Geotechnical Engineering Office, Civil Engineering and Development Department
The Government of the Hong Kong Special Administrative Region

GEO Technical Guidance Note No. 42 (TGN 42) Supplementary Guidelines on the Use of Eurocodes and UK National Annexes for Structural Design of Slope Works under the Landslip Prevention and Mitigation Programme

1. SCOPE

1.1 This Technical Guidance Note (TGN) promulgates supplementary guidelines on the use of Eurocodes and UK National Annexes (EC & UK NA) for structural design of slope works under the Landslip Prevention and Mitigation Programme (LPMitP).

1.2 Any feedback on this TGN should be directed to Chief Geotechnical Engineer/Landslip Preventive Measures 2 of the GEO.

2. TECHNICAL POLICY

2.1 The technical recommendations promulgated in this TGN were agreed by GEO Geotechnical Control Conference (GCC) on 10 February 2014.

2.2 With effect from 1 January 2015, the structural design of slope works under the LPMitP shall comply with the requirements stipulated in this TGN. In the meantime, the use of the TGN is optional.

3. RELATED DOCUMENTS

3.1 BD (2013). *Code of Practice for Structural Use of Concrete 2013*. Buildings Department, Hong Kong, 191p.

3.2 BSI (1997). *Structural Use of Concrete. Part 1 – Code of Practice for Design and Construction (BS 8110-1:1997).* British Standards Institution, London, 168p.

3.3 BSI (2001). *Structural Use of Steelwork in Building. Part 1 – Code of Practice for Design. Rolled and Welded Sections (BS 5950-1:2000).* British Standards Institution, London, 224p.

3.4 BSI (2002a). *Eurocode. Basis of Structural Design (BS EN 1990:2002+A1:2005).* British Standards Institution, London, 120p.

3.5 BSI (2002b). *Eurocode 1: Actions on Structures – Part 1-1: General Actions – Densities, Self-weight, Imposed Loads for Buildings (BS EN 1991-1-1:2002).* British Standards Institution, London, 50p.

3.6 BSI (2004a). *Eurocode 2: Design of Concrete Structures – Part 1-1: General Rules and Rules for Buildings (BS EN 1992-1-1:2004).* British Standards Institution, London, 230p.

3.7 BSI (2004b). *UK National Annex for Eurocode. Basis of Structural Design (NA to BS EN 1990:2002+A1:2005).* British Standards Institution, London, 18p.

3.8 BSI (2005a). *Eurocode 3: Design of Steel Structures – Part 1-1: General Rules and Rules for Buildings (BS EN 1993-1-1:2005).* British Standards Institution, London, 96p.

3.9 BSI (2005b). *UK National Annex to Eurocode 1. Actions on Structures – Part 1-1: General Actions – Densities, Self-weight, Imposed Loads for Buildings (NA to BS EN 1991-1-1:2002).* British Standards Institution, London, 16p.

3.10 BSI (2005c). *UK National Annex to Eurocode 2: Design of Concrete Structures – Part 1-1: General Rules and Rules for Buildings (NA to BS EN 1992-1-1:2004).* British Standards Institution, London, 26p.

3.11 BSI (2006). *Eurocode 1: Actions on Structures – Part 1-7: General Actions – Accidental Actions (BS EN 1991-1-7:2006).* British Standards Institution, London, 72p.

3.12 BSI (2008a). *Eurocode 3: Design of Steel Structures – Part 1-11: Design of Structures with Tension Components (BS EN 1993-1-11:2006).* British Standards Institution, London, 38p.

3.13 BSI (2008b). *UK National Annex to Eurocode 3: Design of Steel Structures – Part 1-1: General Rules and Rules for Buildings (NA to BS EN 1993-1-1:2005).* British Standards Institution, London, 12p.

3.14 BSI (2008c). *UK National Annex to Eurocode 3: Design of Steel Structures – Part 1-11: Design of Structures with Tension Components (NA to BS EN 1993-1-11:2006).* British Standards Institution, London, 12p.

3.15 HKSARG (2012). *Construction Standard CS2:2012 Steel Reinforcing Bars for the Reinforcement of Concrete.* The Standing Committee on Concrete Technology, Hong Kong, 51p.

4. BACKGROUND

4.1 In the structural design of civil engineering structures in Hong Kong, ample references are made to the British Standards (BS). Since March 2010, the British structural design standards have been progressively withdrawn and replaced by EC & UK NA through the implementation of BS EN Standards.

4.2 According to the Development Bureau, EC & UK NA together with local guidance documents should be adopted for the design of civil engineering structures in public works projects with effect from 1 January 2015. In this connection, the works departments including Drainage Services Department (DSD), Highways Department (HyD) and Water

Supplies Department (WSD) have reviewed and updated their design manuals[1] for migration to EC & UK NA.

4.3 Currently, the structural design of slope works under the LPMitP follows the relevant BS such as BS 8110 and BS 5950. Based on the results of a study, it was found that EC & UK NA are generally applicable for use as the structural design codes for slope works under the LPMitP, provided that appropriate amendments are made to suit the local conditions and engineering practice. Therefore, supplementary guidelines for the structural design of slope works under the LPMitP have been prepared.

5. TECHNICAL RECOMMENDATIONS

5.1. The structural design of slope works under the LPMitP shall be carried out according to the relevant EC & UK NA, except as modified or otherwise provided in the supplementary guidelines given in Annex TGN 42 A1.

5.2. Explanatory notes in Annex TGN 42 A2 provide the rationale for the requirements of the supplementary guidelines.

5.3 The structural capacity of soil nails, prestressed ground anchors or reinforcement in reinforced fill structures shall be determined in accordance with the relevant provisions stipulated in the geotechnical guidance documents issued by the GEO. The EC & UK NA and the supplementary guidelines given in Annex TGN 42 A1 are not applicable under the circumstances.

6. ANNEXES

6.1. TGN 42 A1 – Supplementary Guidelines on the Use of Eurocodes and UK National Annexes for Structural Design of Slope Works under the LPMitP

6.2 TGN 42 A2 – Explanatory Notes for the Requirements of the Supplementary Guidelines

(H N Wong)
Head, Geotechnical Engineering Office

[1] The design manuals include DSD's Stormwater Drainage Manual and Sewerage Manual, HyD's Structures Design Manual for Highways and Railways and WSD's Civil Engineering Design Manual.

Annex TGN 42 A1 – Supplementary Guidelines on the Use of Eurocodes and UK National Annexes for Structural Design of Slope Works under the LPMitP

1 Reinforced Concrete Design

1.1 Concrete Parameters

Parameters	**Recommendations**
Stress-strain curve of concrete	To adopt Figure 3.8 in BD (2013)
Elastic modulus	To adopt Equation 3.1 in BD (2013)
Parameters for durability design: Exposure condition; nominal cover; minimum concrete grade in cube; maximum free water /cement ratio; minimum cement content	To follow Tables 4.1 and 4.2 in BD (2013)

1.2 Reinforcing Steel Parameter

Parameter	**Recommendation**
Characteristic yield strength of steel reinforcement bar, f_{yk}	500 MPa

2 Structural Steel Design

2.1 Partial Factor for Resistance of Cross-sections in Tension to Fracture

Parameter	**Recommendation**
Partial factor for resistance of cross-sections in tension to fracture, γ_{m2}	1.25

2.2 Use of Wire Rope in Flexible Barriers

Description	Recommendation
Determination of the design tension resistance of wire rope (including wire rope/cable used in the net) in the design of flexible barriers	Only checking against the breaking strength of the wire rope according to Section 6 of BSI (2008a) is required

3. Combination of Actions

3.1 Factors of Variable Actions, ψ_0, ψ_1, & ψ_2 in Sections 6.4.3 and 6.5.3 of BSI (2002a)

Parameters	Recommendations
Factor for combination value of a variable action, ψ_0	1.0
Factor for frequent value of a variable action, ψ_1	1.0
Factor for quasi-permanent value of a variable action, ψ_2	1.0

3.2 For Structural Design of Rigid/Flexible Debris-resisting Barriers, Boulder/Rockfall Barriers and Their Foundations

Descriptions	Recommendations
Debris/boulder impact load	To be considered as an Accidental Action in the combination of actions
Debris impact scenarios	To be checked against the Ultimate Limit State under Accidental Design Situation in BSI (2002a) and BSI (2004b)

Annex TGN 42 A2 – Explanatory Notes for the Requirements of the Supplementary Guidelines

1 Reinforced Concrete Design

1.1 Concrete Parameters

1.1.1 The mechanical properties and durability of the concrete specified in BSI (2004a) and BSI (2005c) may not be suitable for the application in Hong Kong as they depend on the types and proportions of minerals used in concrete mix and the local environment. In this regard, adoption of stress-strain curve, elastic modulus and parameters for durability design in the local guidelines BD (2013) are recommended in this TGN.

1.2 Reinforcing Steel Parameter

1.2.1 According to BSI (2004a), the types of ribbed steel reinforcement bars suitable for use in concrete structures include Classes A, B and C steel bars with a yield strength varying between 400 MPa and 600 MPa. However, only Classes B and C ribbed steel reinforcement bars with a yield strength of 500MPa are covered in CS2:2012. Hence, the yield strength of ribbed steel reinforcement bars for design of slope works is taken as 500 MPa.

2 Structural Steel Design

2.1 Partial Factor for Resistance of Cross-sections in Tension to Fracture

2.1.1 BSI (2008b) recommends a partial factor for resistance of cross-sections in tension to fracture as 1.0 which is less conservative than the 1.25 as specified in the BSI (2005a). It is noted that BSI (2008b)'s recommendation takes account of the fact that almost all structural steels used in UK are locally manufactured. Unlike UK, Hong Kong relies on imported structural steels and the quality of steel may vary by a greater margin. Therefore, it is recommended to adopt the recommended partial factor for resistance of cross-sections in tension to fracture according to BSI (2005a).

2.2 Use of Wire Rope in Flexible Barriers

2.2.1 According to Section 6 of BSI (2008a), the tension resistance of wire rope should be determined based on the breaking strength and proof (yield) strength of wire rope. Since the design criterion in respect of the proof (yield) strength is for ensuring the wire rope to remain elastic which is not a design requirement for wire rope in flexible barrier, it is recommended that the design criterion for checking the proof (yield) strength should be omitted and only checking of the breaking strength of the wire rope shall be required.

3. Combination of Actions

3.1 Factors of Variable Actions, ψ_0, ψ_1, & ψ_2 in Sections 6.4.3 and 6.5.3 of BSI (2002a)

3.1.1 In EC & UK NA, partial factors ψ_0, ψ_1, & ψ_2 are applied to variable actions such as wind loads, traffic load and construction loads under different combinations of actions for the design of engineering structures under the Ultimate Limit State (ULS) and the Serviceability Limit State (SLS). However, the recommended values of these partial factors in BSI (2002a) and BSI (2004b), which vary from 0 to 1.0, are only applicable for building structures, road bridges and footbridges. As a conservative approach, it is recommended that a notional value of 1.0 should be used as the partial factors for variable actions in the structural design of slope works.

3.2 For Structural Design of Rigid/Flexible Debris-resisting Barriers, Boulder/Rockfall Barriers and Their Foundations

3.2.1 Section 1.5.3.5 in BSI (2002a) defines Accidental Action as "action, usually of short duration but significant magnitude, that is unlikely to occur on a given structure during the design working life". Examples of the Accidental Actions as given in Section 4.1 in BSI (2006) are impacts from trains, ships, road vehicles, etc. It is considered that the nature of impact by boulders/debris on the rigid/flexible debris-resisting and boulder/rockfall barriers is similar to these impacts. Therefore, the impact by boulders/debris can be considered as an Accidental Action in EC & UK NA. Moreover, the impact scenarios in the structural design of rigid/flexible debris-resisting and boulder/rockfall barriers and their foundations should be checked against the ULS under Accidental Design Situation.