



EG6 – SEISMIC Design

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meetings

Tele-meeting no.	Date held/scheduled	Available from webpage?
1	18 July 2011	Yes
2	11 September	Yes
3	30 November	Yes
4	26 January 2012	Yes
5	21 May	Yes
6	24 July	Yes
7	11 October	Yes
8	4 December	Yes
9	21 January 2013	Yes
10	12 March 2013	No
11	26 April 2013	No

GEOTECHNICAL DESIGN IN SEISMIC CONDITIONS WITH EUROCODES

In EC7: concepts of «regional seismicity» and earthquakes are just mentioned as factors or design situations to be considered for geotechnical design; the Ground Investigation Report must include informations about the seismicity of the area

In EC8-1: seismic actions are defined for different ground conditions (e.g. soil types A,B,C....) and the need of a «seismic» ground investigation is made clear

In EC8-5:

- Ground properties (recommended partial factors as for static case);
- Siting: slope stability, liquefaction
- Methods of analysis (dyn. or pseudostatic)
- Design criteria for foundations, earth retaining structures (pseudostatic analysis allowed)



TC250/SC7/EG6 Seismic Design

Scope of work

The purpose of EG6 is to advise TC250/SC7 on the interplay between Eurocode 7 and Eurocode 8, specifically of its part 5.

Methodology: examine geotechnical design as it results from the joint use of the two Eurocodes outlining possible inconsistencies between their respective design principles and evaluating the efficiency and the sustainability of the resulting design in the whole.

Deliverables:

EG6 will prepare a report to SC7 outlining the changes that could be made to Eurocode 7 to improve its application when designing geotechnical structures in seismic environments.

EG6 will assist SC8 in their revision of Eurocode 8

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

The problem of Geotechnical Seismic design is just mentioned in EC7 and is presently matter of EC8 parts 1 and 5 only.

Which of those clauses should remain unchanged in the next edition of Eurocode 7? **VERY FEW IN EC7**

Which of those clauses should be deleted from the next edition of Eurocode 7?
And why? NOTHING TO DELETE, BETTER TO ADD

Which of those clauses should be changed in the next edition of Eurocode 7?

What changes should be made? **And why?**

What new clauses should be added on your topic in the next edition of Eurocode 7? **And why?**



Actions agreed at the meeting in Brussels to improve EC7 on «shaking» matters

- Introduce recalls to highlight differences between static design conditions and dynamic/seismic ones, for actions and material properties
- Ground investigation (in EC7) must cover seismic issues (siting !!, liquefaction)
- For ground investigation reference should be made to dynamic soil properties (shear wave velocity)
- Foundation design with dynamic loadings (vibrating machines) needs to be covered

But we need as well an improvement
of EC8 towards a more
sustainable seismic geotechnical design

- EC8-PHILOSOPHY: separate designs, static & seismic, then choose the worst between the two
- OUR CONVINCEMENT: Static design first step, followed by a performance check with seismic actions

DESIGN PRINCIPLES

- *The seismic design of a geotechnical structure should be conceived according to the principles of safety and economical sustainability;*
- *Design of foundations and of earth retaining structures is a unique process to be accomplished by considering all the possible boundary (e.g. loading) and environmental (e.g. seismicity) conditions since the very beginning of the design process;*
- *Recommended design procedures must ensure a smooth transition between static and seismic designs.*

Thoughts for discussion within SC8

- Consider the possibility of occurrence of non reversible deformations of the foundation soil during seismic event as it is accepted for slopes or gravity retaining walls
- EC8 implicitly adopts DA1-2 with partial factors γ_M as given in EC7; most seismic countries are adopting DA2 instead
- With DA1-2, possibly differentiate the partial factors on geotechnical parameters for the static and the seismic design situations

- *For obvious reasons it will be very difficult for a Country to adopt partial factors on material properties lower than those recommended, even if this possibility is not excluded by EC8_5; it would be better to eliminate the recommended values;*
- *Suggest new design procedures for the seismic loading case based on the “**performance based design**” concept; such procedures aim at evaluating the seismic performance of geotechnical structures as designed for static loadings to estimate their permanent displacements caused by the earthquake and their structural capacity strictly needed; a Resistance Factor Approach in this case may be used to introduce safety margins.*



SOME SPECIFIC REQUIREMENTS TO ACCOMPLISH THE ABOVE PRINCIPLES

- *The transfer of action effects to the ground should consider the possibility of permanent deformations of foundations and of embedded retaining structures, similarly to what is already accepted for other geotechnical system such as slopes (4.1.3.1) and free gravity walls (Table 7.1);*
- *Similarly to what is done for the superstructure, mitigate ground acceleration/seismic demand by accepting (post-quake) permanent displacements and considering dissipation mechanisms in the ground;*

- *clauses 5.1(1)_a) and b) in EC8_5 need clarification about the meaning of “functional” requirements; these requirements are given irrespectively of the seismic action considered (are those collapse or damage limitations ?; is any permanent deformation of the foundation in the soil, itself acceptable ?)*
- *in clause 7.3.2.2(4) Table 7.1 , the value of $r=1$ for flexible r.c. retaining structures, that is no dissipation at all, appears very strict and not really justified;*

- *For geotechnical design in seismic regions, more emphasis is needed in EC7_EC8 to the assessing of seismic-dynamic properties of the ground;*
- *Parts dedicated to siting and selection of foundation soils should be improved in EC8_5, considering possible interferences with similar parts in EC7; as an example of such interferences, any improvement of the foundation soil can have an impact on the siting and on the selection of foundations both for static and for seismic loading conditions;*
- *Ground investigation must consider seismic issues concurrently with the general geotechnical characterization of the construction site; therefore the treatment of this subject in EC7 should uniformly address all related issues;*

on design approaches

- *EC8_5 does not adopt explicitly any of the Design Approaches given in EC7. But partial factors on geotechnical parameters are suggested, apparently referring to Design Approach 1, combination 2;*
- *most of the European countries are now orienting themselves towards Design Approach 2;*



The use of Material Factor Approach for ULS verification with seismic loadings and pseudostatic analysis should be carefully discussed:

- *partial factors for material properties for seismic geotechnical design could well be lower than those for the static case, particularly considering the capacity design philosophy adopted by EC8_5*
- *this possibility is never mentioned explicitly in EC8_5 and seismic values are recommended equal to the static ones (3.1 (3) NOTE);*
- *in some situations, stronger soils can be detrimental for the superstructures and in this cases upper and lower values of γ_M should be considered;*