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Use of Geo-Studio Software for Slope Stability of Earthen Dams

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***Abstract*: Geo-Studio software is mainly designed for geo-engineering and earth science problems. Slope stability analysis is very important to check the stability of the structure. In this project, we are going to find out the factor of safety of Kashypi dam by finite element method and are going to compare it with the actual factor safety of dam. Analysis of slopes for stability and safety is a major factor in civil engineering. Hence, this is the main reason that so many implementation methods have been developed so far. This paper and software involves determining the factor of safety of the dam and then taking preventive measures on the basis of results.**

***Keywords*: Slope stability, Sudden drawdown, Berm, Drain, Earthen dam, GEOSTUDIO software, Factor of safety.**

1. Introduction

Detection of Slope stability is an important term of geology. In general, linear problems such as the prediction of settlements and deformations, the estimation of flow quantities due to steady and transient seepage are all more susceptible to answer by finite elements. The uses of finite element method for slope stability and seepage have attain name in recent years due to its capability to handle critical condition. The initial and main focus of this research is to study the effect of various water levels to the dam slope by using finite element method, and to determine failure mechanism. Slope stability and seepage analysis using technology such as computers are easy task for engineers when the slope configuration and the soil parameters are well known. However, the selection of the slope stability analysis is not an easy task and the field conditions should be collected and the failure observations in order to know the failure mechanism, which gives the slope stability method that should be used in the analysis. Therefore, the theoretical background of each slope stability method should be investigated in order to analyse the slope failure and assess the reliability of their results. Two-dimensional slope stability is mostly used method in the engineer due to their easiness. Geostudio software is one of the popular geotechnical software based on the finite element and can also do the analysis like stress-strain, seepage, slope stability, dynamic analysis and water drawdown in the reservoir.

2. Objectives

The main objectives of slope stability analysis are finding endangered areas, investigation of potential failure mechanisms, determination of the slope sensitivity to different triggering mechanisms, designing of optimal slopes with regard to safety, reliability and economics, designing possible remedial measures, e.g. barriers and stabilization. Successful design of the slope requires geological information and site characteristics, e.g. properties of soil/rock mass, slope geometry, groundwater conditions, alteration of materials by faulting, joint or discontinuity systems, movements and tension in joints, earthquake activity, etc. Choice of correct analysis technique depends on both side conditions and the potential mode of failure, with careful consideration being given to the varying strengths, weaknesses and limitations inherent in each methodology.

3. Literature review

System reliability analysis of slope stability using generalized subset simulation [Dian-Qing Li, Zhi-Yong Yang, June 2017]:

The stability of earth dam depends on its geometry, its components, materials, properties of each component and the forces to which it is subjected. Such as geological and subsurface explorations, the earth and/or rockfill materials available for construction should be carefully studied. The existing design results are compared with the stimulated results obtained from software.

Fernando Flávio Marques de Almeida [(1916–2013), Brazilian geologist, member Brazilian Academy of Sciences] For an aspiring geologist, training typically includes significant coursework in physics, mathematics, and chemistry, in addition to classes offered through the geology department; historical and physical geology, and structural geology are among the many required areas of study. Most geologists also need skills in GIS and other mapping techniques. Geology students often spend portions of the year, especially the summer though sometimes during a January term, living and working under field conditions with faculty members. Many non-geologists often take geology courses or have expertise in geology that they find valuable to their fields; this is common in the, fields-of geography, engineering, chemistry, urban planning, environmental studies, among others.

Claude Allègre [1900-1937, French geochemist, member of the French Academy of Sciences]. First published his famous

book, Principles of Geology, in 1830. This book, which influenced the thought of Charles Darwin, successfully promoted the doctrine of uniformitarianism. This theory states that slow geological processes have occurred throughout the Earth's history and are still occurring today. In contrast, catastrophism is the theory that Earth's features formed in single, catastrophic events and remained unchanged thereafter. Though Hutton believed in uniformitarianism, the idea was not widely accepted at the time.

4. Methodology

Kashypi Dam, is an earthfill dam on Kashyapi river near Rajapur, Nashik district in the state of Maharashtra in India. The height of the dam above lowest foundation is 41.75 m (137.0 ft) while the length is 1,380 m (4,530 ft). The volume content is 0.05174 km^3 (0.01241 cu mi) and gross storage capacity is 0.05269 km^3 (0.01264 cu mi). Downstream of this dam is the Gangapur Dam which opened in 1965. Due to silt deposition in the reservoir area, the storage capacity of the Gangapur Dam has gradually reduced. The right side canal running towards Nashik is also closed due to the high civilization in the area. For these two reasons, the Kashypi Dam was constructed. The purpose of this dam is for irrigation purpose.

The information for this project we have collected from Maharashtra Engineering Research Institute, Nashik. In the Central Dams Organization Department, there was a sub division called as Irrigation Department. From this department, we collected all the details regarding the Kashypi Dam such as soil stability, factor of safety, cut – off trenches, type of foundation, type of soil, etc. The type of soil available during the construction of dam was black cotton soil. The factor of safety of dam was 1.5. According to IS 7895 – 1975, we are going to perform all the required activities. For this dam, there is no foundation provided. A flat base was prepared and then dam was constructed. No cut – off trenches are provided to the dam.

The modeling software for geo-engineers and earth scientists. Rigorous analytical capability. Sophisticated product integration. Broad application to diverse geo-engineering and earth science problems. Combine analyses in a single, integrated project GeoStudio enables you to combine analyses using different products into a single modeling project, using the results from one as the starting point for another. GeoStudio software is mainly designed for finding out the factor of safety of the respective dams by finite element method. GeoStudio runs each analysis solver in parallel, allowing multiple analyses to be solved efficiently on computers with modern, multi-core processors. GeoStudio Basic Edition includes elementary features of SLOPE/W, SEEP/W, SIGMA/W, QUAKE/W, TEMP/W, CTRAN/W, AIR/W and VADOSE/W for solving slope stability and related geotechnical analyses.

Kashypi Dam	
 Location of Kashypi Dam in Maharashtra	
Official name	Kashypi Dam D03105
Location	Rajapur
Coordinates	20.0692741°N 73.6012318°ECoordinates: 20.0692741°N 73.6012318°E
Opening date	1998[1]
Owner(s)	Government of Maharashtra, India
Dam and spillways	
Type of dam	Earthfill
Impounds	Kashyapi river
Height	41.75 m (137.0 ft)
Length	1,291 m (4,236 ft)
Dam volume	0.002761 km^3 (0.000662 cu mi)
Reservoir	
Total capacity	0.05269 km^3 (0.01264 cu mi)
Surface area	46.1 km^2 (17.8 sq mi)

A. Finite Element Method

The overall factor of safety computed using the finite element method source good agreement with the factors of safety computed using any one of several limit equilibrium methods. The finite element stress analysis provides input information for the calculation of the stability of a slope. Further research must be undertaken on the stress analysis in order to ensure that the proper boundary conditions are being used and that a reasonable stress deformation model is being used. The finite element stress analysis method of slopes concentrated mainly on deformation rather than stability analysis of slopes. No assumption needs to be made in advance about the shape or area of the sudden failure surface. The calculate factor of safety using finite element stress methods is different factor of safety as in the limit equilibrium obtain. The factor of safety of a slope by the finite element stress method is term as the ratio of the summation of the resisting shear force rS along a slip surface to the summation of the mobilized shear force Sm along a slip surface.

5. Conclusion

The most efficient method will be finite element method. As compared to manual work, software gives more better result. It gives a more realistic view of the dam and its characteristics. Analysis of slopes for stability and safety is a major area of concern in civil engineering. This is the main reason that so many analysis techniques have been developed so far. As compared to manual work, this software method gives more accurate results. It saves time and no need of manual calculation is required.

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