STRENGTH IMPROVEMENT OF SUBGRADE USING FLY ASH, RICE HUSK ASH AND GROUNDED GRANULADED BLAST FURNACE SLAG

In partial fulfilment for the award of the degree of

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Under The guidance of

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DECLARATION

I, Shubham Bhalla hereby declare that the project report entitled, **"STRENGTH IMPROVEMENT OF SUBGRADE USING FLY ASH, RICE HUSK ASH AND GROUNDED GRANULADED BLAST FURNACE SLAG"** 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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*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 minerals like Fly Ash, RHA and GGBS 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 Fly ash, RHA and GGBS with soil and check the bearing capacity of soil and compare it with the locally available soil. The study aim of this research is to improve the strength of soil, as most of 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, GGBS from iron industry and RHA from the rice grinding process. As the previous studies we will find by adding these three we get better results as compare with the locally available untreated soil. So I decide to add or mix these three 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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CHAPTER 1

INTRODUCTION

1.1 GENERAL:

In Transportation Engineering Soil or Subgrade is the very first layer of road over that other layers are constructed. It is almost compacted with rollers before construction of road. If bearing strength of soil or subgrade is less, then add different types of modifiers for increase its bearing capacity. Subgrade is the very important layer in the structure of road because it is the first layer and over that another layers are lying. It is handle wheel loads and load of another layers, so if foundation is strong then road can easily bear the heavy wheel load of vehicles. It will play a most important role when weathering conditions is poor and also opposite load condition.

The formation of ruts, humps and corrugation are failure in the road structure because of less CBR value of soil and less strength of the subgrade. Vibratory rollers are used for compaction of soil to provide good strength and some other tests such as California Ratio Test, Plate bearing test will perform for check the strength of subgrade. If strength of subgrade is strong than it will reduce the pavement thickness and if the strength is not good than it will easily increase thickness of road pavement structure. So that we always prefer less thickness of pavement because if the pavement thickness is less, it will affects the time and charges of the project. So for reduces the road pavement thickness we add some chemicals or some minerals to increase the strength of soil. There are four type of layers in road pavement as shown below:

Fig 1.1: Road Pavement

1.2SUBGRADE PERFORMANCE:

The performance of subgrade depends basically on two main characteristics:

• **Bearing capacity of Subgrade:** Subgrade is one of the basic layer in road pavement. It is able to accomplish the load that is transmitted by the other layers of road pavement. Load bearing capacity of subgrade is generally depends on the moisture content present in soil, type of soil and amount of compaction. If we perform load bearing tests such as plate load test, proctor test, CBR test etc and its values are all right. It means the soil that we use in subgrade is good.

• **Volume Changes:** Most of the soils modifications extent when exposed to moisture in awful climate circumstance or freezing circumstance in some of the areas. The soil starts swell and shrink depending on the moisture content and can be liable to the frost heave at freezing regions. The change in extent of the soil may additionally effect on the road and creating humps on the pinnacle of the road floor.SO, In case of road construction bad subgrade may be avoided if possible.

But generally there's some techniques that may be used for treatment of the subgrade before creation of the road layers over subgrade are as below:

• The loose or negative soil have to be eliminated and replace it with great soil such that which has excessive bearing potential as compare to the present soil.

• We can also use different types of binders that is use to increase the bearing capacity or bearing potential of soil.

• Additional base layer have to be furnished or we can divided subgrade into elements and offer compaction, these layer spread pavement load over a big subgrade region. But we now not use this method, we more often than not use above strategies.

1.3 STABILIZATION TECHNIQUES:

Almost possibly negative sub grades need to be prevented however if in a few instances it's far essential to construct over the weak soil there are many techniques to improve the situation of the soil.

- **Removal and replacement** (over-excavation): It is one of the most high priced techniques to enhance the soil situation. In these techniques, we can remove the poorly graded soil and replace it with expensive soil for providing good subgrade strength. These type of techniques we use with black cotton soil because black cotton soil is not good for subgrade.
- **Stabilization with different binders:** In this technique, stabilization can be done by using different binders such as cement, asphaltic binders, lime etc. By addition of such kind of binders in appropriate proportion increase the bearing, performance of subgrade. It can also decrease the swelling nature of soil.
- **Addition of base layers:** Poor sub grade soils may be made perfect by including some base layers to take greater load consequently. These layers are beneficial unfold the hundreds alongside the pavement in larger location of sub grade. This technique may be taken extraordinary. Because, as opposed to designing more base layers it is easy to design a base layer with more thickness. This may also satisfy the most equations in the layout. However those equations are within the empirical part and are majorly avoided in lots of instances. As to say that the thick pavement structure over the weak sub grade won't make a very good pavement.

1.4 NEED OF THE STUDY:

The desires of this research are as under:

- Save Money: By studies the bearing capacity of the soil improved after which thickness of the pavement should be decreased. It directly affects the cost of the project and cost of the project reduced.
- Save Time: As the strength of subgrade increased and thickness of road pavement decreased. So due to that less time to be taken for complete the project.
- Save Design: As the thickness reduce then the design is yet not complicated. By doing this many layers of road pavement may be skipped. So we can without delay lay the bitumen over the compacted layer.

- Winter working: As the strength of subgrade is increases by adding different admixtures like Grounded blast furnace slag, Rice husk ash and Fly ash, its water absorption properties increases and stable in awful weather.
- Save Waste: Waste created from different types of factories creates pollution in the atmosphere and harmful for animals as well as human beings. So use of these waste in the road pavement is best.
- Save Environment: Fly ash, Blast furnace slag contains many chemicals which is toxic and harmful for environment as well as for human beings. So use of these kind of toxic wastes in road pavement is a positive step for environment.
- Benefits to Factories: As we use these kind of toxic wastes in the subgrade layer of road pavement. So it is beneficial for company as well as for user.

1.5 OBJECTIVES OF THE STUDY:

The essential objective of this new research is to investigate the use of the admixture like Grounded Blast furnace slag, rice husk and Fly ash. As we recognize this three Fly ash, rice husk ash and Blast furnace is the waste made of the factories like Power Thermal Plant, Iron industry and Waste of rice. So it is right for utilize these waste products and help to construct better road pavement. By this study we also calculate the appropriate proportion of Fly ash, Rice husk ash and Grounded blast furnace slag for increase the strength of soil. Due to this the capacity of the soil increases and the price of the task decrease.

Delays in construction because of awful weathered conditions is to be controlled with the assist of stabilization of soil and saving the cost of project and also saving time. The saving of time and cost can be calculated by using code IS37-2012 and amount of material this is to be stored is likewise calculated.

In this study, we will perform different tests on soil such as CBR test, Proctor test etc and find the strength of subgrade. In the past studies we notice that by using appropriate proportion of Rice husk ash, Fly ash and Grounded blast furnace slag individually effects on the soil and increased its strength. So in this new research we will use the proportion of Grounded blast furnace slag, Rice husk ash and Fly ash together and perform different tests on soil with these three waste products. I hope it will increase the strength of subgrade and this research is beneficial for us.

1.6 SCOPE OF THE STUDY:

The major scope of this research is as beneath:

- It will minimize the soil plasticity index.
- It will minimize the soil water sensitivity.
- It will minimize the soil shrinkage factor.
- It will rises the soil impermeability.
- It will rises the soil strength.
- It will also rises up the soil load bearing capacity.
- It will expands the soil durability.
- The construction of subgrade will be environment friendly in nature.

CHAPTER-2

LITERATURE REVIEW

2.1 PAST STUDIES:

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

This paper is described have a look at the behavior of the fly ash using for the stabilization of the expensive soil in various percent. It describes the methods of placing the materials in different layers of various thickness to be required. This should be operating with assist of disc harrow. It also takes the trail of having embankment of 30metre, length of 6metre and width of 0.6 metre and constructed.

The test to be performed for this research is analysis of Grain size, Standard Proctor Test, CBR Test, Permeability Test etc. The fly ash added in different percentage like 10%, 20%, 40% and 50% with the expensive soil. By addition of fly ash as 10% the content of water reduces from 2.61% to 2.34%, dry density remains same as 18.04 KN/m3 and the value of unconfined compressive strength increases from 2697 KN/m2 to 3533 KN/m2.

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

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

By using fly ash up to 50% content of water rises from 1.80% to 1.84%, dry density decreasesfrom 16.17 KN/m3 to 15.13 KN/m3 and the value of unconfined compressive strength decreases from 2160 KN/m2 to 1176 KN/m2.

The results of tests related to adding fly ash as with expensive soil from the upper table shows 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.

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.

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.

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.

Kumar Anil, Sivapullaiah P.V, 2015

In this study, an artificially-combined expansive soil changed into stabilized with exclusive quantities of binder, frequently which include fly ash and GGBS at a combining ratio of 7:3. The basic objective of this study was to check the effects of GGBS and fly ash on the physical properties as well as compression and bearing strength of soil.

By addition of binder in soil, was found that increased its maximum dry density (MDD) while deceased its optimum moisture content (OMC).

This research has shown that GGBS mixed with fly ash improves the properties of expansive soil and it reduce the requirement of chemicals such as lime, cement etc. So, we conclude from this research is that mixture of GGBS with fly ash decrease construction cost as well as reduce environmental effects.

E.A Basha, R. Hashim, H.B Mahmud, A.S Muntohar, 2003

In this study, mixture RHA and cement was deceased the plasticity of soil. In general, 10-15% mixture of RHA and 6-8% of cement with soil show optimum amount for decease the moisture content of soil. Decrease in the value of PI indicates the improvement in soil.

The result confirms that 5% RHA, 4% cement and 20% RHA, 8% cement mixtures provides maximum CBR value of soil, respectively 53% and 60%. Multiple increment in the value of CBR when lesser amount of cement and RHA mixed.

The effect of addition of additives at the soil shape has been found by using SEM and X-ray diffraction test.

RHA and cement decrease the plastic index of soil. With increase in the quantity of cement MDD slightly decreases. OMC increased steeply by adding cement and RHA. The compressive strength of cement stabilized soil is increases with increase in the amount of RHA. Addition of RHA gives better strength to the soil and needs less amount of cement for stabilization.

With increase in the content of cement and RHA, CBR value also increases rapidly. A highest value of CBR is 60% is obtained at a combination of 5% RHA and 4% cement content. In common, 15-20% of RHA and 6-8% of cement content display the optimum quantity to raise properties of soil.

Kumar Anupam, Kumar Praveen, Ransinchung GD, 2014

In this research rice husk as well as fly ash is used as soil stabilizers. Using stabilizers as fly ash and rice husk, the deformation behavior of soil mixtures under different repeated loading is conducted. It is learnt that, the permanent deformation reduces with raise in confining pressure of different types of samples. By using, 30% fly ash and 25% of rice husk minimum permanent deformation obtained.

On other hand, lower of deviator strain (σd) value indicates improvement in the permanent strain. At the mixture of 30% fly ash and 25% rice husk with soil minimum value of deviator strain is 2.21 % and 2.04%. Improvement in the expansive soil by adding rice husk ash and fly ash, which increased in the confinement as well as pozzolanic reactions. So, with the help of fly ash and rice husk ash bonding of the soil particles closer and stronger.

Sharma Anil, Sivapullaiah P.V, 2012

The motive of this research to increase the unconfined compression strength of Black cotton soil by using GGBS. In this, prepare the samples and curing the samples at 7, 14, 28 days and its strength is determined by using proctor test.

Addition of Grounded Granulated Blast Furnace Slag reduced the maximum dry density (MDD) as well as optimum moisture content (OMC) of black cotton soil.

For 7 and 14 days curing period, increased in the unconfined strength of black cotton soil with the amount of GGBS upto 20%. For 28 curing period, strength increased with GGBS upto 40%. Further addition of GGBS in black cotton soil reduces its strength.

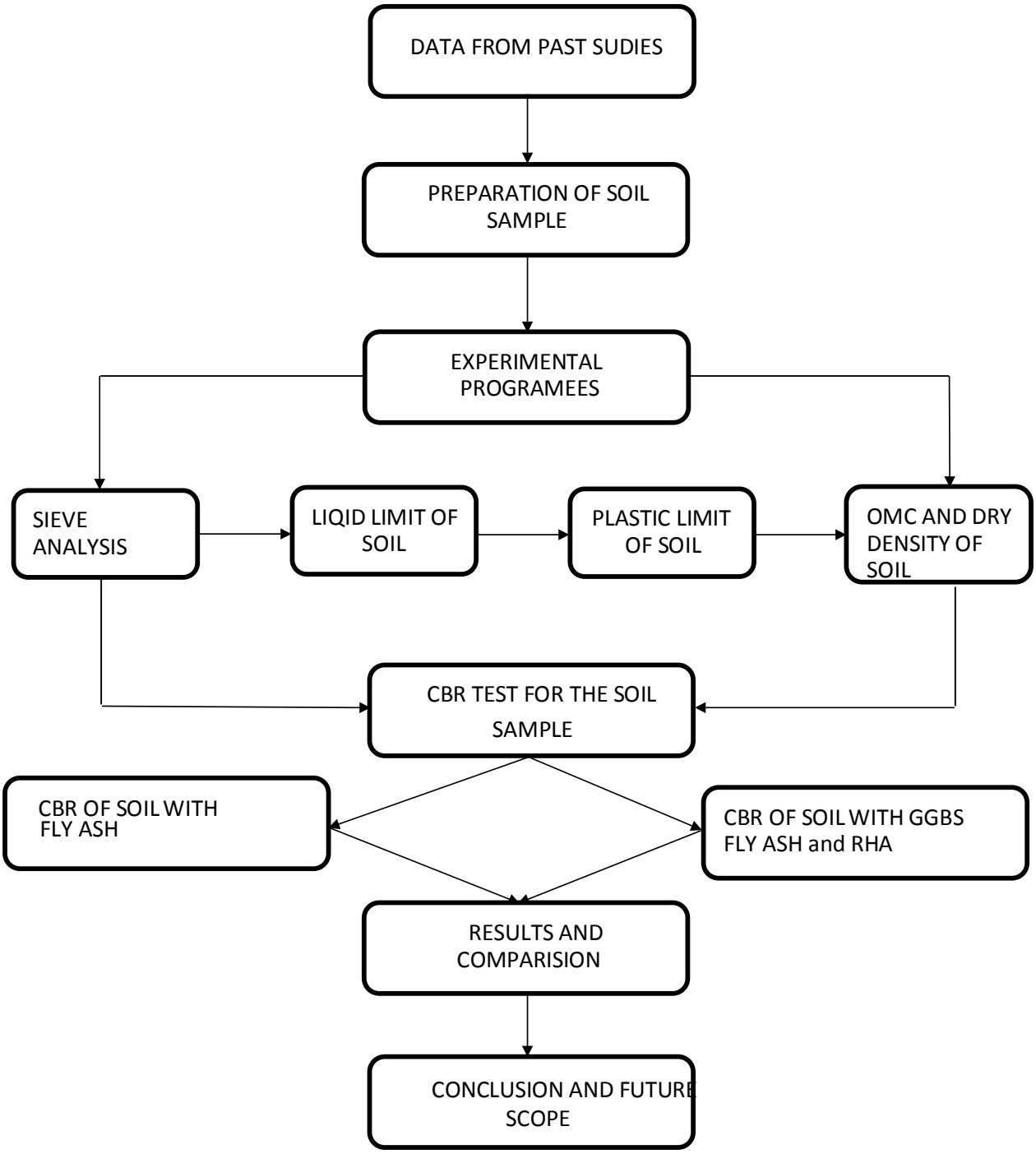
Udeyshankra D.hakar, 2008

The motive of this 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 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,

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 identified as Pulverized fuel ash inside the United Kingdom, it's 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.

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.

Fig 3.1: Fly ash

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.

TABLE 3.1: 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

3.2.3 RICE HUSK ASH

Rice husk or Rice hulls are the solid protecting covers of rice grain. It is used in fuel, building material, insulation etc. Rice husk ash (RHA) generates from the firing of rice husks. Rice husk is extraordinarily conventional in South and East Asia due to the manufacturing of rice on this area. The rich land and tropical weather make for pleasant conditions to domesticate rice and is taken benefit with the useful resource of those Asian nations. The husk from the rice is eliminated with the help of farming methods. It also has been discovered that make numerous things by burning of rice husk. Rice husk ash is used as a admixture in cement. It is also used in subgrade for provide more strength in road pavement. So the rice by product that is rice husk ash is used in eco –friendly approach. One powerful approach used nowadays to rid the rice husk and is to apply it to fuel kilns. These kilns assist to provide bricks and other clay products that are used in each day existence

Fig 3.2: Rice husk

3.2.4 Engineering Performance of RHA

- RHA is used in cement to improve its binding properties.
- It is used in subgrade or soil to increase its Engineering properties.
- It can be used in subgrade or soil to increase its Engineering properties.
- It can be used in other layers of road structure such as base layer and sub base layer. In this research, we use it is in subgrade.

3.2.5 Grounded Granulated Blast Furnace Slag (GGBS)

Grounded granulated blast furnace slag (GGBS) is product from blast furnaces for utilization of iron. GGBS operates at approximately a temperature of 1500 degree Celsius.

Iron core is decreased to iron and the last materials from a slag that floats at the pinnacle of the iron. This slag is periodically tapped off as a molten liquid and if it's miles for use for the manufacture of GGBS it has for use for the manufacture of GGBS it has to be rapidly quenched in big volumes of water. The quenching, optimizes, the cementitious residences and produces granules much like a coarse sand. This 'granulated' slag is then dried and ground to a high-quality powder.

Fig 3.3: GGBS

3.3 EXPERIMENTS / TESTS TO BE CONDUCTED:

- **Sieve analysis**
- **Liquid limit**
- **Plastic limit**
- **Standard Proctor test**
- **California bearing ratio test**

3.3.1 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.

Fig 3.4 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.

3.3.2 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

Fig 3.5: Liquid Limit Testing

3.3.3 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.

Fig 3.6 Rolled soil sample

3.2.4 STANDARD PROCTOR TEST:

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 the soil 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:

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

$$\gamma_d = Dry\ density$$

$$\gamma_b = Bulk\ density$$

$$w = water\ content$$

Fig 3.7: Equipment for test

3.3.5 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 28 stabilization will be done. Higher the value of CBR lowers the thickness of subgrade or pavement.

Fig 3.8: CBR testing machine

To perform the test the apparatus as per IS: 2720 comprises of mold with internal diameter 150mm 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.

Compute CBR valve based of below formula

Load or pressure sustained by specimen at2.5 or 5.0mm penetration *100

Figure 3.9: Equipment used in CBR test

CHAPTER-4

RESULT AND DISCUSSION

4.1 SIEVE ANALYSIS RESULTS:

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

The percentage of loss is 0.8 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.

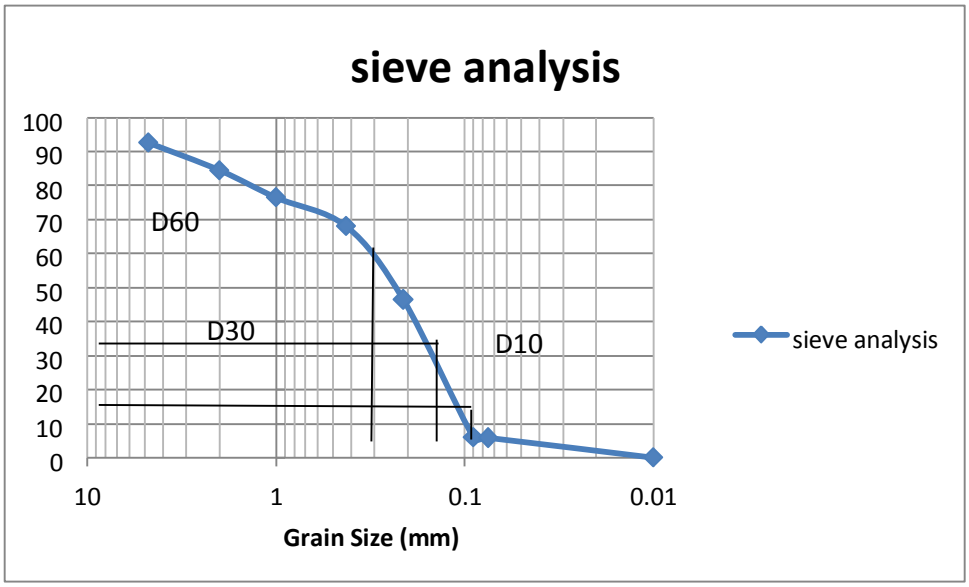


Fig 4.1 Sieve analysis log graph

- From the graph D10=0.1, D30=0.16, D60=0.33 are known.

Cu= D60/D10

=0.33/0.1 = 3.3 mm

Cc= (D30)2/ (D10*D60)

= 0.78 mm

- This satisfied the both the conditions of poorly graded sand.

Cu<6 and/or 1>Cc>3

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 soil	Moisture content (%)	Blows count
25	22	4	0.18	18.18	36
95	78	18	0.23	23.07	29
31	24	6	0.25	25	19

Liquid limit of normal is 23

By performing the liquid limit analysis it is known that he soil sample contains 23% of the moisture content.

4.3 PLASTIC LIMIT RESULTS:

- 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.

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