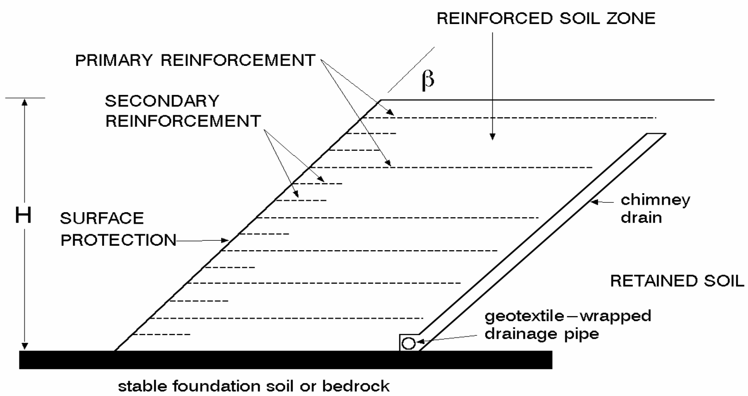
Geosynthetics in Slopes over Stable Foundations

Prepared by Prof. R.J. Bathurst

Layers of geosynthetic reinforcement are used to stabilize slopes against potential deep-seated failure using horizontal layers of primary reinforcement. The reinforced slope may be part of slope reinstatement and (or) to strengthen the sides of earth fill embankments. The reinforcement layers allow slope faces to be constructed at steeper angles than the unreinforced slope. It may be necessary to stabilize the face of the slope (particularly during fill placement and compaction) by using relatively short and more tightly spaced secondary reinforcement and (or) by wrapping the reinforcement layers at the face. In most cases the face of the slope must be protected against erosion. This may require geosynthetic materials including thin soil-infilled geocell materials or relatively lightweight geomeshes that are often used to temporarily anchor vegetation. The figure below shows that an interceptor drain may be required to eliminate seepage forces in the reinforced soil zone.

Example remediated slope with reinforced slope structure

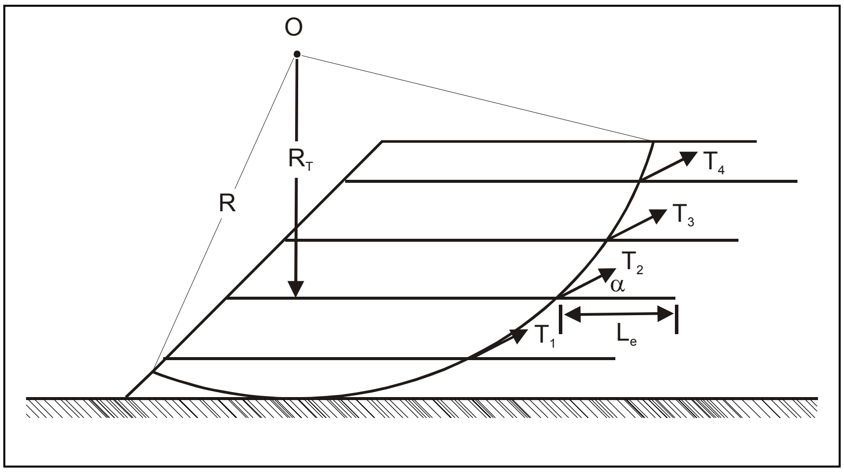


Geosynthetic reinforced soil slope over stable foundation

The location, number, length and strength of the primary reinforcement required to provide an adequate factor-of-safety against slope failure is determined using conventional limit-equilibrium methods of analysis modified to include the stabilizing forces available from the reinforcement. The designer may use a "method of slices" approach together with the assumption of a circular failure surface, composite failure surface, two-part wedge or a multiple wedge failure mechanism. The reinforcement layers are assumed to provide a restraining force at the point of intersection of each layer with the potential failure surface being analyzed. A solution for the factor-of-safety using the conventional Bishop's Method of analysis can be carried out using the following equation:

$$FS = \left(\frac{M_R}{M_D}\right)_{unreinforced} + \frac{\sum T_{allow} \times R_T \cos\alpha}{M_D}$$

where M_R and M_D are the resisting and driving moments for the unreinforced slope, respectively, α is the angle of tensile force in the reinforcement with respect to the horizontal, and T_{allow} is the reinforcement maximum allowable tensile strength. Since geosynthetic reinforcement is extensible the designer can assume that the reinforcement force acts tangent to the failure surface in which case $R_T \cos \alpha = R$. The potential failure surfaces must also include those passing partially through the reinforced soil mass and into the soil beyond the reinforced zone as well as those completely contained by the reinforced soil zone.



Example circular slip analysis of reinforced soil slope over stable foundation

Primary reinforcement

Completed reinforced embankment

About the IGS

The **International Geosynthetics Society (IGS)** is a non-profit organization dedicated to the scientific and engineering development of geotextiles, geomembranes, related products and associated technologies. The IGS promotes the dissemination of technical information on geosynthetics through a newsletter (IGS News) and though its two official journals (Geosynthetics International - www.geosynthetics-international.com and Geotextiles and Geomembranes - www.elsevier.com/locate/geotexmem). Additional information on the IGS and its activities can be obtained at www.geosyntheticssociety.org or contacting the IGS Secretariat at IGSsec@aol.com