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Landslide Slope Stability Analysis Using Geostudio

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ABSTRACT: Slope failures may occur due to heavy rainfall, earthquakes, rapid drawdown etc. Manmade or Natural slopes are often reinforced to increase stability and minimize risk. Many conventional methods are considered in field conditions have their own limitations.

In order to simulate actual field conditions it is more appropriate to use Geostudio software which is based on stress deformation analysis. In present to study an embankment various conditions are considered and analyzed for stability using Geostudio. Modern limit equilibrium software is used to deal with complex stratigraphy, highly irregular pore-water pressure conditions, various linear and nonlinear shear strength models, almost any kind of slip surface shape, concentrated loads, and structural reinforcement of finite slopes.

In Geostudio software, slope/w module is used for stability analyses. The effect of pore water pressure, factor of safety for an embankment is determined. For an embankment the most critical slip surface is taken for analysis. The critical factor of safety can be determined, which enables to design the reinforced and check the stability. By using above applications we find the stability of finite slope. The stability of finite slopes is determined and graphs are also generated by using SLOPE/W module.

I. INTRODUCTION

In olden days, designing of slopes are based on the experience of Geotechnical Engineers and design approach was based on prevailing site conditions. This approach of designing slopes has resulted in extensive property damage and occasionally resulted in the loss of life. Now a day's there is an increased demand for engineering cut and fill slopes on construction projects. The construction of finite height sloped embankments is a common practice in dams, highways and railway projects. The finite element analysis of stability failures and seepage analysis demands increased to handle complex problems in the construction field.

Stability and seepage analysis for earthen dams are very important to maintain the stability of the structure. Embankments of earthen dams must be designed to construct stable against any type of force conditions which develops in the life of the structure. Mostly loading conditions are critical like sudden drawdown and steady seepage which can cause piping through the foundation or within the embankment. To derive factor of safety, slope stability analysis of the embankment may be carried out for the 10m height of the homogeneous dam. The analysis has been performed using Mohr-Coulomb constitutive model. There are many analysis methods such as Method of Slices, Bishop's method, Janbu's method and Morgenstern Method etc. using any of the methods we can determine the stability analysis. SLOPE developed to be a general software tool for the stability analysis of earth structures for the proposed project of the raw water reservoir /W and SEEP/W has been used with "Morgenstern method" to do the stability analysis. It is designed and developed to be a general software tool for the stability analysis of earth structures for the proposed project of the raw water reservoir.

II. METHODOLOGY

A minimum factor of safety as low as 1.25 is used for highway embankment side slopes. This value of the safety factor should be increased to a minimum of 1.30 to 1.50 for slopes whose failure would cause significant damage such as end slopes beneath bridge abutments, major retaining structures and major roadways such as regional routes, inter states, etc The selection of the design safety factor for a particular project depends on:

1. The method of stability analysis used
2. The method used to determine the shear strength.
3. The degree of confidence in the reliability of subsurface data.
4. The consequences of a failure.
5. How critical the application is.

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6. Stability Analysis Methods (General)

There are several available methods that can be used to perform a circular arc stability analysis for an approach embankment over soft ground. The simplest basic method is known as the **Normal** or **Ordinary Method of Slices**, also known as Fellenius' method (Fellenius, 1936) or the Swedish circle method of analysis. The Ordinary Method of Slices can easily be performed by hand calculations and is also a method by which the computation of driving and resisting forces is straightforward and easily demonstrated. For this method, the failure surface is assumed to be the arc of a circle as shown in Figure 4 and the factor of safety against sliding along the failure surface is defined as the ratio of the moment of the total available resisting forces on the trial failure surface to the net moment of the driving forces due to the embankment weight, that is:

$$FoS = \frac{\text{Sum of Resisting Forces} \times \text{Moment Arm (R)}}{\text{Sum of Driving Forces} \times \text{Moment Arm (R)}} \quad (1)$$

Note that since the method consists of computing the driving and resisting forces along the failure arc, the moment arm R is the same for both the driving and resisting forces. Thus, Equation 1 reduces to:

$$FoS = \frac{\text{Sum of Resisting Forces}}{\text{Sum of Driving Forces}} \quad (2)$$

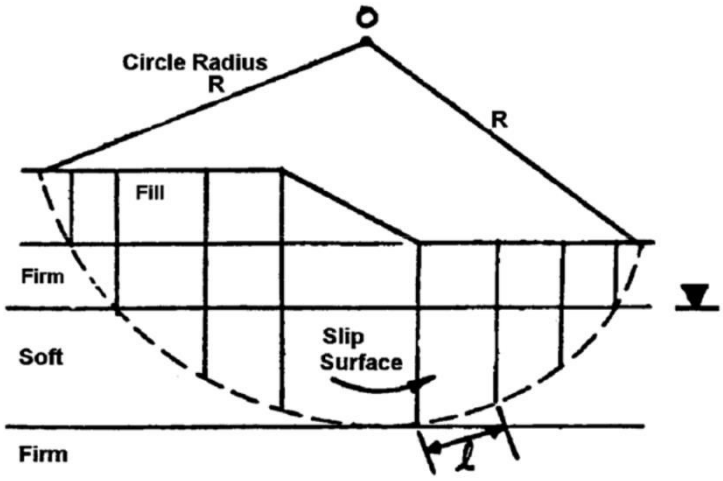

Figure 1 Geometry of Ordinary Method of Slices.

For slope stability analysis, the mass within the failure surface is divided into vertical slices as shown in Figure4 A typical vertical slice and its free body diagram is shown in Figure 4.1 for the case where water is not a factor. The following assumptions are then made in the analysis using Ordinary Method of Slices:

The available shear strength of the soil can be adequately described by the Mohr-Coulomb equation:

$$\tau = c + (\sigma - u) \tan \varphi \quad (3)$$

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IV. RESULTS AND DISCUSSIONS

Factor of Safety of Embankment

Slope with Height 6 m and subjected to No Pore water Condition with Homogeneous Material is analysed and factor of safety and slip surface are generated

Figure 2 .Embankment of 6m elevation is analysed by using Bishops method

METHOD	FACTOR OF SAFETY	PORE WATER PRESSURE(kPa)
Ordinary Method	1.939	0
Janbu Method	1.913	0
Bishops Method	2.007	0

Slope with Height 6 m and subjected to Pore water Condition with Homogeneous Material is analysed and factor of safety and slip surface are generated

Figure 3. Embankment of 6m elevation is analysed by using Janbu method specifying Peizometric Line

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METHOD	FACTOR OF SAFETY	PORE WATER PRESSURE(kPa)
Ordinary Method	1.739	20.65
Janbu Method	1.748	20.65
Bishops Method	1.855	20.65

Slope with Height 6 m and subjected to Pore water Condition with Non Homogeneous Material is analysed and factor of safety and slip surface are generated

V. CONCLUSIONS

From above results the following conclusions are withdrawn

1. Slope with 6m elevation are more stable than slopes of 8m and 10m.The Factor of Safety of slope 6m elevation is 1.939 where as for 8m and 10m are 1.053 ,0.843 respectively
2. Slopes of homogeneous materials are more stable than Slopes of Non Homogeneous materials .Factor of Safety of Slopes of homogeneous material of 6m 8m 10m elevations are 1.939, 1.053 ,0.843 and Non Homogeneous slopes are 1.628, 1.141 , 0.874 respectively .
3. Among Ordinary method ,Bishop and Janbu, Janbu Method is analysing slopes with more assumptions thus resulting in higher Factor of safety. Factor of Safety of slope of 6m using Bishop method is 2.007 where as Ordinary Method gives 1.939 and Janbu Method 1.913
4. Uniform Pore water pressure in slope of 6m elevation in both homogeneous and non homogeneous materials are more stable than slopes of 8m and 10m elevations with different materials.
5. As Inclination angle is inversely proportional to factor of safety .Slope of 6m elevation is more stable as it is having less inclination angle of 33 degrees and 8m, 10m is 45 degrees and 53 degrees respectively.

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