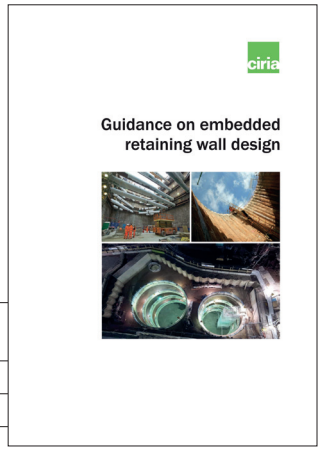
Review

CIRIA's new guide to embedded retaining wall design is a welcome update of a popular publication that will likely gain the same high level of acceptance within the industry as its predecessor, believes David Puller.

Guidance on embedded retaining wall design (CIRIA C760)



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Referred to by nearly all who have designed embedded retaining walls in the UK during the last decade or so, CIRIA guide *C580 Embedded retaining walls – guidance for economic design* became CIRIA's most popular guide both in terms of hard copy sales and downloads. Published in 2003, it covered the design of both cantilever and multi-propped walls in stiff clays and other competent soils. However, in 2004 along came *Eurocode 7: Geotechnical Design* and, as a result, the CIRIA guide became slightly outdated. UK practitioners became progressively used to adopting the EC7 approach but still making reference to CIRIA C580 in specific areas not covered by EC7.

However, earlier this year, a new guide, *C760 Guidance on embedded retaining wall design*, was published which supersedes the previous document. The new guide is compatible with the relevant Eurocodes and its range of application has been extended to include soft clays and weak rocks. Thanks to the authors and a steering group made up from representatives from specialist contractors, consultants, academics and client bodies including High Speed 2, the resulting guide is likely to gain the same high level of acceptance within the industry as its predecessor.

As with C580, the guide is intended for use in the design of sheet pile, king post, contiguous bored pile, secant bored pile and diaphragm walls. It is over 400 pages long, including annexes which provide worked examples to assist in the understanding of the design method. While the word 'economic' no longer features in the title of the document, the new guide emphasises the importance of economical design from the outset. The introductory section reminds the designer that the greatest opportunities for economy are available at the concept stage, with the selection of wall type, construction sequence and optimisation of the temporary and permanent utilisation of the wall being key issues. Further savings are available later in the process by using soil–structure interaction software as opposed to limit equilibrium methods.

The guide assists the designer in the process of wall selection in a section dealing with construction considerations. Excellent information is provided on different wall types, including typical verticality tolerances, retained heights and ability to control groundwater in the temporary and permanent case. The relative costs and pros and cons of each wall type are also presented. Practical details including structural connections and waterproofing arrangements at the wall-to-slab interface are covered.

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A new section dealing with the key environmental issue of carbon emissions provides an example of the embedded and emitted CO_2 for a typical piled wall and highlights the design tools now available to make comparisons between wall type. The benefits in terms of whole-life carbon emissions are also explained with reference to the incorporation of geothermal loops in bored piles and diaphragm walls.

The longest chapter in the guide deals with the determination and selection of parameters for use in design calculations. It provides a useful explanation as to the various means of deriving characteristic geotechnical parameters, but still leaves some degree of discretion to the designer. There is detailed guidance on the determination of soil parameters such as unit weight, strength, stiffness and permeability, and the guide also stresses the importance of a sound understanding of *in situ* stresses.

A new section deals with weak rocks (with an unconfined compressive strength less than 5MPa) and refers to the various methods that can be used to assess the rock mass behaviour, as well as the application of Mohr–Coulomb and Hoek–Brown models in wall design. The expansion of the range of soil types to include soft clays and weak rocks is an important enhancement which will increase use of the guide, particularly outside the UK.

The process of site investigation is set out from desk study to ground investigation field campaign and the importance of a thorough site investigation is quantified in a new section by comparing worked examples of scenarios of 'minimal' and 'appropriate and well considered' site investigation. The aspiration here is no doubt to emphasise the point that the savings which can be realised through a thorough site investigation can more than offset this upfront expenditure.

The section on ground surface movements includes graphical presentation of numerous case-history data for settlement and lateral movement resulting from the installation of bored pile and diaphragm walls in stiff clays. The vertical settlement due to wall deflection following bulk excavation is also presented for examples in soft-to-firm and stiff clay, as well as for sands. Building damage classification and measures to minimise the effects of settlement are also covered.

The design section provides a step-by-step explanation of the process using Design Approach 1 with Combinations 1 and 2 to check ultimate limit state using worked examples. Issues such as groundwater pressures, wall friction and unplanned excavation, which have caused some confusion in the past, are clarified. In an updated section, design by the Observation Method is covered in some detail; it is hoped that this will promote its use on more projects in future.

The section on retaining wall support has been updated to include more information on the design of temporary props and ground anchors, including the effects of temperature on prop design and the sway due to out-of-balance forces. The modelling of temporary berms is also considered.

A new section on inspection, monitoring and maintenance covers the important aspect of whole-life costs, discussing the trade-off between risk of non-inspection, cost of inspection and asset condition. A useful overview of monitoring is also provided in terms of what needs to be measured, why it needs to be recorded and what instruments (e.g. piezometers) should be considered to do it.

In conclusion, the guide sets out some suggested amendments for the next iterations of EC7 and EC2 which, if implemented, would simplify the design process, benefit projects with better quality site investigation and reduce excessively high material factors.

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