EUROCODE 7: A FRAMEWORK FOR GEOTECHNICAL DESIGN

G. Franzén[1], B. Hansson[2], and J. Spross[3]

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ABSTRACT

During the past 8 years, European engineers have spent many hours discussing, analysing, checking, drafting, and finally approving the next generation of Eurocode 7. The driving force has been to ensure that Eurocode 7 is a useful toolbox for the geotechnical engineers working with soil, rock, fill and groundwater, including all vital aspects for the design, giving guidance but also recognising that the key to a successful geotechnical design is engineering judgement and comparable experience.

This paper gives an overview of part of the content of the second generation of Eurocode and how it can be a useful tool not only as a reference document in procurement but also as a common framework for the development of geotechnical engineering. The paper highlights some new items in the second generation of Eurocode 7; Geotechnical reliability, sustainability, and robustness, and how these items might influence geotechnical engineers' day-to-day work. Finally, the paper elaborates on using the opportunities with a national implementation (EG 2.0).

1. HOW TO MAKE A STANDARD A USEFUL TOOL

The words "standard" and "tool" are somewhat contradictory. A tool is valuable, and we all happily use it since it facilitates our work. A standard gives a firm recommendation on what to do, and as engineers with creative and free-minded thinking, we hesitate to follow the rules determined by others but try to find our alternative. We do not like somebody else telling us what to do by referring to a standard. Hence, is the mandate for the second generation of Eurocode feasible? The aim is to create a user-friendly, up-to-date, harmonised

[1] GeoVerkstan, Kungsbacka, Sweden. gunilla.franzen@geoverkstan.se
[2] Keller Grundläggning, Kungsbacka, Sweden. bengt.hansson@keller.se
[3] KTH, Royal Institute of Technology, Stockholm, Sweden. johan.spross@byv.kth.se

common reference design code that opens for innovation within the civil engineering and building industry on a common market with fair competition. It is a high ambition set out on the European level, and several steps have been taken to make the aim come true. In a few years' time, the second generation will be implemented, and hopefully, it will be the tool that geotechnical engineers need to develop their skills and engineering judgement further.

For Eurocode 7, the key to ensuring that the standard becomes a useful toolbox is to include flexibility and trust that the user fulfils Eurocode's assumption that the user is a competent engineer. The engineer will select the most appropriate tools for the specific project and use them within their limitations and specifications. Let´s look at some of the tools in the second-generation toolbox and how they can be used by the competent engineers.

2. PARTIAL FACTORS IS NOT MANDATORY

If all material codes are considered, The partial factor approach is the most commonly used method to verify structural safety in the Eurocodes. However, Eurocode 7 states that design by calculation using partial factors is only one of at least four options. To verify the ultimate limit state, you can in fact use calculation with any reliability-based method (not only partial factor approach), prescriptive rules, testing or observational method. The basic requirement is that you prove that, with an appropriate level of reliability, the probability of failure is less than the requirement specified by your country. However, using partial factors is a convenient method for most geotechnical structures. Preparing the national annexes includes analyses to ensure that the recommended values will fulfil the probability of failure if used appropriately according to the code. Hence, the engineer does not have to prove it specifically for the considered structure and design. Selecting another verification method is up to the engineer to demonstrate compliance with the requirements in the code.

What is an appropriate level of reliability? The second generation of Eurocode states that different levels of reliability may be adopted, considering the consequences of failure in terms of human lives and injuries as well as social and environmental impacts. The public's reaction and the cost of limiting the risk of failure should also be considered. Once again, Eurocode introduces flexibility that should be used both on the national level to set the requirements on safety linked to consequences and by the engineer for a specific project to use engineering judgement to determine the consequence class, geotechnical complexity class and geotechnical category. The selected geotechnical category will give recommendations on the quality and extent of ground investigation, validation of calculation methods, checking, qualification, documentation, inspection and other measures to ensure that the final product has a quality that fulfils the appropriate level of reliability.

3. DESIGN ANNO 2024 IS NOT ONLY RELATED TO SAFETY

In 1975, industry and academia took the initiative to establish a European common design code for civil engineering. Developing the tools that more than 500,000 engineers use daily throughout Europe has been a long process. However, since 1975, a lot has changed in the world: climate change, digitalisation, and urbanisation; the list is long with new items that need consideration in the design of buildings and other civil engineering structures. Therefore, the second-generation Eurocode provides requirements and recommendations not only on structural safety but also on serviceability, durability, robustness, and sustainability.

Opening the Eurocode for design with consideration of sustainability has caused much discussion. Should a design code that traditionally has dealt only with structural safety now also put requirements on sustainable construction, or is that the responsibility of other parties? In the end, the requirement in the Eurocode is vague: Sustainability shall be considered, though how and by whom is up to us as geotechnical engineers. The Eurocode gives flexibility, and it is up to us on a national level to implement a way to consider ecological, social, and economic sustainability. We must take this challenge if we, as geotechnical engineers, want to contribute to a sustainable future.

Robustness is another item where we, as geotechnical engineers, need to tweak our minds. Eurocode is clear: A most probable climate scenario for the design service life of the structure shall be included as an action in the ordinary design of the ultimate and serviceability limit state. So, what is robustness? According to Eurocode, our structures, if designed according to Eurocode, fulfil the requirements of Robustness. But the aim is to review the technical solution and ask – what if? What if there is flooding, storm, or failure in part of the structure or nearby structures, or the loads increase? Are there any adjustments that can be made to minimise the damage and ensure that if the structure fails, it is not catastrophically? Once again, it is up to the engineer to use engineering judgment. Is it worthwhile to adjust the structure, or is it an unnecessary cost?

In 1975, it was still expected to use pen, paper and a slide-rule to verify and design geotechnical structures, see Figure 1.

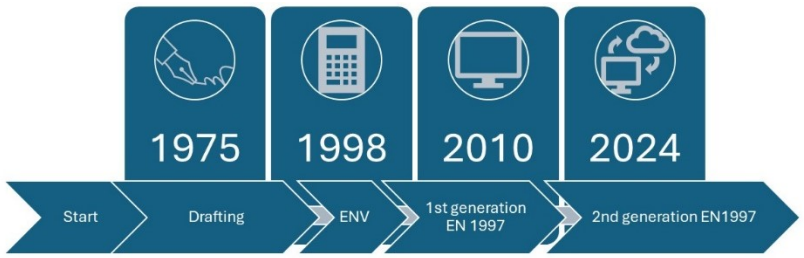

Figure 1 Eurocode adapting to the designer's environment

The pen is still used; however, the methods are changing with the extensive amount of data and computational resources. Eurocode has adapted to the new working environment by giving more precise guidance on how to use numerical models for the verification of any geotechnical structures, opening the application of statistical approaches in those cases where extensive data is available, and opening the reporting of digital information in BIM (building information model). This is to ensure that the 2nd generation of Eurocode will still be applicable in ten years, with respect to the technical developments of computational tools that the engineer uses.

4. IMPLEMENTATION ON NATIONAL LEVEL

Drafting a standard on a European level is a huge task, and the Nordic group has extensively contributed to it. The result is a standard consisting of three parts: general rules [1], ground properties [2], and geotechnical structures [3]. It is a common framework with flexibility that makes it adjustable for application throughout our Nordic countries [4]. However, we still have a huge amount of work in front of us - the implementation on a national level. Of course, the standard is applicable directly using the default values and choices. Still, if we, at national and project levels, want to ensure that we not only fulfil the requirements but are open to engineers using their knowledge and experience to build the future with economic, innovative, and sustainable structures. We need further discussion and analysis to use the flexibility the Eurocodes provide.

As geotechnical engineers, we love to discuss and argue, but to make sure that the conclusions become useful not only for the debaters, the outcome needs to be formulated into guidelines and national choices. The Implementation Commission for European Standards within Geotechnical Engineering, 2.0 (IEG 2.0) has been reactivated in Sweden to use the revision of Eurocode 7 to facilitate a national joint development of geotechnical engineering practice, where the flexibility of the Eurocodes is used with consideration of all parties views. IEG.2.0 is a non-profit organisation with 56 members from all parts of the Swedish geotechnical industry (authorities, clients, consultants, contractors, academia, societies, and manufacturers). See Figure 2.

The members' funds work together to analyse the changes and flexibility, summarizing the results in recommendations on national choices and preparation of guidelines. Coming together makes it possible to give financing to members who are recognised for their knowledge within the different areas of expertise to do the analyses that will form the base for the national recommendations. This industry-wide collaboration procedure was a great success the first time it was used, and we expect the same outcome this time: it will facilitate an increased competence among Swedish geotechnical engineers and,

therefore, increase the competitiveness of the Swedish geotechnical construction industry. More information about the work can be found on IEG's website [5].

Figure 2 Members of IEG 2.0

5. CONCLUSION

The second generation of Eurocode is a common step on the European level to update the reference design code to include future challenges. It is open for national adaptation but recognises that we depend more on each other and work across European borders. Hence, there is a need for a common framework to avoid mistakes and unnecessary misunderstandings within our civil engineering and building projects. Eurocode provides the framework where we, on the national level and in the project, can make use of the included flexibility by allowing the competent engineer to use their engineering judgement.

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