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Comparative Study of Strengthening of Soil using admixtures and industrial wastes (Fly Ash, Silica Fumes and Waste Plaster of Paris)

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ABSTRACT: Detail study of the characteristics of the soil at the site of construction (project site) to check it's strengthening, and if it fails to the pass the required specifications the adequate engineering methods that have been proved and tested to be satisfactory are applied to implement these engineering properties. Enhancing the quality of the soil properties for financial, strong and durable structure by using proportioning and mixing, compaction and addition of the admixtures is termed as strengthening of soil. Various types of industrial wastes and some admixtures can be proved to be efficient in developing the soil properties. The current paper explains the detailed study of Fly Ash, Silica and Waste Plaster of Paris for Strengthening of soil. The soil sample was collected from Taluka Chikhli, Dist. Buldana, and Maharashtra state. Quantity of Silica fumes, Waste Plaster of Paris, Fly Ash varies from 4% to 8% and 2% to 6%, 8% to 24% accordingly. Various engineering tests like Liquid Limit, Plastic Limit, Plasticity Index, Dry Density and Moisture Content are used for performance analysis. This attempt to compare soil strengthening by changing different parameters is seen in this research paper

KEYWORDS: Strengthening, Black Cotton Soil, Fly Ash, Silica, Waste Plaster of Paris, Liquid Limit, Plastic Limit, Dry Density and Moisture Content.

I. INTRODUCTION

Black Cotton soil is spread over the entire region of eastern Maharashtra state. According to M.A. Rahman[1], Black cotton Soil has unfavorable engineering characteristics. It is plastic, compressible, it is expensive soil and it has low shear strength and have significant volume changes with change in moisture content. They can creep overtime under the constant loading which makes them affected to sliding and buckling when shear stress is near its shear strength. This makes Black Cotton Soil unfavorable for foundation of structure and road pavement. Because of this unfavourability there is huge yearly expenditure on maintenance and repair.

Various types of industrial wastes and some admixture can be proved to be suitable in enhancing the soil properties. These use can be proved best for the economical construction, durable structures over black cotton soil. There is a serious problem now a days for the dispensation of the industrial waste, the use of such admixture for enhancing the soil properties will be helpful in proper dispensation and will reduce dispensation problems.

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II. OBJECTIVES

- i. To make an economical and eco-friendly soil by using admixtures and industrial wastes gaining the same strength to the soil. To investigate on Black Cotton Soil by using Fly Ash, Silica Fumes & POP Wastes.
- ii. To found out Strengthening of Soil by using admixtures and industrial wastes of by volume of Silica fumes, Waste Plaster of Paris, Fly Ash varies from 4% to 8% and 2% to 6%, 8% to 24% accordingly.
- iii. To analyse the Bearing Capacity of the soil by using various percentage admixtures and industrial wastes.
- iv. Improves homogeneity of the soil by increasing strengthening of soil.

III. PROBLEM STATEMENT

This research is an approach to find the best suitable solution regarding the foundation and pavement problems due to weak engineering properties of locally available soil and to reduce the dispensation problem of industrial waste generated by utilizing them in the construction.

In this research paper we analyze the properties of soil by using various admixtures with different proportions. The admixtures to be used are fly ash, Silica fumes and Plaster of Paris. The tests that we conducted are Plastic limit test, Liquid limit test and Standard proctor test. The Liquid limit, Plastic limit, Dry density and Optimum Moisture Content of soil using various admixtures in different proportions was found out

IV. METHODOLOGY

Materials:

Soil:

In this experiment the soil was obtained about 2m deep underground at site. The soil is brought from local area of Buldana, State of Maharashtra, India having latitude and 20.4451° N, longitude 76.2624° E. All the engineering properties as per the relevant Indian standard code (IS 2720).

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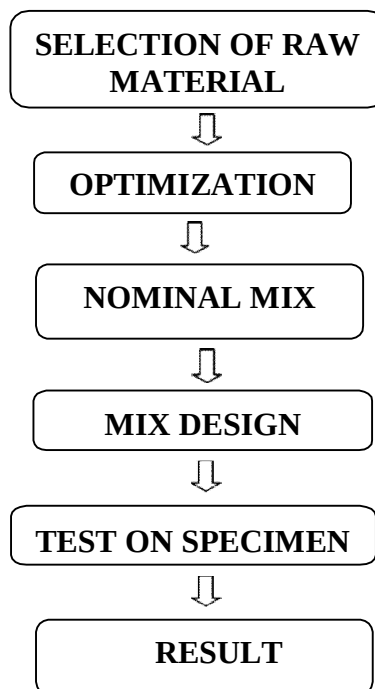


Fig -1: Flow chart of Methodology

FlyAsh:

Fly Ash is obtained from thermal power plant Paras Dist. Akola, Maharashtra state. Fly ash is non-plastic and confining to result 300 of IS4031 P2.

Silica fumes: Silica fumes is obtained from the local RMC plant in Mahalunge, Pune.

Waste Plaster of Paris:

Waste Plaster of Paris is obtained from Demolished construction site, Plaster of Paris used is passing through IS standard sieve size no 40 of size 425micron.

Laboratory Tests:

Laboratorial tests were carried out on the soil sample with different percentage of Fly Ash, Silica and Waste POP. All the test carried out are confining to the standard procedure laid by the Indian standard code.

A) Liquid Limit

Liquid limit is the moisture content at which soil acts as liquid and begin to flow.

B) Plastic limit:

Plastic limit is moisture content at which soil behaves as semisolid material but plastic Liquid Limit and Plastic Limit test were carried out at different admixture percentage. Casagrande's apparatus was used for liquid

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limit Test. As per the procedure laid down by IS 2720 Part V.

Plasticity Index:

Plasticity Index is determined from Liquid Limit and Plastic Limit results. Plasticity index can be defined as the difference in the liquid limit and plastic limit value. Plasticity index is the range of water content in the soil in which the soil continues to acts as the plastic material. It is the measure of plasticity of soil.

Standard Proctor Compaction Test:

Compaction is the process to densify the soil mass by reducing the percentage of air voids and pores present in it. Standard Proctor Test was carried out on the mould of internal diameter of 100mm and height of 127.3mm of capacity 1000cc. Standard Proctor Compaction Test were performed at various admixture content to determine the dry density corresponding to optimum moisture content. Standard proctor test was carried by procedure given by IS2720-VII.

V. EXPERIMENTAL RESULTS

Index Properties of black cotton soil:

As per tests on the soil, the specific gravity is found out to be approximately 2.3. the Liquid limit of soil was found to be more than 70% and the Plastic limit was found to be more than 45%. Further details about the properties of soil are described in Table 1.

Table 1: Index properties of Black Cotton Soil

Sr.No.	Property Name	Property Value
1	Specific Gravity	2.35
2	Liquid Limit	74%
3	Plastic Limit	47.60%
4	Shrinkage Limit	10.10%
5	Optimum Moisture Content	30.43%
6	Dry Density	1.362

Effect of admixture on liquid limit of soil:

Liquid limit of virgin soil is 74%. Fig 1 shows the variation of liquid limit of soil when various admixtures such as Fly ash, Silica fumes and Plaster of Paris is used as stabilizing agent.

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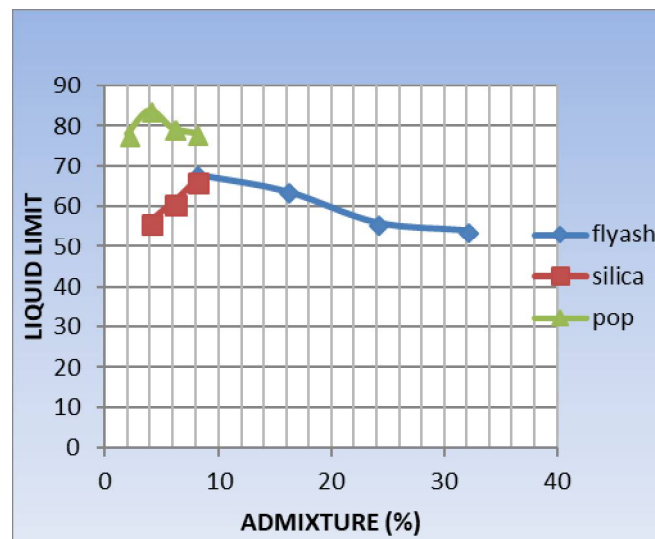


Fig 1: Liquid limit Vs Admixture content

Liquid limit of the virgin soil decreases when fly ash and silica fumes are used as admixtures, while liquid limit of the soil increases when Plaster of Paris is used as admixture. Liquid limit of the soil when fly ash is used as admixture first increase then decreases. Maximum liquid limit for fly ash is obtained at 16% which is 63.8%. Liquid limit of soil for silica fumes increases continuously with the increase in silica percentage. For plaster of Paris, liquid limit first increases and then decrease. Maximum liquid limit value for Plaster of Paris is obtained at 6% which is 84. For 8% of admixture content maximum liquid limit is obtained for Plaster of Paris as 78%.

Effect of admixture on plastic limit of soil:

Plastic Limit of soil is 47.6%. The Fig 2 shows the variation in Plastic limit due to effect of various admixtures used as stabilizing agent on the soil from eastern Maharashtra.

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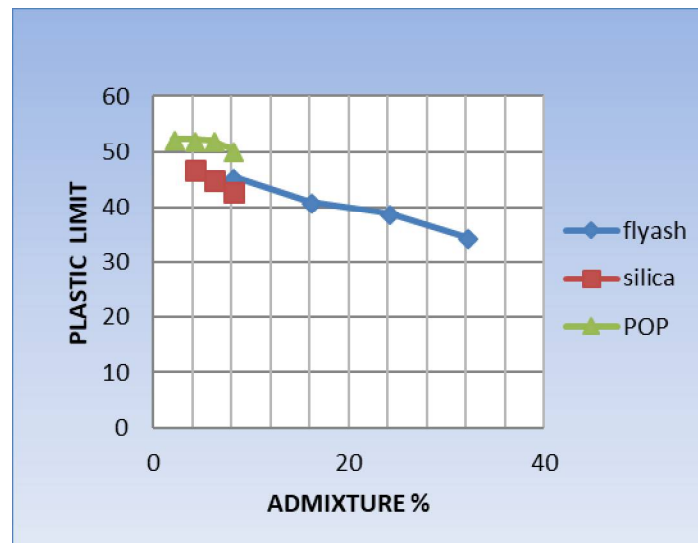


Fig 2: Plastic Limit Vs Admixture Content

Plastic limit of the soil increases continuously when flyash, silica fume and waste Plaster of Paris is added in the soil wrt their percentage. Maximum plastic limit value is for waste Plaster of Paris at 2% and minimum for fly ash at 32% which are 52.4% and 34.6% accordingly. Plastic limit decreases for every admixture content when the percentage of respective admixture increases. Plastic limit value at 8% of flyash, silica fumes and waste Plaster of Paris are 45.6%, 43.13% and 50.4% accordingly.

Effect of admixture on plasticity index of soil:

Plasticity index of virgin soil is obtained as 26.4%. The Fig 3 shows the variation of plasticity index of soil from the eastern part of Maharashtra state when various admixtures are used as stabilizing agent.

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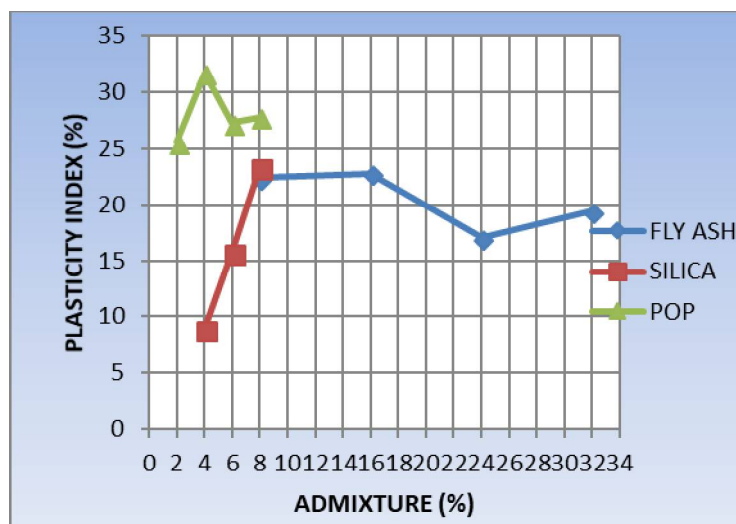


Fig 3: Plasticity Index Vs Admixture Content

The maximum value of plasticity index is obtained for 4% Plaster of Paris content is 31.7%. Minimum value of plasticity index is obtained at 4% of silica content as 8.9%. Plasticity index for fly ash is optimum for 16% which is 22.8%. Similarly, for silica maximum Plasticity Index is obtained at 8% as 23.37%. For the 8% of fly ash, silica and Plaster of Paris content maximum value obtained for Plaster of Paris which is 27.8%.

Effect of admixture on dry density and optimum moisture content:

Optimum dry density and corresponding moisture content for the virgin soil sample is 1.37 and 30.4%. Graph 3.4.1 shows the variation of optimum moisture content with the variation in the admixture content. Graph 3.4.2 shows the variation of dry density with the change in percentage of stabilizing agent. Optimum moisture content is decreased from plain soil sample with the increase in flyash, silica fumes and waste Plaster of Paris. OMC decreases with the increase in flyash content from 29.45% for 8%, 26.815% for 16% to 19.846 for 24%. OMC for silica fume at 4% is 21.429%, it increases for 6% and further decreases till 21.158 at 8%. OMC of waste Plaster of Paris decreases from 30.3% for 2% to 22.813% for 6% of waste Plaster of Paris content. Maximum dry density is increased for every soil content with respect to virgin soil sample. Maximum dry density is obtained for fly ash whereas minimum is obtained for the silica fumes. Maximum dry density for fly ash, silica fumes and waste Plaster of Paris is obtained 16%, 8% and 6% accordingly.

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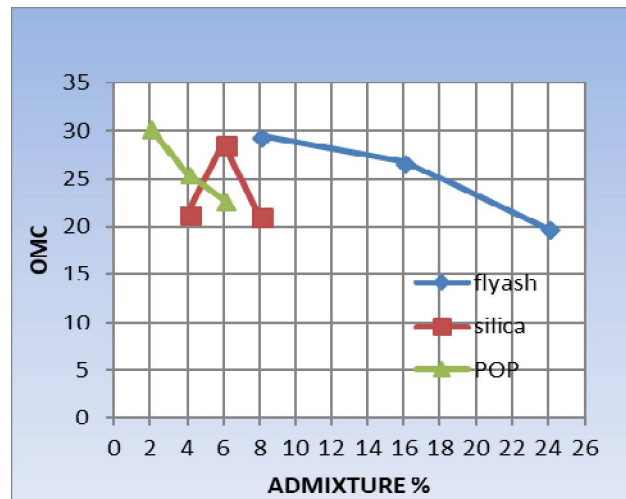


Fig 4: Optimum Moisture Content Vs Admixture Content

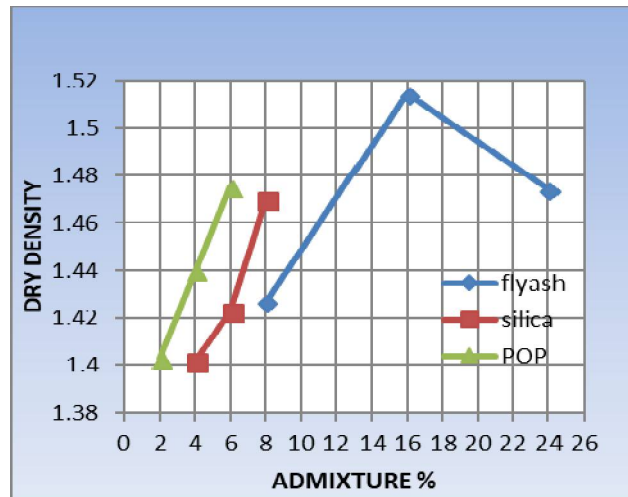


Fig 5: Dry Density Vs Admixture Content

VI. CONCLUSION

Liquid limit of soil decreases when fly ash and silica fumes are used as admixtures. Whereas liquid limit of soil increases when POP is used as admixture. Liquid limit for soil continuously decreases with increase in fly ash content while liquid limit increases with increase in silica content. Liquid limit for Plaster of Paris first increases upto 6% and then decreases. Maximum liquid limit is obtained for 6% of Plaster of Paris as admixture.

Plastic limit of the soil decreases with the increase in flyash, silica fumes and Plaster of Paris content. plastic limit for fly ash is maximum for 8% which is 45.6, for silica it is maximum for 4% which is 47.2 and for Plaster of Paris

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it is maximum for 2% which is 52.4. For 8% of fly ash, silica and Plaster of Paris, maximum value is 52.4 for Plaster of Paris.

Plasticity Index of soil when fly ash is used, first increases then decreases and further increases. Plasticity index when silica is used continuously increases. Plasticity index when Plaster of Paris is used, first increases then decreases and again increases. Maximum value of plasticity index for fly ash, silica and Plaster of Paris is obtained at 16%, 8% and 4% of admixture content accordingly. Plasticity index at 8% of admixture content of Plaster of Paris is optimum which is 27.8%.

Dry density of the soil increases when admixtures are added initially. Maximum dry density when fly ash is used was obtained at 16% as 1.514 at 26.815% OMC. For silica, maximum dry density is obtained at 8% as 1.47 at 21.158% OMC. For POP, maximum dry density is obtained at 6% as 1.475 at 22.813% OMC.

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