

6 January 2005

To : All Authorized Persons
Registered Structural Engineers
Registered General Building Contractors and
Registered Specialist Contractors

Dear Sir/Madam,

**Design of Excavation and Lateral Support Works
by the Limit State Partial Factor Method**

A review on the design of excavation and lateral support works has recently been conducted by the Geotechnical Engineering Office of the Civil Engineering and Development Department and the Buildings Department. The review has arrived at a recommendation that for the design of excavation and lateral support works, the limit state partial factor method as outlined in Report No. C580 published by the Construction Industry Research and Information Association (CIRIA) of the United Kingdom, may be accepted by the Building Authority, subject to the proposal satisfying all the conditions specified in Appendix A - "Notes on Design of Excavation and Lateral Support Works Using CIRIA Report No. C580".

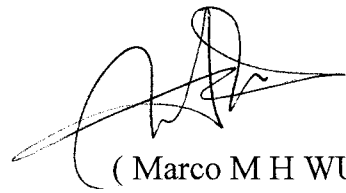
The use of the limit state partial factor design approach may be considered as an alternative to the requirements stipulated in the GCO Publication No. 1/90 issued by the then Civil Engineering Services Department. The approach may be adopted with immediate effect and for a trial period of two years, commencing from 6 January 2005.

All designs of excavation and lateral support works adopting the CIRIA Report No. C580 approach shall conform to the modifications stipulated in Appendix A. These modifications are required to cater for the local conditions and practices.

Any computer programs used to support the design proposals adopting the limit state partial factor method given in the CIRIA Report No. C580 should be submitted to the Buildings Department for prior acceptance. For the general requirements of prior acceptance of computer programs, reference should be made to Practice Note for Authorized Persons and Registered Structural Engineers (PNAP) 79.

Upon completion of the works, a performance review in accordance with the requirements stipulated in PNAP 246 should be submitted to the Buildings Department.

Yours faithfully,

A handwritten signature in black ink, appearing to be 'M H WU', with a long horizontal stroke extending to the right.

(Marco M H WU)
Building Authority

**Notes on Design of Excavation and Lateral Support Works
Using the Limit State Partial Factor Method in the CIRIA Report No. C580**

1. SCOPE

- 1.1 This document provides the technical guidance on the adoption of the design approach outlined in the CIRIA Report No. C580 (as an alternative to GCO Publication No. 1/90) for the design of excavation and lateral support (ELS) works in Hong Kong. It also stipulates the requirements on the use of geotechnical computer programs in design, qualified site supervision, monitoring and performance review of ELS works associated with the use of the technical guidance.
- 1.2 It is intended that a review will be carried out in about two years time to assess the suitability of the guidance for long-term implementation.
- 1.3 All enquiries and feedback on the content and use of this document should be directed to the Chief Geotechnical Engineer/Mainland East of the Geotechnical Engineering Office (GEO) of the Civil Engineering and Development Department (CEDD).

2. BACKGROUND

- 2.1 In Hong Kong, design of ELS works is normally carried out using the global factor of safety approach and the guidance given in GCO Publication No. 1/90, which is promulgated through the GEO Technical Guidance Note TGN 1.
- 2.2 The CIRIA Report No. C580 'Embedded retaining walls – guidance for economic design' outlines a design framework different from the use of global factors of safety to guard against sliding, uplift and overturning of retaining walls. Soil-structure interaction analyses used in conjunction with the limit state partial factor method of design are advocated.
- 2.3 In January 2004, GEO set up a Review Group, comprising members from GEO/CEDD, Buildings Department, consultants and contractors, to review the design approach outlined in the CIRIA Report No. C580. The review was completed in March 2004. The Review Group considers the CIRIA design approach to be rational and that it would result in safe designs that could be economical in some cases. The Review Group has therefore recommended that the design approach outlined in CIRIA Report No. C580 can be adopted for

design of the ELS works in Hong Kong, subject to certain modifications to suit local design standards and practice.

- 2.4 The Review Group has recommended that the design approach outlined in the CIRIA Report should be adopted for a trial period of at least 2 years. A review should then be carried out after a sufficient number of cases have been completed to assess its suitability for formal adoption for routine engineering practice in Hong Kong.

3. GEOTECHNICAL CONTROL OF PRIVATE DEVELOPMENT AND PUBLIC WORKS PROJECTS

- 3.1 ELS works designed in accordance with the approach outlined in the CIRIA Report No. C580, incorporating the modifications and requirements detailed in this document, will be acceptable to the Building Authority and the GEO/CEDD.

4. TECHNICAL RECOMMENDATIONS

4.1 DESIGN

- 4.1.1 In order to suit local design standards and practice, certain modifications are required in applying the design approach outlined in the CIRIA Report No. C580. These are as follows:
- (a) The minimum partial factors and surcharge loading recommended in Geoguide 1 (second edition), together with its guidance on site investigation, ground modelling, and selection of geotechnical parameters and design water pressures, be adopted instead of those given in the CIRIA Report.
 - (b) The limit state design method should be used for structural design, and a minimum load factor of 1.4 should be applied on the forces and bending moments obtained from the Serviceability Limit State (SLS) calculations carried out in accordance with the CIRIA Report, instead of the value of 1.35 given in the CIRIA Report. Depending on the structural code to be adopted, additional structural calculations using the partial factors given in the structural code may be required to check the structural design.
 - (c) SLS checks should be carried out to assess the impacts on adjoining buildings, structures, services and land, where necessary. The results of the SLS analyses should be reviewed critically in the light of the available performance monitoring data obtained from projects on excavations in similar ground conditions and using similar construction

methods/techniques, for the controls that can normally be achieved in practice (see data in GCO Publication No. 1/90 and CIRIA Report No. C580).

- (d) Sensitivity analyses against the Ultimate Limit State (ULS) of collapse or excessive deformation should be carried out for cases of singly propped excavations, with respect to possible deviations in the prop level ($\pm 0.5\text{m}$) and surcharge behind the wall (full surcharge/without surcharge). The results of the analyses should be used to assess the actions needed in the design and/or supervision of the works.
- (e) For the assessment of ground movements and lateral wall movements caused by retaining wall installation, dewatering and excavation, and for checking against hydraulic failure (including piping and ground heave), the guidance given in GCO Publication No. 1/90 should be followed.

4.1.2 In using the design approach outlined in the CIRIA Report No. C580, the guidance given in the following sections should also be adopted.

4.2 USE OF GEOTECHNICAL COMPUTER PROGRAMS

4.2.1 A BD/GEO approved geotechnical computer program should be used for carrying out soil-structure interaction analyses for the design of ELS works in accordance with this document. The results of the SLS and ULS analyses in support of the submission to the BD/GEO should be reviewed and certified by a competent person (e.g. an RPE(G) or equivalent). The review should assess:

- (a) whether the theory behind the computer program is generally applicable to excavation design, supported by experience in such application,
- (b) the reasonableness of default settings in the program (e.g. the maximum permitted out-of-balance forces and moment and the maximum number of iterations allowed for convergence, the allowable difference in deformation values between iterations, etc.) and limitations in excavation analysis,
- (c) the soil constitutive models in the program are appropriate for the types of soils (e.g. sands, clays, etc.) encountered at the site,
- (d) the ground and structural modelling in the analyses is appropriate (e.g. boundary conditions, element/mesh sizes, equivalent stiffness of structural framing, etc.),
- (e) the ground model is supported by the available site investigation data (e.g. adequacy of data to arrive at the soil layer thicknesses and groundwater level/pressures for analyses),

- (f) the input data are correct, and
- (g) whether the analysis results are reasonable (e.g. whether the deformed shape of the wall is kinematically realistic and the results are generally consistent with local experience).

4.2.2 The certification should state that the analyses demonstrate that there is adequate safety margin against collapse of the excavation, and that there will be no unacceptable impacts due to the ELS works provided that the assumptions are verified and found to be valid and the works are being carried out as specified during construction. In addition to the certification of the analyses, a report documenting the analyses and listing the assumptions required to be verified during construction and the range of computation results for the key parameters requiring monitoring and checking and the critical working procedures requiring inspection and certification during construction should also be prepared. This report should be certified by the competent person and provided to the qualified site supervision personnel responsible.

4.3 QUALIFIED SITE SUPERVISION

4.3.1 For public works projects and for private development projects where the ELS works plan submitted is a prescribed plan under the Buildings Ordinance, the qualified site supervision personnel (Category I or II) shall carry out or ensure the quality of the monitoring of the critical locations of the works or the aspects that could lead to unacceptable impacts/consequences.

4.3.2 The qualified site supervision personnel shall regularly review the monitoring trends and the actual performance of the excavation during critical stages of the works, taking into account the construction method and sequence, and adequately document the data and the observations. Such duties are in addition to the normal duties of reviewing design assumptions, recommending design modifications and necessary preventive/contingency measures and working procedures to ensure safety of the excavation and to prevent unacceptable impacts on the surrounding buildings and other facilities, and checking that the works are being carried out as specified during excavation.

4.4 MONITORING

4.4.1 Monitoring requirements shall be imposed to check the actual performance of the design during construction. As a minimum, monitoring of deflections and rotations of the retaining wall, ground settlement/heave and piezometric pressures should be carried out to provide data for design review, risk management/control and performance review.

* * * * *