

# **Reinforced Fill Design Software**

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## **1. Introduction**

Geogrids are widely used in earth retaining reinforcement as recognized by the improved strength of polymer, the ease of installation and the relatively low cost in construction. Design software is introduced to give an indication of the internal stability analysis with the use of Tenax TT geogrids in reinforced fill structure and slope design.

## **2. Tenax Geogrids**

Tenax geogrids are an integral structure with continuous stable strength. The product is made from high density polyethylene and is manufactured in a continuous extrusion process. The final product has cross directional bars integrally connected to the longitudinal strands to form a geogrid without mechanical or chemical bonding. The soil stresses are transferred to the geogrids through bearing or passive resistance mechanism against the cross directional bars. The soil is interlocked into the openings of the geogrids and through shear or friction mechanism at the soil-geogrid interface.

## **3. Reinforced Design Software**

The software provides a conservative design which follows fully GEO Geoguide 6 based on the use of Tenax TT geogrids. The characteristic short-term tensile strength of Tenax TT geogrids is 45kN/m to 160kN/m and their long-term design tensile strength is 21.2kN/m to 75.4kN/m in accordance to the latest GEO Endorsement Certificate for Reinforced Fill Products: Tenax TT Geogrids (Certificate No. RF 1/07).

## **4. Methodology of Design Software**

The design methodology is based on guidance given in Geoguide 6. Features with a vertical or near vertical facing, defined as within 20° from the vertical, are treated as reinforced fill structures, where features with face at inclination of more than 20° from the vertical are treated as reinforced fill slopes. Failures due to rupture and pullout of the reinforcement and wedge stability are considered in the design. In

checking against internal instability limit state, the use of partial safety factors (in Geoguide 6 Section 6.5 & 6.6) is adopted to evaluate if the design loading is less than the design resistance.

For tension in reinforcement, the design tension in the reinforced elements on any plane is determined by using factored dead and live loads and the design shear strength parameters of the fill material. Zero pore water pressure within the reinforced block may be assumed if adequate drainage measures are incorporated in the design. The design tension to be resisted by the  $i^{\text{th}}$  level reinforcing element is calculated in accordance with the guidelines given in Geoguide 6 Section 7.5.3.

For rupture of reinforcement, the design tension of every individual layer of reinforcement at different levels within the reinforced block is calculated and checked against design strength of reinforcing elements in accordance with the guidelines given in Geoguide 6 Section 7.5.4(1). The long-term design strength of  $i^{\text{th}}$  level reinforcement is to be larger than the total design tension to be resisted by that layer.

For pullout of reinforcement, the design tension of every individual reinforcing element at different levels within the reinforced block is calculated and checked against pullout resistance of that layer in accordance with the guidelines given in Geoguide 6 Section 7.5.4(2). The design pullout resistance of the  $i^{\text{th}}$  level reinforcement is to be larger than total design tension to be resisted by the  $i^{\text{th}}$  level reinforcement. The effective bond length of the reinforcing element is taken as that which protrudes beyond the potential failure surface under consideration.

For wedge stability check, the total tensile force to maintain wedge stability is calculated and checked against the total resistance provided by the layers of reinforcement anchoring the wedge in accordance with the guidelines given in Geoguide 6 Section 7.5.5. Total resistance for anchoring the wedge is to be greater than total tensile force to maintain wedge stability.

## **5. Guide to Design Software**

The design parameters such as geometry of the slope, surcharge details, geotechnical characteristics of the soil and the initial sizing of reinforcements are to be input (Appendix I), design tensions will then be calculated. These tensions can be refined by adjusting or modifying the reinforcement configuration such as

insertion length and spacing for each layer of geogrid (Appendix II and III). Choices of different grade of geogrids of each layer can then be selected and applied. The factors of safety against rupture, pullout and wedge stability will be shown to ascertain stability (Appendix IV). Reiteration is needed to appreciate the proper factor of safety.

## **6. Liability**

- 6.1 The design software is introduced to give an indication to the stability calculation with the use of Tenax TT geogrids. G and E Company Ltd. shall not be held liable or responsible for the accuracy or reliability of the computations performed by this software and its associated documentation. To the best of our knowledge, the calculations performed by this software are accurate.
- 6.2 The final design shall be verified by a professional registered engineer who shall review in particular the design prior to the construction to ensure that the design is complied to project specific requirement or other statutory legislation.

## **7. References**

- 7.1 For the theory and the equation used in this software, reference is made to GEO Geoguide 6: Guide to Reinforced Fill Structure and Slope Design, Geotechnical Engineering Office, Civil Engineering Department, The Government of the Hong Kong Special Administrative Region.
- 7.2 For the design value of Tenax TT geogrids used in this software, reference is made to GEO Endorsement Certificate for Reinforced Fill Products: Tenax TT Geogrids (Certificate No. RF 1/07), Geotechnical Engineering Office, Civil Engineering Department, The Government of the Hong Kong Special Administrative Region.