A few aspects of EUROCODE 7
‘Geotechnical design’

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STRUCTURAL EUROCODES

EN 1990

Basis of Structural design

EN 1991

Actions on structures

EN 1992
EN 1993
EN 1994

«Material » resistance

EN 1995
EN 1996
EN 1999

Geotechnical and seismic design

EN 1997
EN 1998
CEN
European standardization committee
(Comité Européen de Normalisation)

National standards body of:

- 27 EU Member states (including Romania, Bulgaria)
- 3 EFTA Member States: Iceland, Norway and Switzerland
- Albania, FYROMacedonia and Turkey are affiliate Members
Eurocode 7 – Geotechnical design

- **EN 1997-1**: General rules (ENV 1997-1)
- **EN 1997-2**: Ground investigation and testing (ENV 1997-2 + ENV 1997-3)
1. History and present deadlines
2. Contents of documents (Parts 1 & 2)
3. Some aspects of Eurocode 7-1
   Characteristic values
   ULS Design Approaches
   SLS –Serviceability limit states
1. History and present deadlines - Part 1

May 1997: Positive vote for transformation of ENV into an European Norm

In the meantime ...

Resolution N 87 (Paris, 6 September 1996)

- CEN/TC 250 accepts the principle that ENV 1997-1 might be devoted exclusively to the fundamental rules of geotechnical design and be supplemented by national standards

November 2004: promulgation by CEN of the document in 3 languages and by November 2006: publication of EN with National Annex
2001: Positive vote for transformation of ENVs into an European Norm

March 2007: promulgation by CEN of the document in English

and publication by CEN of document in French and German during 2007
Contents of Part 1 (EN 1997-1)

- Section 1 General
- Section 2 Basis of geotechnical design
- Section 3 Geotechnical data
- Section 4 Supervision of construction, monitoring and maintenance
- Section 5 Fill, dewatering, ground improvement and reinforcement
- Section 6  Spread foundations
- Section 7  Pile foundations
- Section 8  Anchorages
- Section 9  Retaining structures
- Section 10 Hydraulic failure
- Section 11 Site stability
- Section 12 Embankments
Informative annexes

Annexes D & E: Bearing capacity of foundations

\[ \frac{R}{A'} = c' \times N_c \times b_c \times s_c \times i_c + \\
q' \times N_q \times b_q \times s_q \times i_q + \\
0.5 \times \gamma \times B' \times N_\gamma \times b_\gamma \times s_\gamma \times i_\gamma \]

\[ \frac{R}{A'} = \sigma_{v0} + k \times p^*_{le} \]

Annexe C – Active earth pressure

\[ \beta = 0 \]

Annexe C – Passive earth pressure

\[ \delta = \frac{2}{3} \varphi \]

Annexe F: Settlement of foundations

\[ s = p \times b \times f / E_m \]
Part 2 (EN 1997-2): Geotechnical design - Ground investigation and testing

Laboratory and field tests:

- essential requirements for the equipment and tests procedures

- essential requirements for the reporting and the presentation of results

- interpretation of test results and derived values

They are NOT test standards → see TC 341
Contents of Part 2 (EN 1997-2)

- Section 1 General
- Section 2 Planning and reporting of ground investigations
- Section 3 Drilling, sampling and gw measurements
- Section 4 Field tests in soils and rocks
- Section 5 Laboratory tests on soils and rocks
- Section 6 Ground investigation report

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3. Some aspects of Eurocode 7-1

- Characteristic values
- ULS Design Approaches
- SLS and deformations of structures
Type of test
F = field  L = laboratory

Correlations

Test results and derived values
EN 1997-2
EN 1997-1

Information from other sources on the site, the soils and rocks and the project

Cautious selection

Geotechnical model and characteristic values of geotechnical properties

Application of partial factors

Design values of geotechnical properties
The characteristic value of a geotechnical parameter shall be selected as a cautious estimate of the value affecting the occurrence of the limit state.

If statistical methods are used, the characteristic value should be derived such that the calculated probability of a worse value governing the occurrence of the limit state under consideration is not greater than 5%.
EN1990 - Ultimate limit states
EQU and STR/GEO

$E_d < R_d$

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### Actions ($\gamma_F$)

| Permanent | $\gamma_G$ | 1.35 | 1.00 |
| Unfavourable | $\gamma_G$ | 1.00 | 1.00 |
| Favourable | $\gamma_G$ | 1.00 | 1.00 |

### Variables ($\gamma_Q$)

| Unfavourable | $\gamma_Q$ | 1.50 | 1.30 |
| Favourable | $\gamma_Q$ | 0.00 | 0.00 |

### Soil Parameters ($\gamma_M$)

- **Angle of shearing resistance**
  - $\gamma_{\phi'}$ | 1.00 | 1.25 |
- **Effective cohesion**
  - $\gamma_{c'}$ | 1.00 | 1.25 |
- **Undrained shear strength**
  - $\gamma_{cu}$ | 1.00 | 1.40 |
- **Unconfined strength**
  - $\gamma_{qu}$ | 1.00 | 1.40 |
- **Weight density**
  - $\gamma_{\gamma}$ | 1.00 | 1.00 |

### Resistance ($\gamma_R$)

- **Bearing Portance**
  - $\gamma_{RV}$ | 1.00 | 1.40 | 1.00 |
- **Sliding**
  - $\gamma_{Rh}$ | 1.00 | 1.10 | 1.00 |

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STR/GEO : accidental situations

All $\gamma_F$ on actions $= 1.0$

$\gamma_R$ depends on the “accident”

STR/GEO : seismic situations

See EN 1998-5
Additional ULS for geotechnical design

- Loss of equilibrium of the structure or the ground due to uplift by water pressure (buoyancy) or other vertical actions (UPL)

- Hydraulic heave, internal erosion and piping in the ground caused by hydraulic gradients (HYD)
Ultimate limit states (UPL)

Examples of situations where uplift might be critical

\[ G_{dst;d} + Q_{dst;d} \leq G_{stb;d} + R_d \]
Ultimate limit states (HYD)

Example of situation where heave or piping might be critical

\[ u_{dst;d} \leq \sigma_{stb;d} \]
\[ \Delta u_{dst;d} \leq \sigma'_{stb;d} \]

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EN1990 - Serviceability limit states

Verifications:

\[ E_d \leq C_d \]

\( C_d \) = limiting design value of the relevant serviceability criterion

\( E_d \) = design value of the effects of actions specified in the serviceability criterion, determined on the basis of the relevant combination
Movements and deformations of structures

- settlement \( s \), differential settlement \( \delta s \), rotation \( \theta \) and angular strain \( \alpha \)
- relative deflection \( \Delta \) and deflection ratio \( \Delta/L \)
- \( \omega \) and relative rotation (angular distortion) \( \beta \)

(after Burland and Wroth, 1975)
Conclusions

Eurocode 7:

- A tool to help European geotechnical engineers speak the same language
- A necessary tool for the dialogue between geotechnical engineers and structural engineers
Eurocode 7 helps promoting research

- it stimulates questions on present geotechnical practice from ground investigation to design models
and to really conclude:

- It should be considered that knowledge of the ground conditions depends on the extent and quality of the geotechnical investigations. Such knowledge and the control of workmanship are usually more significant to fulfilling the fundamental requirements than is precision in the calculation models and partial factors.
Thank you for your attention!