

2020 vision: Future direction of Eurocode 7

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Chairman TC 250/SC 7

Geocentrix – putting you at the centre



Outline of talk

- Quo vadis, Eurocode 7?
- What are we changing in Eurocode 7?
- What are we removing from Eurocode 7?
- What are we adding to Eurocode 7?
- What happens next?
- Summary of key points

2020 VISION: FUTURE DIRECTION OF EUROCODE 7

QUO VADIS, EUROCODE 7?



Harmonization of technical specifications

In 1975, the Commission of the European Community* (CEC) decided to create an action programme in the field of construction...

“with the objective of promoting free trade between the member states by the elimination of technical obstacles and the harmonization of technical specifications”

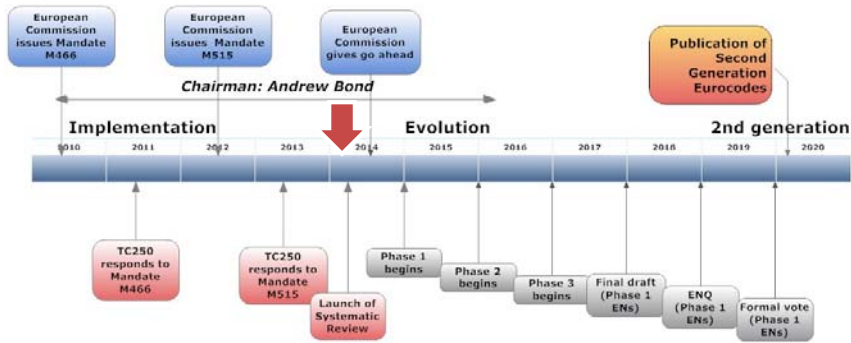
*At the time, the European Economic Community (EEC)

Members of EEC in 1974



BOND (2011) PAST, PRESENT, AND FUTURE OF EC7

Eurocode 7 timeline 2010-2020

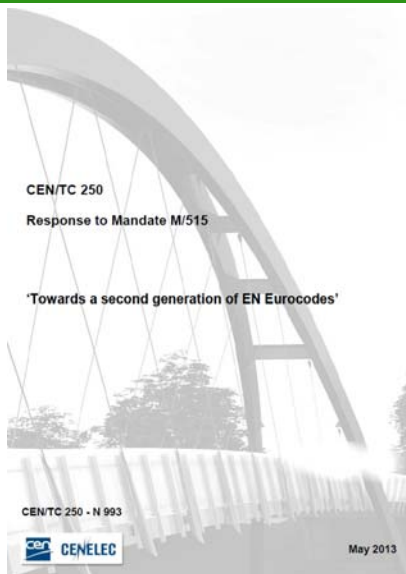


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Response to Mandate M/515



May 2010: European Commission (EC) Mandate M/466 invited CEN to 'initiate the process of further evolution of the Eurocode system, incorporating both new and revised Eurocodes'

Jun '11: CEN's reply, prepared by TC 250, was issued to EC

Dec '12: EC Mandate M/515 invited CEN to develop a detailed work programme based on its reply to M/466

Q1 2013: TC250 prepared a work programme comprising 77 discrete tasks, following consultation with Member States (the 'Response' – since favourably received by EC)

Q1 2014: TC250/CEN submitted technical proposal and financial quotation to EC

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TC250/SC7's six tasks in Response to M/515

Phase 1

1. **Harmonization and ease-of-use**
Reorganized framework for Eurocode 7, to be used as starting documents for Tasks 2-5 below
2. **General rules**
Revised Eurocode 7 Part 1

Phase 2

3. **Ground investigation**
Revised Eurocode 7 Part 2 plus new/revised paragraphs input to Task 2
4. **Foundation, slopes, and ground improvement**
Sections 2-5 and new Annexes in (new) Eurocode 7 Part 3
5. **Retaining structures, anchors, and reinforced ground**
Sections 6-8 and new Annexes in (new) Eurocode 7 Part 3

Phase 3

6. **Rock mechanics and dynamic design**
New/revised paragraphs into Tasks 2-5

WHAT ARE WE CHANGING IN EUROCODE 7?



Planned changes for EN 1997: 2020

Restructure Eurocode 7 to ...

- Make the code easier to navigate
- Harmonize the contents with other Eurocodes
- Make space for new topics

Improved guidance on...

- Selecting characteristic ground parameters
- Selecting design water pressures
- Applying Eurocode 7 to numerical methods
- Rock mechanics and dynamic design

Improve ease-of-use...

- Improve the clarity of existing clauses
- Remove repetition
- Remove 'useless' information

Proposed structure of EN 1997: 2020

EN 1997: 202x

1. General rules
2. Ground investigation
3. Geotechnical constructions

Part 1 – General rules

1. General
2. Basis of geotechnical design
3. Materials
4. Durability
5. Geotechnical analysis
6. Ultimate limit states
7. Serviceability limit states
8. Execution
9. Reporting

Part 2 – Ground investigation

1. General
2. Principles of ground investigation
3. Planning of ground investigations
4. Sampling and groundwater measurements
5. Field tests
6. Laboratory tests
7. Reporting

Part 3 – Geotechnical constructions

1. General
2. Slopes, cuttings, and embankments
3. Spread foundations
4. Pile foundations
5. Retaining structures
6. Anchors
7. Ground improvement
8. Reinforced ground structures

WHAT ARE WE REMOVING FROM EUROCODE 7?



Eurocode 7's existing Design Approaches

Ground strength is verified using ONE of THREE different Design Approaches (DAs). Each DA uses a different set of partial factors

$$E_d \leq R_d$$

Design Approach 1:

A1 "+" M1 "+" R1 (Combination 1)
A2 "+" M2 "+" R1 (Combination 2)

...except for piles, when:

A1 "+" M1 "+" R1 (Combination 1)
A2 "+" (M1 or M2) "+" R4 (Combination 2)

Design Approach 2:

A1 "+" M1 "+" R1

...except for slopes, when the A1 factors must be applied to *effects* of actions

Design Approach 3:

(A1* or A2†) "+" M1 "+" R1 (Combination 1)

...*on structural actions and †on geotechnical actions

Design Approaches expressed more simply

Partial factors applied to	Design Approach				
	1		2		3
	Comb. 1	Comb. 2	(2)	(2*)	
Actions	✓		✓		✓
Material strengths		✓			✓
Effects of actions				✓	
Resistance			✓	✓	

3rd ISSMGE Webinar, Past, present, and future of Eurocode 7, 19 Dec 2011

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National choice of Design Approach for slopes



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AFTER BOND (2013) SPECIAL GEOTECH. PUBL.

National choice of Design Approach for pile foundations



Design Approaches expressed mathematically

Verification of strength $E_d \leq R_d$

Design Approach 1 $E\{\gamma_f F_{rep}\} \leq R\{X_k\}$ and $E\{F_{rep}\} \leq R\left\{\frac{X_k}{\gamma_M}\right\}$

Design Approach 2 $E\{\gamma_f F_k\} \leq \frac{R\{X_k\}}{\gamma_R}$ or $\gamma_f E\{F_k\} \leq \frac{R\{X_k\}}{\gamma_R}$

Design Approach 3 $E\left\{\gamma_f F_{rep, str} / F_{rep, geo}\right\} \leq R\left\{\frac{X_k}{\gamma_M}\right\}$

E = action-effect; R = resistance; F = action; X = material property
 $\gamma_f, \gamma_M, \gamma_E, \gamma_R$ = partial factors

Universal method for verifying strength in EN 1997: 2020

$$E_d \leq R_d$$

$$\gamma_E E \{F_d, X_d, a_d\} \leq \frac{R \{F_d, X_d, a_d\}}{\gamma_R}$$

$$F_d = \sum_i \gamma_{F,i} \psi_i F_{k,i}, X_d = \frac{X_k}{\gamma_M}, a_d = a_{nom} \pm \Delta a$$

E = action-effect; R = resistance; F = action; X = material property; a = geometrical data; $\gamma_F, \gamma_M, \gamma_E, \gamma_R$ = partial factors; Δ_a = safety margin ψ = combination factor

Design combinations to replace Design Approaches

Table 3a – Partial factors for persistent design situations

Limit State	GEO/STR													
	Slopes			Retaining structures			Shallow foundations			Piles			Numerical methods	
Foundation type	1	2a	2b	3	4a	4b	5	6	7	8a	8b	9		
Combination ¹	MFA	MFA	EFA	SFA ¹¹	MFA	EFA	SFA ¹¹	SFA ¹¹	SFA ¹¹	MFA	EFA	RFA		
Approach ¹														
<i>Partial factors on actions⁸ (from EN 1990) including importance factor K₁</i>														
Unfavourable permanent ^{2,3}	γ_Q	1.0 K ₁	Same as (1) ¹¹	1.0	1.35 K ₁	1.35 K ₁	1.0	Same as (4a) ¹¹	1.35 K ₁	1.0 K ₁	1.0	Same as (8a)		
Unfavourable variable ^{2,4}	γ_Q	1.3 ψ_i K ₁		1.1 ψ_i	1.5 ψ_i K ₁	1.5 ψ_i K ₁	1.1 ψ_i		1.5 ψ_i K ₁	1.3 ψ_i K ₁	1.1 ψ_i			
Favourable perm.	$\gamma_{Q,adv}$	1.0		1.0			1.0		1.0		1.0			
<i>Partial factors on ground parameters including importance factor K₂</i>														
Shearing resistance ⁵	$\gamma_{c,adv}$	1.25 K ₂	Same as (1)	1.0	1.0	Same as (1)	1.0	1.0	1.0	Same as (1)	1.0	1.0		
Effective cohesion ⁵	γ_c	1.25 K ₂												
Undrained strength ^{5,12}	γ_{cu}	1.4 K ₂												
Weight density	γ_s	1.0		1.0			1.0		1.0					
<i>Partial factors on ground resistance including importance factor K₃</i>														
Bearing resistance ²	γ_{Rd}	1.0 γ_{Rd}	1.0 γ_{Rd}	1.4 γ_{Rd} K ₃	1.0 γ_{Rd}	1.4 γ_{Rd} K ₃	1.4 γ_{Rd} K ₃					?		
Sliding resistance ²	γ_{Rd}			1.1 γ_{Rd} K ₃		1.1 γ_{Rd} K ₃	1.1 γ_{Rd} K ₃					?		
Earth resistance ²	γ_{Rd}			1.4 γ_{Rd} K ₃		1.4 γ_{Rd} K ₃	1.4 γ_{Rd} K ₃					?		
Pile shaft resistance ^{2,3}	γ_{Rd}			1.1 (1.2 γ_{Rd}) K ₃		1.1 (1.2 γ_{Rd}) K ₃	1.1 (1.2 γ_{Rd}) K ₃	1.0	1.0			?		
Pile shaft (tension) ^{2,3}	γ_{Rd}			1.15 (1.2 γ_{Rd}) K ₃		1.15 (1.2 γ_{Rd}) K ₃	1.15 (1.2 γ_{Rd}) K ₃					?		
Pile base resistance ^{2,3}	γ_{Rd}			1.1 (1.2 γ_{Rd}) K ₃		1.1 (1.2 γ_{Rd}) K ₃	1.1 (1.2 γ_{Rd}) K ₃					?		
Pile top resistance ^{2,3}	γ_{Rd}			1.1 (1.2 γ_{Rd}) K ₃		1.1 (1.2 γ_{Rd}) K ₃	1.1 (1.2 γ_{Rd}) K ₃					?		
Anchor resistance ^{2,3,4}	γ_{Rd}			1.15 (1.2 γ_{Rd}) K ₃		1.15 (1.2 γ_{Rd}) K ₃	1.15 (1.2 γ_{Rd}) K ₃					?		
<i>Partial factors on effects of actions⁷ including importance factor K₄</i>														
Permanent ^{2,3}	γ_{Ed}	1.0	1.0	1.35 K ₄ ¹²	1.0 ¹¹	1.0	1.35 K ₄ ¹²	1.0 ¹¹	1.0 ¹¹	1.0	1.35 K ₄ ¹²	1.35		
Variable ^{2,4}	γ_{Ed}											1.5		

Design Combinations 2020 – applying partial factors

Verification of strength for slopes:

$$\gamma_{G,0} = 1.0, \gamma_{G, fav} = 1.0, \gamma_{Q,0} = 1.3$$

$$\gamma_{\varphi,0} = \gamma_{c,0} = 1.25, \gamma_{cu,0} = 1.4$$

$$(\gamma_{E,0} = 1.0, \gamma_{R,0} = 1.0)$$

... for pile foundations:

$$\gamma_{G,0} = 1.35, \gamma_{G, fav} = 1.0, \gamma_{Q,0} = 1.5$$

$$\gamma_{b,0} > 1.0, \gamma_{s,0} > 1.0, \gamma_{t,0} > 1.0$$

$$(\gamma_{E,0} = 1.0, \gamma_{\varphi,0} = \gamma_{c,0} = \gamma_{cu,0} = 1.0)$$

... for shallow foundations and retaining structures:

$$\gamma_{G,0} = 1.0, \gamma_{G, fav} = 1.0, \gamma_{Q,0} = 1.1$$

$$\gamma_{G,0} = 1.0, \gamma_{G, fav} = 1.0, \gamma_{Q,0} = 1.1$$

$$\gamma_{E,0} = 1.35$$

$$\gamma_{E,0} = 1.35$$

$$(\gamma_{\varphi,0} = \gamma_{c,0} = \gamma_{cu,0} = 1.0)$$

$$\gamma_{Rv,0} = \gamma_{Re,0} = 1.4, \gamma_{Rh,0} = 1.1$$

$$(\gamma_{Rv,0} = \gamma_{Rh,0} = \gamma_{Re,0} = 1.0)$$

$$(\gamma_{\varphi,0} = \gamma_{c,0} = \gamma_{cu,0} = 1.0)$$

+ slope stability check (above)

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PROVISIONAL – DO NOT USE!

WHAT ARE WE ADDING TO EUROCODE 7?



Proposed new Part 3 – Geotechnical constructions

Part 3 – Geotechnical constructions

1. General
 2. Slopes, cuttings, and embankments
 3. Spread foundations
 4. Pile foundations
 5. Retaining structures
 6. Anchors
 7. **Ground improvement**
 8. **Reinforced ground structures**
- Annexes – including **calculation models** for each type of construction

Part 3's common sub-sections

1. General
2. Limit states
3. Actions and design situations
4. Design methods and design considerations
5. Ultimate limit state design
6. Serviceability limit state design
7. Structural design
8. Execution

Reliability differentiation



Each partial factor is 'built-up' from various sub-factors:

$\gamma_{F,0}$ = 'base' load factor

$\gamma_{M,0}$ = 'base' material factor, etc.

K_I = 'importance' factor

γ_{Rd} = model factor

$$\gamma_G = \gamma_{G,0} \times K_{FI}$$

$$\gamma_Q = \gamma_{Q,0} \times K_{FI}$$

$$\gamma_\varphi = \gamma_{\varphi,0} \times K_{MI}$$

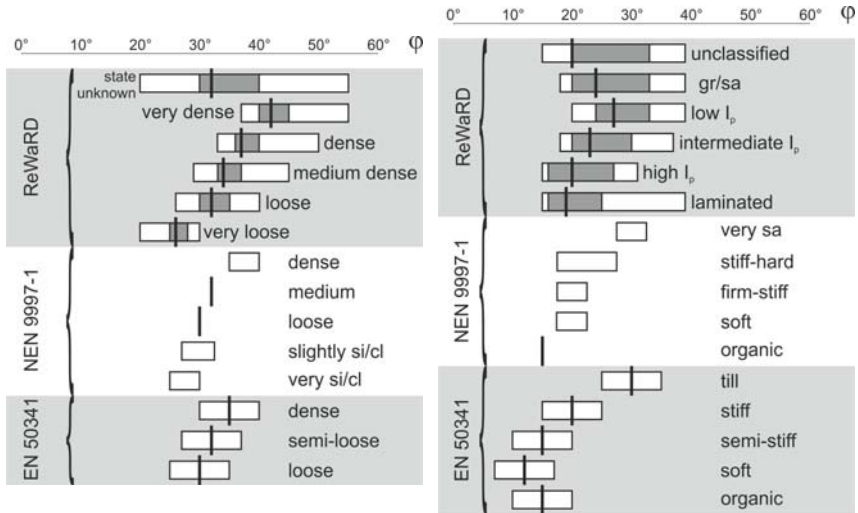
$$\gamma_c = \gamma_{c,0} \times K_{MI}$$

$$\gamma_{cu} = \gamma_{cu,0} \times K_{MI}$$

$$\gamma_E = \gamma_{E,0} \times K_{EI}$$

$$\gamma_R = \gamma_{R,0} \times K_{RI} \times \gamma_{Rd}$$

Presumed values compared – sand and clay



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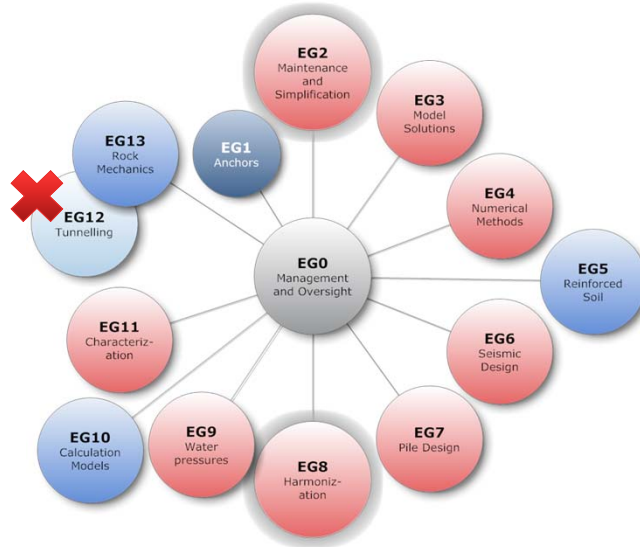
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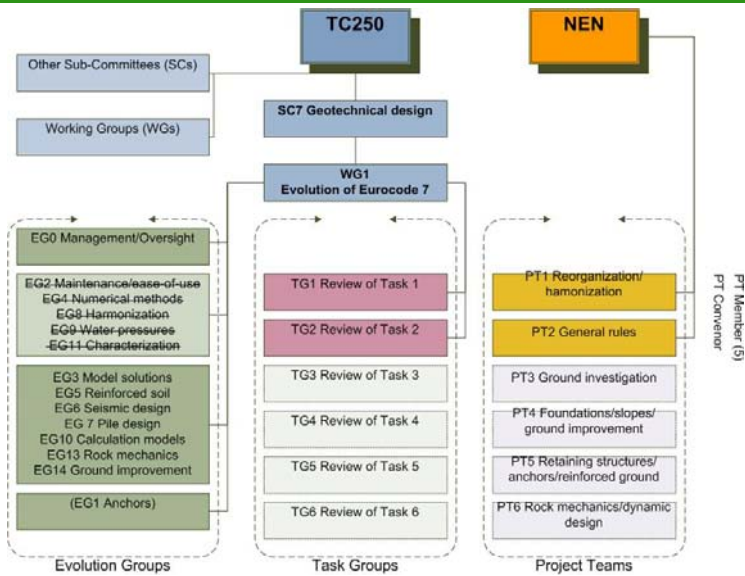
WHAT HAPPENS NEXT?



SC7's Evolution Groups (established 2010)



Proposed reorganization of SC7 'sub-groups' starting 2014



Next steps towards EN 1997: 2020

- ✓ Mandate Response with Quotation submitted to Commission (5/3/14)
Quotation may need to be revised in line with FPA 2014...
- 1. Framework Partnership Agreement (FPA) between CEN and the Commission
FPA governs flow of money from European Commission to CEN to NSBs
Existing agreement expired end 2013
All funding on hold until FPA 2014 is signed
- 2. 'Call for Experts' to undertake mandated work (June 2014?)
- 3. Selection of Project Teams (September 2014?)
- 4. Contract negotiation between PTs and NEN (November 2014?)
- 5. Mandated work by Phase 1 Project Teams begins (December 2014?)
- ✓ Systematic Review of relevant Eurocodes
NSBs to launch public review of all Eurocodes in Phase 1
Can run in parallel to the above
To start end of March 2014

Systematic Review of Eurocode 7

Opportunity for public comments on current Eurocode (Parts 1 and 2 of EN 1997)

1. Do any clauses require editorial or technical correction?
2. Which clauses would benefit from improvements in clarity?
3. Where should the scope of the EN be extended?
4. Where could the EN be shortened?
5. *Are there any clauses whose application results in uneconomic construction?*
6. Are there any clauses whose application necessitates excessive design effort?

In simpler terms:

1. What should we **correct**?
2. What should we **clarify**?
3. What should we **add**?
4. What should we **remove**?
5. What's **too expensive**?
6. What's **too much effort**?



How to respond to the Systematic Review

1. Obtain the 'Template for comments and secretariat observations'
2. Complete the template with your suggestions
3. Submit the template to your NSB
4. NSB will forward to CEN and then onto SC7

In early April 2014, visit www.eurocode7.com

... to find out where this document can be found on the BSI website

Or, follow my blog at blog.eurocode7.com

Template for comments and secretariat observations					Date:	Document:	Project:
MS/NC ¹	Line number (e.g. 17)	Clause/ Subclause (e.g. 3.1)	Paragraph/ Figure/ Table (e.g. Table 1)	Type of comment ²	Comments	Proposed change	Observations of the secretariat

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SUMMARY OF KEY POINTS



2020 vision: future direction of Eurocode 7

Eurocode 7 is now almost 20 years old...

Preparatory work of improving the code has been underway since 2010

By the end of 2014, funded work will be underway on the Eurocode evolution...

The 2nd generation of Eurocodes are expected to appear in 2020

From April to September 2014, several Eurocodes will be 'out for comment'

This is **YOUR chance** to influence the future direction of Eurocode 7

Don't miss this once in a lifetime opportunity!



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Decoding the Eurocodes

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