

**GEO Technical Guidance Note No. 9 (TGN 9)  
Updating of GEO Report No. 56 : Application of Prescriptive Measures  
to Slopes and Retaining Walls (Second Edition)**

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**1. SCOPE**

- 1.1 This Technical Guidance Note (TGN) provides an update on GEO Report No. 56 “Application of Prescriptive Measures to Slopes and Retaining Walls (Second Edition)” in respect of standard prescriptive soil nail layout for soil cut slopes and replacement of an impermeable slope cover.
- 1.2 Any feedback on this TGN should be referred to Chief Geotechnical Engineer/Standards and Testing of the GEO.

**2. TECHNICAL POLICY**

- 2.1 The technical recommendations promulgated in this TGN were agreed by GEO’s Geotechnical Control Conference.

**3. RELATED DOCUMENTS**

- 3.1 GEO (2008). Guide to Soil Nail Design and Construction (Geoguide 7). Geotechnical Engineering Office, Hong Kong, 97 p.
- 3.2 Lui, B.L.S. & Shiu, Y.K. (2005). Prescriptive Soil Nail Design for Concrete and Masonry Retaining Wall (GEO Report No. 165). Geotechnical Engineering Office, Hong Kong, 78 p.
- 3.3 Wong, H.N., Pang, L.S., Wong, A.C.W., Pun, W.K. & Yu, Y.F. (1999). Application of Prescriptive Measures to Slopes and Retaining Walls (GEO Report No. 56) (Second Edition). Geotechnical Engineering Office, Hong Kong, 73 p.
- 3.4 Works Bureau (1999). Geotechnical Manual for Slopes - Guidance on Interpretation and Updating (Works Bureau Technical Circular No. 13/99). Works Bureau, Government Secretariat, Hong Kong, 12 p.

**4. TECHNICAL RECOMMENDATIONS**

**4.1 Appendix A to GEO Report No. 56**

- 4.1.1 Table A2 of GEO Report No. 56 provides recommended standard soil nail layouts for soil cut slopes. Only eleven soil nail layouts are given in the Table. In many cases the number and length of soil nails required may differ significantly for just a slight difference in the effective height ( $H_e$ ) of a slope. To facilitate more cost-effective applications of the prescriptive soil nails, additional soil nail layouts have been derived and they are shown in Annex TGN 9 A1. The soil nail layouts provided in Annex TGN

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9 A1 basically follow those given in Table A2 of GEO Report 56, but are supplemented with layouts for additional  $H_e$ . Opportunities have also been taken to round up the recommended lengths of soil nails to the nearest metre. The new soil nail layouts and the rounded-up nail lengths are highlighted in italic script in Annex TGN 9 A1.

- 4.1.2 The soil nail layout derived from prescriptive design based on a consideration of the maximum effective slope height may be applied to the whole slope where the variation in height along the slope is not large. Alternatively, as indicated in Appendix A.6 of GEO Report No. 56, the slope may be split into different sections, with the soil nail layout for each section designed by the use of the maximum effective slope height for the respective section. This would enhance the cost-effectiveness of the prescriptive designs especially for large soil cut slopes.
- 4.1.3 Annex TGN 9 A1 hereby replaces Table A2 of GEO Report No. 56.
- 4.1.4 The recommended sizes of soil-nail heads for soil nails designed using the prescriptive approach are shown in Annex TGN 9 A2. The typical reinforcement details of a soil-nail head are shown in the latest version of Standard Drawing Nos. C2106/2&3 promulgated by the Civil Engineering and Development Department.
- 4.1.5 The design of corrosion protection measures for the steel reinforcement of prescriptive soil nails should follow the guidance given in Section 5.5 of Geoguide 7 - Guide to Soil Nail Design and Construction (GEO, 2008).
- 4.1.6 The design of slope facing should follow the guidance given in Section 5.6.5 of Geoguide 7.

**4.2 Appendix C to GEO Report No. 56**

- 4.2.1 Appendix C to GEO Report No. 56 provides recommended measures for the prescriptive use of vegetation cover for existing soil cut slopes. One of the recommendations is that a relatively impermeable cover (e.g. a shotcrete cover) on an existing soil cut slope could be replaced by vegetation cover only when soil nailing works are to be carried out to upgrade the slope at the same time. Following a review of the application of this recommendation, it is considered that the recommendation may not be applicable to the maintenance of soil cut slopes of consequence-to-life Category 3 (as defined in WBTC No. 13/99). In carrying out the assessment to decide on whether an impermeable slope cover can be replaced by a vegetation cover, account should be taken of the average and local slope angles, the size of the upslope catchment and whether there is likely to be concentrated surface water flow onto the slope, signs of seepage from the slope surface, records of past failure of slopes of similar nature, the likelihood of casualty should a failure occur, etc. Consideration should also be made of the potential socio-economic impact should failure occur, in consultation with the owner.

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4.2.2 A new paragraph will be added to Appendix C.2 of GEO Report No. 56 to promulgate the above change in recommendation when the Report is reprinted. The new paragraph is shown in italic font in Annex TGN 9 A3.

5. **ANNEX**

5.1 TGN 9 A1 - Revised Standard Prescriptive Soil Nail Layout for Soil Cut Slopes.

5.2 TGN 9 A2 - Size of Soil-nail Heads for Soil Nails Designed using the Prescriptive Approach.

5.3 TGN 9 A3 - Appendix C.2 to GEO Report No. 56.

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Table A2 (Rev. 1) - Revised Standard Prescriptive Soil Nail Layout for Soil Cut Slopes

Standard Soil Nail Layout	$H_e$ (m)	$\phi_r$ (mm)	$\phi_h$ (mm)	A			B			C		
				N	L(m)	$S_h$ (m)	N	L(m)	$S_h$ (m)	N	L(m)	$S_h$ (m)
(a)	3	25	100	2	4	1.5	2	4	1.5	2	4	1.5
(b)	4	25	100	2	5	1.5	2	5	1.5	2	5	1.5
(c)	5	25	100	3	6	1.5	3	6	1.5	3	6	2.0
(d)	6	25	100	4	8	1.5	3	8	1.5	3	7	1.5
(e)	7	25	100	4	9	1.5	4	8	1.5	3	7	1.5
(f)	8	25	100	5	9	1.5	4	8	1.5	3	8	1.5
(g)	9	25	100	5	10	1.5	4	9	1.5	4	8	1.5
(h)	10	25	100	6	10	1.5	4	10	1.5	4	9	1.5
(i)	12	32	100	6	11	1.5	5	10	1.5	5	10	2.0
(j)	14	32	100	6	12	1.5	5	11	1.5	6	10	2.0
(k)	16	32	100	7	12	1.5	7	12	2.0	6	11	2.0
(l)	18	32	100	8	13	1.5	8	12	2.0	7	12	2.0
(m)	20	32	100	10	14	2.0	9	12	2.0	8	12	2.0
(n)	22	32	100	11	14	2.0	10	12	2.0	8	12	2.0
(o)	24	32	100	12	14	2.0	10	12	2.0	8	12	2.0
(p)	25	32	100	12	15	2.0	10	12	2.0	8	12	2.0

Notes: (1)  $H_e$  is the maximum effective slope height,  $\phi_r$  the nail diameter,  $\phi_h$  the hole diameter,  $s_h$  the horizontal spacings of nails, and N & L the number and length of the soil nails respectively.  
(2) For  $H_e$  between any of the two consecutive values, the soil nail layout corresponding to the higher  $H_e$  value should be adopted.  
(3) Soil nails should be evenly spaced over the slope face.  
(4) N is the number of soil nails per vertical column required at the critical section, i.e. the section with the maximum effective height,  $H_e$ . At other parts of the slope, soil nails should be provided at vertical and horizontal spacings similar to that at the critical section. Alternatively, different soil nail layouts according to the maximum  $H_e$  of that part of the slope may be adopted.  
(5) 'A', 'B' and 'C' refer to factor of safety increase in the ranges 0.3 to 0.5, 0.1 to less than 0.3, and less than 0.1 respectively.  
(6) If, in the process of drilling, rock is encountered such that part of the soil nails will be installed in rock (e.g. installation through a PW50/90 zone or better, see Geoguide 3), the designer may exercise professional judgement to reduce the nail length L.  
(7) The designer should check the land status to see whether the nails encroach into adjoining land and if so whether this is acceptable to the land owner.  
(8) The parts of the slope lower than 2m do not usually require reinforcement by soil nails.

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Soil Nail Steel Bar Diameter <sup>(1)</sup> (mm)	Geology	Square Nail Head Size (mm x mm)	
		Slope Angle < 55°	55° ≤ Slope Angle ≤ 65°
25 or 32	Highly decomposed granitic or volcanic rock.	600 x 600	600 x 600
25 or 32	Soils including colluvial, residual or completely decomposed materials of granitic and volcanic origin, and weathered sedimentary rocks.	800 x 800	600 x 600
<p>Notes: (1) Refer to GEO Report No. 56 (Wong et al, 1999) for prescriptive design of soil nails for cut slopes and GEO Report No. 165 (Lui &amp; Shiu, 2005) for prescriptive soil nail design for concrete and masonry retaining walls. (2) The minimum thickness of the nail head should be 250 mm. (3) For slope angles larger than 65°, reinforced concrete grillage beams instead of isolated soil-nail heads should be used.</p>			

Size of Soil-nail Heads for Soil Nails Designed using the Prescriptive Approach

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**APPENDIX C.2 to GEO REPORT No. 56**

**C.2 RECOMMENDED MEASURES**

Recommended measures for the prescriptive use of vegetation cover for existing soil cut slopes of different gradients are given in Table C1. Such measures are appropriate for existing soil cut slopes which have an inadequately developed vegetation cover or a defective chunam cover which no longer serves as an impermeable cover effectively. They should be used in conjunction with suitable items of prescriptive measures recommended in this Report (see Appendix A). Figure C1 shows the typical details of the prescriptive vegetation cover with other appropriate erosion protection works.

The recommended measures may also be prescribed to replace a relatively impermeable cover (e.g. a shotcrete cover) on an existing soil cut slope, but this should be done only when soil nailing works are to be carried out to upgrade the slope at the same time in accordance with the recommendations of this Report. For such cases, the upgrading works should be designed to give an increase in factor of safety for the slope to meet the standards for a new slope (Table A3). Also, a wire mesh structurally connected to the soil nail heads should be provided to the slope.

*The above recommendation may not be applicable to the maintenance of soil cut slopes of consequence-to-life Category 3 (as defined in WBTC No. 13/99). In carrying out the assessment to decide on whether an impermeable slope cover can be replaced by a vegetation cover in slope maintenance, account should be taken of the average and local slope angles, the size of the upslope catchment and whether there is likely to be concentrated surface water flow onto the slope, signs of seepage from the slope surface, records of past failure of slopes of similar nature, the likelihood of casualty should a failure occur, etc. Consideration should also be made of the potential socio-economic impact should failure occur, in consultation with the owner.*

It is essential to provide a bio-degradable protective fabric to a slope face after hydroseeding is completed, irrespective of slope gradient. The temporary fabric serves to reduce raindrop impact and erosion while the grass is establishing.