International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 05 Issue: 05 | May-2018 www.irjet.net p-ISSN: 2395-0072

Stabilization of Soil by Foundry Sand Waste with Fly-Ash

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Abstract - *Soil is the basic foundation of any civil engineering structure. It is required to bear the load without any failure. But in some places the soil may be weak which cannot resist the oncoming load. In such cases the soil stabilization is done. In our project we have used fly-ash and foundry sand waste as additives to stabilize the soil which was obtained from the college ground. The fly ash and the foundry sand waste may hamper the environment around us if not disposed of properly, so using them in soil stabilization helps to keep our environment clean. In this study the fly-ash and foundry sand waste is being mixed with soil to investigate the relative strength gain in terms of bearing capacity and compaction and the experiment conducted by using standard proctor compaction apparatus. The tests were performed as per Indian standard specification.*

The varied percentage of fly-ash and foundry sand waste that we have used in our project consists of 1% fly-ash and 0% foundry sand waste, 1% fly-ash and 0.25% foundry sand waste, 1% fly-ash and 0.5% foundry sand waste. After this to verify our results we have used 2% fly-ash and 0.5% foundry sand waste and 3% fly-ash and 0.75% foundry sand waste.

KEY WORDS: Bearing capacity, Stabilization, Standard proctor, Fly-ash, Foundry sand waste.

1. INTRODUCTION

In any civil engineering structure the most important role is played by its foundation and for the foundation to be strong the soil around it plays a very critical role. Many places have suitable soil for construction but some places do not have suitable soil for construction. To make soil suitable for construction soil stabilization process can be done. Even if we turn the pages of history and look in the roman civilization they have also used many methods to enhance the strength of soil.

Stabilization is the process of blending and mixing materials with the soil to improve certain properties of soil. The process may include the blending of soils to achieve a desired gradation or the mixing of commercially available additives that may alter the gradation, texture or plasticity or act as a binder for cementation of the soil. Soils are generally stabilized to increase their strength (thereby increasing the bearing capacity) and durability.

Here, in this project, soil stabilization has been done with the help of foundry sand waste and fly-ash. Both of these products are waste products and their disposal is a concern for the entire world. By using these waste materials in soil stabilization we can reduce the problem of their disposal and get a better soil base for foundation.

1.1 Fly-Ash

The residue left after the combustion process is called fly-ash. The most commonly used fly-ash in the construction and industrial application is the one which is generated by coal-fired power plants. A huge amount of electricity in India is generated by coal power plants which lead to a large amount of production of fly-ash and not only have power plants produced fly-ash many other industries do the same. If humans are exposed to fly-ash it can do a lot of damage to their body like kidney disease, skin ulcers, high blood pressure, swelling of the brain etc. So the disposal of the fly-ash is very important to us.

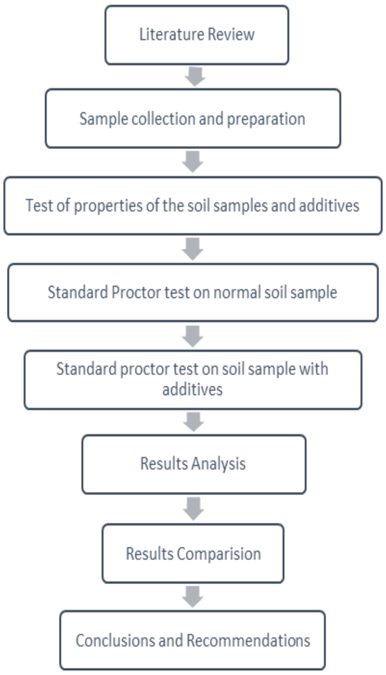
As it is a byproduct and available in abundance we can use it in soil stabilization which solves our problem of its disposal and it also helps the industry economically as it can sell it in the market to gain some profit.

1.2 Foundry Sand Waste

The discarded material from the metal casting industry which mainly consist of silica sand and impurity of ferrous and nonferrous by-products from the metal casting process itself and a variety of binders is called foundry sand waste. It is produced in huge amount from the metal casting industry, almost 10 million tons annually in India. Now we all can imagine the amount it is produced in the whole world. This huge amount can be used in construction work rather than just disposing it off. The use of foundry sand in construction work will also be economical because of its availability.

2. Methodology

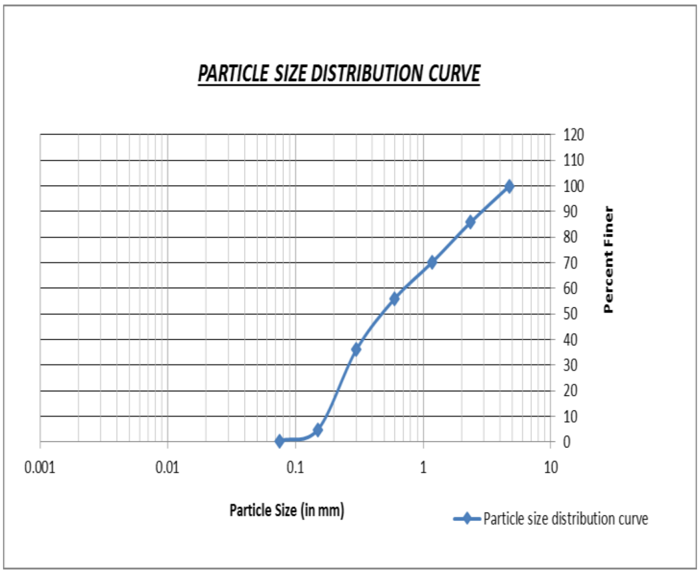
Methodology consists of the following steps and are followed in the given order.



3. Results

Tests Performed on the Soil Sample and Additives

- **Sieve analysis of soil sample**



Graph 1: Particle size distribution curve

From Graph, values of D_{10}, D_{30} and D_{60} are **0.18**, **0.26** and **0.70** respectively.

Coefficient of uniformity, C_u = 3.88
Coefficient of curvature, C_c= 5.536

- **Specific gravity**

Soil sample	2.42
Foundry sand waste	2.636
Fly- ash	2

- **Normal moisture content**

Soil sample	12.73%
Foundry sand waste	1.3%
Fly- ash	2.63%

- **Atterberg's limit test of soil**

Plastic limit	22.63
Liquid limit	34.4

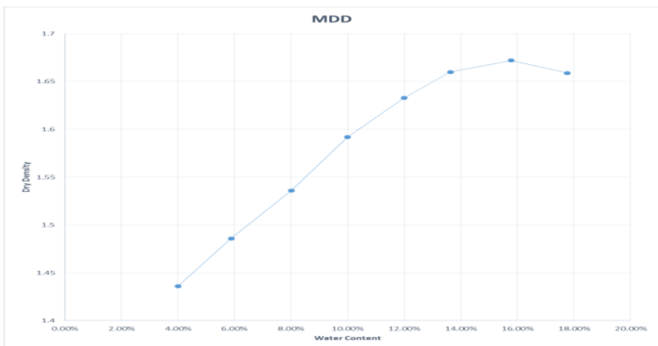
Standard Proctor Test

This test is used to determine the optimum moisture content (OMC) and Maximum dry density (MDD) of the soil. In this test soil is filled in the mould in layers with equal no. of compaction blows to each layer.

- Observations and Results
- Normal soil sample without any additives

Table 1: Observations of Standard Proctor test on normal soil

S.no.	Bulk density (in g/cc)	Dry density (in g/cc)	Water content
1	1.494	1.436	4.00%
2	1.567	1.486	5.88%
3	1.659	1.536	8.00%
4	1.752	1.592	10.00%
5	1.83	1.633	12.00%
6	1.893	1.66	13.63%
7	1.94	1.672	15.78%
8	1.958	1.659	17.77%

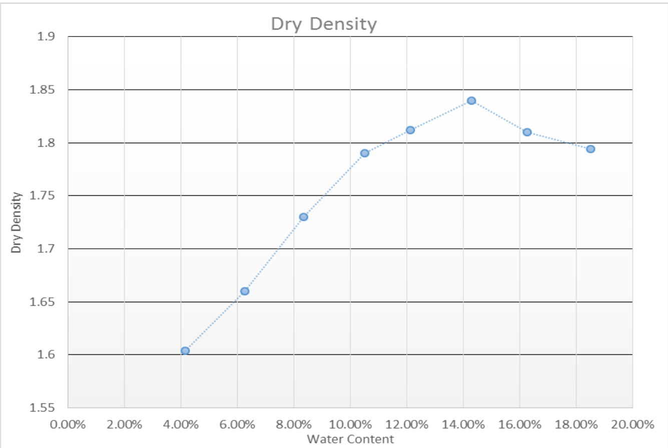


Graph**2**: Dry density of normal soil

- Maximum Dry Density: 1.672
- Optimum Moisture Content: 15.78%
- Soil with 1% Fly-ash and 0% Foundry sand waste

Table **2**: Observations of Standard Proctor test on soil with 1% F.A. and 0% F.S.

S.no.	Bulk density (in g/cc)	Dry density (in g/cc)	Water content
1	1.669	1.604	4.16%
2	1.763	1.66	6.25%
3	1.869	1.73	8.33%
4	1.976	1.79	10.50%
5	2.03	1.812	12.12%
6	2.097	1.84	14.28%
7	2.11	1.81	16.25%
8	2.117	1.794	18.50%

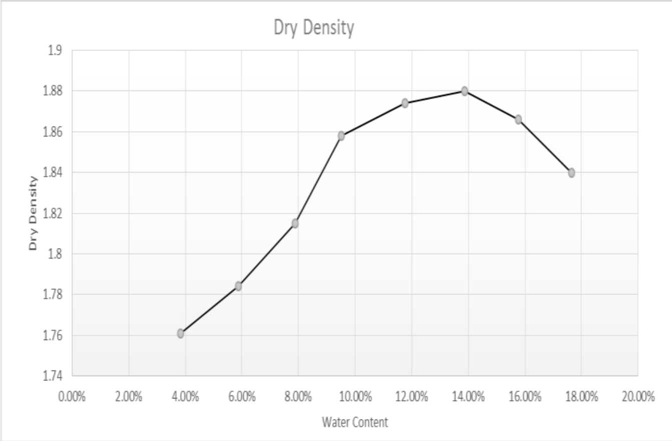


Graph **3**: Dry density of soil with 1% F.A. and 0% F.S.

- Maximum Dry Density: 1.84
- Optimum Moisture Content: 14.28%
- Soil with 1% Fly-ash and 0.25% Foundry sand waste

Table **3**: Observations of Standard Proctor test on soil with 1% F.A. and 0.25% F.S.

S.no.	Bulk density (in g/cc)	Dry density (in g/cc)	Water content
1	1.832	1.761	3.84%
2	1.892	1.784	5.88%
3	1.96	1.815	7.89%
4	2.044	1.858	9.52%
5	2.099	1.874	11.76%
6	2.143	1.88	13.88%
7	2.165	1.866	15.78%
8	2.179	1.84	17.64%

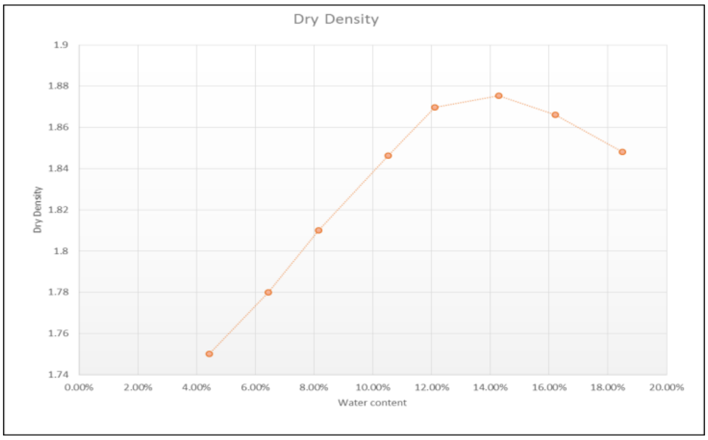


Graph 3: Dry density of soil with 1% F.A. and 0.25% F.S.

- Maximum Dry Density: 1.88
- Optimum Moisture Content: 13.88%
- Soil with 1% Fly-ash and 0.5% Foundry sand waste

Table **4**: Observations of Standard Proctor test on soil with 1% F.A. and 0.5% F.S.

S.no.	Bulk density (in g/cc)	Dry density (in g/cc)	Water content
1	1.821	1.75	4.44%
2	1.865	1.78	6.45%
3	1.901	1.81	8.16%
4	2.031	1.8463	10.52%
5	2.094	1.8696	12.12%
6	2.138	1.8754	14.28%
7	2.165	1.866	16.21%
8	2.181	1.848	18.50%

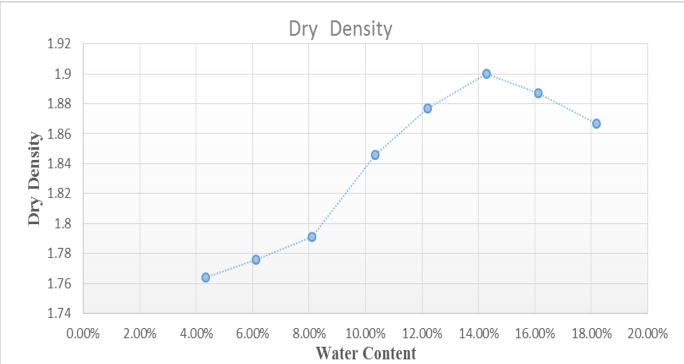


Graph **4**: Dry density of soil with 1% F.A. and 0.5% F.S.

- Maximum Dry Density: 1.8754
- Optimum Moisture Content: 14.28%
- Soil with 2% Fly-ash and 0.5% Foundry sand waste

Table **5**: Observations of Standard Proctor test on soil with 2% F.A. and 0.5% F.S.

S.no.	Bulk density (in g/cc)	Dry density (in g/cc)	Water content
1	1.834	1.764	4.34%
2	1.883	1.776	6.12%
3	1.935	1.791	8.10%
4	2.031	1.846	10.34%
5	2.103	1.877	12.19%
6	2.167	1.9	14.28%
7	2.189	1.887	16.12%
8	2.204	1.867	18.18%

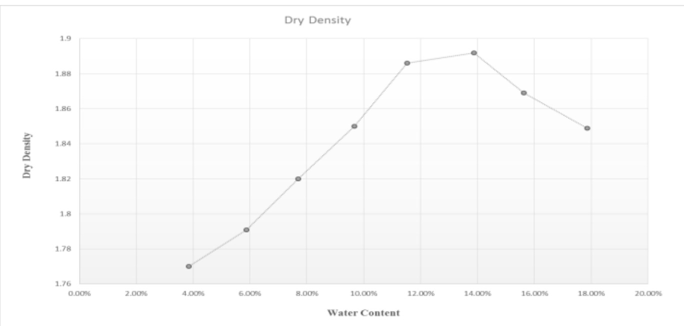


Graph **5**: Dry density of soil with 2% F.A. and 0.5% F.S.

- Maximum Dry Density: 1.9
- Optimum Moisture Content: 14.28%
- Soil with 3% Fly-ash and 0.75% Foundry sand waste

Table 6: Observations of Standard Proctor test on soil with 3% F.A. and 0.75% F.S.

S.no.	Bulk density (in g/cc)	Dry density (in g/cc)	Water content
1	1.84	1.77	3.84%
2	1.9	1.791	5.88%
3	1.965	1.82	7.69%
4	2.036	1.85	9.67%
5	2.113	1.886	11.53%
6	2.157	1.892	13.88%
7	2.169	1.869	15.62%
8	2.182	1.849	17.85%

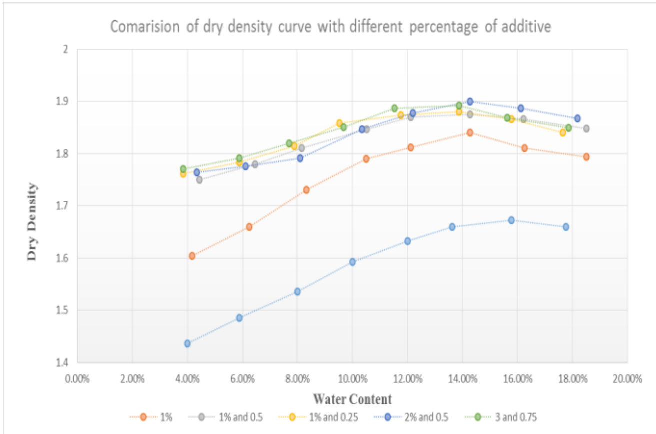


Graph 6: Dry density of soil with 3% F.A. and 0.75% F.S.

- Maximum Dry Density: 1.892
- Optimum Moisture Content: 13.88%
- Comparison of dry density curve with different percentage of additives

Table **7**: Comparison of dry density curve with different percentage of additives

S.No.	Percentage of Fly-ash	Percentage of Foundry sand waste	MDD	OMC %
1	0	0	1.672	15.78
2	1	0	1.84	14.28
3	1	0.25	1.88	13.88
4	1	0.5	1.8754	14.28
5	2	0.5	1.9	14.28
6	3	0.75	1.892	13.88



Graph 7: Comparison of dry density curve with different percentage of Fly-Ash and Foundry sand waste

3. CONCLUSIONS

The present study investigated the effect of stabilizing the soil with fly-ash and foundry sand waste both. In this course of study we have used varied percentage of fly ash and foundry sand waste to stabilize the soil.

These results have been drawn from our study:

1. Addition of 1% fly ash and 0% of foundry sand waste gave 1.84g/cc of MDD.
2. Addition of 1% fly ash and 0.25% of foundry sand waste gave 1.88g/cc of MDD.
3. Addition of 1% fly ash and 0.5% of foundry sand waste gave 1.875g/cc of MDD.

The decrease in MDD in the third attempt of our experiment gave us the saturation point. The ratio of fly ash to that of foundry sand waste to be used is 1:0.25 i.e. the foundry to be added is 1/4th of the fly ash.

So to verify the results we obtained we started adding varied percentage of fly ash also along with foundry sand waste.

The results we obtained are:

1. Addition of 1% fly ash and 0.25% of foundry sand waste gave 1.88g/cc of MDD
2. Addition of 2% fly ash and 0.5% of foundry sand waste gave 1.9g/cc of MDD.
3. Addition of 3% fly ash and 0.75%of foundry sand waste gave 1.892g/cc of MDD.

Here also the decrease in MDD gave us the saturation point. The ratio of fly ash to that of foundry sand waste to be used is 2:0.5 i.e. the foundry sand waste to be added is 1/4th of the fly ash, the ratio which we have obtained earlier and this verifies our experiment.

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