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An Innovative Technique of Improving the C.B.R Value of Soil Using Hair fibre

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ABSTRACT

The treatment of soil with the various waste product and bio-product is the majority of research these days. It has been found that various by-products can enhance or even maintain the properties of soil. Among various waste products, Human Hair fibres have been used with Fly Ash. This paper elucidates the effect of these fibres on properties of fly ash to increase the bearing ratio of the soil. The study has been done on fly ash by using different proportions of coconut fiber at 0.5,1.0,1.5, by percentage .Required OMC is find out by Compaction and CBR tests has been done for bearing ratio. We have seen that the C.B.R value of soil is increased by large percent by using fibres. With using hair fiber the C.B.R value of soil is increased.

Keywords: Fly ash, hair fiber, CBR value.

1. INTRODUCTION

1.1 Fly ash: Fly ash, also known as flue-ash, is one of the residues generated in combustion, and comprises the fine particles that rise with the flue gases. Ash which does not rise is termed bottom ash. In an industrial context, fly ash usually refers to ash produced during combustion of coal. Fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys of coal-fired power plants, and together with bottom ash removed from the bottom of the furnace is in this case jointly known as coal ash. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline) and calcium oxide (CaO), both being endemic ingredients in many coal-bearing rock strata.

Fig. 1.1: Fly Ash Growth

Toxic constituents depend upon the specific coal bed makeup, but may include one or more of the following elements or substances in quantities from trace amounts to several percent: arsenic, beryllium, boron, cadmium, chromium, hexavalent chromium, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium, along with dioxins and PAH compounds. In the past, fly ash was generally released into the atmosphere, but pollution control equipment mandated in recent decades now require that it be captured prior to release. In the US, fly ash is generally stored at coal power plants or placed in landfills. About 43% is recycled, often used to supplement Portland cement in concrete production. Some have expressed health concerns about this. In some cases, such as the burning of solid waste to create electricity ("resource recovery" facilities a.k.a. waste-to-energy facilities), the fly ash may contain higher levels of contaminants than the bottom ash and mixing the fly and bottom ash together brings the proportional levels of contaminants within the range to qualify as non-hazardous waste in a given state, whereas, unmixed, the fly ash would be within the range to qualify as hazardous waste.

1.2 Chemical Composition and Classification

COMPONENT	BITUMINOUS	SUB BITUMINOUS	LIGNITE
SiO_2 (%)	20-60	40-60	15-45
Al_2O_3 (%)	5-35	20-30	20-25

Fe_2O_3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOI (%)	0-15	0-3	0-5

1.3* Fly Ash Reuse*: There is no U.S. governmental registration or labelling of fly ash utilization in the different sectors of the economy - industry, infrastructures and agriculture. Fly ash utilization survey data, acknowledged as incomplete, are published annually by the American Coal Ash Association.

1.4 Class F Fly Ash: The burning of harder, older anthracite and bituminous coal typically produces Class F fly ash. This fly ash is pozzolanic in nature, and contains less than 20% lime (CaO). Possessing pozzolanic properties, the glassy silica and alumina of Class F fly ash requires a cementing agent, such as Portland cement, quicklime, or hydrated lime, with the presence of water in order to react and produce cementitious compounds. Alternatively, the addition of a chemical activator such as sodium silicate (water glass) to a Class F ash can lead to the formation of a geo polymer.

1.5 Class C Fly Ash: Fly ash produced from the burning of younger lignite or subbituminous coal, in addition to having pozzolanic properties, also has some self-cementing properties. In the presence of water, Class C fly ash will harden and gain strength over time. Class C fly ash generally contains more than 20% lime (CaO). Unlike Class F, self-cementing Class C fly ash does not require an activator. Alkali and sulfate (SO4) contents are generally higher in Class C fly ashes.

2. HUMAN HAIR FIBER

Hair is a filamentous biomaterial that grows from follicles found in the dermis. Hair is one of the defining characteristics of mammals. The human body, apart from areas of glabrous skin, is covered in follicles which produce thick terminal and fine vellus hair. Most common interest in hair is focused on hair growth, hair types and hair care, but hair is also an important biomaterial primarily composed of protein, notably keratin. Attitudes towards hair, such as hairstyles and hair removal, vary widely across different cultures and historical periods, but it is often used to indicate a person's personal beliefs or social position, such as their age, gender, or religion.

Fig. 1.1: Human Hair

The lightweight, strength and deformation properties of fibres make them effective materials in various foundation-engineering applications. Human hair fibres were used throughout this study to reinforce the soil. They are considered as valueless solid wastes which are being dumped to waste landfills. They consist of fibres of varying length (4–40 mm) and diameter (40–111μm). Scanning Electron Microscope analysis was conducted to obtain the average diameter of human fiber. The parameter of concern in fiber selection was fiber content by weight of soil. Samples were prepared by adding fiber content of 0.5%, 1.0%, 1.5%, 2.0% and 2.5% by weight of soil. Figure 1 show typical fibres used in this study. Figure 2 give the SEM images of human hair fibres from which the diameter of human hair fiber was measured.

Fig 1.2: Human hair fibres.

Fig. 1.3: SEM Image of Human hair fibres.

3. PROCESSING

Green coconuts, harvested after about six to 12 months on the palm, contain pliable white fibres.

Brown fibre is obtained by harvesting fully mature coconuts when the nutritious layer surrounding the seed is ready to be processed into copra and desiccated coconut. The fibrous layer of the fruit is then separated from the hard shell (manually) by driving the fruit down onto a spike to split it (dehusking). A well-seasoned husker can manually separate 2,000 coconuts per day. Machines are now available which crush the whole fruit to give the loose fibres. These machines can process up to 2,000 coconuts per hour.

3.1 Brown Fibre: The fibrous husks are soaked in pits or in nets in a slow-moving body of water to swell and soften the fibres. The long bristle fibres are separated from the shorter mattress fibres underneath the skin of the nut, a process known as wet-milling. The mattress fibres are sifted to remove dirt and other rubbish, dried in the sun and packed into bales. Some mattress fibre is allowed to retain more moisture so it retains its elasticity for twisted fibre production. The coir fibre is elastic enough to twist without breaking and it holds a curl as though permanently waved. Twisting is done by simply making a rope of the hank of fibre and twisting it using a machine or by hand. The longer bristle fibre is washed in clean water and then dried before being tied into bundles or hanks. It may then be cleaned and 'hackled' by steel combs to straighten the fibres and remove any shorter fibre pieces. Coir bristle fibre can also be bleached and dyed to obtain hanks of different colours.

3.2 White Fibre: The immature husks are suspended in a river or water-filled pit for up to ten months. During this time, micro-organisms break down the plant tissues surrounding the fibres to loosen them — a process known as retting. Segments of the husk are then beaten by hand to separate out the long fibres which are subsequently dried and cleaned. Cleaned fibre is ready for spinning into yarn using a simple one-handed system or a spinning wheel.

3.3 Waste and Byproduct: Coir fibres make up about a third of the coconut pulp. The rest, called peat, pith or dust, is biodegradable, but takes 20 years to decompose. Once considered as waste material pith is now being used as mulch, soil treatment and a hydroponic growth medium.

4. STANDARD PROCTOR COMPACTION- TEST

The Proctor compaction test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become most dense and achieve its maximum dry density. The term Proctor is in honor of R. R. Proctor, who in 1933 showed that the dry density of a soil for a given compactive effort depends on the amount of water the soil contains during soil compaction. His original test is most commonly referred to as the standard Proctor compaction test; later on, his test was updated to create the modified proctor compaction test.

Fig. 1.4: Compaction Machine

5. COMPARISON OF TESTS

The original Proctor test, ASTM D698 / AASHTO T99, uses a 4-inch-diameter (100 mm) mould which holds 1/30th cubic foot of soil, and calls for compaction of three separate lifts of soil using 25 blows by a 5.5 lb hammer falling 12 inches, for a compactive effort of 12,400 ft-lbf/ft³. The "Modified Proctor" test, ASTM D1557 / AASHTO T180, uses same mould, but uses a 10 lb. hammer falling through 18 inches, with 25 blows on each of five lifts, for a compactive effort of about 56,000 ft-lbf/ft³. Both tests allow the use of a larger mould, 6 inches in diameter and holding 1/13.333 ft³, if the soil or aggregate contains too large a proportion of gravel-sized particles to allow repeatability with the 4-inch mould. To ensure the same compactive effort, the number of blows per lift is increased to 56.

Fig. 1.5: Testing tools

5.1 Objectives for using fibre

- Increasing the bearing capacity of foundations
- Decreasing the undesirable settlement of structures
- Control undesirable volume changes
- Reduction in hydraulic conductivity
- Increasing the stability of slopes

5.2 **Compaction** is one kind of densification that is realized by rearrangement of soil particles without outflow of water. It is realized by application of mechanic energy. It does not involve fluid flow, but with moisture changing altering.

5.3 **Consolidation** is another kind of densification with fluid flow away. Consolidation is primarily for clayey soils. Water is squeezed out from its pores under load. California Bearing Ratio: The California bearing ratio (CBR) is a penetration test for evaluation of the mechanical strength of road sub grades and base courses. It was developed by the California Department of Transportation before World War II.

Fig. 1.6: CBR testing tool

The test is performed by measuring the pressure required to penetrate a soil sample with a plunger of standard area. The measured pressure is then divided by the pressure required to achieve an equal penetration on a standard crushed rock material. The CBR test is described in ASTM Standards D1883-05 (for laboratory-prepared samples) and D4429 (for soils in place in field), and AASHTO T193. The CBR test is fully described in BS 1377: Soils for civil engineering purposes: Part 4, Compaction related tests. The CBR rating was developed for measuring the load-bearing capacity of soils used for building roads. The CBR can also be used for measuring the load-bearing capacity of unimproved airstrips or for soils under paved airstrips. The harder the surface, the higher the CBR rating. A CBR of 3 equates to tilled farmland, a CBR of 4.75 equates to turf or moist clay, while moist sand may have a CBR of 10. High quality crushed rock has a CBR over 80. The standard material for this test is crushed California limestone which has a value of 100.

$$CBR = \frac{p}{p_s} \cdot 100$$

p = measured pressure for site soils [N/mm²]

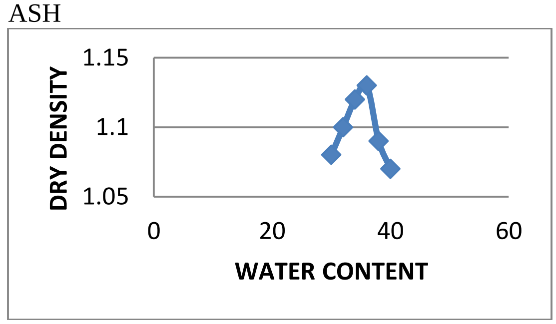
p_s = pressure to achieve equal penetration on standard soil [N/mm²]

5.4 METHODOLOGY

FLY ASH	STANDARD PROCTOR TEST	CALIFORNIA BEARING RATIO
Fly ash	Standard Proctor Test	California Bearing Ratio
Fly ash + 0.5% of Hair Fibre	Standard Proctor Test	California Bearing Ratio
Fly ash + 1% of Hair Fibre	Standard Proctor Test	California Bearing Ratio
Fly ash + 1.5% of Hair Fibre	Standard Proctor Test	California Bearing Ratio

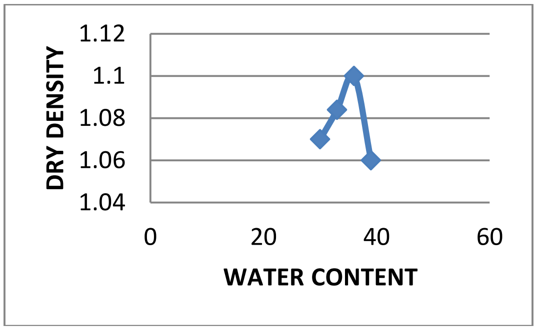
5.5 GRAPH SHOWING OPTIMUM MOISTURE CONTENT

1. OPTIMUM MOISTURE CONTENT FOR FLY ASH



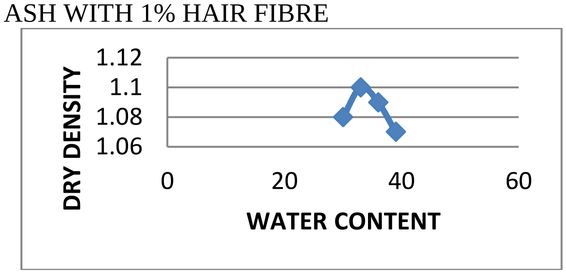
O.M.C FOR FLY ASH = <u>1.13@36%</u>

2. OPTIMUM MOISTURE CONTENT FOR FLY ASH WITH 0.5% HAIR FIBRE



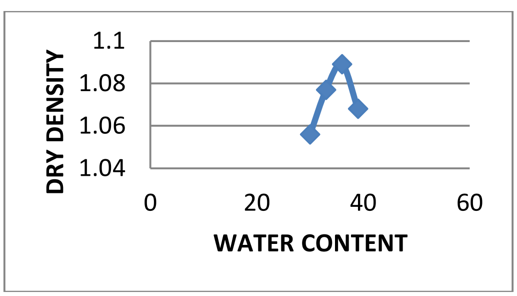
O.M.C FOR FLY ASH WITH 0.5% HAIR FIBER = 1.10@36%

3. OPTIMUM MOISTURE CONTENT FOR FLY ASH WITH 1% HAIR FIBRE



O.M.C FOR FLY ASH WITH 0.5% HAIR FIBER = 1.1@33%

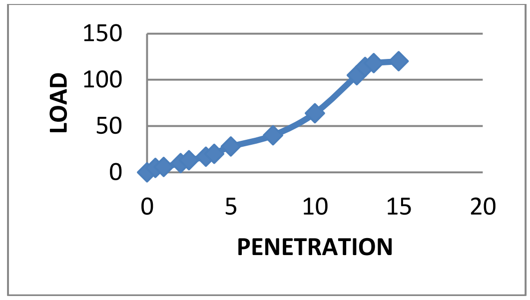
4. OPTIMUM MOISTURE CONTENT FOR FLY ASH WITH 1.5% HAIR FIBRE



O.M.C FOR FLY ASH WITH 1.5% HAIR FIBER = 1.089@36%

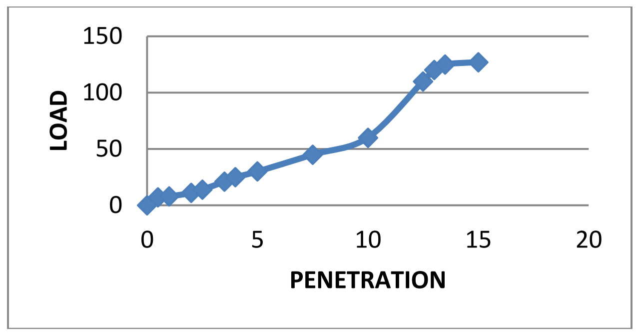
5.6 GRAPH SHOWING C.B.R VALUE

1. CALIFORNIA BEARING RATIO FOR FLY ASH



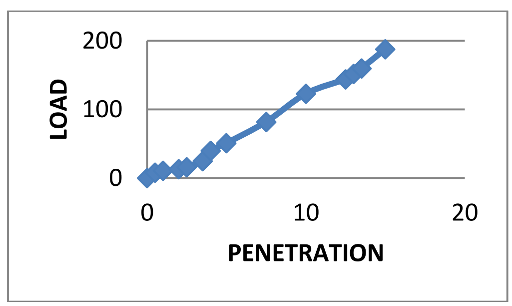
C.B.R VALUE AT 2.5 mm PENETRATION = 9.48
C.B.R VALUE AT 5 mm PENETRATION =13.61

2. CALIFORNIA BEARING RATIO FOR FLY ASH WITH 0.5% HAIR FIBRE



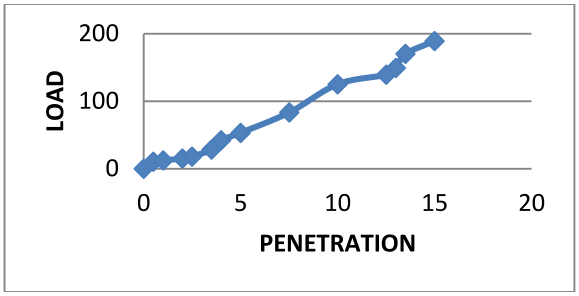
C.B.R VALUE AT 2.5 mm PENETRATION = 10.21
C.B.R VALUE AT 5 mm PENETRATION = 14.61

3. CALIFORNIA BEARING RATIO FOR FLY ASH WITH 1% HAIR FIBRE



C.B.R VALUE AT 2.5 mm PENETRATION = 11.67
C.B.R VALUE AT 5 mm PENETRATION = 24.80

4. CALIFORNIA BEARING RATIO FOR FLY ASH WITH 1.5% HAIR FIBRE



C.B.R VALUE AT 2.5 mm PENETRATION = 13.13
C.B.R VALUE AT 5 mm PENETRATION = 25.77

6. CONCLUSION

We have seen that the C.B.R value of soil is increased by large percent by using fibres .With using hair fibre the C.B.R value of soil is increased.

At .5 % fibre	C.B.R Value of fly ash with hair fibre
At 2.5% penetration	10.21
At 5% penetration	14.61

At 1% fibre	C.B.R Value of fly ash with hair fibre
At 2.5% penetration	11.67
At 5% penetration	24.80

At 1.5% fibre	C.B.R Value of fly ash with hair fibre
At 2.5% penetration	13.13
At 5% penetration	25.77

7. REFERENCES

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