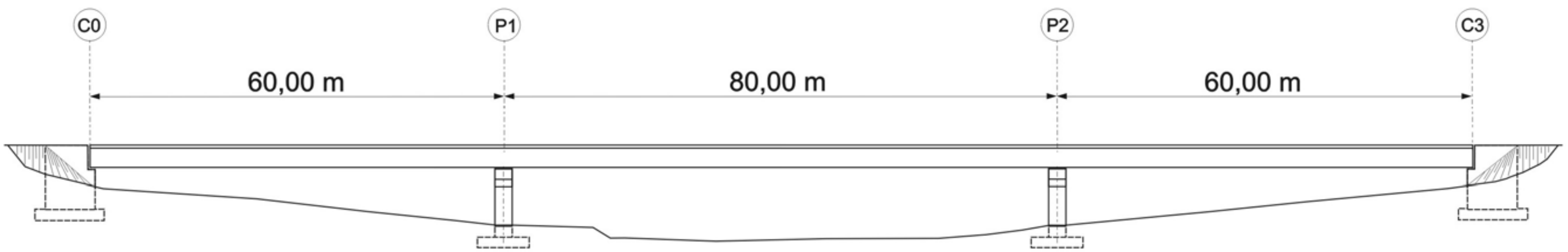
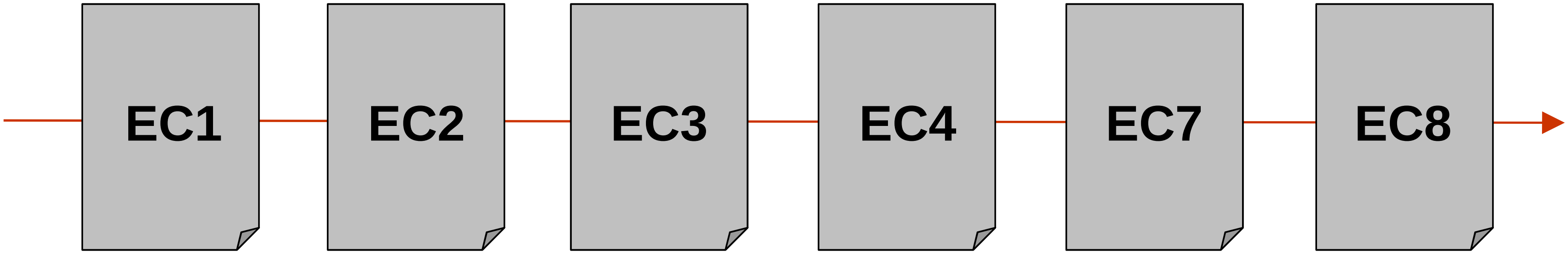
Introduction to design examples

Pilar Crespo
Roads Administration
Ministry of Public Works (Spain)

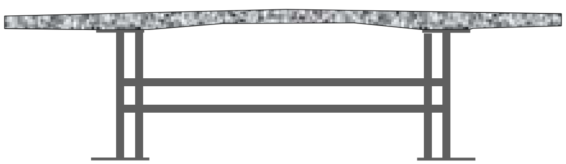
Introduction to design examples

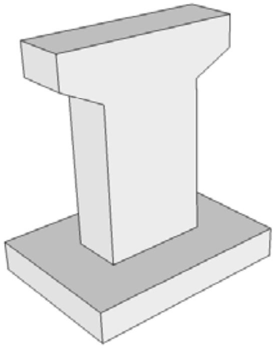


Main example



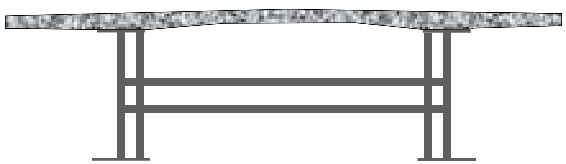
Introduction to design examples

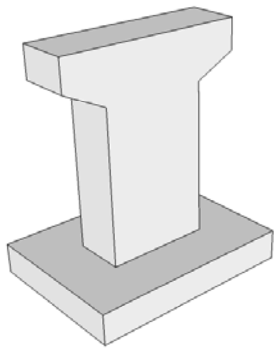




Partial alternative examples

Introduction to design examples



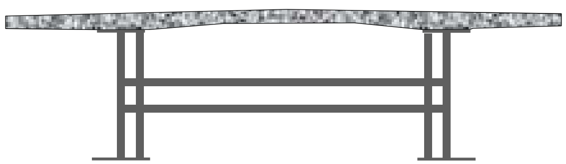


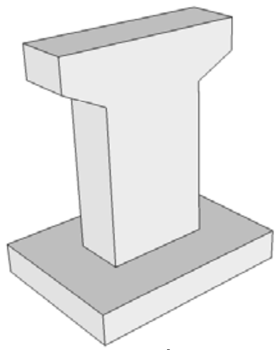
Partial alternative examples

EC2

EC4

Introduction to design examples



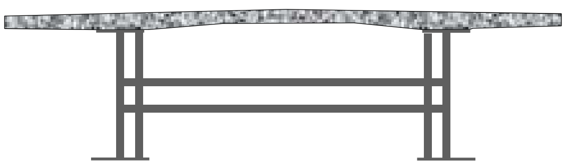


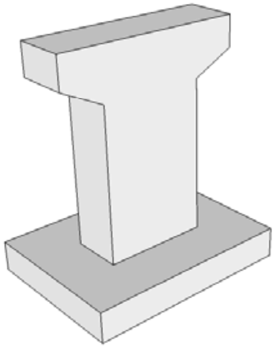
Partial alternative examples

EC1

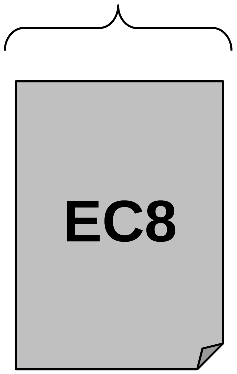
EC2

Introduction to design examples





Partial alternative examples

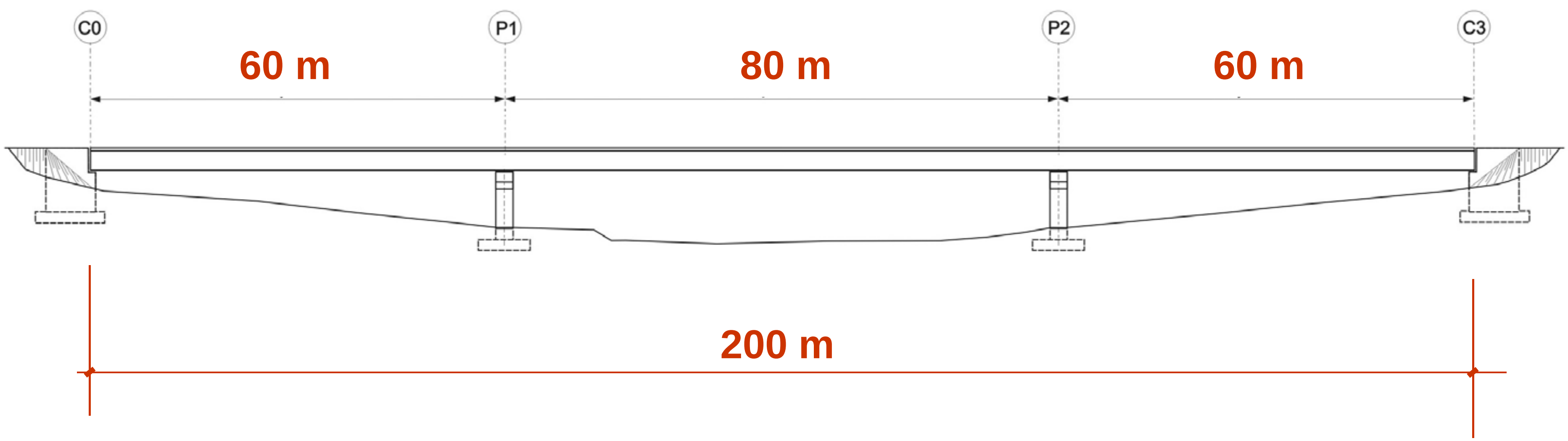


Introduction to design examples

1. Geometry of the deck
2. Geometry of the substructure
3. Design specifications
4. Materials
5. Structural details
6. Construction process

Geometry of the deck

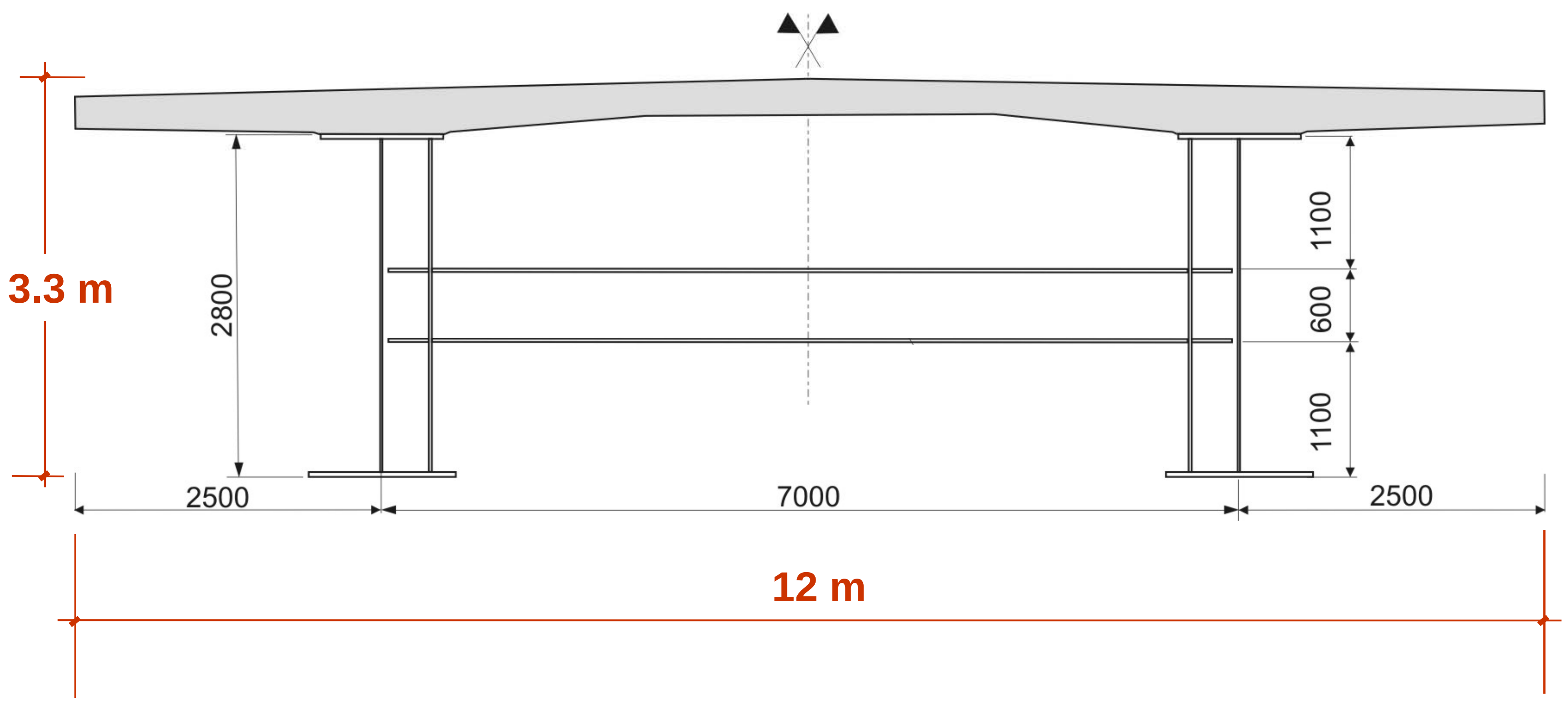
Main example



- Continuous three span
- Composite steel-concrete deck
- Constant depth
- Longitudinal axis: straight and horizontal

Geometry of the deck

Main example



Two girder composite deck

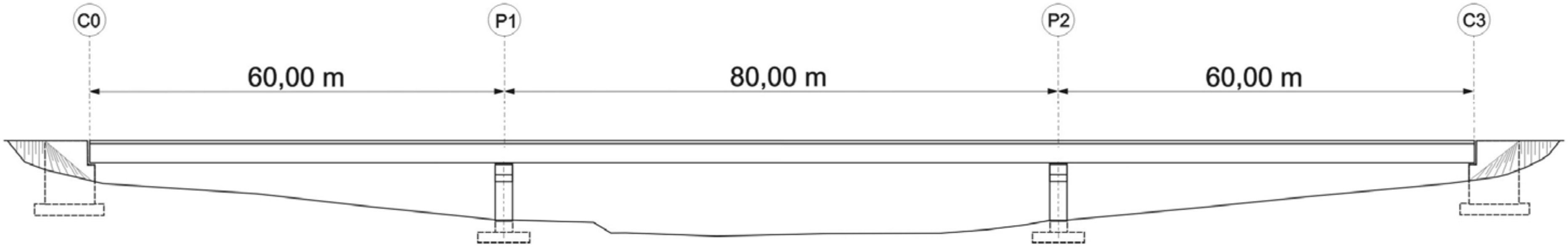
Geometry of the deck

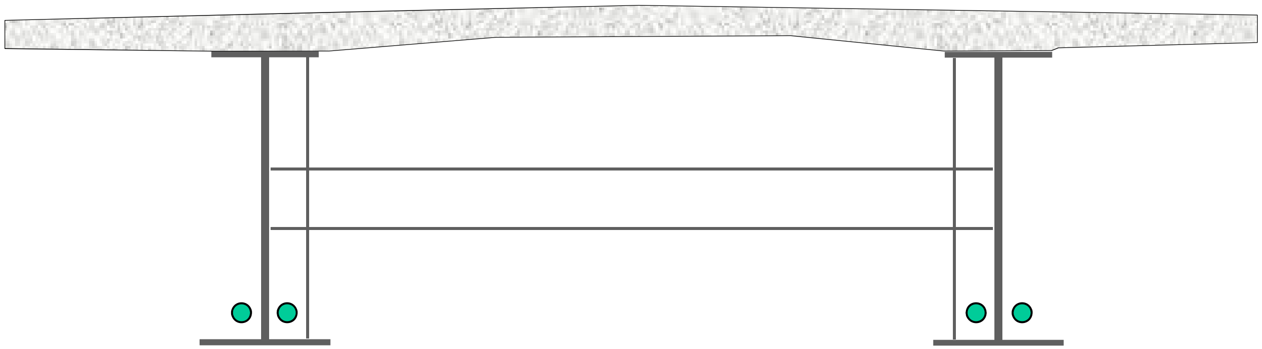
Main example

Two girder composite deck

Geometry of the deck

Alternative deck (I)

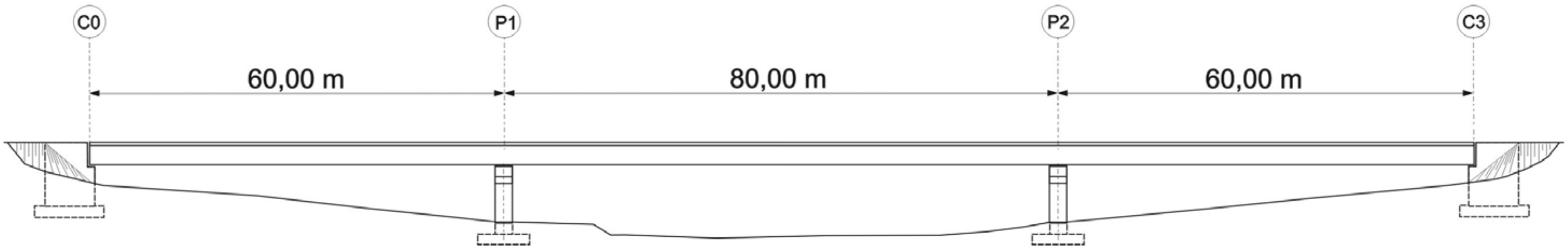


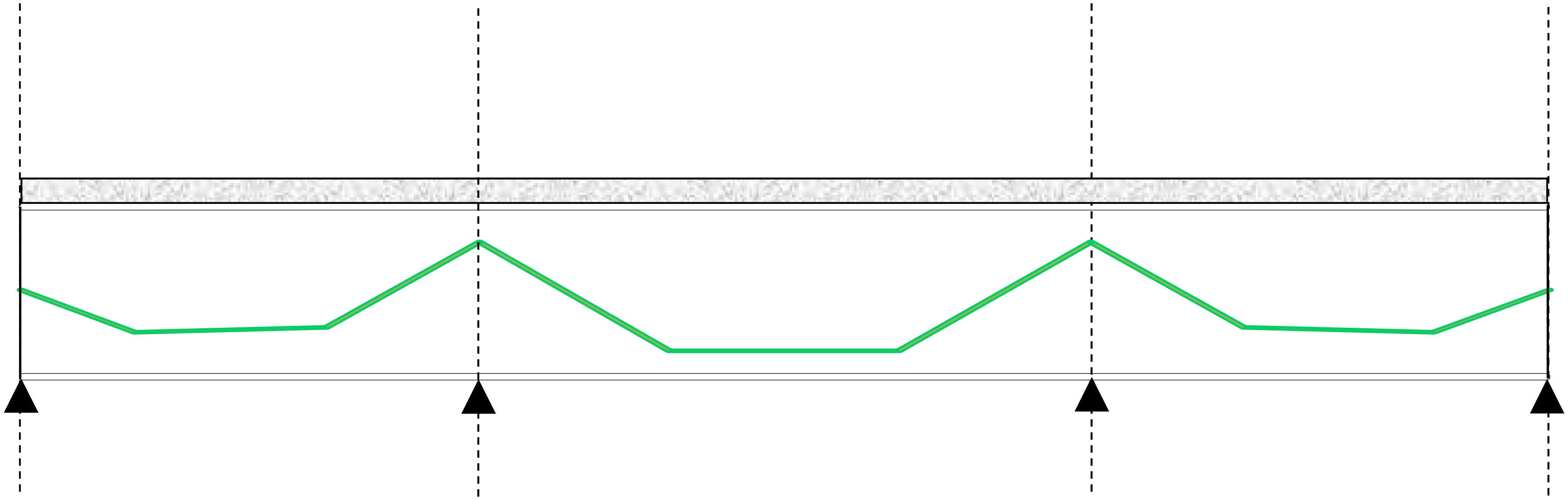


Externally prestressed composite deck

Geometry of the deck

Alternative deck (I)

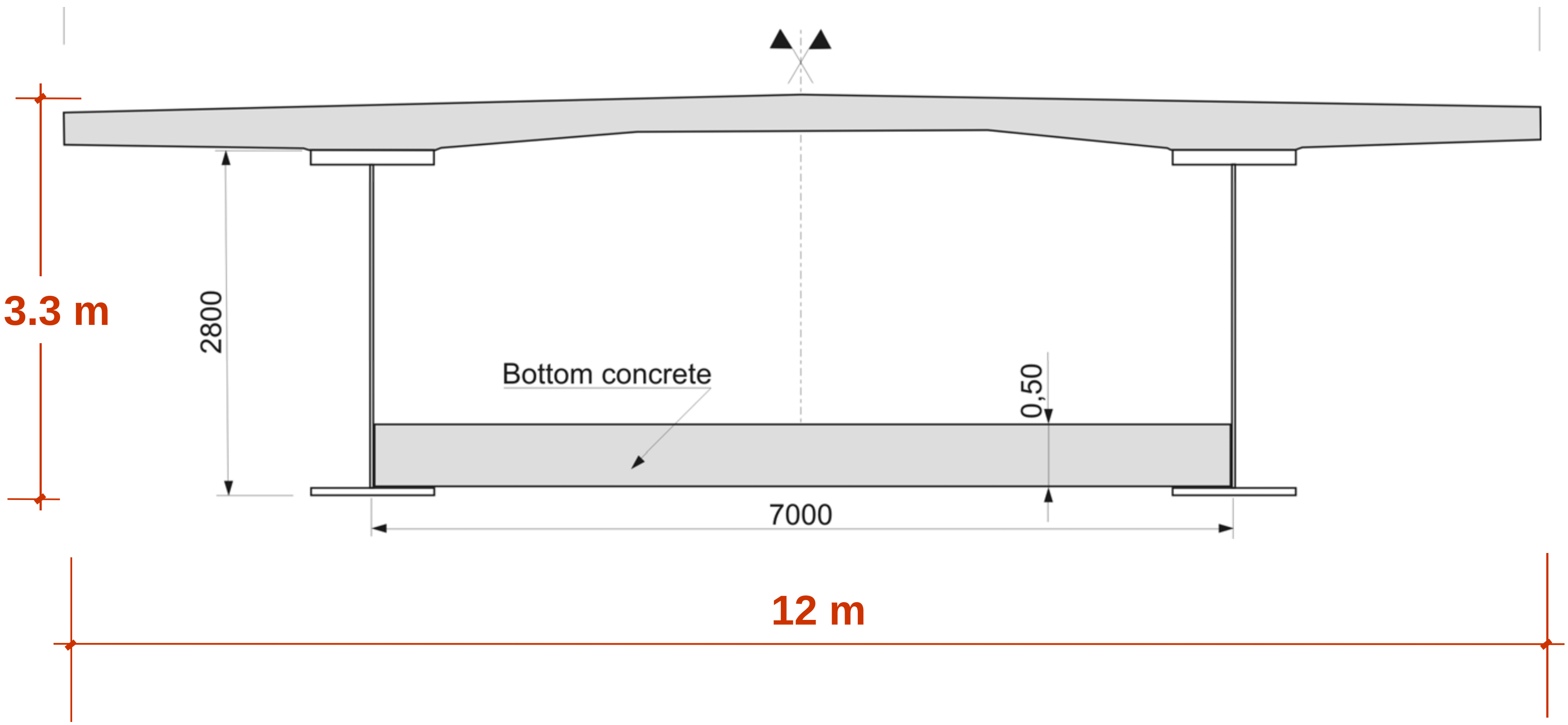




Externally prestressed composite deck

Geometry of the deck

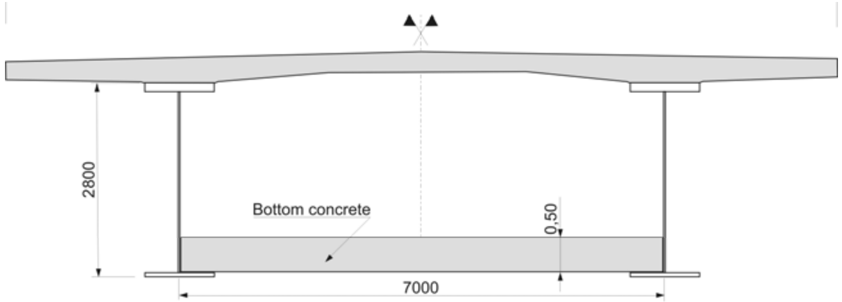
Alternative deck (II)



Double composite deck

Geometry of the deck

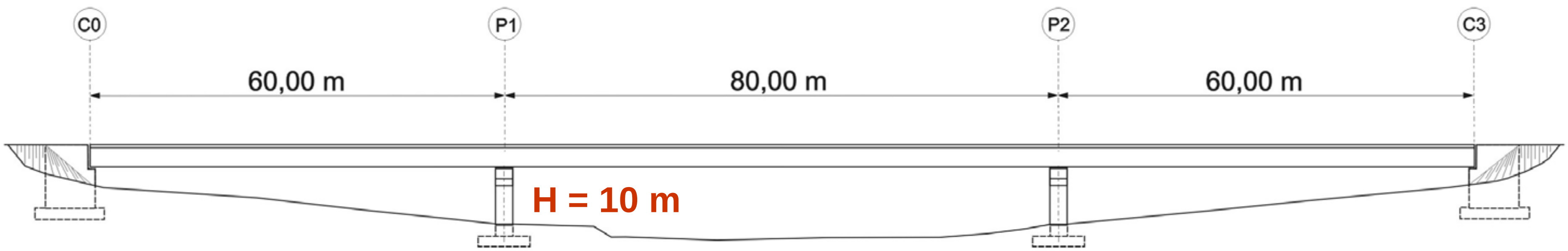
Alternative deck (II)



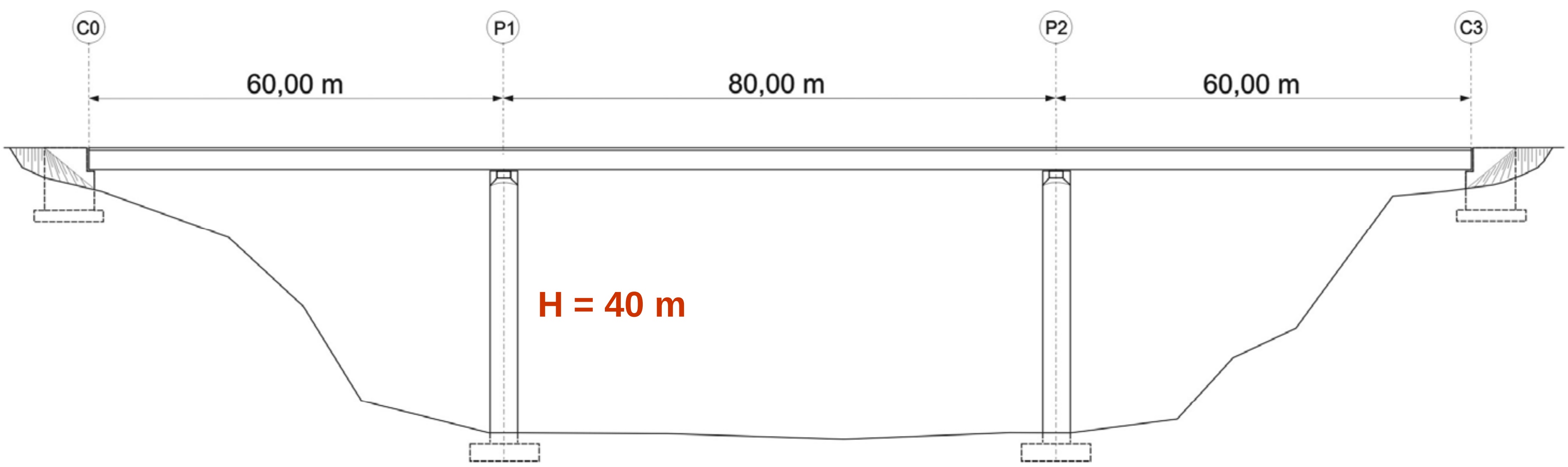
Double composite deck

Geometry of the substructure

Piers



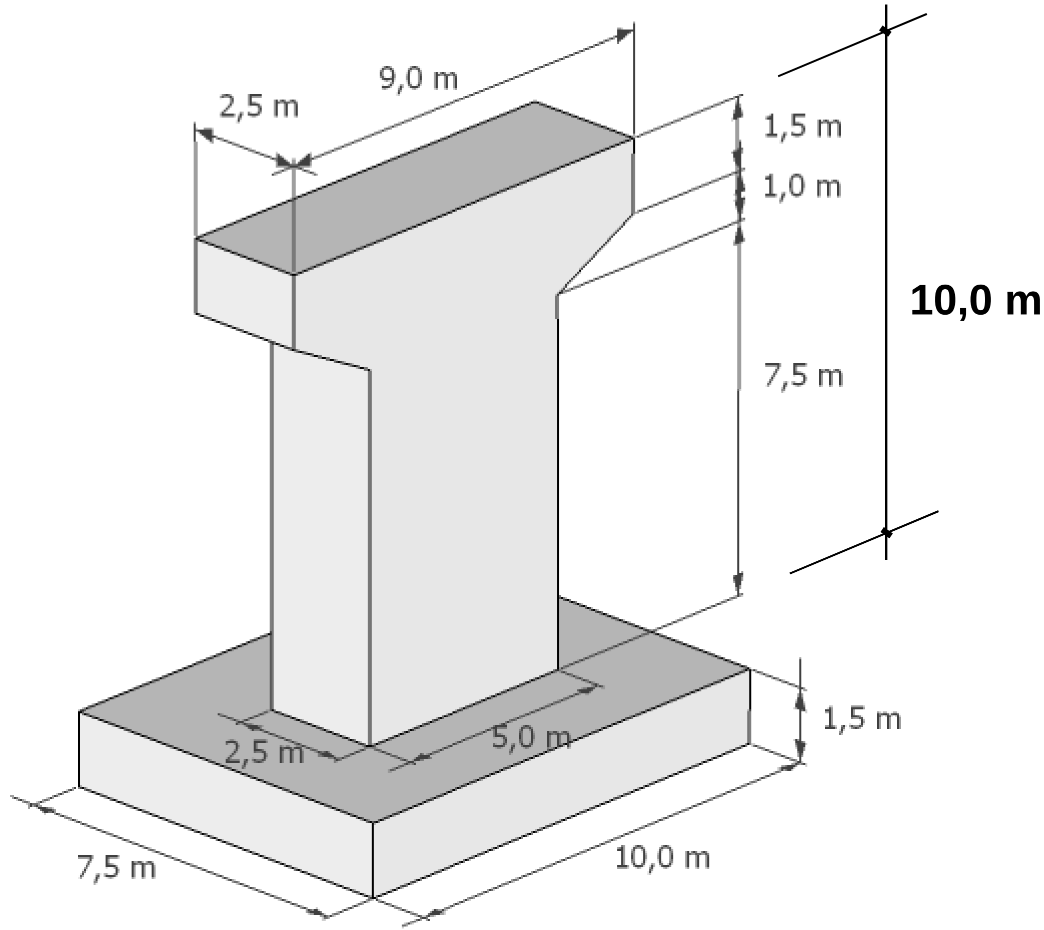
Squat pier case



High pier case

Geometry of the substructure

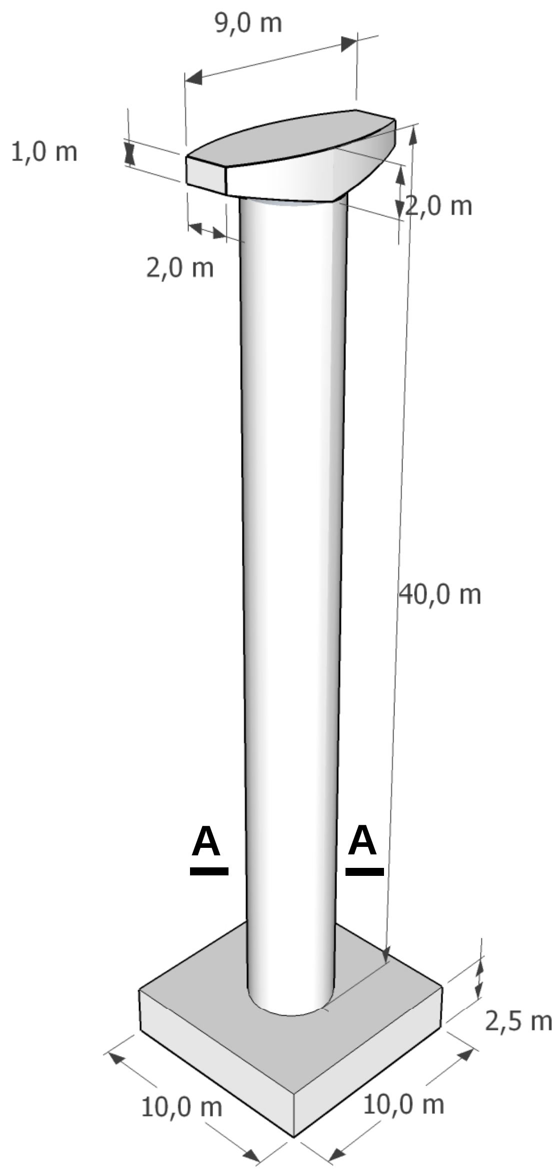
Piers (I)

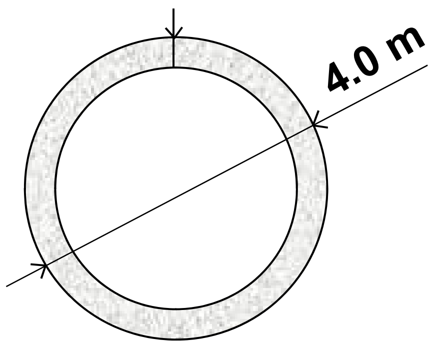


Squat pier case

Geometry of the substructure

Piers (II)



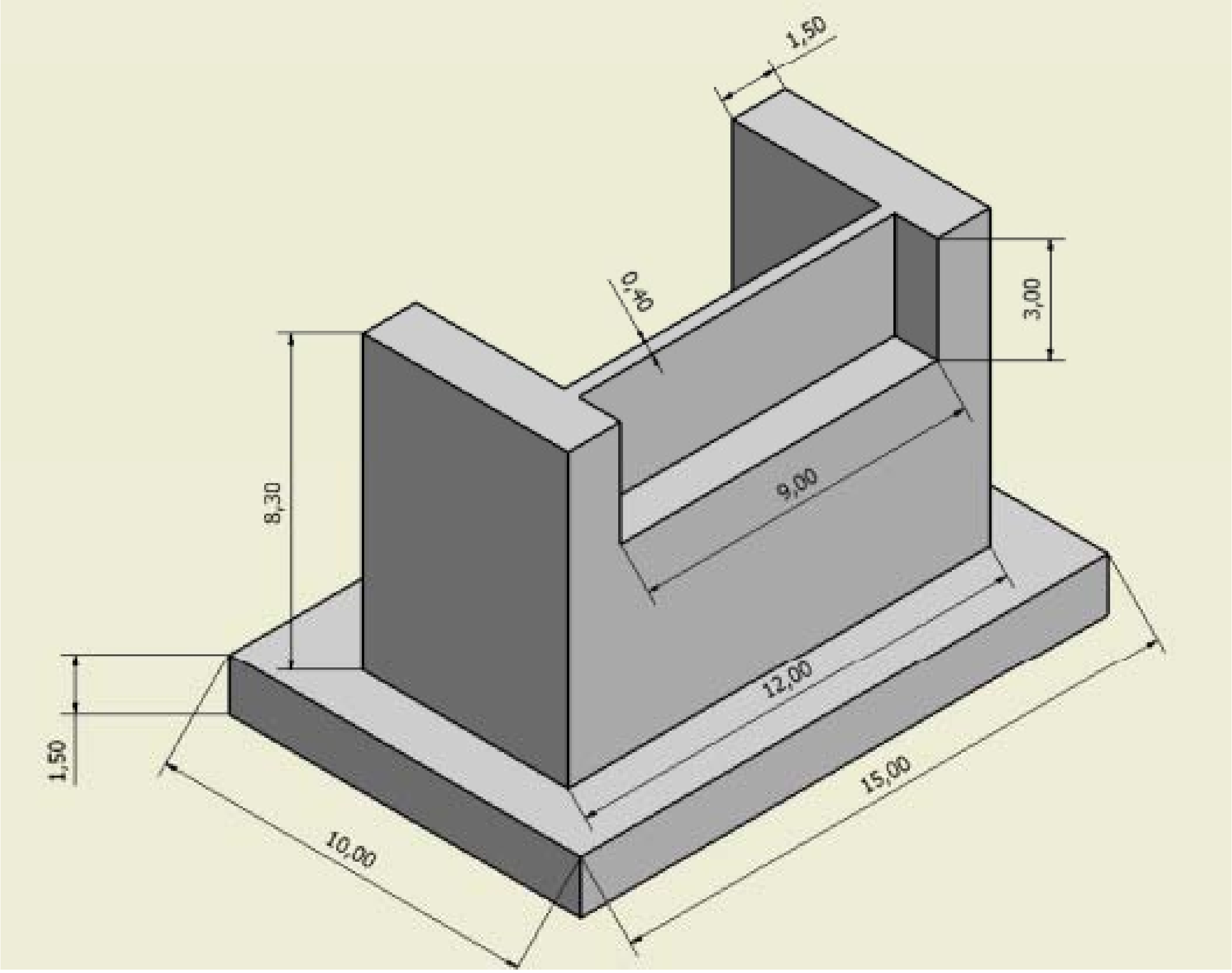


Section A-A

High pier case

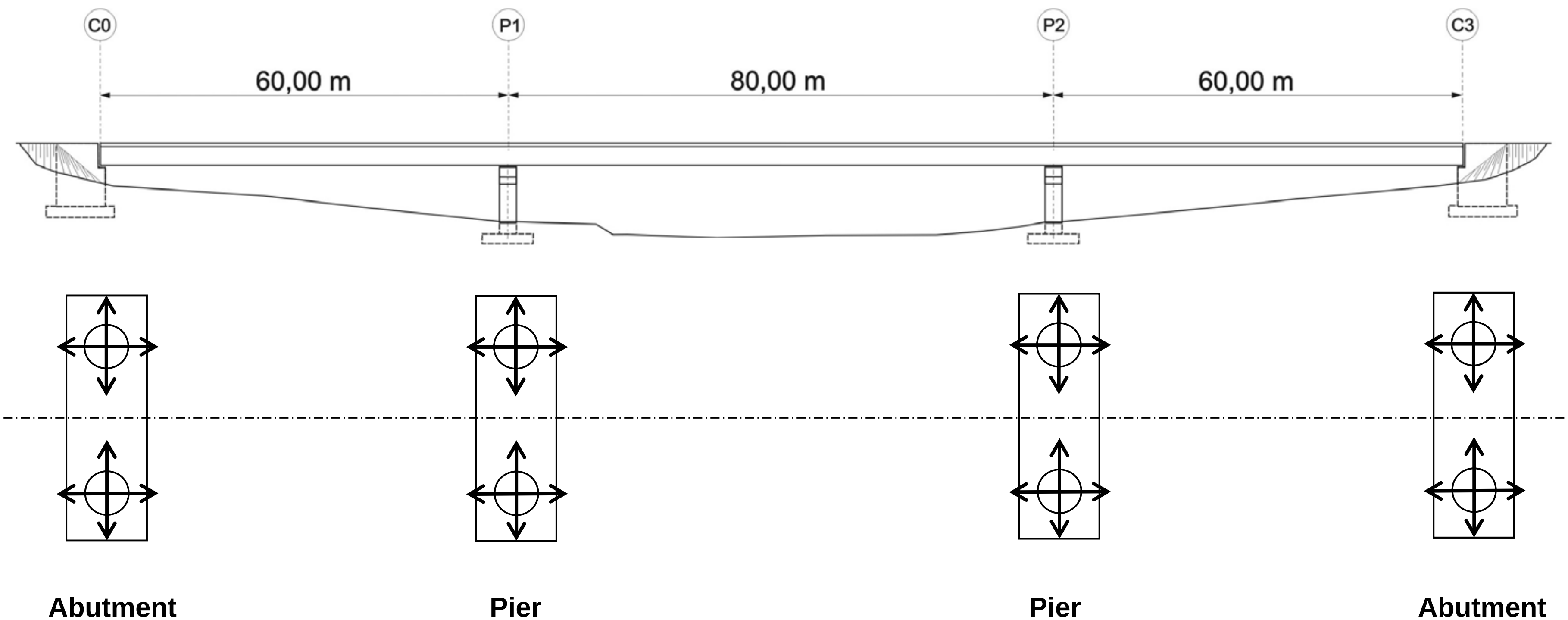
Geometry of the substructure

Abutments



Geometry of the substructure

Bearings (I) Squat pier case

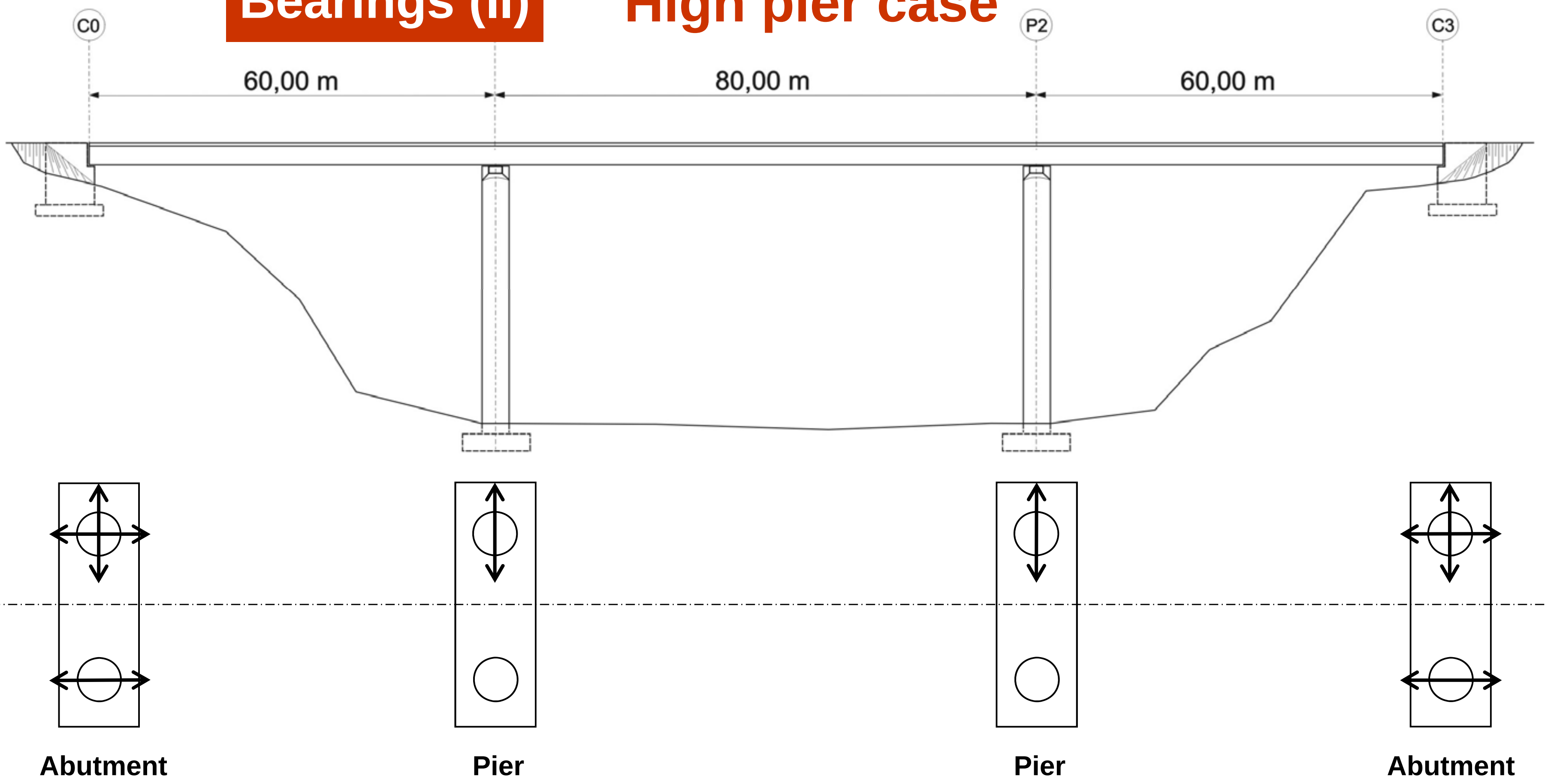


- Seismic isolation system (two bearings per support)
- Triple Friction Pendulum bearings
- Non-linear behaviour in both directions

Geometry of the substructure

Bearings (II)

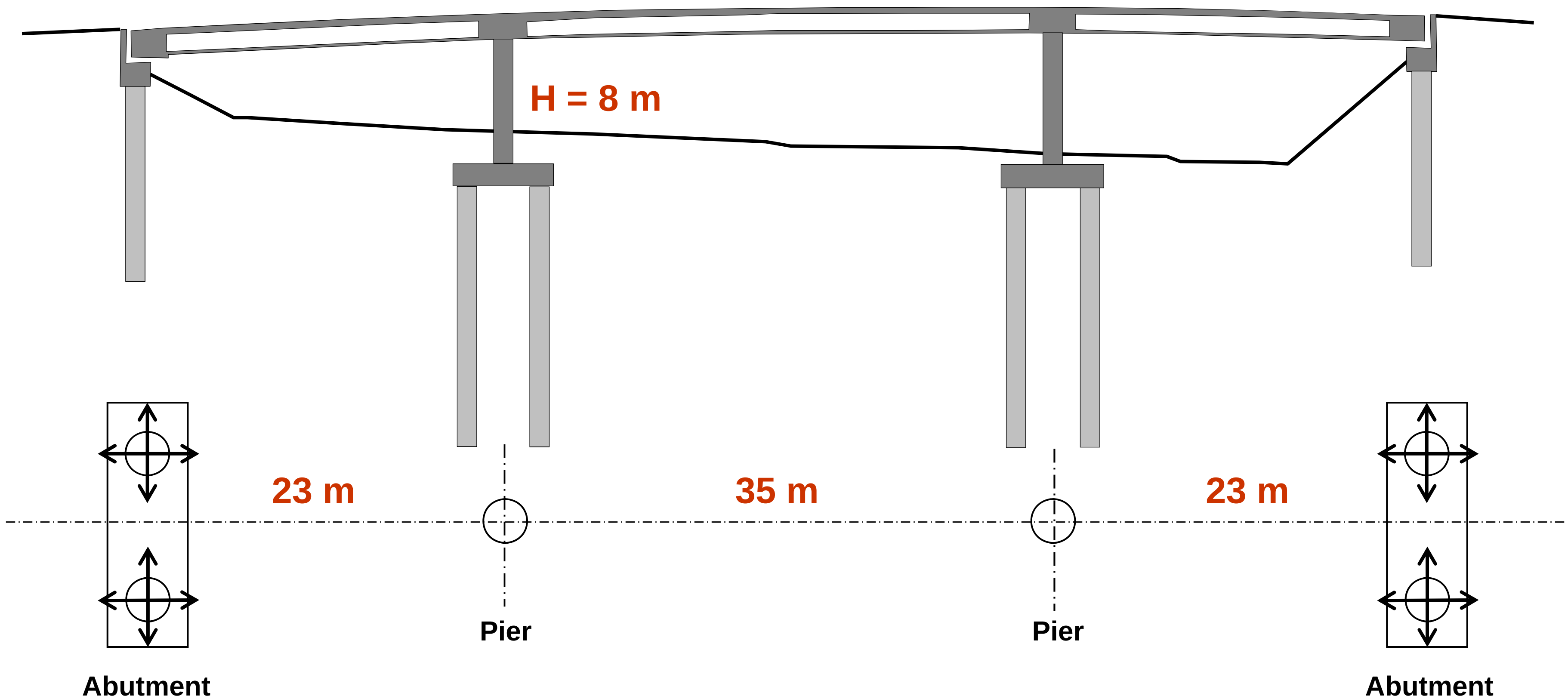
High pier case



- **Limited ductile piers concept**
- **Articulations at piers**
- **Bearings at abutments**

Geometry of the substructure

Bearings (III) Special example for seismic design



- Ductile behaviour of piers
- Piers rigidly connected to the deck (H = 8 m; D = 1.2 m)
- Bearings at abutments

Introduction to design examples

1. Geometry of the deck
2. Geometry of the substructure
3. Design specifications
4. Materials
5. Structural details
6. Construction process

Design specifications

- **Design working life: 100 years**

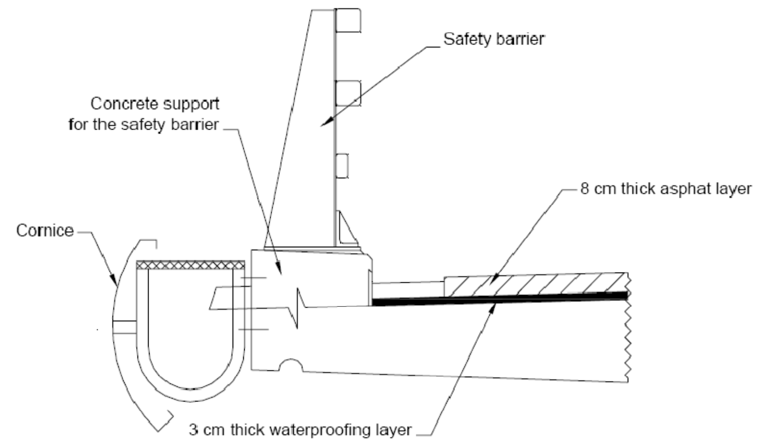
  - ***Assessment of some actions (wind, temperature)***
  - ***Minimum cover requirements for durability***
  - ***Fatigue verifications***

Design specifications

- **Design working life:** **100 years**

- **Non-structural elements**

  - *Parapets + cornices*
  - *Waterproofing layer (3cm)*
  - *Asphalt layer (8cm)*

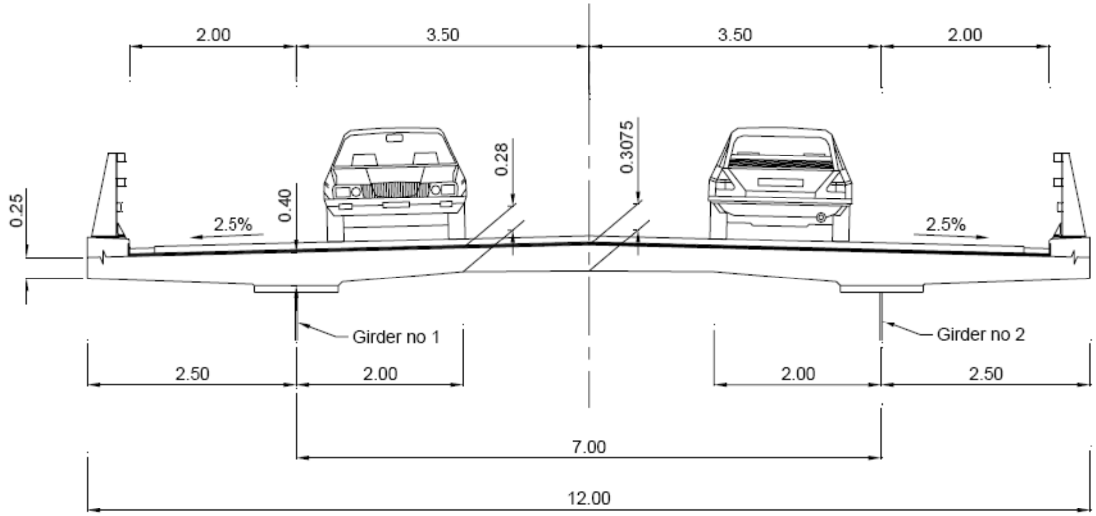


Design specifications

- **Design working life:** **100 years**

- **Non-structural elements**

- **Traffic data**



· ***Two traffic lanes (3.5m)***

· ***Two hard strips (2.0m)***

· ***LM1:*** $\alpha_{Qi} = \alpha_{qi} = \alpha_{qr} = 1.0$

· ***No abnormal vehicles***

For fatigue verifications:

· ***Two slow lanes (same position as actual lanes)***

· ***Vehicle centrally placed on the lane***

} For assessment of general action effects

· ***Slow lane close to the parapet*** → For assessment of transverse reinforcement

· ***Medium flow rate of lorries***

Design specifications

- **Shade air temperature**: $T_{min} = -20ºC$ $T_{max} = 40ºC$

  Selection of steel quality ←

- **Humidity**: RH = 80%

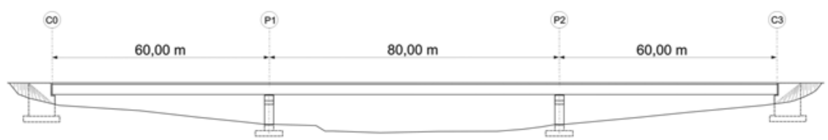
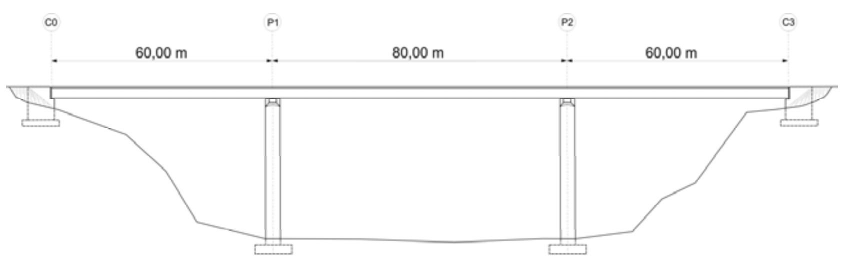
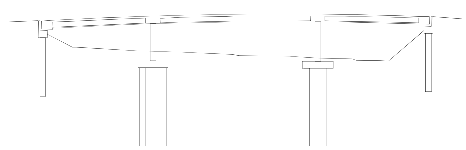
- **Wind**:
  Flat valley with little isolated obstacles
  Fundamental value of basic wind velocity $v_{b,0}$ = 26 m/s
  Maximum wind for launching v = 50 km/h = 14 m/s

- **Exposure Class**:
  XC3 (top face of concrete slab)
  XC4 (bottom face of concrete slab)
  → $c_{min,dur}$
  Limiting crack width

Design specifications

- **Soil conditions:** No deep foundation is needed
  Settlement P1: 30 mm

- **Seismic data:** Bridge of medium importance ($\gamma_I = 1.0$)

	**Seismic isolation case** Ground type B Peak ground acceleration: $a_{gR} = 0.40$ g
	**Limited ductile piers case (q = 1.5)** Ground type B Peak ground acceleration: $a_{gR} = 0.30$ g
	**Ductile piers case (q = 3.5)** Ground type C Peak ground acceleration: $a_{gR} = 0.16$ g

Materials

a) Structural steel

Thickness	Subgrade
$t \leq 30$ mm	S 355 K2
$30 \leq t \leq 80$ mm	S 355 N
$80 \leq t \leq 135$ mm	S 355 NL

b) Concrete C35/45

c) Reinforcing steel Class B high bond bars f_{sk}=500 MPa

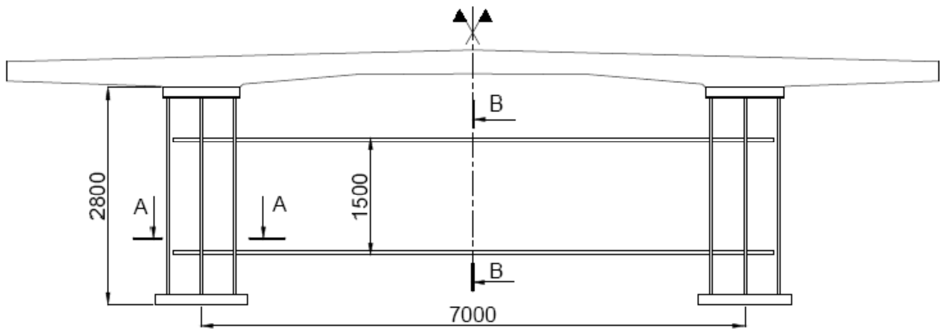
d) Shear connectors S235J2G3 f_u=450 MPa

Introduction to design examples

1. Geometry of the deck
2. Geometry of the substructure
3. Design specifications
4. Materials
5. Structural details
6. Construction process

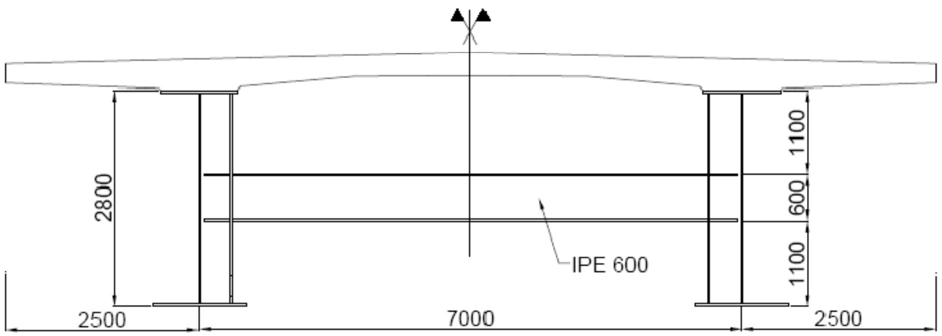
Structural details

Structural steel



Support cross-section

Upper flange: 1000 mm x 120 mm
Lower flange: 1200 mm x 120 mm
Web: 26 mm
Cross-bracing: built-up welded

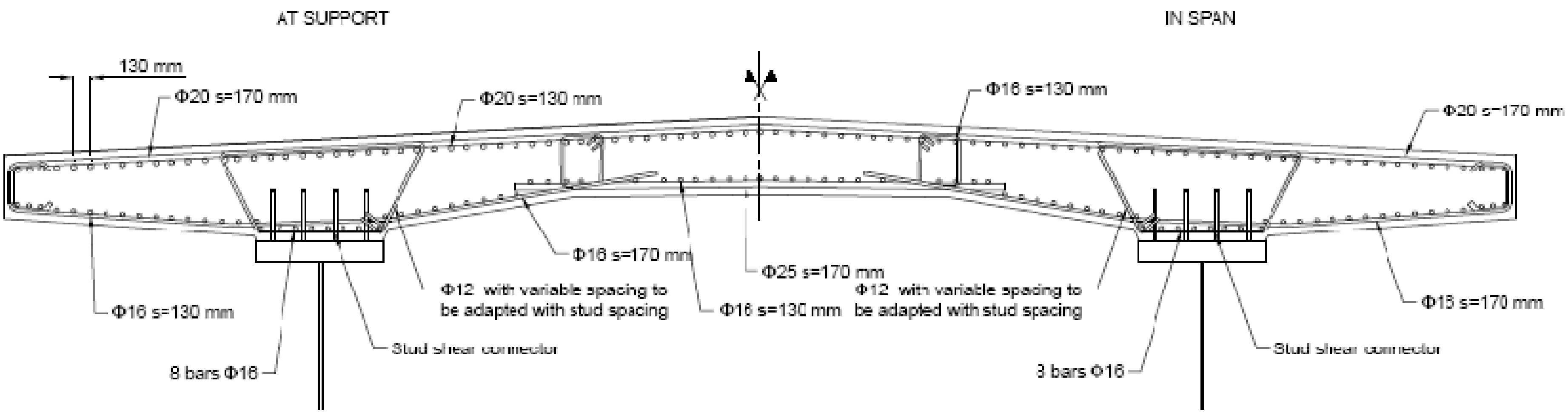


Mid-span cross-section

Upper flange: 1000 mm x 40 mm
Lower flange: 1200 mm x 40 mm
Web: 18 mm
Cross-bracing: IPE-600

Structural details

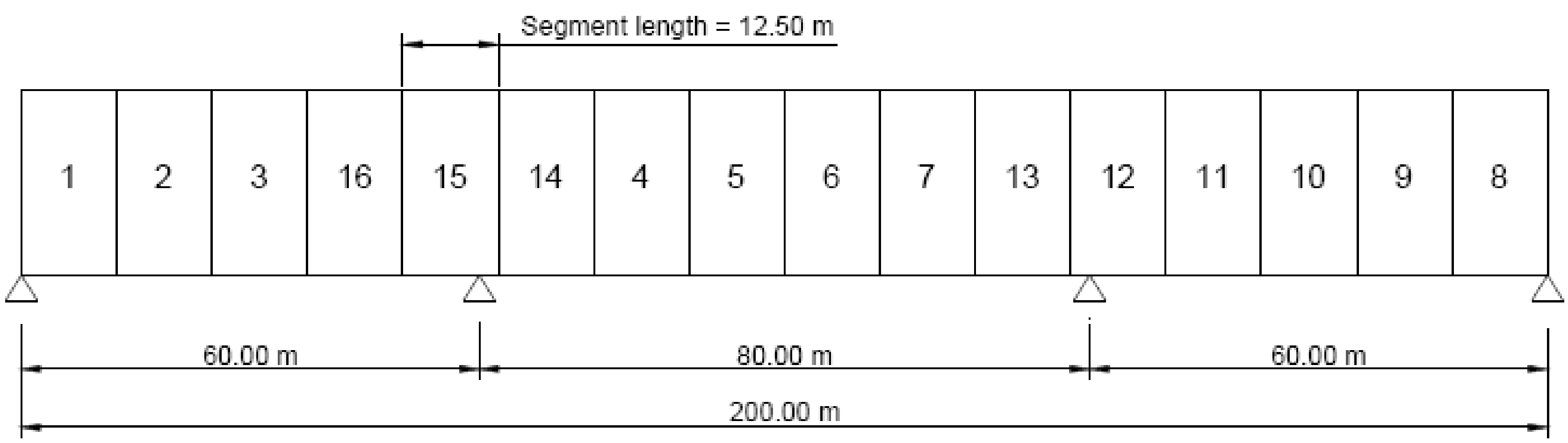
Slab reinforcement

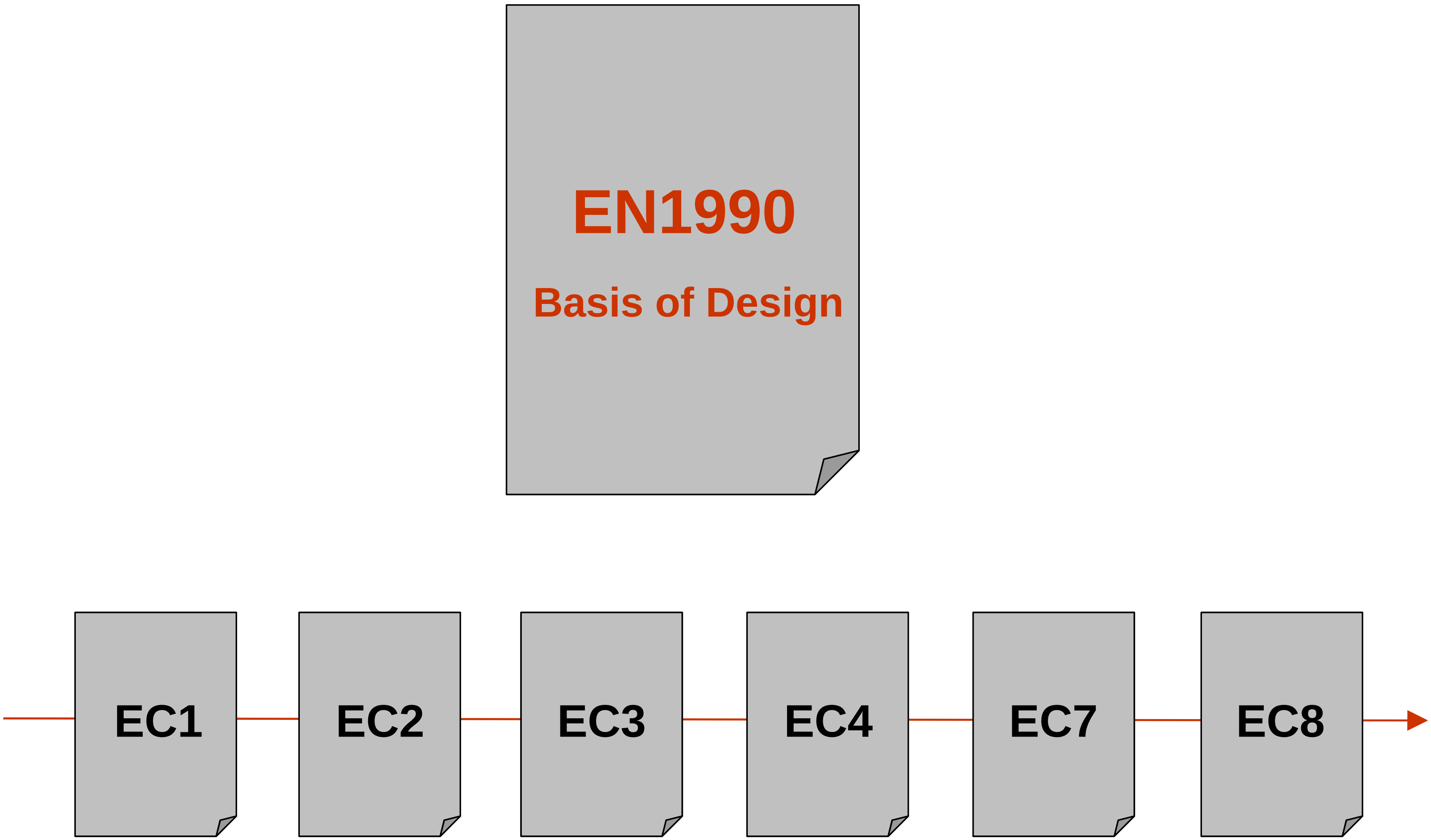


Construction process

- **Launching of the steel girders**
- **Cast in-place slab**

  (a segment every three days)




EN1990
Basis of Design
EC1
EC2
EC3
EC4
EC7
EC8