SOFT FOUNDATION EMBANKMENT

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ABSTRACT

Construction of dikes or levees on extremely soft foundations is frequently prohibited by conventional building methods because it is not economically, practically, or technically practicable. However, geotextile-strengthened dikes were constructed using a design that allowed them to float on very thin foundations. Due to their higher device mobility, expedited construction, and ability to provide elevation without failure, geotextiles were used in these dikes to solve several production issues associated with soft-floor dike construction. The potential failure mechanisms and specifications for the design and choice of geotextiles for reinforced embankments are covered in this study.

Keywords: Geotextile, Embankment, Foundation, Failure.

1. Introduction

The presence of fine-grained dirt intermixed with the aggregate foundation materials destroys the structural strength of the aggregate by interfering with stone-to-stone contact, according to the majority of research into road failures built on soft soil. It be also mentioned here that unsatisfactory performance of poor sub- grade is again associated with lateral displacement of the sub-grade and the base materials under load (Ansari & Daigavane, 2020,2020a; Daigavane & Ansari, 2021a).The traditional solution for dealing with this problem is to implement a blanket strategy of using stabilized local soils as a sub-base layer instead of concrete.The flaw found with the old technique requires that the problem he addressed at its most basic level by correcting the formation sub-fundamental grade's deficiency and settling on a strategic remedy.

It is in this sense that geotextile is found to solve the problem by improving the consistency of poor soil sub-grade when added at the interface of the sub-grade (Daigavane & Ansari, 2021). This principle of integrating an additional indigenous feature at the sub-grade level, though is a new thought by way of a modern idea.

2. Modes of Potential Embankment Failure

When compared to traditional soft foundation construction methods and techniques, the design and construction of geotextile-reinforced dikes on soft foundations is technically possible, operationally viable, and cost effective. The failure modes are as follows:

- Horizontal sliding and spreading
- Rotational slope and/or foundation failure
- Excessive vertical foundation displacement

Horizontal sliding and spreading:

During conventional construction, Shear forces created along the dike-foundation interface would help the dikes resist various kinds of failure. Where geotextiles are used between the soft foundation and the dike, the geotextile will increase the resisting forces of the foundation. Geotextile reinforced dikes may fail by fill material sliding off the geotextile surface, geotextile tensile failure, or excessive geotextile elongation(Nene & Daigavane, 1994).Geotextiles with the

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requisite tensile strength, tensile modulus, and soil-geotextile friction qualities can be specified to avoid these failures.

Rotational Slope and/or foundation failure:

Dikes reinforced with geotextiles and built to a specific height and side slope will withstand conventional rotational failure if the foundation and dike shear strengths plus the geotextile tensile strength are adequate. The rotational failure mode of the dike can only occur through the foundation layer and geotextile. The dike side slopes are less than the internal angle of friction for cohesion less fill materials. Because the geotextile lacks flexural strength, it must be arranged in such a way that the critical arc determined from a conventional slope stability analysis intercepts the horizontal layer (Ansari et al. 2021; Nene & Daigavane, 1999).

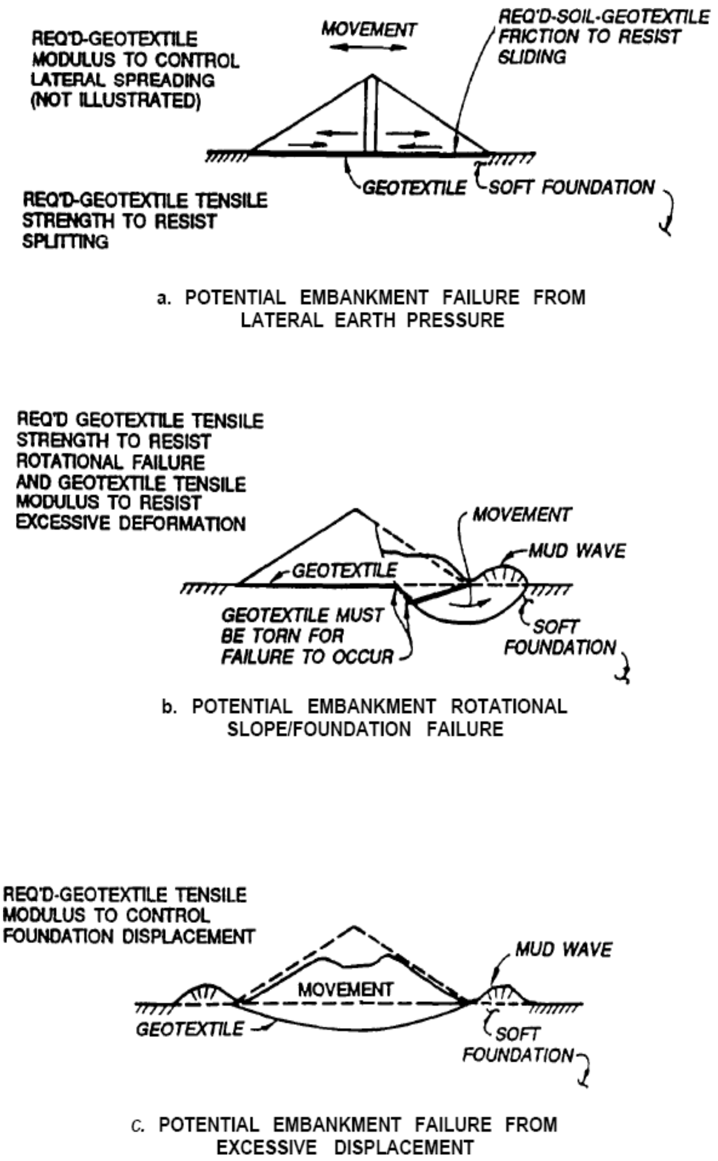

Figure1. Modes of potential embankment failure(Daigavane & Ansari, 2020)

Excessive vertical foundation displacement:

Consolidation settlements of dike foundations, whether geotextile-reinforced or not, will be similar. When geotextile-reinforced dikes are consolidated, the settlements are usually more uniform than when non-reinforced dikes are consolidated. One of the goals of geotextile reinforcement is to keep the dike together until the foundation can be stabilized and strengthened. Generally, only two types of foundation bearing capacity failures may occur partial or center-section foundation failure and rotational slope stability/foundation stability.

3. Recommended Criteria

The limit equilibrium analysis is recommended for design of geotextile-reinforced embankments. These design procedures are quite like conventional bearing capacity or slope stability analysis. Despite the fact that the rotational stability study implies that ultimate tensile strength will arise quickly to resist the active moment, some geotextile strain and hence embankment displacement will be required to create tensile stress in the geotextile.

Overall bearing capacity:

Whether or not geotextile reinforcement is utilized, the overall bearing capacity of an embankment must be calculated. There is no use in reinforcing the embankment if the overall stability of the embankment is not met. Standard foundation engineering textbooks include several bearing capacity procedures. Bearing capacity assessments for trip footings use assumed logarithmic spiral or circular failure surfaces and follow traditional limiting equilibrium analysis. The likelihood of lateral squeeze (plastic flow) of the underlying soils is another source of bearing capacity failure. As a result, the lateral stress and shear forces created beneath the embankment should be compared to the total of the resisting passive forces and the product of the soil failure plane area's shear strength. Stability can be addressed by adding berms or extending the base of the embankment if the total bearing capacity study shows an unsafe situation to provide a wide mat, thus spreading the load to a greater area. These berms or mats can be strengthened with suitably designed geotextiles to keep the embankment consistent and limit the possibility of lateral spreading.

Slope stability study:

If the embankment's overall bearing capacity is confirmed to be adequate, the rotational failure potential should be assessed using a traditional limit equilibrium slope stability analysis or Wedgwood analysis.

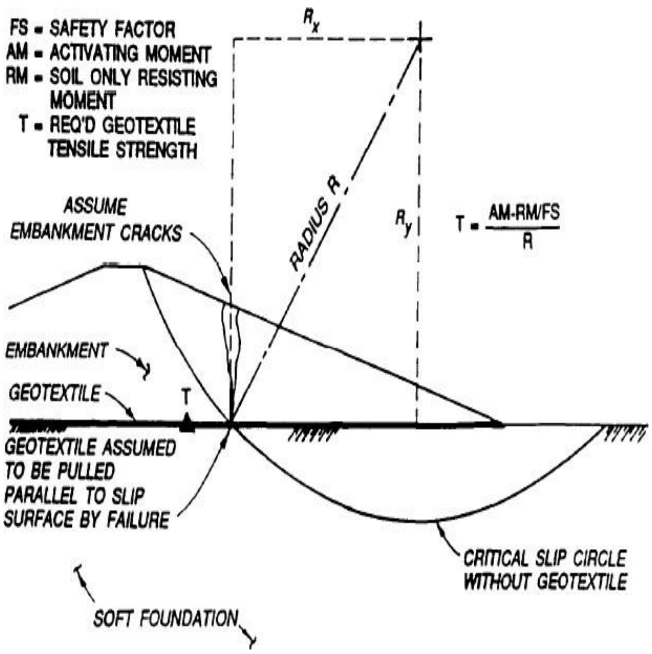

Fig. 2. Concept used for determining geotextile tensile strength necessary to prevent slope failure

Longitudinal geotextile strength requirements:

For both the transverse and longitudinal directions of the embankment, geotextile strength needs must be assessed and defined. The geotextile is dragged not only longitudinally, but also laterally toward the embankment toes, by the mud wave.

Erosion of the Embankment:

The reduction of vertical and horizontal deformations is one of the key goals of geotextile reinforcement in an embankment. The impact of this strengthening on horizontal movement in embankment spreading modes has already been discussed. Estimating the deformation or sinking produced by consolidation and plastic flow or creep of very soft foundation materials is one of the most difficult jobs. Elastic deformations are a function of the subgrade modulus. A strengthened embankment may result in a minor reduction in total settlement, but no major improvement. Other research suggests that high strength, high tensile modulus geotextiles can reduce foundation displacement during construction, although the methods of analysis aren't as well-established as those for stability analysis. The lateral and vertical motions induced by subsidence from consolidation settlements, plastic creep, and flow of the soft foundation materials will be avoided if the embankment is constructed for stability as mentioned previously. To determine foundation settlements, it is advised that a traditional consolidation analysis be done.

4. Conclusion

When compared to traditional soft foundation construction methods and techniques, the design and construction of geotextile-reinforced dikes on soft foundations is technically possible, operationally viable, and cost effective. The dikes would resist these kinds of failure during traditional construction by shear stresses created along the dike-foundation interface. If the foundation and dike shear strengths, as well as the geotextile tensile strength, are enough, geotextile-reinforced dikes constructed to a certain height and side slope, will withstand classic rotational failure.The overall bearing capacity of an embankment must be determined whether geotextile reinforcement is used. Wick drains can be used to quickly consolidate the soil and reach the desired strength in cases when it has a limited bearing capacity. The use of geotextile reinforcement can help speed up the construction process. Geotextile strength requirements must be evaluated and specified for both the transverse and longitudinal direction of the embankment.

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