Bachelor’s Degree in Architecture

Fundamentals of structural analysis/ *Fabrizio Barpi*

Group 11: Mert Akkaya s241219, Mert Babaoglu s252473, Ekin Sahin s241345, Batzorig Tserenbat s253366

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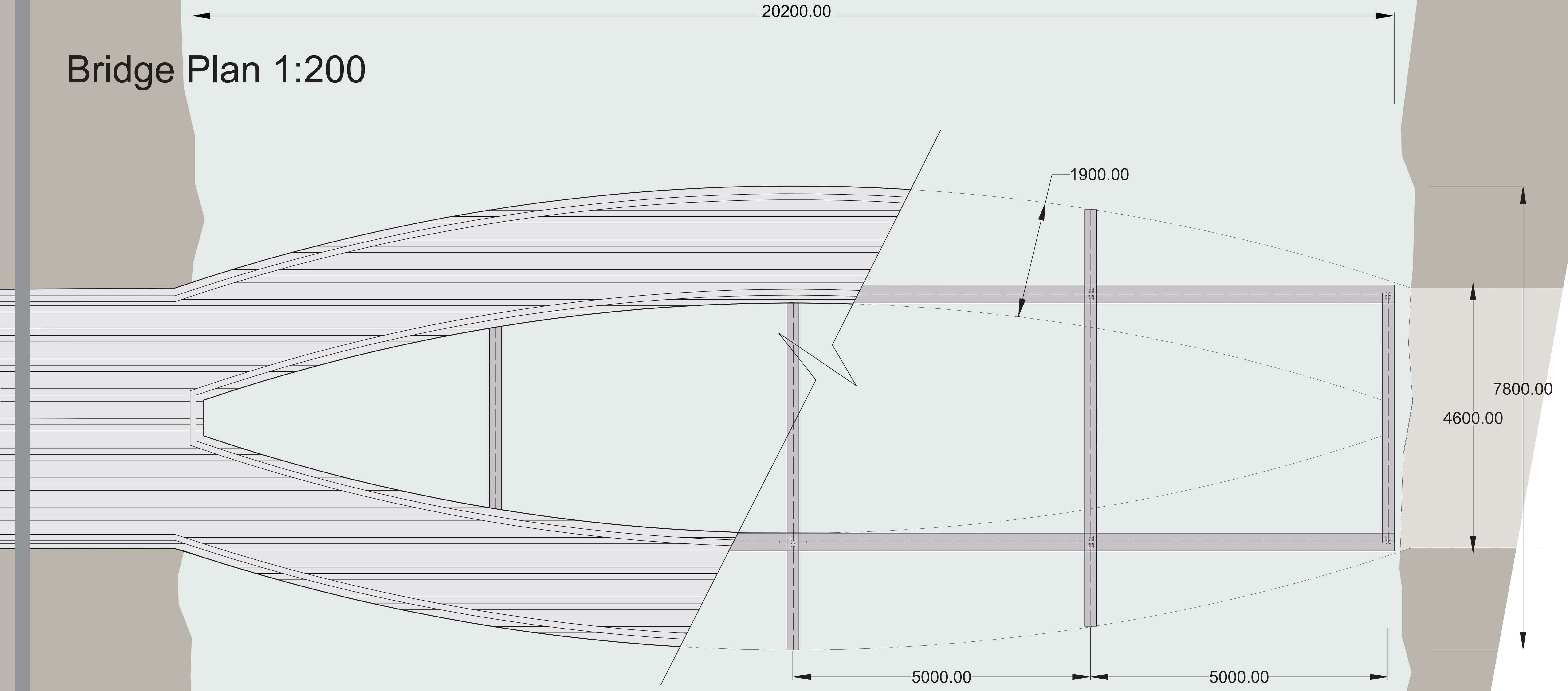
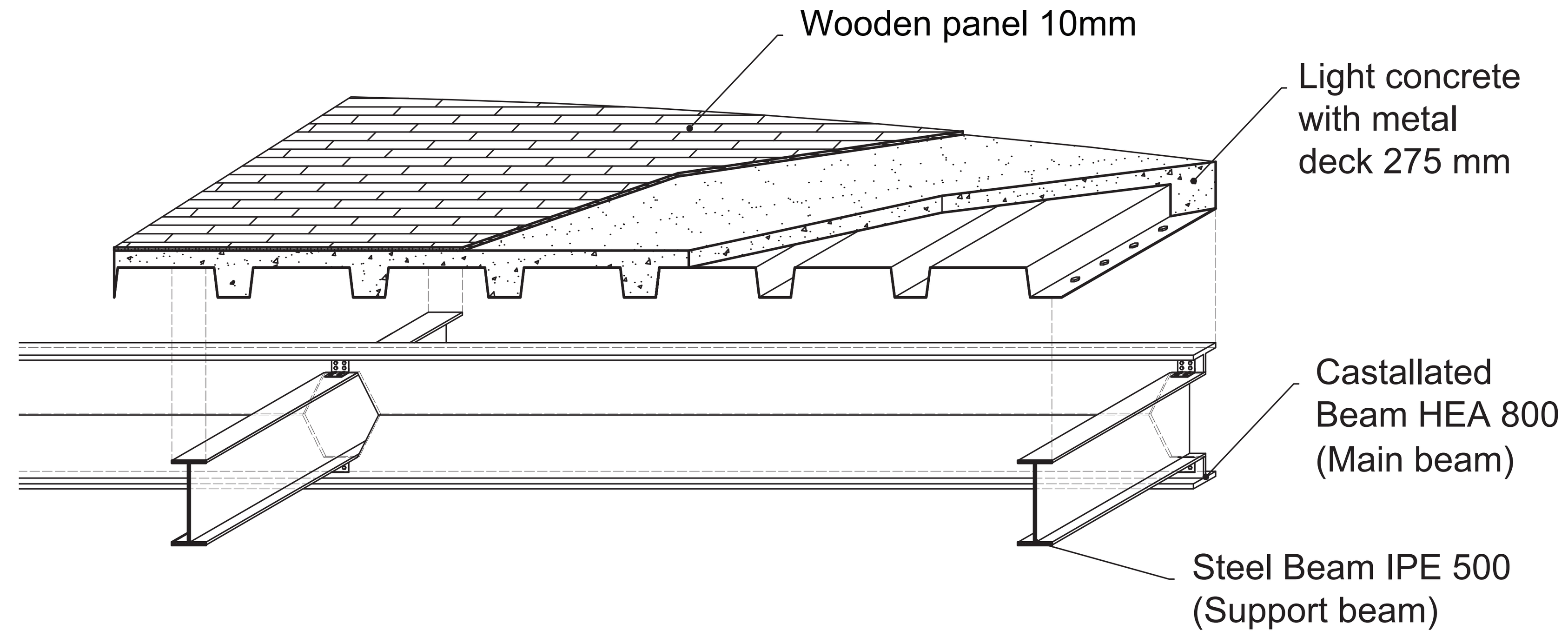
Bridge Plan 1:200



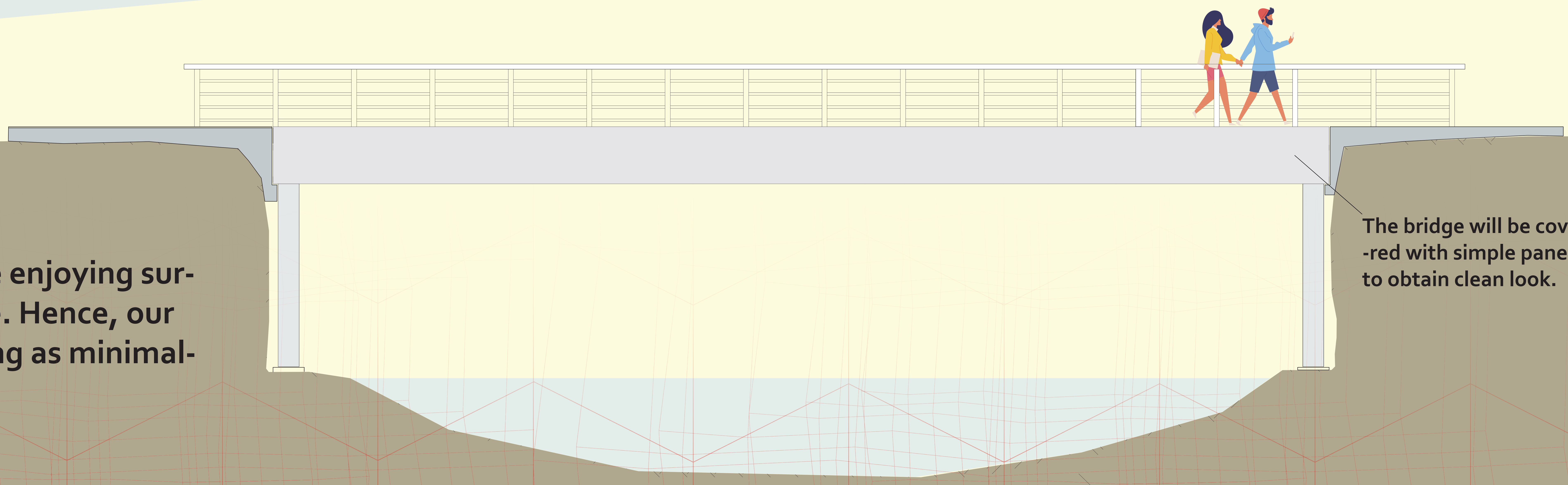
Only the metal decking will be shaped with curvature.



Castallated beam will allow supporting beams to pass the main beam, making it possible to shape the deck.

Light concrete with metal deck will be installed to beam structure. It will be layered with wooden panel as the top layer.

Elevation 1:200



The bridge will be cove- -red with simple panels to obtain clean look.

The main goal of the bridge will be enjoying sur-rounding without any interference. Hence, our design goal was to make everything as minimal-istic as possible.

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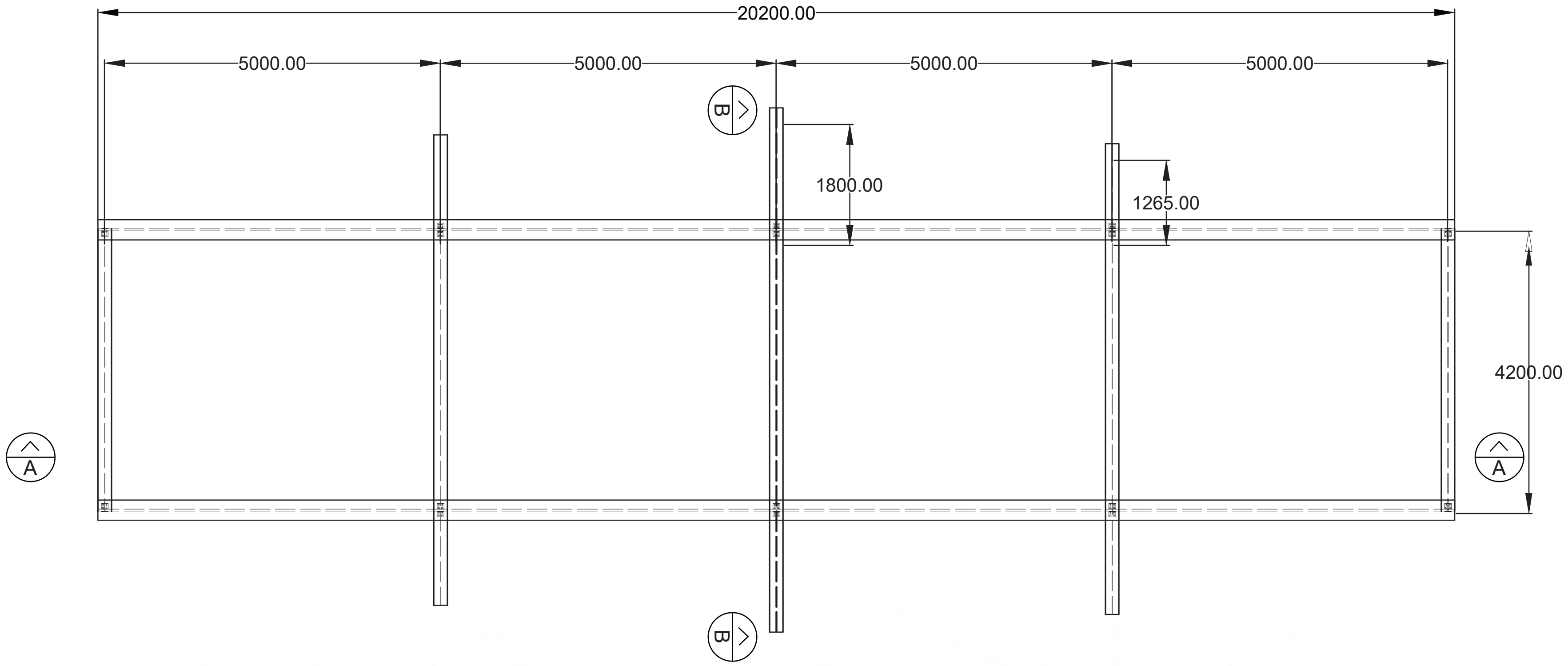
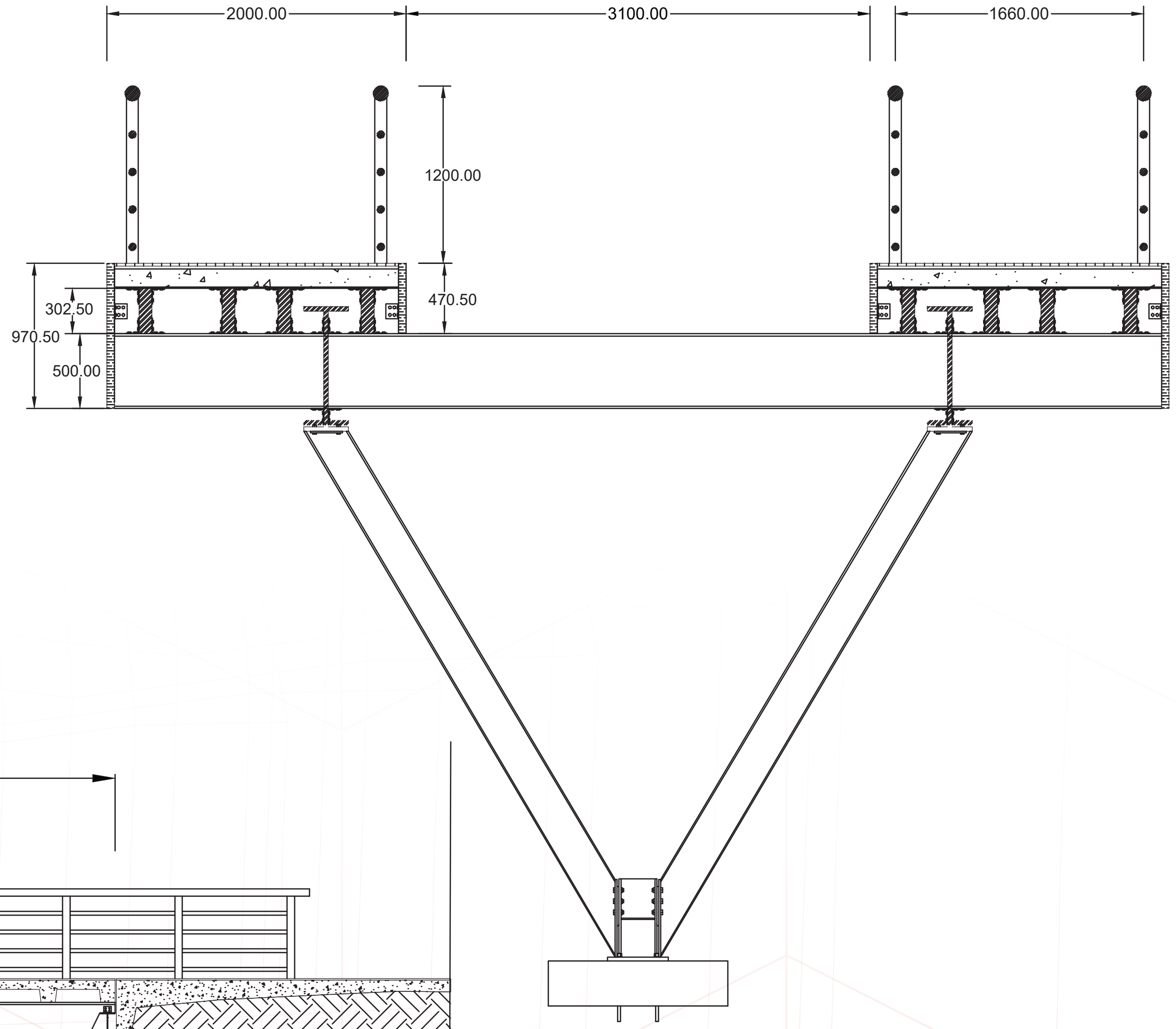
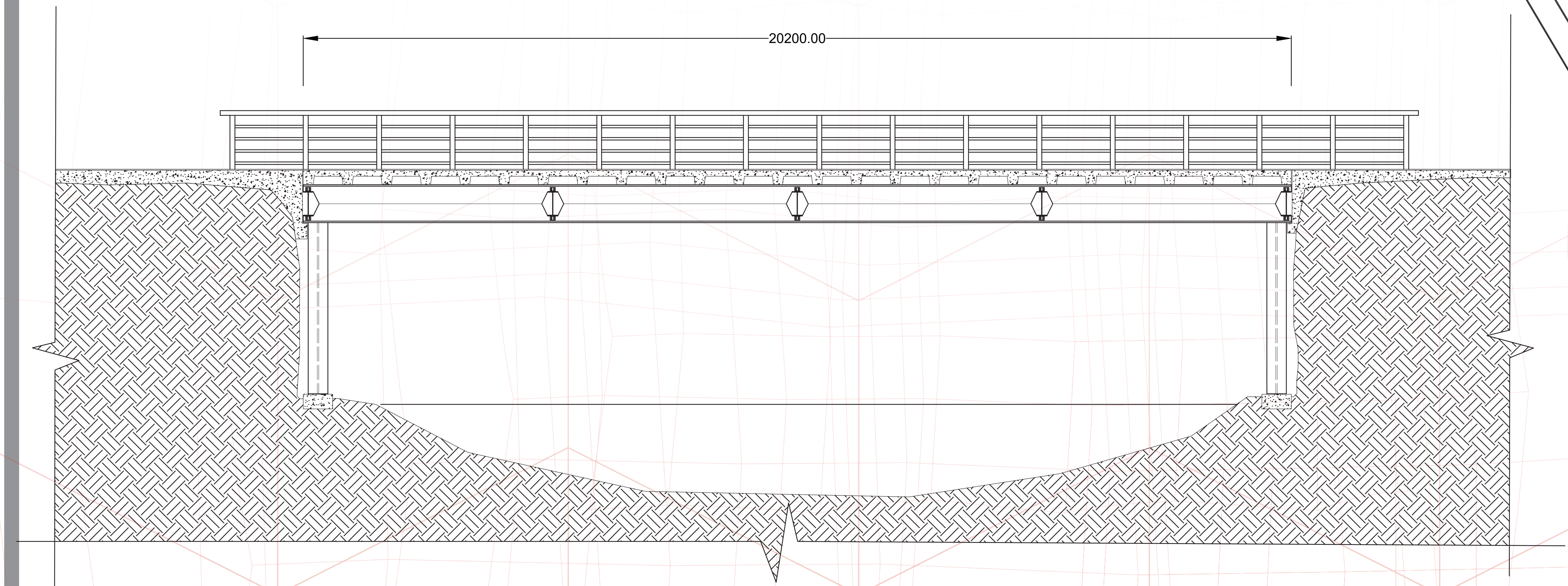
Structural plan of the beam 1:100



Section B-B 1:50



Section A-A 1:100



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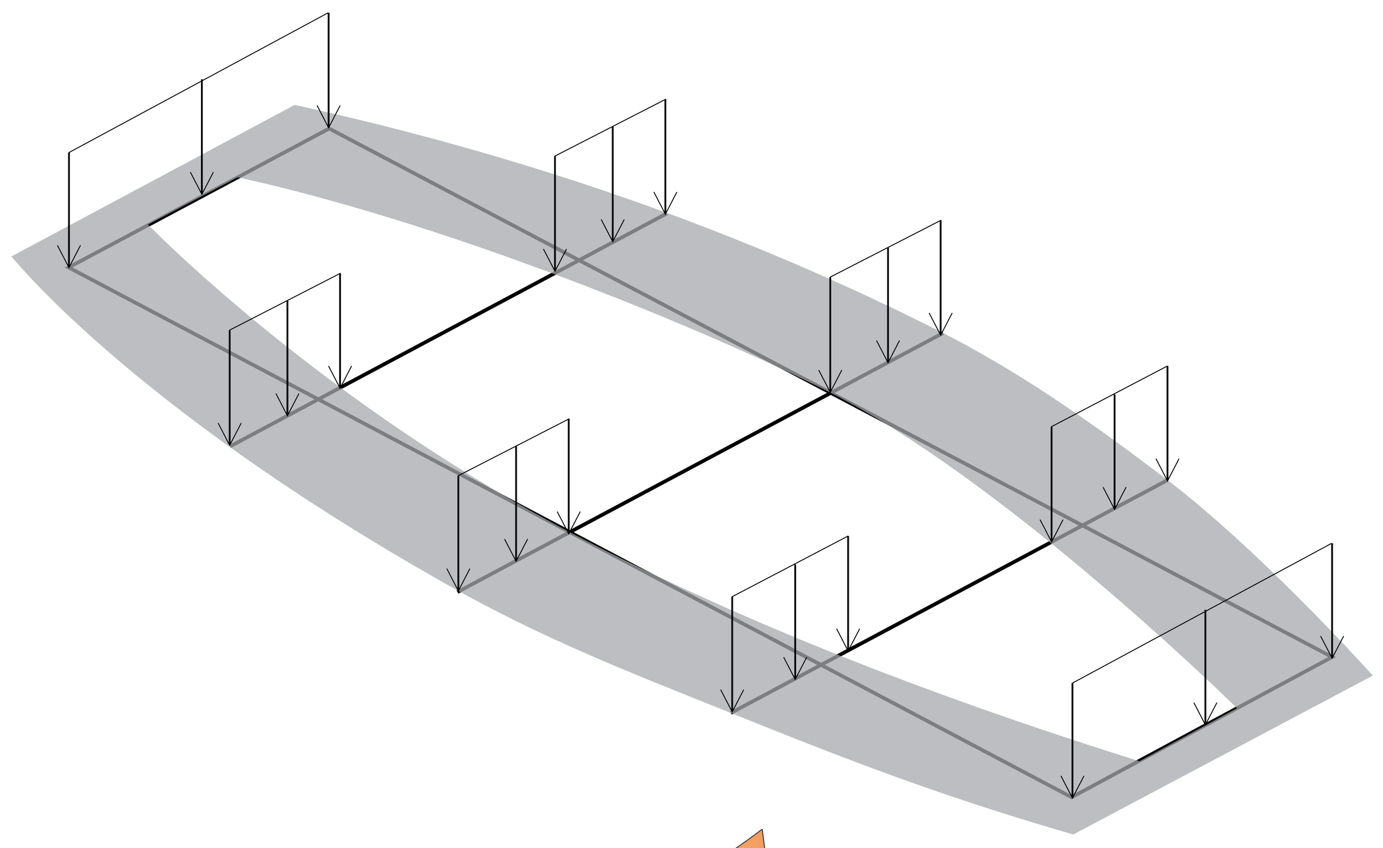
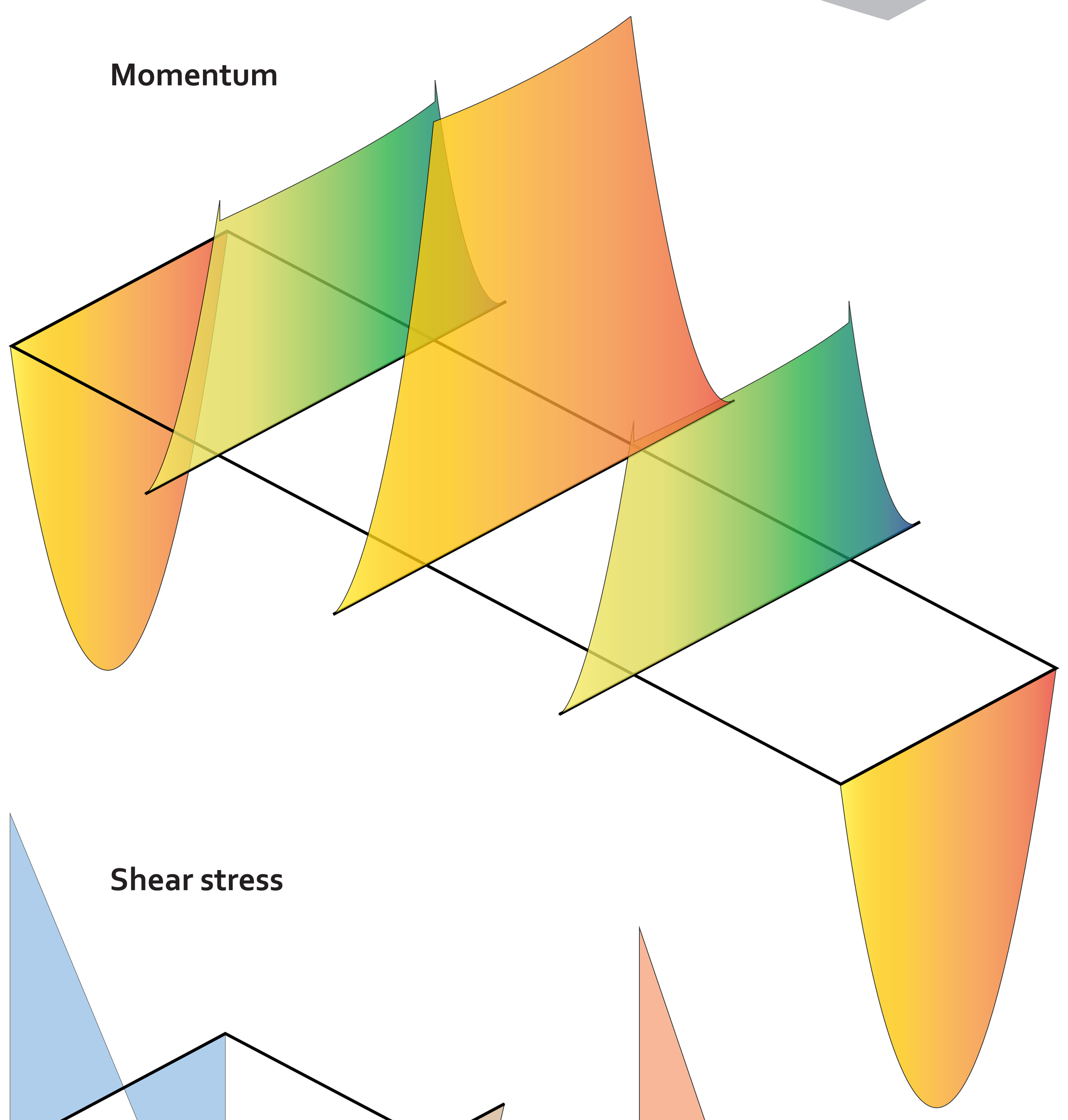
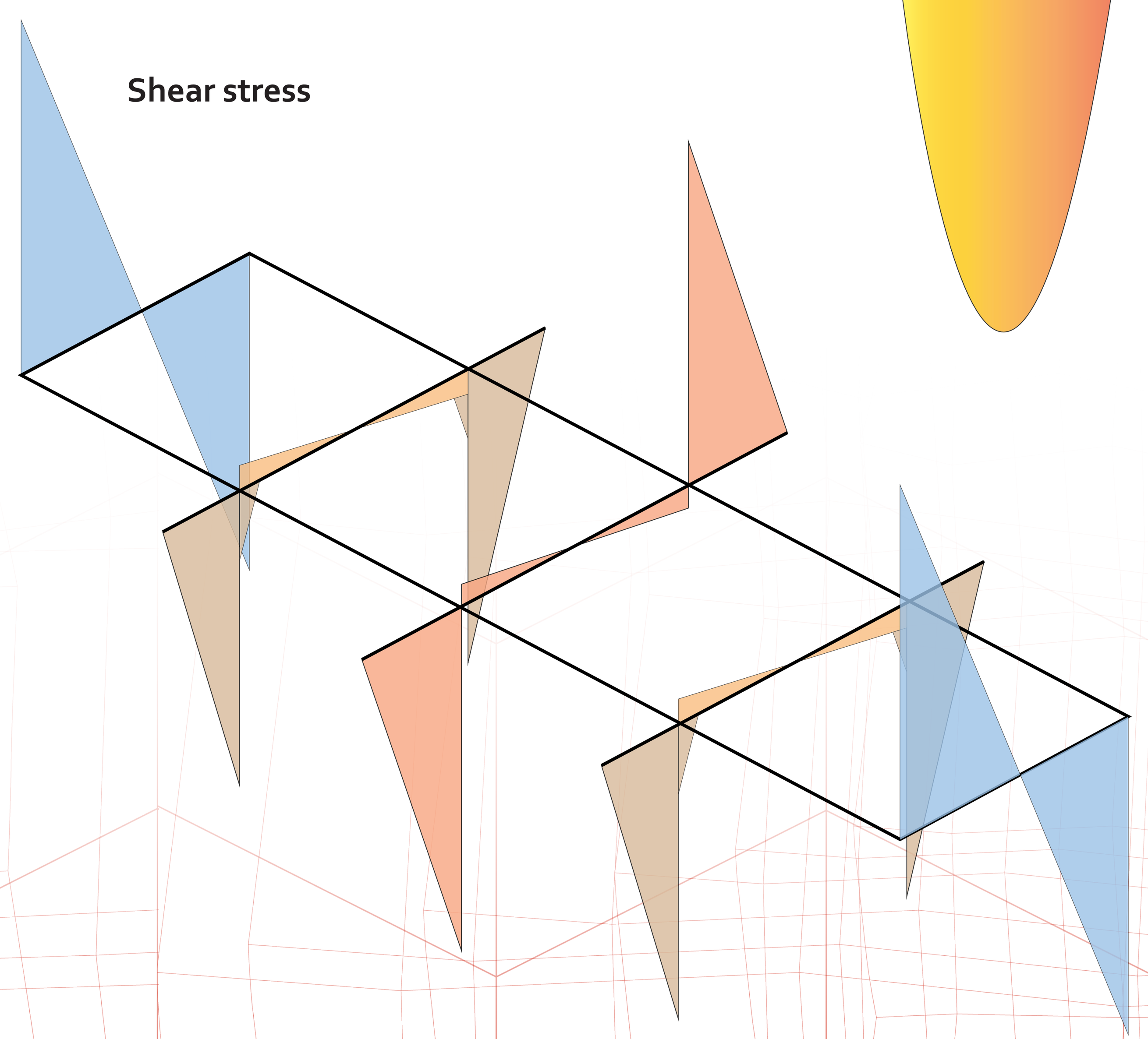
Vertical Forces



Momentum



Shear stress



Calculation of the beams

Support beam 1

ΣFx = 0:   HB = 6050 (kN)   ΣMA = 0:
The sum of the moments about the roller support at the point A:
P1*1.8 + q1*1.5*(1.8 - 1.5/2) + P2*0.3 + RB*4.2 - P3*4.5 - q2*1.5*(4.5 + 1.5/2) - P4*6 = 0
ΣMB = 0: The sum of the moments about the pin support at the point B:
P1*6 + q1*1.5*(6 - 1.5/2) + P2*4.5 - RA*4.2 - P3*0.3 - q2*1.5*(0.3 + 1.5/2) - P4*1.8 = 0
2. Calculate reaction of pin support at the point B:
RB = (- P1*1.8 - q1*1.5*(1.8 - 1.5/2) - P2*0.3 + P3*4.5 +q2*1.5*(4.5 + 1.5/2) + P4*6) / 4.2 = (- 189*1.8 - 10.33*1.5*(1.8 - 1.5/2) - 189*0.3 + 189*4.5 + 10.33*1.5*(4.5 + 1.5/2) + 189*6) / 4.2 = 393.50 (kN)
3. Calculate reaction of roller support at the point A:
RA = (P1*6 + q1*1.5*(6 - 1.5/2) + P2*4.5 - P3*0.3 - q2*1.5*(0.3 + 1.5/2) - P4*1.8) / 4.2 = (189*6 + 10.33*1.5*(6 - 1.5/2) + 189*4.5 - 189*0.3 - 10.33*1.5*(0.3 + 1.5/2) - 189*1.8) / 4.2 = 393.50 (kN)
4. Solve this system of equations:
HB = 6050 (kN)
5. The sum of the forces about the Oy axis is zero:
ΣFy = 0: - P1 - q1*1.5 - P2 + RA + RB - P3 - q2*1.5 - P4 = - 189 - 10.33*1.5 - 189 + 393.50*1 + 393.50*1 - 189 - 10.33*1.5 - 189 = 0

Support beam 2

ΣFx = 0: HB = 6050 (kN)   ΣMA = 0:
1. The sum of the moments about the roller support at the point A:
P1*1.4 + q1*1.5*(1.4 - 1.5/2) - P2*0.1 - P3*4.1 – q2*1.5*(4.1 + 1.5/2) + RB*4.2 - P4*5.6 = 0
ΣMB = 0:   The sum of the moments about the pin support at the point B:
P1*5.6 + q1*1.5*(5.6 - 1.5/2) - RA*4.2 + P2*4.1 + P3*0.1 - q2*1.5*(-0.1 + 1.5/2) - P4*1.4 = 0
2. Calculate reaction of pin support at the point B:
RB = (- P1*1.4 - q1*1.5*(1.4 - 1.5/2) + P2*0.1 + P3*4.1 + q2*1.5*(4.1 + 1.5/2) +P4*5.6) / 4.2 =
=(- 189*1.4 - 10.33*1.5*(1.4 - 1.5/2) + 189*0.1 + 189*4.1 + 10.33*1.5*(4.1 + 1.5/2) + 189*5.6) / 4.2 = 393.50 (kN)
3. Calculate reaction of roller support at the point A:
RA = (P1*5.6 + q1*1.5*(5.6 - 1.5/2) + P2*4.1 + P3*0.1 - q2*1.5*(-0.1 + 1.5/2) - P4*1.4) / 4.2 = (189*5.6 + 10.33*1.5*(5.6 - 1.5/2) + 189*4.1 + 189*0.1 -10.33*1.5*(-0.1 + 1.5/2) - 189*1.4) / 4.2 = 393.50 (kN)
4. Solve this system of equations:
HB = 6050 (kN)
5. The sum of the forces about the Oy axis is zero:
ΣFy = 0:   - P1 - q1*1.5 + RA - P2 - P3 - q2*1.5 + RB - P4 = - 189 - 10.33*1.5 + 393.50*1 - 189 - 189 - 10.33*1.5 + 393.50*1 - 189 = 0

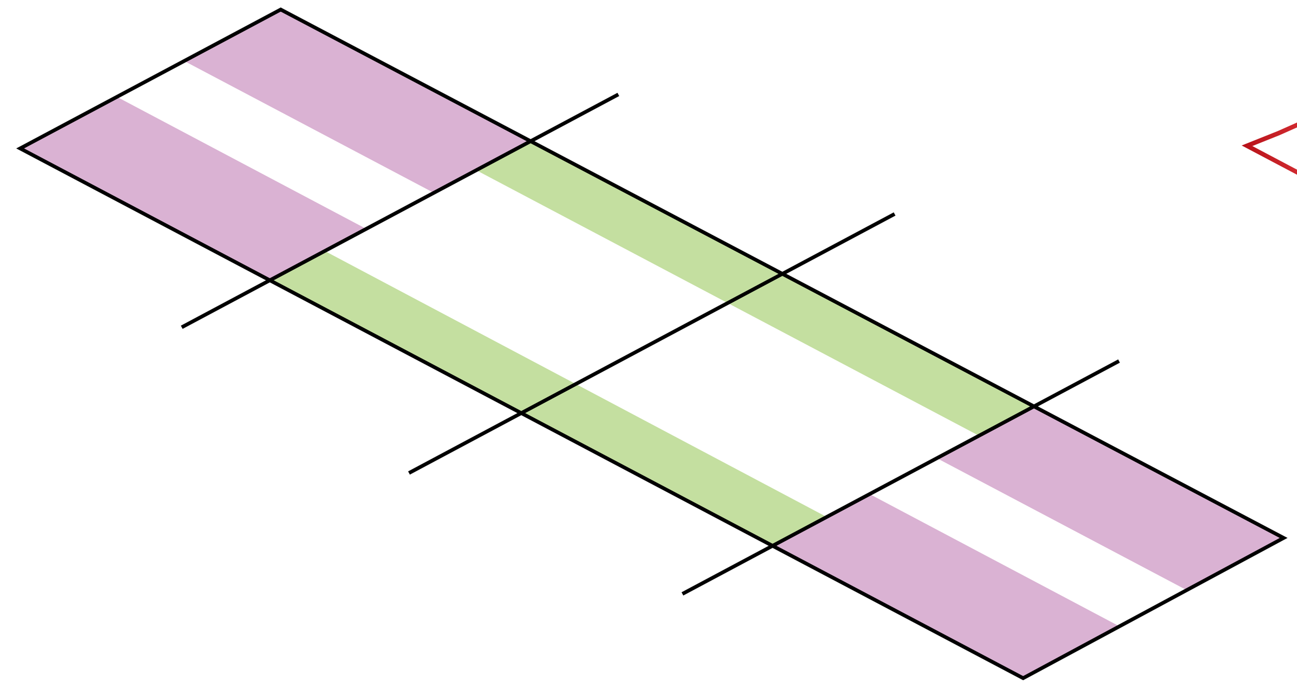
Support beam 3

ΣFx = 0: HB = 0 ΣMA = 0:
1. The sum of the moments about the pin support at the point A:
- q1*4.2*(4.2/2) + RA*4.2 - P2*4.2 = 0
ΣMB = 0: The sum of the moments about the roller support at the point B:
- RB*4.2 + P1*4.2 + q1*4.2*(4.2 - 4.2/2) = 0
2. Calculate reaction of roller support at the point B:
RB = (q1*4.2*(4.2/2) + P2*4.2) / 4.2 = (10.33*4.2*(4.2/2) + 189*4.2) / 4.2 = 210.69 (kN)
3. Calculate reaction of pin support at the point A:
RA = (P1*4.2 + q1*4.2*(4.2 - 4.2/2)) / 4.2 = (189*4.2 + 10.33*4.2*(4.2 - 4.2/2)) / 4.2 = 210.69 (kN)
4. Solve this system of equations:
HB = 0 (kN)
5. The sum of the forces about the Oy axis is zero:
ΣFy = 0:   RB - P1 - q1*4.2 + RA - P2 = 210.69*1 - 189-- 10.33*4.2 + 210.69*1 - 189 = 0

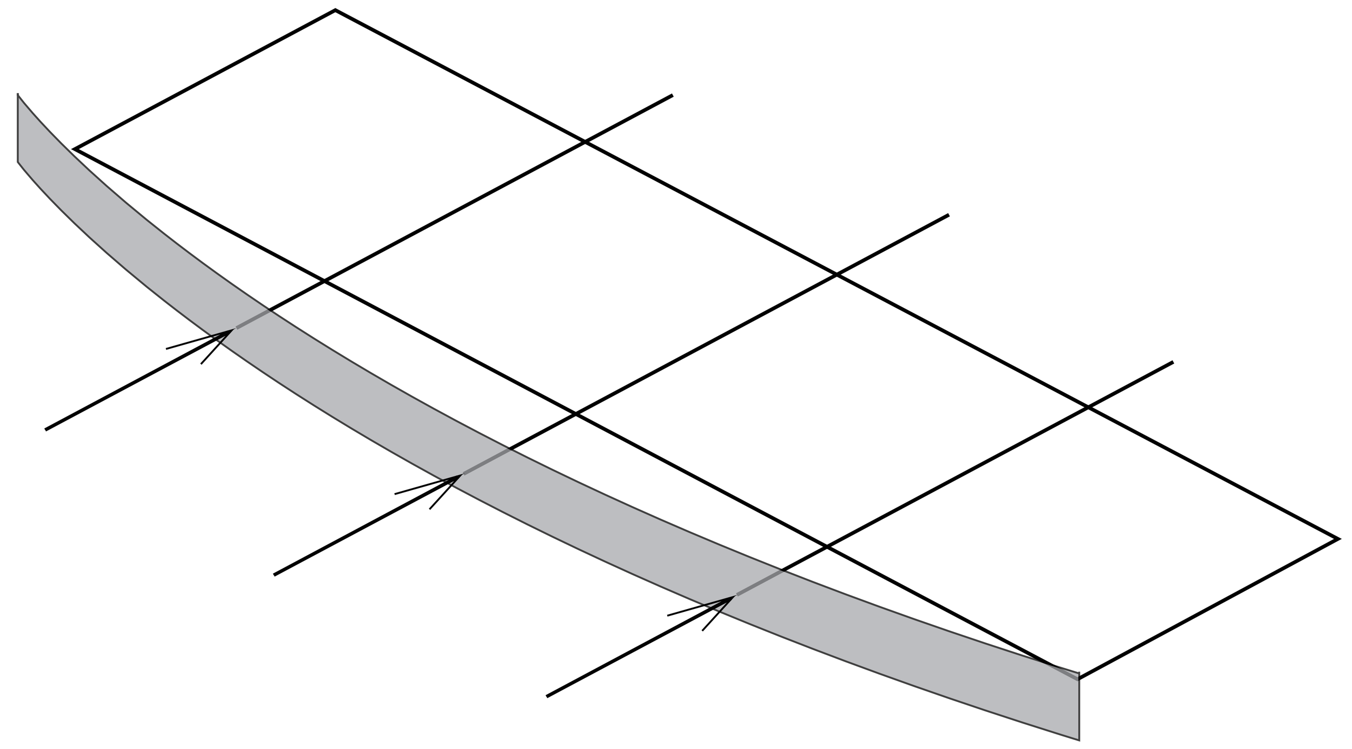
Main beam

ΣFx = 0:   HB = 18150 (kN)   ΣMA = 0:
1. The sum of the moments about the pin support at the point A:
- P2*5 - P3*10 - P4*15 + RA*20 - P5*20 = 0
ΣMB = 0:
The sum of the moments about the roller support at the point B:
- RB*20 + P1*20 + P2*15 + P3*10 + P4*5 = 0
2. Calculate reaction of roller support at the point B:
RB = (P2*5 + P3*10 + P4*15 + P5*20) / 20 =
= (1470*5 + 1805*10 + 1470*15 + 78*20) / 20 = =2450.50 (kN)
3. Calculate reaction of pin support at the point A:
RA = (P1*20 + P2*15 + P3*10 + P4*5) / 20 = (78*20 + 1470*15 + 1805*10 + 1470*5) / 20 = 2450.50 (kN)
4. Solve this system of equations:
HB = 18150 (kN)
5. The sum of the forces about the Oy axis is zero:
ΣFy = 0:   RB - P1 - P2 - P3 - P4 + RA - P5 = 2450.50*1 - 78 - 1470 - 1805 - 1470 + 2450.50*1 - 78 = 0

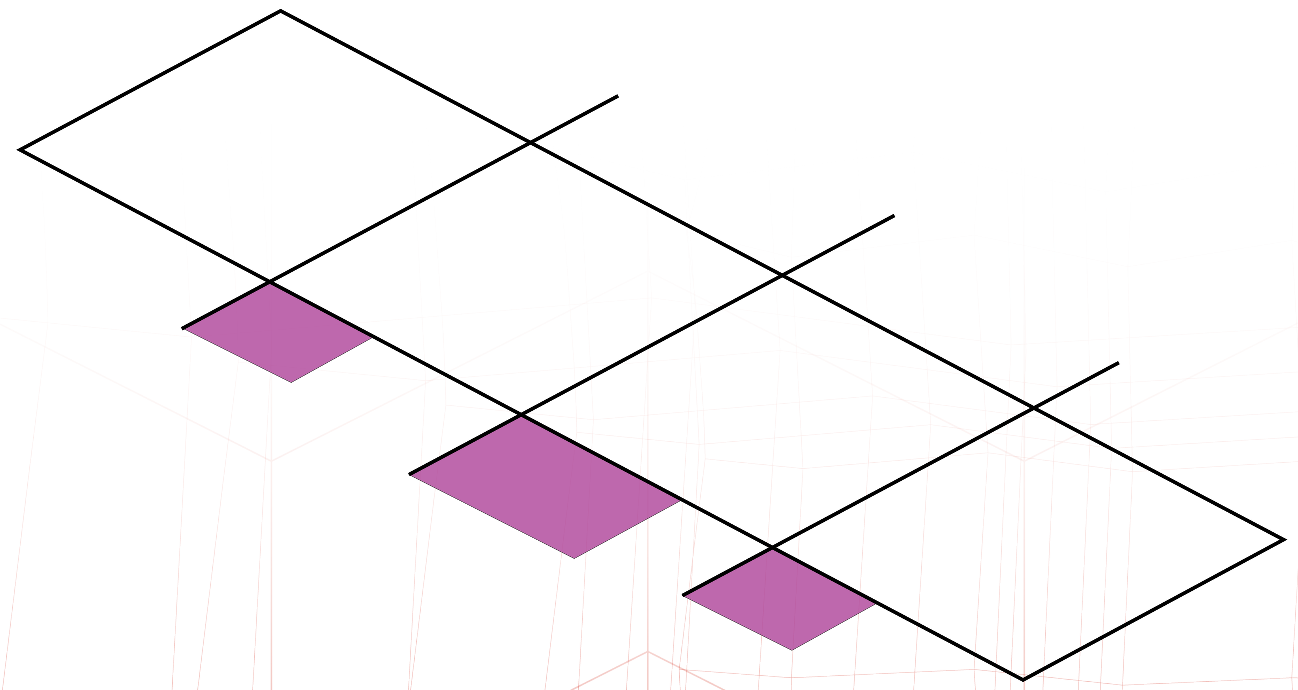
Torsion of the vertical forces



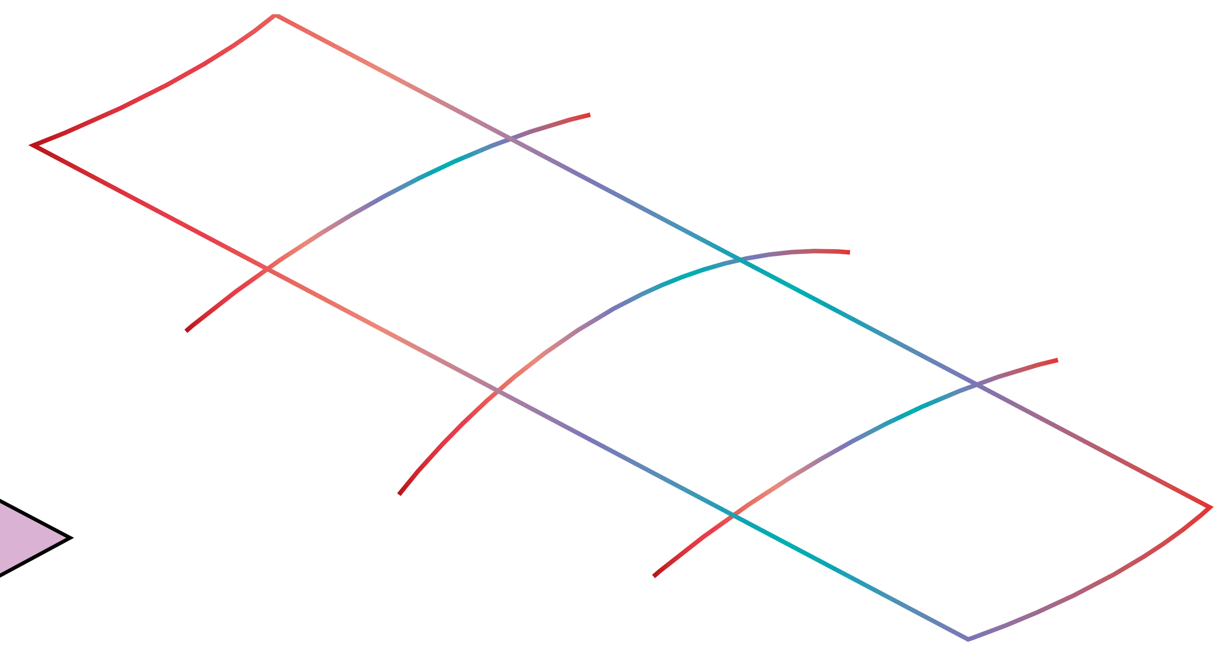
Horizontal forces

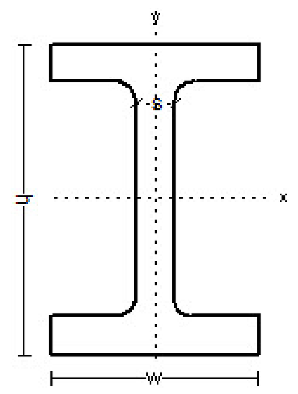


Horizontal



Deformation





h = 500mm,
w = 200mm,
s = 10.2mm,
t=16mm,
IPE 500

For the slenderness value, we have used IPE 500 for the support beam 1

Critical load
P = (π2 * E * I) / (K * L)2

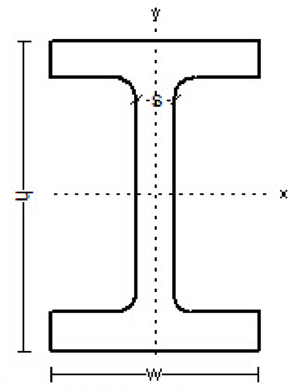
We have chosen support beam 1 for its length
L = 7.8m   K = 2.1   E = 210,000 MPa
I = 48600   P = 37504

Slenderness
λ = L / Kmin

Kmin = sqrt (I/A) = sqrt (48600 / 62.6) = 20.46
λ = 780 / 20.46 = 381.0706

Max deformation
σ = M / I * y
M = 65000 Nm2   Y = 0.25 m

σ = 65000 * 48600 / 25 = 208.33
σy * 0.8 = 390 * 0.8 = 312   σ < σy



h = 800mm,
w = 190mm,
s = 14.6mm,
t=9.4mm,
HEA 800

For the slenderness value, we have used HEA 800 for the Main beam

Slenderness
λ = L / Kmin

Kmin = sqrt (I/A) = sqrt (303442/ 286) = 32.57
λ = 2000 / 20.46 = 307.0048
Max deformation
σ = M / I * y
M = 75922 Nm2 Y = 0.4 m

σ = 75922 * 303442 / 40 = 151.844
σy * 0.8 = 390 * 0.8 = 312   σ < σy

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