

Strength Improvement of Soil Sub grade by Using Fly Ash and Molasses

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Abstract: As we all aware about the present situation of the country day by day the traffic is going to increase and load carrying capacity also increased and this leads to increment in stress over the pavement layers, which is not easy to handle and at last the result is failure of pavement layers. Sub grade is the basic or down most layer of the pavement or we can say it is the starting layer of the pavement and it need to be strong because if the bottom is strong the upper part of the construction is safe. The weathering action, permeability of soil decreases the load bear capacity of the soil will be one of the major cause of the loose or failure of sub grade or pavement. But we can decrease the failure of soil up to some extent by soil stabilization of earth work and we can also use aggregates and bitumen to improve the pavement bearing capacity. Soil stabilization enhances the chemical, mechanical and physical properties of soil. By this report we will add the sugarcane Molasses and Fly ash with soil and check the capacity of soil and compare it with the locally available soil in the site. The expected results that we get by mixing of molasses and fly ash with soil, this will decrease the liquid limit and plastic limit of soil, the amount of thickness of the pavement is reduced.



Fig.1.1 Road Pavement layers

The target of this research is to enhances the strength of soil, as most o the places in India the strength of the soil is not good so we can increase the thickness of the pavement and compacted the different layers up to the design compaction and this will directly increase the cost and time of the project. So, we study on the waste products or material which is easily available from the factories like Fly ash collect from thermal power plant and Molasses collect from the sugar factory.

Keywords: Soil Stabilization, Fly ash, Molasses, Liquid limit, Plastic limit, Permeability.

I. INTRODUCTION

In Transportation engineering the Sub grade is the last layer under the constructed road pavement or railway track, formation level is also the name of sub grade. It is mostly compacted before the construction of the road, railway track. If the bearing capacity of sub grade is low, by adding some modifier it can also be stabilized. The sub grade is the important layer of the road because all the layers of pavement lying over it and it can handle all the load of the moving vehicles so, if the foundation is good the road can bear heavy load of vehicles. It will also play an important role when the weathering condition is not good and also on adverse loading condition.

The formation of humps on road surfaces, rutting and corrugation are the failure because of less bearing capacity or load conceded of the sub grade soil. The soil sub grade is to be compacted by using vibratory rollers to attain good strength some other tests will also be performed related to check the load bear capacity of the soil is Plate Load test, CBR test etc. If the load carrying capacity of soil is good the depth of road pavement will be less and if the load (bearing capacity) is less thickness of pavement will be more. We always prefer to reduce the thickness of the pavement because it will direct result on the cost and time of the project. There are basic four layers of road pavement are shown below.

1.1 PERFORMANCE OF SUBGRADE:

The performance of the Sub grade basically depends upon the two main characteristics:

a) Bearing capacity of soil Sub grade in pavement design: It will able to procure the load that should be transmitted by the above road structure of the road pavement.

b) Volume Changes: The number of type of soils changes volume when exposed to dihydrogen monoxide in deplorable weather condition or freezing condition in some of the areas. The soil will shrink and swell depending upon the content and may be susceptible to the frost heave at freezing areas.

1.2 SOIL STABILIZATION TECHNIQUES:

Virtually weak soil subgrade should be eschewed but if number of cases it is indispensable to construct the pavement above the loose soil there are number of ways to amend the condition of the soil.

1.REMOVAL AND SUPERSESSION

2.STABILIZATION

3.ADDITION OF BASE LAYERS

1.3 OBJECTIVES OF STUDY:

The main research purpose of this project is to investigate the utilization of the admixture like Fly ash and Molasses. As we know this two Fly ash and Molasses is the waste product of the factories like Power Thermal Plant and Sugar factory so it is good to utilize the waste products which avail to making good road pavement. By this research we also calculate the quantity of mix of both Fly ash and Molasses needed for better capacity of soil. Due to this the strength or B.C. of the soil increases and the cost of the project decreases.

1.4 NEED OF THE STUDY:

1.Save Money: By research the strength or bearing capacity of the soil increased and then thickness of the pavement should be decreased and result of that the cost of the project decreased so save money of the project.

2.Save Time: less time needed to complete the less thickness of the pavement so we can save time of the project.

3.Save Design: As the thickness is less than the design is not complicated so easily prepared. Many of the layers may be skipped.

4.Save Waste: The waste that is released directly from the factories which is harmful to human beings is used for some good purpose is one of the best step for us and atmosphere also.

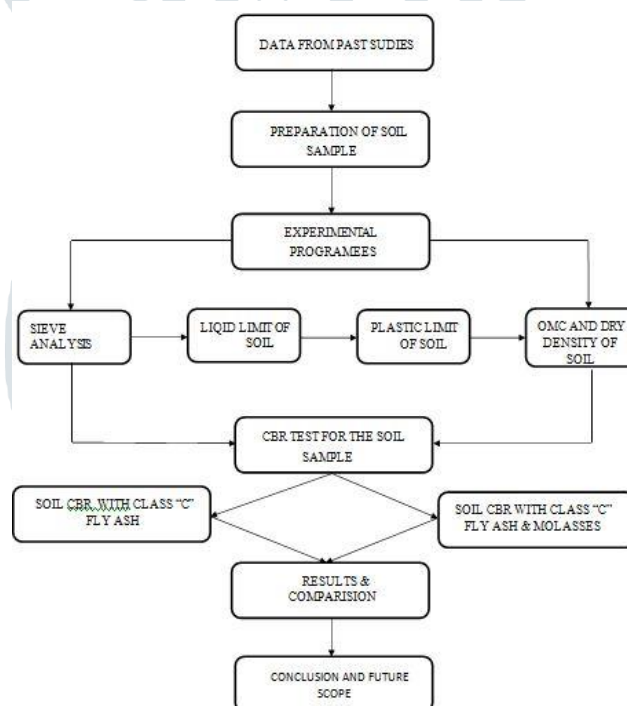
5.Save Land Fill Taxes: If we not use this waste in road work, this is to be stored in big containers or fill in land or pond and have to pay taxes to the government, so it save taxes also.

6.Save Environment: the Fly ash contains many harmful chemicals that is not good for our health, by putting into the ponds it may be mix in the air which is not good for us so by using it in road soil stabilization we also save our environment.

7.Benefits to Factories: As we use these two materials in stabilization of soil the company earn money from us but they formally put it into ponds or through outside so it is good for both user and company.

II. RESEARCH STUDY AND EXPERIMENTAL SETUP

METHODOLOGY



III. MATERIAL USED FOR STABILIZATION

3.1 FLY ASH:

Fly ash or Pulverized fuel ash, it is the coal product composition, is taken from the boiler with the fuel gases and fine particles. The coal ash is present at the underneath of the boiler is known as the bottom ash. In thermal power plant coal burning to generate electricity, the coal burned through the flue ash is removed along with the bottom ash from the boiler is also known as coal ash. The composition of fly ash depends on the quality of the coal, but generally all fly ash contains Silicon dioxide (SiO_2), Aluminum oxide, (Al_2O_3), and Calcium of the oxide (CaO), coal-bearing rocks mineral layers of the main board.

3.1.1 Class F Fly-ash:

This type of fly ash produces after the harder bituminous coal and produces F type fly ash. The cement like OPC cement, quick lime or hydraulic lime mixed with water, it reacts and produces a good cementing compound. We can also add some chemicals like sodium silicate to class F ash and geo polymer will be formed.

TABLE 3.1: Chemical composition of Class F fly ash

PROPERTY	ASTM C-618 REQUIREMENT
$\text{SiO}_2 + \text{Al}_2\text{O}_3 + \text{Fe}_2\text{O}_3$ (MINIMUM)	70.0 %
SO_3 (MAXIMUM)	5.00 %
MAXIMUM WATER CONTENT	2.90 %
MAXIMUM LOSS ON IGNITION	5.50 %

3.1.2 Class C Fly-ash:

The class C fly-ash is produced by burning of sub bituminous coal. It is the Pozzolan and also has self compacting properties. It with the presence of water shows the hardness and also stronger. It contains 20 percent of lime (CaO), the alkali and sulfate (SO₄) and it does not require any activator.

TABLE 3.2: Chemical composition of class “C” fly ash

PROPERTY	ASTM C-618 REQUIREMENT
SO ₃ (MAXIMUM)	5.00%
SiO ₂ + Al ₂ O ₃ + Fe ₂ O ₃ (MINIMUM)	50.00%
MAXIMUM MOISTURE CONTENT	2.90%
MAXIMUM LOSS ON IGNITION	5.50%

3.2 MOLASSES:

It is the product that is to be produced by the refining of the sugarcane or sugar beets into sugar. The quality of Molasses varies by the amount of sugar, methods of extraction and normal age of the plant. The primary use of Molasses for sweetening and flavoring of foods. It is also the main component of the fine commercial brown sugar. Different type of Molasses are as under:

3.2.1 Integral High Test Molasses: The juice of the sugarcane that is to be unclassified produces this type of molasses. This Molasses is called Integral high test Molasses because it is concentrated from the unclassified sugarcane and heavy incrustations and scum deposits that may leads to the frequent type of mill interruptions and that's why it should increases the maintenance cost of the factory.

3.2.2 High test Molasses: It is same in nature as compare to above Integral high test Molasses and at the time of manufacture it does not raise any type of problems as compare to Integral high test Molasses.

3.2.3 A Molasses: The another name of this type of Molasses is known as First Molasses and we get this after the first sugar crystal extraction from the first stage of processing in the manufacturing of the sugar in the factory. It contains 80-85% of DM.

3.2.4 B Molasses: The DM content is same as compare to A type Molasses and it is also called Second Molasses. The amount of sugar is less in this type and does not crystallize.

3.2.5 C Molasses: Another name of this Molasses is called Third Molasses because it is produced at the last in the processing of preparing sugar in the sugar factories. It contains 32-42% of Sucrose. This type of Molasses are Mostly are in Liquid or solid form and there is no choice to be crystallize.

3.2.6 Syrup Off: It is prepared by the Centrifugation of final refined masecuite in the factory of raw sugar. It is also known as Liquor type. Generally it is to be sent in the refinery of raw sugar here it is then again refined to produce more sucrose. It has 90-92 % DM which is very high. It is also the best source of monogenetic energy.

3.2.7 Refinery Final Molasses: It is produced by refined sugar extraction. The properties and composition is to be same as per C type and also it has to be stored same type of tanks.

TABLE 3.3: Chemical composition of Molasses

COMPONENTS	PERCENTAGE	COMPONENTS	PERCENTAGE
CALCIUM	21%	PHOSPHORUS	4%
IRON	36%	POTASSIUM	31%
MAGNESIUM	68%	SODIUM	2%
MANGANESE	73%	ZINC	2%

IV. RESULT AND DISCUSSION:

Table 4.1 Results of soil with molasses and fly-ash

Sample No.	Soil : molasses : fly-ash	MDD (g/cm ³)	OMC (%)
1	100:00:20	1.88	15.9
2	75:05:20	1.90	16.1
3	73:07:20	1.90	16.2
4	71:09:20	1.91	16.3
5	69:11:20	1.91	16.4
6	67:13:20	1.91	16.5

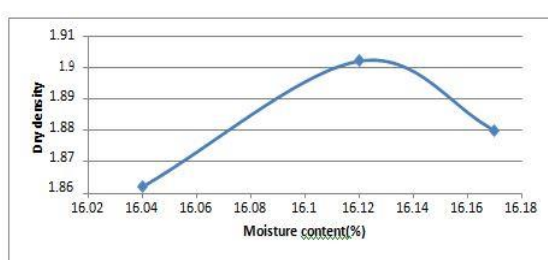


Fig. 4.1 : Soil with 5 % molasses and 20 % fly ash

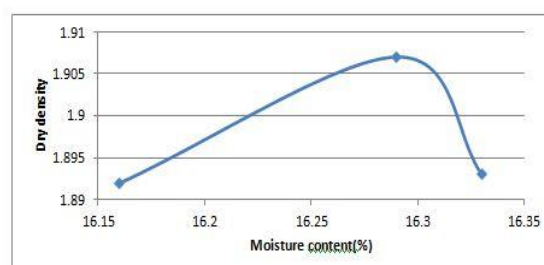


Fig. 4.2 : Soil with 7 % molasses and 20 % fly ash

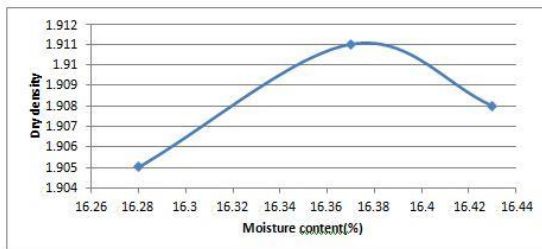


Fig. 4.3 : Soil with 9 % molasses and 20 % fly ash

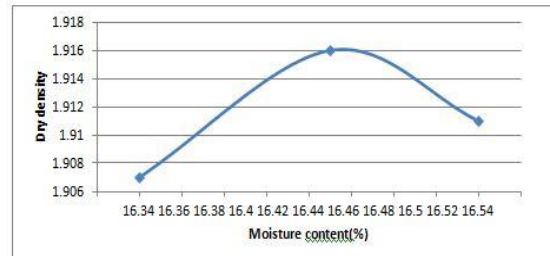


Fig. 4.4 : Soil with 11% molasses and 20% fly ash

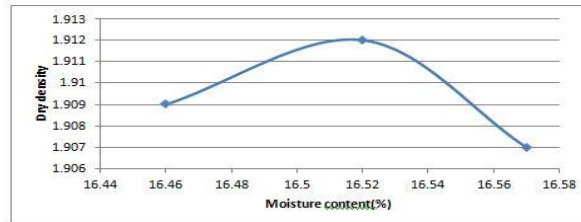


Fig. 4.5 : Soil with 13 % molasses and 20 % fly ash

Table 4.2: CBR of Soil with Class "C" fly ash

Sample No.	Soil : fly ash	CBR Un-soaked	CBR soaked
1	100:00	1.7	1.1
2	95:05	2.7	2.1
3	90:10	3.3	2.9
4	85:15	4.7	3.5
5	80:20	5.1	4.1
6	75:25	4.9	3.9

Table 4.3 : CBR of Soil with fly ash and molasses

Sample No.	Soil : flyash : molasses	CBR Un-soaked	CBR soaked
1	80:20:00	5.1	4.1
2	75:20:05	5.8	4.5
3	73:20:07	6.3	5.0
4	71:20:09	6.9	5.6
5	69:20:11	7.2	6.1
6	67:20:13	6.8	5.8

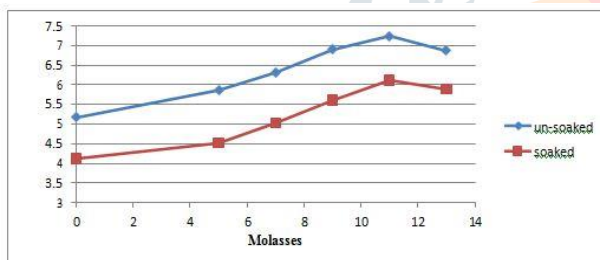


Fig. 4.6: CBR of soil with class C Fly-ash and Molasses

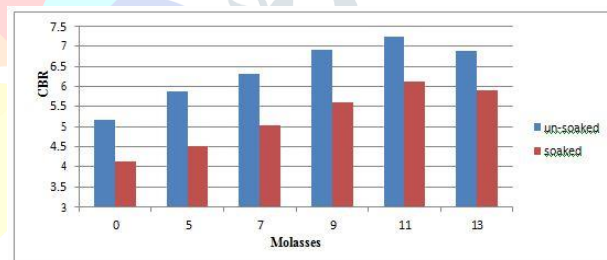


Fig. 4.7: CBR of soil with class C Fly ash and Molasses

V. CONCLUSION:

The poorly graded sand is not good for construction and that's why it needed some admixture to changing the properties of soil which give the good strength to attain the heavy load. After checking the results of different percentage of fly ash like 5%, 10%, 15%, 20%, 25% the better results of proctor test where maximum MDD is shown at 20% of fly ash when we mix it with soil. By adding the admixture like fly-ash and molasses the strength or load carrying capacity of the soil increases as shown in the above results, the CBR values increases when we add fly ash with soil from 1.17 to 5.17 in un-soaked condition and 1.17 to 4.12 in soaked condition.

Now I fix the fly ash at 20% and add molasses with the increment of 2% with soil and when we add the molasses with the soil the CBR will also increases from 5.17 to 6.87 in un-soaked condition and 4.12 to 5.89 in soaked condition. It will clearly show that by adding fly ash with molasses in soil the results is good and we use it in the sub grade layer in future for the construction of roads at places where the soil is poorly graded sand.

VI. FUTURE SCOPE:

As per this research the results is good by this we will improve the sub grade of road but for future we will use it in the above layers that is sub-base, base course, and surface course. We will also use the other materials with these two Fly ash and Molasses or individually and I think it will definitely increase strength of the soil. By improving strength of the soil it directly decrease the thickness of the pavement, when thickness reduces the cost will also reduce. There are many methods to calculate the thickness of the pavement like

1. US corps engineering method
2. California state highway method
3. IRC 37 1970
4. IRC 37 1984/2001
5. IRC 37 2012

With the help of this result we definitely prepare a good road.

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