



SLOPE STABILITY AND SEEPAGE ANALYSIS OF EARTHENDAM OF A SUMMER STORAGE TANK: A CASE STUDY BY USING DIFFERENT APPROCHES

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ABSTRACT-- Dams are constructed for various purpose like flood control, navigation, water sources, recreation, power generation and irrigation etc. earth dams have always been associated with seepage as they impound water it. The water seeks paths of least resistance through the dam and its foundation. Seepage will become a problem only if it carries dam material also along with it. Seepage must be controlled to prevent the erosion of embankment or its foundation. Embankment dam are more common than any other type of dams because of various reason like the use of ordinary technology construction method utilizing cheap raw soil material and subsurface materials, no need of a particular valley shape etc. one of the important factor causing failure of embankment dam by seepage and hence seepage analysis of embankment dam is of greater importance. Geo-studio software is one of the geotechnical software and it is based on the finite element that can be considering the analysis of seepage and slope stability analysis. In this project for determination of seepage analysis Nandyal summer storage tank has been done by SEEP/W software. In order to evaluate the type and size of mesh size on the total flow rate and total head through the dam cross section, four mesh size such as coarse, medium, fine and unstructured mesh is considered. The slope stability analysis of Nandyal summer storage tank has been done by SLOPE/W software and is used in under different conditions to evaluate slope stability. Analyzes for each state and each slope with Bishop and other ordinary method of slides is calculate that the minimum factor of safety in this methods

Key words: Seepage analysis, Slope Stability analysis, Analytical method, Geo-studio Software

INTRODUCTION

Dams are constructed regarding numerous purpose just like overflow command, course-plotting, water solutions, sport, power creation as well as irrigation and so forth. Soil dams have invariably been associated with seepage while they impound water it. Water looks for routes regarding the very least opposition from the dam and it is groundwork. Seepage could be the main problem also it travels from the dam product looked after transporting dam supplies. Seepage must be handled just to save the actual erosion regarding embankment or even their groundwork.

Embankment dam are common in different other style of dams on account of numerous cause just like the employment of everyday development technologies method while using cheap fresh land product as well as subsurface supplies, absolutely no require of your distinct area condition and so forth. one of several important factor producing failing regarding embankment dam by simply seepage and hence seepage analysis regarding embankment dam is usually regarding larger significance.

The slide is nothing but failure of volume of soil in downward direction. It is approximately caused by a slowly disintegration of the soil structures, by an increasing of pore- water pressure in a few more permeable layers, or by a shock that liquidizes of soil. The main factor for increasing of pore-water pressure the soil is failed in shear strength. The falling of shear strength may occur due to shock loads, rise in water content, varies in pore water pressure, weathering or any other cause. Most of general slopes failure occurs during rainy season, as an including of moisture content causes both increased stresses and the loss of strength with the development of modern method of technique of stability investigation, a safe and cost of design of a slope have a thorough knowledge various methods for checking the failure of slopes and their restrictions.

The SEEP/W and SLOPE/W computer software can be used to estimate the flow of water through the soil and failure slope analysis of Nandyal summer storage tank. This soft ware solves the underground water problems for stable, unstable, wet and dry conditions. This software not only the superiority to the graphic method and manual calculations, but also regarding the time we can gain good results. This software has many applications which helps designers in best designing of dams and analyzing the weak or strength points of dams and also designing of the construction which dealing with the seepage problems.



OBJECTIVES

1. Study the earthen dam details
2. Study the failures of earthen dam
3. Study the problems of earthen dam
4. Calculation of seepage in earthen dam by the analytical approach
5. Calculation of slope stability analysis in earthen dam by analytical approach
6. Determining the seepage analysis by using geo-studio software in earthen dam
7. Determine the slope stability analysis by using geo-studio software in earthen dam

LITERATURE AND RIVEW

Earthen dam have always been associated with seepage as they impound water in it. The water seeks path of least resistance through the dam and its foundation. Seepage will become a problem only if it carries dam materials also along with it. Seepage must be controlled to prevent the erosion of embankment or its foundation. Different methods like analytical, electrical analogy and flow net (Ali,S.,and Fardin,2005; Abdullahi et al.2000, and casagranade,1961) are used to study and monitor seepage in dams. Dr. S.P. Tatewar, et.al., are study the stability analysis of earthen dam by geo-studio software. Slope stability analysis of earth dam is very important to ascertain the stability of the structure. The stability of the earth dam depends on its geometry, its components, materials, properties of each component and the forces to which it is subjected. Teghavi et.al., investigated geotechnical parameters effects on embankment dam analysis and design. Variation of strength parameters are discussed when soil is sheared in different situation and stress-strain level.

Zomordian and Abodollahzadeh investigated the effect of horizontal drains on upstream slope of earth fill dams during rapid drawn down using finite elements and limit equilibrium method. H.Hasani, J. Mamizadeh and H. Karimi 2013 are research seepage analysis in ilam earth fill dam has been done by seep/w software. In order to evaluate the type and size of mesh size on the total flow rate and total head through the dam cross section, four mesh size such as coarse, medium, fine and unstructured mesh is considered. Ms.Abhilasha P.S., T.G. Antony Balan e-ISSN:2778-1684 studied the numerical analysis of seepage in embankment dams. In this report study the mathematical modeling of seepage in embankment dams and various software used in the analysis of embankment dams like MODEFLOW, SEEP/W, ANASYS, PLAXIS, PDEase2D,SVFLX, etc., are discussed with reported case studies.

Ashutosh kainthola, et.al., Volume 2, No.6, june 2013 studied the review on numerical slope stability analysis and detailed review of equilibrium methods of slope stability analysis is presented. These methods include the ordinary method of slices, Bishop’s Modified method, force equilibrium methods, Janbu’s generalized procedure of slices, Morgenstern and prices’s method and spencer’s method. Nilesh M.et.al., oct 2012 found the Use of Graphical Technique for Stability Analysis of Embankment, By using computer program these critical slip surfaces are originated and their correlation with the height, slope, and seepage conditions of the embankment has been established. Both toe circles and slope circles that envisage above the toe have been analyzed using this technique

STAUDY AREA

Summer storage tank is constructed in the year of 2009 and it is located at Nandyal, Kurnool (dist) A.P. The purpose of S.S. tank is constructed for drinking of water. The S.S. tank is constructed mainly clay, sand, gravel materials. The clay soils are filled on upstream side and gravel soil is filled on downstream side and the sand layer is used for the purpose of to drain out the seepage of water from the embankment

1.	Nandyal population	166,344 lacks of people
2.	Top width	4.5m
3.	Tank Bund Level	+223.00
4.	Maximum water level	+221.00
5.	Low water level	+214.50
6.	Ground level	+213.20
7.	Slope	2 in 1
8.	Base width	22.5m
9.	Area covered	204 acres
10	Name of S.S.Tank	Peddacheruvu
11	Type of dam	Earthen dam
12	Name of river	Peleruvagu (local stream)

MATERIALS AND METHODOLOGY

Summer storage tank is constructed in the year of 2009 and it is located at Nandyal, Kurnool (dist) A.P. The purpose of S.S. tank is constructed for drinking of water. The S.S. tank is constructed mainly clay, sand, gravel materials. The clay soils are filled on upstream side and gravel soil is filled on downstream side and the sand layer is used for the purpose of to drain out the seepage of water from the embankment. In this project the seepage and slope stability analysis is done in two ways (i) Analytical approach (ii) Computer approach.

Analytical approach

The analytically the seepage analysis is calculated by using Darcy's law, and the slope stability analysis is done by using Bishop Method. This analytical approach is done based on the earthen dam details and with their material properties.

Computer approach

In order to achieve the objectives of this study, Geo-studio software is used. The Geo-studio software is mainly based on finite element method that can be used for evaluate the performance of dams. The Geo-studio software is suitable for eight products. SLOPE/W for slope stability, SEEP/W for ground water seepage, SIGMA/W for stress-deformation, QUAKE/W for dynamic earthquake, TEMP/W for geothermal, CTRAN/W for contaminant transport, AIR/W for air flow, VADOSE/W for vadose zone & covers. On this research SLOPE/W and SEEP/W is used. The product SLOPE/W is calculate the analysis of slope stability and pore-water pressure conditions, soil properties, analysis of methods and loading conditions. For analysis of slope stability having a several methods such as Bishop, Ordinary, janbu, Morgenstern-price, Spencer. The product SEEP/W is used for the analysis of seepage. Calculate the leak using partial differential equations makes the water flow.

GEOSTUDIO SOFTWARE

Geo-studio software is mostly obtained in obtained inside varies civil engineering applications along with its problem analysis from considering other consideration. Now days it's widely used the particular usually are mostly intended for finite element analysis, slope stability, seepage analysis so at some other applications. Immediately after are usually methods with regard to obtained Geo-studio 2007 software. For seepage analysis open the Geo-studio SEEP/W define module

RESULTS AND DISCUSSIONS

CALCULATION OF SEEPAGE THROUGH THE EARTH DAM BY ANALYTICALLY

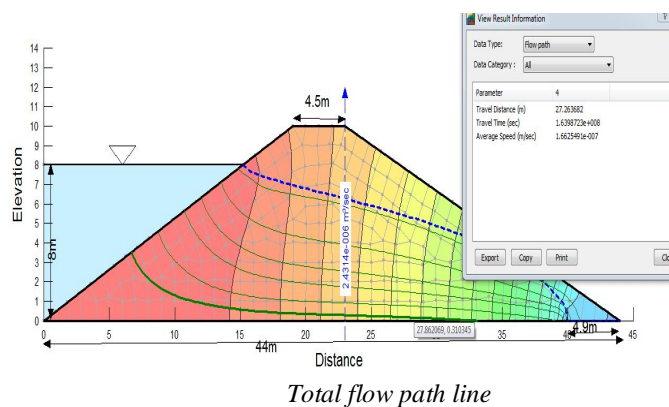
From the Earth dam dimensions Total height of dam is 9.8m, Up stream and Downstream slope is 2:1, Top width of the dam is 4.5m and length of the Blanket is 4.9m and coefficient of permeability is $x = 1.685 \times 10^{-6}$ cm/sec, $y = 3.638 \times 10^{-6}$ cm/sec and free board is 2m. Therefore seepage through the earth dam is 1.074×10^{-6} m³/sec/m.

SEEPAGE ANALYSIS BY USING COMPUTER APPROACH (SEEP/W)

Input data : Earthen dam dimensions , Soil properties

Earthen Dam dimensions : Top Width 4.5 m, Bottom width 44 m, Total height of the dam is 9.8 m, Maximum water level is 8 m, Slope of dam is 2 in 1 both U/S and D/S, Sand blanket 4.9 m.

Soil properties: permeability of soil is 1.685×10^{-6} cm/sec, unit weight of soil is 19.21 KN/m³, cohesion 40 kpa, angle of internal friction 5°, liquid limit 47.5%.



CALCULATION OF SLOPE STABILITY ANALYSIS BY ANALYTICALLY

From the soil properties of embankment, the unit weight of soil $\gamma = 19.21 \text{ KN/m}^3$ cohesion $C = 40 \text{ kpa}$, angle of internal friction $\phi = 5^\circ$, Total height of the dam $h = 9.8 \text{ m}$ and angle of slope $\beta = 45^\circ$ by using bishop method and ordinary, Morgenstern method . Therefore the factor of safety is 1.465

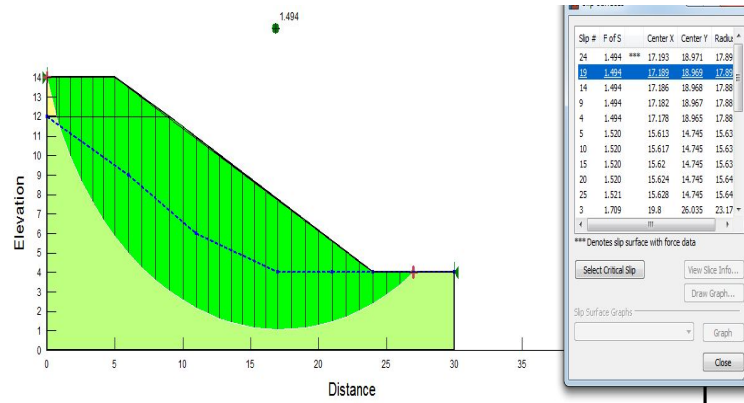
Slice No	Height of slice (z) m	Width of slice (B) m	Area of slice (A) m ²	Weight (γA) kN/m ²	δ (deg)	$N = W \cos \delta$ kN	$T = W \sin \delta$ kN
1	2.2	2	2.2	42.262	-25	38.302	-17.86
2	3.5	2	7	134.47	-20	126.36	-45.99
3	4.5	2	9	172.89	-10	170.263	-30.02
4	5.5	2	11	211.31	-5	210.50	-18.41
5	6	2	12	230.52	-3	230.20	-12.064
6	6.3	2	12.6	242.046	0	242.046	0
7	6.5	2	13	249.73	22	248.96	93.22
8	6.3	2	12.6	242.046	28	213.71	113.63
9	5.9	2	11.8	226.678	37	181.033	136.41
10	5.6	2	11.2	215.152	50	138.29	164.81
11	4.5	2	9	171.89	61	83.33	150.33
12		2	4.5	86.445	65	36.33	78.345

SLOPE STABILITY ANALYSIS USING COMPUTER APPROACH (SLOPE/W)

Input data : Earthen dam dimensions, soil properties

Earthen dam dimensions : Top width of dam is 4.9m, downstream side slope 2 in 1, base width of the dam is 30 m, height of the dam is 9.8 m.

Soil properties : unit weight of soil 19.21 kn/m^2 , cohesion 49 kpa , angle of internal friction 5° .

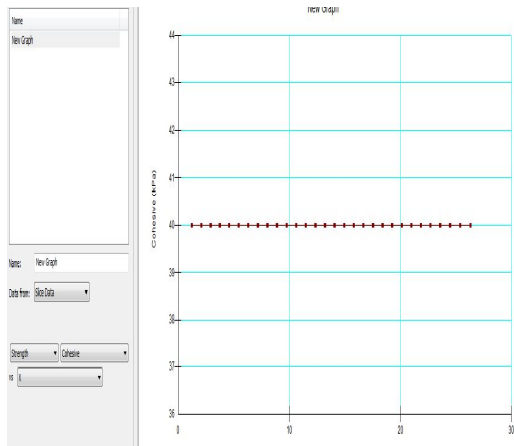


Critical slip circle for wet condition

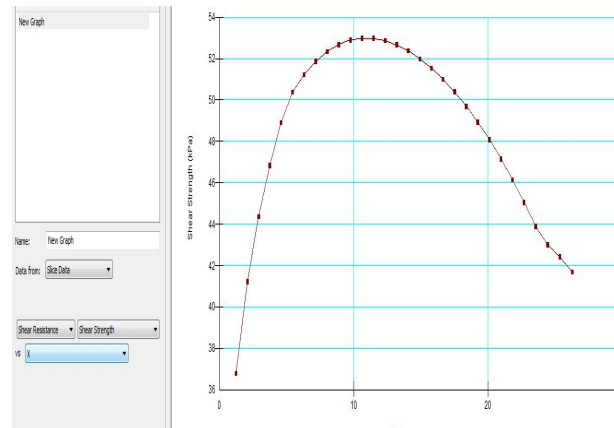
SLOPE STABILITY ANALYSIS IN DRY CONDITION USING SLOPE/W



Critical slip circle for dry condition



Graph for strength and cohesion



Graph for Shear resistance and shear strength

Final Result

Type of Analysis	Seepage	Slope stability Analysis of	Factor of Safety
Analytically	$1.074 \times 10^{-6} \text{ m}^3/\text{sec}/\text{m}$		1.465
Geo-studio software	$1.6625 \times 10^{-6} \text{ m}^3/\text{sec}/\text{m}$	1.494 with water table	1.699 without water table

CONCLUSION

Study the existence problems in the earthen dam. To calculate the failures of the dams seepage failure by analytical approach $1.074 \times 10^{-6} \text{ m}^3/\text{sec}/\text{m}$. To calculate the safety measures of the dam by using Bishop Method. The factor of safety of the dam is obtained 1.465 with in permissible limit. To calculate the seepage failure by using computer approach the value is $1.6625 \times 10^{-6} \text{ m}^3/\text{sec}/\text{m}$. To calculate the factor of safety of the dam by using computer approach 1.494 with water table and 1.699 without water table.

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