STRENGTH IMPROVEMENT OF SUBGRADE USING MOLASSES AND FLY ASH

Submitted in partial fulfillment of the requirement for the award of the degree of

MASTER OF TECHNOLOGY

In

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By

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DECLARATION

I, Vinod kumar hereby declare that the project report entitled, **"STRENGTH IMPROVEMENT OF SUBGRADE USING MOLASSES AND FLY ASH**", is submitted in the partial fulfillment of the requirements for the award of degree of Master of Civil Engineering, in the school of Civil Engineering at Lovely professional University. This is my own work and the results are presented in this report. The material is not copied from any source or from any institution.

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Certified that this project report entitled **"STRENGTH IMPROVEMENT OF SUBGRADE USING MOLASSES AND FLY ASH",** submitted individually by **VINOD KUMAR** student of Civil Engineering, Lovely professional University carried out the work under my supervision for the award of degree. This report has not been submitted to any other university/institution for the award of any degree

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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. Subgrade 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 bearing capacity of the soil will be the main cause of the loose or failure of subgrade or pavement. But we can reduce 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.

Some of the other factors will be there in the unstable soil, it will create problem when we applied load and this will improve by adding some chemicals like Molasses and Fly Ash by mixing both in some percentage with soil. Stabilization of soil saves money, cutting, replacement of the soil etc. Soil stabilization improves the chemical, physical and mechanical properties of soil. By this report we will add the Molasses and Fly ash with soil and check the bearing capacity of soil and compare it with the locally available soil. The expected results that we get by mixing of fly ash and molasses with soil, this will decrease the liquid limit and plastic limit of soil, the amount of thickness of the pavement can also be studied by different methods of soil for flexible pavement and it will depend upon the California bearing ratio of the soil.

The study aim of this research is to improve 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 from thermal power plant and Molasses from the sugar factory. As the previous studies we will find by adding these two materials Molasses and Fly ash individually we get better results as compare with the locally available untreated soil. So I decide to add or mix the Fly ash and Molasses both together with soil in some percentage, expected outcome of this research is we will increase the bearing capacity of soil when we check the California bearing ratio of the soil.

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INTRODUCTION

1.1 GENERAL:

In Transportation engineering the Subgrade is the last layer under the constructed road pavement or railway track, formation level is also the name of subgrade. It is mostly compacted before the construction of the road, railway track. If the bearing capacity of subgrade is low, by adding some modifier it can also be stabilized. The subgrade 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 due to low bearing capacity of the subgrade soil. The subgrade is to b compacted by using vibratory rollers to attain good strength some other tests will also be performed related to check the bearing capacity of the soil is Plate Load test, California Bearing Ratio test etc. If the load bearing capacity of soil is good the thickness of 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 directly affect the cost and time of the project. There are basic four layers of road pavement are shown below:

FIGURE 1.1: Road Pavement layers

1.2 SUBGRADE PERFORMANCE:

The performance of the Subgrade basically depends upon the two main characteristics:

- **Bearing capacity of Subgrade:**

  The subgrade is the basic and important layer of the road pavement. It will able to attain the load that should be transmitted by the above road structure of the road pavement. The load bearing capacity generally related to the moisture present in the soil, type of the soil present and the degree and amount of compaction. The Subgrade is said to be good if the load bearing capacity of the subgrade is good as per testing like CBR, Plate load test etc.

- **Volume Changes:**

  Most of the soils changes volume when exposed to moisture in bad weather condition or freezing condition in some of the areas. The soil will shrink and swell depending upon the moisture content and may be susceptible to the frost heave at freezing areas. The change in volume of the soil may effect on the road and creating humps on the top of the road surface.

  Mostly on construction of the road poor subgrade should be avoided if possible.

  But generally there is some methods that can be used for treatment of the subgrade before construction of the road layers over subgrade are as under:

  - The loose or poor soil should be removed and replace it with good quality soil such that which has high bearing capacity as compare to the present soil.
  - Stabilization with the use of some types of binders which will directly increase the bearing capacity of the soil.
  - Additional base layer should be provided or we can divided subgrade into parts and provide compaction, these layer spread pavement load over a large subgrade area. But we not use this method, we mostly use above methods.

1.3 STABILIZATION TECHNIQUES:

Almost possibly poor sub grades should be avoided but if in some cases it is necessary to construct over the weak soil there are many techniques to improve the condition of the soil.

- **Removal and replacement** (over-excavation): It is one of the most expensive techniques to improve the soil condition. The weak sun grade soil can be excavated and can be filled by the soil having good quality and good strengthening properties
- **Stabilization**: Stabilization can be done by using cementing or asphaltic binders. Addition of these kinds of materials in the appropriate proportion may increase the sub grade performance and can reduce the swelling nature.
- **Addition of base layers**. Poor sub grade soils can be made acceptable by adding some base layers to take more load accordingly. These layers are useful spread the loads along the pavement in larger area of sub grade. This method may be taken a exceptional. Because, instead of designing more base layers it is easy to design a base layer with more thickness. This may satisfy the most equations in the design. However these equations are in the empirical part and are majorly avoided in many cases. as to say that the thick pavement structure over the weak sub grade may not make a good pavement.

1.4 OBJECTIVES OF THE STUDY:

The main objective of this research is to investigate the usage of the admixture like Molasses and Fly ash. 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 help to making good road pavement. By this research we also calculate the quantity of mix of both Fly ash and Molasses needed for better strength of soil. Due to this the capacity of the soil increases and the cost of the project decrease.

Delays in construction due to bad weathered conditions is to be controlled with the help of stabilization of soil and saving the time of the project which is also save the cost. The saving of time and cost is to be calculated by the code IS37-2012 and amount of material that is to be saved is also calculated.

By this research we will find the strength of soil by using different tests related to soil. From the previous researches we observe that by adding certain amount of Fly ash and Molasses individually some effect may note in the results that the strength of the soil increased in some extent and now we want to add the mixture of both Fly ash and Molasses and it will definitely increase the bearing capacity of the soil and our research is in positive way.

1.5 NEED OF THE STUDY:

The needs of this research are as under:

- Save Money: By research the bearing capacity of the soil increased and then thickness of the pavement should be decreased and automatically cost of the project decreased so save money of the project.
- Save Time: As the bearing capacity of the soil increased then the thickness decreased and less time needed to complete the less thickness of the pavement so we can save time of the project.
- Save Design: As the thickness is less than the design is not complicated so easily prepared. Many of the layers may be skipped. We can directly lay the bitumen over the compacted layer.
- Winter working: As the properties of the soil improves with the help of adding the admixtures like Fly ash and Molasses in the soil, the water absorbing properties will be more and stable in bad weather and provide good strength
- 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.
- 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.
- 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.
- 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.

1.6 SCOPE OF THE STUDY:

The main scope of this research is as under:

- It will reduce the plasticity index of the soil.
- It will reduce the water sensitivity of the soil.
- It will reduce the shrinkage factor of the soil.
- It will increase the water impermeability of the soil.
- It will increase the strength of soil.
- It will increase the load bearing capacity of the soil.
- It will increase the durability of the soil.
- The construction will be Eco-friendly.

CHAPTER-2

LITERATURE REVIEW

2.1 PAST STUDIES:

Mwanga and Eliafie wilson, 2015

The motive of this research is to analyzing the effect of molasses when we add or mix with the silt clay soil and used for construction purpose. This is to be conducted by making seven sample's which is to be collected from the pits and adding molasses of different percentage of 5%, 5.5 %, 6 %, 6.5% ,7 % and 7.5% and prepare the samples. These soil samples then tested for check the shear strength, the permeability and the compaction of the soil.

As we check the results by adding the molasses of 6.5% with the soil, the cohesion of the soil increases from 6.0 KN/m2 to 43.8 KN/m2 and it would also be decreased the angle of friction of the soil according to results from 22.1 degree to 8.6 degree.

The dry unit weight of the soil also increased from 18.5 KN/m3 to 19.40 KN/m3. Bulk unit weight of the soil should also be increased from 20.72 KN/m3 to 21.34 KN/m3. The optimum moisture content of the soil deceased from 12 % to 10 %. As we increase the percentage of the molasses the permeability of the soil also decreased from 6.062 x 10-5 mm pee second to 2.105 x 10-5 mm per second when we increase molasses up to 6 %.

Now all the result shown that the strength of the silt clay soil is increased hen we mix it with molasses at different percentage. From this it should be clear when we increase the percentage of molasses the strength will also increase. The tests give better results when we add 6.5 -7 % of molasses in silt soil. After that the trails on field should be mandatory but we get a better idea and behavior of silt soil from this research.

S Bhuvanshwari, R.G.Robinson and S.R.Gandhi, 2005

This paper is defined the study the behavior of fly ash using for the stabilization of the expensive soil in various percentage. It describes the methods of placing the materials in different layers of different thickness that is to be required. This should be operating with the help of disc harrow. It also takes the trail of having embankment of 30m, length by 6m and width by 0.6 m and constructed.

The test that is to be performed for this research is Grain Size Analysis, Atterberg Limits, Proctor Test, California Bearing Ratio Test, Permeability Test etc. The fly ash is added in different percentage like 10%, 20%, 40% and 50% with the expensive soil.

By adding the fly ash by 10% the water content decreases from 2.61% to 2.34%, dry density remains same as 18.04 KN/m3 and unconfined compressive strength increases from 2697 KN/m2 to 3533 KN/m2.

By adding the fly ash to 20% water content decreases from 2.34% to 2.22%, dry density decreases from 18.4 KN/m3 to 17.15 KN/m3 and unconfined compressive strength decreases from 3533 KN/m2 to 2850 KN/m2.

By adding the fly ash to 40% water content decreases from 2.22% to 1.80%, dry density decreases from 17.15 KN/m3 to 16.17 KN/m3 and unconfined compressive strength decreases from 2850 KN/m2 to 2160 KN/m2.

By adding the fly ash to 50% water content increases from 1.80% to 1.84%, dry density decreases from 16.17 KN/m3 to 15.13 KN/m3 and unconfined compressive strength decreases from 2160 KN/m2 to 1176 KN/m2.

The results of tests related to adding fly ash with expensive soil from the upper table shows hen we increase the fly ash from 0 to 10 % the unconfined compressive strength is increased from 2697 to 3533 KN/m2, Water content decreases from 2.61 to 2.34 %, Dry density remains same. It is good the strength of soil is increase. But for another percentage of fly ash it will decrease. The maximum increase in compressive strength only in the case of 10 % addition of fly ash and the water content decreases from first test to last test and dry density also. The graph will show firstly increase of the compressive strength then decreases.

Edrem o. Tastan, tuncer B. Edil and Craig h. Benson, 2011

The main objective of this research is to check the unconfined compressive strength of the organic soil when this soil is mixed with fly ash in some percentage. The three samples of organic soil and six samples of fly ash are to be taken. The Portland cement and some of silt that should be inorganic in nature are to be used as a stabilizer only for reference purpose. The fly ash is mixed with the three different percentages and with two different water contents.

The unconfined compressive strength of the concrete can be increased and it should be depend upon the type of the soil and also the type of fly ash and its characteristics. The mixture of soil was prepared with fly ash contents it should be based on the dry weight of both with some percentage of fly ash of 10%, 20% and 30%. The tests is conducted mostly on the wet condition, corresponding to the 6-14% of the optimum water content for the Lawson soil, 5-22% of the optimum water content for the Theresa soil and 5-18% of the optimum water content for the Markey peat. This very wet condition is taken as per taking the actual nature condition of the upper Midwestern of the United States. Additional test is conducted as per the standards for taking the values for proctor test. These tests are now to be conducted is to check the effect of water content. As the specimen is prepared for the testing at standard optimum moisture content with fly ash of 10%, 20% etc. the value of the compressive strength of the soil is different for different percentage of fly ash. The strength of the organic soil will increase with the increase in fly ash in to the soil. Positive soil strength results when we applying some kind of load over specimen.

Dr. R.e. Ravi, a.t. Manikandan and Animesh Sharma, 2015

The aim of this study is to improve the strength of the fine grained soil with the help of adding molasses in soil in certain amount; here we take two types of fine grained soil and check the California bearing capacity for both. In the result we will find the value of bearing capacity of the soil is increased and the value is increased with the increased the percentage of the molasses. The California bearing ratio is increased from 2 5% to 3.5 %.

The two types of clays used in this study are Intermediate Compressible Clay and High Compressible Clay.

In intermediate soil, first sample add the molasses of 5% with the intermediate soil the CBR value increases from 13.41% (un soaked) to 18.01% (3 days curing) at 6% of molasses CBR should be 13.48% in un soaked condition to 19.60% after three days curing.

In high compressible soil, the second first sample add the molasses of 9% with the intermediate soil the CBR value increases from 10.60% (un soaked) to 14.83% (3 days curing) at 10% of molasses CBR should be 10.76% in un soaked condition to 16.01% after three days curing.

By the results it is clear the use of molasses increased the unconfined compressive strength of the soil. Effect of molasses is more as per the results of the tests on Intermediate compressive soil as compare to High compressive soil.

From both of the cases of the soil there was the positive effects and the CBR value is increased after curing of three days and the CBR value decreased while we soak the sample.

Joel H.Beeghly, 2003

The objective of this study is to check the behavior of the mixture of both fly ash and lime together with the soil and use it to stabilize the subgrade soil, base and asphalt recycled purpose. The percentage 8% of lime is added with the soil and check the bearing capacity by CBR test and after that take the sample of 4% lime and 8% fly ash and mix it with the soil and also check the bearing capacity of the soil, this will show the better results and CBR value is more in second sample as compare to first sample.

Results after seven days curing having the minimum UCS of 600 psi. The mixture of both fly ash and the lime is show the low plasticity in soil that having higher silt contents. The combination of class F fly ash and the lime shows the better effects in compacting a wet soil by allowing the density which is maximum and to be achieved at higher moisture content.

From the both CBR penetration test and UCS test, three soil sample should be taken with moderate plasticity (Pi<20) and the silt content should be high (>50%) shows that the mixture of LFA can be achieve strength that is higher than the lime alone, even though the lime was use in the lime-only test. The capillary soaked results in a loss of 15-20% UCS. The bearing strength of the soil improves by adding the fly ash and lime as a mixture and it will save cost of the project.

Deok Hyun moon and Dimitris Dermatas, 2006

The main objective of this study to reduce the leaching of Pb and as by using fly ash. The S/S treated samples was used to evaluated in the study of semi-dynamic leaching test of release of AS and Pb . Identified the mechanism of the controlling the AS and Pb and the S/S treatment is then evaluated. The main significant factor to control the leaching is the amount of fly ash to be used. By adding of the 25% of the fly ash the 98.3% and 98.5% reduction is to be evaluated of AS and Pb respectively by S/S test.

By the guideline of the Environment Canada Waste water Technological center all S/S treated sample will be acceptable for controlled of utilization. The fly ash S/S treatment is very effected to reducing the leaching of AS and Pb. The fly ash plays very good role to control the leaching.

Dimitris Dermates and Xiaoguang Meng, 2003

The fly ash is added with the quick lime-sulfate S/S treatment of heavy metal the contaminated soil is mainly responsible for their effective immobilization. Due to the

presence of very large number of the heavy metals contamination along with the sulfates in the solid under the study and the results as per study can be used to the management of the incinerator and the fly ash, boiler slag, flue gas like desulfurization waste.

The addition of fly ash increase the Pb,Cr3+ and Cr6+ and immobilization pH and this would achieved by the absorption controlled immobilization capacity of solids that's is to be treated. The addition of the fly ash also results to improving of the stress-strain properties of the solid that is treated, therefore it would enable to reuse in construction purpose. The metal contaminant of high level of heavy metal contents re used, the presence of sulfates, gradation and pozzolanic content in our solid mixes is studied and enable the results presented in waste utilization scenarios to a wide variety.

Moreover the studies related to heavy metals are the highest concern related to the risk assessment of perspective. That is related to the radionuclides and mercury which are not to be expected, present in heavy quantity of such waste. The procedure for this study clear that the heavy metal is contaminated artificial soils then add the quicklime and fly ash with water, mix it and apply the proper compaction and cure. The strength test, durability test, swell test also conducted. The results show that when we use the fly ash with quick lime it improves the strength 1000 times as compare to untreated soil. The compressive strength is 6662.5 kPa without sulfate and when we take it with sulfates the compressive strength increases to 7219.7 kPa. Positive results related to the fly ash providing the strength to the soil.

Rajendra parsad hardaha, 2013

In this research he uses fly ash in black cotton soil to stabilize the road. The increase in CBR values while use fly ash in soil and dry density also increases. By adding the fly ash of 30% it will give the maximum values of CBR and dry density of the black cotton soil. The liquid limit is also decreases and reduces the swelling index of the soil.

Karthik.S, Ashok Kumar, 2014

The research is based upon the stabilization of the Red soil by using fly ash as admixture. As the results shown the California bearing ratio of the red soil increases and decreases the liquid limit of the soil. The CBR value is 4.82 and the thickness calculated for the pavement of A type traffic is 12 inches. At the addition of 6% of the fly ash the soil shows maximum CBR value.

Crag H.Benson, Lin Li

This report says that the monitoring data from a street of a city and the country road in which the cementious fly ash is used as 10% by weight in the sub base during the time ofreconstruction of the road.

.

Udeyshankra D.hakar

The motive of thi result is to stabilize the black cotton soil by using fly ash and while they use fly ash in soil the liquid limit and plastic limit of the soil is decreases and te shear strength of the soil is increased. The plastic index of the soil is also decreased and the shrinkage limit of the soil is increases, the unconfined compressive strength of the soil increases and the California bearing ratio also increases as per the report results,

Sai Darshan T R

On addition of any ash decreases the diffused double layer thickness of mixture and hence water holding capacity of soil mixtures decreases.

On addition of any ash the gradation of mixture is adversely affected which leads in reduction of dry density for higher content of ash.

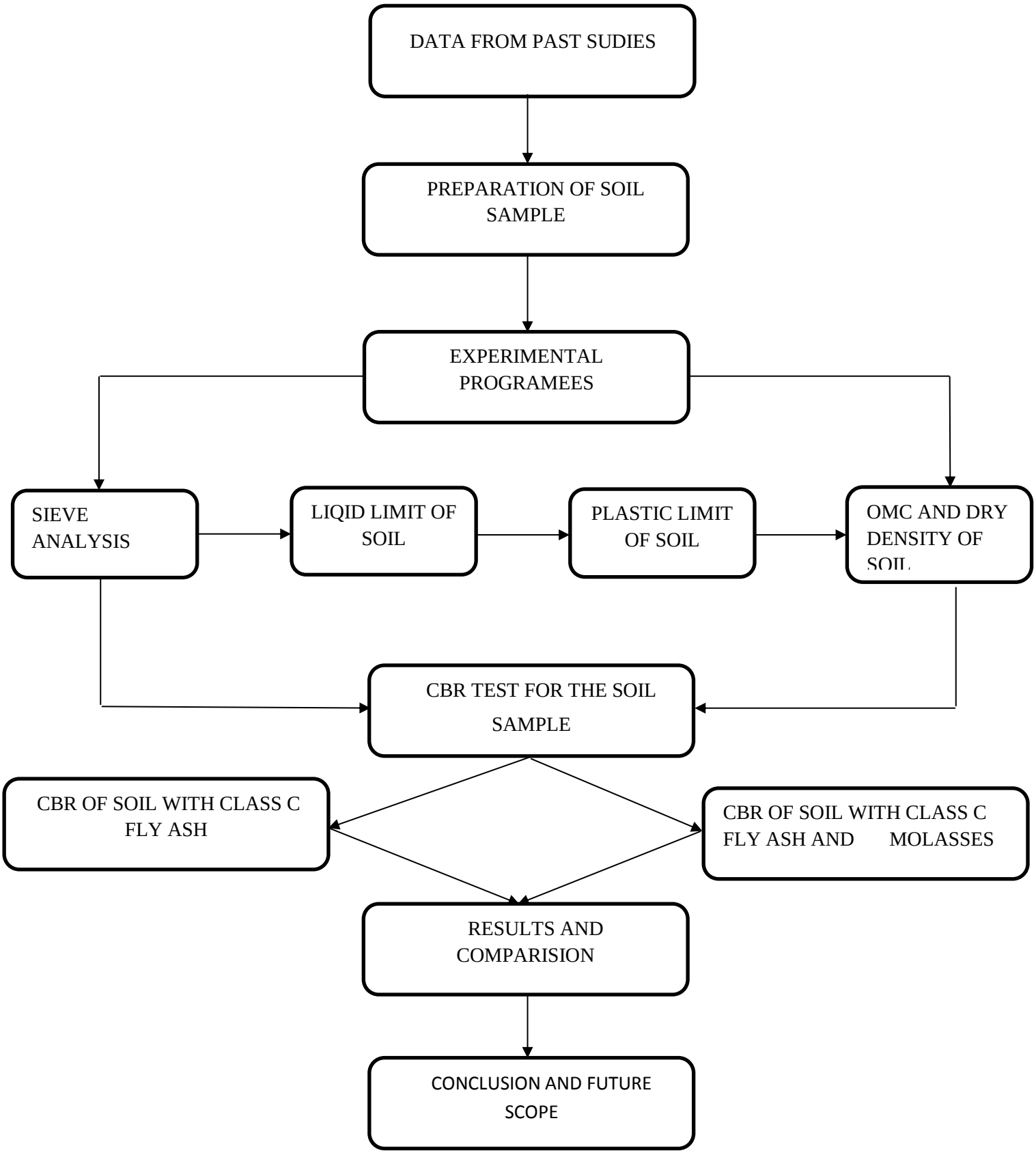
Fly ash can be used as a good stabilizer along with secondary additives.

Cement and lime imparts considerable strength in soil.

CHAPTER-3

RESESRCH METHODOLOGY AND EXPERIMENTAL SETUP

3.1 METHODOLOGY:



3.2 MATERIAL USED FOR STABALIZATION:

The materials that are used in this research work are as under:

3.2.1 FLY ASH:

Fly ash also known as Pulverized fuel ash in the United Kingdom, it is coal composition product, is taken out from the boiler with the flues gases and are fine in particles. The ash present at the bottom of the boiler is known as bottom ash. In thermal power plant the coal is burnt to generate electricity, coal is burnt through the chimneys the ash is removed together with the bottom ash of the boiler is known as coal ash. The composition of the fly ash depends upon the quality of the coal but generally all fly ash contains Silicon dioxide (SiO2), Aluminum oxide (Al2O3), and Calcium oxide (CaO), the coal bearing rocks strata is the main mineral compound.

In past the fly ash coal combustion was simply entrained in the flue gases and produces the fly ash and dispersed in the atmosphere. This is not good for environment and health. Throughout world 65 percent of the fly ash produces from the thermal power plant and is disposed in ash ponds and fill the land.

Now from few past years fly ash to be recycled due to increase in cost of landfills. In a report of United States Coal-fired power plant published in year 2005, shows that 71.1 million tons of fly ash is produced and out of it 29.1 million tons to be reused in various purposes. If the rest 42 million tons are unused, what we can do with that unused ash and also it require 27,500 acre ft area or 33900000 cubic meter area for placing t of this unused fly ash.

As per report in the year of 2006, 125 million tons of coal combustion products including fly ash were produced in U.S. every year and 43 percent of it will be used for commercial applications according to American coal ash association. In 2008, it would increase up to 50 percent as per the report published in year 2011.

Fly ash was generally released into the atmosphere and it causes the air pollution and requires special treatment to control the air pollution. So by reducing this problem we can use it in some of the places as per the above report 43 percent of fly ash is used in many of the good purposes and the remaining will be stored or Landfills. As the fly ash has pozzolans, so it can be used in hydraulic cement or hydraulic plaster or particle replacement of Portland cement

on production of concrete. Pozzolans decreases the setting time and protect the concrete from wet condition and chemical attacks.

There are two types of Fly ash:

- **Class F Fly ash:**

  This type of fly ash produces after the harder anthracite and bituminous coal and produces F type fly ash. This fly ash is pozzolanic in nature and it contains about 7 percent of lime (CaO).

  The cement like Portland 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.

FIGURE 3.1: Class F fly ash

TABLE 3.1: Chemical composition of class F fly ash

PROPERTY	ASTM C618 REQUIREMENT
Sio2 +Al2O+Fe2O3 (MIN.)	70 %
SO3 (MAX.)	5 %
MOISTURE CONTENT (MAX.)	3 %
LOSS ON IGNITION (MAX.)	6 %

- **Class C Fly ash:**

  The class C fly ash is produced by burning of Lignite or sub bituminous coal. It has 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.

  An announcement by the United States manufacturer that a fly ash brick contains 50 percent of class C fly ash. Testing results will shows the brick meet or exceeds and the performance in standard and is listed in ASTMC 216 for clay brick that is conventional. It should also be shown for concrete bricks in ASTMC 55 in shrinkage limit and standard for concrete building bricks. It is estimated the method for production of fly ash bricks is reduced the embodied energy up to 90 percent for masonry construction. Before the 2009 end bricks and pavers are expected to available in commercial quantities.

FIGURE 3.2: Class C fly ash

The c class fly ash is used in this research and results will show the properties and strength with soil and molasses below at the result part.

TABLE 3.2: Chemical composition of class C fly ash

PROPERTY	ASTM C618 REQUIREMENT
Sio2 +Al2O+Fe2O3 (MIN.)	50 %
SO3 (MAX.)	5 %
MOISTURE CONTENT (MAX.)	3 %
LOSS ON IGNITION (MAX.)	6 %

TABLE 3.3: General composition of fly ash

Component	Bituminous	Sub-Bituminous	Lignite
SiO2 (%)	20-60	40-60	15-45
Al2O3 (%)	5-35	20-30	20-25
Fe2O3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOl (%)	0-15	0-3	0-5

3.2.2 ENVIRONMENT PROBLEMS:

The yearly production of fly ash by 460 Coal-Fired Plant is 131 million tons in united states. In year 2008 a survey should be estimated, 43 percent of the fly ash is reused. The fly ash is made up of coal and this coal contains Boron, Arsenic, Thallium, Mercury, Cadmium, Selenium, Beryllium, Chromium and the fly ash is obtained after the combustion of this coal and it will spread directly pollution in the atmosphere and water. A special awareness should be needed and the new treatments also. In United states of America the fly ash should be placed in the pit by protecting the walls of the pits and ensure that it may not be polluting the ground water.

In 2014,North Carolina, persons living near the Buck Steam station in Duke Ville, told that the pit of coal ash near to his home leaching dangerous material and pollute the ground water.

The fly ash is stored under pit in bulk and usually stored in wet condition to minimize the dust. But sometimes the pond of fly ash may effect to the nearby buildings.

In 2008, the embankment is collapsed where the wet fly ash should be stored and tree houses was damaged and flowing into the Emory river and this fly ash was stored in the pit by Tennessee Valley authority's Kingston Fossil Plant . This plant caused a major release of 5.4 million cubic yards of coal fly ash. The cleanup cost after the leaching is $1.2 billion.

In 2014, Ten thousand tons of fly ash should be spilled into the Dan River in North Carolina near den and this is released by the Coal- Fired Plant of Duke Energy. It is the third big coal ash spill in United States. For a week a 120 cm pipe spilled arsenic into the river and was successfully plugged by company Duke Energy. The authority of United States Federal Government plans is to investigate and warns the peoples along the river to stay away from the river water. New rules are to be published by Federal Government on 19 December 2015 for disposal and safe storage of fly ash or coal ash and strict guideline to it is provided. The design of the pound failure should be reviewed and make new design and protection for ground water, records of areas and inspection is included in this new rule.

3.2.3 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.

In United States, sweet sorghum syrup are called sorghum Molasses. The similar products include Honey, Invent syrup, Trade, Maple syrup etc. and these syrups are in the milder flavor mostly.

The procedure of making of the Molasses, Sugarcane is harvested from the field by the farmers and leaves are stripped out. After take it to the sugar factory by loading over the trucks. the juice of the sugarcane is extracted by cutting, crushing or mashing. The juice of the sugarcane is then boiled to concentrate and have to promote sugar crystallization. The

result that is come after first boiling of the juice is called "First Syrup" and the sugar content is very high quantity in it. The other name of the first syrup in Southern United State is "Cane Syrup" as opposite to Molasses. The second Molasses is produced by the boiling of the sugar cane and sugar extraction. Cane sugar is now obtained after evaporation, crystallization and from centrifugation. From the process of sugar extraction and the second sugar refining the Molasses are to be made and the output of the processes specifies the type of Molasses.

FIGURE 3.3: Liquid Molasses

In 1965, Perez has to be described different type of Molasses are as under:

- **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.

- **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.

- **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 sugar factory. This Molasses contains 80-85 % of DM. It should be inverted at the time of storage to prevent from crystallization

  .

- **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.

- **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.

- **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.

- **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.

The Molasses that is to be produced with the help of sugarcane is used in alcohol production and also for the feeding of the animals it can be used. The 60 Million Tons of sugarcane and molasses is produced in all over the world by the report that is published in year 2007 and 15.8 million tons are feed as livestock. It can be produced mostly in countries like India, Pakistan, Brazil, Indonesia Australia, Mexico, United States, Russia, Thailand and China. It is the basic need of every country now days. The plantation is easy and the farmers get good profit.

TABLE 3.4: Chemical composition of Molasses

COMPONENTS	PERCENTAGE
CALCIUM	21 %
IRON	36 %
MAGNESIUM	68 %
MANGANESE	73 %
PHOSPHORUS	4 %
POTASSIUM	31 %
SODIUM	2 %
ZINC	3 %

3.3 EXPERIMENTS / TESTS TO BE CONDUCTED:

- **Collection of soil from site**
- **Sieve analysis**
- **Liquid limit**
- **Plastic limit**
- **California bearing ratio test**

3.3.1 COLLECTION OF SOIL FROM SITE:

The soil that is used for testing is collected from the site and after that all the tests will performed below to check the strength and other properties

Figure 3.4: collection of soil from LPU site

- **3.3.2 Sieve analysis:**

  To know the classification of soil sieve analysis should be conducted on that particular soil. The sizes of the sieves are taken from 0.75mm to 4.75mm and these sieves should be arranged in the ascending order. While conducting the test most important point to be considered is the percentage loss should not be more than 2%. The process of sieving starts by placing the sample of 1kg in top panel. This process should be done 15 to 18 minutes. Note the values of soil remained in each sieve and calculate the total percentage of loss.

FIGURE 3.5 Different Sieves

Take the is sieves and place them in increasing order from bottom to top i.e.0.75, 0.009, 0.212, 0.425, 1, 2, and4.75.the point to be remember while performing the test is that the percentage loss should not be exceeding 2%.after that the soil that has to be tested should bring from the site to the lab for experimentation. Take soil of 1kg place it on the top pan and start the process of sieving for 15-18 minutes. Note the values of the soil that is passing from the each sieve and the soil that has retained on the each sieve. From the noted valves calculate the percentage of passing and percentage of retained on the each sieve.

FIGURE 3.6 Sieve analysis of soil

After calculating the percentages of total loss will be obtained. For this the percentage of loss is0.8 the valve less than the 2.so we can continue to the further process that is soil classification.

- First look the .075 in which passing is less than 50% so it is coarse grain soil.
- Percentage of passing through the sieve size 4.75 mm is greater than 50% so it is sand.
- In third step looks the sieve size .075mm in which fines is greater < 5% so it is having
- Calculate the C_u and C_c values from the below log graph.
- Log is used because sizes of particles are accurately denoted.
- From the graph D_{10}=0.1, D_{30}=0.16, D_{60}=0.33 are known.

  $C_u = D_{60}/D_{10}$

  $=0.33/0.1 \quad = 3.3$ mm

  $C_c = (D_{30})^2 / (D_{10} * D_{60})$

  $= 0.78$ mm

- This satisfied the both the conditions of poorly graded sand

  $C_u < 6$ and/or $1 > C_c > 3$

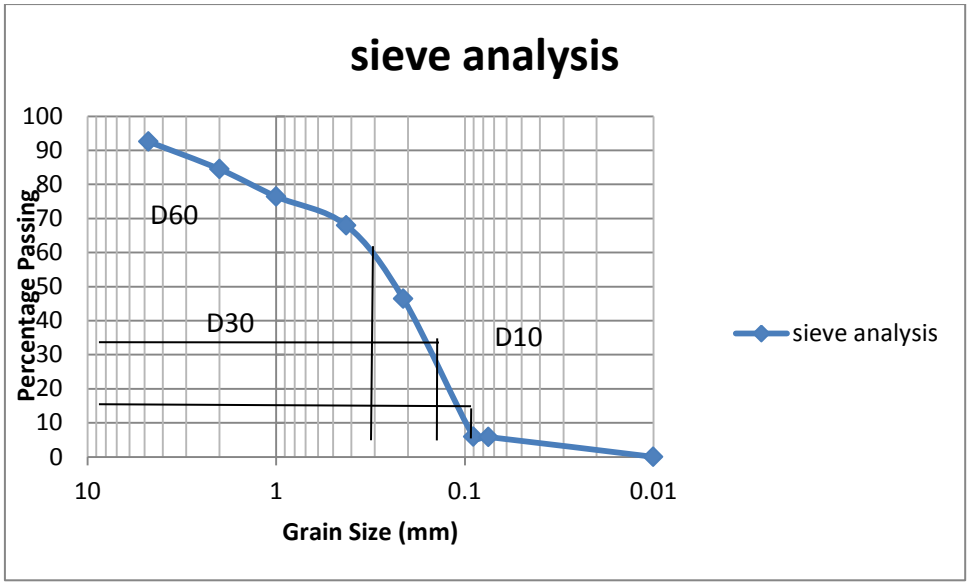


FIGURE 3.7 Sieve analysis semi log graph to effective size values

Finally is has concluded that the soil is poorly graded sand.

- **3.3.3 Liquid limit:**

  Liquid limit is defined as the moisture content of the soil at the stage when the soil starts flowing with liquid amenity. At this stage soil totally behaves like a liquid material. This test is done to know the moisture content of the particular selected soil sample. This test is conducted with the help of casagrande apparatus. This is particularly made to perform the liquid limit test. The liquid limit can be determined by the determination of atterberg limits. These limits are the basic things to measure for the soil sample. Dry clayey soil absorbs more water compared to wet clayey soil. First check the device to ensure that it was clean and working order. A soil sample of is prepared by sieving the soil in 0.425mm sieve take 120gm of it in dish. Add some distilled water tom the sample and mix it thoroughly to from a uniform paste with the help of spatula. Then soil become clay and left it for 20min to ensure uniform master distribution. Now place a portion of paste in the cup of liquid limit device and squeeze down and spread the paste in the cup with spatula. Trim the soil at the top so that the maximum depth of soil in the cup is 1cm.Now use the casagrades tool to groove the soil if it is clay and if it is sandy use ASTM type grooving tool. Now lift and drop the cup by rotating handle at the rate of two revolutions per second ill the two half's of the soil cake come in contact by flowing not by sliding with the bottom of the group along the distance about 12mm.count the number of blows required for the process

and note in table. Ensure that the number of blows should be 15to 34. From the float portion take a representative of the soil using spatula in sample container of known weight. Ensure that spatula cuts the soil across the right angle to the group. Repent the experiment with different water contents that is dryer to water conditions of the soil and record the various observations.

After taking various samples place these samples in the oven for drying tov24hours. After on day weight the samples and note the values in the table. Then calculate the

moisture content of the soil in particular number of blows. Plot the graph between moisture content and number of blows on a semi log graph. The moisture content corresponding to the 25 blows from the flow curve is the liquid limit of the soil.

Calculation:

Water content= [(W1-W2/W2-W0)*100%].

W0 = Weight of container.

W1 = Weight of container+ wet soil.

W2 = Weight of container+ oven dry soil.

W1 -W2 = Weight of water.

W2 –W0 = Weight of oven- dry soil

Result: The obtained liquid limit of the normal soil is 24

Figure 3.8: Liquid Limit Testing

- **3.3.4 Plastic limit:**

  Plastic limit of the soil is one of the most commonly determined atterberg limits along with the liquid limit. Plastic limit of the soil can be determined by making soil sample into the form of threads by mixing it with some content of water. While making the soil as thread by rolling, at some point threads began to crumble. The point where the soil thread gets crumble is considered as plastic limit of the soil sample.

  Plastic limit is the water content at which the soil just begins to crumble when rolled into a thread approximately 3mm in diameter. The 50gm soil sample is taken which is sieved in 0.425mm sieve. Now add distill water to the soil sample mix it thoroughly so that the soil mass is plastic enough to be easily molded.

  Plastic limit is the water content at which the soil just begins to crumble when rolled into a thread approximately 3mm in diameter. The 50gm soil sample is taken which is sieved in 0.425mm sieve. Now add distill water to the soil sample mix it thoroughly so that the soil mass is plastic enough to be easily molded. Now prepare a ball from the soil mass of 8 gm and place it on the glass plate and roll it with the figures so that a thread of uniform diameter is formed. The rate of rolling should be 80to90 stalks per minute and continue the rolling until thread reaches to 3mm by taking the reference of the metallic rod. Then collect crumble pieces of soil thread in a container and weight them and determine the moisture content. Repeat the process two more times and record the values.

After this take the sample and put in the oven and calculate the moisture content

FIGURE 3.9 Rolled soil sample

- **3.2.5 STANDARD PROCTOR TEST:**

Compaction is a process where the soil particles are artificially rearranged and joined together in to close state of contact by mechanical means in order to decrease the quantity of void ratio and it will increase the dry density of the soil. The process of compaction can be performed by tamping, rolling and vibrating depending upon the type of soil.in this process we can find out the dry density and optimum water content of soil using light compaction as per IS:2720 part 7.

The equipment required for the test is compaction collar, mould, , weighing machine, water, , detachable plate, metal rammer and oven, weight of rammer is 2.6kg and for preparing sample take the soil 2.5 kg and for sandy soil the water content of soil is 4% and if it is clayey then water content is 8%. First clean the mould and apply oil or grease to avoid the sticky ness of soil in the mould. Take mould weight without collar attached to it. Put the soil into the mould in three layers and compact every layer with the rammer in 25 blows and having a free fall from height of 36cm. Now after completing three layers remove the collar and trim off the excess soil projecting on the top of the mould using the straight edge. Take again the weight of the mould with thesoil that is to be compacted with the heip of rammer and note the values. Now remove the soil from inside the mould by using the tool and take the sample of the soil from the middle portion of the mould in to a container for check the water quantity determination.

The dry density of the soil can be determined by using the formula is shown below:

$$\gamma_d = \gamma_b / (1 + w)$$

$\gamma_d = Dry\ density$

$\gamma_b = Bulk\ density$

$w = water\ content$

Figure 3.10: Proctor Testing

- **3.3.6 CALIFORNIA BEARING RATIO TEST:**

  This test is conducted to know the bearing capacity of the selected soil sample. This is the best way to know about the soil or subgrade performance. CBR test is conducted to the soil at two different conditions. One is wet state and the other is totally dry state. Thus we can be able to know about the soil capacity in its optimum moisture content state and the dry state. This helps us to stabilize the soil by treating it with some additives in a particular manner that the soil can achieve the requirements of the pavement to be constructed. We should be more care towards the apparatus while conducting the test. The values of CBR should be noted and according to those values

stabilization will be done. Higher the value of CBR lowers the thickness of subgrade or pavement.

To perform the test the apparatus as per IS: 2720 comprises of mold with internal diameter150mm and height of 175mm with the detachable collar and detachable base plate having perforations at the bottom. A spacer disc of 148mm diameter and a height of 47.7mm.the surcharge weights having central hole of 2.5kg and a plunger with 15mmdia and 100mm height.

A loading machine of 5000kg and capable of travelling vertically of 1.25mm per minute.

The test consists of two parts there are preparing test specimen and penetration test.

Penetration test specimen: the specimen can be prepared by dynamic compaction and static compaction. In static compaction the load applied gradually and in dynamic compaction the load is applied by hammering. The dynamic compaction can be prepared by the light compaction or heavy compaction. In light compaction the specimen prepared in three layers the hammer used is 2.6kg with a free fall of 30cm with 56blows to each layer. Various in the heavy compaction the specimen prepared in five layers the hammer used is 4.89kg with a free fall of 45cm with 75blows to each layer. Let us see the hoe dynamically compacted specimen is prepared to assemble the mold space the spacer disc with threaded hole side at the bottom of base plate and filter paper top on it and apply lubricating liquid at inner side of the mold to prevent the sticking of the soil also fix the color and tight the clamps. Now take the 5kg of soil passing from the20mm sieve and mix with the predetermined quantity of the water such that the water content of the soil is equal to OMC or equal to the field moisture content.

Mix the water and soil thoroughly so has to prepare the uniform consistency. Transfer the soil in to the mold and fill such that after compaction the layer is about 1/3rd. or1/5th of the total thickness case may be .now compact soil with suitable number of blows as stated above. After compaction of the soil scratch on the top surface of the layer and add more soil and compact in similar manner for second layer .repeat the same process for top layer also and remove the color and trim the top of the surface also remove the base plate and filter paper. Remove the spacer disc and place the filter paper at the bottom place the mold such that the compacted surface at the bottom. Place the assembly on the pedestal of the loading machine to fix the plunger and bring

the plunger in contact with the soil sample and apply seating load of 4kg this is to establish the good contact between soil and plunger.

Now add other 2.5kg slotted weight at the top and set dial readings zero allow the plunger to penetrate at rate of 1.25mm per minute. Note down the readings on proving ring corresponding to a penetration of 0.5, 1.0, 1.5, 1.5, 2.0, 4.0, 5.0 7.5, 10.0, and12.5.somestimes the CBR curve may exhibit a concavity in the beginning in which case the correction is to be applied. From the curve determine the load corresponding to 2.5mm and 5.0mm penetration and compute CBR valve based of below formula

$$\text{CBR, \%} = \frac{\text{Load or pressure sustained by specimen at2.5 or 5.0mm penetration} \quad *100}{\text{Load or pressure sustained by standard aggregates at the corresponding}}$$




FIGURE 3.11: CBR testing

CHAPTER-4

RESULT AND DISCUSSION

4.1 SIEVE ANALYSIS RESULTS:

- By performing the sieve analysis it is known that he soil sample taken is poorly graded sand.
- By performing the liquid limit analysis it is known that he soil sample contains 24% of the moisture content.
- By performing the plastic limit analysis it is known that the plastic for the sandy soils are not able to prove because the sample breaks when it is rolled.so the soil ha non-plastic properties.
- Result of sieve analysis

Table 4.1 Sieve Analysis

Sieve sizes (mm)	mass retained in each sieve(grams)	% retained	% passing
4.75	77	7.854985	92.14502
2	82	8.056395	84.08862
1	81	8.257805	75.83082
0.425	84	8.459215	67.3716
0.212	214	21.55086	45.82075
0.09	405	40.7855	5.035247
0.075	1	0.100705	4.934542

Finally we concluded that the soil is poorly graded sand.

4.2 LIQUID LIMIT RESULTS:

Table 4.2 Liquid Limit for Normal soil

Wet weight of soil(w1)	Dry weight of soil(w2)	Wet weight of soil-dry weight of soil(w1-w2)	weight of water/dry weight of soil	Moisture content (%)	Blows count
26	22	4	0.18	18.18	36
96	78	18	0.23	23.07	29
30	24	6	0.25	25	19

Liquid limit of normal is 24

4.3 STANDARD PROCTOR RESULTS:

Dry density and OMC of the normal soil is represented below for different water proportions
Fig 4.1 Dry density vs moisture content for the normal soil

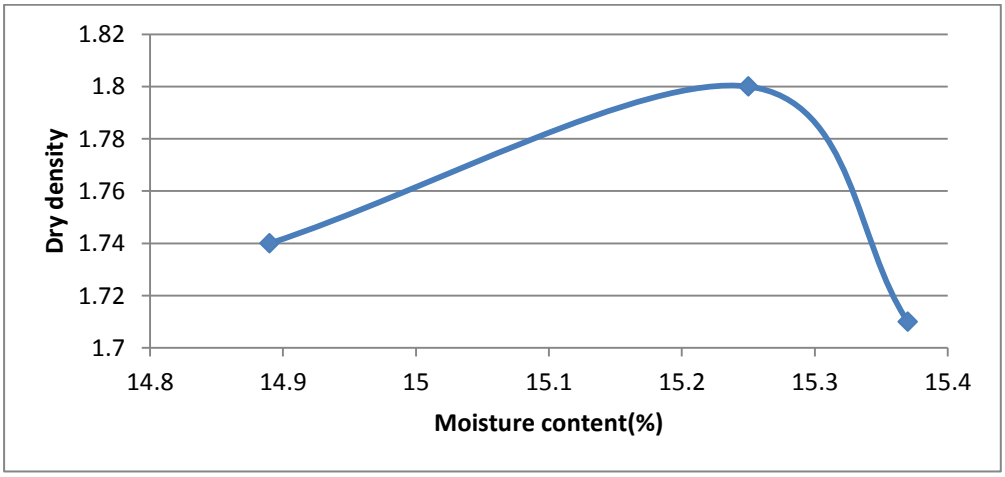


Figure 4.1: Normal Soil Proctor Results

The graph is plotted between moisture content on X-axis and dry density on y-axis as shown in figure above for the normal soil and the maximum optimum moisture content is 15.25 at dry density of 1.8 g/cm3.

Table 4.3: Proctor results of Soil with Fly ash results

Sample no.	Proportion Soil : Fly ash	MDD (g/cm3)	OMC (%)
1	100:0	1.800	15.25
2	95:5	1.860	15.29
3	90:10	1.877	15.32
4	85:15	1.882	15.73
5	80:20	1.889	15.95
6	75:25	1.875	16.02

From the results it will clear that at 20% fly ash the dry density is 1.889 g/cm3 with omc 15.95 %. The graphs of all the above values shown the dry density and omc below.

Graphs of soil with Fly ash:

In the graph below in fig 4.2 when we add the fly ash 5% by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.86 g/cm3 and the moisture content is 15.29% on x-axis. This value is the maximum value according to the graph when we take the different samples.

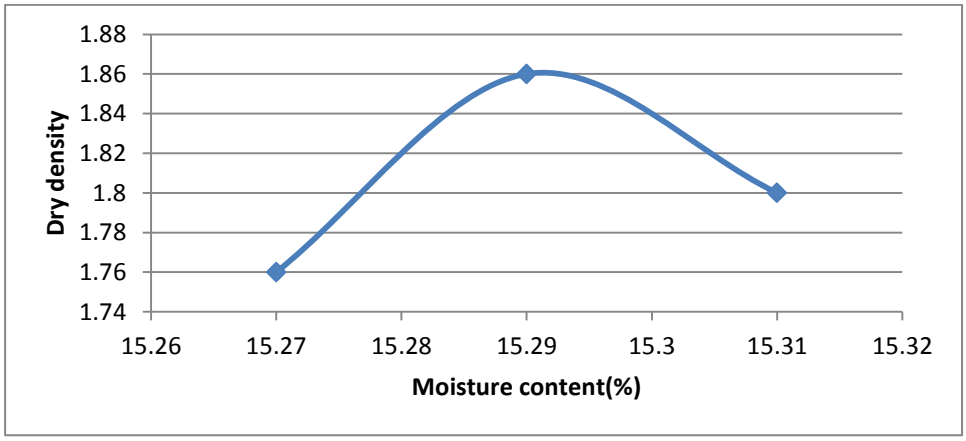


Figure 4.2: Soil with 5% fly ash

In the graph below in fig.4.3 when we add the fly ash 10% by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.877 g/cm3 and the moisture content is 15.32% on x-axis. This value is the maximum value according to the graph when we take the different samples.

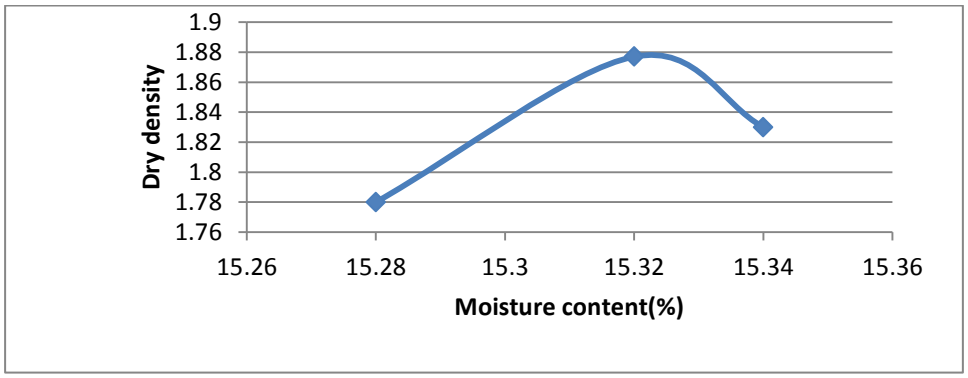


Figure 4.3: Soil with 10 % fly ash

In the graph in fig 4.4 below when we add the fly ash 15% by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.882 g/cm3 and the moisture content is 15.73% on x-axis. This value is the maximum value according to the graph when we take the different samples.

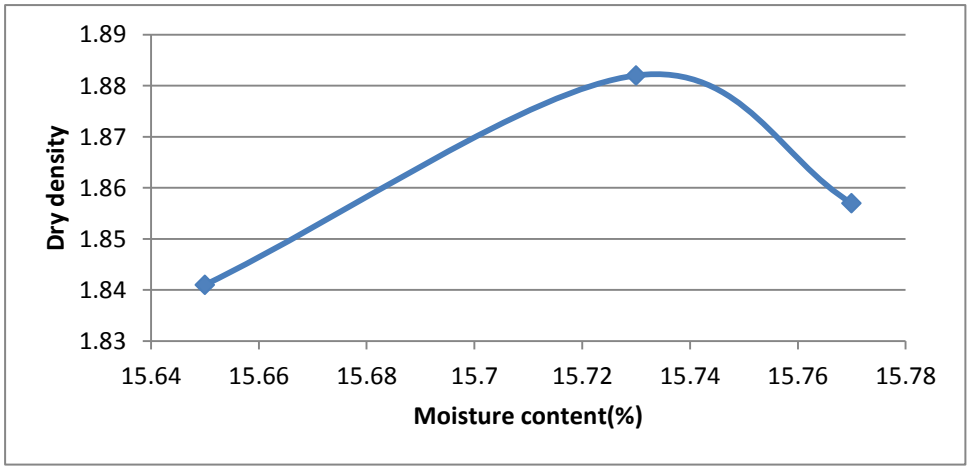


Figure 4.4: Soil with 15% Fly ash

In the graph fig 4.5 below when we add the fly ash 20% by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.889 g/cm3 and the moisture content is 15.95% on x-axis. This value is the maximum value according to the graph when we take the different samples.

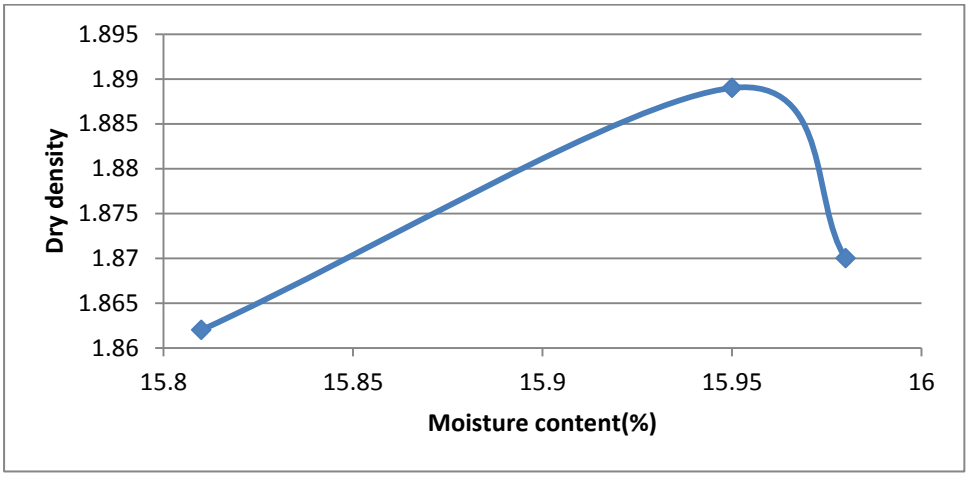


Figure 4.5: Soil with 20% Fly ash

In the graph fig .6below when we add the fly ash 25% by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.875 g/cm3 and the moisture content is 16.02% on x-axis. This value is the maximum value according to the graph when we take the different samples.

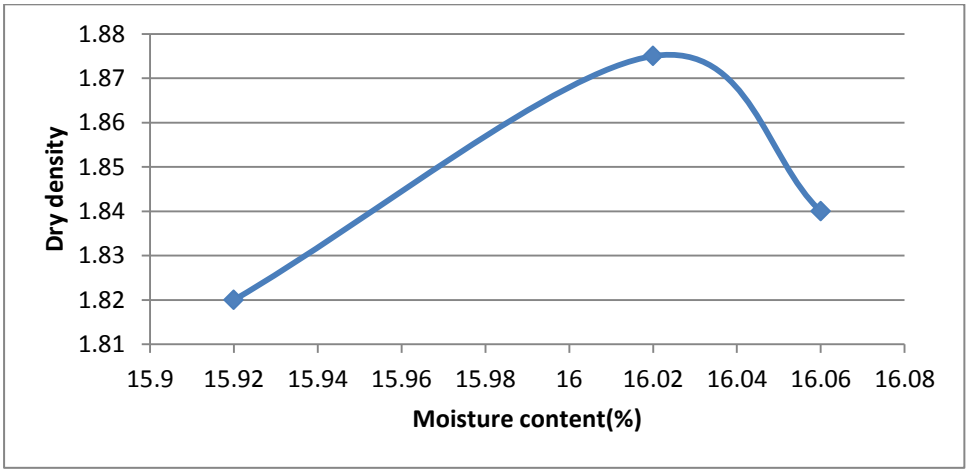


Figure 4.6: Soil with 25% Fly ash

As the above results the dry density of soil is maximum at 20% fly ash when we add with soil and now I fix the fly ash at 20% and perform the tests with molasses of different proportion and the procedure is same as per above tests.

Table 4.4 Results of soil with molasses and fly ash:

Sample no.	Soil:molasses :fly ash	MDD	OMC
1	100:0:20	1.889	15.95
2	75:05:20	1.902	16.12
3	73:07:20	1.907	16.29
4	71:09:20	1.911	16.37
5	69:11:20	1.916	16.45
6	67:13:20	1.912	16.52

By adding 11% molasses with 20% fly ash the MDD is max. The results of above values are plotted in the graphs below:

Graphs for soil with molasses and fly ash:

In the graph figure 4.7 below when we add the fly ash 5% molasses and 20% fly ash by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.902 g/cm3 and the moisture content is 16.12% on x-axis. This value is the maximum value according to the graph when we take the different samples.

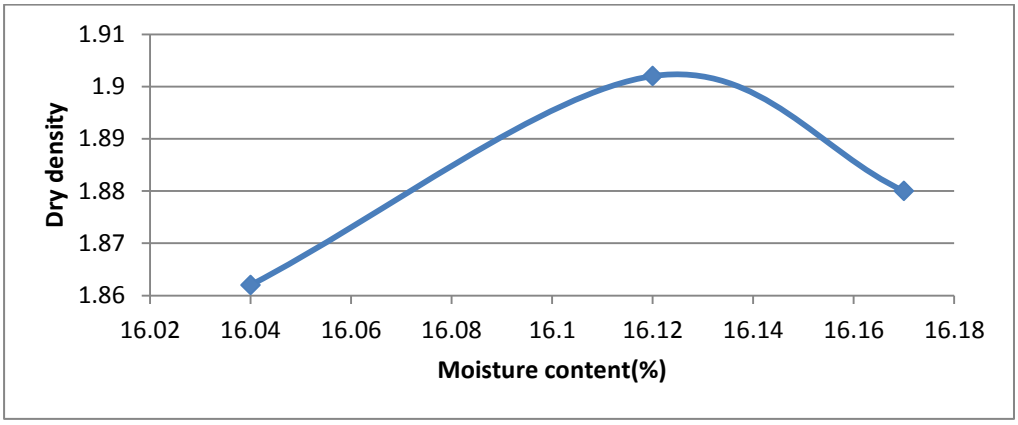


Figure 4.7: Soil with 5% molasses and 20% fly ash

In the graph figure 4.8 below when we add the fly ash 7% molasses and 20% fly ash by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.907 g/cm3 and the moisture content is 16.29% on x-axis. This value is the maximum value according to the graph when we take the different samples.

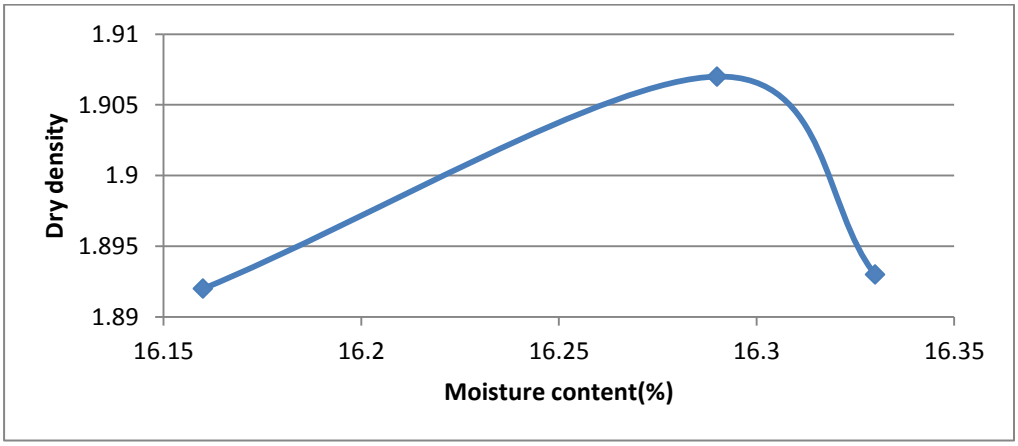


Figure 4.8: Soil with 7% molasses and 20% fly ash

In the graph figure 4.9 below when we add the fly ash 9% molasses and 20% fly ash by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.9011 g/cm3 and the moisture content is 16.37% on x-axis. This value is the maximum value according to the graph when we take the different samples.

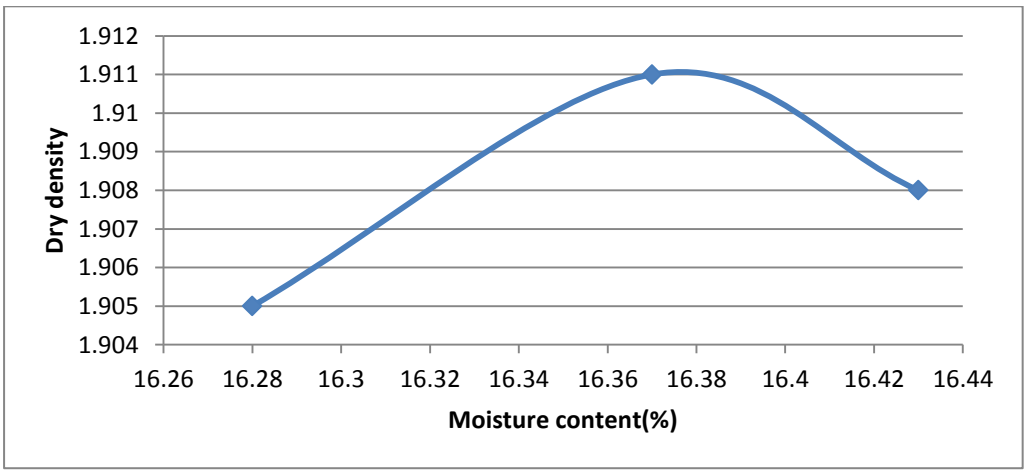


Figure 4.9: Soil with 9% molasses and 20% fly ash

In the graph figure 4.7 below when we add the fly ash 11% molasses and 20% fly ash by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.916 g/cm3 and the moisture content is 16.45% on x-axis. This value is the maximum value according to the graph when we take the different samples.

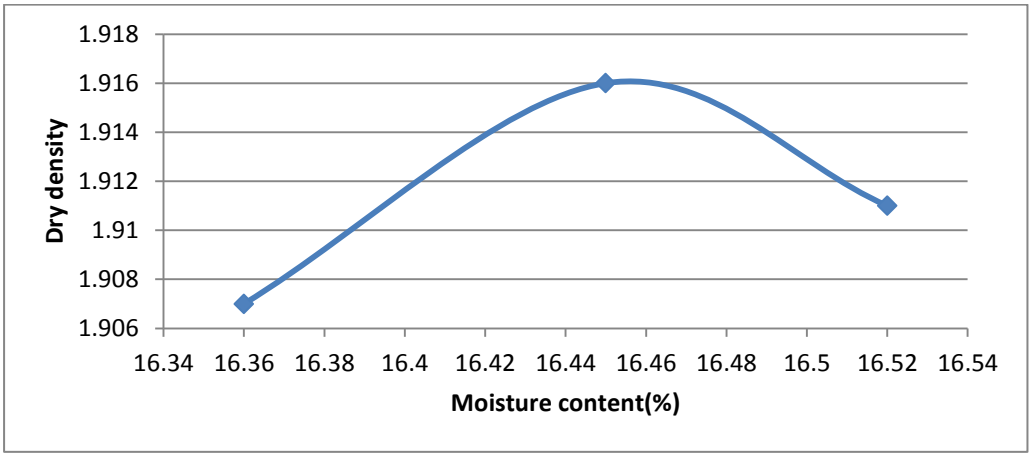


Figure 4.10: Soil with 11% molasses and 20% fly ash

In the graph figure 4.7 below when we add the fly ash 13% molasses and 20% fly ash by weight with soil to perform the proctor test and the dry density that is show on y-axis is 1.912 g/cm3 and the moisture content is 16.52% on x-axis. This value is the maximum value according to the graph when we take the different samples.

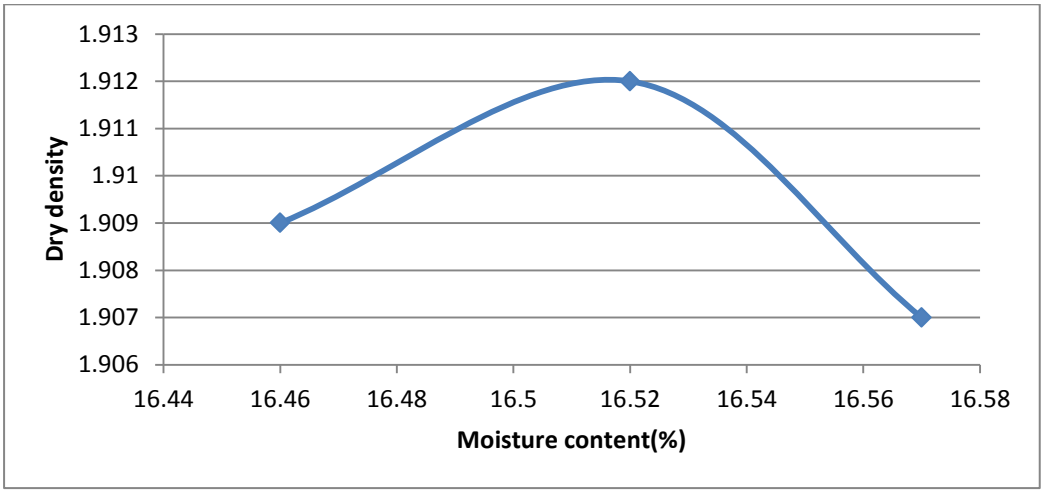


Figure 4.11: Soil with 13% molasses and 20% fly ash

4.4 CBR TEST RESULTS:

As the results shown below on table 4.5 of CBR in soaked and un-soaked conditions.. the Class C fly ash at the increment of 5% is taken in this research, by past studies I take the addition of Class C fly ash from 5% and the next samples is taken at 5% increments like 5%, 10%,15%, 20% and 25%. When we add class C fly ash with soil the values of CBR test is increased from 1.75 to 5.17 when we add fly ash from 0 to 20% by weight with soil and then decreased to 4.90 when we add fly ash 25% with soil by weight in un-soaked condition and when we add fly ash with soil the values of CBR test is increased from 1.17 to 4.12 when we add fly ash from 0 to 20% by weight with soil and then decreased to 3.96 when we add fly ash 25% with soil by weight in soaked condition.

So it is clear from the results that the values of CBR are maximum at 20% fly ash is 4.12 and 5.17 in soaked and un-soaked conditions respectively. The values of un-soaked soil are above then 5% so it is good.

So for the next tests I fix the percentage of fly ash at 20% by weight and perform the tests with molasses in different proportion.

Table 4.5: CBR of Soil with Class C fly ash

Sample no.	Soil: fly ash	CBR Un-soaked	CBR soaked
1	100:0	1.75	1.17
2	95:5	2.70	2.19
3	90:10	3.32	2.93
4	85:15	4.76	3.53
5	80:20	5.17	4.12
6	75:25	4.90	3.96

In table 4.6 the results of CBR is maximum at 20% fly ash and 11% molasses when we add by weight with soil.

In this we fix the percentage of fly ash at 20% and add molasses with 2% increment means we take molasses at 5%, 7%, 9%, 11% and 13% by weight with soil. We take the increment of molasses as 2% by the past studies. The values of CBR at un-soaked condition is increased when we add molasses 0 to 11% from 5.17 to 7.25 and decreased from 7.25 to 6.87in un-

soaked condition and when we add molasses 0 to 11% from 4.12 to 6.12 and decreased from 6.12 to 5.89 in soaked condition.

Table 4.6: CBR of Soil with fly ash and molasses

Sample no.	Soil: flyash: molasses	CBR Un-soaked	CBR soaked
1	80:20:0	5.17	4.12
2	75:20:5	5.87	4.52
3	73:20:7	6.32	5.03
4	71:20:9	6.90	5.61
5	69:20:11	7.25	6.12
6	67:20:13	6.87	5.89

In the graph figure 4.12 all the above values of CBR in above table 4.5 is plotted below when we add class C fly ash with soil, red line show the soaked values and blue shows the un-soaked values. The graph is firstly increased and reaches at maximum CBR value 5.17 when we add 20% fly ash by weight with soil and then decreases. For soaked condition the graph is firstly increased and reaches at maximum CBR value 4.12 when we add 20% class C fly ash by weight with soil and then decreases to 3.96 at the addition 20% class C fly ash by weight with soil.

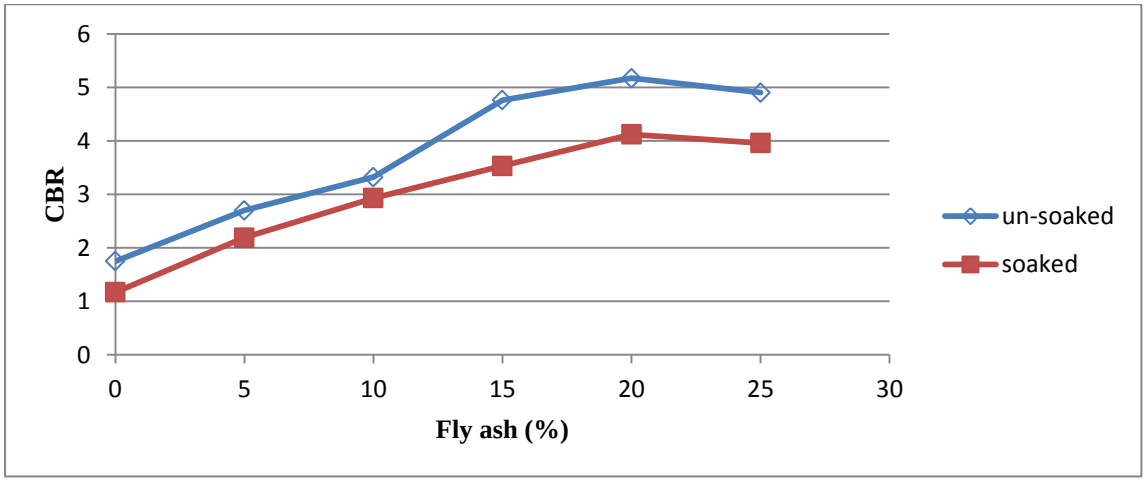


Figure 4.12: CBR of soil with class C fly ash

The figure 4.13 shows the bar chart values of CBR test of the above values of table 4.5 and the blue color bars shows the CBR values in un-soaked condition and the red bars shows the CBR values in soaked condition.

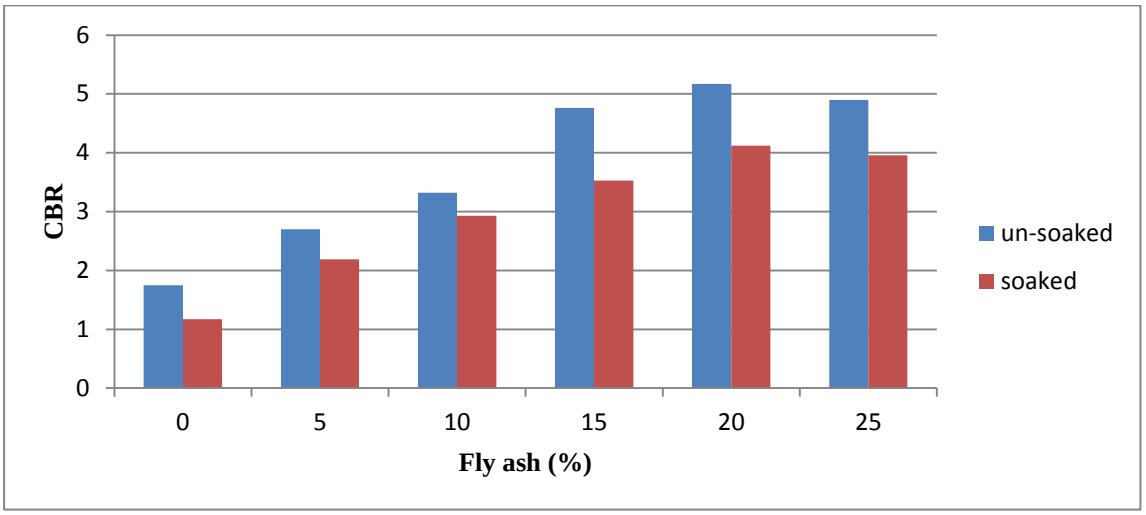


Figure 4.13: CBR of soil with class C fly ash

In the graph figure 4.14 all the values of CBR in above table 4.6 is plotted below, red line show the soaked values and blue line shows the un-soaked values. The graph is firstly increased and reaches at maximum CBR value 7.25 when we add 20% class C fly ash and 11% molasses by weight with soil and then decreases. For soaked condition the graph is firstly increased and reaches at maximum CBR value 6.12 when we add 20% class C fly ash and 11% molasses by weight with soil and then decreases to 5.89 at the addition of 13% molasses and 20% class C fly ash by weight with soil.

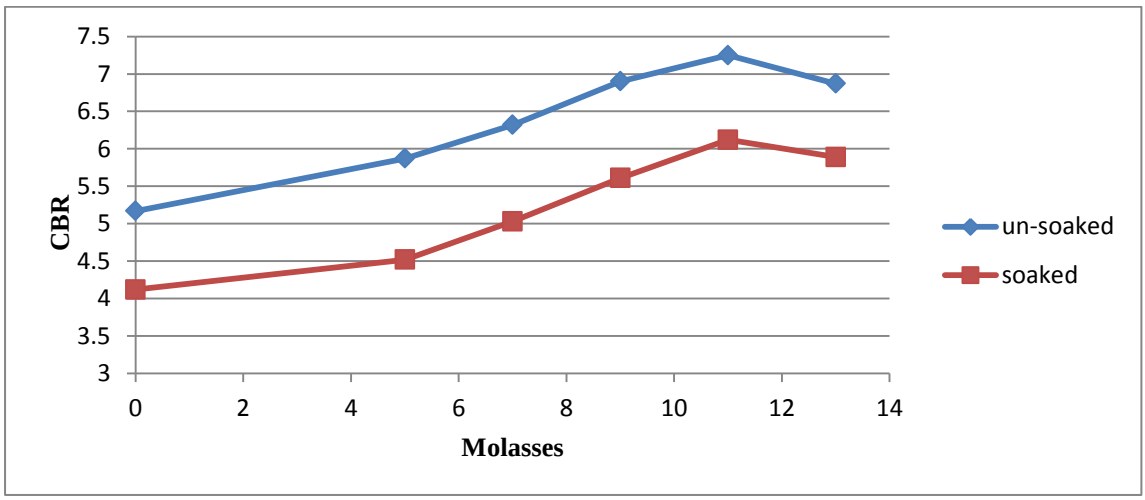


Figure 4.14: CBR of soil with class C Fly ash and Molasses

The figure 4.15 shows the bar chart values of CBR test of the above values in table 4.6 when we add class C fly ash and molasses with soil. The blue color bars shows the CBR values in un-soaked condition and the red bars shows the CBR values in soaked condition

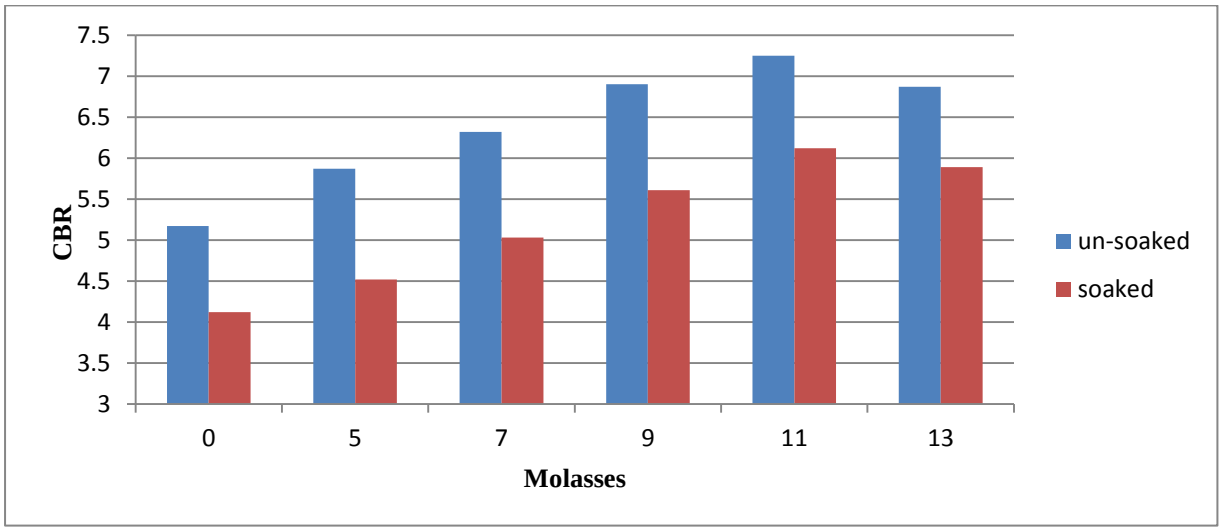


Figure 4.15: CBR of soil with class C Fly ash and Molasses

CHAPTER-5

CONCLUSION:

The poorly graded sand is not good for construction and that's why it needed some admixture to change 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 of the soil increases as shown in the above results, the CBR values increases when we add fly ash with soil from1.17 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 from5.17 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 subgrade layer in future for the construction of roads at places where the soil is poorly graded sand.

FUTURE SCOPE:

As per this research the results is good by this we will improve the subgrade of road but for future we will use it in the above layers i.e. 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

- US corps engineering method
- California state highway method
- IRC 37 1970
- IRC 37 1984/2001
- IRC 37 2012

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

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