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Use of Composite Mixture of M-Sand and Fly Ash as a Sub grade Material

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Abstract: *Pulverized Fuel ash is an industrial waste produced in thermal power plants across the world. Fly ash is an engineering material that can be used as embankment material or sub grade material. When compared with typical soils used for embankment construction, fly ash has large uniformity coefficient consisting of silt-sized particles mostly. Addition of Manufactured sand modifies the particle size distribution of fly ash and also there will be an increase in unit weight of the mixed material. The present experimental work has been carried out to know the possibility of using fly ash in combination with M-Sand. The engineering properties of this mixture (fly ash-M-Sand) have been studied to bring out the possibility of using fly ash in the construction of embankments. Addition of M-Sand to fly ash results in an increase in Maximum Dry Density (MDD), and at the same time observed a decrease in Optimum Moisture Content (OMC). The composite consisting of 40% fly ash + 60% M-Sand produced a Maximum Dry Density (MDD) of 1. 55 g/cm^3. This composite material may be used for the construction of subgrade for rural roads.*

Keywords: *Fly Ash, M-Sand, MDD, OMC, composite mixture*

I. Introduction

Fly ash is one of the industrial products obtained from combustion of coal. In the past decades, fly ash obtained from coal combustion was simply dumped into the atmosphere which caused many environmental and health hazards. More than 65% of fly ash produced is disposed of in landfills. India alone covers an area of 40,000acres (160 sq.km) with fly ash as landfills. Addition of fly ash stabilizes the soil, which in turn improves engineering performance of soil. On the other hand, Recycling fly ash includes environmental benefits such as reducing demand for virgin materials that would need quarrying and substituting materials which may be energy intensive to produce. This study has been undertaken to explore the possibility of use of fly ash with addition of M-Sand and also the engineering properties of the composite material (fly ash-M-Sand) have been studied. The discussion of results includes the possibility of use of fly ash in the construction of rural roads sub-grades. Beeghly (2003) showed in his study that a combination of lime and fly ash is beneficial for high silt content soils. Singh., B et al, (2014) reported that by use of fly ash mixed with small amount of lime, improves some of the engineering properties of the clayey soils including hydraulic conductivity as well as strength. Chauhan et al (2008) observed that with increase in percentage of fly ash mixed with M-Sand there will be an increase in optimum moisture content and decrease in maximum dry density. In present days, about 10% of fly ash is utilized in ash dyke construction and land filling and only 3% of ash is utilized in other construction industries. So far, the combination of fly ash and M-Sand as a sub grade material has not been studied in detail.

II. Need For Utilization And Sub grade Characteristics

Fly ash causes environmental pollution, causing health hazards and disposal of fly ash requires large area. Fly ash possesses several desirable characteristics such as light weight, ease of compaction, faster rate of consolidation, better drainage, etc. Compaction process of fly ash can be started much earlier even after rainfall when compared to soil compaction process. Fly ash is a preferable material for the construction of embankments over weak sub soil. Subsequently, it is mandatory to use fly ash at all road works, located within a 100 km distance from a thermal power station (IRC:SP:20-2002). As per IRC guidelines (IRC:37-2001), on the basis of CBR values the sub-grade material may be classified as very poor for CBR value of 2, poor for CBR value of 3-4, fair for CBR value of 5-6, good for CBR value of 7-9 and very good for CBR value of 10-15. IRC: SP: 89-2010 containing guidelines for soil, use of cement, lime and fly ash for material stabilization is important for selecting proper stabilized materials based on local soil. The objective of this experimental work is to develop a fly ash – M-Sand composite with CBR value greater than 10 (very good) preferably or at least in the range of 7-9 (good).

III. Scope And Objectives

A study was made to know the engineering properties of different proportions of fly ash, M-Sand to know the possibility of using the composite for construction of sub-grades for rural roads. Fly ash is obtained from Dr.Narla Tata Rao Thermal Power Station, which is well renowned as V.T.P.S., Ibrahimpatnam and M-Sand obtained from stone crushers.

The main objectives of the study are:

1. Geotechnical properties of fly ash and M-Sand were determined individually and combinations with various proportions at regular intervals of 10%.
2. Varying percentages of Fly ash and M-Sand were mixed and maximum dry density and optimum moisture content of the mix were determined.

IV. Engineering Properties of Materials

The materials used in this study include fly ash and M-Sand in the powder form. As per Indian Standard soil classification system, the M-Sand was classified as well graded M-Sand (SW). As per IS: 2720 (Part 4) 1975, the particle size distribution curves for fly ash, M-Sand and their combinations are shown in Fig. 1. The basic properties of M-Sand and fly ash are given in Table 1.

Table 1 Basic Properties of M-Sand and Fly ash

Particulars of test	M-Sand	Fly ash
Specific gravity IS:2720(Part3)1980	2.71	2.5
Coefficient of uniformity Cu	11.3	3.1
Coefficient of curvature Cc	1.04	1.7
IS Soil classification	SW	-
Liquid limit(%),IS:2720(Part5)1975	-	-
Plastic limit (%)	-	-
MDD (g/cc),IS:2720(Part7)1980	2.187	1.387
OMC(%),IS:2720(Part2)1973	5.9	18.2

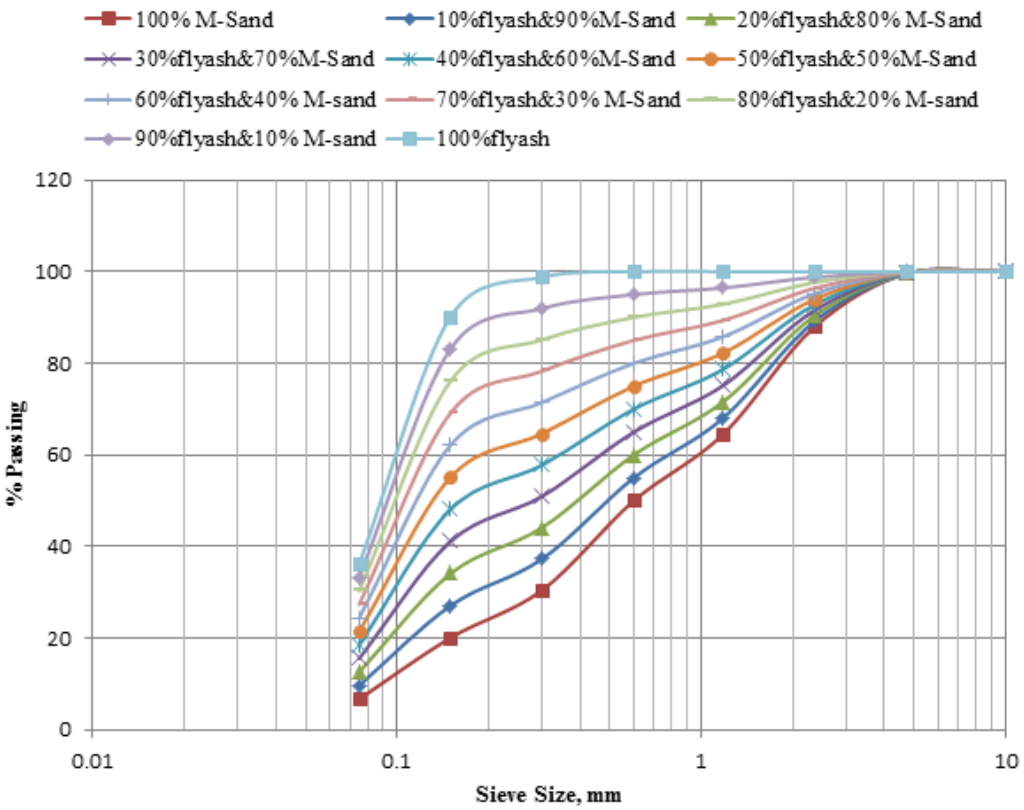

Fig. 1 Particle Size Distribution Curves of M-Sand, Fly ash and M-Sand + Fly ash Composite

V. Method of Testing

Laboratory tests were conducted as per Indian Standards with Combination of M-Sand with fly ash in varying percentages of 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, and 90%. The mixing was carried out manually and maximum care was taken to attain a uniform mix. The properties like moisture density relation (IS light compaction) for the M-Sand blended with varying percentage of fly ash were determined.

VI. Results And Discussion

6.1 Compaction Characteristics of M-Sand Fly ash Composite

IS Light compaction tests were carried out for different proportions of M-Sand and fly ash as per the procedure presented in IS: 2720 (Part7) 1980/87 in order to study the relationship between moisture and density. The variation of dry density with water content for M-Sand, fly ash and different combinations of M-Sand and fly ash is presented in Fig.2. From observations, Maximum Dry Density (MDD) increases with the increase in M-Sand content; whereas the optimum moisture content decreases. This may be due to the higher specific gravity and coarser nature of M-Sand than fly ash which leads to increase in MDD and the lower specific surface of M-Sand leads to decrease in OMC.

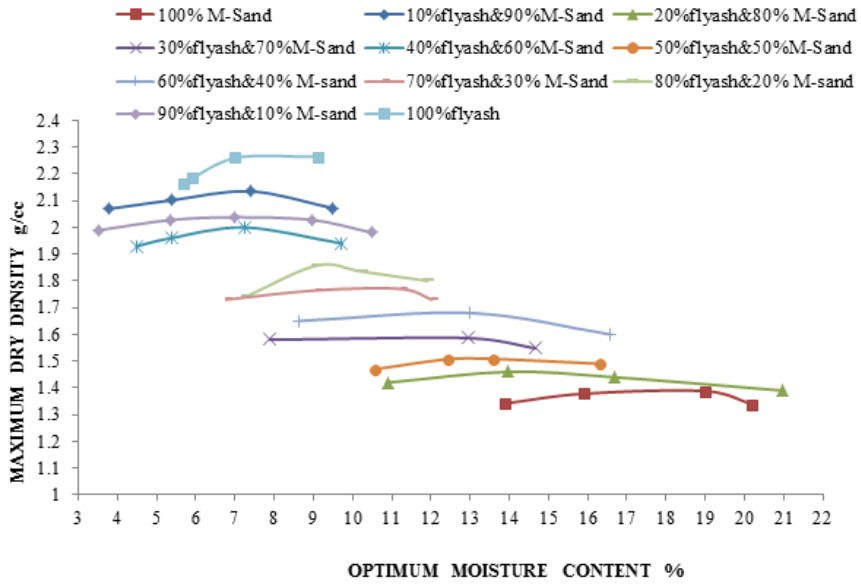

Fig. 2 variation of Dry Density of M-Sand with Fly ash Content

With increase in percentage of M-Sand, the variation of Maximum Dry Density (MDD) and Optimum Moisture Content (OMC) is shown in Fig. 2. The variation in maximum dry density can be expressed in terms of linear relationship given by equation:

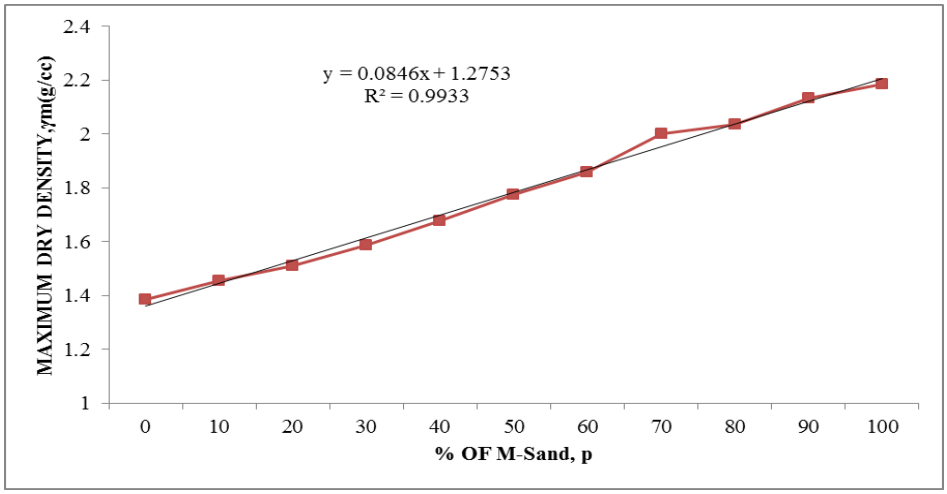

Fig. 3 Variation of MDD of Fly ash-M-S and Composite

The Variation of Maximum Dry Density (MDD) can be expressed by the equation:
$\gamma_m = 0.084x+1.275$, $R^2 = 0.993$ (Eq.1)
Where, γ_m = Maximum Dry Density in g/cc and
p = Percentage of M-Sand

The Variation of Optimum Moisture Content (OMC) can be expressed by the equation:
$w = -1.122x +17.44$, $R^2=0.942$ (Eq.2)
Where, w = Percentage of Optimum Moisture Content and
p = Percentage of M-Sand

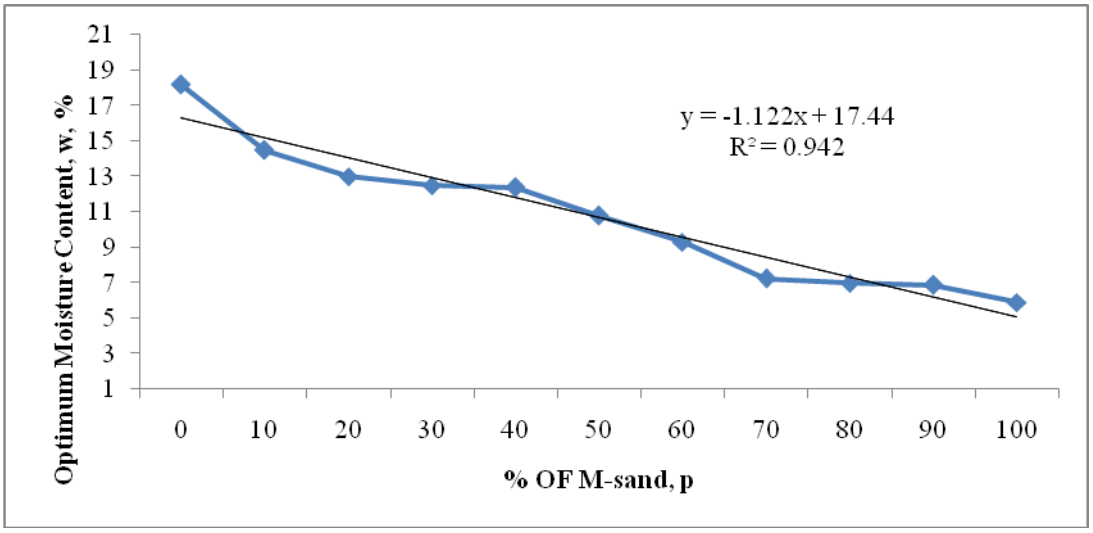

Fig. 4 Variation of OMC of Fly ash-M-Sand Composite

VII. Conclusion

Fly ash is a waste material produced by the burning of coal in thermal plants and has low specific gravity and CBR value. The addition of M-Sand to Fly ash improves the properties of the composite thus formed, and allows its application in the construction of roads leading to a safe disposal of fly ash. Based upon the above study the following conclusions can be drawn:

1. Addition of sand to fly ash results in an increase in maximum dry density with a decrease in optimum moisture content.
2. The composites of 40% fly ash + 60% M-Sand and 50% fly ash + 50% M-Sand and 60% fly ash + 40% M-Sand were given promising results.
3. The above conclusions are based upon the results of laboratory investigations and need to be further validated under field conditions.

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