

KEY ASPECTS IN THE REVISION OF THE GEOTECHNICAL PART OF EUROCODE 8

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ABSTRACT

The Member States enquiry about Eurocode 8 Part 5, the geotechnical part of Eurocode 8, clearly pointed out some deficiencies and lacks in the present version of the code. The ongoing revision aims at providing practical and easy to use recommendations and design rules. The main goals of this new version are to improve coordination and consistency in the design approaches between the Geotechnical Eurocode (Eurocode 7) and its seismic counterpart (Eurocode 8 – Part 5). The determination of seismic loads and design checks remain in Eurocode 8, which defines the soil parameters needed, and determination of these parameters is the task of Eurocode 7. Development of several other technical aspects have been requested by the Member States and will be addressed in the revision.

Keywords: Eurocode 8; Geotechnical aspects; new provisions.

1. INTRODUCTION

The Member States enquiry about Eurocode 8 Part 5, the geotechnical part of Eurocode 8, clearly pointed out some deficiencies and lacks in the present version of the code. The ongoing revision aims at providing practical and easy to use recommendations and design rules as well as to complement some technical aspects improperly, or not, covered in the present document. For Part 5 the revision has been initiated in September 2017 and is intended to be completed in June 2020 with the final draft of the code submitted to TC250 after having been reviewed by the Sub-Committee 8 (SC8) and the mirror groups in each national country. Due to this planning, it is obvious that the present paper cannot present the future document; furthermore, only general trends are presented with the intent to give more details at the conference as almost one year would have passed since the inception of the revision. The first orientations provided herein address the comments provided by the National Standardization Bodies (NSBs) during the enquiry and result from the first discussions initiated within the Project Team.

The Project Team established by CEN/TC250 is composed of 5 members:

- Alain Pecker, AP Consultant and Ecole des Ponts ParisTech (France), who acts as PT leader
- Pr. Luigi Callisto, University La Sapienza, Rome (Italy)
- Pr. George Gazetas, National Technical University of Athens (Greece)
- Dr. Amir Kaynia, Norwegian Geotechnical Institute (Norway)
- Pr. Kyriazis Pitilakis, Aristotle University of Thessaloniki (Greece)

The choice of the project team's members was dictated by the need of having a good balance between practice and academy and between regions of low and high seismicity.

2. GENERAL REQUIREMENTS OF THE REVISION

The general objectives of the revision of Eurocode 8 were clearly stated in the mandate from CEN to

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TC250:

- enhance the ease of use of the document
- and reduce the number of NDPs (Nationally Determined Parameters) which should only be related to safety; all other former NDPs that can be described by mathematical/mechanical models should no longer be considered as NDPs and should be attributed a fixed value.

Only the first bullet is really relevant for Part 5 as the number of NDPs is limited and they represent true NDPs, except one related to the decrease of the peak ground acceleration with depth, which can easily be removed. At the end, the only NDPs that will remain are the material factors on the strength parameters: cohesion, friction angle, unconfined compressive strength and undrained cyclic shear strength for cohesionless soils (presently called factor of safety against liquefaction).

3. SPECIFIC REQUIREMENTS FOR PART 5

These requirements have two origins: the comments raised by the NSBs during the enquiry and the items specifically identified in the mandate from TC250 to SC8.

3.1 Revisions arising from the mandate

It is recognized that dynamic soil-structure interaction may influence substantially the seismic response of structures and, accordingly, consideration of such effects is already required in EN 1998-5 (Foundations, retaining structures and geotechnical aspects) for some specific cases and in all cases in the case of pile foundations. However, the provisions included are quite generic and can be extended and improved with more practical information for the designer for shallow and deep foundations and for the verification of dynamic base failure. On the other hand, there could be cases of foundations where soil-structure interaction may be disregarded. These cases should be identified for the sake of the ease of use of EN 1998-5.

Therefore, updating of EN 1998-5 for the inclusion of soil-structure interaction in the case of shallow and deep foundations will be considered in the future revision; special attention will be brought to the relative importance of kinematic interaction and inertial interaction, even for shallow foundations. For piled foundations, lateral restraint of piles provided by successive soil layers and the inclusion of specific seismic design provisions for modeling, analysis, dimensioning and detailing of piles will be considered.

Finally, as displacement-based design will become one of the design approaches for structures in EN 1998-1, or for the assessment of existing structures in EN 1998-3, the new provisions for soil-structure interaction will attempt to take account of the implication of the development of the pushover analysis.

A second item that has been assigned in the mandate is the evaluation of the seismic action on underground structures. It is known that buried structures do not respond to seismic loads as do above ground structures and there is a need to provide evaluations of the seismic action for several types of underground structures; these may include culverts, underpasses, galleries, shallow tunnels, etc...It should, however, be pointed out that the task of the Project Team will be restricted to the evaluation of the seismic loads and no provisions for design will be included.

3.2 Revisions arising from the enquiry

During the enquiry the member states were invited to formulate comments, criticisms, suggestions for the future revision of Eurocode 8. As expected, these comments were based on the feedback from the use of Eurocode 8 in the members countries and represent valuable information towards an improvement of the standard. 94 comments were collected by TC250 dealing with almost all chapters of EN 1998-5. The main comments can be summarized as follows:

- As a general comment, several approaches in EN 1998-5 are judged overconservative. The

intent of the PT is to give consideration to this aspect by attributing more importance to a displacement-based approach rather than to a force-based approach. Displacement checks for defining the dynamic failure of geotechnical structures like foundations, retaining structures, slopes will be included in the revised document. These criteria will be tentatively dependent on the limit states to check: significant damage (SD), near collapse (NC) and damage limitation (DL).

- A more precise definition of the soil characteristics should be provided. This issue is closely linked to the work of SC7 (the geotechnical Eurocode) and implicitly implies a better coordination between both sub-committees. This liaison has already been initiated and it has been agreed that SC8 will define the characteristics needed for earthquake geotechnical design and SC7 will provide the definition and describe the means to obtain these characteristics either from direct measurements or, possibly, from indirect correlations.
- The material safety factors γ_m need to be revisited. Presently the material factors for the seismic situation are equal to those of the persistent and transient situations. Several countries complained that these values are overconservative. The PT will examine the values and probably propose smaller values than the actual ones; this is still open to discussion, but it must be noted that in any case the recommended values will remain NDPs subject to the choice of each country. Furthermore, more details will be provided for an appropriate choice of the material factors in relation with the type of analysis: force-based or displacement-based design.
- The status of the normative annexes, namely the two annexes related to liquefaction analyses from SPT and to earth pressures based on the Mononobe & Okabe formula, will be changed into informative annexes in order to allow for use of more recent outcomes from research and practice.
- The content of Annex E, related to the earth pressure evaluations, will be extended to handle soils with both cohesion and friction, partially submerged profiles, surface loads on the ground surface. Other than gravity retaining structures, like underpasses, sheet pile walls, etc... will also be covered.
- The passive earth pressure formulation for retaining structures will be revisited; in its present formulation this passive pressure is computed as an extension of the Mononobe-Okabe active earth pressure and is overconservative and not scientifically based.
- The annex on the foundation bearing capacity for shallow foundations will be completed to consider soils with both cohesion and friction, circular foundations and embedded ones.

3.3 Additional topics

In addition to the topics listed in the previous two paragraphs, which are mandatory, other modifications might be implemented at the initiative of the Project Team; before becoming effective, these modifications should however receive the approval of SC8. At this stage they are only tentative proposals and have not been discussed within the sub-committee.

To enhance the ease of use of the standard it is proposed to move all clauses related to foundations from the other parts, essentially Part 1, to Part 5. For instance, in the present version of the document, the actions on the foundations and detailing provisions for reinforced concrete are covered in Part 1; would the proposal be accepted by SC8, geotechnical engineers would have a stand-alone document for designing foundations.

In several instances it may be necessary for the seismic design of geotechnical structures to rely on dynamic calculations. Therefore, it is proposed to add a short informative annex on the good practice in dynamic calculations of soil media; the intent is not to detail all aspects of dynamic finite element analyses, which can be found in textbooks, but rather to give general guidance on what should and should not be done when dealing with infinite media.