Partial Replacement of Bottom Ash from Burnt Coal for Improving Factor of Safety of Earthen Dam

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***Abstract*— Agriculture is main industry in India. In this project we are improving the factor of safety of earthen dam by using bottom ash from coal industries. The factor of safety of earthen dam is most important. The soil which is used to construct the earthen dam is a natural property so that by mixing of bottom ash the in earthen dam we can save the soil and improve the factor of safety. Bottom ash is byproduct of coal industry. By using bottom ash in earthen dam we are solving the pollution problem. As the bottom ash is dumping on land by industries therefore the pollution is increased and the land is also required. So it is better to utilize the bottom ash in earthen dam. In the project we are taking the bottom ash from coal industry in Kolhapur. The earthen dam for case study of SarafNalla. SarafNalla is right bank tributary of river Hirenyakeshi having a confluences near village Khedage in Ajara Taluka of Kolhapur district. The soil sample of dam and bottom ash mix together by percent by weight in various percentages. The standard proctor test is conducted on these samples for finding optimum moisture content. The sample is selected on the basis of minimum optimum moisture content and maximum dry density is achieved. This sample is then tested for shear test to find out c and ∅ values. These results were used for a case study. In which Swedish slip circle method of slices is used for finding the factor of safety of earthen dam.**

***Keywords*: Bottom ash, Earthen dam, Swedish slip circle method, Factor of safety**

I. INTRODUCTION

Irrigation is extremely important system as it helps agriculture industry to meet the basic human needs of food, fabric and edible; increases production; provides employment and creates employment potential and increase property of farmer. India is basically agricultural country and all its basic resources depend on the agriculture. Earthen dam and earthen embankments are the most ancient types of embankments, as they can be built with natural material to impound and divert water. The main advantages involved in the construction of earth dams are: Local natural materials are used, design procedures are straight forward, and comparatively small plant is required. The finer ash particles are carried away by the flue gas to the electrostatic precipitators and are referred as fly ash, whereas the heavier ash particles fall to the bottom of the boiler constitute about 20% of total ash content of the coal fed in the boilers are called as bottom ash. Bottom ash is incombustible by product that is collected from the bottom of furnaces that burn coal (from pulverized-coal fire furnace). Coal ash is the waste by-product of thermal power plants, which is produced in high quantity and its disposal is a major problem from an environmental point of view and also it requires a lot of disposal areas. For the effective disposal of bottom ash various eco-friendly solutions should be provided. Therefore an attempt will be made in this research study for eco-friendly disposal of bottom ash by mixing them in appropriate amount in soil used in construction of Dam.

II. OBJECTIVES

Objectives of research work

1. Collection of the data required for the analysis of bottom ash and design of earth dam.

2. To study the analysis of earth dam on the basis of data availability for the selected site.

3. To understand the site conditions for the study area under consideration and to check the physical characteristics of the soil mixed with bottom ash.

4. To study the improvement in factor of safety of earthen dam after soil mixed with bottom ash.

III. METHODOLOGY

Slip Circle Method:

Out of the numerous methods of slope stability which have been devised over the last 40 years, the Swedish slip circle method of stability analysis is the one most generally accepted. In this method the potential failure surface is assumed to be cylindrical and factor of safety against sliding is defined as the ratio of the average shearing strength, as determined by coulombs equation S = C + tan to the average shearing stresses determined by statics on a potential sliding surface.

Stepwise procedure of Slip Circle Analysis –

Step1. For a homogeneous c-ф soil, the centre of slip circle lie on a line PQ, in which the point Q has its co-ordinates ‘h’ downwards from toe and 4.5h horizontally away.

Step 2. The other point P is located with the help of directional angle α and β. Generally α = 250 and β = 350

Step 3. When the line PQ is obtained, trial canters are obtained on it and factor of safety corresponding to each centre is calculated.

Step 4. These various factor of safety so obtained are plotted as ordinates on the corresponding centers and smooth curve is obtained. The centre corresponding to the lowest factor of safety is the critical circle

Step 5. Let z1, z2........be the boundary ordinates of the slices .let the width of each slices be b and the width of the last slice be mb.

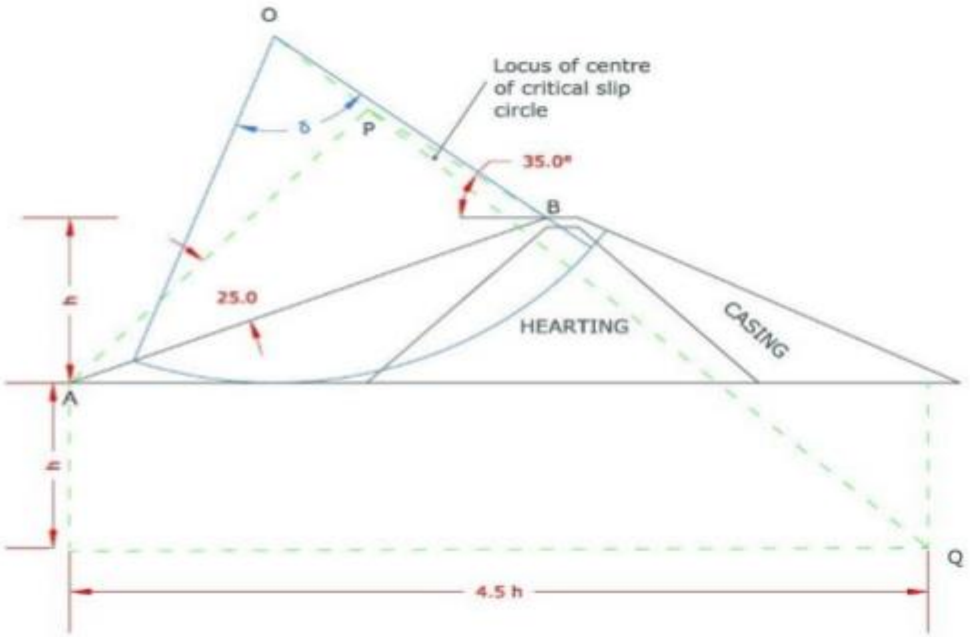

Figure3.1 Basics of Slip circle analysis

Step 6. The total weight component ΣW of the sliding sector, in terms of area can be written as

$$\Sigma W = b[z1+z2+......... \left(\frac{1+m}{2}\right)zn]$$

Step 7. This shows that the weight can be taken corresponding to the each slice, this weight can be resolved into two components i.e. N and T. Then the N ordinates are plotted by measuring various N values as abscissa and the constant width b as the ordinate.

Step 8. It should be clear that in the rectangular plot method if there are n-slices, the total no. of ordinates will be (n-1).

Step 9. Calculate the areas of each slice and value of ϴ for corresponding slice. Find separate areas for casing and hearting.

Step 10 Table 3.1 Calculate all Normal and Tangential components

Strip No.	Area of strip m^2	Weight (KN)	Unit angle of repose Θ^o	T = W sinϴ KN	N = W cosϴ KN
1	A_1	W_1	Θ_1	T_1	N_1
2	A_2	W_2	Θ_2	T_2	N_2
-	-	-	-	-	-
-	-	-	-	-	-
n	An	Wn	ϴn	Tn	Nn
				ΣT	ΣN

Table 1 – Calculation of Normal and Tangential components

Step 11.Calculation of all the forces

Length of Arc Casing = R $\times \frac{\delta\pi}{180}$ m [Use for casing]

Length of Arc Hearting = R $\times \frac{\delta\pi}{180}$ m [Use for hearting]

C.L. Casing = Ccasing length of arc of casing KN acting per meter

C.L. Hearting = Chearting length of arc of hearting KN acting per meter

Tanφ Casing = Tan $\times \frac{\phi\pi}{180}$

Tanφ Hearting = Tan $\times \frac{\phi\pi}{180}$

ΣN Casing = N1 + N2 + ……. KN

ΣN Hearting = N1 + N2 + ……. KN

ΣT = T1 + T2 + ……... KN

Driving force = CL + Σ N Tanφ KN

Factor of Safety without Earthquake = $\frac{CL+\Sigma N\ TAN\varphi}{\Sigma T}$ > 1.25 Hence safe.

IV. CASE STUDY

The Saraf Nalla is right bank tributary of river Hiranyakeshi having a confluence near village Khedage in Ajara Taluka of Kolhapur District. Hiranyakeshi River is tributary of Ghatprbha River. The Saraf Nalla originates in Sahyadri ranges at an elevation of 960.37 meter in Ajara Taluka & flows about 4 kilometers to reach the proposed dam site at Khedage & further travels 0.6 kilometres to join Hiranyakeshi river. The total catchment of Saraf Nalla at proposed site is 11.68 sq.km. Proposed irrigation project on Surfnala River U/s of village Khedge Parpole, Taluka- Ajara, District- Kolhapur, Maharashtra, India with lifts on both flanks including an area of 2644 Hector in Ajara Taluka.

V. Experimental work

We are conducted standard proctor test for determining the dry density of different sample. The maximum dry density sample is choosing for further experiment. Maximum dry density sample of mixture is taken to shear test for finding cohesion and angle of friction of the mixture. Then by Swedish slip circle methods we are calculate the values of factor of safety of earthen dam. We found the values of factor of safety of earthen dam increases.

VI. RESULT AND ANALYSIS

For case study of Saraf Nalla factor of safety is increased as follows:

Radius of Slip circle (meters)	Factor of Safety without using bottom – ash	Factor of Safety using bottom - ash
87 (u/s)	2.10	2.31
83 (u/s)	1.88	2
80 (d/s)	2.10	2.28
75 (d/s)	2.00	2.14

Table 2 – Results Summary

Chart of factor of safety

X axis : no of iteration

Y axis : factor of safety

Series 1 factor of safety of earthen dam without using bottom ash

Series 2 factor of safety of earthen dam using bottom ash

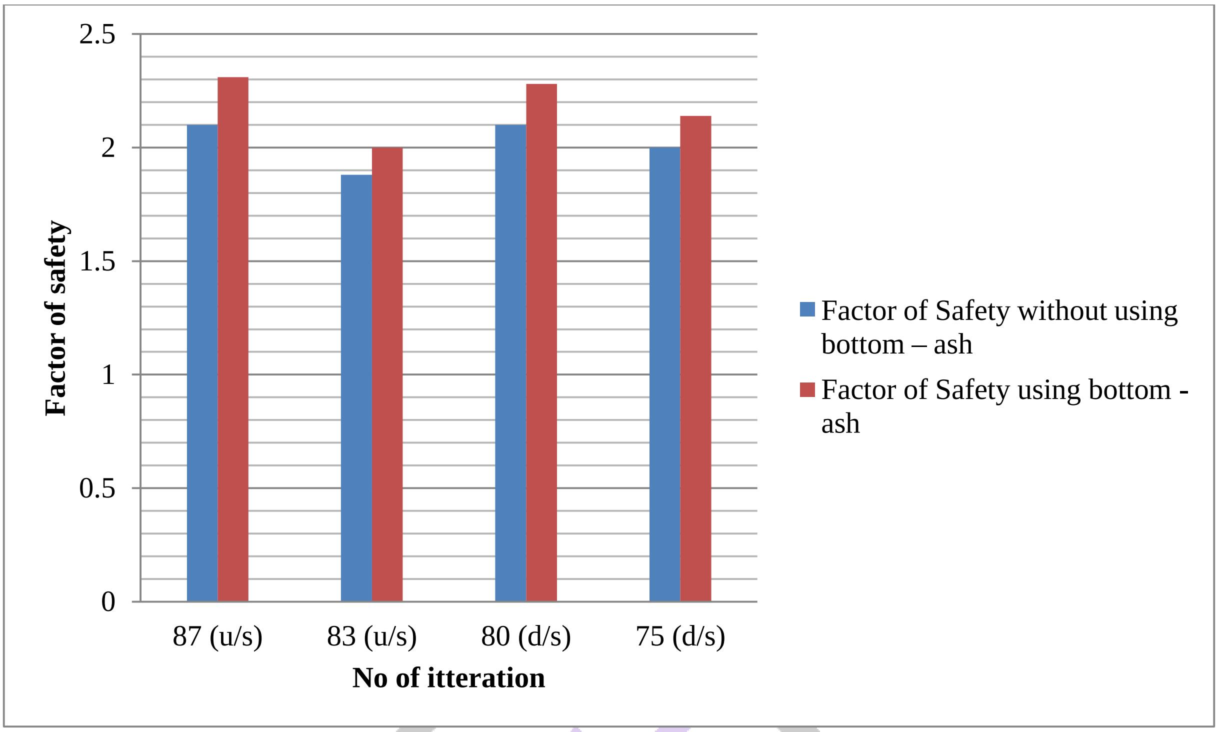

Chart 1- comparison between Factor of safety of earthen dam using bottom ash and without bottom ash

VII. CONCLUSION

1. The value c and Ø of available soil is increased when bottom ash is mixed with soil.

2. The partial replacement for naturally available soil by 15% is achieved and it gives best results i.e. minimum water content and maximum dry density is observed.

3. Now days the disposal of bottom ash is a big problem for the thermal plants. This problem can be solved by using it for stabilization of soil in earthen dams. It is also cost effective as it is available free of cost in various plants nearby Kolhapur Maharashtra India

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