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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 °C. 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*

1. 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

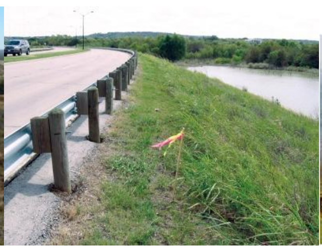

Fig. 2

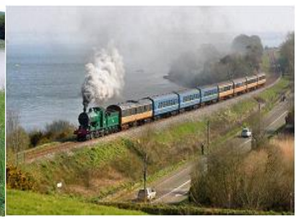

Fig. 3

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. 4 Rice husk ash classification.

2. METHODOLOGY

2.1 Test to be performed

Liquid limit

The liquid limit of a soil is the humidity content which is expressed as a chance of the weight of the roaster- dried soil, at the boundary between the liquid and plastic countries of thickness. After this liquid limit on addition of further water the soil may turn to plastic. The humidity content at this boundary is defined as the water content at which two halves of a soil cutlet will flow together, for a distance of 12 mm along the bottom of a groove of standard confines separating the two halves. Readings are taken and a graph is colluded with no. of blows on X-axis and the corresponding humidity 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 humidity content which is expressed as a chance of the weight of the roaster-dry soil, at the boundary between the plastic and circumfluous countries of thickness. It's the humidity content at which a soil will just begin to break when rolled into a thread of roughly 3 mm in periphery on a glass plate. Readings are taken and graph is colluded, and the normal of all readings is the average plastic limit of that soil.

2.2 Stability analysis of a finite pitch

The stability of a finite pitch can be delved by a number of styles. We shall deal with the following styles

1. Culmann’s system for planar failure face

2. The Swedish circle system (slip circle system)

3. The disunion circle system

4. Bishop’s system

Still, occasionally “ Taylor’s stability number and stability angles” has been also used for chancing out the stability analysis of pitches.

2.3 Friction Circle Method

The friction circle system is useful for the stability analysis of pitches made of homogeneous soils. In this system, the slip face is assumed to be an bow of a circle. The compass of the disunion circle is equal to Rsin. Any line digression to the disunion circle must cross the indirect failure are at an oblique angle.

Thus, any vector to an element of the failure face must be digression to the disunion circle. The analysis is grounded on total stresses and assumes that the cohesion c is constant with depth. For a given value of the critical height of a pitch is given by the equation

Hc = Ns (c/) (2.1)

Where,

Hc = Critical height

c = Cohesion

= Unit weight of soil

Ns = Stability factor

The stability factor Ns is a pure number, depending only on the pitch angle and disunion angle the disunion circle; make an angle m with the normal of the slip face.

These lines represent the direction of the combined normal and mustered frictional forces on the slip face. The value of m is attained from Eq.2.2

after choosing a value of F.

F = tan/ tan m (2.2)

Therefore, the response R is tangential to the disunion circle.

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

Or a = r La/ Lc (2.3)

Obviously, the distance a is lesser than r, as La> Lc. The crossroad of the weight W and the cohesive force Cm establishes a point P through which the response R must act. The direction of R is attained by drawing a line tangential to the- 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 attained from Eq.2.5 isn't equal to the assumed value of F the analysis is repeated. The procedure is repeated after taking another trail face. The slip circle which gives the minimal factor of safety (Fs) is the most critical circle.

Generally, the analysis is repeated 3-4 times to gain a wind between the

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

For a purely cohesive soil = 0 and the disunion circle reduces to a point. The factor of safety is determined from the resisting moment due to C and actuating moment due to W. Occasionally, the factor of safety with respect to disunion (F) is assumed to be concinnity and the factor of safety with respect to only cohesion is attained.

Literature Review

In the group of pozzolanic accoutrements, the rice husk ash appeared to be one of the most reactive, and the optimum burning conditions between the energy consumption and the quality of the rice husk ash were suggested to be 500^{o}C in 2 hours and cooling it snappily.

To be a secondary reagent for soil stabilization, its results was seen also veritably promising. Among results of the different experimenters about the capability of the rice husk ash in soil enhancement, some experimenter paid attention in the reactivity of the material and intended to produce a high quality ash for their trials, while there were also some other experimenters who intended to use unbridled burnt ash so as to use the original agrarian waste produced and have frugality.

Interestingly in all the cases, the rice husk ash still showed a positive result. Because these experimenters worked singly of each other and with different soil types in different regions, it's delicate to compare the effect of the controlled and unbridled burnt rice husk ash.

The plus point of unbridled burnt rice husk ash expresses possibility that might believe the investment of energy into rice husk ash product can be reduced at a certain position, and also the disquisition of the burning conditions to the connection of the rice husk ash in soil enhancement is useful.

Rice cocoon junking during rice refining, creates disposal problem due to lower marketable interest.

Also, handling and transportation of rice husk is problematic due to its low viscosity. RHA is a great terrain trouble causing damage to land and girding jilting areas due to carbon and silica content. Thus, salutary use of rice husk and its ash is the indispensable result to disposal problem.

The use of rice husk as energy/ electricity generation in effective manner is likely to transfigure this agrarian waste material in to a precious energy for artificial sectors because of containing high spicy value. A proper salutary and methodical approach to this useful material can give a new birth to being artificial sector of rice husk.

3. 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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