Setting an example

Report on the joint BGS/ICE Ground Board workshop "Eurocode 7: A Commentary" held at the Institution of Civil Engineers on 5 October 1998, by Chris Raison, Keller Ground Engineering.

Introduction

The half-day workshop held in October 1998 on the UK publication *Eurocode 7: A Commentary* was presented by the authors, Dr Brian Simpson of Arup Geotechnics and Richard Driscoll of the Building Research Establishment. The workshop, chaired by Hugh St John, set out to bring the audience up to date with the status of EC7-1 and to outline the contents of the commentary, in particular worked examples demonstrating the use of EC7.

Eurocode 7: A commentary is set out in five sections. Part A presents the fundamentals of EC7-1 along with general background information about its development and its relationships with other codes and documents. It also contains sections on how to use EC7-1, the UK National Application Document and other CEN, ISO and British Standards.

Part B introduces important features of the Eurocode 7 part 1 and includes discussion essays on some of the more difficult or controversial concepts.

Part C contains a clause by clause commentary intended to provide comment and clarify the meaning of the EC7-1 text. This section is a reference that needs to be read alongside EC7-1.

Part D considers the future development needs and also considers the use of EC7-1 outside of Europe. The last section, part E, provides worked examples for many geotechnical design problems.

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Eurocode 7 – an introduction

Brian Simpson explained that Eurocodes are intended to provide a consistent set of codes for the geotechnical and structural design of buildings and civil engineering works. The codes were originally conceived as checking documents for design compliance with European regulations and were not intended to advise or educate.

Part A of the commentary introduces EC7-1, including background information, a history of its development and a brief review of the current status of the suite of Eurocodes (**Table 1**).

It was pointed out that the commentary relates only to the European pre-standard version of Eurocode 7, DD ENV 1997-1:1995, which was published in 1995 together with the UK National Application Document. This version of the code is still current and is available from the British Standards Institution.

Important features of Eurocode 7

Richard Driscoll described the important features of EC7-1, which are covered in part B of the commentary. These include some of the more contentious and difficult issues associated with Eurocode 7 such as geotechnical categories, limit state design, the difficulties in choosing characteristic values for soil properties, and design Cases A, B and C.

Table 1: Suite of Eurocodes

EN 1991	Eurocode 1: Basis of design and actions on structures
EN 1992	Eurocode 2 :Design of concrete structures
EN 1993	Eurocode 3: Design of steel structures
EN 1994	Eurocode 4: Design of composite steel and concrete structures
EN 1995	Eurocode 5: Design of timber structures
EN 1996	Eurocode 6: Design of masonry structures
EN 1997	Eurocode 7: Geotechnical design
EN 1998	Eurocode 8: Design of structures for earthquake resistance
EN 1999	Eurocode 9: Design of aluminium alloy structures

In introducing the concept of limit state design, Driscoll described the ultimate limit state to be where collapse, excessive deformation or loss of stability occurs and the service limit state to be the point beyond which service requirements are no longer met.

Part B also includes a section on design by calculation, prescriptive measures, testing and the observational method. It was emphasised that EC7-1 does not preclude design by other means, or in combination.

Characteristic values

One of the major difficulties geotechnical engineers have had in accepting Eurocode 7 is the concept of characteristic values.

Calculations are carried out using design values obtained by applying partial factors to the characteristic values. It was pointed out that since partial factors are specified, choice of characteristic values are where engineers are required to apply skill and judgement. However, Simpson pointed out that geotechnical engineers have always had a similar responsibility.

Eurocode 1 provides statistical definitions of characteristic values that may be applicable to materials such as steel or concrete but are not easily applied to soils. EC7-1 recognises this difficulty, in particular that what can be measured in the laboratory is not necessarily what exists in the field. Characteristic values must also take into account geological and geometrical variability, the scale of the loading, workmanship, effect of the construction activities and many other factors.

Simpson concluded that characteristic values are a cautious estimate relevant to prevention of the limit state under consideration. These are similar to the moderately conservative values of CIRIA 104, and the representative values of BS8002.

Cases A, B and C

Eurocode cases A, B and C originated in Eurocode 1 with cases A and B relating to structural engineering codes. Case C was added to deal with situations where the strength of the ground is under consideration. In general the cases can be generally classified as **Table 2**.

Table 2: Classification of cases

A	Loss of static equilibrium (where the strength of the ground or the structure is insignificant)
B	Failure of the structure or structural element (governed by the strength of the material)
C	Failure in the ground

EC7-1 Table 2.1 and Table 1 of the United Kingdom National Application Document specify partial factors to be applied to actions, (loads or deformations), and to ground properties for the three cases.

It was emphasised that all designs must comply with all three cases in all respects, both geotechnical and structural. However, often it is one case that is critical.

Case B can be difficult to apply in certain situations such as slope stability problems and in other cases can lead to physically unreasonable situations, particularly when dealing with water pressures. EC7-1 allows the ground to be considered as one source with a single partial factor applied depending on whether the resulting actions are favourable or unfavourable.

The code also allows a single "model factor" to be applied to the results of calculations carried out using characteristic earth pressures. This is applicable to retaining walls and to other cases such as pile design, where partial factors are applied to computed shaft and end bearing resistance rather than soil parameters.

Worked examples

A series of worked examples was used to demonstrate how EC7-1 could be applied to a variety of geotechnical problems. These included spread foundations, pile foundations, assessment of characteristic capacity from pile load tests, slope stability, cantilever stem retaining wall and embedded retaining wall structures, both cantilever and propped. All examples were selected from those contained within part E of the commentary.

Driscoll presented a short worked example to show how EC7-1 can be applied to spread foundation design. This demonstrated the difficulty in identifying the most critical design case in some circumstances.

Simpson introduced two worked examples relating to piled foundations. EC7-1 contains a large section on piling and it was necessary for him to summarise the approach which will be unfamiliar for most engineers. In particular, EC7-1 presents factors for deriving characteristic load capacity from load tests and partial factors to be applied to end and shaft components which vary depending on the pile system. These factors are applied to resistance, not soil parameters.

Figure 1 shows worked example E6 presented during the workshop. Characteristic shaft and end bearing resistance are obtained by dividing the mean relationships by, in this case, a factor of 1.5. Design shaft and end bearing resistance are then obtained by dividing the resulting characteristic values by the appropriate partial factor. These are then compared to the design action (load) obtained from the characteristic loads multiplied by the appropriate partial factors.

Driscoll then presented a slope stability problem illustrating the influence of effective cohesion and Simpson presented a number of worked examples for retaining structures.

The future and the way forward

The authors provided an overview of the use of EC7-1 both within Europe and further afield, adding some comments about the future.

In general, it was noted that Scandinavian countries are supportive of EC7-1 but both France and Germany are striving to embody their national practice within the code. The southern European countries, which are generally those without existing national codes, are generally in favour.

Further afield, it was noted that both South Africa and Israel were looking very closely at EC7-1 and that Japan was also rethinking its codes.

Looking to the future, the speakers believed that Eurocode 7 Part 1 would receive EN status during 2000 and would be published during 2001.

Part 2, covering laboratory testing, and Part 3, covering field testing, are expected to be published as drafts for development during 1999. However, it was pointed out that the programme was still uncertain, particularly the redrafting of EC7-1.

It was also noted that cases A, B and C were still under discussion and may be joined by additional cases requested by Germany and France. The application of model factors may also be extended to other situations.

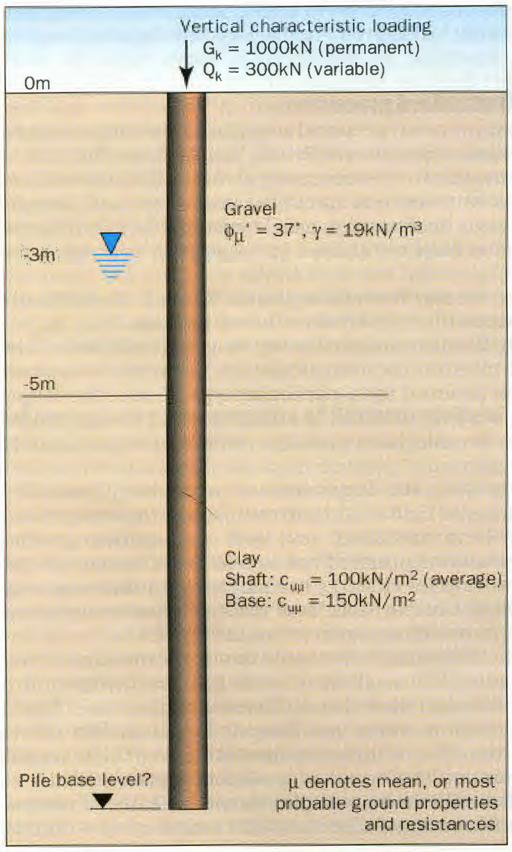

Figure 1: Worked example E6: Design of a compression pile. A structure is to be supported on bored piles. Each pile supports a single column with vertical characteristic loading of Gk=1000kN (permanent) and Qk=300kN (variable). Based on this load information and the soil properties shown, it is necessary to calculate the required toe level of a 0.6m diameter bored pile.