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Soil Stabilization of Clayey Sand Using Polypropylene Fibre and Fly Ash

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Abstract—***This paper Stabilization of soil using polypropylene fiber and fly ash is a study aimed to utilize waste products and optimize inclusion of these waste products in such a manner that maximum possible strength is imparted to soil being used in pavements, foundations etc. A varying percentage of polypropylene and optimized fly ash was used with soil for testing strength parameters using CBR and Direct Shear Test. With optimized flay ash, increase in percentage of polypropylene resulted in increase of CBR and Cohesion factor. In comparison to virgin soil (Clayey Sand – SC group) the soil mixed with 7%fly ash gave a substantial increment of 26.98% in CBR value. For soil mixed with 7%fly ash and polypropylene in varying percentages, a maximum 33.46% increment in CBR value was observed.***

Keywords— Soil Stabilization, Waste polypropylene Fiber, Fly Ash, Shear Strength, CBR Test

I. Introduction

Infrastructure projects such as highways, railways, water reservoirs, reclamation etc. requires earth material in very large quantity. In urban areas, borrow earth is not easily available which has to be hauled from a long distance [1]. Quite often, large areas are covered with highly plastic and expansive soils, which is not suitable for such purposes. As fly ash is freely available from Thermal Power Plants, it can be used for stabilization of expansive soils for various uses. [2] This study presents the laboratory work on soil stabilized with fly ash (FA) and polypropylene fibre (PPF). The samples soils were collected from the Morni sub-division (Morni range) of district Panchkula, Haryana, India. Morni range forms a part of the Outer Shivalik Himalaya and its coordinates are 300 35' to 340 45' N latitude and 700 00' to 750 15' E longitude.[3][4]

Fly Ash is itself an industrial waste which imposes many health and environmental hazards Dumping fly ash is not an environmentally suitable measure as it degrades the soil and water quality nearby the dumping area. Consistent infiltration of fly ash in the agricultural fields may render the crop area infertile. On similar lines, polypropylene too is an industrial waste which can be utilized in constructional activities. Of late polypropylene has been used in many road works all across the country.[5] Rajagopalan Vasudevan, the 2018 Padma Shri awardee pioneered the art of using plastic in road construction works and through this study we aim to further find what different percentage of polypropylene can be used in road works when mixed with soil.[6]

II. OBJECTIVE OF THE STUDY

1. To study the effects of mixing waste material in soil sample on strength parameters of the soil
2. To achieve an optimized percentage of waste material that gives a satisfactory strength and bearing capacity to the soil.

1) Polypropylene Fiber: Polypropylene fiber was obtained from shree rama industries Panipat. The polypropylene fiber obtained was of with a specific gravity of .91 and diameter in range of 24 micron to 53 micron The melting point of polypropylene is about 165°C and remains flexible at temperatures in the region of -55°C respectively.

III. METHODOLOGY

A. Compaction Test

Standard Proctor Test was performed in this phase of study in accordance with IS: 2720 (Part7) 1980. Compaction Test was performed on virgin soil as brought from the site and also on blended sample constituting of varying percentages of fly ash. After establishing an optimized percentage of fly ash (7%) varying percentages of polypropylene were added to the mix and again Standard Proctor Test was performed on the sample. Thus Optimum Moisture Content and Maximum Dry Density of virgin and blended mix was obtained.

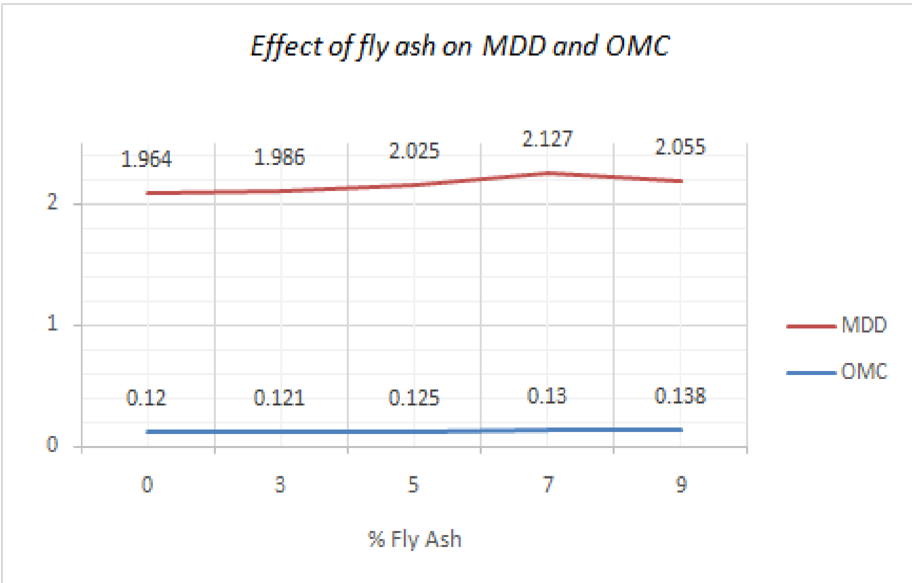
B. California bearing ratio test

In accordance with IS: , CBR Test was performed on virgin soil, soil blended with fly ash and lastly on fly ash optimized soil mixed with varying percentages of polypropylene.

IV. RESULTS AND DISCUSSION

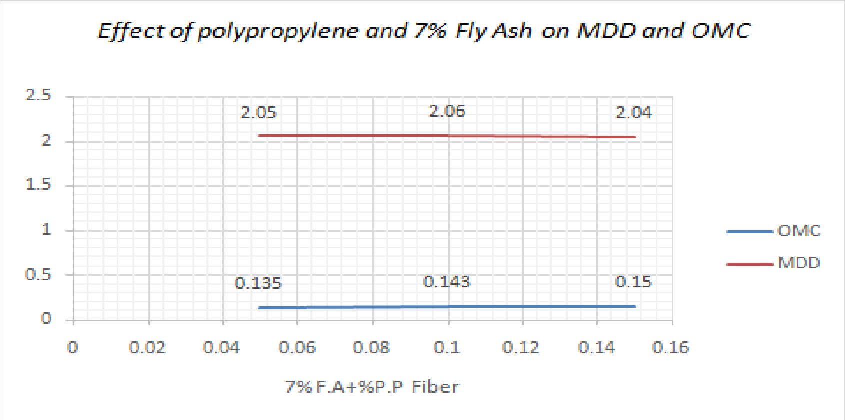
A. Effect of fly ash on MDD and OMC

The increase in Fly Ash was done incrementally by increasing fly ash percentage in three increments – 3%, 5%, and 7%, and 9%. With increase in fly ash content, the MDD increased upto 7% and decreased at 9% fly ash content. Thus fly ash content was fixed at 7% for further blending of polypropylene waste material. The comparison curves are shown in Figure and Figure. The decrease in MDD beyond has been marginal in nature but further addition would have resulted in decreasing the MDD value.



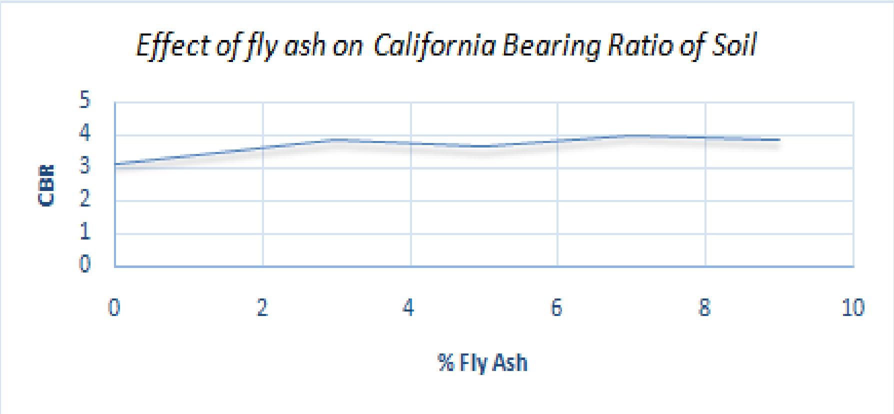
B. Effect of polypropylene and 7% Fly Ash on MDD and OMC

While the amount of Fly Ash was kept constant at 7% (optimized value), the content of polypropylene waste was blended in three different trials. The polypropylene waste was added at .05%, .1%, and .15%. The length of waste fiber was kept constant to keep a check on the scope of work. It was observed that MDD was achieved at 0.1% polypropylene fiber which shows an increase of 4.88% with comparison to virgin soil. The comparison curves are shown in Figure and Figure.



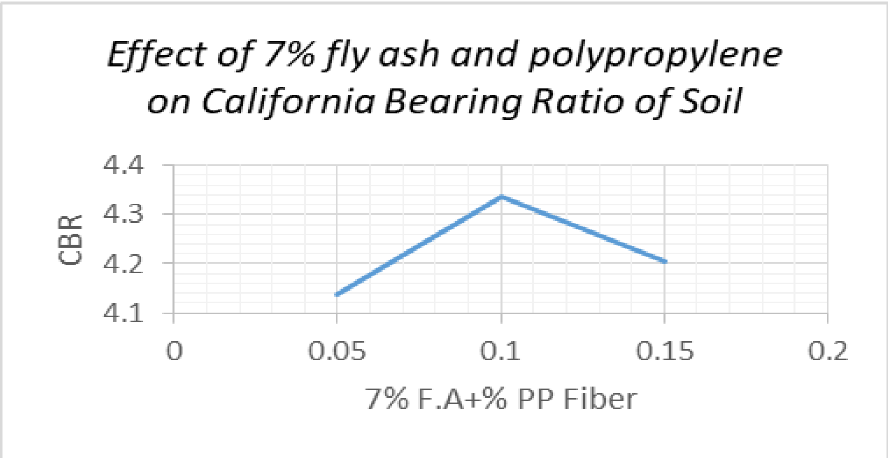
C. Effect of fly ash on California Bearing Ratio of Soil

In comparison to virgin soil (Clayey Sand – SC group) the soil mixed with 7%fly ash gave a substantial increment of 26.98% in CBR value. Incremental addition of fly ash was done – 3%, 5%, 7% and 9%. With increase in fly ash content, the CBR value was consistently found to be increasing. However, to achieve maximum strength, it was decided to use the 7%fly ash content because that resulted in Maximum Dry Density as described above. The comparison curves are shown in Figure and Figure.



D. Effect of 7% fly ash and polypropylene on California Bearing Ratio of Soil

With increase in polypropylene content in the soil mix, at 7% fly ash, the CBR value was found to be increasing upto .15%. Polypropylene was added in 4 incremental values - .05%, .1%, .15%, and .2%. The CBR value dropped after at .2 % and the maximum value was achieved at .15%. The reason behind this fall was excessive fiber causing reduction in grain to grain contact that resulted in loss of strength. The comparison curves are shown in Figure and Figure.



V. CONCLUSION

In this study strength characteristics of soil mixed with an optimized percentage of fly ash and varied percentage of polypropylene mix has been studied. Based on the findings of laboratory tests conducted under controlled conditions, following observations can be made.

A. Through Standard Proctor Test, it was concluded that maximum dry density and optimum moisture content were obtained at 7% fly ash mixed in soil. Compared to virgin soil, a marginal 8% increase in Maximum Dry Density was observed.

B. In comparison to virgin soil (Clayey Sand – SC group) the soil mixed with 7%fly ash gave a substantial increment of 26.98% in CBR value. Thus it was concluded to fix the percentage of fly ash a 7% to further analyse effect of polypropylene in the soil mix.

C. At .05% polypropylene fiber mixed with 7% fly ash content, a marginal increase of 4.9% in MDD value was observed. At 7% fly ash content, MDD was found to be further improved as compared to just fly ash mixed with soil.

D. As compared to soil mixed with 7% fly ash, .1% polypropylene mixed with 7% fly ash gave CBR value of 4.33. Thus 8.25% increase in CBR value was observed.

E. In comparison to virgin soil, an overall gain of 37.46% of CBR value was obtained with 7%fly ash and 0.1% polypropylene fiber mix.

F. The fibrous mix develops resistance towards sudden failure by improvising upon grain contact of the overall mix.

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