Project report-J component

Slope stability analysis using Oasys Software

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B. Tech. – Civil Engineering

CLE2010 Ground Improvement Techniques
Submitted by

PRATHAM KUMAR - 19BCL0085
HARINI S - 19BCL0123
DEETYA R - 19BCL0012
PAVITHRA P - 20BCL0080
PRIYADHARSHINI - 20BCL0110

Project guided by - Prof.**Dr.MUTHUKUMAR.M**

ABSTRACT

The study of slope stability has attracted a lot of attention.due to its current day relevance in terms of practicality. To deliver the safest, sharpest slopes possible.There are still investigations ongoing. The stability is based on the equilibrium between shear stress and shear strength if there are forces on hand are greater than the forces causing movement.The slope is thought to be steady. One aspect of safety is the forces preventing mobility are divided by the driving forces behind motion A slope that was constant in the past Initially impacted by antecedent circumstances, the slope temporarily unstable The subject of slope stability consists of slope stability, both static and dynamic, of earth-fill and rock-fill dams,embankment slopes, excavated slopes, and naturally occurring slopes in soft rock and soil.

The analysis of slope stability can be done using a variety of methods.This paper aims to provide an overview of slope stability methods based on assumptions, the calculation of the Factor of Safety, the conditions and types of the soil, the applicability of the method's output, and its limitations. This research focuses on use of OASYS software that can be used for slope stability analysis.

Oasys Slope gives civil and geo-technical engineers the capacity to research and validate their projects requiring slope stability analyses—a crucial component of designing linear infrastructure with cuttings for long-term projects, for instance.

INTRODUCTION

One of the most significant and delicate issues in civil engineering is slope stability, which is often a difficulty in huge and significant projects like dams, motorways, and tunnels. There are numerous methods for determining if a slope is stable. The ability of slopes covered in soil to tolerate and experience movement is known as slope stability. Shear stress and shear strength must be balanced to maintain stability.

The angle (β) produced between a slope's slope surface and the horizontal as well as the slope's height, crest, and toe all serve to characterize a slope.It is possible for slopes to fail due to internal (loss of shear strength, liquefaction, rise in water table) or external (weather) reasons (seismic events, loss of toe by water drainage, lack of internal drainage system).Slope failure occurs when the soil's shear strength is less than the generated stress.

Numerous natural and man-made slopes have failed over the years, causing terrible death and ruin.When working on projects like dams, highways, and tunnels, civil engineers are expected to evaluate the safety of slopes.Geology, groundwater, surface drainage, and soil shear strength must all be given special consideration in order to raise the slope's Factor of Safety.

LITERATURE REVIEW

Sr no.	Author	Title/Journal	Key Findings
1.	Karam, Sousa, Manchao He	Slope stability risk management in open pit mines	The application of automated risk management system is successfully installed in china to monitor sliding forces on pre-stressed rock bolts and stabilization methods is based on properties like strength, stiffness and response to potential instabilities.
2.	Zulfu Gurocak, Selcuk Alemdag, Musharraf M. Zaman	Rock slope stability and excavatability assessment of rocks at the Kapikaya dam site, Turkey	The kinetically analyses of the slopes indicated that no failure is expected for the right and left slopes at the dam site.According to results of numerical analysis, Strength Reduction Factor (SRF) of the right and left slopes are 8.08 and 6.5 respectively and any rotational failure will not occur. The excavation category of the diabases was determined as easy ripping for the right slope and easy-hard ripping for the left slope.
3.	Mr. Digvijay P. Salunkhe, Ms. Rupa N. Bartakke, Prof. Guruprasd Chvan	An Overview on Methods for Slope Stability Analysis	In Limit equilibrium methods investigate the equilibrium of a soil mass tending to slide down under the influence of gravity.The limit equilibrium is statically indeterminate analysis.Finite element method can compute displacement.Numerical modelling techniques provide an approximate solution to problems which otherwise cannot be solved by conventional methods,
4.	K. Singh, V. Kumar	Slope Stability Analysis of landslide Zones in the part of Himalaya, Chamba, Himachal Pradesh, India	The landslides occurrence can be analyzed through geo-technical, mineralogical, and chemical properties of the soil forming slopes. Re-profiling is an effective way of controlling slope instability in case of soil slopes;a. The stability of the soil slope sites has been analyzed using circular failure charts (CFC) and based on the factor of safety calculated, the mitigation measures were suggested which will be beneficial to various stakeholders like planners and engineers.
5.	N.Mizal-Azzmi, N.Mohd-Noor, N.Jamaludin	Geotechnical Approaches for Slope Stabilization in Residential Area at Perk District, Malaysia	From the methods used in this study, slope surface configurations determined by data collection have birth the idea of retaining structure design. These early steps are important to identify the cause of slope instability and failure. Apart from the soil stress factor, be it lateral or horizontal stress, the climate factor in Malaysia, which is hot and humid contributes to soil failure.

Sr no.	Author	Title/Journal	Key Findings
6.	T. K. Rajak, L. Yadu, S. K. Pal	Analysis of Slope Stability of Fly Ash Stabilized Soil Slope	Fly ash was mixed with soil in different proportions to conduct proctor compaction and direct shear test. As percentage of fly ash increased, angle of internal friction increased, but dry density and cohesion decreased. Under varying weather conditions, native soil slope was stable only up-to 12m. On adding fly ash, FoS increased with slope stability up to 14m.
7.	Aniruddha Sengupta, Anup Upadhyay	Locating the critical failure surface in a slope stability analysis by genetic algorithm	The proposed GA has 2 steps (1) choosing and minimizing fitness function (2) fine tuning the parameters. Minimum factor of safety obtained from genetic algorithm, grid method, Monte-Carlo method was compared. What was found to be a stable FOS from GA was reported as lowest FOS. After multiple generations, FOS from GA stabilized at global minima value. This is one of GA's strengths - the ability to pin point the global minima. Computationally speaking, GA consumed less memory compared to Monte-Carlo method. Because the Grid technique is prone to falling for local minima, its memory usage was irregular.
8.	Amit Srivastava, G.L. Sivakumar Babu, Sumanta Haldar	Influence of spatial variability of permeability property on steady state seepage flow and slope stability analysis	Three issues were investigated using Monte Carlo simulations. (1) the influence of stochastic soil permeability on seepage flow statistics in comparison to the analytic (Dupuit′s) solution available for the uniformly constant permeability characteristic; (2) strain and deformation pattern; and (3) stability of the given slope as measured by factor of safety (FS). The study showed that with increase in coefficient of variation in the permeability parameter, there is a decrease in seepage discharge. The effect of reduced factor of safety is more pronounced for steeper slopes and higher permeability values.

EXPERIMENTAL/NUMERICAL INVESTIGATION

In order to perform stability analysis it was necessary to make assumptions based on site-specific project information and on-site observations. A sensitivity analysis performed on phi angle and ground water profile.

Slope Analysis Method: Swedish Circle(Fellenius) Bishop's Method Janbu's Method(Non-Circular Slip Surfaces) All these Methods of analysis use the method of Slices to determine FOS. We have used slip definition as circular slip specification using a defined radii.Location of Circular surfaces is defined using a rectangular grid of centers and then a number of radii, a common tangential surface at which the circle almost touches

The ground section is built up by specifying each layer of material, from the surface downwards, as a series of x and y coordinates. The strength of the materials is represented by specifying cohesion and an angle of shearing resistance. Linear variations of cohesion with depth can also be entered. The ground water profile and pore water pressure distribution i set individually for each soil stratum, using a phreatic surface with hydro-static pore pressure distribution.

SLOPE STABILITY ANALYSIS

Materials

	Unit Weight (KN/m^2)	Unit Weight (KN/m^2)			
Description	**Above GWL**	**Below GWL**	**Condition**	**phi ' (KN/m^2)**	**C ' (KN/m^2)**
Embankement	15	19.5	Drained Linear Strength	20	5
Foundation	18	21.5	Drained Linear Strength	25	10
Bed Rock	22	24	Drained Linear Strength	40	15

Ground Water

Original

X	Y
0	11
15	10
35	3
50	3

Raised

X	Y
0	14
15	14
35	4
50	4

Strata

Embankment

X	Y
0	14
15	14
35	4
50	4

Foundation

X	Y
0	4
35	4
50	4

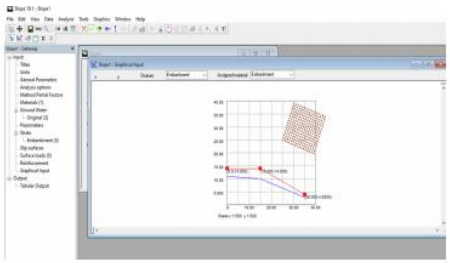
Bed Rock

X	Y
0	0
50	0

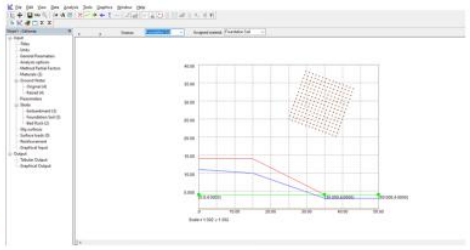
PROCEDURE

Sr no.	Procedure Followed for finding out the factor of safety
1.	Setting Title(Job Description) and Unit
2.	Setting the Condition and entering the unit weight for Above GWL and BWL and setting shear strength parameters(phi' and c')
3.	Stratum Definition and Stratum coordinates
4.	Setting up Original Groundwater coordinates
5.	Setting up Slip surface definition
6.	After Clicking Finish we will get output for embankment
7.	Input the Material Description of (Embankment,Foundation soil and Bed rock)-> Unit Weight Above and Below GWL in (kN/m^2)->condition as Drained Linear strength->Shear Strength Parameters(phi' and c')
8.	Ground Water->Add GW Profile X and Y in m.
9.	Add strata coordinates for Embankment,Foundation soil and Bed rock
10.	Output with FOS will be displayed
11.	To view the worst case slip cases.Right click in the grid view to view Factor of safety for different circles
12.	Click on Edit Label Icon.Position the cursor near the red spot shown on top left of the label. Double click on Tabular output in gateway>Select to view summary Results and Detailed Results(Worst Case)

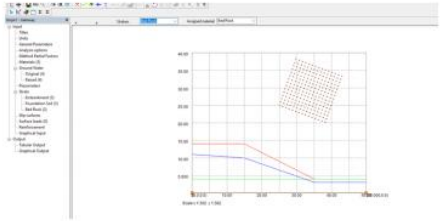
RESULT



Output 1 for embankment

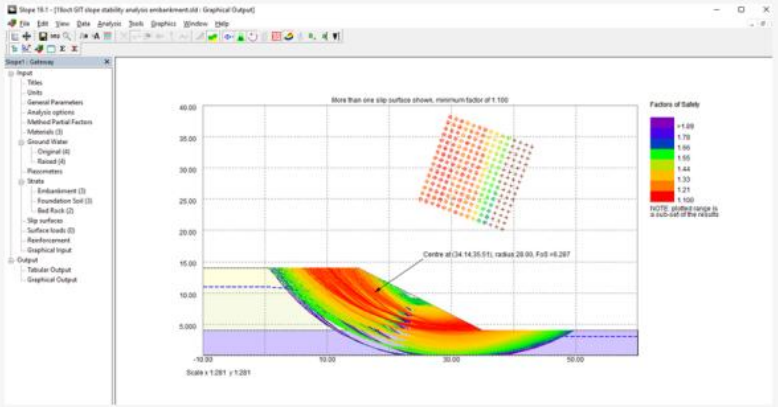


output 1 for foundation rock



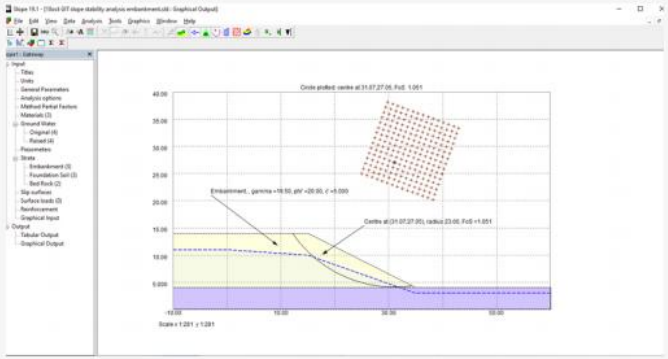
Output 1 for bed rock

Graphical Output with FOS Red color:



GRAPHICAL OUTPUT:

Slices analysed for the specific Slip Circle.



CONCLUSION

- Strength of slope directly depends on the material contained within. Slope Strength is determined By resulting factor of safety(FOS).
- The result of analysis using conservative input values to the model indicate that the overall landslide slopes are stable for some period however some localized failures have likely occurred.
- Since the landfill is freely standing the Factor of safety is equal to 1.1.
- Due to high variability of unit weight it is likely that localized failure will occur in some location in future(depending on the chosen phi angle).
- To ensure construction proceeds on safe manner on site ensure that designed FS is adequate.
- Depending on stability of material remedial plan should be devised

REFERENCES

Articles:

- Tan Y. C. & Gue, S.S. (2006), "Landslide: Case Histories, Lessons Learned and Mitigation Measures", IEM/JKR Geo-technical Engineering Conference 2006, Ipoh, Perak, 6 - 7 March 2006. [2] Terzaghi K ,Mechanisms of landslides. Geological Society of America, Berkeley Vol, pp 83–123,1950
- Rajak, T., Yadu, L., & Pal, S. (2018). Analysis of Slope Stability of Fly Ash Stabilized Soil Slope. Lecture Notes In Civil Engineering, 119-126. doi: 10.1007/978-981-13-0368-5_13

Videos:

- https://youtu.be/hxukAvr-9NY
- https://youtu.be/oltBMly3ho0
- https://youtu.be/CUw3lQHa1Kw

Books:

- Soil Strength and Slope Stability, 2nd Edition
- J. Michael Duncan, Stephen G. Wright, Thomas L. Brandon

Websites:

- https://www.slideshare.net/PallaviBadry/slope-stability-74922154
- https://www.geoengineer.org/education/slope-stability/slope-stabilization
- https://theconstructor.org/geotechnical/slope-stabilization-methods-classification construction/47087/