Singapore Standard SS EN 1990 : 2008

**Eurocode – Basis of structural design**

# CORRIGENDUM NO. 1

May 2011

This Corrigendum contains the modifications from the Erratum No. 1, which has been withdrawn.

**1. Page v, National Foreword**

*Replace* the 2nd and 3rd paragraphs with the following:

This SS EN is the identical implementation of EN 1990 : 2002 'Eurocode – Basis of structural design' (incorporating the CEN Corrigendum dated April 2010, denoted in the text by AC> <AC) and is adopted with permission of CEN, Avenue Marnix 17, 1000 Brussels.

**2.** *Insert* the attached EN 1990:2002/A1:2005/AC (dated April 2010) after CEN Amendment 1 (EN 1990:2002/A1:2005/AC, December 2005).

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

# EN 1990:2002/A1:2005/AC

April 2010
Avril 2010
April 2010

**ICS** 91.010.30

English version
Version Française
Deutsche Fassung

Eurocode - Basis of structural design

Eurocodes structuraux - Eurocodes: Bases de calcul des structures

Eurocode: Grundlagen der Tragwerksplanung

This corrigendum becomes effective on 21 April 2010 for incorporation in the three official language versions of the EN.

Ce corrigendum prendra effet le 21 avril 2010 pour incorporation dans les trois versions linguistiques officielles de la EN.

Die Berichtigung tritt am 21.April 2010 zur Einarbeitung in die drei offiziellen Sprachfassungen der EN in Kraft.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

**Management Centre: Avenue Marnix 17, B-1000 Brussels**



Ref. No.:EN 1990:2002/A1:2005/AC:2010 D/E/F

**Notice**

The present corrigendum contains the modifications from the former corrigendum EN 1990:2002/A1:2005/AC:2008.

## 1) Modification to the very beginning of the amendment

*Very beginning of EN 1990:2002/A1:2005, just after the Foreword and before Annex A2, add the following pages containing the new modifications going from Modifications 1) [for Modifications to "Background of the Eurocode programme"] until Modifications 17) [for Modifications to A1.4.1]:*

## 1) Modifications to "Background of the Eurocode programme"

*2nd paragraph, 3rd line, replace* "national rules" *with* "national provisions".

*4th paragraph, 7th and 8th lines, replace* "Council Directives 93/37/EEC, 92/50/EEC and 89/440/EEC" *with* "Council Directives 2004/17/EC and 2004/18/EC".

## 2) Modifications to "Status and field of application of Eurocodes"

*2nd paragraph, 5th and 6th lines, after* "product standards", *add* "and ETAGs".

*3rd paragraph, 2nd line, replace* "component" *with* "parts of works and structural construction".

## 3) Modifications to "Links between Eurocodes and harmonised technical specifications (ENs and ETAs) for products"

*2nd line, replace* "technical rules" *with* "technical provisions".

*3rd line, replace* "refer to" *with* "use the".

## 4) Modifications to "National annex for EN 1990"

*2nd paragraph, replace:*

"National choice is allowed in EN 1990 through :"

*with:*

"National choice is allowed in EN 1990 Annex A1 through;".

*After A.1.4.2(2), add:*

"National choice is allowed in EN 1990 Annex A2 through:

*General clauses*

| Clause | Item |
|---|---|
| A2.1 (1) NOTE 3 | Use of Table 2.1 : Design working life |
| A2.2.1(2) NOTE 1 | Combinations involving actions which are outside the scope of EN 1991 |
| A2.2.6(1) NOTE 1 | Values of $\psi$ factors |
| A2.3.1(1) | Alteration of design values of actions for ultimate limit states |
| A2.3.1(5) | Choice of Approach 1, 2 or 3 |
| A2.3.1(7) | Definition of forces due to ice pressure |
| A2.3.1(8) | Values of $\gamma_P$ factors for prestressing actions where not specified in the relevant design Eurocodes |
| A2.3.1 Table A2.4(A) NOTES 1 and 2 | Values of $\gamma$ factors |
| A2.3.1 Table A2.4(B) | - NOTE 1 : choice between 6.10 and 6.10a/b<br>- NOTE 2 : Values of $\gamma$ and $\xi$ factors<br>- NOTE 4 : Values of $\gamma_{Sd}$ |

| | |
|---|---|
| A2.3.1 Table A2.4(C) | Values of $\gamma$ factors |
| A2.3.2(1) | Design values in Table A2.5 for accidental designs situations, design values of accompanying variable actions and seismic design situations |
| A2.3.2 Table A2.5 NOTE | Design values of actions |
| A2.4.1(1)<br>NOTE 1 (Table A2.6)<br>NOTE 2 | Alternative $\gamma$ values for traffic actions for the serviceability limit state<br>Infrequent combination of actions |
| A2.4.1(2) | Serviceability requirements and criteria for the calculation of deformations |

*Clauses specific for road bridges*

| Clause | Item |
|---|---|
| A2.2.2 (1) | Reference to the infrequent combination of actions |
| A2.2.2(3) | Combination rules for special vehicles |
| A2.2.2(4) | Combination rules for snow loads and traffic loads |
| A2.2.2(6) | Combination rules for wind and thermal actions |
| A2.2.6(1) NOTE 2 | Values of $\psi_{1,infq}$ factors |
| A2.2.6(1) NOTE 3 | Values of water forces |

*Clauses specific for footbridges*

| Clause | Item |
|---|---|
| A2.2.3(2) | Combination rules for wind and thermal actions |
| A2.2.3(3) | Combination rules for snow loads and traffic loads |
| A2.2.3(4) | Combination rules for footbridges protected from bad weather |
| A2.4.3.2(1) | Comfort criteria for footbridges |

*Clauses specific for railway bridges*

| Clause | Item |
|---|---|
| A2.2.4(1) | Combination rules for snow loading on railway bridges |
| A2.2.4(4) | Maximum wind speed compatible with rail traffic |
| A2.4.4.1(1) NOTE 3 | **Deformation and vibration requirements for temporary railway bridges** |
| A2.4.4.2.1(4)P | Peak values of deck acceleration for railway bridges and associated frequency range |
| A2.4.4.2.2 – Table A2.7 NOTE | Limiting values of deck twist for railway bridges |

| | |
|---|---|
| A2.4.4.2.2(3)P | Limiting values of the total deck twist for railway bridges |
| A2.4.4.2.3(1) | Vertical deformation of ballasted and non ballasted railway bridges |
| A2.4.4.2.3(2) | Limitations on the rotations of non-ballasted bridge deck ends for railway bridges |
| A2.4.4.2.3(3) | Additional limits of angular rotations at the end of decks |
| A2.4.4.2.4(2) – Table A2.8 NOTE 3 | Values of $\alpha_i$ and $r_i$ factors |
| A2.4.4.2.4(3) | Minimum lateral frequency for railway bridges |
| A2.4.4.3.2(6) | Requirements for passenger comfort for temporary bridges |

".

## 5) Modification to 1.3

*Article (2), 3rd dash, replace this list entry with the following one:*

"

– adequate supervision and quality control is provided during design and during execution of the work, i.e., factories, plants, and on site;

".

## 6) Modification to 1.5.3.17

*Add the following NOTE:*

"NOTE For the frequent value of multi-component traffic actions see load groups in EN 1991-2.".

## 7) Modification to 1.5.6.10

*Title, delete* "(first or second order)".

## 8) Modification to 1.6

*Replace the content of the entire subclause with:*

"For the purposes of this European Standard, the following symbols apply.

NOTE The notation used is based on ISO 3898:1987.

*Latin upper case letters*

| | |
|---|---|
| $A$ | Accidental action |
| $A_d$ | Design value of an accidental action |
| $A_{Ed}$ | Design value of seismic action $A_{Ed} = \gamma_I A_{Ek}$ |
| $A_{Ek}$ | Characteristic value of seismic action |
| $C_d$ | Nominal value, or a function of certain design properties of materials |
| $E$ | Effect of actions |
| $E_d$ | Design value of effect of actions |
| $E_{d,dst}$ | Design value of effect of destabilising actions |

| | |
|---|---|
| $E_{d,stb}$ | Design value of effect of stabilising actions |
| $F$ | Action |
| $F_d$ | Design value of an action |
| $F_k$ | Characteristic value of an action |
| $F_{rep}$ | Representative value of an action |
| $F_w$ | Wind force (general symbol) |
| $F_{wk}$ | Characteristic value of the wind force |
| $F_W^*$ | Wind force compatible with road traffic |
| $F_W^{**}$ | Wind force compatible with railway traffic |
| $G$ | Permanent action |
| $G_d$ | Design value of a permanent action |
| $G_{d,inf}$ | Lower design value of a permanent action |
| $G_{d,sup}$ | Upper design value of a permanent action |
| $G_k$ | Characteristic value of a permanent action |
| $G_{k,j}$ | Characteristic value of permanent action *j* |
| $G_{k,j,sup}$ / $G_{k,j,inf}$ | Upper/lower characteristic value of permanent action *j* |
| $G_{set}$ | Permanent action due to uneven settlements |
| $P$ | Relevant representative value of a prestressing action (see EN 1992 to EN 1996 and EN 1998 to EN 1999) |
| $P_d$ | Design value of a prestressing action |
| $P_k$ | Characteristic value of a prestressing action |
| $P_m$ | Mean value of a prestressing action |
| $Q$ | Variable action |
| $Q_d$ | Design value of a variable action |
| $Q_k$ | Characteristic value of a single variable action |
| $Q_{k,1}$ | Characteristic value of the leading variable action *1* |
| $Q_{k,i}$ | Characteristic value of the accompanying variable action *i* |
| $Q_{Sn}$ | Characteristic value of snow load |
| $R$ | Resistance |
| $R_d$ | Design value of the resistance |
| $R_k$ | Characteristic value of the resistance |
| $T$ | Thermal climatic action (general symbol) |
| $T_k$ | Characteristic value of the thermal climatic action |
| $X$ | Material property |
| $X_d$ | Design value of a material property |
| $X_k$ | Characteristic value of a material property |

*Latin lower case letters*

| | |
|---|---|
| $a_d$ | Design values of geometrical data |
| $a_k$ | Characteristic values of geometrical data |
| $a_{nom}$ | Nominal value of geometrical data |
| $d_{set}$ | Difference in settlement of an individual foundation or part of a foundation compared to a reference level |
| $u$ | Horizontal displacement of a structure or structural member |

| | |
|---|---|
| $w$ | Vertical deflection of a structural member |

*Greek upper case letters*

| | |
|---|---|
| $\Delta a$ | Change made to nominal geometrical data for particular design purposes, *e.g.* assessment of effects of imperfections |
| $\Delta d_{set}$ | Uncertainty attached to the assessment of the settlement of a foundation or part of a foundation |

*Greek lower case letters*

| | |
|---|---|
| $\gamma$ | Partial factor (safety or serviceability) |
| $\gamma_{bt}$ | Maximum peak value of bridge deck acceleration for ballasted track |
| $\gamma_{df}$ | Maximum peak value of bridge deck acceleration for direct fastened track |
| $\gamma_{Gset}$ | Partial factor for permanent actions due to settlements, also accounting for model uncertainties |
| $\gamma_f$ | Partial factor for actions, which takes account of the possibility of unfavourable deviations of the action values from the representative values |
| $\gamma_F$ | Partial factor for actions, also accounting for model uncertainties and dimensional variations |
| $\gamma_g$ | Partial factor for permanent actions, which takes account of the possibility of unfavourable deviations of the action values from the representative values |
| $\gamma_G$ | Partial factor for permanent actions, also accounting for model uncertainties and dimensional variations |
| $\gamma_{G,j}$ | Partial factor for permanent action *j* |
| $\gamma_{G,j,sup}$ / $\gamma_{G,j,inf}$ | Partial factor for permanent action *j* in calculating upper/lower design values |
| $\gamma_I$ | Importance factor (see EN 1998) |
| $\gamma_m$ | Partial factor for a material property |
| $\gamma_M$ | Partial factor for a material property, also accounting for model uncertainties and dimensional variations |
| $\gamma_P$ | Partial factor for prestressing actions (see EN 1992 to EN 1996 and EN 1998 to EN 1999) |
| $\gamma_q$ | Partial factor for variable actions, which takes account of the possibility of unfavourable deviations of the action values from the representative values |
| $\gamma_Q$ | Partial factor for variable actions, also accounting for model uncertainties and dimensional variations |
| $\gamma_{Q,i}$ | Partial factor for variable action *i* |
| $\gamma_{Rd}$ | Partial factor associated with the uncertainty of the resistance model |
| $\gamma_{Sd}$ | Partial factor associated with the uncertainty of the action and/or action effect model |
| $\eta$ | Conversion factor |
| $\xi$ | Reduction factor |

$\psi_0$ Factor for combination value of a variable action
$\psi_1$ Factor for frequent value of a variable action
$\psi_2$ Factor for quasi-permanent value of a variable action"
".

## 9) Modification to 2.1

*Article (1)P, 2nd dash, replace:*

"- remain fit for the use for which it is required."

*with the following bullet point including a new NOTE:*

"- meet the specified serviceability requirements for a structure or a structural element.

NOTE See also 1.3, 2.1(7) and 2.4(1) P.".

## 10) Modification to 3.3

*Article (4)P, replace the NOTE with:*

"NOTE Different sets of partial factors are associated with the various ultimate limit states, see 6.4.1.".

## 11) Modifications to 4.1.3

*Article (1)P, list entry (b), replace NOTE 2 with:*

"NOTE 2 The infrequent value, represented as a product $\psi_{1,infq}Q_k$, may be used only for the verification of certain serviceability limit states specifically for concrete bridges The infrequent value which is defined only for road traffic loads (see EN 1991-2) is based on a return period of one year.".

*Article (1)P, list entry (b), add new NOTE 3 as follows:*

"NOTE 3 For the frequent value of multi-component traffic actions see EN 1991-2.".

## 12) Modification to 4.1.5

*Replace:*

"(1) The characteristic and fatigue load models in EN 1991 include the effects of accelerations caused by the actions either implicitly in the characteristic loads or explicitly by applying dynamic enhancement factors to characteristic static loads."

*with:*

"(1) The load models defined by characteristic values, and fatigue load models, in EN 1991 may include the effects of accelerations caused by the actions either implicitly or explicitly by applying dynamic enhancement factors.".

## 12) Modifications to 6.4.1

*Article (1)P, list entry a), 1st dash, replace this list entry with:*

"

- minor variations in the value or the spatial distribution of permanent actions from a single source are significant, and

".

*Article (1)P, list entry d), replace the NOTE with:*

"NOTE For fatigue design, the combinations of actions are given in EN 1992 to EN 1995, EN 1998 and EN 1999.".

*Article (1)P, add new list entries e) and f) as follows:*

"

e) UPL : loss of equilibrium of the structure or the ground due to uplift by water pressure (buoyancy) or other vertical actions ;

NOTE See EN 1997.

f) HYD : hydraulic heave, internal erosion and piping in the ground caused by hydraulic gradients.

NOTE See EN 1997.
".

## 13) Modification to 6.4.3.3

*Article (4), 2nd paragraph, replace with:*

"For fire situations, apart from the temperature effect on the material properties, $A_d$ should represent the design value of the indirect effects of thermal action due to fire.".

## 14) Modification to A.1.2.2

*Article (1), replace the NOTE with:*

"NOTE Recommended values of $\psi$ factors for the more common actions may be obtained from Table A1.1. For $\psi$ factors during execution see EN 1991-1-6 Annex A1.".

## 15) Modifications to A.1.3.1

*Replace Article (7) with:*

"(7) Hydraulic (HYD) and buoyancy (UPL) failure (e.g. in the bottom of an excavation for a building structure) should be verified in accordance with EN 1997.".

*Tables A1.2(A), A1.2(B) and A1.2(C), replace these tables and their respective titles with the following ones:*

"

**Table A1.2(A) - Design values of actions (EQU) (Set A)**

| Persistent and transient design situations | Permanent actions | | Leading variable action (*) | Accompanying variable actions | |
|---|---|---|---|---|---|
| | Unfavourable | Favourable | | Main (if any) | Others |
| (Eq. 6.10) | $\gamma_{G,j,sup} G_{k,j,sup}$ | $\gamma_{G,j,inf} G_{k,j,inf}$ | $\gamma_{Q,1}$ $Q_{k,1}$ | | $\gamma_{Q,i} \psi_{0,i} Q_{k,i}$ |

(*) Variable actions are those considered in Table A1.1

NOTE 1 The $\gamma$ values may be set by the National annex. The recommended set of values for $\gamma$ are :

$\gamma_{G,j,sup}$ = 1,10

$\gamma_{G,j,inf}$ = 0,90

$\gamma_{Q,1}$ = 1,50 where unfavourable (0 where favourable)

$\gamma_{Q,i}$ = 1,50 where unfavourable (0 where favourable)

NOTE 2 In cases where the verification of static equilibrium also involves the resistance of structural members, as an alternative to two separate verifications based on Tables A1.2(A) and A1.2(B), a combined verification, based on Table A1.2(A), may be adopted, if allowed by the National annex, with the following set of recommended values. The recommended values may be altered by the National annex.

$\gamma_{G,j,sup}$ = 1,35

$\gamma_{G,j,inf}$ = 1,15

$\gamma_{Q,1}$ = 1,50 where unfavourable (0 where favourable)

$\gamma_{Q,i}$ = 1,50 where unfavourable (0 where favourable)

provided that applying $\gamma_{G,j,inf}$ = 1,00 both to the favourable part and to the unfavourable part of permanent actions does not give a more unfavourable effect.

## Table A1.2(B) - Design values of actions (STR/GEO) (Set B)

| Persistent and transient design situations | Permanent actions | | Leading variable action | Accompanying variable actions (*) | |
|---|---|---|---|---|---|
| | Unfavourable | Favourable | | Main (if any) | Others |
| (Eq. 6.10) | $\gamma_{G,j,sup}G_{k,j,sup}$ | $\gamma_{G,j,inf}G_{k,j,inf}$ | $\gamma_{Q,1}Q_{k,1}$ | | $\gamma_{Q,i}\psi_{0,i}Q_{k,i}$ |

| Persistent and transient design situations | Permanent actions | | Leading variable action (*) | Accompanying variable actions (*) | |
|---|---|---|---|---|---|
| | Unfavourable | Favourable | Action | Main | Others |
| (Eq. 6.10a) | $\gamma_{G,j,sup}G_{k,j,sup}$ | $\gamma_{G,j,inf}G_{k,j,inf}$ | | $\gamma_{Q,1}\psi_{0,1}Q_{k,1}$ | $\gamma_{Q,i}\psi_{0,i}Q_{k,i}$ |
| (Eq. 6.10b) | $\xi\gamma_{G,j,sup}G_{k,j,sup}$ | $\gamma_{G,j,inf}G_{k,j,inf}$ | $\gamma_{Q,1}Q_{k,1}$ | | $\gamma_{Q,i}\psi_{0,i}Q_{k,i}$ |

(*) Variable actions are those considered in Table A1.1

NOTE 1 The choice between 6.10, or 6.10a and 6.10b will be in the National annex. In case of 6.10a and 6.10b, the National annex may in addition modify 6.10a to include permanent actions only.

NOTE 2 The $\gamma$ and $\xi$ values may be set by the National annex. The following values for $\gamma$ and $\xi$ are recommended when using expressions 6.10, or 6.10a and 6.10b.

$\gamma_{G,j,sup}$ = 1,35
$\gamma_{G,j,inf}$ = 1,00
$\gamma_{Q,1}$ = 1,50 where unfavourable (0 where favourable)
$\gamma_{Q,i}$ = 1,50 where unfavourable (0 where favourable)
$\xi$ = 0,85 (so that $\xi\gamma_{G,j,sup} = 0,85 \times 1,35 \cong 1,15$).
See also EN 1991 to EN 1999 for $\gamma$ values to be used for imposed deformations.

NOTE 3 The characteristic values of all permanent actions from one source are multiplied by $\gamma_{G,sup}$ if the total resulting action effect is unfavourable and $\gamma_{G,inf}$ if the total resulting action effect is favourable. For example, all actions originating from the self weight of the structure may be considered as coming from one source; this also applies if different materials are involved.

NOTE 4 For particular verifications, the values for $\gamma_G$ and $\gamma_Q$ may be subdivided into $\gamma_g$ and $\gamma_q$ and the model uncertainty factor $\gamma_{Sd}$. A value of $\gamma_{Sd}$ in the range 1,05 to 1,15 can be used in most common cases and can be modified in the National annex.

**Table A1.2(C) - Design values of actions (STR/GEO) (Set C)**

| Persistent and transient design situation | Permanent actions | | Leading variable action (*) | Accompanying variable actions (*) | |
|---|---|---|---|---|---|
| | Unfavourable | Favourable | | Main (if any) | Others |
| (Eq. 6.10) | $\gamma_{G,j,sup} G_{k,j,sup}$ | $\gamma_{G,j,inf} G_{k,j,inf}$ | $\gamma_{Q,1}\ Q_{k,1}$ | | $\gamma_{Q,i} \psi_{0,i} Q_{k,i}$ |

(*) Variable actions are those considered in Table A1.1

NOTE The $\gamma$ values may be set by the National annex. The recommended set of values for $\gamma$ are :

$\gamma_{G,j,sup} = 1,00$

$\gamma_{G,j,inf} = 1,00$

$\gamma_{Q,1} = 1,30$ where unfavourable (0 where favourable)

$\gamma_{Q,i} = 1,30$ where unfavourable (0 where favourable)

".

## 16) Modification to A.1.3.2

*Table A1.3, replace the table with the following one:*

"

| Design situation | Permanent actions | | Leading accidental or seismic action | Accompanying variable actions (**) | |
|---|---|---|---|---|---|
| | Unfavourable | Favourable | | Main (if any) | Others |
| Accidental (*) (Eq. 6.11a/b) | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $A_d$ | $\psi_{1,1}$ or $\psi_{2,1} Q_{k,1}$ | $\psi_{2,i}\ Q_{k,i}$ |
| Seismic (Eq. 6.12a/b) | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $A_{Ed} = \gamma_I A_{Ek}$ | | $\psi_{2,i}\ Q_{k,i}$ |

(*) In the case of accidental design situations, the main variable action may be taken with its frequent or, as in seismic combinations of actions, its quasi-permanent values. The choice will be in the National annex, depending on the accidental action under consideration. See also EN 1991-1-2.

(**) Variable actions are those considered in Table A1.1.

".

## 17) Modification to A1.4.1

*Table A1.4, replace the table with the following one:*

"

| Combination | Permanent actions $G_d$ | | Variable actions $Q_d$ | |
|---|---|---|---|---|
| | Unfavourable | Favourable | Leading | Others |
| Characteristic | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $Q_{k,1}$ | $\psi_{0,i}Q_{k,i}$ |
| Frequent | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $\psi_{1,1}Q_{k,1}$ | $\psi_{2,i}Q_{k,i}$ |
| Quasi-permanent | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $\psi_{2,1}Q_{k,1}$ | $\psi_{2,i}Q_{k,i}$ |

".".

## 2) Modification to "Annex A2"

*Just before the line "Annex A2" and the title of the Annex, add the following instruction:*

### "18) Modification to the Annexes

*At the end of Annex A1 and before Annex B, add the following Annex A2:*".

## 3) Modification to A2.1.1

*Delete the line with the subclause number and title:*

"**A2.1.1 General**".

## 4) Modification to A2.1.2

*Delete the whole subclause A2.1.2.*

## 5) Modification to A2.2.4

*Paragraph (2), list, replace the second list entry with the following one:*

"

– vertical rail traffic actions excluding dynamic factor and lateral rail traffic actions from the “unloaded train” defined in EN 1991-2 (6.3.4 and 6.5) with wind forces for checking stability.”

".

## 6) Modifications to A2.2.5

*Article (2), replace NOTE 1 with:*

"NOTE 1 For actions due to impact from traffic, see EN 1991-1-7.".

*Article (3), replace NOTE 1 with:*

"NOTE 1 For actions due to impact from traffic, see EN 1991-1-7.".

## 7) Modifications to A2.2.6

*Table A2.1, 4th column ("*$\Psi_1$*"), 7th row (*"Traffic loads"/"gr3 (Pedestrian loads)"*), replace:*

"0"

*with:*

"0,40".

*Table A2.1, 4th column ("*$\Psi_1$*"), 8th row (*"Traffic loads"/"gr4 (LM4 – Crowd loading))"*), replace:*

"0,75"

*with:*

"-".

*Table A2.1, 4th column ("$\Psi_1$"), 9th row (*"Traffic loads"/"gr5 (LM3 – Special vehicles))"*), replace:*

"0"

*with:*

"-".

*Replace Paragraph (2) with the following one:*

"(2) For railway bridges, a unique $\psi$ value should be applied to one group of loads as defined in EN 1991-2, and taken as equal to the $\psi$ value applicable to the leading component of the group.".

*Replace Paragraph (3) with the following one:*

"(3) For railway bridges, where groups of loads are used the groups of loads defined in EN 1991-2, 6.8.2, Table 6.11 should be used.".

*Replace Paragraph (4) with the following one:*

"(4) Where relevant, combinations of individual traffic actions (including individual components) should be taken into account for railway bridges. Individual traffic actions may also have to be taken into account, for example for the design of bearings, for the assessment of maximum lateral and minimum vertical traffic loading, bearing restraints, maximum overturning effects on abutments (especially for continuous bridges), etc., see Table A2.3.".

## 8) Modifications to A2.3.1

*Replace Paragraph (7) with the following one:*

"(7) Hydraulic (HYD) and buoyancy (UPL) failure (e.g. in the bottom of an excavation for a bridge foundation), if relevant, should be verified in accordance with EN 1997.".

*Tables A.2.4(A), (B) and (C), replace these tables and their respective titles with the following ones:*

"

**Table A2.4(A) - Design values of actions (EQU) (Set A)**

| Persistent and transient design situation | Permanent actions | | Prestress | Leading variable action (*) | Accompanying variable actions (*) | |
|---|---|---|---|---|---|---|
| | Unfavourable | Favourable | | | Main (if any) | Others |
| (Eq. 6.10) | $\gamma_{G,j,sup} G_{k,j,sup}$ | $\gamma_{G,j,inf} G_{k,j,inf}$ | $\gamma_P P$ | $\gamma_{Q,1} Q_{k,1}$ | | $\gamma_{Q,i} \psi_{0,i} Q_{k,i}$ |

(*) Variable actions are those considered in Tables A2.1 to A2.3.

NOTE 1 The $\gamma$ values for the persistent and transient design situations may be set by the National Annex.

For persistent design situations, the recommended set of values for $\gamma$ are:
$\gamma_{G,sup} = 1,05$
$\gamma_{G,inf} = 0,95^{(1)}$
$\gamma_Q = 1,35$ for road and pedestrian traffic actions, where unfavourable (0 where favourable)
$\gamma_Q = 1,45$ for rail traffic actions, where unfavourable (0 where favourable)
$\gamma_Q = 1,50$ for all other variable actions for persistent design situations, where unfavourable (0 where favourable).
$\gamma_P$ = recommended values defined in the relevant design Eurocode.

For transient design situations during which there is a risk of loss of static equilibrium, $Q_{k,1}$ represents the dominant destabilising variable action and $Q_{k,i}$ represents the relevant accompanying destabilising variable actions.

During execution, if the construction process is adequately controlled, the recommended set of values for $\gamma$ are:
$\gamma_{G,sup} = 1,05$
$\gamma_{G,inf} = 0,95^{(1)}$
$\gamma_Q = 1,35$ for construction loads where unfavourable (0 where favourable)
$\gamma_Q = 1,50$ for all other variable actions, where unfavourable (0 where favourable)

(1) Where a counterweight is used, the variability of its characteristics may be taken into account, for example, by one or both of the following recommended rules:
– applying a partial factor $\gamma_{G,inf} = 0,8$ where the self-weight is not well defined (e.g. containers);
– by considering a variation of its project-defined position specified proportionately to the dimensions of the bridge, where the magnitude of the counterweight is well defined. For steel bridges during launching, the variation of the counterweight position is often taken equal to ± 1 m.

NOTE 2 For the verification of uplift of bearings of continuous bridges or in cases where the verification of static equilibrium also involves the resistance of structural elements (for example where the loss of static equilibrium is prevented by stabilising systems or devices, e.g. anchors, stays or auxiliary columns), as an alternative to two separate verifications based on Tables A2.4(A) and A2.4(B), a combined verification, based on Table A2.4(A), may be adopted. The National Annex may set the $\gamma$ values. The following values of $\gamma$ are recommended:
$\gamma_{G,sup} = 1,35$
$\gamma_{G,inf} = 1,25$
$\gamma_Q = 1,35$ for road and pedestrian traffic actions, where unfavourable (0 where favourable)
$\gamma_Q = 1,45$ for rail traffic actions, where unfavourable (0 where favourable)
$\gamma_Q = 1,50$ for all other variable actions for persistent design situations, where unfavourable (0 where favourable)
$\gamma_Q = 1,35$ for all other variable actions, where unfavourable (0 where favourable)
provided that applying $\gamma_{G,inf} = 1,00$ both to the favourable part and to the unfavourable part of permanent actions does not give a more unfavourable effect.

## Table A2.4(B) - Design values of actions (STR/GEO) (Set B)

| Persistent and transient design situation | Permanent actions | | Prestress | Leading variable action (*) | Accompanying variable actions (*) | |
|---|---|---|---|---|---|---|
| | Unfavourable | Favourable | | | Main (if any) | Others |
| (Eq. 6.10) | $\gamma_{G,j,sup}G_{k,j,sup}$ | $\gamma_{G,j,inf}G_{k,j,inf}$ | $\gamma_P P$ | $\gamma_{Q,1}Q_{k,1}$ | | $\gamma_{Q,i}\psi_{0,i}Q_{k,i}$ |

| Persistent and transient design situation | Permanent actions | | Prestress | Leading variable action (*) | Accompanying variable actions (*) | |
|---|---|---|---|---|---|---|
| | Unfavourable | Favourable | | | Main (if any) | Others |
| (Eq. 6.10a) | $\gamma_{G,j,sup}G_{k,j,sup}$ | $\gamma_{G,j,inf}G_{k,j,inf}$ | $\gamma_P P$ | | $\gamma_{Q,1}\psi_{0,1}Q_{k,1}$ | $\gamma_{Q,i}\psi_{0,i}Q_{k,i}$ |
| (Eq. 6.10b) | $\xi\gamma_{G,j,sup}G_{k,j,sup}$ | $\gamma_{G,j,inf}G_{k,j,inf}$ | $\gamma_P P$ | $\gamma_{Q,1}Q_{k,1}$ | | $\gamma_{Q,i}\psi_{0,i}Q_{k,i}$ |

(*) Variable actions are those considered in Tables A2.1 to A2.3.

NOTE 1 The choice between 6.10, or 6.10a and 6.10b will be in the National Annex. In the case of 6.10a and 6.10b, the National Annex may in addition modify 6.10a to include permanent actions only.

NOTE 2 The $\gamma$ and $\xi$ values may be set by the National Annex. The following values for $\gamma$ and $\xi$ are recommended when using expressions 6.10, or 6.10a and 6.10b:

$\gamma_{G,sup} = 1,35$ [1)]

$\gamma_{G,inf} = 1,00$

$\gamma_Q = 1,35$ when $Q$ represents unfavourable actions due to road or pedestrian traffic (0 when favourable)

$\gamma_Q = 1,45$ when $Q$ represents unfavourable actions due to rail traffic, for groups of loads 11 to 31 (except 16, 17, 26[3)] and 27[3)]), load models LM71, SW/0 and HSLM and real trains, when considered as individual leading traffic actions (0 when favourable)

$\gamma_Q = 1,20$ when $Q$ represents unfavourable actions due to rail traffic, for groups of loads 16 and 17 and SW/2 (0 when favourable)

$\gamma_Q = 1,50$ for other traffic actions and other variable actions [2)]

$\xi = 0,85$ (so that $\xi\gamma_{G,sup} = 0,85 \times 1,35 \cong 1,15$).

$\gamma_{Gset} = 1,20$ in the case of a linear elastic analysis, and $\gamma_{Gset} = 1,35$ in the case of a non linear analysis, for design situations where actions due to uneven settlements may have unfavourable effects. For design situations where actions due to uneven settlements may have favourable effects, these actions are not to be taken into account.

See also EN 1991 to EN 1999 for $\gamma$ values to be used for imposed deformations.

$\gamma_P$ = recommended values defined in the relevant design Eurocode.

[1)] This value covers: self-weight of structural and non structural elements, ballast, soil, ground water and free water, removable loads, etc.

[2)] This value covers: variable horizontal earth pressure from soil, ground water, free water and ballast, traffic load surcharge earth pressure, traffic aerodynamic actions, wind and thermal actions, etc.

[3)] For rail traffic actions for groups of loads 26 and 27 $\gamma_Q = 1,20$ may be applied to individual components of traffic actions associated with SW/2 and $\gamma_Q = 1,45$ may be applied to individual components of traffic actions associated with load models LM71, SW/0 and HSLM, etc.

*Table continued on next page*

*Table continued from previous page*

NOTE 3 The characteristic values of all permanent actions from one source are multiplied by $\gamma_{G,sup}$ if the total resulting action effect is unfavourable and $\gamma_{G,inf}$ if the total resulting action effect is favourable. For example, all actions originating from the self-weight of the structure may be considered as coming from one source; this also applies if different materials are involved. See however A2.3.1(2).

NOTE 4 For particular verifications, the values for $\gamma_G$ and $\gamma_Q$ may be subdivided into $\gamma_g$ and $\gamma_q$ and the model uncertainty factor $\gamma_{Sd}$. A value of $\gamma_{Sd}$ in the range 1,0–1,15 may be used in most common cases and may be modified in the National Annex.

NOTE 5 Where actions due to water are not covered by EN 1997 (e.g. flowing water), the combinations of actions to be used may be specified for the individual project.

**Table A2.4(C) - Design values of actions (STR/GEO) (Set C)**

| Persistent and transient design situation | Permanent actions | | Prestress | Leading variable action (*) | Accompanying variable actions (*) | |
|---|---|---|---|---|---|---|
| | Unfavourable | Favourable | | | Main (if any) | Others |
| (Eq. 6.10) | $\gamma_{G,j,sup} G_{k,j,sup}$ | $\gamma_{G,j,inf} G_{k,j,inf}$ | $\gamma_P P$ | $\gamma_{Q,1}\ Q_{k,1}$ | | $\gamma_{Q,i} \psi_{0,i} Q_{k,i}$ |
| (*) Variable actions are those considered in Tables A2.1 to A2.3 | | | | | | |
| NOTE The $\gamma$ values may be set by the National Annex. The recommended set of values for $\gamma$ are:<br>$\gamma_{G,sup}$ = 1,00<br>$\gamma_{G,inf}$ = 1,00<br>$\gamma_{Gset}$ = 1,00<br>$\gamma_Q$ = 1,15 for road and pedestrian traffic actions where unfavourable (0 where favourable)<br>$\gamma_Q$ = 1,25 for rail traffic actions where unfavourable (0 where favourable)<br>$\gamma_Q$ = 1,30 for the variable part of horizontal earth pressure from soil, ground water, free water and ballast, for traffic load surcharge horizontal earth pressure, where unfavourable (0 where favourable)<br>$\gamma_Q$ = 1,30 for all other variable actions where unfavourable (0 where favourable)<br>$\gamma_{Gset}$ = 1,00 in the case of linear elastic or non linear analysis, for design situations where actions due to uneven settlements may have unfavourable effects. For design situations where actions due to uneven settlements may have favourable effects, these actions are not to be taken into account.<br>$\gamma_P$ = recommended values defined in the relevant design Eurocode. | | | | | | |

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## 9) Modification to A2.3.2

*Paragraph (1), Table A2.5, replace the table with the following one:*

"

| Design situation | Permanent actions | | Prestress | Accidental or seismic action | Accompanying variable actions (**) | |
|---|---|---|---|---|---|---|
| | Unfavourable | Favourable | | | Main (if any) | Others |
| Accidental(*) (Eq. 6.11a/b) | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $P$ | $A_d$ | $\psi_{1,1}Q_{k,1}$ or $\psi_{2,1}Q_{k,1}$ | $\psi_{2,i}\ Q_{k,i}$ |
| Seismic(***) (Eq. 6.12a/b) | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $P$ | $A_{Ed} = \gamma_I A_{Ek}$ | | $\psi_{2,i}\ Q_{k,i}$ |

(*) In the case of accidental design situations, the main variable action may be taken with its frequent or, as in seismic combinations of actions, its quasi-permanent values. The choice will be in the National Annex, depending on the accidental action under consideration.

(**) Variable actions are those considered in Tables A2.1 to A2.3.

(***) The National Annex or the individual project may specify particular seismic design situations. For railway bridges only one track need be loaded and load model SW/2 may be neglected.

NOTE The design values in this Table A2.5 may be changed in the National Annex. The recommended values are $\gamma$= 1,0 for all non seismic actions.

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## 10)Modification to A2.4.1

*Paragraph (1), Table A2.6, replace the table with the following one:*

"

| Combination | Permanent actions $G_d$ | | Prestress | Variable actions $Q_d$ | |
|---|---|---|---|---|---|
| | Unfavourable | Favourable | | Leading | Others |
| Characteristic | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $P$ | $Q_{k,1}$ | $\psi_{0,i}Q_{k,i}$ |
| Frequent | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $P$ | $\psi_{1,1}Q_{k,1}$ | $\psi_{2,i}Q_{k,i}$ |
| Quasi-permanent | $G_{k,j,sup}$ | $G_{k,j,inf}$ | $P$ | $\psi_{2,1}Q_{k,1}$ | $\psi_{2,i}Q_{k,i}$ |

".