**TC250/SC7/EG8: Harmonization**

**(draft) Final Report** **2014**

# Which clauses in the current EN 1997-1 and -2 are relevant to your EG's topic?

The following clauses are relevant to the Design Approaches:

EN 1997-1: 2.4.7.3.4 Design Approaches

EN 1997-1: 7.6.2.3(9)P mention of Design Approach 3

EN 1997-1: 7.6.3.3(7)P mention of Design Approach 3

EN 1997-1: 9.5.1(9)P mention of Design Approaches

EN 1997-1: Annex A Partial factors

EN 1997-1: Annex B Background to Design Approaches

# Which of those clauses should remain unchanged in the next edition of Eurocode 7?

Not relevant to this EG’s work

# Which of those clauses should be deleted from the next edition of Eurocode 7? Why?

See answer to 4 below.

# Which of those clauses should be changed in the next edition of Eurocode 7? What changes should be made? Why?

The Design Approaches in Eurocode 7 are the singularly most confusing aspect of the code to practicing engineers. They confuse many non-geotechnical engineers in the application of Eurocode 7 and are a major barrier to future harmonization of practice across Europe. They can be replaced by a much simpler approach without any loss of the flexibility they were intended to provide.

All of the clauses listed under 1 above should be deleted or rewritten in order to remove the Design Approaches from Eurocode 7.

See proposal under 5 below.

# What new clauses should be added on your topic in the next edition of Eurocode 7? Why?

## 5.1 Replacing the Design Approaches with Design Combinations

EG8 proposes replacing the Design Approaches (summarized in Table 1) with a series of ‘Design Combinations’, each of which would have its own set of partial factors (see Table 2). The Design Combinations would be numbered 1, 2, 3, etc. and guidance would be given as to which combination should be checked in which circumstance. For example:

* For design of slopes, verify DC1
* For design of retaining structures, verify DCs 2a and 2b – OR - DC 3
* For design of shallow foundations, verify DCs 4a and 4b – OR - DC 5
* For design of pile foundations, verify DC 6 –OR- DC 7
* For numerical methods, verify DC 8a and 8b
* Additional DCs may be needed to cater for EQU, UPL, and HYD – these are under consideration
* DCs for anchors have yet to be proposed

Some of the Design Combinations may turn out to be identical (e.g. the current partial factor values for DC2a and DC1 are identical) – so some rationalization and simplification of table 2 may be possible.

The Design Combinations differ in where partial factors are applied:

* Design Combinations 1, 2a, 4a, and 8a apply partial factors primarily to material strengths (a ‘material factor approach’, MFA).
* Design Combinations 3, 5, 6, and 7 apply partial factors primarily to resistances (a ‘resistance material factor approach’, RFA).
* Design Combinations 2b, 4b, 8b apply partial factors primarily to effects of actions (an ‘effect factor approach’, EFA).

The options indicated by “- OR –” above are provided so that each country may choose (in its National Annex) whether to adopt an MFA or an RFA approach. Thus none of the existing flexibility of the current Design approaches is lost.

## 5.2 Allowing for consequences of failure

EG8 proposes an explicit allowance for the consequence of failure, by adopting the approach suggested in the current EN 1990 with regards to modifying partial factors according to the class of consequence (CC) of the structure/foundation.

EN 1990 currently allows (in an informative annex):

wherein the ‘basic’ partial factor on actions can be increased (or decreased) by an ‘importance factor’ K­FI whose value varies according to Consequence Class (e.g. K­FI = 1.1 for high importance, 1.0 for ‘normal’ importance; and 0.9 for low importance). However, modifying γF in this way has no effect on the verification of slope stability (for example) or other problems when a large proportion of the action comes from the ground (and is therefore determined by ground strength).

EG8 proposes generalizing the concept given in EN 1990, by introducing importance factors for material (i.e. ground) strength (factor K­MI) and resistance (factor K­RI), resulting in:

Only one importance factor (either K­FI or K­MI or K­RI) would be used in any one verification.

**Opinions are sought on what values to assign to K­MI and K­RI for different Consequence Classes. More detailed definition of Consequence Classes is also required. At least two countries in CEN (Netherlands and Denmark) currently specify values for the equivalent of KMI in their National Annexes.**

## 5.3 Values of partial factors for Persistent, Transient, and Accidental Design Situations

EG8 proposes giving explicit values for Persistent, Transient, and Accidental Design Situations (see Table 2). The current version of EN 1997-1 is ambiguous with regard to the values of partial factors for Accidental Design Situations.

**Opinions are sought on whether partial factors for Transient Design Situations should be the same as those for Persistent Design Situations or smaller. At least two countries in CEN (Germany and Austria) currently specify smaller values for Transient Design Situations in their National Annexes.**

**A question for Germany and Austria is whether the reduction in partial factors for Transient Design Situations in your National Annexes could be adequately catered for by the proposal to introduce importance factors on ground strength and resistance (see 5.2 above)?**

# Report prepared by:

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## Table 1 – Current Design Approaches (EN 1997-1: 2004)

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Limit State | | | | STR/GEO | | | | | |
| Design Approach | | | | DA1 | | DA2 | DA3 | DA1 | DA2\* |
| Combination | | | | 1 | 2 |  |  | 1† | ‡ |
| Permanent | Structural | Unf. | γG | 1.35 | 1.0 | 1.35 | 1.35 | 1.0 | 1.0 |
| Fav. | γG,fav | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Geotechnical | Unf. | γG | 1.35 | 1.0 | 1.35 | 1.0 | 1.0 | 1.0 |
| Fav. | γG,fav | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Vari-able | Structural | Unf. | γQ | 1.5 | 1.3 | 1.5 | 1.5 | 1.11 | 1.0 |
| Geotechnical | Unf. | γQ | 1.5 | 1.3 | 1.5 | 1.3 | 1.11 | 1.0 |
| Accidental | | | γA | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Coefficient of shearing resistance | | | γϕ | 1.0 | 1.25 | 1.0 | 1.25 | 1.0 | 1.0 |
| Effective cohesion | | | γc | 1.0 | 1.25 | 1.0 | 1.25 | 1.0 | 1.0 |
| Undrained shear strength | | | γcu | 1.0 | 1.4 | 1.0 | 1.4 | 1.0 | 1.0 |
| Unconfined strength | | | γqu | 1.0 | 1.4 | 1.0 | 1.4 | 1.0 | 1.0 |
| Weight density | | | γγ | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 |
| Bearing resistance | | | γRv | 1.0 | 1.0 | 1.4 | 1.0 | 1.0 | 1.4 |
| Sliding resistance | | | γRh | 1.0 | 1.0 | 1.1 | 1.0 | 1.0 | 1.1 |
| Earth resistance | | | γRe | 1.0 | 1.0 | 1.4 | 1.0 | 1.0 | 1.4 |
| Permanent effects of actions | | | γG | 1.0 | 1.0 | 1.0 | 1.0 | γE = 1.35 | 1.35 |
| Variable effects of actions | | | γQ | 1.0 | 1.0 | 1.0 | 1.0 | 1.5 |
| Accidental effects of actions | | | γA | 1.0 | 1.0 | 1.0 | 1.0 | 1.0 | 1.0? |
| DA1-1† - this is a convenient way to implement DA1-1 in software  DA2‡ - this is an allowed alternative to DA2, the ‘star’ name being suggested by the Thomas Telford Guide by Frank et al. | | | | | | | | | |

## Table 2 – ‘Basic’ partial factors for persistent/transient/accidental design situations

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Limit State | | GEO/STR | | | | | | | | | | |
| Foundation type | | Slopes | Retaining structures | | | Shallow foundations | | | Piles | | Numerical methods | |
| Combination0 | | 1 | 2a | 2b | 3 | 4a | 4b | 5 | 6 | 7 | 8a | 8b |
| Approach1 | | MFA | MFA | EFA | RFA6 | MFA | EFA | RFA6 | RFA6 | RFA6 | MFA | EFA |
| ***Partial factors on actions9 (from EN 1990) including importance factor KFI*** | | | | | | | | | | | | |
| Unfavourable permanent | γG,n | 1.0 | (1) | 1.0 | 1.35/1.35/1.0\* | 1.35/1.35/1.0\* | 1.0 | (4a) | 1.35/1.35/1.0\* | | 1.0 | 1.0 |
| Unfavourable variable | γQ,n | 1.3/1.3/1.0 | 1.1/1.1/1.0 | 1.5/1.5/1.0\* | 1.5/1.5/1.0\* | 1.1/1.1/1.0 | 1.5/1.5/1.0\* | | 1.3/1.3/1.0 | 1.1/1.1/1.0 |
| Favourable perm. | γG,fav,n | 1.0 | 1.0 | | | 1.0 | | | 1.0 | | 1.0 | |
| ***Partial factors on ground parameters including importance factor KMI*** | | | | | | | | | | | | |
| Drained str2 | γϕ,n | 1.25/1.25/1.1\* | (1) | 1.0 | 1.0 | (1) | 1.0 | 1.0 | 1.0 | | (1) | 1.0 |
| Undrained str3 | γcu,n | 1.4 |
| Weight density | γγ,n | 1.0 | 1.0 | | | 1.0 | | | 1.0 | |  | |
| ***Partial factors on ground resistance including importance factor KRI*** | | | | | | | | | | | | |
| Bearing | γRv,n | 1.0# | 1.0# | | 1.4/1.4/1.2\*# | 1.0# | | 1.4/1.4/1.2\*# |  | | 1.0# | 1.0# |
| Sliding | γRh,n | 1.1\*# | 1.1\*# |
| Earth | γRe,n | 1.4/1.4/1.2\*# | 1.4/1.4/1.2\*# |
| Pile shaft4 | γs,n |  | | | | | | | 1.1 ξn\*#$ | |
| Pile sh. tension4 | γs,t,n | 1.15 ξn\*#$ | |
| Pile base4 | γb,n | 1.1 ξn\*#$ | |
| Pile total4 | γt,n | 1.1 ξn\*#$ | |
| Anchor4 | γa,n | 1.15 ξn\*#$ | |
| ***Partial factors on effects of actions7 including importance factor KEI*** | | | | | | | | | | | | |
| Permanent5 | γEG | 1.0 | 1.0 | 1.35/1.35/1.0\* | 1.0 | 1.0 | 1.35/1.35/1.0\* | 1.0 | 1.0 | | 1.0(#) | 1.35/1.35/1.0\*# |
| Variable5 | γEQ |

Where three values are given (e.g. 1.3/1.2/1.0), choose the value according to the design situation (persistent/transient/accidental)

\*values should be multiplied by the appropriate value of γI (Do not apply multiple importance factors: if KFI ≠ 1.0, then KMI = KRI = KEI = 1.0; if KMI ≠ 1.0 or KRI ≠ 1.0, then KFI = KEI = 1.0; etc.)

#values should be multiplied by the appropriate value of γRd or γSd; $when using the ‘alternative’ procedure, set ξn = 1.0

NOTE 0: for Combinations 1-4 must satisfy (Combination X) OR (Combinations Xa AND Xb), corresponding to EN 1990’s exp. (6.10) OR (6.10a AND 6.10b)  
NOTE 1: MFA = material factor approach; RFA = resistance factor approach; EFA = effect factor approach  
NOTE 2: same factor is used for all drained strength parameters (i.e. γϕ = γc)  
NOTE 3: same factor is used for undrained strength and unconfined strength (i.e. γqu = γcu)  
NOTE 4: factors for pile resistance also include the correlation factor ξn based on the number of tests (n) OR a model factor γRd  
NOTE 5: factors on effects of actions apply to structural effects (e.g. bending moments, shear forces, etc.) and geotechnical effects (e.g. bearing and earth pressures)  
NOTE 6: partial factors on actions may be applied to action effects instead  
the factors shaded in peach are defined in EN 1990 (and are outside of SC7’s control)