TC250/SC7/EG 4: Numerical Methods

Progress Report No 2 for the period April-Dec 2012

AGREED SCOPE OF WORK

The scope is wide and potentially includes the implementation, using numerical methods, of any part of Eurocode 7. At this stage, no potential applications of numerical methods should be excluded but the following structure types are considered more common applications of numerical methods:

- gravity walls: SLS, ULS (GEO)
- embedded cantilever and supported walls: SLS, ULS (GEO, STR)
- excavations and dewatering: SLS, ULS (GEO, UPL, HYD)
- spread foundations including storage tanks: SLS, ULS (GEO, STR)
- pile analysis (including pile groups and piled rafts): SLS, ULS (GEO, STR)
- embankment construction: SLS, ULS (GEO)
- slope stability: ULS (GEO)
- tunnelling (depends on work of EG12 on tunnelling)

As work progresses from a general level to narrower, specific applications, well-defined case studies (real or generic) of each of the above structure types will be used to aid in collating the work of EG4 members. It is not expected that significant issues will arise from SLS analysis. For ULS analysis, broadly speaking, it is anticipated that two categories of "issue" will arise:

- wider issues concerning ULS design using numerical methods (e.g. influence of finite element mesh, influence of stress ratio K0)
- specific issues concerning Eurocode 7, mostly associated with applying partial factors for ULS (GEO and STR)

While the wider ULS issues are beyond the scope of EG4, they may be studied to the extent that the specific Eurocode 7 issues have knock-on effects on the wider issues. The wider issues may also be considered later for a possible checklist for geotechnical design using numerical methods, so they should be noted during the work of EG4.

KEY ISSUES UNDER DISCUSSION

- Prepared benchmark problems of spread foundations, embedded retaining wall and slope for collective study of issues.
- Performed analyses of benchmark problems and compared results.

- Reached a consensus in the group on all the main issues concerning numerical methods and EC7, as described below.
- Identified some further issues including appropriate values of partial factors for numerical methods, methods of including different action factors on permanent and variable loads, and factoring structural resistance.

DECISIONS/OUTCOMES

- To recommend new sub-section in Section 2 of EN1997-1 specifically for numerical methods (NM), as well as new informative annex or separate document to provide wider guidance.
- The new clauses in Section 2 are expected to bring to the attention of designers issues such as the competency of users of NM, that NM is particularly suited to SLS verification, and partial factoring in ULS verification.
- Regarding Design Approaches, we will recommend a double-check approach combining a DA2* type approach to obtain design values of structural forces with a DA1/2 type approach to check for geotechnical failure as well as obtain further design values of structural forces. In some countries, there is a strong desire to retain the resistance factoring approach to verify all possible geotechnical failures. This will be permitted as an option but, since the material factoring check is quite straightforward and is often performed in such countries to check overall stability in any case, the material factoring check will be mandatory.
- Factoring effective stress strength parameters for undrained analyses is an issue for concern because of the significant influence of the constitutive model's prediction of pore pressures and hence undrained strength. The errors in a poorly-executed analysis could well exceed the currently recommended 1.25 partial factors. It should be emphasised to the designer that the partial factors to be applied to effective stress parameters in an undrained analysis must achieve the equivalent strength reduction of factoring c_u by 1.4 (or the value given in the NA).
- For other model parameters that can have a significant influence on the degree of conservatism in NM, such as stress ratio K_0, stiffness and dilation ψ, it would be inappropriate to recommend specific partial factors nor to relate them directly with any soil strength factoring. Therefore, the attention of the designer will be drawn to the importance of such parameters in NM, emphasising the need for appropriate values giving conservative values of outputs, using sensitivity analyses where necessary.

MEETINGS HELD/PLANNED

Tele-meeting no.	Date held/scheduled	Available from webpage?
4	22nd May 2012	Yes
5	19th July 2012	Yes
6	11th September 2012	Yes
7	February 2013	

ACTIVE MEMBERSHIP

Name	Position*	Country	Listed on webpage?
Andrew Lees	Convenor & Secretary	Cyprus	Yes
Helmut Schweiger		Austria	Yes
Markus Herten		Germany	Yes
Michael Kavvadas		Greece	Yes
Dan Ungureanu		Romania	Yes
César Sagaseta		Spain	Yes
Anders Kullingsjö		Sweden	Yes
Brian Simpson		UK	Yes
Colin Smith		UK	Yes

*please indicate Convenor/Secretary

REPORT PREPARED BY:

Andrew Lees

3rd November 2012