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A Study on Stabilization of Soil Subgrade by using Bottom Ash in Flexible Pavements

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Abstract*: Waste materials used in construction practices are common now days. These methods are found to be improving engineering properties of materials with which they are used and also to provide a more nature and economic friendly process of construction. There has been very much working done on usage of waste plastic and fly ash in road construction. Almost all studies have accepted that these otherwise waste materials can be used in construction of rigid and flexible pavements up to a certain extent. In this study for stabilization of subgrade soil, Bottom Ash is used. Bottom ash is basically a coal combustion product that is produced along with fly ash in coal fired thermal power plants. Around 10 to 15% of total ash generated in these power plants is bottom ash. Bottom ash is similar to fly ash having grey to black color and particle coarser than fly ash. It is generated in bottom of boilers and collected in hopper so that it is called Bottom Ash. In this work various percentages of bottom ash is mixed with locally available soil and then different laboratory tests are performed to evaluate properties like optimum moisture content (OMC), Maximum dry density (MDD), unconfined compressive strength (UCS), California bearing ratio (CBR), Direct Shear Strength and Permeability. Various results are analyzed to find out optimum mixture of soil and bottom ash to give maximum stability to subgrade.
KEYWORDS: BOTTOM ASH, OMC, CBR, UCS, MDD

I. INTRODUCTION

This Bottom ash, a Coal Combustion Product (CCP) is composed of clustered ash particles in nature which are usually coarser than fly ash particles. It is the slag which is formed on the heat absorbing surfaces of the furnace, and which subsequently falls down to the furnace bottom. It is typically grey to black in color and is quite angular and has a porous surface structure. According to Central Electricity Authority annual Report (2011-12) total bottom ash generated in India annually is about 15 to 20 million tonnes. It poses a great threat to environment if not taken care of properly. This can result in the pollution air, water and soil and it is also harmful to humans and other living organisms. Studies have shown that bottom ash can be used in pavement construction as filler, as a replacement of binder material, as an embankment material and as a replacement of natural aggregate. Use of bottom ash in road construction can result in reducing cost of construction as well as protects environment and conserves natural resources.

Usage of Bottom Ash in construction practices is a part of Solid Waste Management. In highly populous countries like India where most of the areas are densely populated, it is not easy to find a suitable site for dumping waste materials. Even if found, doing the same will pose great threat to natural resources like air, water and soil as well as to living organisms nearby.

Studies have shown that using bottom ash as a replacement of fine aggregate in concrete mixes, it is has improved the overall performance along with properties like compressive strength, durability etc. In cases where bottom ash was used as a replacement of filler in bituminous mixes it has been found that modified mix was having improved values of rutting factor and dynamic viscosity compared to the normal mix. Various studies have been done upon utilization of bottom ash in various sections of road construction and almost all results validated beneficial outcomes.

II. METHODOLOGY AND MATERIAL USED

The samples of soil and bottom ash are collected and their various properties are determined. Optimum mix of soil and bottom ash is determined by laboratory testing. Based on the found result, comparative analysis of pavement sections is done with or without stabilized subgrade.

A. Soil

Soil sample has been obtained from Bhiwani-Delhi state highway via Rohtak. Upon visual inspection color of soil was observed as yellowish grey. The various lab tests done and their results are discussed below.

1) Specific Gravity: Specific gravity of soil sample by taking the average was found out to be 2.13.

2) Grain Size Distribution:
Coefficient of Uniformity (C_u) = 2.875 (which is<6)
Coefficient of Curvature (C_c) = 1.14 (should be between 1-3)
So, the soil falls under the category of Poorly Graded Sand.
3) Atterberg Limits

Liquid Limit	25.5%
Plastic limit	13.3%
Plasticity index	12.2%

4) Proctor Compaction Test
Standard Proctor test was done to determine the optimum moisture content and maximum dry density of soil sample. The following results were obtained.
Optimum Moisture Content (OMC) = 10.20 %
Maximum Dry Density (MDD) = 2.13 g/cm^3
5) California Bearing Ratio (CBR)
CBR tests gave the following results:
CBR at 2.50 mm penetration = 3.58%
CBR at 5.00 mm penetration = 3.45 %
As CBR@2.5 mm > CBR@5 mm. So CBR value is 3.58%.

A. Bottom Ash
Bottom ash was collected from Harduaganj Thermal Power Station Aligrah, Uttar Pradesh, India. It was greyish black in colour. Upon touching, it appears sand like in nature offering extremely less cohesion. The various properties of bottom ash is given as-
1) Specific Gravity: The specific gravity of bottom ash on averaging was found to be 2.76.
2) Grain Size Distribution: By sieve analysis it is found that bottom ash sample comes under fine sand category as more than 70% particles came under the range of 0.075mm to 0.425mm.
3) Atterberg Limits: From tests it has been observed that even more than 50% of water was not sufficient to make a cohesive paste for liquid limit test. Similar phenomenon happened for plastic limit test as thread was breaking up even before reaching 3mm diameter. These conditions are attributed to Non-Plastic nature of bottom ash. So bottom ash is non-plastic in nature.
4) Standard Proctor Compaction: Standard proctor test was conducted to find out optimum moisture content (OMC) and maximum dry density (MDD) values for bottom ash. OMC found out was quite high around 42 % and MDD value was low as 0.575 g/cm^3.
5) Unconfined Compression Test: This test was conducted to determine Unconfined Compressive Strength (UCS) and cohesion value of bottom ash. UCS value found out was low as 4.20 N/mm^2 and cohesion value came out to be 2.10 N/mm^2 however low but not zero.

III. EXPERIMENTAL ANALYSIS

For determination of different physical properties of soil, bottom ash and their mixture, various laboratory tests were performed with relevant IRC codes. Different types of test are listed below:
A. Standard Proctor Test
B. Atterberg Limits
C. California Bearing Ratio Test
D. Unconfined compressive test
E. Direct shear test
F. Permeability test

The results obtained through the test mentioned above will helps to determine the optimal composition of soil and bottom ash in the mixture. The following are the results obtained for various properties of the Optimum mix of bottom ash and soil.

1) *Maximum Dry Density:* With increase in percentage of bottom ash in the mix, maximum dry density (MDD) values have shown a continuous decline. Bar charts in fig.1.1 show relation between MDD versus percentage ash in mix.

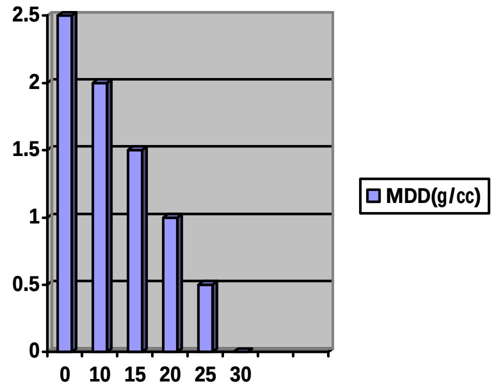


Fig 1.1: MDD vs. % Ash

2) *Optimum Moisture Content (OMC)*

The values of OMC increased continuously as the content of bottom ash was increased in the mix. Subsequent bars in fig.1.2 shows relation between OMC and percentage of ash content in the soil ash mix.

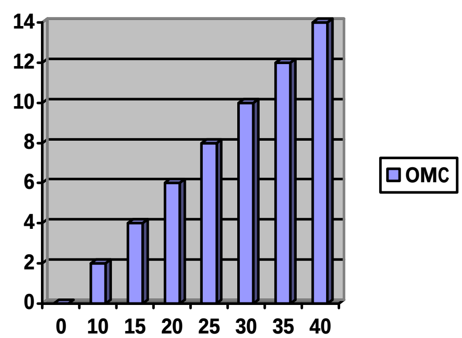


Fig 1.2: OMC vs. % Ash

3) *Plasticity Index (Pi)*

With increase in the bottom ash content in the soil ash mixture, plasticity of decreased continuously. Subsequent bars in fig.1.3 shows relation between plasticity index and percentage of ash in the mix.

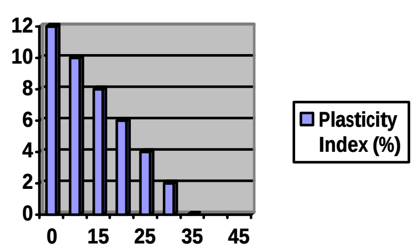


Fig 1.3: Plasticity Index vs. % Ash

4) *Unconfined Compressive Strength:* The values of unconfined compressive strength showed a decrement with increase in ash content in the mix. Subsequent bars in fig 1.4 shows values of UCS obtained against percentage of ash in the mix.

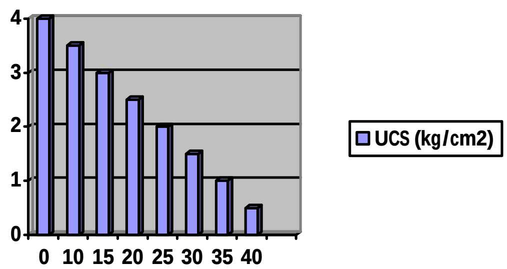


Fig 1.4: UCS vs. % Ash

5) *Angle of Internal Friction:"* The angle of internal friction first increases up to a certain ash content and then starts decreases with further increase in ash content in the soil ash mix. Because of extremely low cohesion of bottom ash particles, shearing resistance of mix decreases if ash content in mix is increased further. Subsequent bars in fig 1.5 shows the relation between %ash and angle of internal friction.

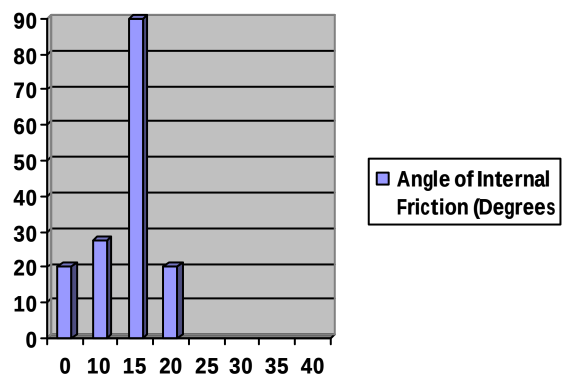


Fig 1.5: Internal Friction vs. % Ash

6) *California Bearing Ratio:* It was interesting to note that CBR values show an increment till the percentage of ash in the mix was up to 30% and thereafter a decline was observed with further increase in ash content. According to CBR values obtained for various samples of soil ash mixture, optimum mix was decided. Subsequent bars in fig 1.6 shows the relation between CBR values and percentage of ash content in the mix. Peak value of CBR obtained is 11.90 % for 70:30 mix of soil and bottom ash. This is considered as optimum mix as after 30% of bottom ash any further addition of ash results in lesser CBR values.

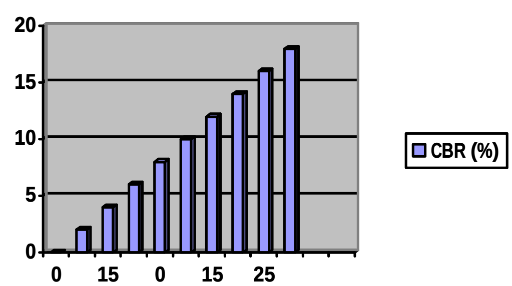


Fig 1.6: CBR vs. % Ash

7) *Coefficient of Permeability:* Coefficient of permeability (k) values decreases up to a minimum value for 15% of ash in the mix representing least permeability; thereafter an increment is observed pertaining to extremely porous nature of bottom ash particles.

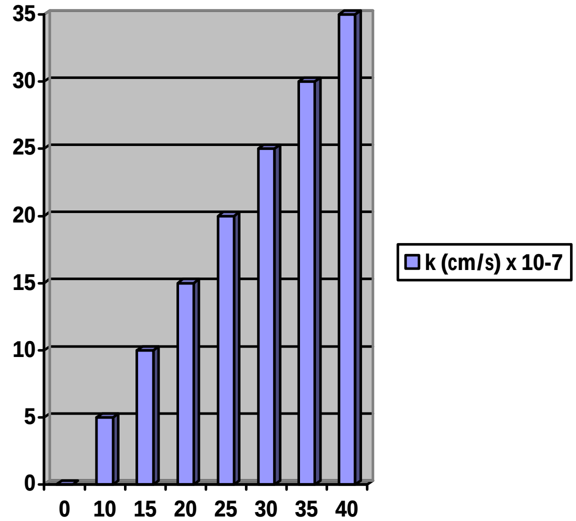


Fig 1.7: K vs. % Ash

IV. CONCLUSIONS

Based on the thesis work and experimental study following conclusions are made: maximum dry density (mdd) and unconfined compressive strength (ucs) values of the mix have shown a gradual decrease with increase in bottom ash content. This can be attributed to the fragile nature of ash particles. The optimum moisture content (omc) values kept increasing upon increasing percentage of bottom ash. This means that as the bottom ash content is increased more amount of water is required for the mixture to each its maximum dry density. Shearing resistance of the mix has increased up to 25% of ash and thereafter a decline is observed. It showed mixed nature owing to the high value of internal friction and low cohesion of bottom ash in comparison to soil particles. Cbr values have shown a mixed nature. These values increased up to 30% inclusion of ash in the mix and thereafter decreased if percentage of ash is increased further. This nature of the mix with respect to cbr values is because of cementing nature of bottom ash by virtue of which bottom ash particles attains strength under the action of moisture. Permeability values have also shown a mixed trend. Permeability (k) values have shown a minimum for 15% of ash representing least hydraulic conductivity and thereafter increase in k values was observed upon further inclusion of ash in the mix. Hence it is observed that use of bottom ash in subgrade can enhance its stability up to a certain quantity. After that optimum content further addition of bottom ash in the subgrade has detrimental effects on the stability. As per the study made with the collected samples of bottom ash and soil, optimum mix was found to be 70:30 mixture of soil and bottom ash owing highest value of cbr of 11.9in comparison to soil cbr of 3.58%. It should be kept in mind that property of soil as well as bottom ash depends largely upon their source. So proportion of optimum mix can change depending upon the origin.

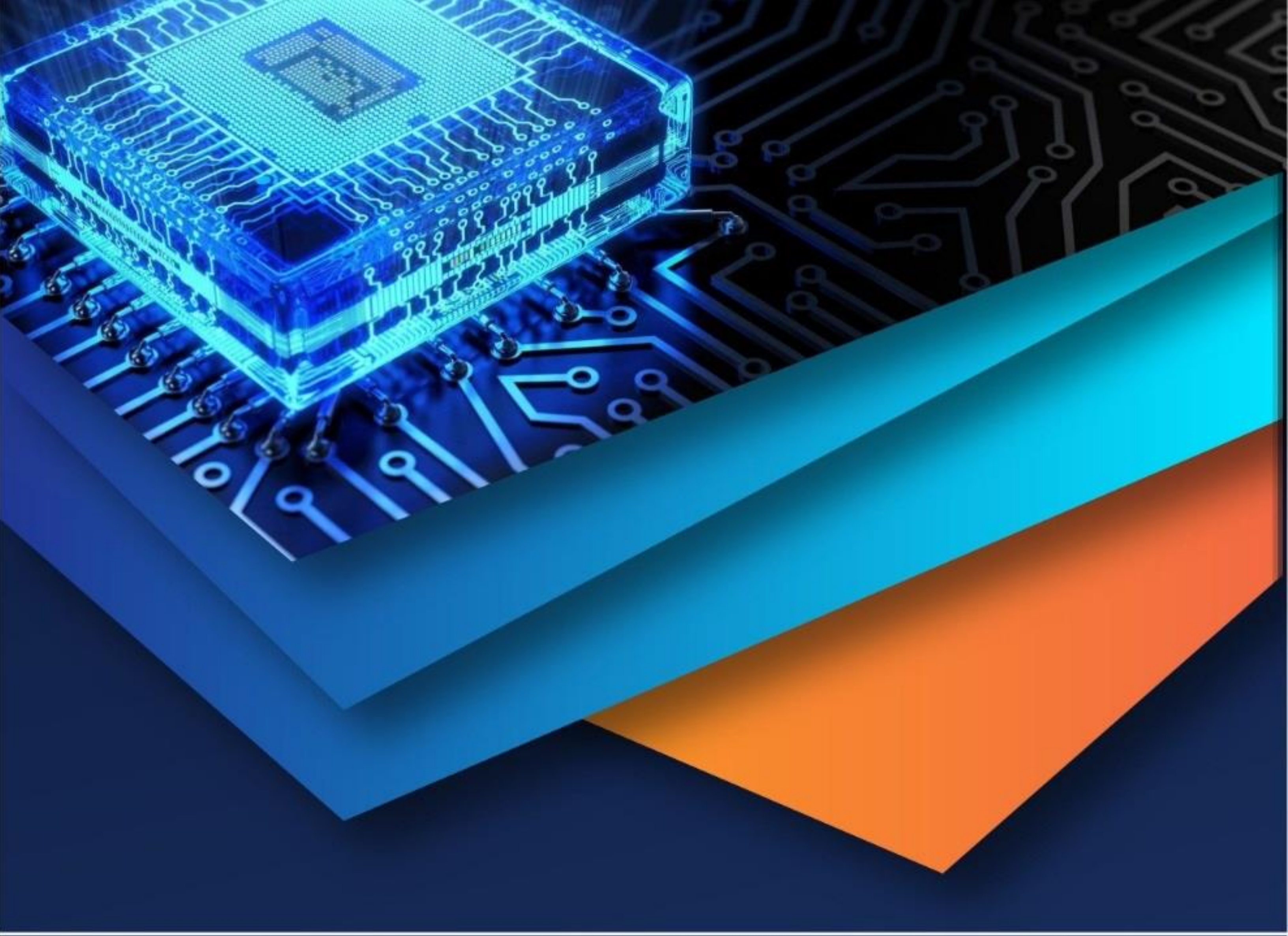
REFERENCES

[1] M. Patil, K. A. Patil(2013) "Effect of Pond Ash and RBI Grade 81 on Properties of Subgrade Soil and Base Course of Flexible Pavement" International Journal of Civil, Architectural, and Structural and Construction Engineering Vol: 7 No: 12

[2] Colonna P., Berloco N., Ranieri V., Shuler S.T. "Application of Bottom Ash for Pavement Binder Course" Procedia - Social and Behavioral Sciences 53(2012) 962 – 972.

[3] Gunalaan Vasudevan. "Performance On Coal Bottom Ash In Hot MixA\ sphal"t.IJRET,International Journal of Research in Engineering andTechnology, Volume: 02 Issue 08,Aug 2013, eISSN: 2319-1163, pISSN: 2321-7308L.

[4] B. Andrade, J.C. Rocha *, M. Cheriaf(2009). "Influence of coal bottomash as fine aggregate on fresh properties of concrete" Construction of Building Materials 23(2009)609-614.



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