Wind-Turbine Bridge

11050 Super-light Structures

Group 10

1 - Inspiration

Reusing existing structures

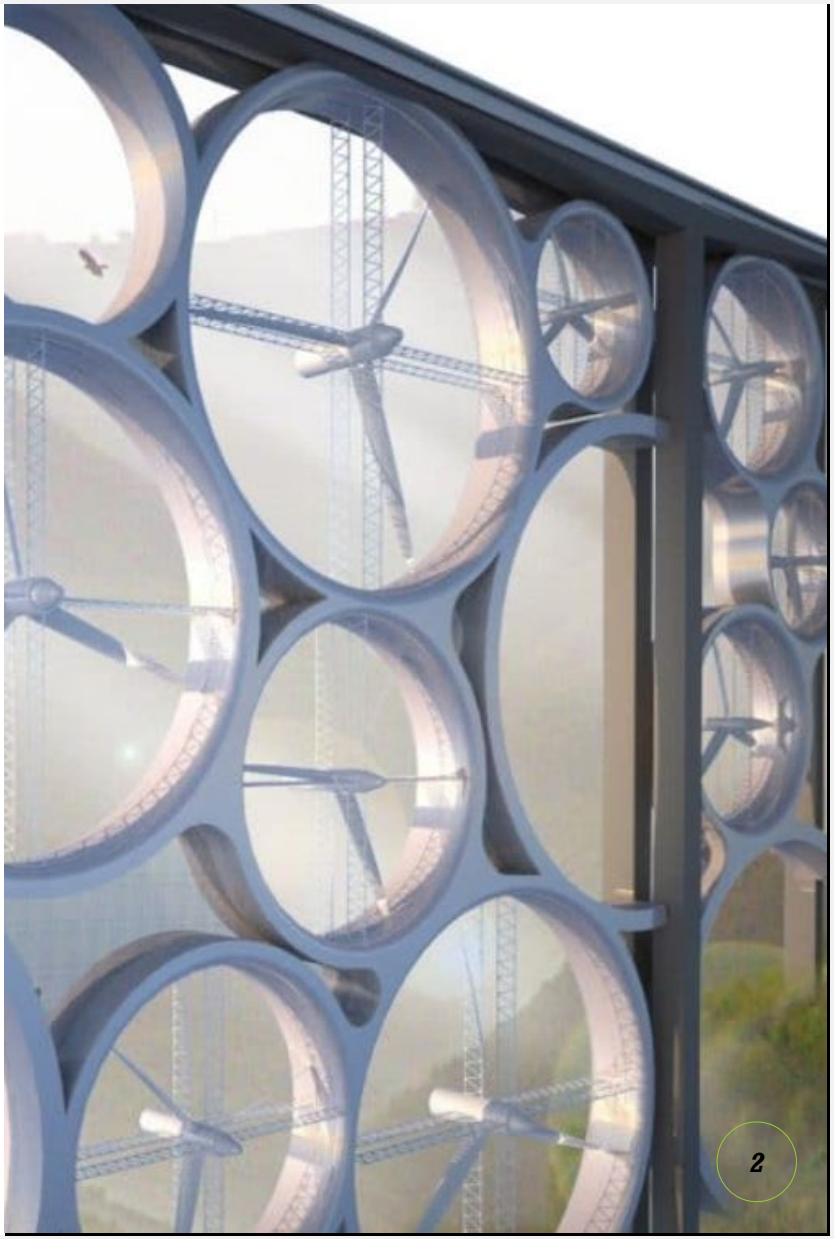
Increase usability from existing structures by creating energy which can benefit the local inhabitants

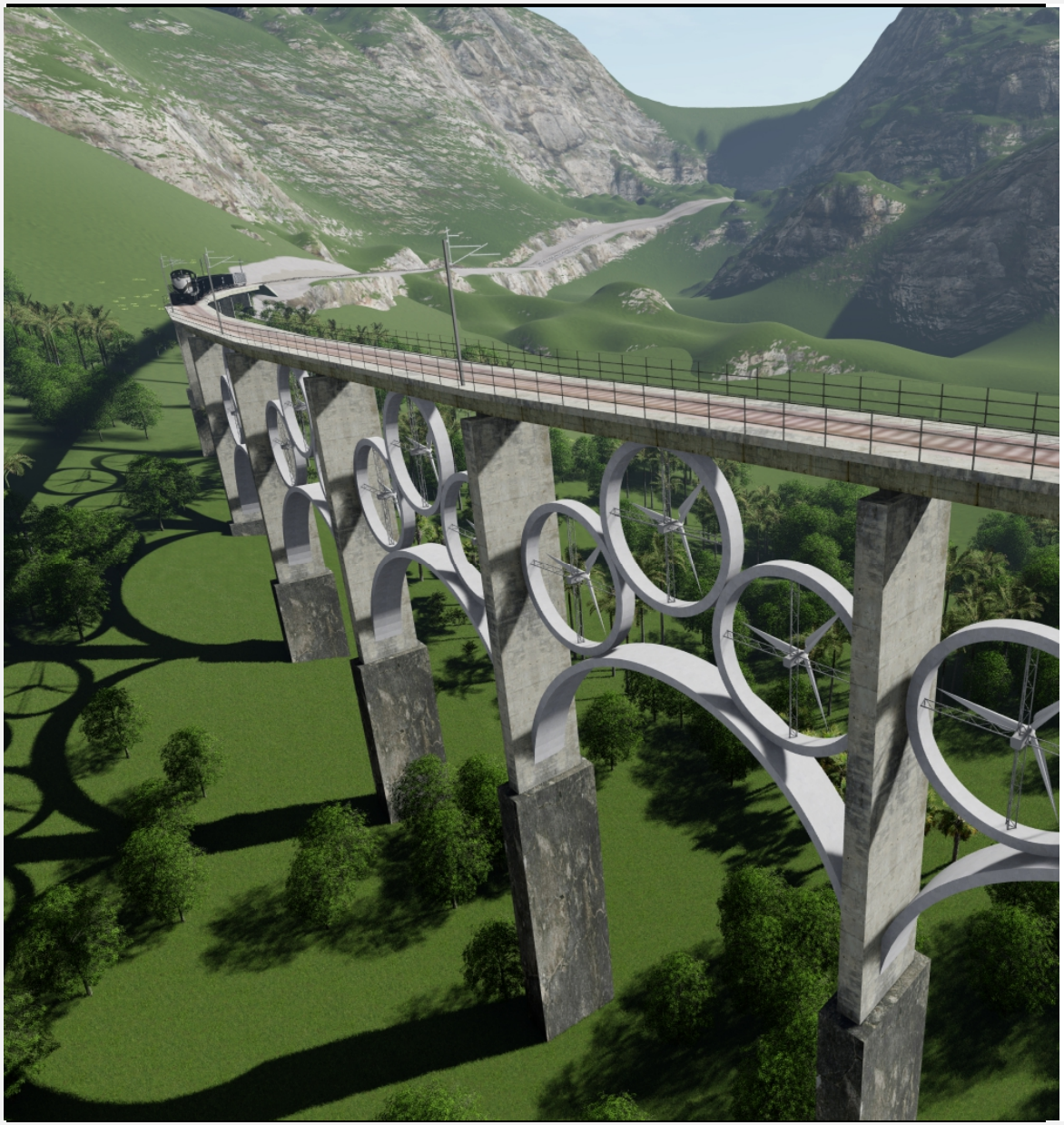
Sustainable Energy Source

Taking advantage of the typical wind in valleys and transform it into a sustainable energy source

Solar Wind Bridge

Architectural design competition in Italy to reuse an existing bridge





2 - Introduction

SL-Technology

Design and plan the construction of a structure, using super-light concrete, that can be reproduced in several locations

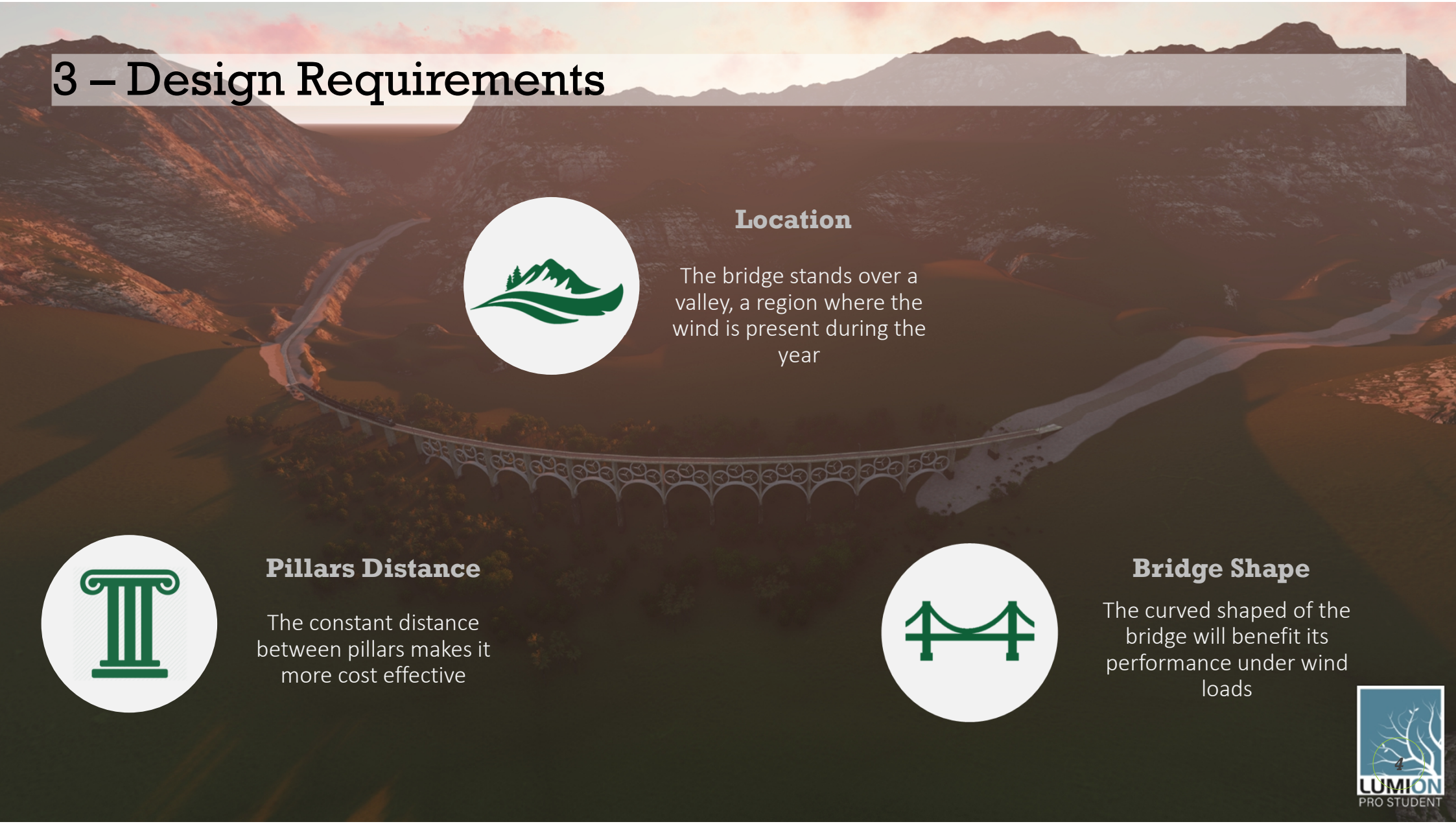
Design Requirements

A bridge is chosen which can fit and sustain small wind turbines

Energy Production

The wind-turbine bridge is able to generate green electricity for the communities around and therefore, provides a sustainable outcome.

3 – Design Requirements



Location

The bridge stands over a valley, a region where the wind is present during the year

Pillars Distance

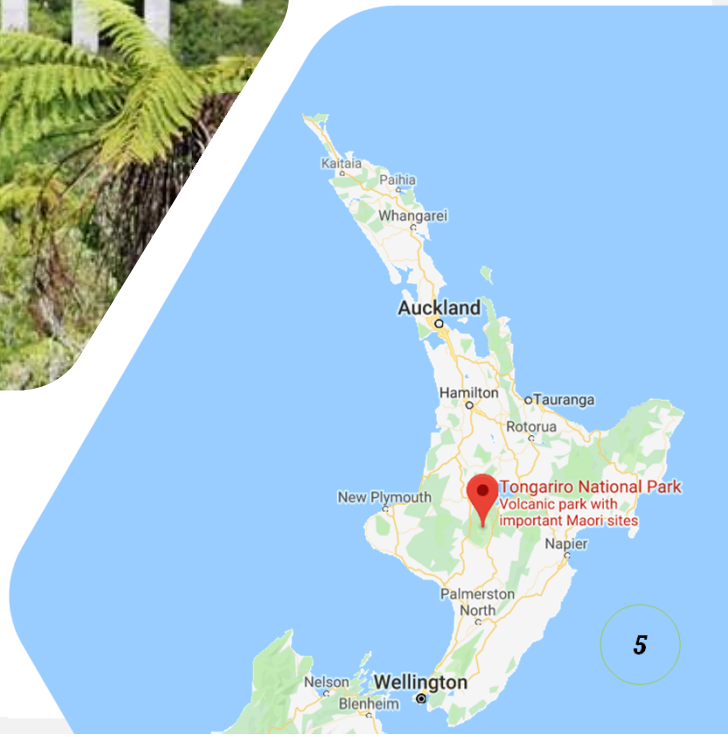
The constant distance between pillars makes it more cost effective

Bridge Shape

The curved shaped of the bridge will benefit its performance under wind loads

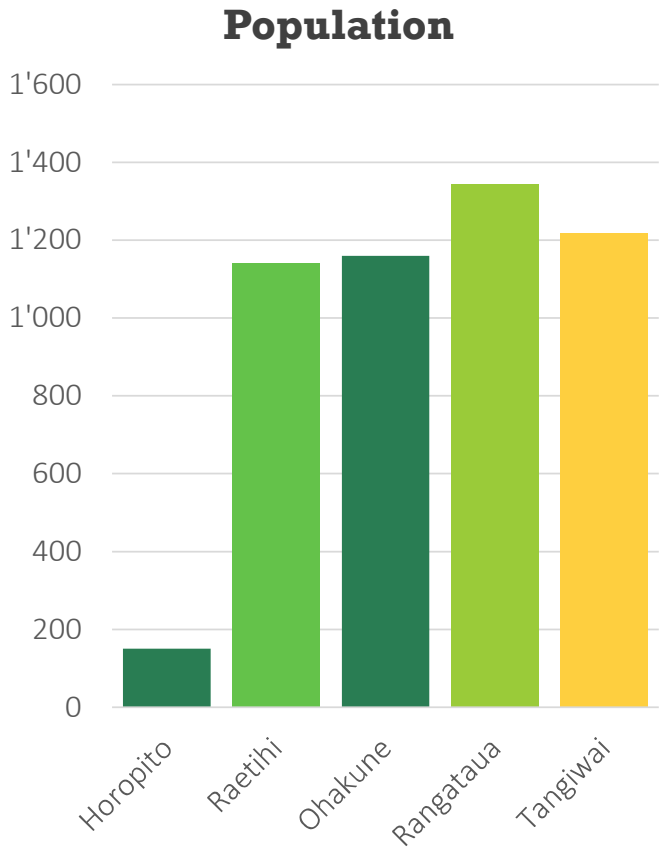
4 - Hapuawhenua Viaduct

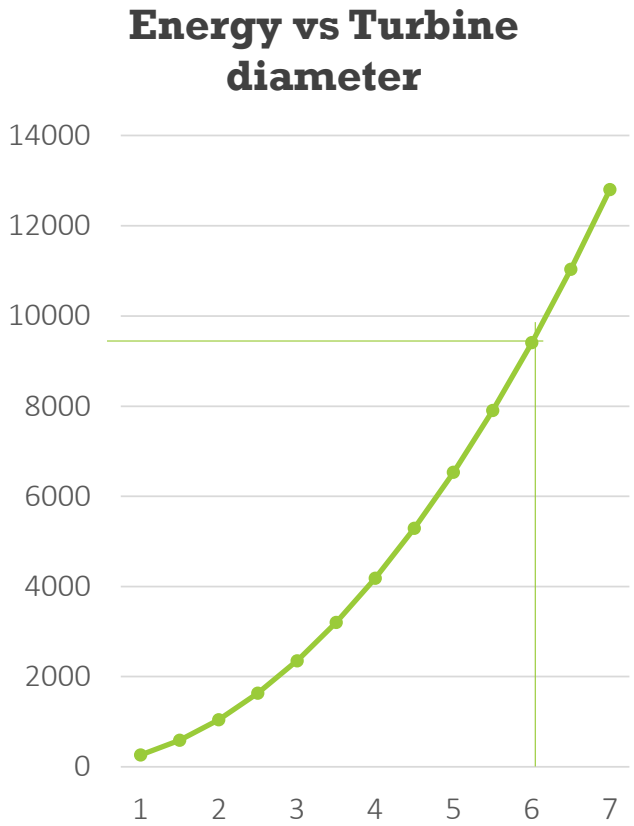
- Tongaroriro National Park (New Zealand).
- 3 existing renewable energy plants in the park.
- Yearly average wind speed is 5m/s .
- Due to the geometry and wind speed, 3 turbines are chosen of 6m diameter each.



4 – Energy Production

The aim of the Windturbine Bridge is to provide energy to benefit the communities next to Tongariro National Park





496800 kWh/year

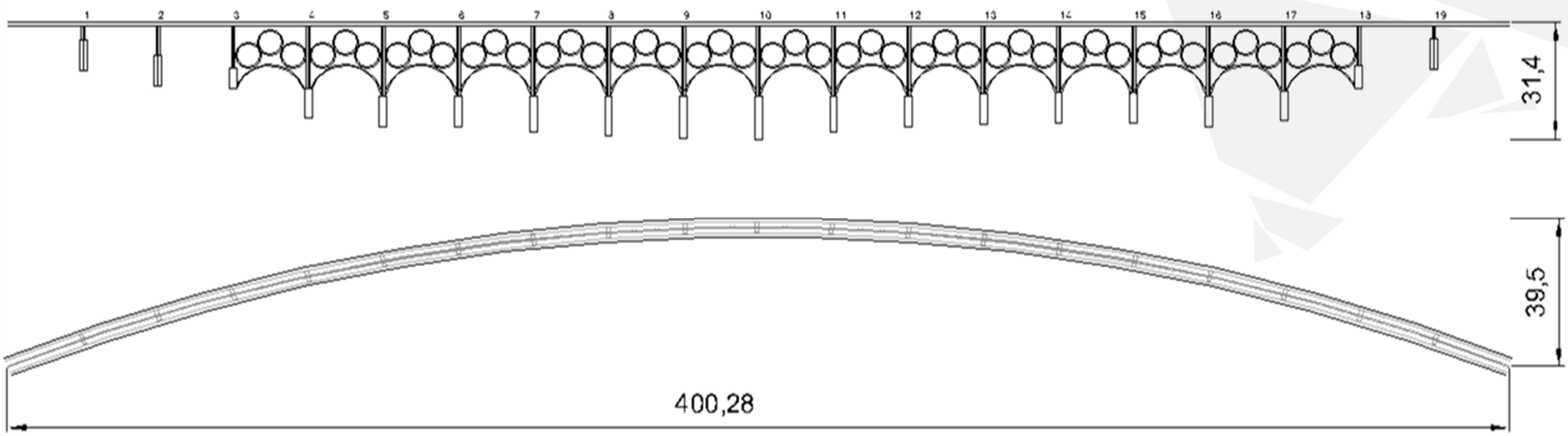
=

150 households

4% of the population arround Tongariro National Park

5 – System/ Units/ Elements

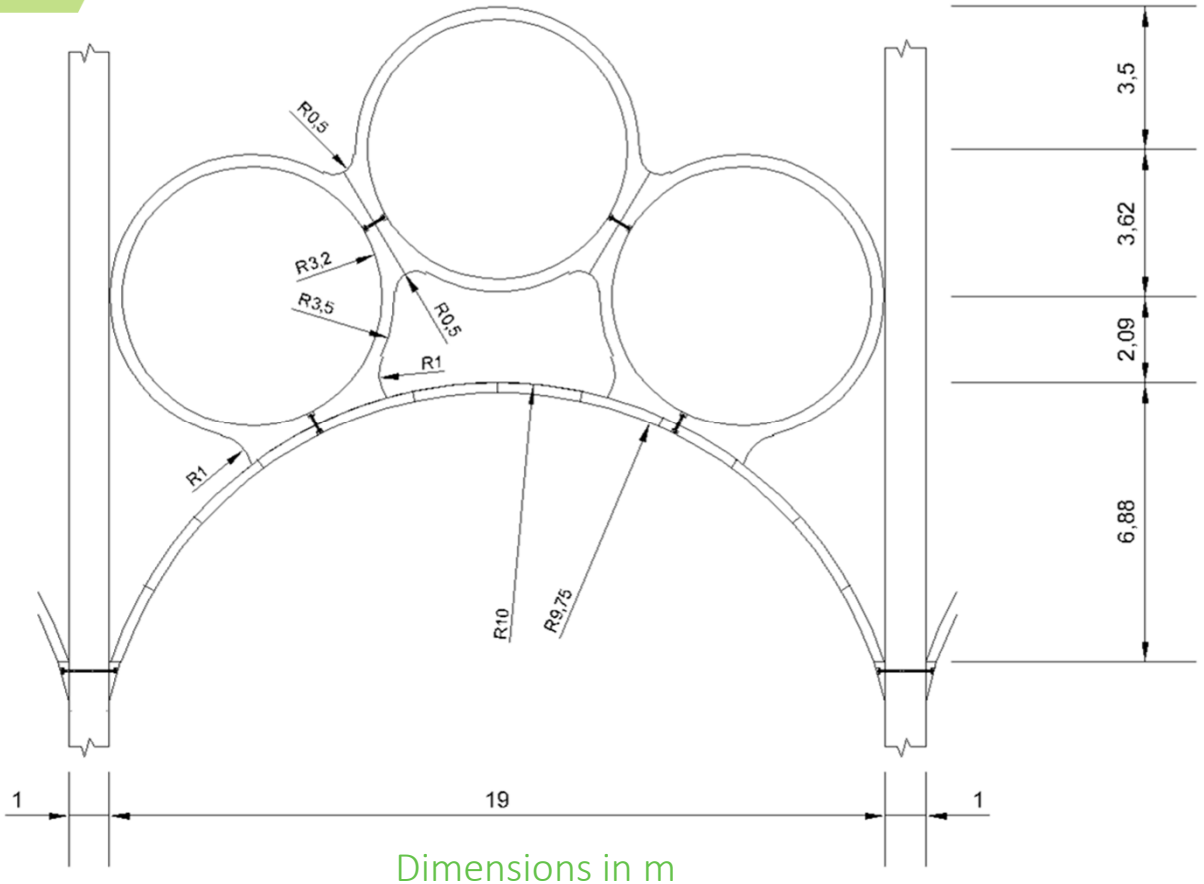
1 *Entire Bridge*



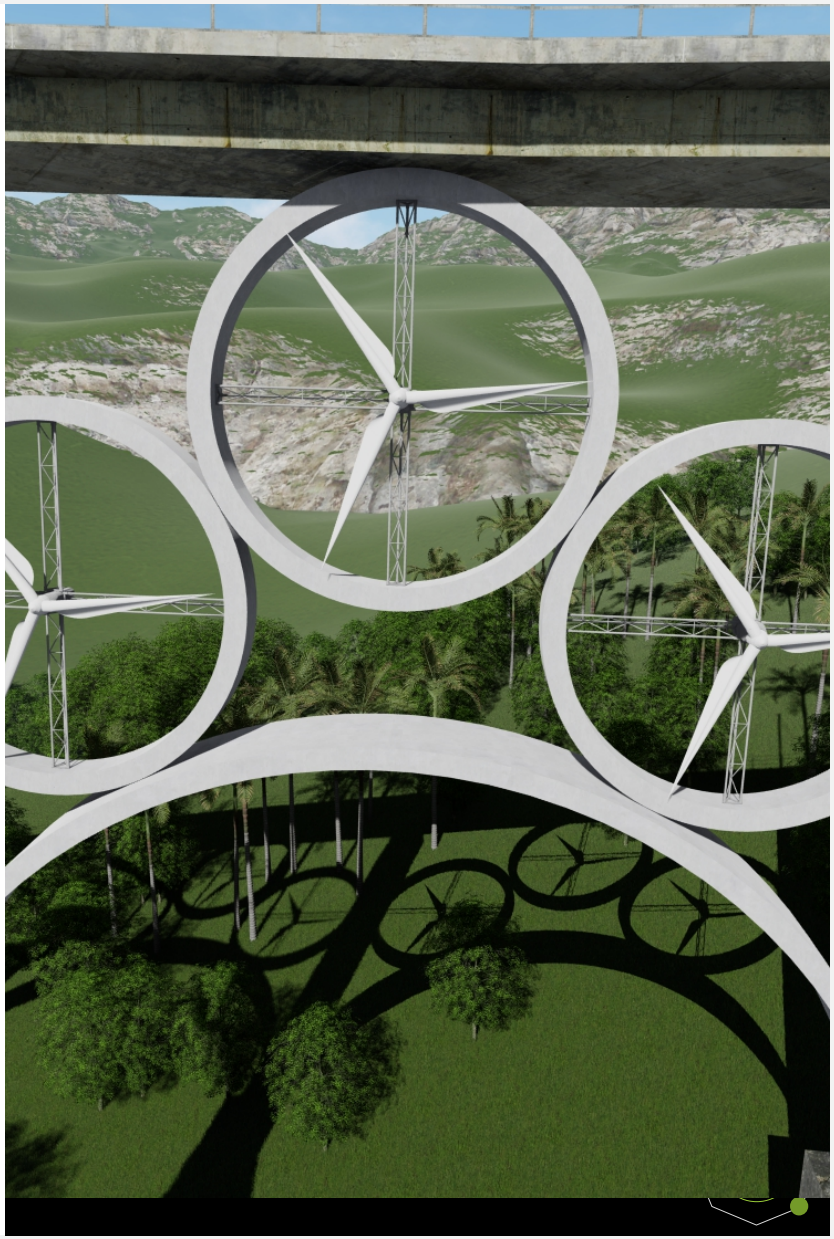
Dimensions in m

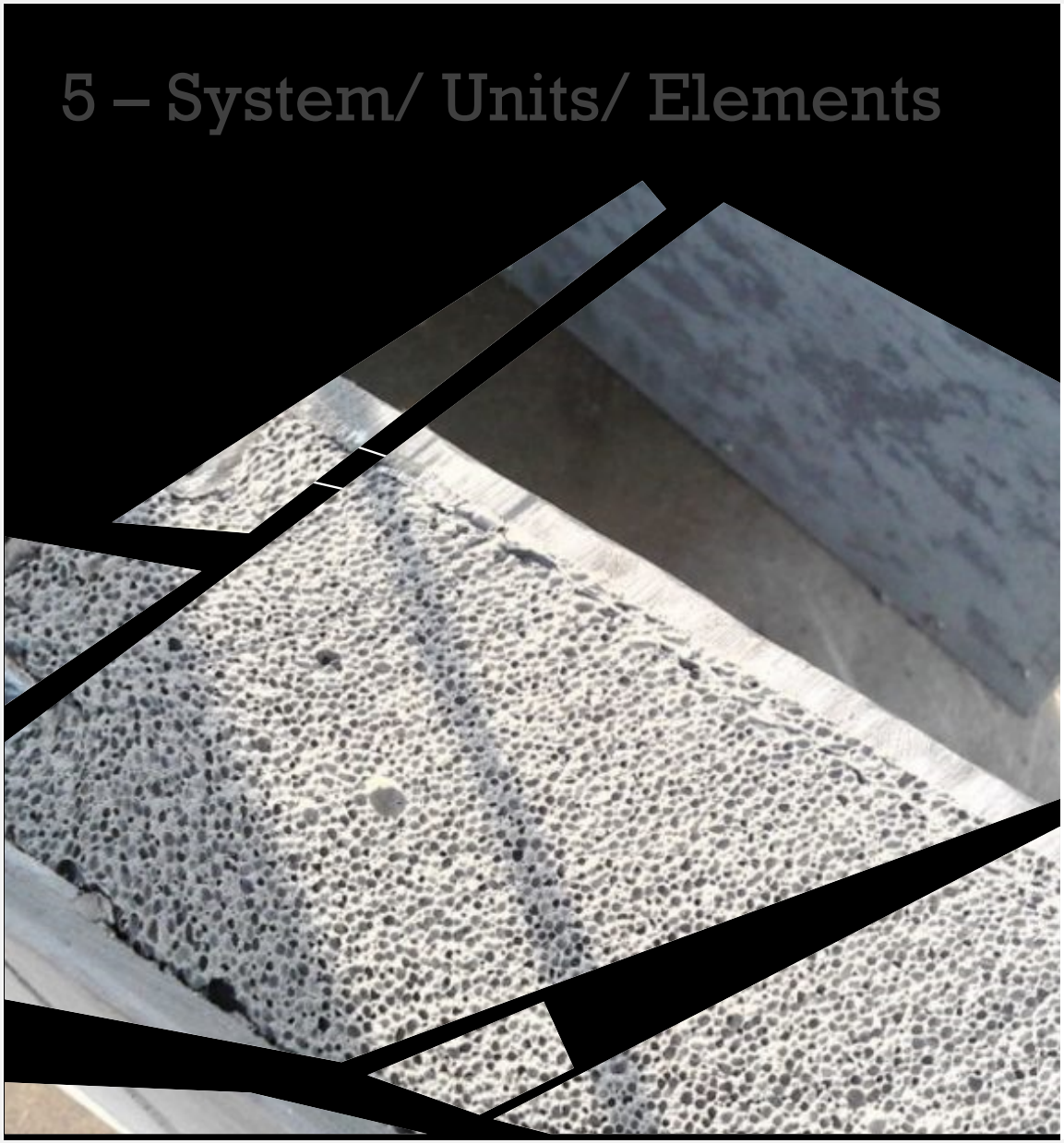
5 – System/ Units/ Elements

2 *Module unit*



Dimensions in m





3 *Materials*

Concrete

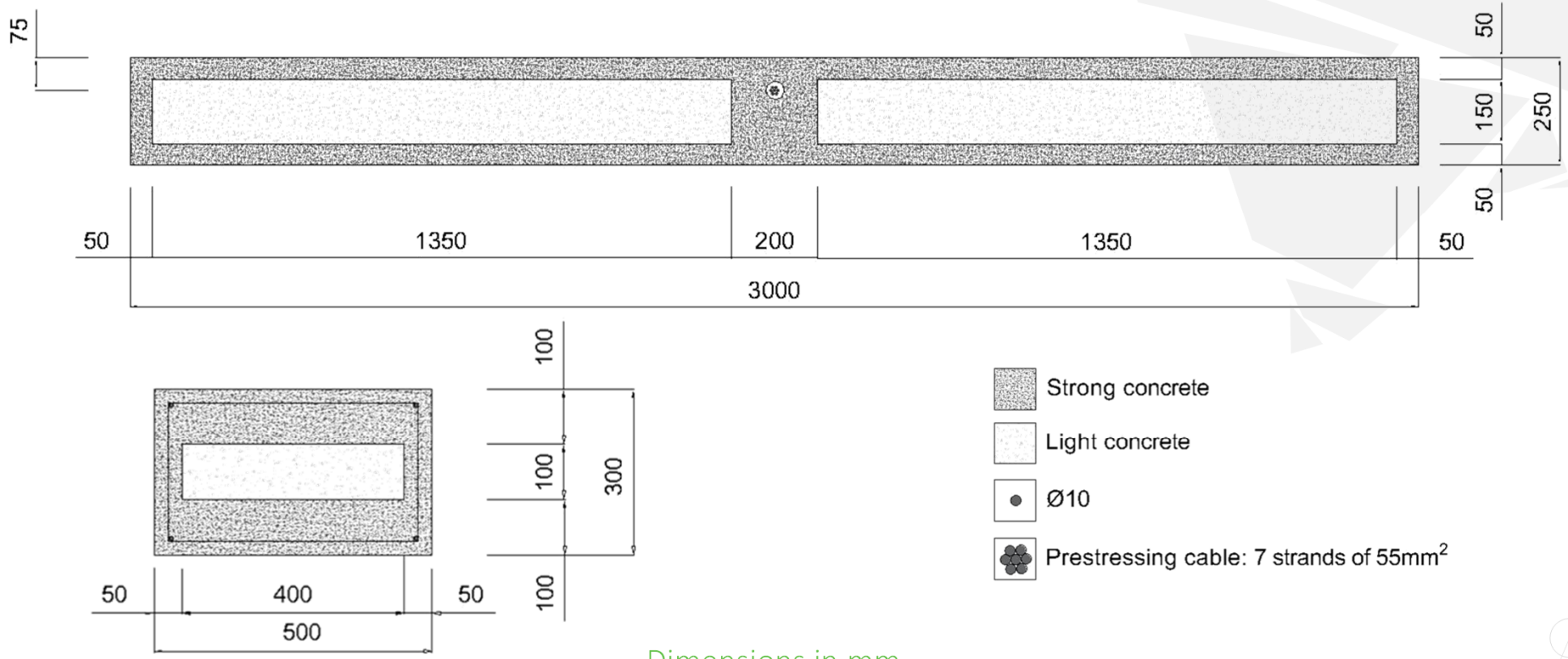
Strong concrete	fc	55 MPa
	ft	4.21 MPa
	E	38.2 GPa
	ρ	2400 kg/m^3
Light concrete	fc	3 MPa
	ft	0.3 MPa
	E	2.1 GPa
	ρ	1700 kg/m^3

Steel

Reinforcement (ø10 bars)	fyk	500 MPa
Pre-stress (7 strands of 55mm^2)	fp0.1k	1582 Mpa
	E	195 Gpa

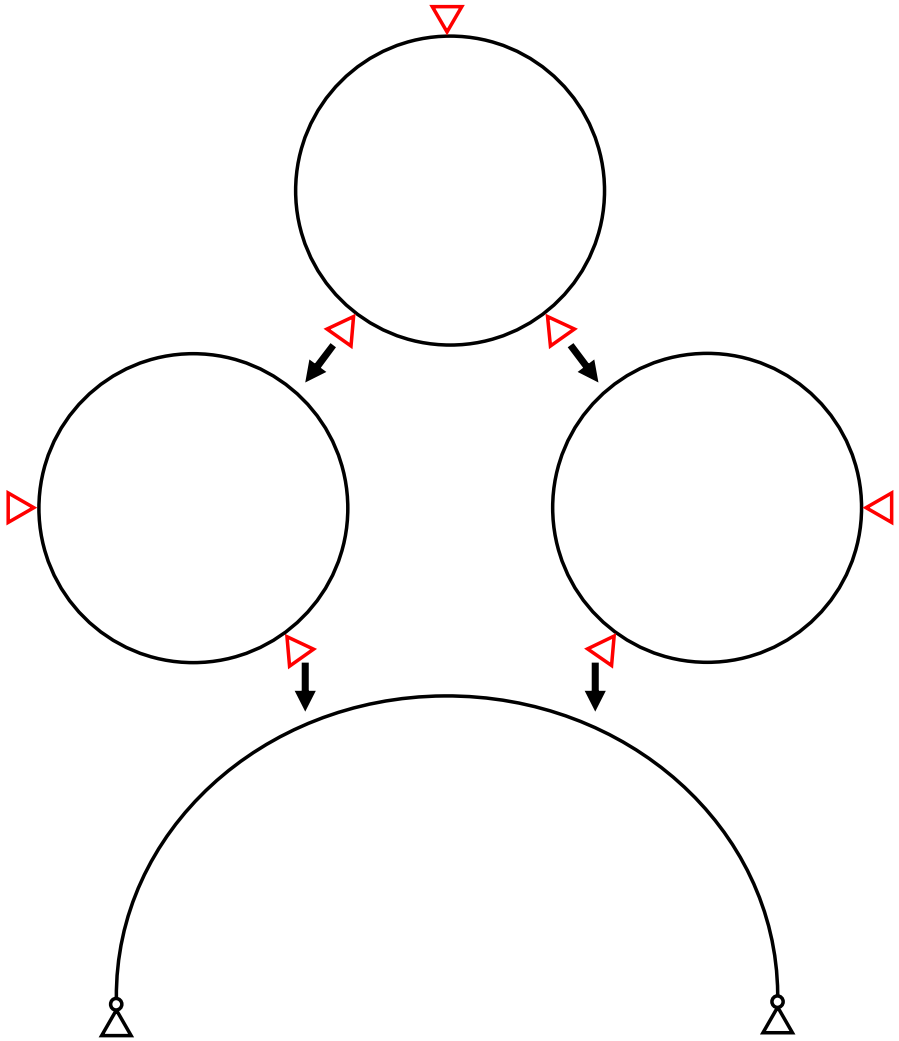
5 – System/ Units/ Elements

4 *Cross-sections*

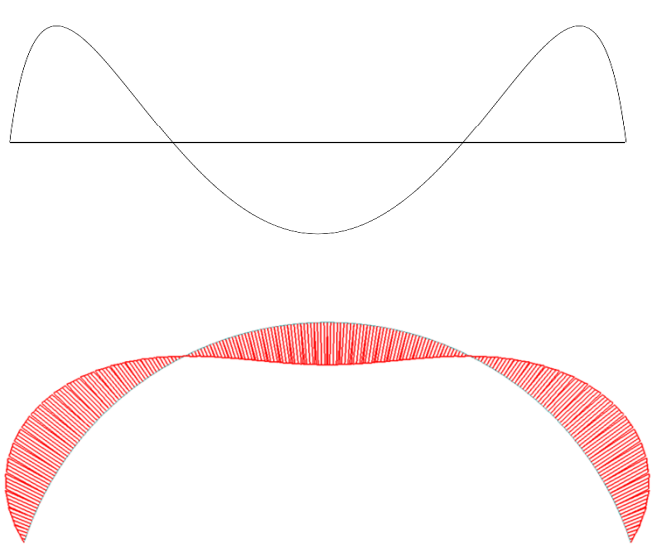


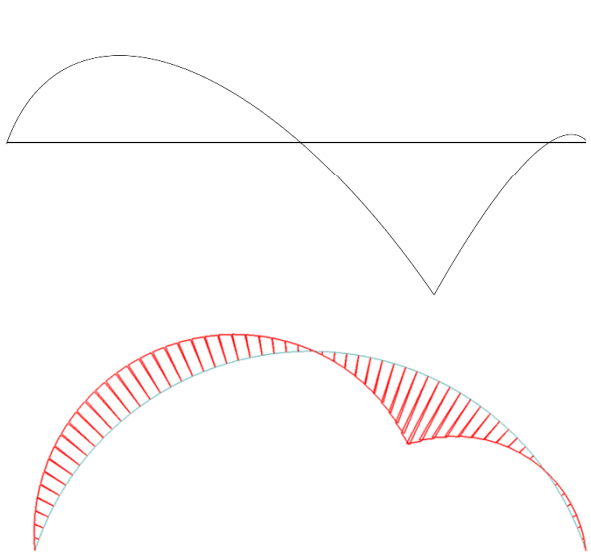
Dimensions in mm

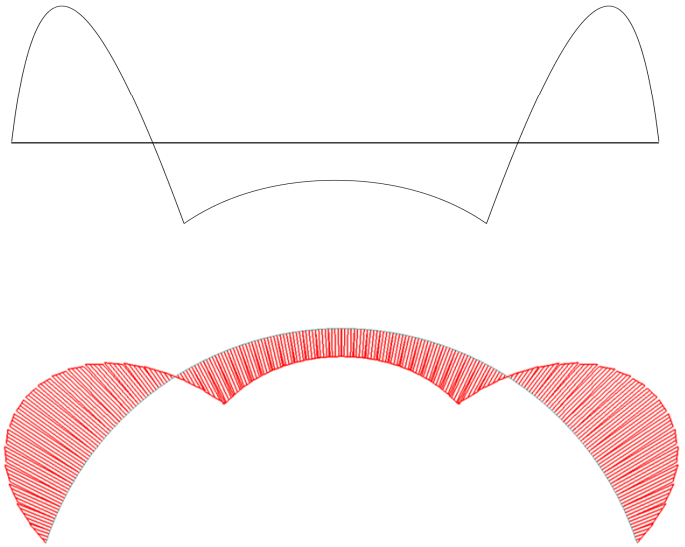
6 – Static System



6 – Structural Calculations (Arch)

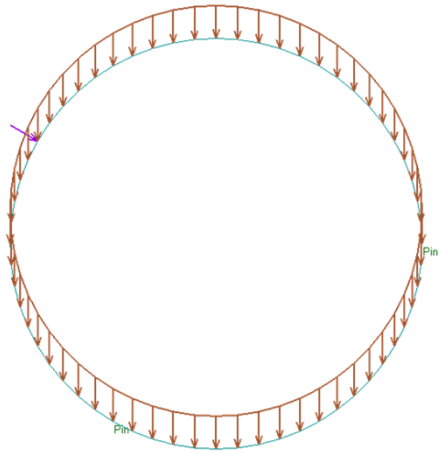


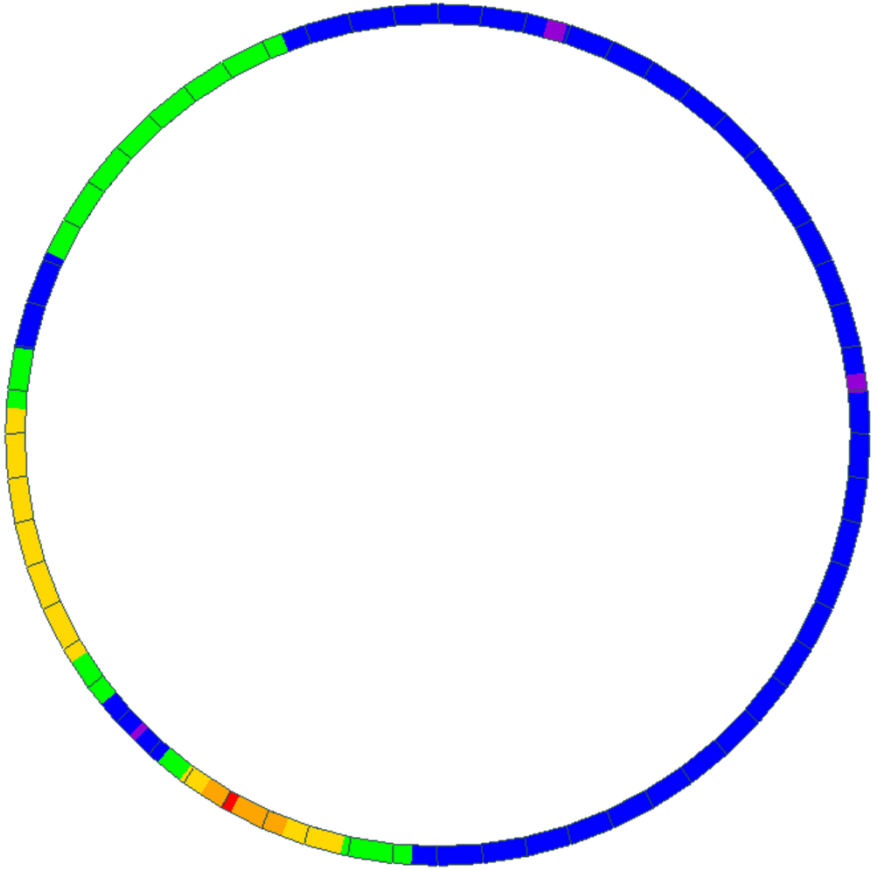




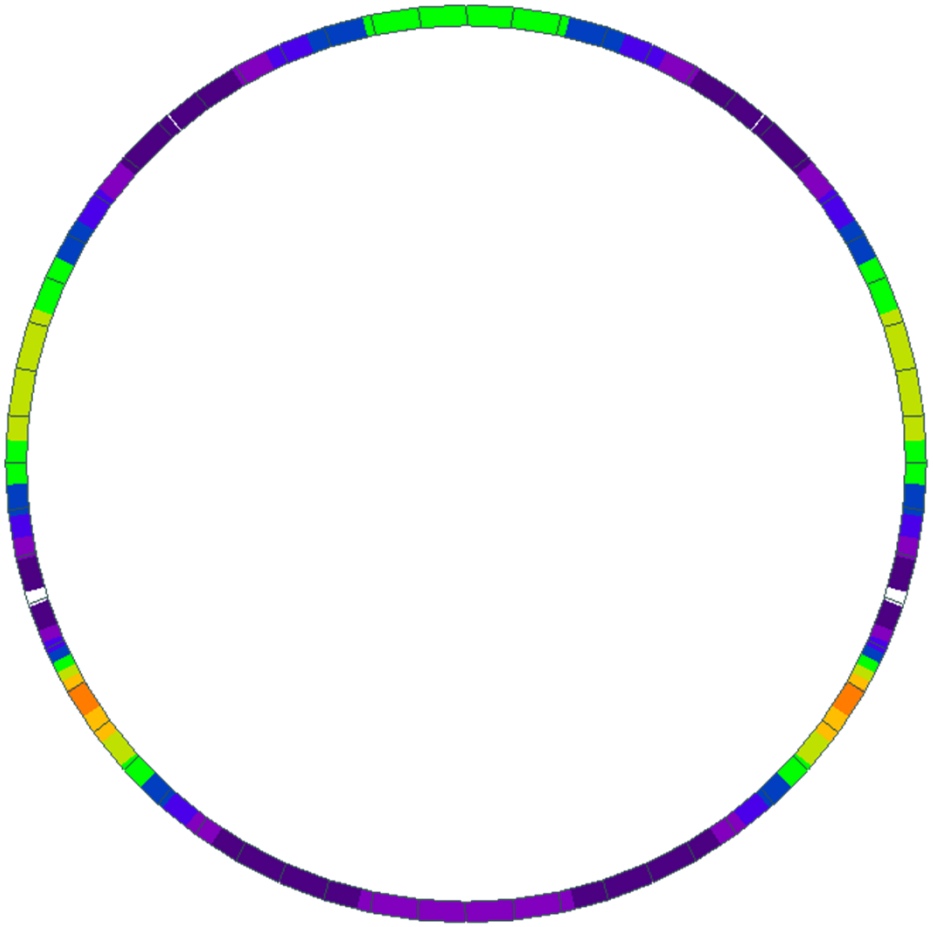
	Self-weight	Point load	Total
$M_{max+\ Analytical}$	55.42 kNm	93.96 kNm	123.78 kNm
$M_{max+\ FEM}$	65.41 kNm	93.59 kNm	134.2 kNm
$M_{max-\ Analytical}$	-43.23 kNm	-161.41 kNm	-74.25 kNm
$M_{max-\ FEM}$	-50.81 kNm	-160.9 kNm	-74.32 kNm

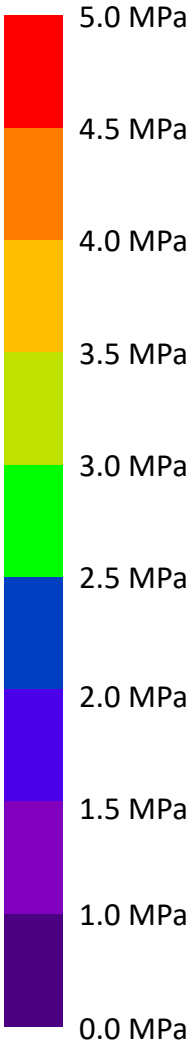
6 – Structural Calculations (Bottom rings)



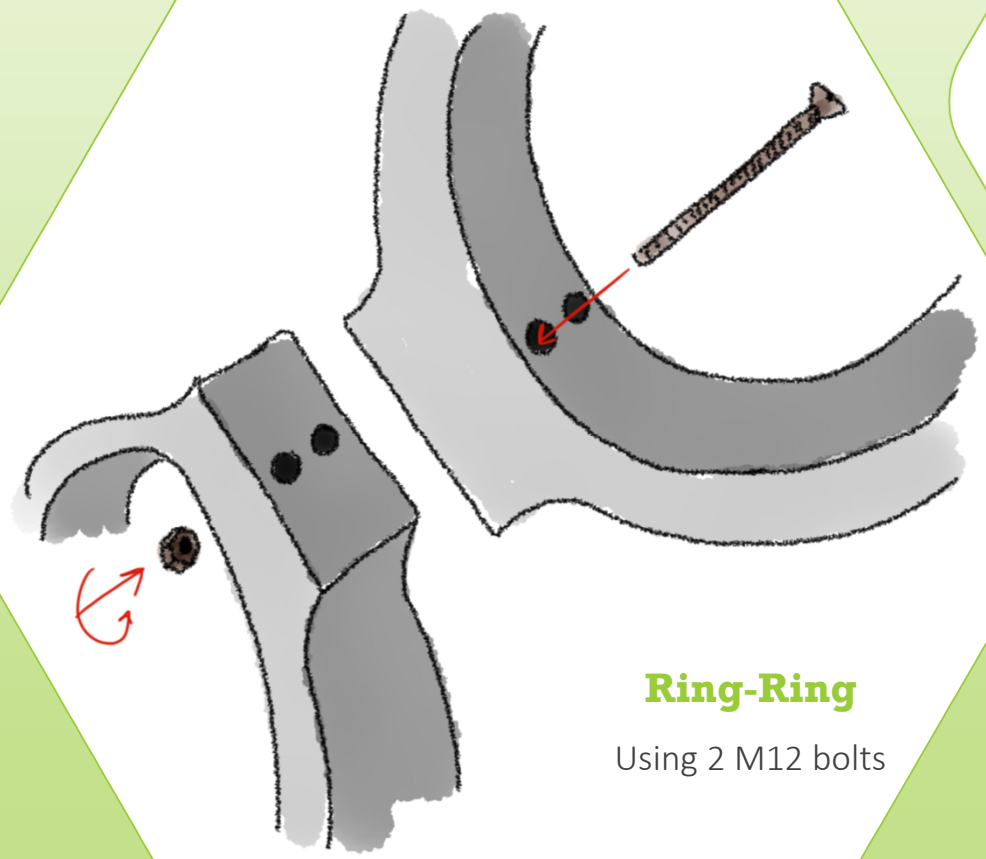


6 – Structural Calculations (Top ring)



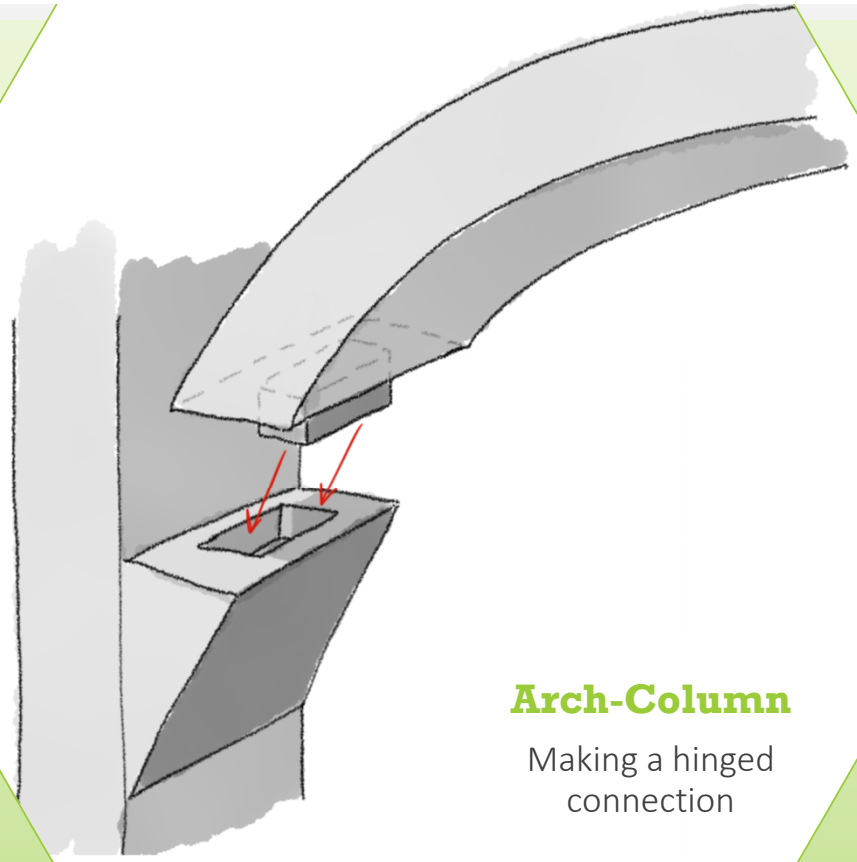


6 – Structural Connections



Ring-Ring

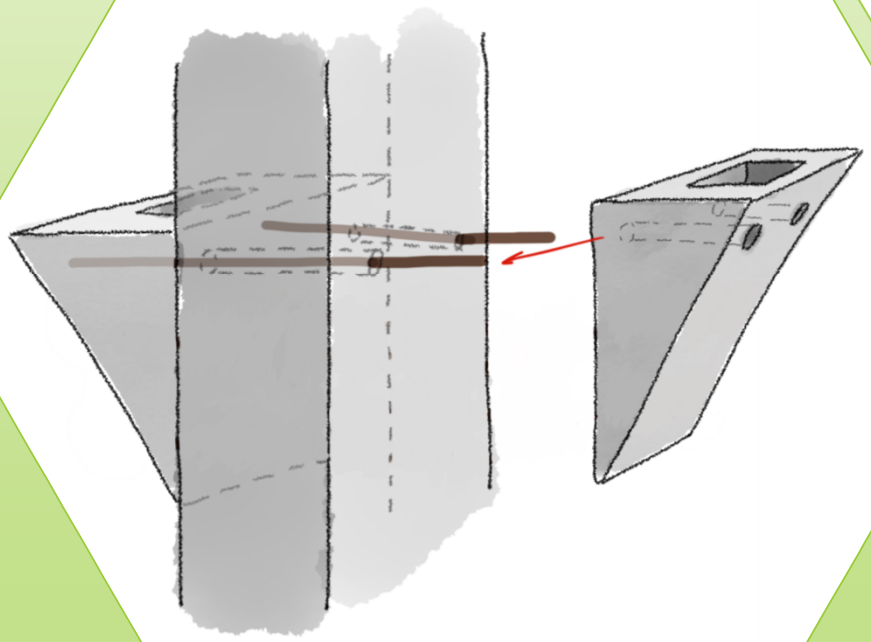
Using 2 M12 bolts

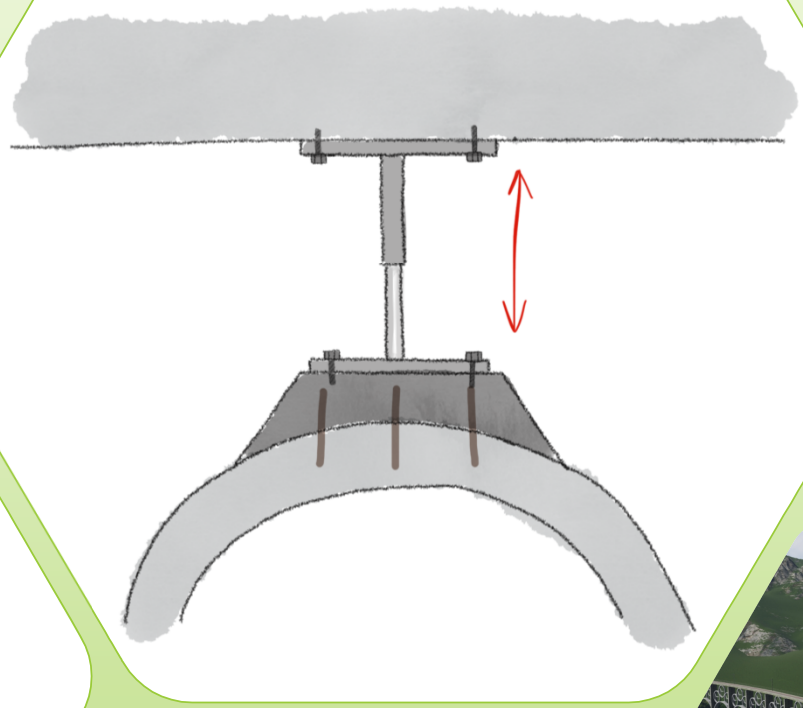


Arch-Column

Making a hinged connection

6 – Structural Connections





Ring-Deck

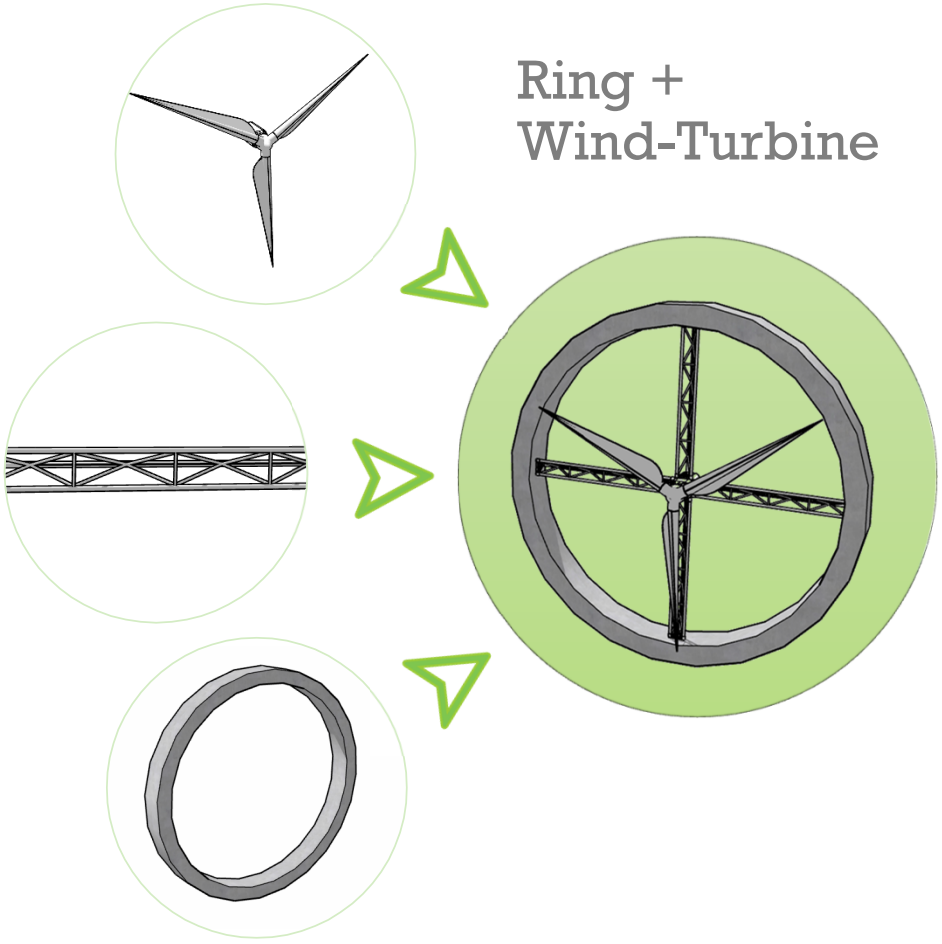
Transferring horizontal shear and allowing vertical deformations

Blister-Column

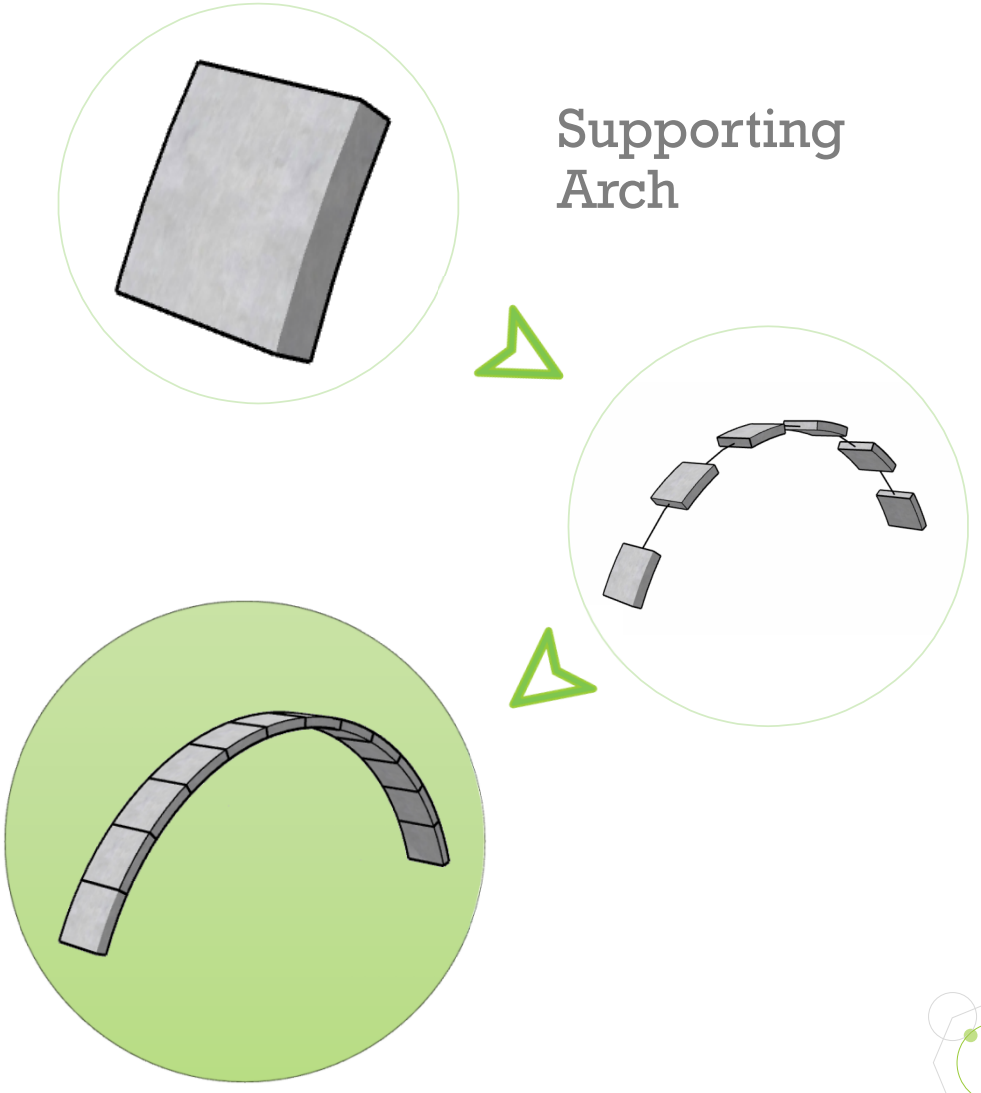
With 2 ø12 rebars

7 – Component Assembly

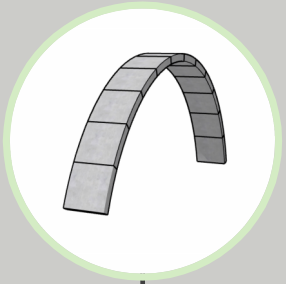
Ring +
Wind-Turbine



Supporting
Arch

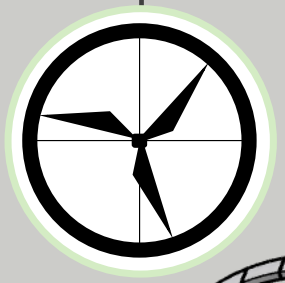


8 – Construction Process



Prefabrication 1

Prefabrication of the arches with pear chain technology

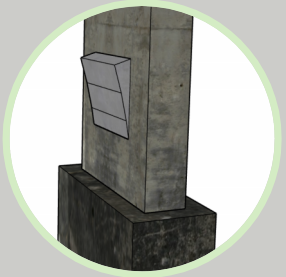


Prefabrication 2

Prefabrication of the rings incl. integrated wind turbines

Transportation

The prefabricated components can be transported from the factory to site on a train

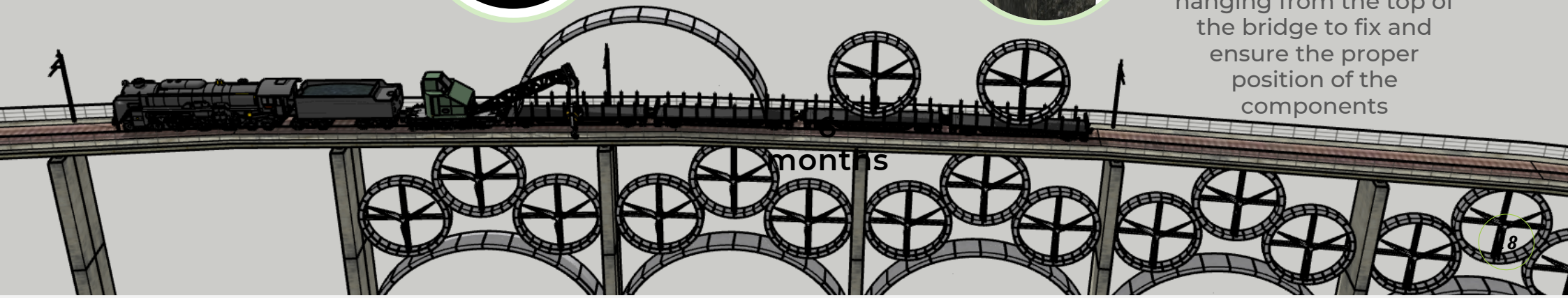


Bridge Preparation

Preparations on the bridge column

Assembly Process

In order to mount the structure under the bridge, a crane will be used, with workers hanging from the top of the bridge to fix and ensure the proper position of the components



months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Thank You
LUMION
PRO STUDENT