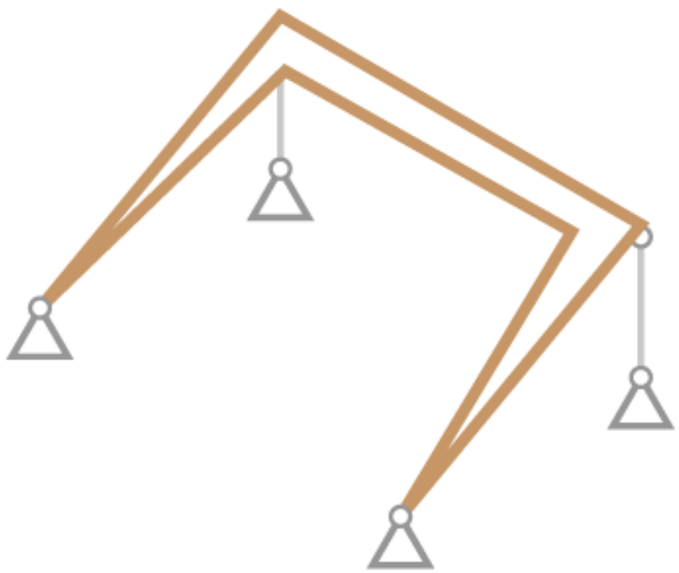

Span module
Transition module
Platform module
Columns
Staircase module
Variable


Longitudinal
Lateral

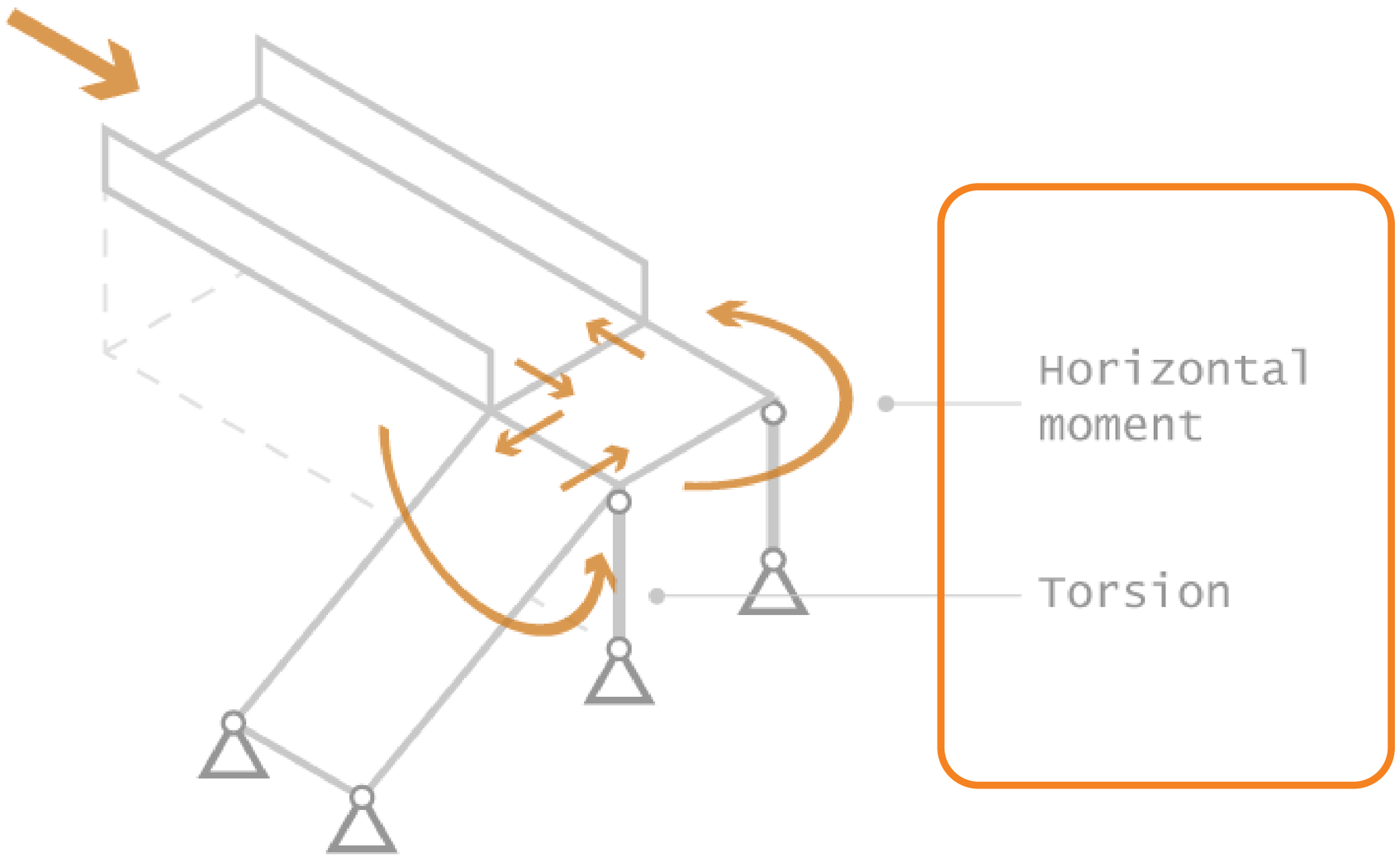
within column

vertical frame

diagonal frame

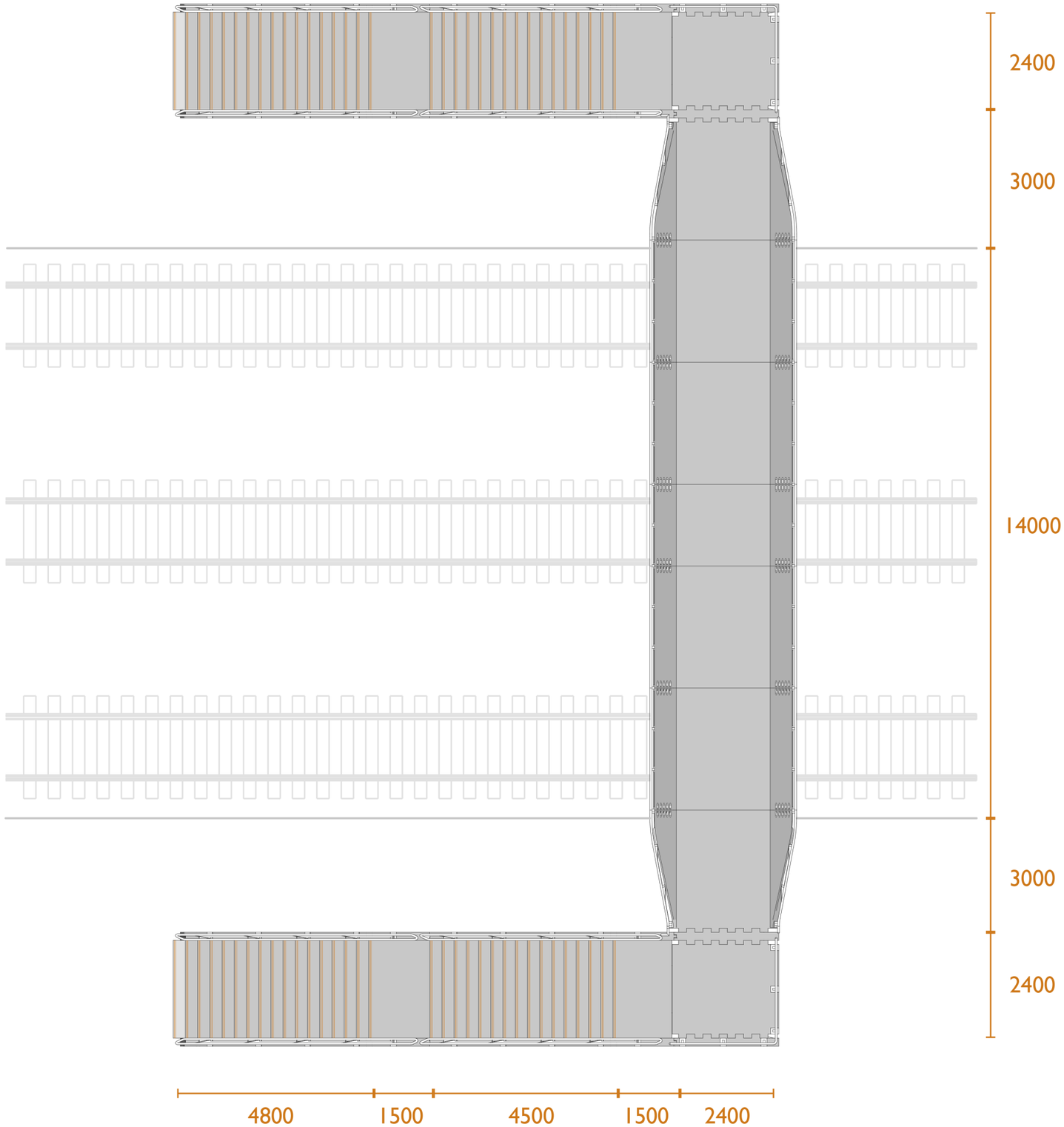


staircase as main stabilizer

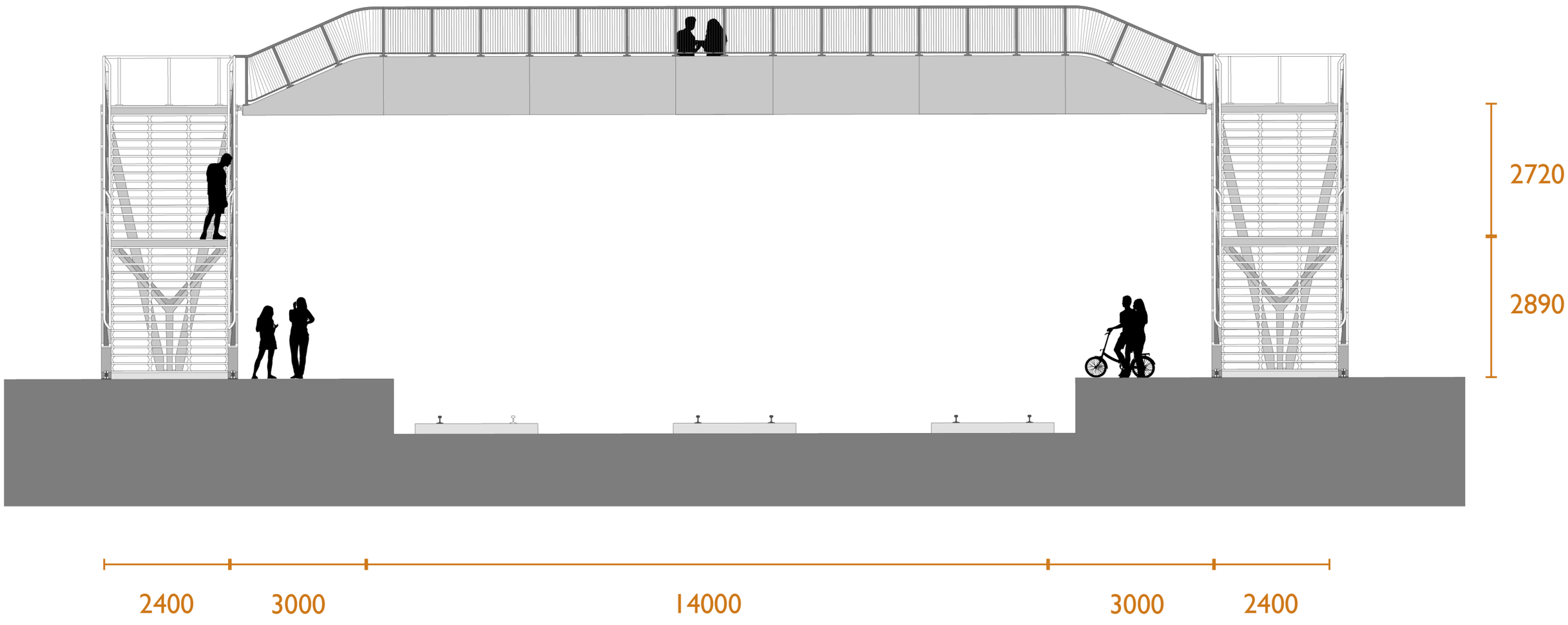

Horizontal moment
Torsion

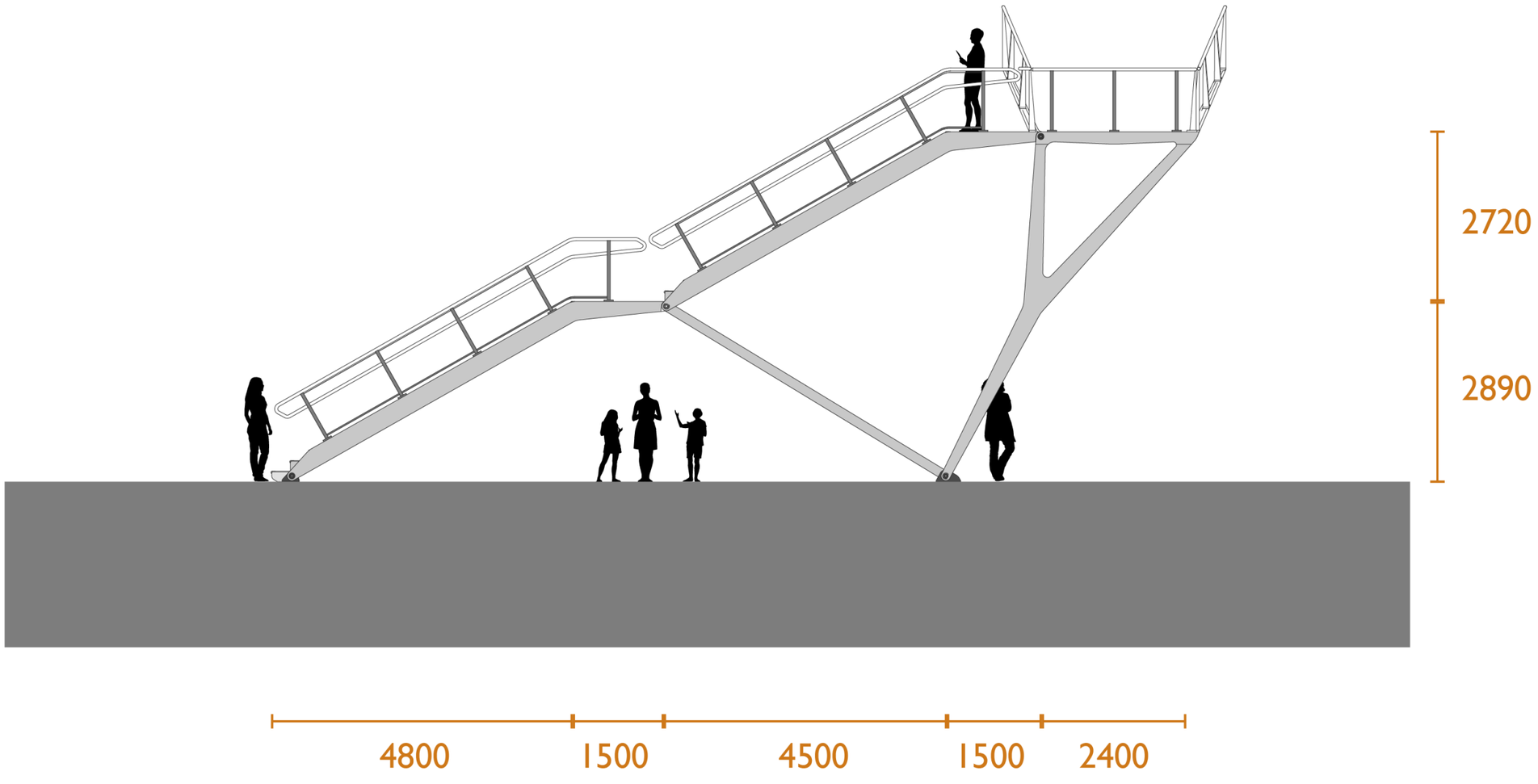
THE DESIGN

DESIGN | AN OUTSIDE VIEW



DESIGN | AN OUTSIDE VIEW

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4500
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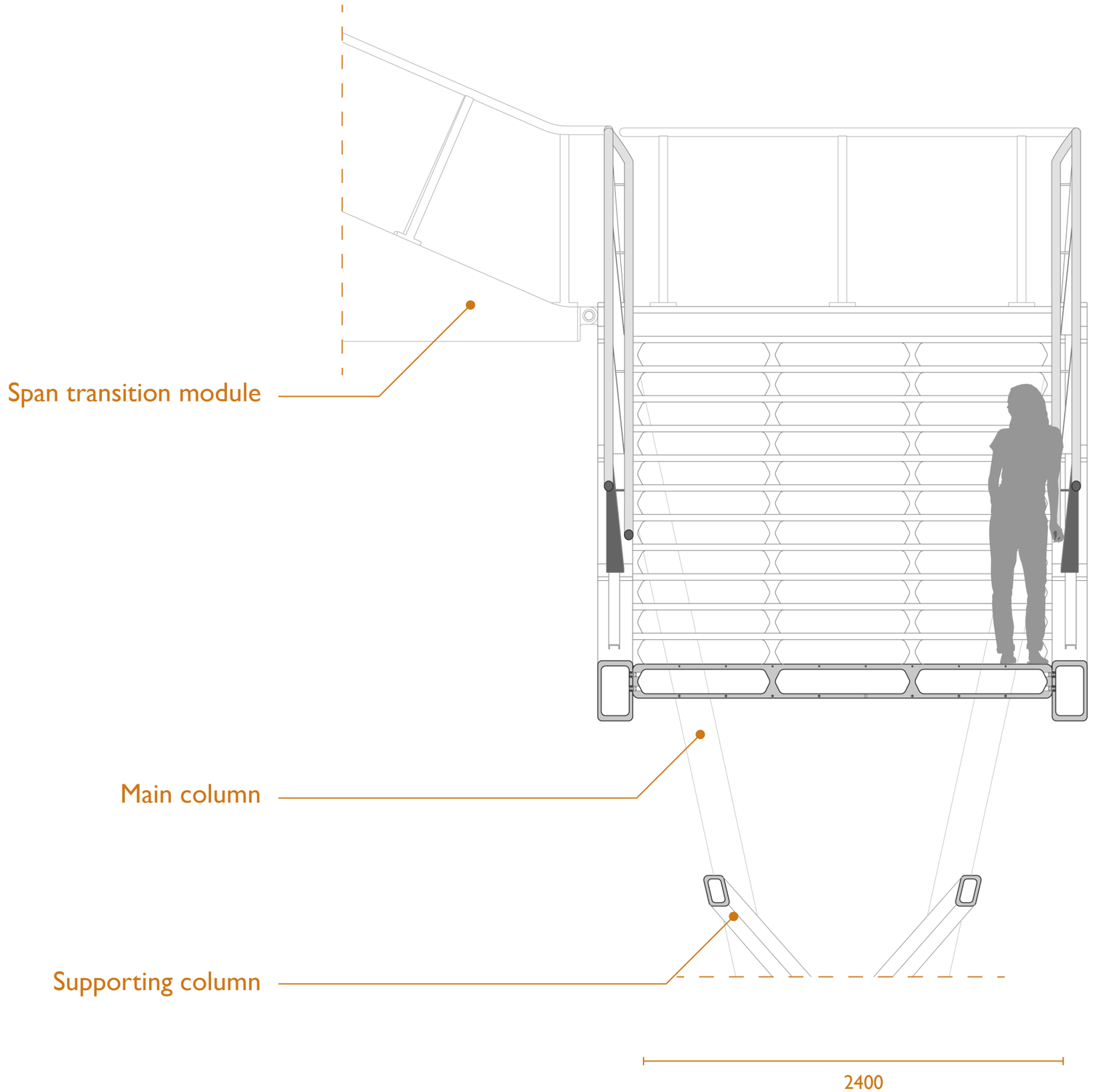
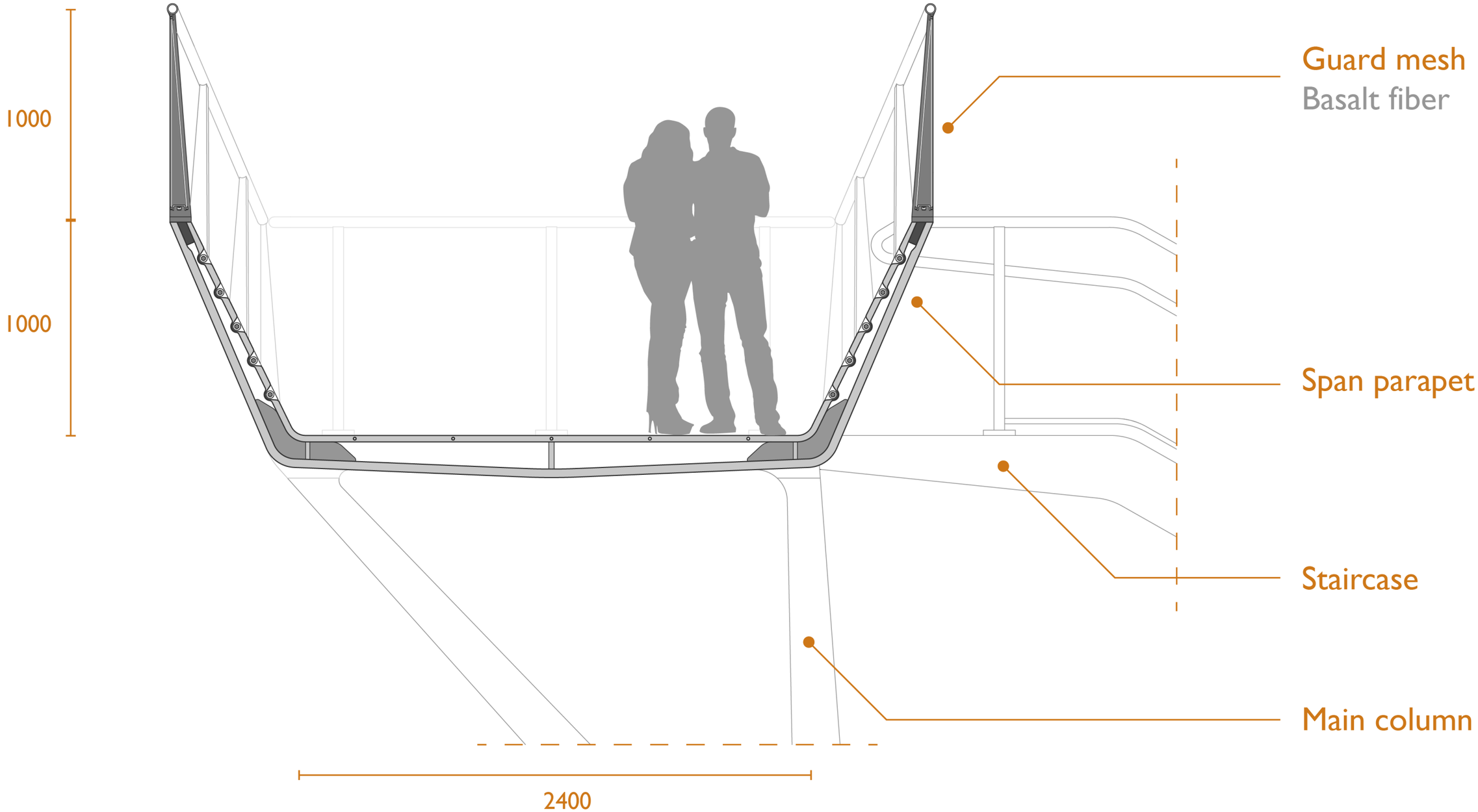
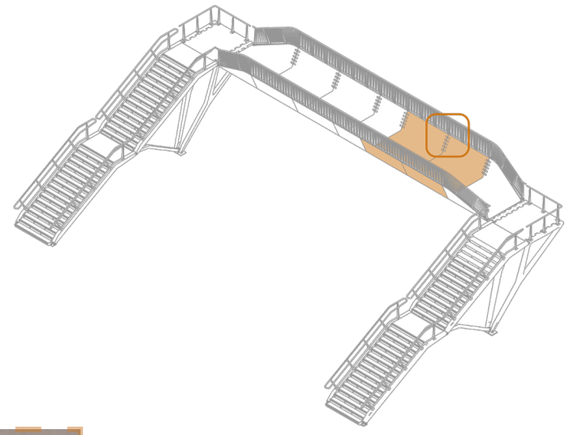
2400

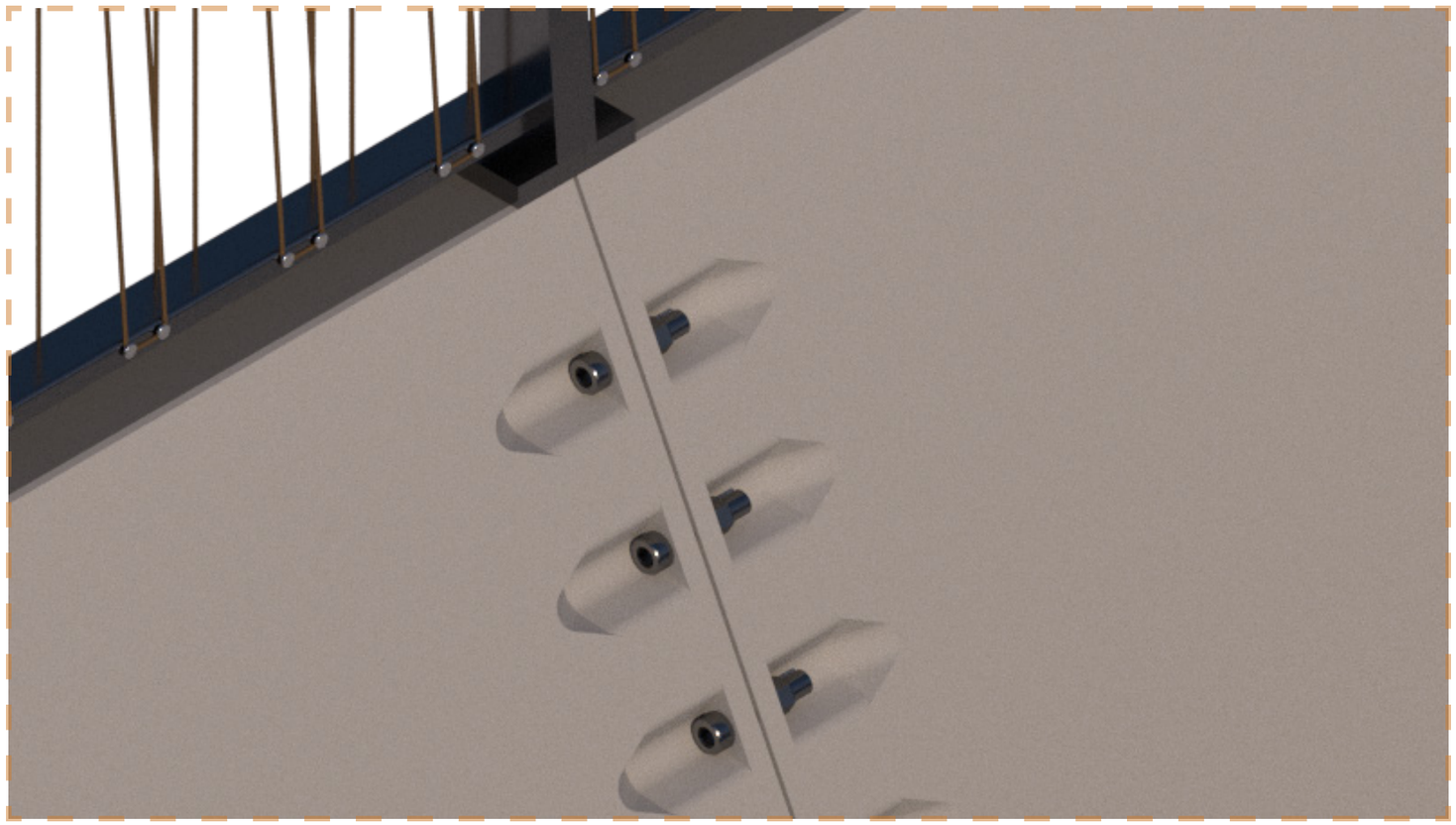
DESIGN | AN INSIDE VIEW



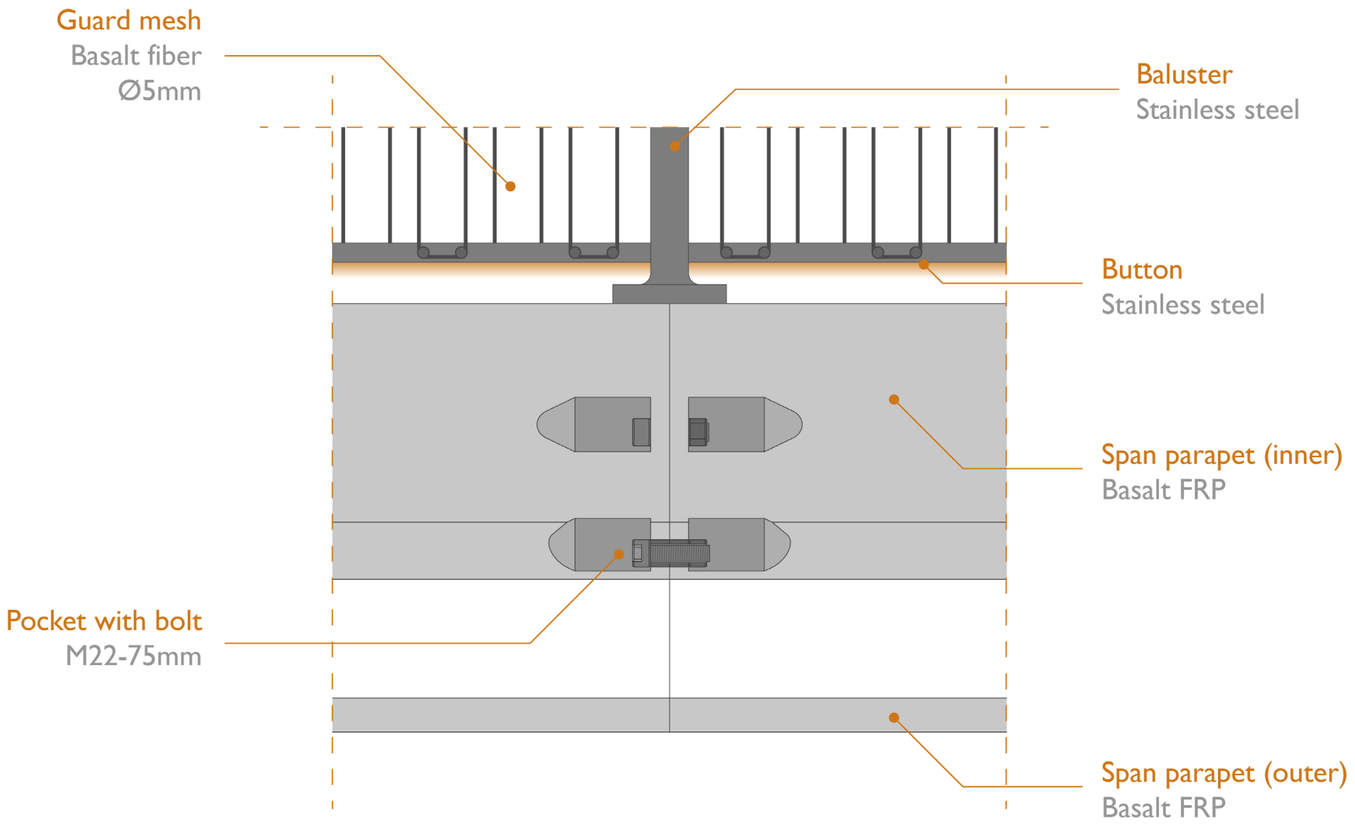
DESIGN | AN INSIDE VIEW



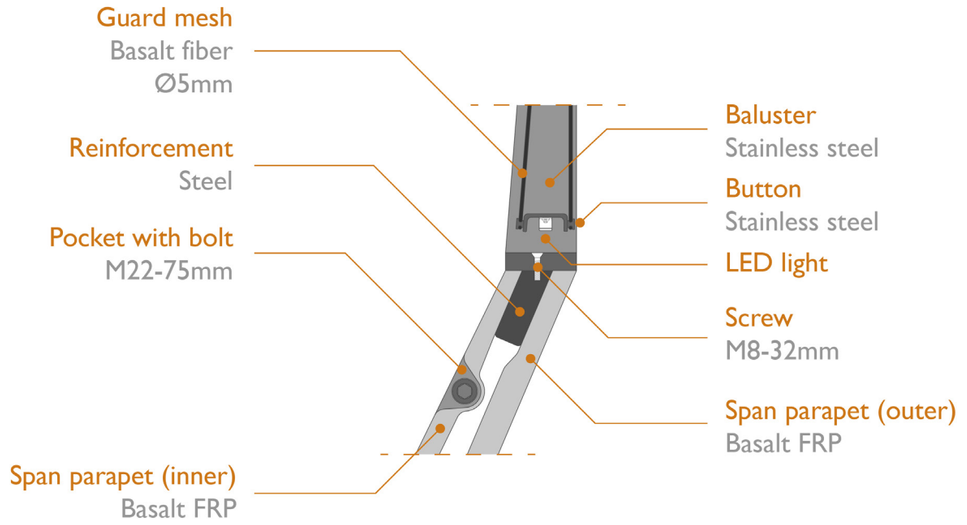




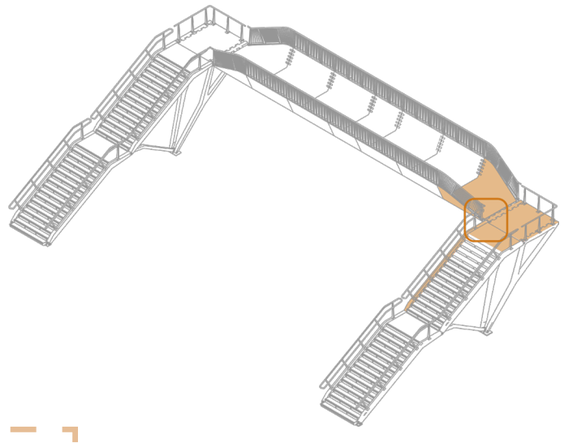
isometric view

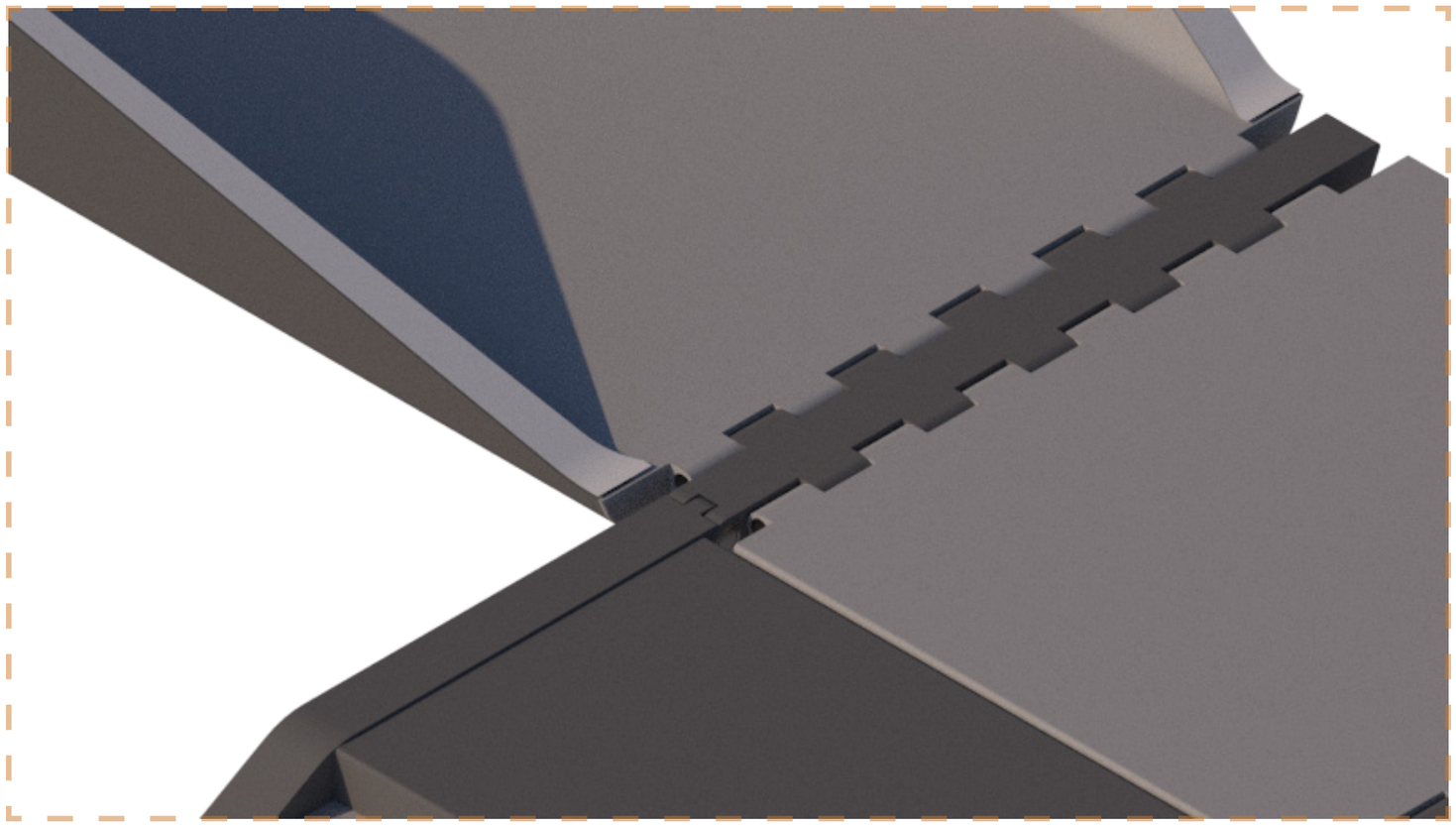


front view and section

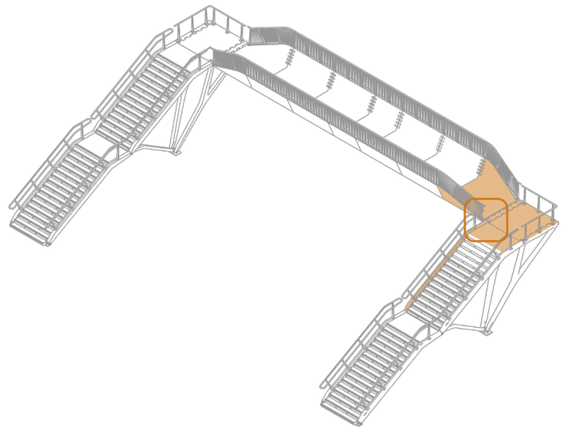


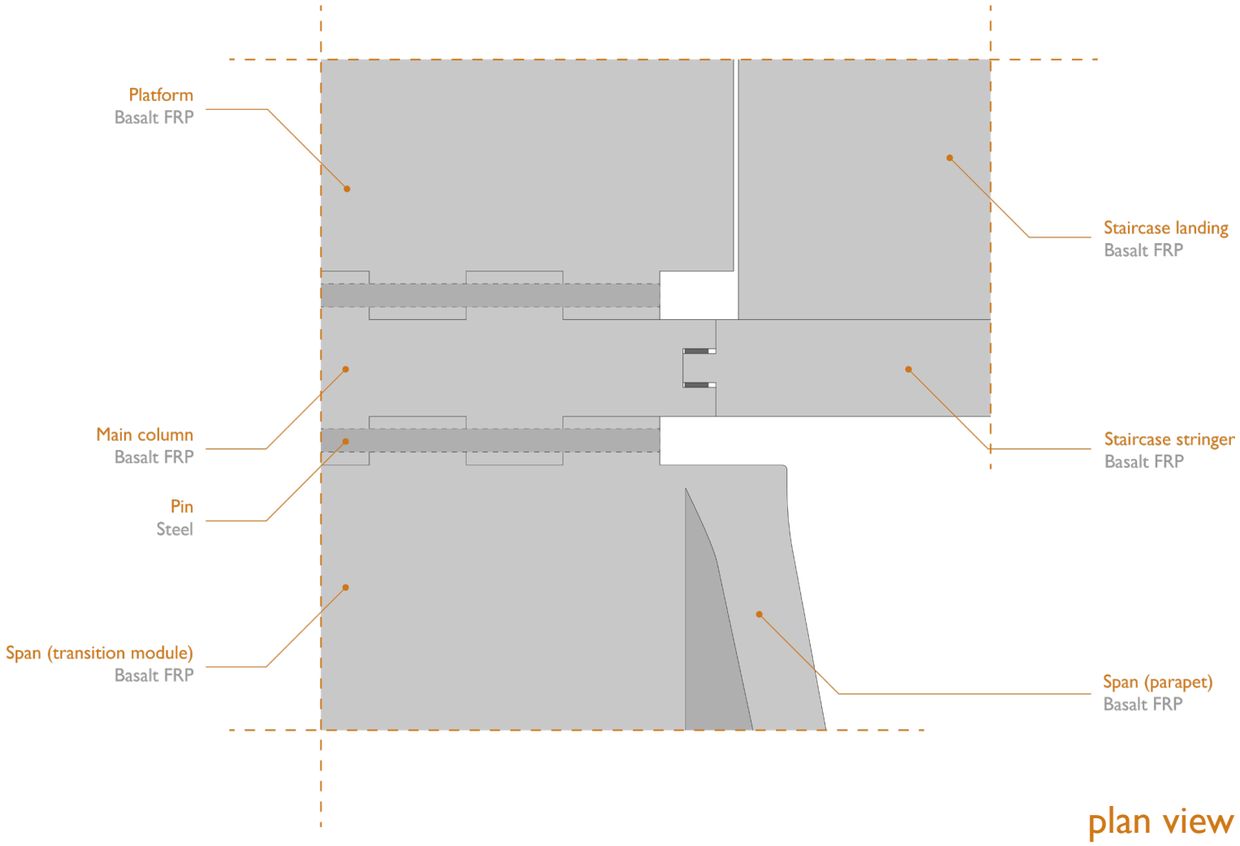
side section



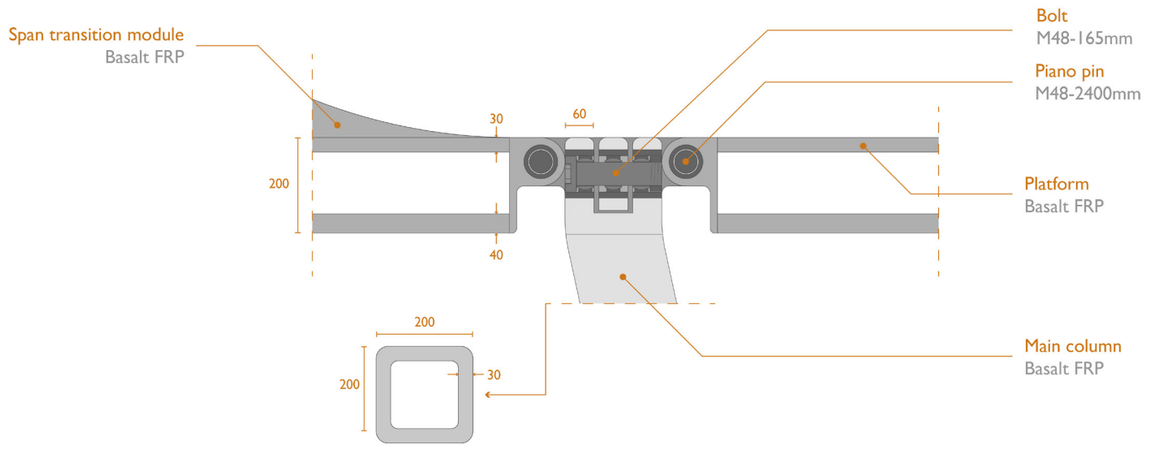


isometric view

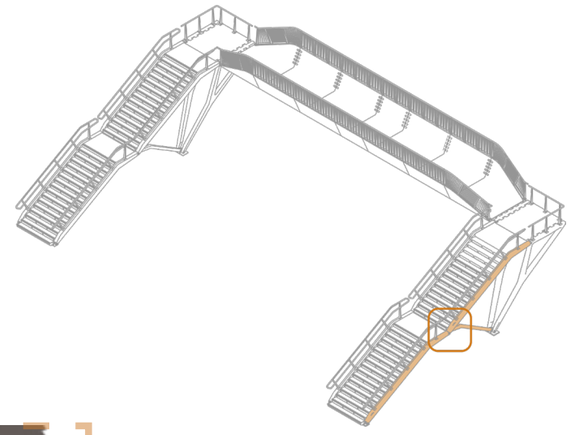


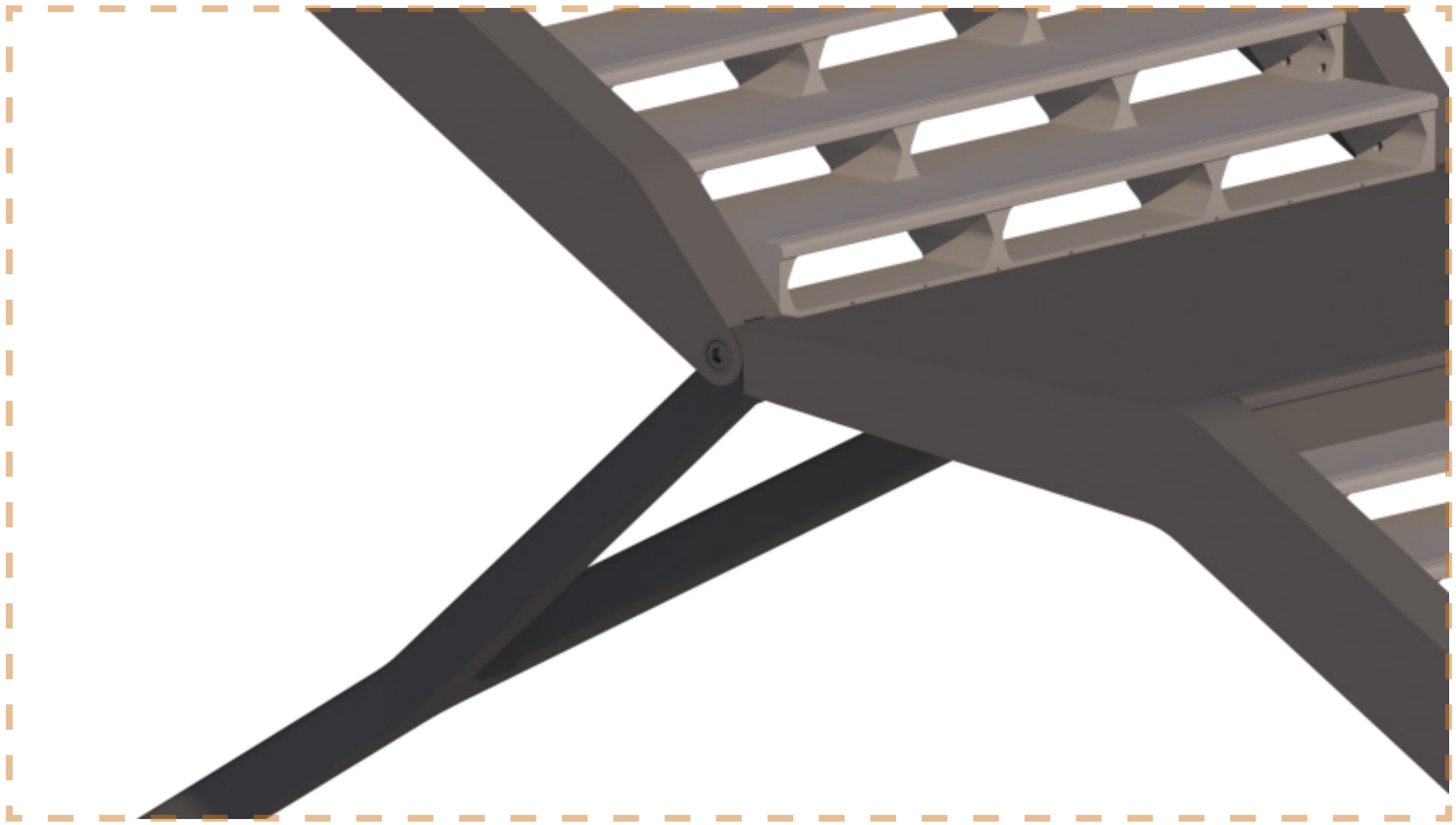


plan view



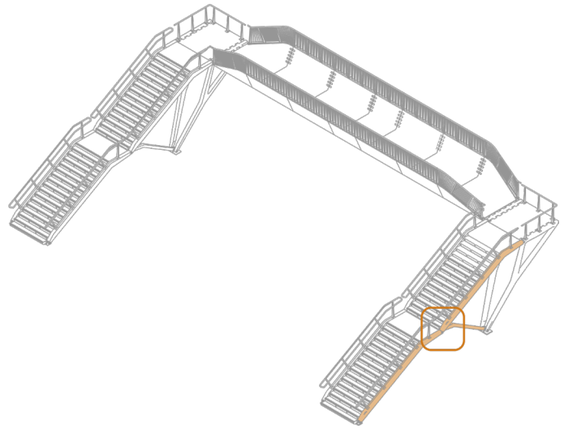
side section

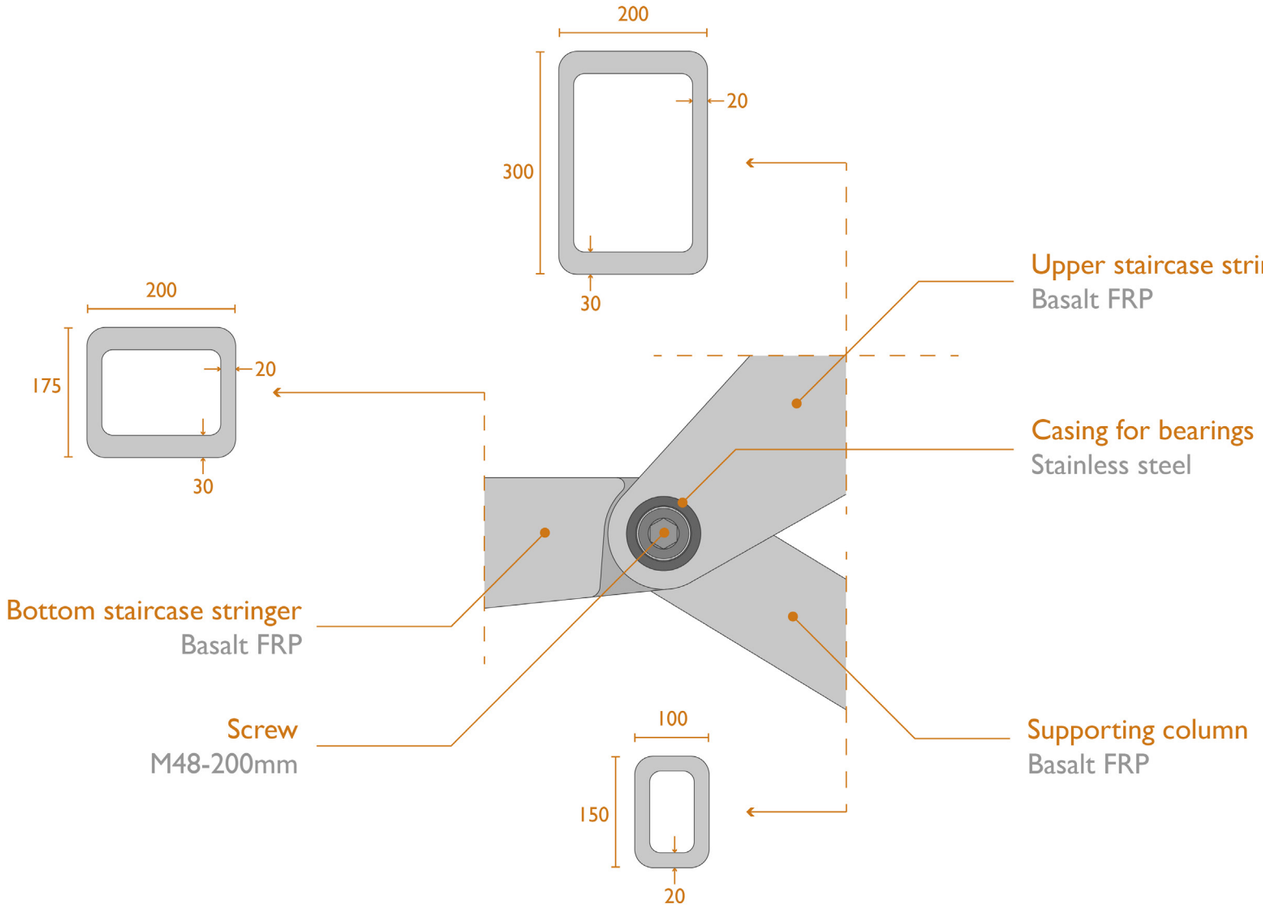




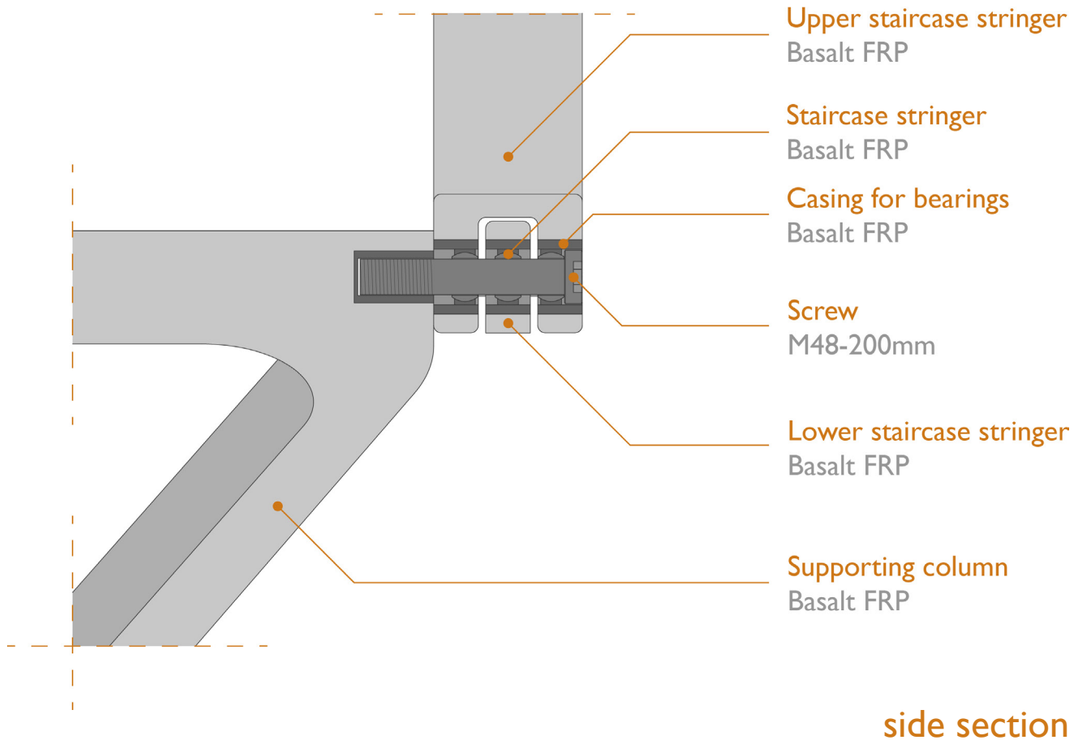
isometric view

DESIGN | DETAILS | STRINGER-STRINGER

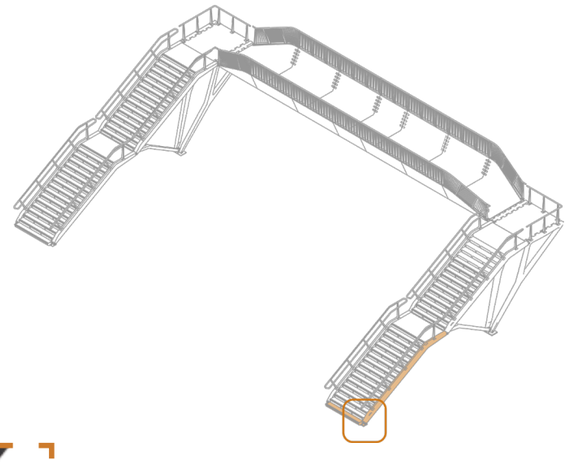


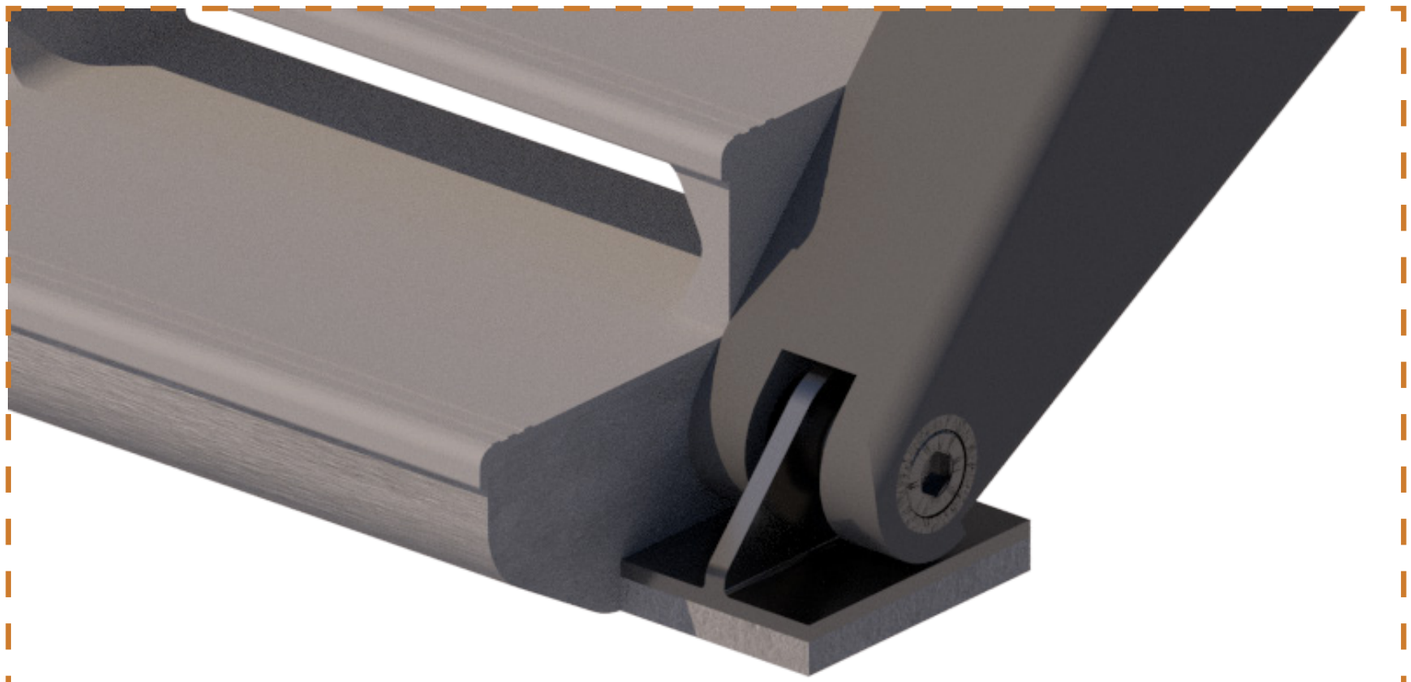


front view



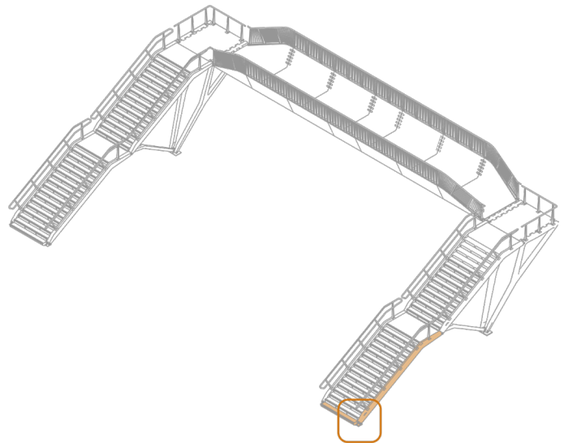
side section

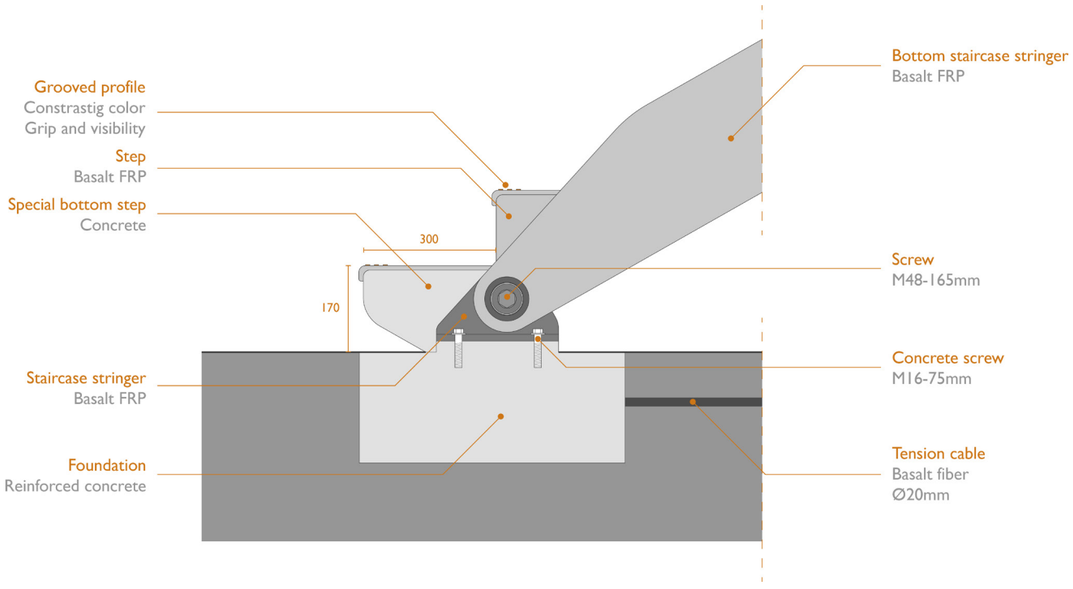




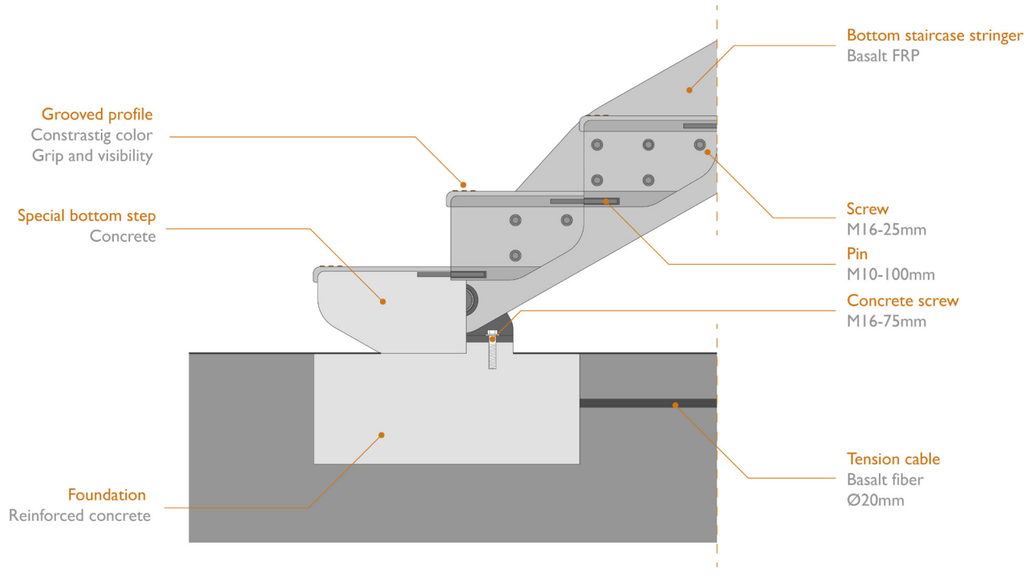
isometric view

DESIGN | DETAILS | STRINGER FOUNDATION

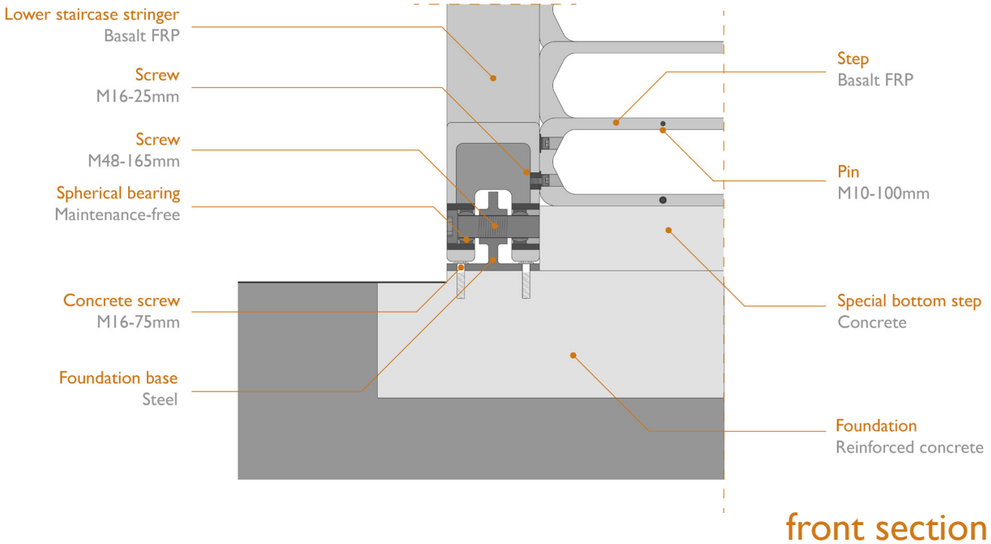




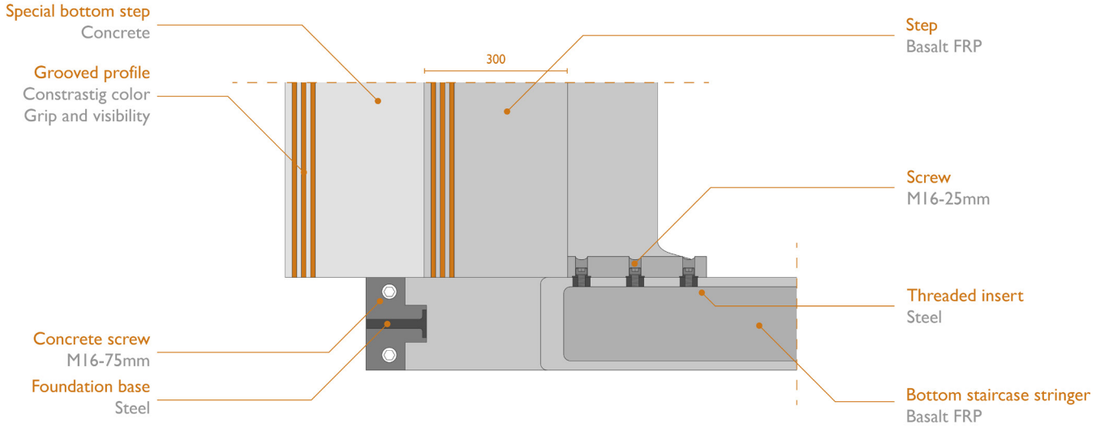
side view



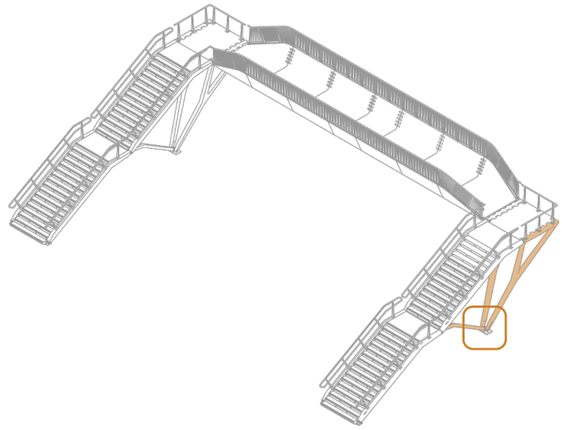
side section

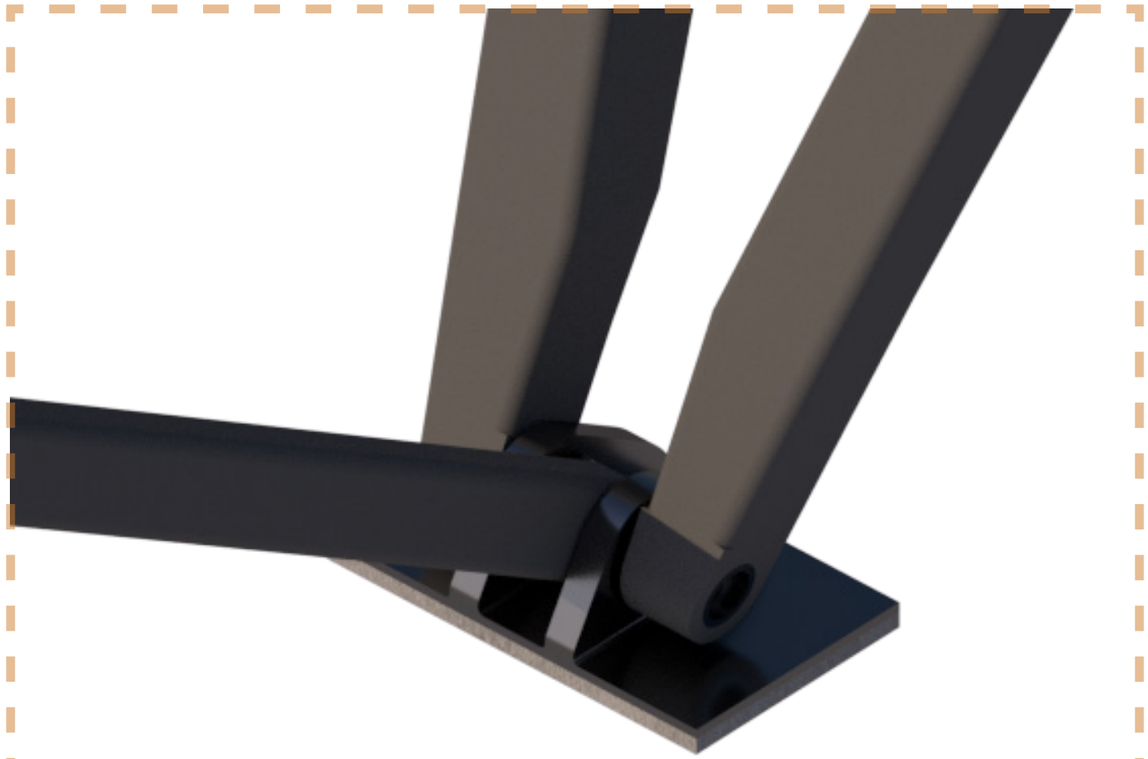


front section

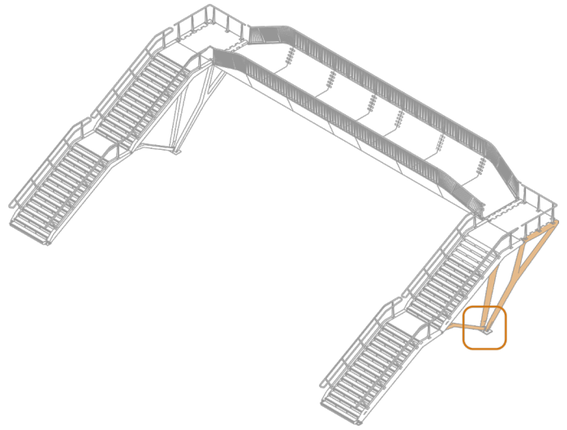


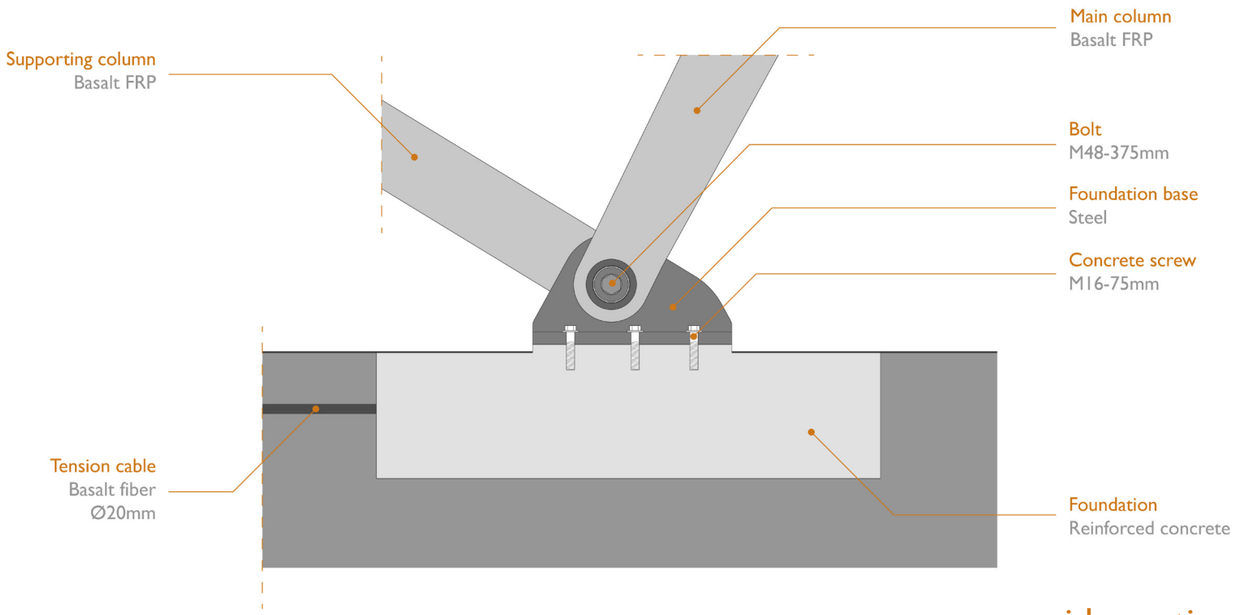
plan section



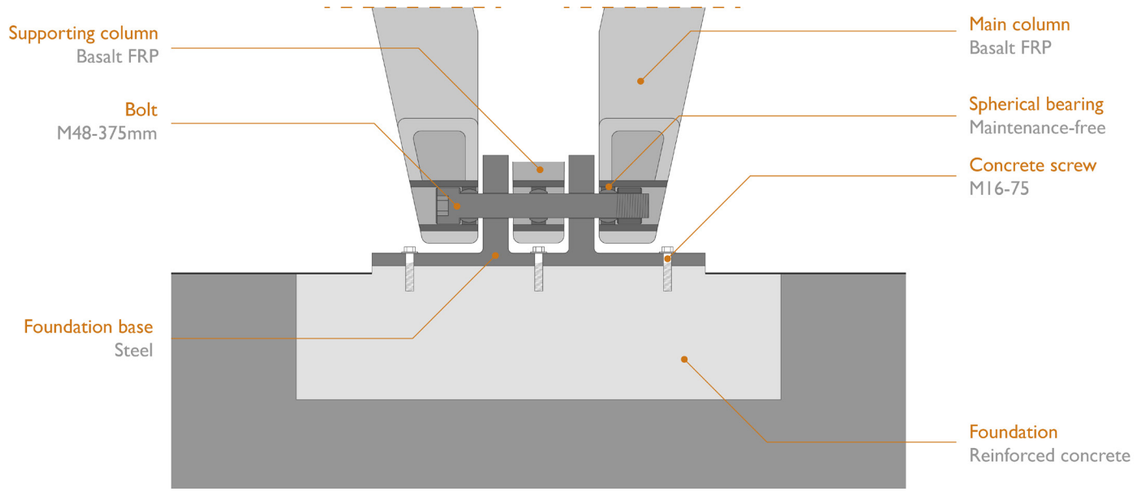


isometric view





side section



front section

DISCUSSION

DISCUSSION

THANK YOU