

TC250/SC7/EG6: Seismic Design

Progress Report No 4 for the period October - March 2014

AGREED 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. The overall aim is to 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. Specific tasks of this group are the following:

1. 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. Identify the interplay and possible inconsistencies between Eurocodes 7 and 8: by means of practical examples
2. Prepare a list of clauses to be added to Eurocode 7 for both part1 and 2, referring the relevant sections of Eurocode 8
3. To collect and list national procedures for geotechnical design in seismic regions
4. Compare levels of safety explicitly or implicitly adopted by the different countries both for static and seismic conditions.
5. To select and suggest design procedures to evaluate the performance under seismic actions of typical geotechnical structures initially designed for static loadings
6. To prepare charts to anticipate when the seismic case becomes more critical with respect to the static case for the design of any specific geotechnical situation.

KEY ISSUES UNDER DISCUSSION

Practical examples of seismic design of typical geotechnical structures have been discussed. Examples are worked by different members of EG6 and comparison between solutions are made at the web conferences. Available examples are the following:

- Footing (prepared by Scarpelli and Papadopoulos)
- Gravity wall (prepared by Peckan and Saglam)
- Cantilever and propped embedded walls (prepared by Pane)
- Pile design example (responsible Di Laora, still missing)

Examples are published on the EG6 webpage.

DECISIONS/OUTCOMES

It has been recognized that changes in EN1997-1 and -2 need to be proposed in strong connection with a parallel revision work for EC8, specifically of parts 1 and 5 of it.

As for both SC7 and SC8, the revision work to include or modify issues concerning geotechnical seismic design will not start immediately, it has been proposed during the last SC8 meeting in ISPRA, November 2013, to establish a more effective liason between the two committees and to find the best possible way to have contributions from both SC's in the relevant PT of EC8.

1. WHICH CLAUSES IN THE CURRENT EN 1997-1 AND -2 ARE RELEVANT TO YOUR EG'S TOPIC OF INTEREST?

Clauses concerning seismic geotechnical design are very few in EC7, and only expressed in general terms. The word "seismic" is used

in EC7 part 1

- 1.1.1 to make clear that special provisions for seismic geotechnical design are in EC8 only;
- 2.2 to include regional seismicity in design requirements;
- 3.1 to consider seismicity when planning site investigation;
- 3.4.2 to include information on seismicity when preparing the site investigation report;
- 7.3.2.4 to consider transverse loading on piles for seismic areas.

in EC7 part 2

- 1.1.1 (7) to make clear that special provisions for seismic geotechnical design are in EC8 only;
- 2.1.1 (3) to include seismicity between objectives of the ground investigation;
- 6.2 to include seismicity of the area in the ground investigation report.

2. WHICH OF THOSE CLAUSES SHOULD REMAIN UNCHANGED IN THE NEXT EDITION OF EUROCODE 7?

The above clauses are far too general and as such do not appear particularly useful for geotechnical design with seismic loading.

Instead, EG6 has indicated few principles according to which the revision of EC7, jointly with the revision of the relevant parts of EC8, should be developed. These principles are the following:

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.*

SOME SPECIFIC REQUIREMENTS TO ACCOMPLISH THE ABOVE PRINCIPLES ARE ALSO GIVEN

- *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;*
 - A) *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;

B) 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;

- *Present version of EC8_5 does not adopt explicitly, for seismic design, any of the Design Approaches given in EC7. Nevertheless, partial factors on geotechnical parameters are suggested, apparently referring to Design Approach 1, combination 2, whereas 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:*
 - o *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);*
 - o *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;*
- *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.*

3. WHICH OF THOSE CLAUSES SHOULD BE DELETED FROM THE NEXT EDITION OF EUROCODE 7? AND WHY?

New parts should be included to consider explicitly seismic aspects for geotechnical design in EC7.

4. WHICH OF THOSE CLAUSES SHOULD BE CHANGED IN THE NEXT EDITION OF EUROCODE 7? WHAT CHANGES SHOULD BE MADE? AND WHY?

See above

5. WHAT NEW CLAUSES SHOULD BE ADDED ON YOUR TOPIC IN THE NEXT EDITION OF EUROCODE 7? AND WHY?

See above

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	See progress report N. 3 and the present report
12	Not yet scheduled	

ACTIVE MEMBERSHIP

Name	Position*	Country	Listed on webpage?
Alberto Bernal		Spain	yes

Raffaele di Laora	Secretary	Italy	yes
Amir Kaynia		Norway	yes
Ziggy Lubkowski		UK	yes
Baran Ozsoy		Turkey	yes
Vincenzo Pane		Italy	yes
Achilleas Papadimitriou		Greece	yes
Panicos Papadopoulos		Cyprus	yes
Onur Peckan		Turkey	yes
Alain Pecker		France	yes
Selman Saglam		Turkey	yes
Giuseppe Scarpelli	Convenor	Italy	yes

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1 March 2014