Workshop "Eurocodes: background and applications"

Brussels, 18-20 February 2008

General presentation of EUROCODE 7

'Geotechnical design'

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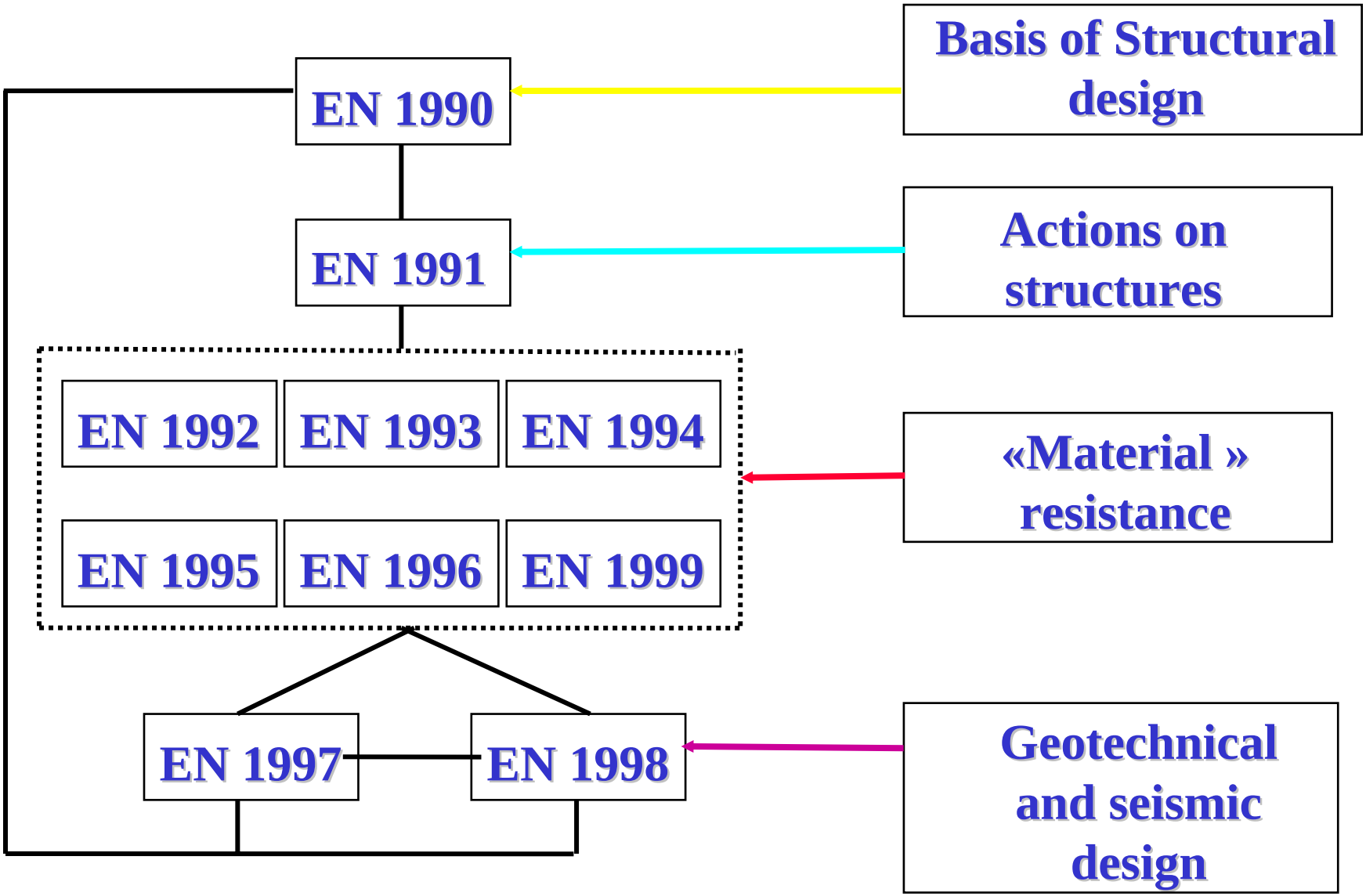
1. Introduction

2. Contents of Eurocode 7 - Parts 1 & 2

3. Some aspects of Eurocode 7-1
   - Characteristic values
   - ULS Design Approaches
   - SLS –Serviceability limit states

STRUCTURAL EUROCODES



Eurocode 7 – Geotechnical design

EN 1997-1 (2004) : Part 1 - General rules

EN 1997-2 (2007) : Part 2 - Ground investigation and testing

2. Contents of Eurocode 7 – Parts 1 & 2

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

EUROPEAN STANDARD EN 1997-1
NORME EUROPÉENNE
EUROPÄISCHE NORM
November 2004

ICS 91.120.20 Supersedes ENV 1997-1:1994

English version

Eurocode 7: Geotechnical design - Part 1: General rules

Eurocode 7: Calcul géotechnique - Partie 1: Règles générales

Eurocode 7: Entwurf, Berechnung und Bemessung in der Geotechnik - Teil 1: Allgemeine Regeln

This European Standard was approved by CEN on 23 April 2004.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Central Secretariat has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

CEN

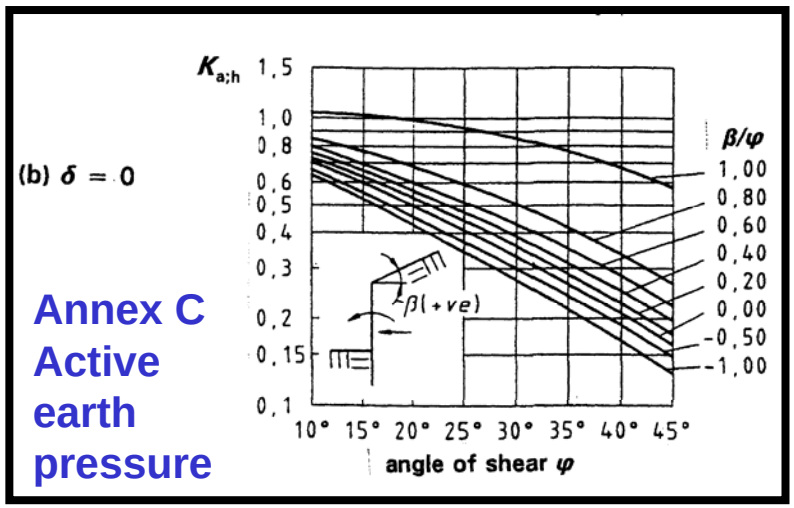
EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

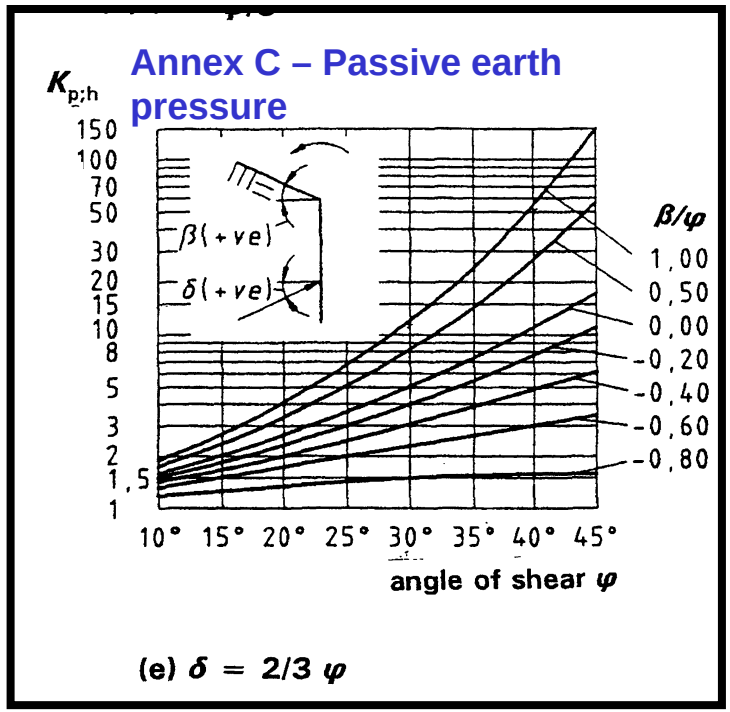
Ref. No. EN 1997-1:2004: E

Contents of Part 1 (cntd)

Informative annexes



Annex C Active earth pressure



Annexes D & E : Bearing capacity of foundations

$$R/A' = c' \times N_c \times b_c \times s_c \times i_c +$$
$$q' \times N_q \times b_q \times s_q \times i_q +$$
$$0{,}5 \times \gamma' \times B' \times N_\gamma \times b_\gamma \times s_\gamma \times i_\gamma$$

$$R/A' = \sigma_{v0} + k \times p^*_{le}$$

Annex 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

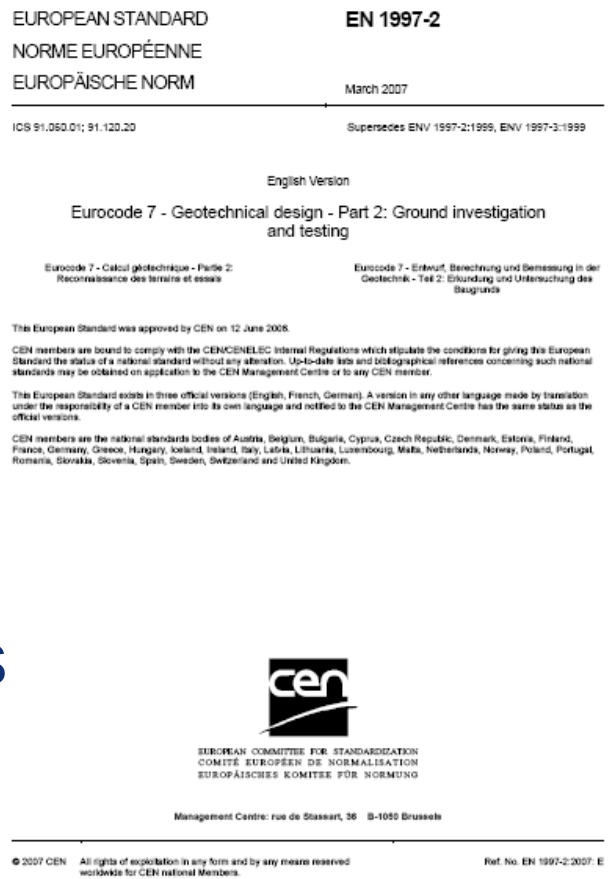
* interpretation of test results and derived values

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

> Also a number of **Informative annexes**



EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 1997-2

March 2007

ICS 91.060.01; 91.120.20

Supersedes ENV 1997-2:1999, ENV 1997-3:1999

English Version

Eurocode 7 - Geotechnical design - Part 2: Ground investigation and testing

Eurocode 7 - Calcul géotechnique - Partie 2: Reconnaissance des terrains et essais

Eurocode 7 - Entwurf, Berechnung und Bemessung in der Geotechnik - Teil 2: Erkundung und Untersuchung des Baugrunds

This European Standard was approved by CEN on 12 June 2006.

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Ref. No. EN 1997-2:2007: E

3. Some aspects of Eurocode 7-1

Characteristic values and design values

ULS Design Approaches

SLS and deformations of structures

Geotechnical properties

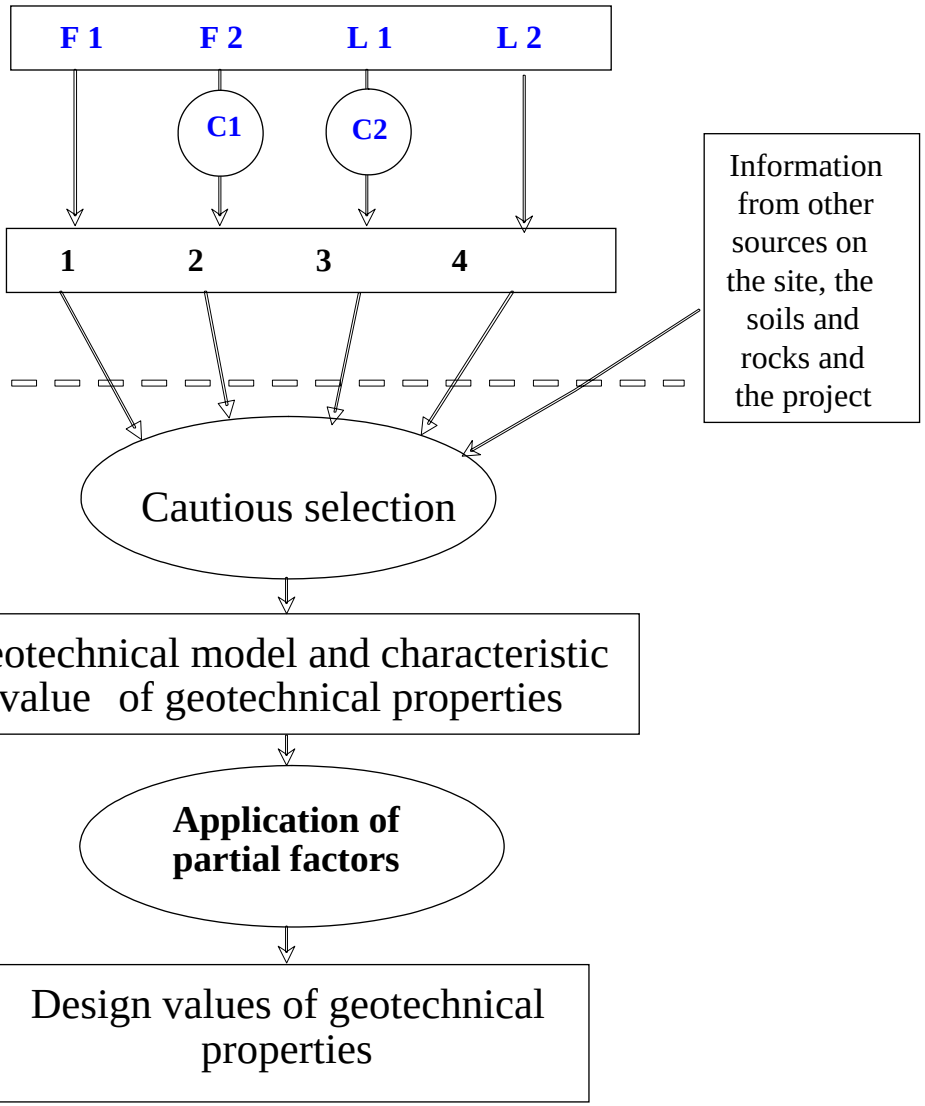
Type of test
F= field L= laboratory

Correlations

Test results and derived values

EN 1997 -2

EN 1997 -1



Characteristic value of geotechnical parameters

P 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%.

Design values of geotechnical parameters

Design value of a parameter : $X_d = X_k / \gamma_M$

Design values of actions and resistances

fulfilling for STR/GEO ULS : $E_d \leq R_d$

$E_d = E \{\gamma_F . F_k\}$ and $R_d = R \{ X_k / \gamma_M \}$

(= “at the source”, MFA)

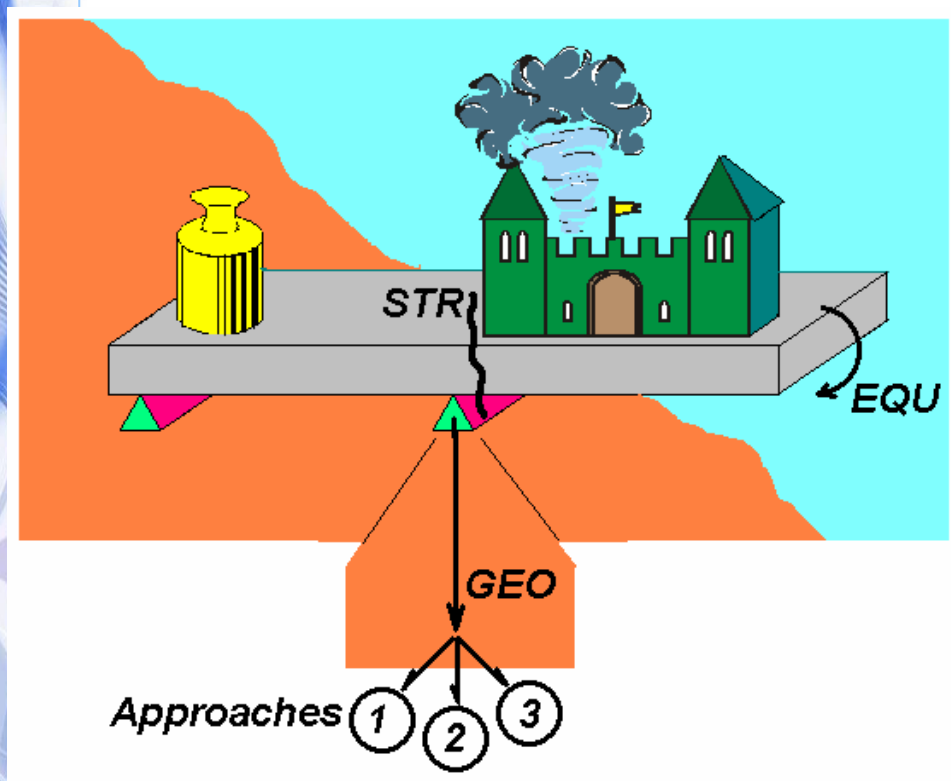
or $E_d = \gamma_E . E \{ F_k \}$ and $R_d = R \{ X_k \} / \gamma_R$

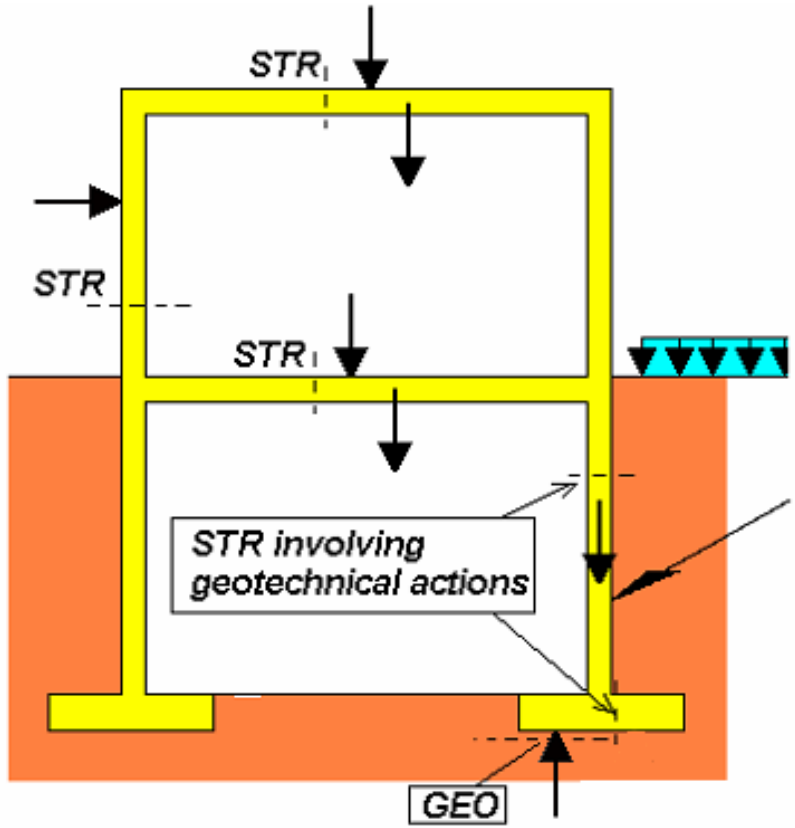
(RFA)

Ultimate limit states – Eurocode 7-1

- EQU : loss of equilibrium of the structure
- STR : internal failure or excessive deformation of the structure or structural elements
- GEO : failure or excessive deformation of the ground
- UPL : loss of equilibrium due to uplift by water pressure (buoyancy) or other vertical actions
- HYD : hydraulic heave, internal erosion and piping caused by hydraulic gradients

EN1990 - Ultimate limit states EQU and STR/GEO





$E_d < R_d$

J.A Calgaro

STR/GEO : persistent and transient situations

Approach	Combinations
1	A1 "+" M1 "+" R1 & A2 "+" M2 "+" R1 Or A2 "+" M1 or M2"+" R4
2	A1 "+" M1 "+" R2
3	A1 or A2 "+" M2 "+" R3

Action (γ_F)	Symbol	Set A1	Set A2
Permanent Unfavourable	γ_G	1,35	1,00
Favourable	γ_G	1,00	1,00
Variable Unfavourable	γ_Q	1,50	1,30
Favourable	γ_Q	0	0

Soil parameter (γ_M)	Symbol	Set M1	Set M2
Angle of shearing resistance	$\gamma_{\varphi'}$	1,00	1,25
Effective cohesion	$\gamma_{c'}$	1,00	1,25
Undrained shear strength	γ_{cu}	1,00	1,40
Unconfined strength	γ_{qu}	1,00	1,40
Weight density	γ_γ	1,00	1,00

Resistance (γ_R)	Symbol	Set R1	Set R2	Set R3
Bearing Portance	γ_{Rv}	1,00	1,4	1,00
Sliding	γ_{Rh}	1,00	1,1	1,00

← γ_R for **Spread foundations**

STR/GEO : accidental situations

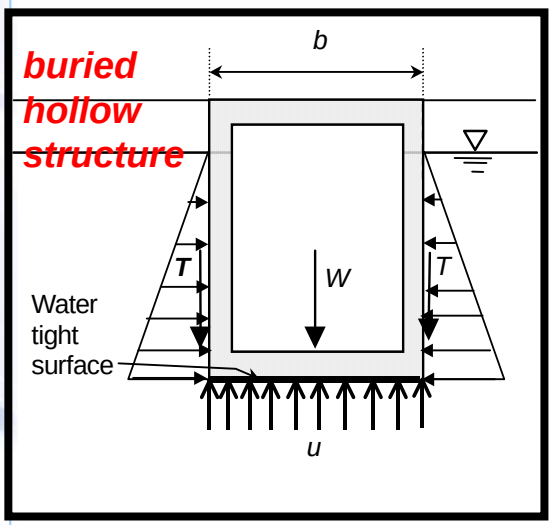
Actions : all values of γ_F (and γ_M) = 1.0

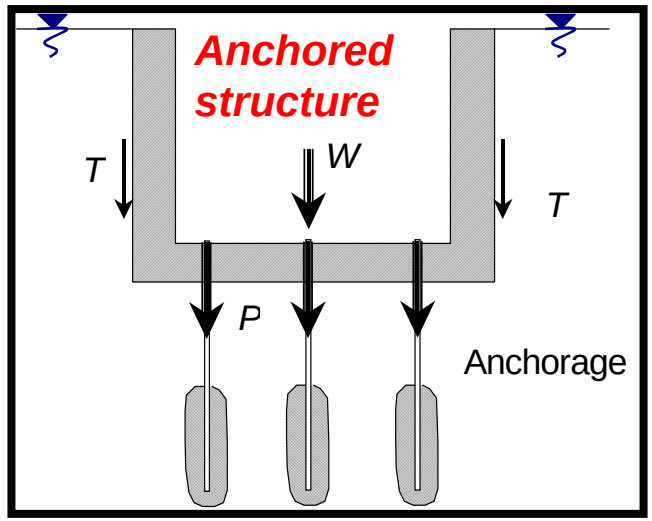
Resistances :

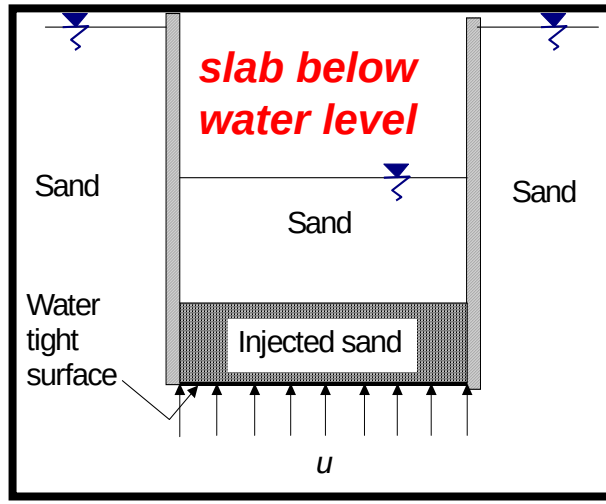
all values of γ_R (and γ_M) depend on the particular accident

Seismic situations: see Eurocode 8-5

Ultimate limit states (UPL)

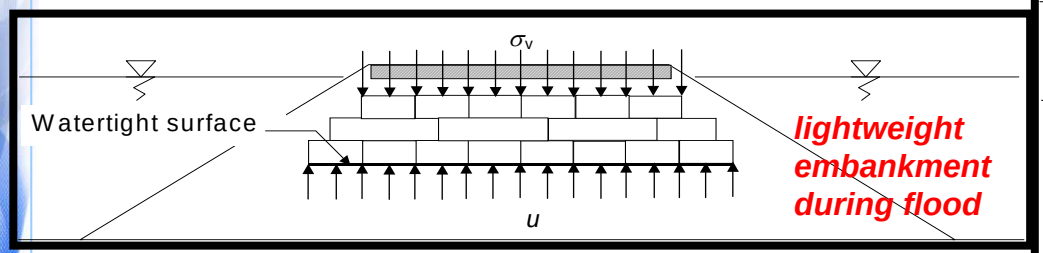


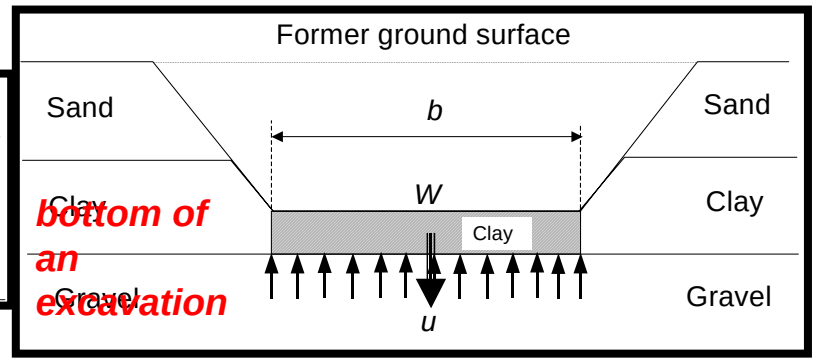




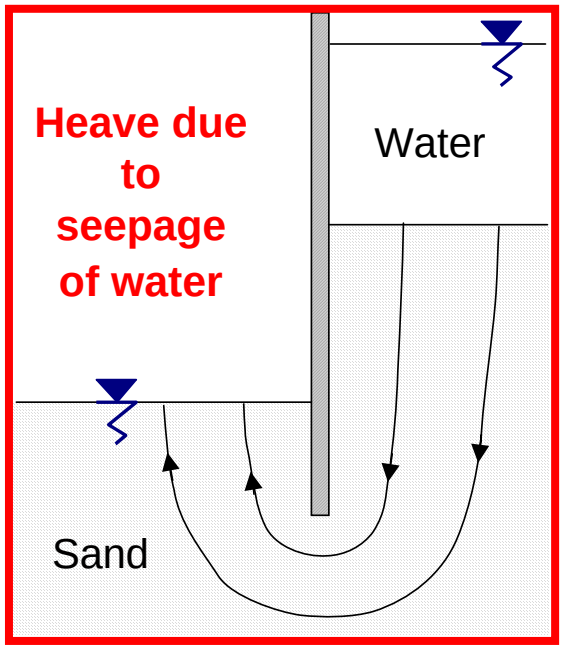
$$G_{dst;d} + Q_{dst;d} \leq G_{stb;d} + R_d$$

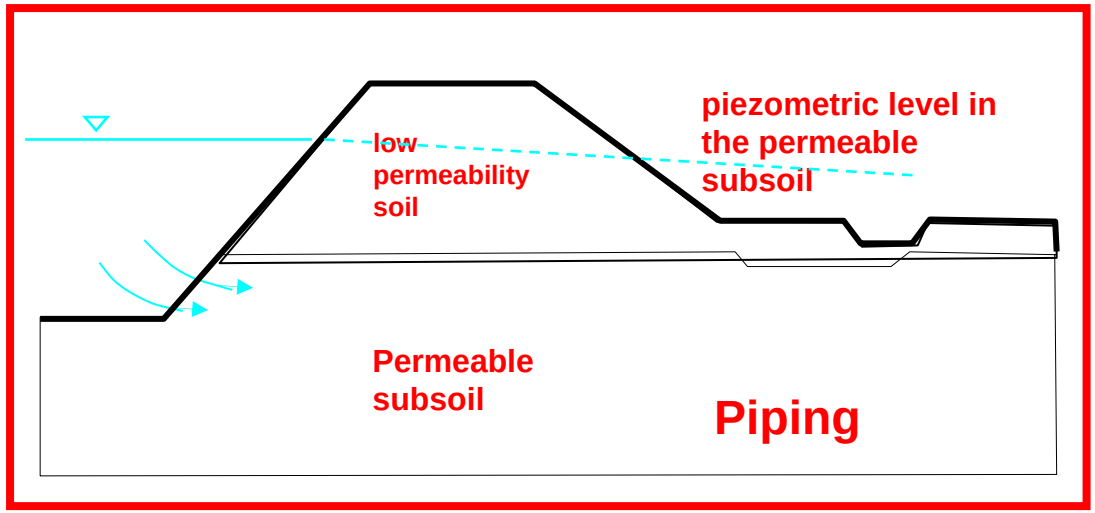
Examples of situations where uplift might be critical





Ultimate limit states (HYD)





$$u_{dst;d} \leq \sigma_{stb;d}$$

$$\Delta u_{dst;d} \leq \sigma'_{stb;d}$$

Example of situation where heave or piping might be critical

Verifications of ULS

Ultimate limit states of static equilibrium (EQU) :

$$E_{d,dst} \leq E_{d,stb}$$

Ultimate limit states of resistance (STR/GEO) :

$$E_d \leq R_d$$

Ultimate limit state of uplift (UPL) :

$$G_{dst;d} + Q_{dst;d} \leq G_{stb;d} + R_d$$

Ultimate limit state of hydraulic failure (HYD) :

$$u_{dst;d} \leq \sigma_{stb;d} \quad \text{or} \quad S_{dst;d} \leq \mathbf{G}'_{stb;d}$$

EN1990 - Serviceability limit states SLS

Verifications :

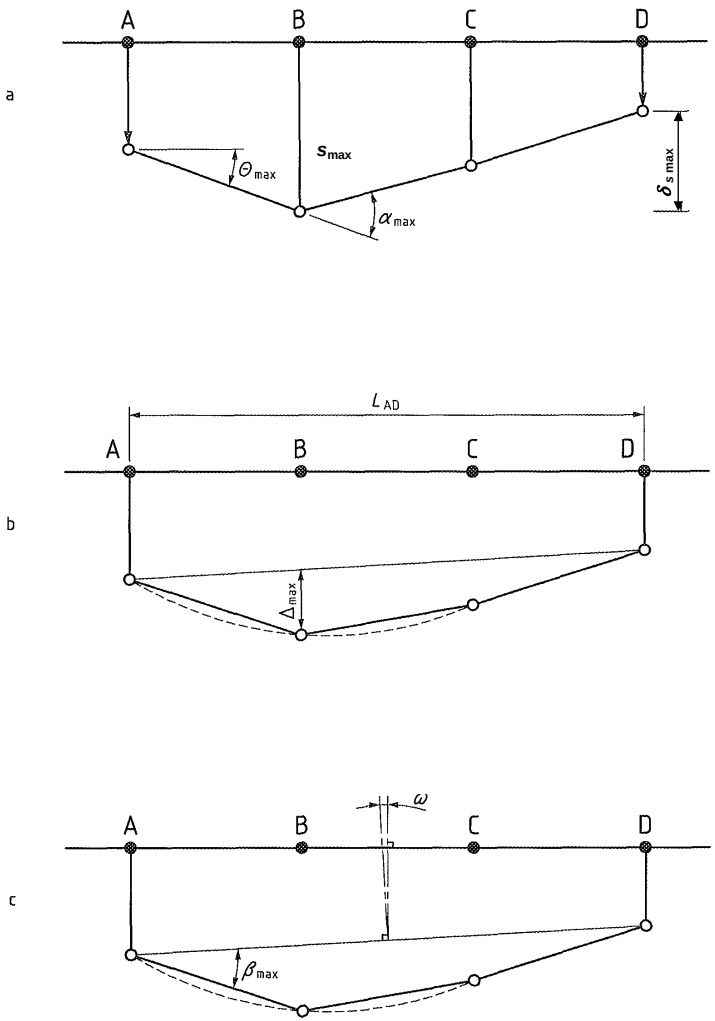
$$E_d \leq C_d$$

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

all γ_F and $\gamma_M = 1.0$

Movements and deformations of structures



settlement s, differential settlement δs, rotation θ and angular strain α

relative deflection Δ and deflection ratio Δ/L

ω and relative rotation (angular distortion) β

(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 !