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Works Bureau Technical Circular No. 30/99

Permanent Reinforced Fill

Scope

This Circular governs the design and construction of structures and slopes incorporating permanent reinforced fill in all Government's projects.

2. Concerned departments outside the Works Bureau and the Planning, Environment and Lands Bureau groups of departments, including Agriculture & Fisheries Department, Home Affairs Department and Housing Department, have agreed to the contents of this Circular.

Effective Date

3. This Circular takes effect on 1 February 2000.

Effect on Existing Circulars

4. This Circular supersedes Works Branch Technical Circular No. 19/91 on Permanent Reinforced Fill Structures with effect from 1 February 2000.

Introduction

5. Permanent reinforced fill comprises soil or rock material placed in layers with reinforcing elements to form a slope or structure, where the reinforcing elements have an intended design life longer than two years. A reinforced fill feature with a face inclination up to 70° from the horizontal shall be considered to be a reinforced fill slope. Features with a face inclination of 70° and steeper from the horizontal shall be considered to be a reinforced fill structure.

Background

6. The Government operates a certificate system to regulate the reinforcing products (steel strips, steel grids, polymeric geogrids and geotextiles) used in permanent reinforced fill, in order to ensure the safety of structures and slopes constructed with these materials. Certificates, signed by the Director of Civil Engineering (DCE), specify allowable long term design loads for individual products.

7. Possession of a valid certificate allows a supplier to be included in the “List of Approved Suppliers of Materials and Specialist Contractors for Public Works” maintained and updated by Works Bureau, under the category of “Certified Reinforcing Products for Permanent Reinforced Fill”, subject to financial assessment of the supplier by Works Bureau.

Objective of the Certification System

8. A number of reinforcing products are manufactured for use in permanent reinforced fill. Owing to their various shapes and sizes, and the different materials from which they are manufactured, testing of these products to determine their reliable long term strength cannot easily be carried out in Hong Kong.

9. In addition, the durability of these products needs to be carefully assessed to ensure that the reinforced fill structure or slope will remain stable for the duration of its design life. This requires carrying out long term tests well in advance of the normal design phase of a project.

10. The certification system confers a level of acceptance on reinforcing products used in permanent reinforced fill. The system ensures consistent and satisfactory standards in the provision of these products, facilitates their specification, and saves time for designers, contractors, manufacturers, suppliers and the Government by eliminating repetitive checking of project proposals.

Certification Requirements

11. All reinforcing products for use in structures and slopes which incorporate permanent reinforced fill material are required to be certified by the DCE before they are used in Government projects. Certificates are issued by DCE to cover products found acceptable for use in Hong Kong.

12. Notwithstanding a certificate for the reinforcing product, a structure or slope incorporating a certified reinforcing product will still need to be adequately designed, and checked by the Geotechnical Engineering Office (GEO) of the Civil Engineering Department. In issuing a certificate, the review carried out by the GEO is limited to durability of the reinforcing product, quality assurance (including possession of an ISO 9002, or 9001, certificate), allowable long term design loads for the reinforcing product, potential for installation damage and requirements for compliance testing.

Geotechnical Checking

13. Following the normal practice for slopes and retaining walls, the project department shall make a submission on the proposed works, which shall include drawings, design calculations, the specification for the reinforced fill, and a copy of the certificate of the reinforcing product with allowable loads and parameters to the GEO for checking. This submission is required according to Lands and Works Branch Technical Circular No. 3/88 "Checking of Geotechnical Designs for Government Works." The project department shall provide other detailed information as requested by the GEO to facilitate the checking and for the on-going review of the certification system.

14. A submission may be made in two stages. In the first stage, overall stability shall be demonstrated and the use of certified reinforcing products may be generically specified. In the second stage, when the relevant certified reinforcing product details are known, another submission shall be made to demonstrate internal stability, and to show that the product used has been certified and the design complies with the conditions in the certificates. Approval from the GEO shall be obtained before works on the reinforced fill commence.

15. Guidance on design and construction of permanent reinforced fill is given in Appendix A.

(W S Chan)
Deputy Secretary (Works Policy)

Guidance on Design and Construction

Guidance on the design of permanent reinforced fill material can be found in Geospec 2, “Model Specification for Reinforced Fill Structures” (GCO, 1989), and GEO Report No. 34, “A Partial Factor Method for Reinforced Fill Slope Design” (Wong, 1993). Geospec 2 can be used for both structures and slopes except Section A.6.3 and A.6.4 which shall be applied to reinforced fill structures only. GEO Report No. 34 is applicable to reinforced fill slopes. Further guidance from overseas can be found in British Standard BS 8006 (1995) “Code of Practice for Strengthened/Reinforced Soils and Other Fills”, and Federal Highway Administration (1997) “Mechanically Stabilised Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines”. Where the overseas guidance documents are used, the designer should review their applicability under Hong Kong climatic and construction conditions in conjunction with the contract specifications based on Geospec 2. In preparing contract documentation, reference should be made to the use of certified products as depicted in the “List of Approved Suppliers of Materials and Specialist Contractors for Public Works”.

2. As stated in the certificates for the reinforcing products, verification of the shear strength between the selected fill material and the reinforcing products is required to be carried out using large shear box tests. A suitable shear box is available at the Public Works Central Laboratory.

3. If a structural face is not provided, then consideration will need to be given to other means of protection against surface erosion, local instability and other forms of damage of the face of a structure or slope of reinforced fill. Procedures for the maintenance of the means of protection is required to be included in the maintenance manual. Also for steel reinforcing components the corrosiveness of filling material should be checked prior to and during construction in accordance with Geospec 2.

4. During design consideration will need to be given to ways of ensuring that the reinforcing products are not disrupted by the installation of drains or utilities. In this respect, the department responsible for maintenance should be consulted at an early stage where the reinforced fill structure is proposed. At completion of works, suitable precaution should be included in the maintenance manual to warn department responsible for maintenance against subsequent installation into the slope or structure. General guidance on the maintenance of slopes and retaining walls and on the preparation of maintenance manual is given in Geoguide 5 (GEO, 1998).

5. Adequate supervision will be needed on site to ensure that the reinforced fill is constructed generally in accordance with the requirements of Geospec 2. In particular, that the correct reinforcing products are installed and they are connected according to the design layout, the type of fill material used in construction is as specified in the design, and also that the fill material is properly compacted. The provisions of the Project Administration Handbook (PAH) should be followed, particularly Chapter 7 para. 4.3 which generally requires Category I and Category III geotechnical supervision (as defined in Appendix 7.47 of the PAH) for reinforced fill structures and slopes. The CV of the Category I or III supervisors should be submitted to the GEO for comments prior to commencement of works. The GEO should be given prior notice of the commencement date of the reinforced fill works. The periodic reports prepared by the Category I Supervisor should also be copied to the GEO.

6. The Designer should specify any necessary compliance testing to be carried out, in addition to those required by Geospec 2 and the Certificates. The Designer and/or the Supplier of the certified reinforcing products should demonstrate the construction procedures to the Contractor and the Site Supervisory staff in the initial construction stage to ensure proper construction method is adopted. The Engineer of the contract should ensure that such tests are carried out and the results are satisfactory.

7. As-built drawings should be provided to the department responsible for maintenance, together with appropriate maintenance manual, including maintenance procedures for any measures used to protect the reinforcing products. Further guidance on maintenance is given in Geospec 2.

References

British Standard BS 8006 (1995). “Code of Practice for Strengthened/Reinforced Soils and Other Fills”, British Standards Institution, London, UK, 161p.

CED (1993) “Project Administration Handbook for Civil Engineering Works,” Civil Engineering Department , Hong Kong, last updated in 1998.

GCO (1989). “Model Specification for Reinforced Fill Structures (Geospec 2)”, Geotechnical Control Office, Hong Kong, 140p.

GEO (1998). “Guide to Slope Maintenance (Geoguide 5)”, Second Edition, Geotechnical Engineering Office, Hong Kong, 91p.

Lands and Works Branch Technical Circular No. 3/88 “Checking of Geotechnical Designs for Government Works”.

U.S. Department of Transportation, Federal Highway Administration (1997). “Mechanically Stabilised Earth Walls and Reinforced Soil Slopes Design and Construction Guidelines”, Federal Highway Administration Report No. FHWA-SA-96-071, 371p.

Wong H.N. (1993). “A Partial Factor Method for Reinforced Fill Slope Design”, GEO Report No. 34, Geotechnical Engineering Office, Hong Kong, 64p.