Introduction to design examples

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Introduction to design examples

Main example

EC1  EC2  EC3  EC4  EC7  EC8
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

EC8
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)**

Extremely 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**

H = 10 m

**Squat pier case**

H = 40 m

**High pier case**
Geometry of the substructure

Squat pier case
Geometry of the substructure

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 \( (H = 8\, \text{m}; \, D = 1.2\, \text{m}) \)
- Bearings at abutments
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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
  - Slow lane close to the parapet
  - Medium flow rate of lorries

  For assessment of general action effects
  For assessment of transverse reinforcement
Design specifications

- **Shade air temperature:** \( T_{\text{min}} = -20^\circ\text{C} \quad T_{\text{max}} = 40^\circ\text{C} \)

- **Humidity:** \( \text{RH} = 80\% \)

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

- **Exposure Class:**
  
  \( \left\{ \begin{array}{l}
  \text{XC3 (top face of concrete slab)} \\
  \text{XC4 (bottom face of concrete slab)}
  \end{array} \right. \)

  \( c_{\text{min, dur}} \)

  Limiting crack width
Design specifications

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

- **Seismic data:** Bridge of medium importance ($\gamma_1 = 1.0$)

<table>
<thead>
<tr>
<th>Seismic isolation case</th>
<th>Ground type B</th>
<th>Peak ground acceleration: $a_{gR} = 0.40$ g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited ductile piers case ($q = 1.5$)</td>
<td>Ground type B</td>
<td>Peak ground acceleration: $a_{gR} = 0.30$ g</td>
</tr>
<tr>
<td>Ductile piers case ($q = 3.5$)</td>
<td>Ground type C</td>
<td>Peak ground acceleration: $a_{gR} = 0.16$ g</td>
</tr>
</tbody>
</table>
**Materials**

a) **Structural steel**

<table>
<thead>
<tr>
<th>Thickness</th>
<th>Subgrade</th>
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<tbody>
<tr>
<td>$t \leq 30$ mm</td>
<td>S 355 K2</td>
</tr>
<tr>
<td>$30 \leq t \leq 80$ mm</td>
<td>S 355 N</td>
</tr>
<tr>
<td>$80 \leq t \leq 135$ mm</td>
<td>S 355 NL</td>
</tr>
</tbody>
</table>

b) **Concrete**

C35/45

c) **Reinforcing steel**

Class B high bond bars  $f_{sk}=500$ MPa

d) **Shear connectors**

S235J2G3  $f_u=450$ MPa
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6. Construction process
Structural details

**Structural steel**

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

**Support cross-section**

**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

AT SUPPORT

130 mm

Φ20 s=170 mm

Φ20 s=130 mm

Φ16 s=130 mm

Φ12 with variable spacing to be adapted with stud spacing

Φ16 s=130 mm

Φ16 s=130 mm

IN SPAN

Φ20 s=170 mm

Φ20 s=170 mm

Φ12 with variable spacing to be adapted with stud spacing

Φ16 s=130 mm

8 bars Φ16

3 bars Φ16

Stud shear connector

Stud shear connector
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