

# Ponti EC4

## Steel and steel-concrete composite bridge decks Eurocode design calculations

Ponti EC4 is a standalone software program carrying out comprehensive calculations to the Eurocodes for grillage and box decks with composite or steel sections also including stiffened flanges as orthotropic plate. The software deals with cross references in Eurocode suite, that make design calculations time-consuming and error-prone without use of Ponti EC4.

The user enters moments and shears from an analysis model, dimensions and selects material data from a library. Ponti EC4 carries out design calculations covering ULS bending, stress, shear and interaction; SLS stress, web breathing and cracking and fatigue checks for main members and connectors. Output uses intuitive graphics and tables and a report is produced automatically in rtf format.

### Rapid and well-structured input

Input is designed to be rapid, using graphics together with spreadsheet-style input and Ponti EC4 has a direct interface to LUSAS Modeller.

A library of steel & concrete material properties makes input rapid, while retaining full flexibility for the user to tweak parameters to suit project requirements.

Concrete slab

- Strength  $f_{ck}$  (N/mm<sup>2</sup>): 33.2
- Strength  $f_{ct,ef}$  (N/mm<sup>2</sup>): 0
- Partial factor  $\gamma_c$ : 1.5
- Cement class: N
- Aggregate type: [dropdown]
- Poisson's ratio: 0.2
- Coeff. of thermal expansion: 1E-05

Concrete age

- When drying shrinkage  $\epsilon_s$  (day): 2
- At time considered  $t$  (day): 25550
- When perm. load is applied to (day): 30
- When shrink. load is applied to (day): 2
- When imposed d. are applied to (day): 30
- Permanent creep multiplier  $\Psi_{sL}$ : 1.1
- Shrinkage creep multiplier  $\Psi_{sL}$ : 0.55
- Deformations creep multiplier  $\Psi_{sL}$ : 1.5

Imposed strain in the slab

- Automatic calc. Shrink.  $\epsilon_{ps}$ : 0
- Temperature d. [dropdown]

Control of crack

- Max. crack wid. [dropdown]
- Shear connect. [dropdown]
- Ultimate streng. [dropdown]

Reference val.

- shear stress [dropdown]
- normal stress [dropdown]

Partial factors:

- $\gamma_v$ : 1.25
- $\gamma_{FF}$ : 1

Modular ratios

- Direct input
- $n_0$ : 0
- $n_L$  permanent loads: 0
- $n_L$  shrinkage: 0
- $n_L$  imposed deformation: 0

Geometry

Segment name: D

Sections (eg. Sec1, Sect2...) X (m) (es. X1, X2...): 4\_1, 4\_11, 3\_1, 3\_11 46.454, 47.878, 49.6286f

Structural steel (D)

- bs (mm): 1100  Top flange in Class 1
- ts (mm): 50  Top flange < 40mm
- hmet (mm): 2700
- twr (mm): 16  Web stiffeners
- alpha: 12  Inclined web
- bi (mm): 1200
- ti (mm): 70  Bottom flange < 40mm

Advanced options for flanges

- Apply options
- Apply options

Vertical stiffeners (D)

- Distance between stiffeners (mm): 4000
- Rigid end post EN 1993-1-5, 5.2(2)

Fatigue (D)

Damage equivalent factor (traffic)

- Steel (Bending moment)  $\lambda_1$ : 1.905
- Steel (Shear)  $\lambda_1$ : 1.905
- Bars  $\lambda_{s,1}$ : 0.000
- Traffic loading factor (Reinforcing bars): 0.000

Detail categories data (D)

Slab concrete (D)

- bcls (mm): 6311.5, 6300
- b1 (mm): 1200
- hcop (mm): 75
- tcsl (mm): 273
- bsx (mm): 2875, 2875, 2875
- Consider haunch

Reinforcing bars (D)

- bar diameter (mm): top layer 26, bottom layer 20
- bar spacing (mm): 100
- bar cover (mm): 40

Shear connection (D)

- $n$  (n'/m): 20
- diameter (mm): 22
- height (mm): 260

Just class 1 and 2 sections in the plastic zones

Distance elastic-plastic section for ULS: L (m) 0

Resulting compression in the concrete current section, for ULS M-min.: Fx (N) 0.000E+000

Sections are described by the engineer in a simple dialog box and organized in a tree structure

Load effects for the various sections to be checked are entered in a spreadsheet style. Construction stages and in-service conditions are assimilated and design combinations organised in groups

PHASE 1. Selfweights

| Section | N (N)      | V (N)       | M (Nm)      | T (Nm)     |
|---------|------------|-------------|-------------|------------|
| A_48_1  | 4.208E+004 | -1.392E+006 | 7.223E+004  | 7.511E+001 |
| A_48_11 | 3.117E+004 | -1.025E+006 | -8.466E+005 | 5.564E+001 |
| A_47_1  | 3.115E+004 | -8.713E+005 | -2.521E+006 | 6.922E+001 |
| A_47_11 | 3.115E+004 | -8.618E+005 | -3.755E+006 | 6.922E+001 |
| C_46_1  | 3.115E+004 | -7.985E+005 | -3.750E+006 | 7.395E+001 |

PHASE 2A. Permanent loads (non-structural bridge equipments)

| Section | N (N)      | V (N)       | M (Nm)      | T (Nm)      |
|---------|------------|-------------|-------------|-------------|
| A_48_1  | 9.672E+003 | -4.757E+005 | 1.046E+004  | -3.176E+003 |
| A_48_11 | 3.115E+004 | -2.232E+005 | -3.007E+005 | -2.353E+003 |
| A_47_1  | 7.6E+005   | -8.672E+005 | -2.558E+003 |             |
| A_47_11 | 7.6E+005   | -1.291E+006 | -2.558E+003 |             |
| C_46_1  | 2.8E+005   | -1.290E+006 | -2.451E+003 |             |

PHASE 2C. Imposed deformations/prestressing

| Section | N (N)      | V (N)      | M (Nm)     | T (Nm)     |
|---------|------------|------------|------------|------------|
| A_48_1  | 0.000E+000 | 0.000E+000 | 0.000E+000 | 0.000E+000 |
| A_48_11 | 0.000E+000 | 0.000E+000 | 0.000E+000 | 0.000E+000 |
| A_47_1  | 0.000E+000 | 0.000E+000 | 0.000E+000 | 0.000E+000 |
| A_47_11 | 0.000E+000 | 0.000E+000 | 0.000E+000 | 0.000E+000 |
| C_46_1  | 0.000E+000 | 0.000E+000 | 0.000E+000 | 0.000E+000 |

PHASE 3A. Thermal actions

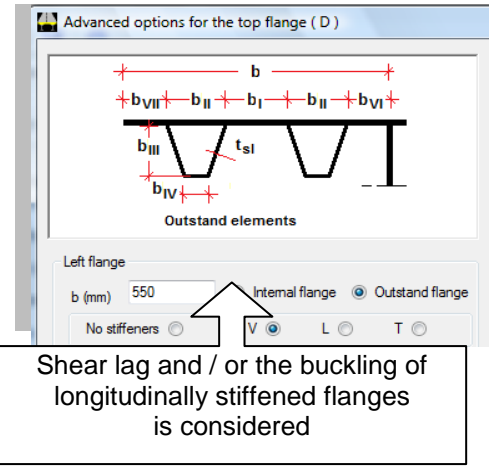
| Section | N (N)      | V (N)      | M (Nm)     | T (Nm)      | (gam psi) Eff. Isost. |
|---------|------------|------------|------------|-------------|-----------------------|
| A_48_1  | 5.688E+003 | 1.710E+005 | 2.385E+003 | 1.433E+001  | 0                     |
| A_48_11 | 5.688E+003 | 1.710E+005 | 1.521E+005 | 1.433E+001  | 0                     |
| A_47_1  | 6.268E+003 | 1.710E+005 | 4.518E+005 | -3.911E+001 | 0                     |

PHASE 3B. Traffic loads

| Section | N (N)       | V (N)       | M (Nm)     | T (Nm)      |
|---------|-------------|-------------|------------|-------------|
| A_48_1  | 1.515E+005  | -1.856E+006 | 1.264E+005 | -1.721E+005 |
| A_48_11 | -3.486E+004 | 2.880E+005  | 2.185E+005 | 4.545E+004  |
| A_47_1  | -7.134E+004 | 2.815E+005  | 6.905E+005 | 5.681E+004  |
| A_47_11 | -7.134E+004 | 2.815E+005  | 1.091E+006 | 5.681E+004  |
| C_46_1  | -7.134E+004 | 2.809E+005  | 1.085E+006 | 5.716E+004  |

## Automated ULS, SLS & fatigue calculations

- Section properties
- Primary (isostatic) effects of shrinkage and temperature change
- Creep & shrinkage coefficients (EN1992-1-1, App B)
- Classification of sections (EN1993-1-1, Table 5.2)
- Ultimate bending check for Class 1 & 2 sections (EN1993-1-1, 6.2.5)
- Stress checks for Class 3 & Class 4 sections (EN1993-1-5, Section 4)
- Ultimate shear & web buckling (EN1993-1-5, Section 5)
- Bending-shear interaction (EN1993-1-5, Section 7)
- SLS stress checks (EN1994-2, 7.2.2 (5) & EN1993-2, 7.3)
- SLS web-breathing check (EN1993-2, 7.4)
- RC crack checks (EN1994-2, 7.4.2)
- ULS, SLS and fatigue checks for connectors (EN1994-2, 6.6 & 6.8)
- ULS, SLS bolted connections (EN 1993-1-8)
- Fatigue checks for both structural steel and reinforcement components (EN 1993-1-9, EN 1994-2, EN 1993-2)
- Longitudinal and transversal stiffeners check (EN 1993-1-5, 9.2.1, (4), (8), (9), 9.3.3 (3))



## Output & reporting

A multi-page form gives the summary results from the checks for each section.

| Phase    | N          | V         | M         | T          |
|----------|------------|-----------|-----------|------------|
| 1        | 4.20E+004  | 2.22E+006 | 1.74E+007 | -1.02E+002 |
| 2a       | -2.96E+004 | 7.13E+005 | 4.77E+006 | 7.78E+001  |
| 2b       | -4.28E+003 | 1.82E+005 | 8.47E+006 | 7.58E+000  |
| Rit. Iso | 0.00E+000  | 0.00E+000 | 0.00E+000 | 0.00E+000  |
| 2c       | 0.00E+000  | 0.00E+000 | 0.00E+000 | 0.00E+000  |
| 3a       | -1.08E+004 | 1.71E+005 | 7.93E+006 | 7.59E+001  |
| DT. Iso  | 0.00E+000  | 0.00E+000 | 0.00E+000 | 0.00E+000  |
| 3b       | -2.64E+005 | 1.26E+006 | 1.46E+007 | -1.78E+002 |
| Total    | -2.66E+005 | 4.55E+006 | 5.31E+007 | -1.94E+002 |

|              | $\epsilon$ | N        | M        | $\gamma_{\psi}$ |
|--------------|------------|----------|----------|-----------------|
| Shrinkage    | -3.366E-4  | -7.56E+6 | -7.04E+6 | 0               |
| Thermal var. | 1E-4       | 5.8E+6   | 3.61E+6  | 0               |

|           | Phase 1  | Phase 2a | Phase 2b | Phase 2c | Phase 3a | Phase 3b |
|-----------|----------|----------|----------|----------|----------|----------|
| Cracked   | -9.69E+2 | 9.62E+2  | 1.39E+2  | 0E+00    | 3.5E+2   | 8.56E+3  |
| Uncracked | -9.69E+2 | 9.74E+2  | 1.39E+2  | 0E+00    | 2.87E+2  | 7.02E+3  |

|                            | c/t    | zpl(mm) | $\alpha$ | $\nu$ | Class    |
|----------------------------|--------|---------|----------|-------|----------|
| Web                        | 161.25 | 2459    | 0.93     | -0.96 | 4        |
| Upper flange               | 10.84  |         |          |       | 1        |
| Lower flange               | 8.46   |         |          |       | 3        |
| <b>Cross-section class</b> |        |         |          |       | <b>4</b> |

**=> Plastic verification NOT APPLICABLE**

|         | N        | M       | N-M Interaction |
|---------|----------|---------|-----------------|
| NEd     | -2.66E+5 | MEd     | 5.31E+7         |
| NRd     | -1.11E+8 | MRd     | 9.42E+7         |
| NEd/NRd | 0.002    | MEd/MRd | 0.564           |
|         |          | MEd/MR  | 0.564           |

Phase 1: Upper flange class=1, Web class=1, Lower flange class=3

Emphasis on descriptive graphics e.g. bending-shear interaction diagram with the web contribution included or excluded.

A report is produced automatically in rtf format, containing all input data and output with references to the Eurocode clauses.



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Ponti EC4 has been developed by Alhambra s.r.l., to meet the needs of engineers in the new era of the Eurocode, which offers opportunities (such as this) for European engineers to share knowledge. The software may be extended to include interfaces with other available software on the basis of interest from users.