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ANALYSIS OF USE OF INDUSTRIAL WASTE FLY ASH IN PAVEMENT CONSTRUCTION

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Abstract- *Fly Ash is an industrial waste, which is a by-product from the Thermal Power Plant. It is a non-reactive inert particle which may suspend from few seconds to several months in the air. This paper investigates the effect of Fly Ash on bearing capacity of subgrade for design of Flexible Pavement. In the present study, the aim is to see the variation of load bearing capacity of soil on adding fly ash in different percentages in soil and is taken from NTPC Badarpur. If the available soil is good in nature then we can construct pavement with ease but if the available soil is weak in nature instead of taking an expensive way, we can use the Fly Ash to improve the soil condition up to certain extent in a cheaper way. Firstly, soil properties were studied by conducting tests on soil and then Atterberg Limits were calculated. A Modified Proctor Test was performed on soil to calculate the Optimum Moisture Content (OMC) and Maximum Dry Density (MDD). For CBR test, a sample is compacted at OMC and the result is analyzed on various percentages 8%,10%,12%,13% on the basis of dry weight of soil. CBR test is conducted to study the load bearing capacity of soil in both soaked and unsoaked conditions so that pavement can withstand even in the worst condition and the thickness of pavement is calculated.*

Key Words: Industrial Waste, Fly Ash, OMC, CBR, Flexible Pavement thickness and Soil Stabilization

1. INTRODUCTION

Fly ash is a byproduct of thermal power plants. When powdered coal is burnt, a large part of it gets converted into very fine powdered form called fly ash. In India every year approximately about 90 million tons of fly ash is produced and only 13% of this is properly managed. At places around power stations, it is abundantly available but finds very little application because of poor management. Due to which it has serious disposal issues, most power plants are facing shortage of dumping land.

In the meanwhile, with various studies conducted over the years, fly ash has a vital role to play in the field of Civil Engineering. From highway engineering point of view it is used in Pavement subgrade stabilization, Portland cement concrete, asphalt filler and many other important applications.

The overall cost of road construction can significantly reduce proper selection of locally available materials. If local soil is not strong enough to bear the wheel loads, the engineering properties can be improved by soil stabilization methods. A low cost road always uses the material which is available in its vicinity. Due to Spherical silt size particles it is effective in filling voids in soil mass which increases the load bearing capacity of soil and also the self –cementing properties makes it a very effective soil stabilizer.

2. Material used in this study

2.1 Soil

The soil used in this study was collected from Najafgarh, near Indu Sharma Office, New Delhi. Various laboratory tests were performed on soil as per IS Code to determine basic properties of soil.

Figure 1 : Soil Sample

Table 1: Basic Properties of Soil

Properties	Values
Soil type as per IS: 1498-1970	SW
Specific Gravity	2.61
Liquid Limit (%)	23%
Plastic Limit (%)	16%
Plasticity Index (%)	7%
OMC	8.25%
MDD	19.58Kn/m^3
CBR value for unsoaked	14.1%

2.2 Fly Ash

Fly ash is a waste residue product so its cost is almost negligible hence incorporating fly ash in concrete mix for highways will be quite beneficial and economical. The Fly Ash was subjected to various laboratory tests as per IS codes to determine various properties.

Figure 2: Fly ash samples

Table 2: Basic Properties of Fly Ash

Properties	Values
Colour	Grey
Specific Gravity	1.97
% finer from 300 µ	98.1
% finer from 150 µ	83.8
% finer from 75 µ	49.7

3. LABORATORY EXPERIMENTS CONDUCTED

The particle of grain size analysis of Soil and Fly Ash is determined as per IS: 2720 (Part 4) - 1985. The Results are shown below.

3.1 Modified Proctor Compaction Test

Modified Proctor or heavy compaction test was performed on soil specimens as per IS: 2720 (Part -8) 1983. The test is used to determine the relationship between dry density and water content of soil. The compaction curves for soil-fly ash mixture were procured and the values of OMC and MDD are given in the Table. The values obtained for OMC and MDD from this test are further used for other tests.

Figure 3 : Preparation of CBR mould

3.2 California Bearing Ratio

The CBR tests for Soil-Fly ash specimens for both unsoaked and soaked conditions were carried out as per IS : 2720 (Part 16) - 1987. For pavement construction under different traffic conditions, CBR is a major parameter of estimating overall thickness of construction above subgrade.

To understand CBR variations with varying fly ash content a laboratory testing was carried out for modified conditions.
Indian Roads Congress recommends to carry out CBR for soaked condition. With help of obtained value and for a particular traffic condition, pavement thickness has been calculated referring to the chart provided by IRC :37- 2018 as shown in Table 5.

Figure 4 : Testing of sample

4. Results and Discussion

4.1 Grain Size Distribution

To study the properties of fly ash and soil, a sieve analysis test was performed. The results are given below.

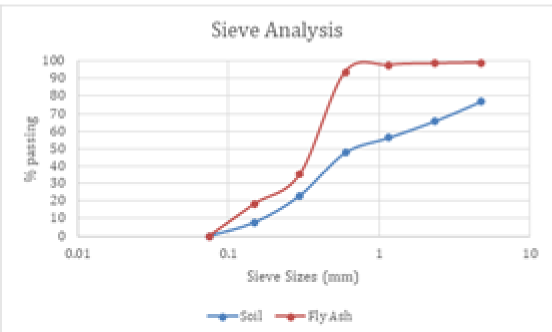

Figure 5 : Particle Size Distribution Curve of Soil and Fly ash samples.

4.2 Compaction Results

Table 3 : OMC, MDD test results

Water Content (%)	Dry Density (kN/m3)
2.5	16.75
4.5	19.01
8.25	19.58
10	19.21
12.5	18.49

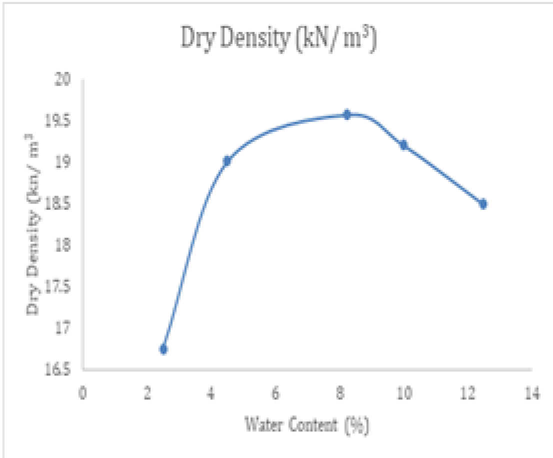

Figure 6 : Moisture content-dry density curve for soil specimen

The Moisture content - dry density curves of soil specimens for modified proctor test are given in Figure 6. From Figure, we can see that as moisture-content increases, dry density moderately increases up to a certain level of moisture-content and further increase in moisture-content leads to decrease in dry density.

4.3 CBR Results

4.3.1 Unsoaked Condition

CBR Curve for 0% Fly Ash

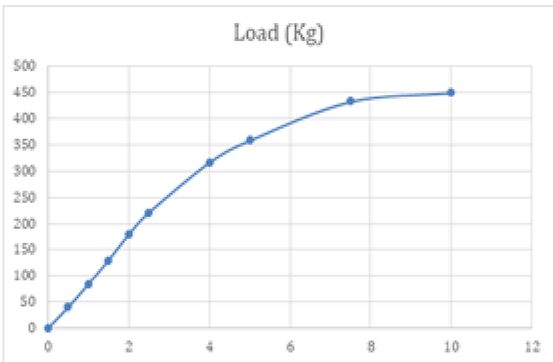

Figure 7 : Load-penetration curve for 0% fly ash

4.3.2 Combined CBR Curve for Unsoaked Condition

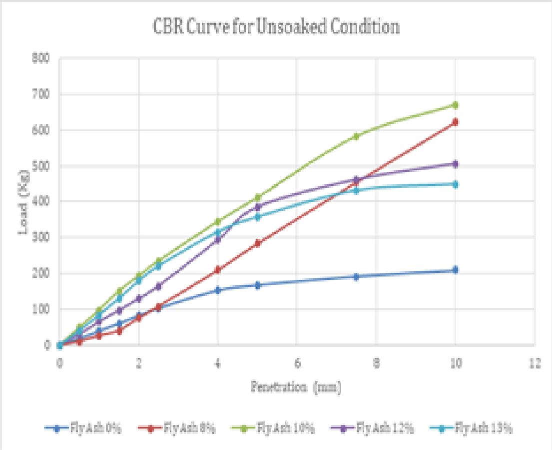

Figure 8 : Combined CBR curve for unsoaked condition of different proportion of fly ash

4.3.3 Soaked Condition

CBR Curve for 0% Fly Ash

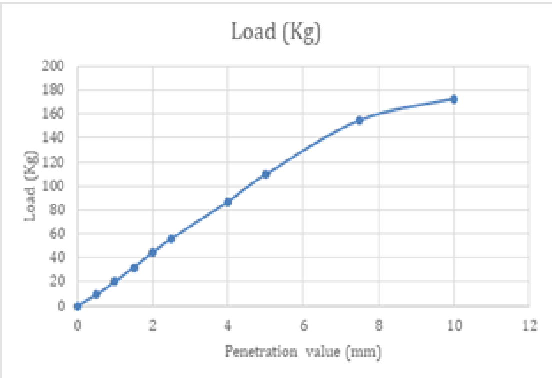

Figure 5 : CBR curve for 0% fly ash for soaked condition

4.3.4 Combined CBR Curve for Soaked Condition

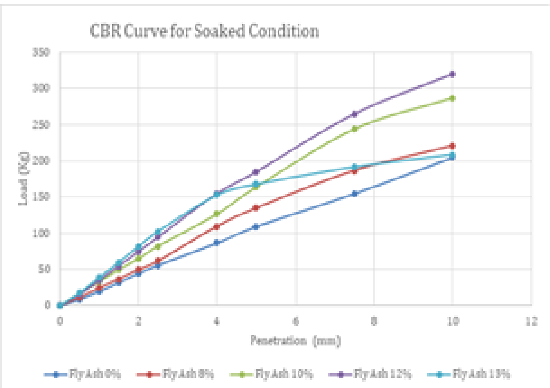

Figure 9 : Combined CBR Curve for Soaked Condition

Table 4 : Comparison of CBR value for Soaked and Unsoaked Condition

Fly Ash Content (%)	CBR value (%)	
	Unsoaked Condition	Soaked Condition
0	14.1	5.32
8	17.03	6.57
10	19.85	7.98
12	18.74	9.02
13	17.4	8.14

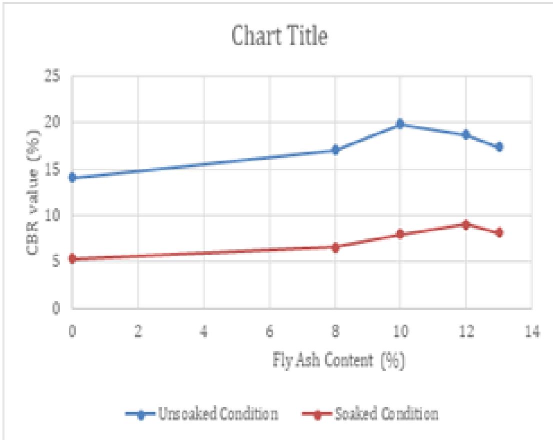

Figure 7 : Combined CBR curve for unsoaked and soaked conditions

Table 5 : Thickness of pavement with respect to different CBR %

Effective CBR (%)	Pavement thickness (mm)
5.32	591.8
6.57	587.85
7.98	570
9	565
8.14	571

5. Conclusion

From the experiments and graphs the following conclusions can be made.

1. From the graphs, it is evident that by adding Fly ash to our soil sample the CBR value increases to 19.35%, which is 1.4 times CBR value of soil sample taken for unsoaked condition and for soaked condition CBR value increases to 9%

which is 1.69 times the CBR value of soil sample taken.

2. For unsoaked condition
   When the percentage of fly ash is increased from 0% to 10%, the CBR value is found to be increasing. For fly ash content beyond 10% addition to soil, CBR value is decreasing.
3. For soaked condition
   When the percentage of fly ash is increased from 0% to 12%, the CBR value is found to be increasing. For fly ash content beyond 12% addition to soil, CBR value is decreasing. As shown in table 5, with increases in CBR value, the pavement construction depth decreases, indicating economical design
4. As there is lack of proper management of fly ash and disposal is also an issue, Soil stabilization by fly ash is one of the best environment friendly and economical methods of disposal

6. References

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