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

GEO Technical Guidance Note No. 26 (TGN 26)
Supplementary Guidelines for Foundation Design in Areas Underlain by Marble and Marble-bearing Rocks

1. SCOPE

1.1 This Technical Guidance Note (TGN) provides supplementary technical guidelines for foundation design in Scheduled Area Nos. 2 and 4 underlain by marble and marble-bearing rocks. This TGN is intended to supplement the guidance given in the Environment, Transport and Works Bureau Technical Circular (Works) (ETWB TC(W)) No. 4/2004 (ETWB, 2004) and the Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers (PNAP) No. APP-61 (BD, 2021).

1.2 This TGN is not applicable to marble and marble-bearing rocks found within the Designated Area of Northshore Lantau.

1.3 Any feedback on this TGN should be directed to the Chief Geotechnical Engineer/Mainland West of the Geotechnical Engineering Office (GEO).

2. TECHNICAL POLICY

2.1 The guidelines promulgated in this TGN were agreed by the GEO's Geotechnical Control Conference (GCC) on 24 April 2025.

3. RELATED DOCUMENTS

3.1 BD (2017). *Code of Practice for Foundations 2017*. Buildings Department, Hong Kong, 111 p.

3.2 BD (2021). *Geotechnical Control on Developments in Area Numbers 2 and 4 of the Scheduled Areas (Practice Note for Authorized Persons, Registered Structural Engineers and Registered Geotechnical Engineers No. APP-61)*. Buildings Department, Hong Kong, 7 p.

3.3 Chan, Y.C. (1994). *Classification and Zoning of Marble Sites (GEO Report No. 29)*. Geotechnical Engineering Office, Civil Engineering Department, Hong Kong, 37 p.

3.4 Chan, Y.C. (1996). Foundations in karst marble in Hong Kong. *Proceedings of the Twelfth Southeast Asian Conference on Geotechnical Engineering and Foundations*, Kuala Lumpur, Volume II, pp 169-199.

3.5 Darigo, N.J. (1990). Marble-bearing Jurassic volcanics of the western New Territories, Hong Kong. *Proceedings of the Conference on Karst Geology in Hong Kong*, Geological Society of Hong Kong, pp 61-72.

3.6 ETWB (2004). *Checking of Foundation Works in the Scheduled Areas of Northwest New Territories and Ma On Shan and the Designated Area of Northshore Lantau (Environment, Transport and Works Bureau Technical Circular No. 4/2004).* Environment, Transport and Works Bureau, Hong Kong, 15 p.

3.7 Frost, D.V. (1992). *Geology of Yuen Long (Hong Kong Geological Survey Sheet Report No. 1).* Geotechnical Engineering Office, Civil Engineering Department, Hong Kong, 69 p.

3.8 GEO (1990). *Foundation Properties of Marble and Other Rocks in the Yuen Long-Tuen Mun Area (GEO Publication No. 2/90).* Geotechnical Engineering Office, Civil Engineering Department, Hong Kong, 112 p.

3.9 Lai, K.W., Chan, H.H.K., Choy, C.S.M. & Tsang, A.L.Y. (2004). The characteristics of marble clast-bearing volcanic rock and its influence on foundation in Hong Kong. *Proceedings of the Conference on Foundation Practice in Hong Kong*, Centre for Research and Professional Development, Hong Kong, pp E1-E10.

3.10 Meigh, A.C. (1991). *General Report on Foundation in Areas Underlain by Marble and Associated Rock (Technical Note No. TN 3/91)*. Geotechnical Engineering Office, Civil Engineering Department, Hong Kong, 193 p.

3.11 Sewell, R.J. (1996). *Geology of Ma On Shan (Hong Kong Geological Survey Sheet Report No. 5)*. Geotechnical Engineering Office, Civil Engineering Department, Hong Kong, 45 p.

3.12 So, K.W.F., Sewell, R.J. (2017). *Guidelines on the Description and Classification of Rocks of the Tuen Mun Formation in the Tuen Mun Valley, Northwestern New Territories (GEO Report No. 327)*. Geotechnical Engineering Office, Civil Engineering and Development Department, Hong Kong, 71 p.

3.13 So, K.W.F., Sewell, R.J. (2019). *Updating of Hong Kong Geological Survey 1:20,000-scale Maps Major Findings and Revisions Map Sheet 6 – Yuen Long (Geological Report No. GR 4/2019)*. Geotechnical Engineering Office, Civil Engineering and Development Department, Hong Kong, 59 p.

4. BACKGROUND

4.1 ETWB TC(W) No. 4/2004 and PNAP No. APP-61 require submission of design and construction details of all permanent foundation works to the GEO for developments within the Scheduled Areas of the Northwest New Territories and Ma On Shan (Scheduled Area Nos. 2 and 4) where marble is known to exist. They give specific guidance on the planning and execution of ground investigation, design and construction of foundation works within the Scheduled Areas. This TGN provides supplementary technical guidance that aims at clarifying some design principles and requirements for foundations in the Scheduled Area Nos. 2 and 4 underlain by marble and marble-bearing rocks.

4.2 Chan (1996) gives a discourse on foundation design for marble area.

5. SUPPLEMENTARY TECHNICAL GUIDELINES

5.1 MARBLE-BEARING ROCKS IN SCHEDULED AREA NO. 2

Scheduled Area No. 2 covers a large area where complex geology and marble-bearing rocks of the Yuen Long Formation and Tuen Mun Formation can be expected. The marble in the Tin Shui Wai and Siu Hang Tsuen Members of the Tuen Mun Formation exists as clasts in the volcaniclastic rocks, with its lithologies highly varies from pyroclastic to epiclastic (Frost, 1992; So & Sewell, 2017, 2019). The marble clasts are generally not interconnected and dissolution of the marble clasts is localised, typically leading to honeycomb weathering of the marble-bearing rocks. They do not usually develop into the karst features that are common in marble of the Yuen Long Formation (Lai et al, 2004). Provided that adequate site investigations are carried out to classify and confirm the lithologies and types of marble-bearing rocks of the Tuen Mun Formation (So & Sewell, 2017), the presumed allowable bearing pressure and bond or friction under the Code of Practice for Foundations 2017 (BD, 2017) could be applicable in lieu of rational design method**.** Nevertheless, the bearing capacity and bond or friction of the marble-bearing rocks should be assessed, taking into account the possible honeycomb structure and dissolution features. While large cavities are rare in the volcaniclastic marble-bearing rocks, there are a few cases (Darigo, 1990; Frost, 1992) where relatively large cavities were encountered, which could have geotechnical significance to the design of foundations.

5.2 DEPTH OF EXPLORATORY DRILLHOLES

ETWB TC(W) No. 4/2004 and PNAP No. APP-61 recommend carrying out exploratory drillholes to penetrate 20 m into sound marble as a minimum requirement when marble is encountered. In the context of determining the founding level of foundations bearing on marble, the sound marble can be taken as marble that has not been or is only slightly affected by dissolution, such as rock with Marble Class I or II (Chan, 1994). For foundation bearing rock involving intercalated marble and calcareous (meta-) sedimentary rocks, these rocks should be duly classified based on the percentage volume of the carbonate minerals (So & Sewell, 2017) for reviewing the termination depth and criteria of exploratory drillholes.

5.3 FOUNDATIONS BEARING ON SOILS

5.3.1 For foundations bearing on soils, such as shallow footings or friction piles, the usual design practice is to limit the increase of vertical effective stress at the marble surface to an insignificant value, so as to reduce the collapse of any cavities in the rock due to the imposition of the foundation load. The following limits on increase of vertical effective stress are considered acceptable:

Site Classification[(1)]	Limits on increase of vertical effective stress at marble surface[(2)]
A	Design controlled by settlement in soil stratum
B	5 – 10 %
C	3 – 5 %
D	< 3 %

Note: (1) Site classification is based on Chan (1994).

(2) Limits on increase of vertical effective stress, as compared with the existing vertical effective stress, are based on Meigh (1991).

For such a design approach, it is not necessary to carry out extensive ground investigation at close spacings to establish the karst dissolution features to a high resolution, unless substantial and severe karst dissolution features exist beneath the site that would be detrimental to the stability of the foundations. Some deep drillholes penetrating the marble bedrock shall be carried out to determine the likely extent of the karst dissolution features and the thickness of the overburden.

5.3.2 Other design requirements, such as bearing capacity and settlement of the foundations within the soil stratum, should be checked to ensure the satisfactory performance of the foundations.

5.3.3 Alternatively, the allowable increase of vertical effective stress can be determined by a rational design approach to demonstrate that the deformation of the marble rock and the infilled materials within cavities would not adversely affect the performance of the foundations.

5.4 FOUNDATIONS BEARING ON MARBLE BEDROCK

5.4.1 Marble is a metamorphic rock composed largely of recrystallised carbonate minerals and its engineering properties are different from other meta-sedimentary rocks. The foundation properties of the sound marble are similar to that of igneous rocks (GEO, 1990) and the following presumed values can be adopted:

Description of marble bedrock	Presumed allowable bearing pressure (kPa)	Presumed allowable bond or friction between rock and concrete/grout (kPa)
Marble Class I or II and with not less than 95% of Total Core Recovery (TCR) of the designated grade, which has a minimum Uniaxial Compressive Strength (UCS) of rock material not less than 50 MPa (or an equivalent point load index strength PLI_{50} not less than 2 MPa)	10,000	1,000 (under compression or transient tension) 800 (under permanent tension)
Marble Class I or II and with not less than 85% of TCR of the designated grade, which has a minimum UCS of rock material not less than 25 MPa (or an equivalent point load index strength PLI_{50} not less than 1 MPa)	7,500	700 (under compression or transient tension) 560 (under permanent tension)

Note: Notes on using the presumed allowable bearing pressure and bond/friction as given in Table 2.1 and 2.2 of the Code of Practice for Foundation (2017) should also be applicable. The Marble Class and TCR of the designated grade should also be proved within the zone of influence of the foundation load, which should be at least three times the diameter of the pile base.

5.4.2 Bored pile foundations are usually designed to found on marble bedrock. The bedrock within the zone of influence of the foundation load should be of sound marble, which has not been or is only slightly affected by dissolution, such as rock mass with Marble Class I or II (Chan, 1994). Furthermore, no cavity should exist within the zone below the pile base to a depth equal to 1.5 times the diameter of the pile base. Other design aspects applicable to foundations bearing on rock, such as overlapping of bearing stresses from adjacent piles and effect of highly undulating rock profile, should also be considered.

5.4.3 Driven piles are commonly designed to be driven to sound marble, such as rock mass with Marble Class I or II (Chan, 1994). Despite the requirement of hard driving, there are chances that the driven piles can be affected by karst features beneath the pile toe or damage sustained during driving. A pile redundancy is provided for these uncertainties. Preboring may be used in case the piles have to penetrate overhangs or roofs of cavities to install piles at greater depth. In such circumstances, the pile redundancy can be adjusted accordingly.

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