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SLOPE STABILITY BY USING RICE HUSK ASH

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Abstract : *Rice husk ash is an attractive pozzolana. Due to its low cost and high activity, it has a promising perspective in sustainable construction. In combination with lime, its effect in soil improvement can be equal to cement treatment but its production process consumes much less energy. The main component of the rice husk ash is silica, which is the element that governs the reactivity of the ash. A delicate burning process is required to eliminate the organic components in the rice husk but keep the silica to be amorphous so that a highly reactive rice husk ash can be obtained. A too high temperature would transform amorphous silica to crystalline silica, which would reduce the reactivity. The suggested burning process in literature is 2 hours at 500 ^oC. However, due to the exothermic property of the burning rice husk it is difficult to control the exact burning temperature, hence there is still a possibility that the carbon and the crystallized silica are present and hinder the activity of the rice husk ash. Consequently, the main perspectives of utilizing rice husk are for energy purpose and silica resource. There was also research about soil improvement effect with uncontrolled burnt ash and it also showed a good result.*

Keywords: *Amorphous, Exothermic, Pozzolana, Rice Husk, Silica*

I. INTRODUCTION

1.1 Definition of slope stabilization

- An Earthen slope is an unsupported, inclined surface of a soil mass. Earth slopes may be found in nature or may be manmade.
- Earth slopes are formed for
    - Highway embankments
    - Earthen dams
    - Embankments for railways
    - Canal banks

1. Dam Embankment 2. Highway Embankment 3. Railway Embankment

Fig 1.1.1

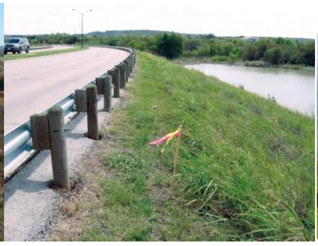


Fig 1.1.2

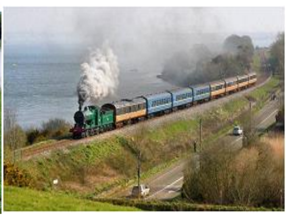


Fig 1.1.3

1.2 Necessity of Stability Analysis

- The failure of a mass of soil is a downward movement of a slope is called slide. It is usually caused by a gradual disintegration of the structure of the soil, by an increase of the pore water pressure in a few exceptionally permeable layers, or by a shock that liquidizes the soil.

- The factor leading to the failure of the slopes may be classified into two categories: the factors, which cause an increase in shear stresses. The stress may increase due to weight of water causing saturation of soils, surcharge loads, seepage pressure or any other cause.

- The stresses are also increased due to steepening of slopes either by excavation or by natural erosion.

- The factors which cause a decrease in the shear strength of the soil. The loss of shear strength may occur due to an increase in water content, increase in pore water pressure, shock loads, weathering or any other cause.

- Most of natural slope failure occurs during rainy season, as the presence of water causes both increased stresses and the loss of strength. With the development of modern methods of technique of stability analysis, a safe and economical design of a slope is possible.

- The geotechnical engineer should have a thorough knowledge of the various methods for checking the stability of slopes and their limitations.

- The effective stress method of analysis should be used for long term stability analysis. Stability analysis determines whether the proposed slope meets the safety requirements. The analysis must be made for the worst conditions, which seldom occur at the time of investigation.

- There are different methods of slope stability analysis such as Taylor's method, Swedish slip circle method, Bishop's method, Bishop and Morgenstern method and Morgenstern & Price method.

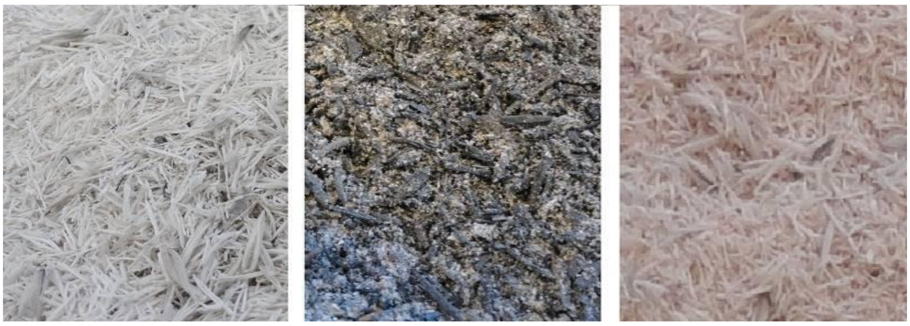
1.3 Introduction to rice husk ash

- RHA is a poor nutrition material, and it is rarely used for agricultural purposes such as animal food or fertilizer.
- The feature property of the rice husk is that its combustion heat is approximately 13.2 MJ/kg, which is a high average calorific value. The inorganic component lying in the collected ash after burning is full of silica. The ash is about 20% of weight of the rice husk, and silica amount can reach to 90-94% of the ash by appropriate burning condition.
- Consequently, the main purpose of utilizing rice husk is for energy purpose and silica resource. About silica industry, silica has a wide range of industrial applications, such as rubber reinforcement, solar panels, catalyst and coating, or detergent and soaps. Liquid sodium silicates are one more product and it can also be used for ceramics and binders or in water treatment and textile processing. These various applications make the rice husk ash become attractive and the technique to collect pure amorphous silica from rice husk has been being investigated.
- In construction field, the most attractive property of silica is its pozzolanic reaction with calcium hydrate to produce calcium silicate hydrate which is the main source of strength of cement and concrete. Replacement of Portland cement is a great application not only in the field of concrete but also in the field of soil stabilization. Research on this application of rice husk ash has been carried out many a times and all of them show the same observation that in combination with lime, the mixture can help to considerably improve the strength, permeability, durability and volume stability of different types of soft soil. The main advantage of the lime-rice husk ash cement compared with the Portland cement is that it can save much energy.

1.4 RHA Classification

TABLE 1

ASH	BURNING CONDITION	COLOUR	EXPECTATION
A-RHA	500^{o}C within 2 hours, cooling quickly	Grey	Very highly active ash
C-RHA	Open-air and quick burning	Black	Due to high amount of carbon average active
Cr-RHA	Slowly burning and cooling	Pink	Averagely active due to crystallized silica in range of 650-750 ^{o}C



A-RHA C-RHA CR-RHA

Fig. 1.4.1 Rice husk ash classification.

II. METHODOLOGY

2.1 Stability analysis of a finite slope

- The stability of a finite slope can be investigated by a number of methods. We shall deal with the following methods:

1. Culmann's method for planar failure surface
2. The Swedish circle method (slip circle method)
3. The friction circle method
4. Bishop's method

- However, sometimes "Taylor's stability number and stability curves" has been also used for finding out the stability analysis of slopes.

2.2 Friction Circle Method

The friction circle method is useful for the stability analysis of slopes made of homogeneous soils. In this method, the slip surface is assumed to be an arc of a circle. The radius of the friction circle is equal to Rsinϕ. Any line tangent to the friction circle must intersect the circular failure are at an oblique angleϕ.

Therefore, any vector ϕ to an element of the failure surface must be tangent to the friction circle. The analysis is based on total stresses and assumes that the cohesion c is constant with depth. For a given value of ϕ the critical height of a slope is given by the equation

Hc = Ns (c/γ) (2.1)

Where,

Hc = Critical height

c = Cohesion

γ= Unit weight of soil

Ns = Stability factor

The stability factor Ns is a pure number, depending only on the slope angle β and friction angle ϕ the friction circle; make an angle ϕm with the normal of the slip surface.

These lines represent the direction of the combined normal and mobilized frictional forces on the slip surface. The value of ϕm is obtained from Eq. 2.2

after choosing a value of Fϕ.

$F\phi = \tan\phi / \tan\phi m$ (2.2)

Thus, the reaction R is tangential to the friction circle.

(Lc x cm) x a = (cm x La) x r

Or a = r La / Lc (2.3)

Obviously, the distance a is greater than r, as La > Lc. The intersection of the weight W and the cohesive force Cm establishes a point P through which the reaction R must act. The direction of R is obtained by drawing a line tangential to the ϕ-circle. The forces Cm and R can be determined from the force triangle.

cm = Cm / Lc (2.4)

Eq. 2.5 gives the factor of safety with respect to cohesion

Fc = c / cm (2.5)

If the value of Fc obtained from Eq. 2.5 is not equal to the assumed value of Fϕ the analysis is repeated. The procedure is repeated after taking another trail surface. The slip circle which gives the minimum factor of safety (Fs) is the most critical circle.

Generally, the analysis is repeated 3-4 times to obtain a curve between the

assumed value of Fϕ and the computed value of Fc. The factor of safety with respect to shear strength Fs is obtained by drawing a line at 450 which gives Fc = Fϕ = Fs

For a purely cohesive soil ϕ= 0 and the friction circle reduces to a point. The factor of safety is determined from the resisting moment due to C and actuating moment due to W. Sometimes, the factor of safety with respect to friction (Fϕ) is assumed to be unity and the factor of safety with respect to only cohesion is obtained.

2.3 Bishop Method of Slices

A slices method of slope stability analysis which involves a different procedure and gives different answers compared with the Ordinary Method of Slices has been proposed by Bishop (1955).

With this method, the analysis is carried out in terms of stresses instead of forces which were used with the Ordinary Method of Slices. The stresses and forces which act on a typical slice, and which are taken into account in the analysis are shown. The major difference between the Bishop Method and the Ordinary Method of Slices is that resolution of forces takes place.

2.4 Culmann Method

A technique for the calculation of slope stability based upon the assumption of a plane surface of failure through the toe of the slope has been proposed by Culmann (see Taylor, 1948).

The forces acting on the wedge are indicated on the figure as the weight of the wedge W, the mobilised cohesive force Cm and the mobilised frictional force P. ϕm is the mobilised angle of shearing resistance.

These three forces are placed in equilibrium to yield the following expression:

$Cm/\rho gH = \cos(i + \phi m - 2\theta) - \cos(i - \phi m)/4 \cos \phi m \sin i$ …… (1)

The term on the left-hand side of this equation is known as the stability number. Since QS is an arbitrarily selected trial plane inclined at an angle θ to the horizontal, it is necessary to find the most dangerous plane along which sliding is most likely. This is done by setting the first derivative with respect to θ of the expression above equal to zero. This results in determination of the critical inclination θcrit given by the following expression: $\theta crit = 1/2(i + \phi m)$

Substitution of θcrit into equation (1) yields the maximum value of the stability number,

$Cm/\rho gH = 1 - \cos(i - \phi m)/4 \cos \phi m \sin i$……. (2)

The factor of safety with respect to strength may be determined from equation (2) by a trial-and-error process similar to that described in section 2. This method of slope stability analysis is not widely used since it has been found that plane surfaces of sliding are observed only with very steep slopes, and for relatively flat slopes the surfaces of sliding are almost always curved.

2.5 Test to be performed

Liquid limit :
The liquid limit of a soil is the moisture content which is expressed as a percentage of the weight of the oven-dried soil, at the boundary between the liquid and plastic states of consistency. After this liquid limit on addition of more water the soil may turn to plastic. The moisture content at this boundary is defined as the water content at which two halves of a soil cake will flow together, for a distance of 12 mm along the bottom of a groove of standard dimensions separating the two halves. Readings are taken and a graph is plotted with no. of blows on X-axis and the corresponding moisture content on Y-axis. In the graph the line corresponding to 25 no of blows is the average liquid limit.
Plastic limit :
The plastic limit of a soil is the moisture content which is expressed as a percentage of the weight of the oven-dry soil, at the boundary between the plastic and semisolid states of consistency. It is the moisture content at which a soil will just begin to break when rolled into a thread of approximately 3 mm in diameter on a glass plate. Readings are taken and graph is plotted, and the average of all readings is the average plastic limit of that soil.

III. CONCLUSION

- RHA increased the OMC of the soil.
- RHA decreased the MDD of the soil.
- The increase in RHA content decreased the plasticity index of the soil. This confirms that the activity of the mixture reduced with the addition of RHA.
- The addition of RHA increased the volume stability of the soil.
- It shows various Fluctuations due to addition of RHA in the soil by different proportions so the use of RHA in soil is limited to certain proportions only as mentioned earlier.
- From the foregoing investigation RHA perform satisfactorily as a cheap stabilizing agent for soil for stability purposes.
- RHA can be used as an additive with cement as it has high binding property.
- The conventional method does not give accurate results in the analysis of natural slopes.
- Sometimes it becomes too tedious and time consuming with equations and calculations.
- Although triggers for landslides in transportation projects are often related to water (including intense rain- fall, rapid snowmelt, water level changes, or stream erosion)
- Slides can also be triggered by earthquakes, human activity, or volcanic eruptions.

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REFERENCE

[1] Properties and Industrial Applications of Rice husk: Ajay Kumar, Kalyani Mohanta, Devendra Kumar and Om Parkash

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[2] Interpretation of Rice Husk Ash on Geotechnical Properties of

Cohesive Soil by Grytan Sarkar, Md. Rafiqul Islam, Dr. Muhammed Alamgir, Dr. Md.

Rokonuzzaman Khulna University of Engineering & Technology (KUET), Khulna, Bangladesh

[3] Potentials of Rice Husk Ash for Soil Stabilization, Musa Alhassan

Department of Civil Engineering, Federal University of Technology
Minna, Niger State, Nigeria.

[4] Agrawal, B. M. (1989). “Utilization of rice husk ash.” Glass Ceram. Bull., 36: 1-2.

[5] Kumar, A. (1993). “Rice husk ash-based cements, mineral admixture in cement and concrete, progress in cement and concrete.” Ed. Ghosh, S. N. Sarker S.L. and Harsh, S. ABI Books Pvt. Ltd. CGCRI, Kolkata, India, 4:342- 367.

[6] Giddel M.R and. Jivan A.P, Waste to Wealth, Potential of Rice Husk in India a Literature Review. International Conference on Cleaner Technologies and Environmental Management PEC, Pondicherry, India. January 4-6,2007.

[7] Agus setyo muntohar, Utilization of uncontrolled burnt rice husk ash in soil improvement dimensi teknik sipil, vol. 4, no. 2, 100 - 105, September 2002Issn 1410-9530

[8] Assureira Estela, Rice husk – an alternative fuel in Peru universtaria cuadra 18 Lima 32 Peru.

[9] Matori K.A, Haslinawati M.M, Producing Amorphous White Silica from Rice Husk. MASAUM Journal of Basic and Applied Sciences, October 2009 Vol. 1, No. 3, 512

[10] Haji Ali F., Adnan A., Chew K. C., *Geotechnical Properties of a Chemically Stabilized Soil from Malaysia with Rice Husk Ash as an Additive*, Journal of Geotechnical and

Geological Engineering, 1992, 10(2), p.117-134.

[11] Arora K. R., *Soil Mechanics and Foundation Engineering (Geotechnical Engineering)*,

Standard Publishers Distributors, Delhi, India, 2008.

[12] Grytan Sarkar, Md. Rafiqul Islam and. Muhammed Alamgir, The effect of RHA on the geotechnical properties of cohesive soil.