BE CIVIL ENGINEERING

PROJECT REPORT

SUB-GRADE STABILISATION USING CRUMB RUBBER AND RICE HUSK ASH

Project submitted in partial fulfillment of the requirements for the degree of

SUBMITTED BY

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This is to certify that the

BE Civil Engineering project entitled

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Has been accepted towards the partial fulfillment of requirements for BE Civil Engineering Degree

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Dedication

This project is dedicated to my parents and teachers who taught me that what is learned for its own sake is the best kind of knowledge, who taught me how to make things happen with dedication.

ACKNOWLEDGEMENT

All gratitude and praise to ALLAH ALMIGHTY.

We bow our heads before ALLAH ALMIGHTY for providing us with an opportunity to capitalize the available resources and terminate our research work. It would never have been possible for us to write this thesis without assistance from several people. We are highly obliged to them and to our respected teacher; we are grateful to our advisor Col Nawab Dogar who was always there for the help, encouragement and inspiration. Their ideas were quiet valuable in our research and a cause of objective achievement. Special thanks to our parents for their unconditional love and prayers.

ABSTRACT

In this project an endeavor has been made to examine the utilization of rice husk ash and Crumb rubber as a stabilizing agent in subgrade soil. Crumb rubber is a waste material of rubber tires. Crumb Rubber and rice husk ash was incorporated at 2.5%, 5%, and 7.5% by weight of virgin soil. In term of performance parameters CBR was evaluated using CBR testing machine. Compaction tests for OMC & MDD were conducted using standard proctor apparatus. Samples were prepared and tested for liquid limit and plastic limit using casagrande's apparatus. Study concluded that CBR is increased and decreased respectively at 0.1 and 0.2 of penetration of stabilizers. It was observed that liquid limit and plastic limit of soil decreased and increased at 5% of both stabilizers respectively. Bearing capacity of soil in terms of CBR increased significantly up to 29% as compared to virgin CBR soil value i.e., 24% by adding 7.5% additives.

Chapter 1

INTRODUCTION AND BACKGROUND

1.1 BACKGROUND

Sub grade stabilization is one of the essential and significant cycles in the development of any expressway. Arising pattern of utilizing waste material in soil settling or soil fortifying is being operational everywhere on the world in present days. The fundamental explanation for this pattern is the exorbitant creation of waste materials like fly debris, plastics, rice husk debris which isn't as it were perils yet additionally messing statement up. Utilizing a portion of these waste materials in development cycles will diminish the issue up by and large. The historical backdrop of adjustment of soil has a long foundation with a huge number of examination results. A few exploration results with squander materials like fly debris, plastics; rice husk debris has too been distributed with their advantages.

Rachel Louise Carson (1907-1964) said "humanity is tested like never before previously to show our authority - not over nature but rather of ourselves", presently a day's we are tested to discover approaches to deliver more energy, decrease our waste creation and limiting utilization of restricted normal assets. Squanders are for the most part inescapable items that are produced by living creatures. This beginnings from a basic unicellular living resembling single adaptable cell the complex multi cell organic entity like man. What's more, the volume of squanders created by these living species relies on their size, limit and intricacy. Before this cutting-edge modern time the creation and kind of waste was extraordinary, on the off chance that we return in nineteenth century we will find that by and large byproducts were remains from consuming wood, agrarian and creature squander, and in those days removal of this basic waste was not a difficult they were utilized to be unloaded in ground and later in years this waste ends up being valuable as far as ripeness of land. Presently the time has changed, industry is becoming greater and greater, world is moving towards modernization and way of life has additionally improved. In any case, have we at any point imagined that this modernization and expectation for everyday comforts is outfitted with various sort of squanders, and a portion of these byproducts are likewise destructive to our wellbeing and climate. These squanders might be in structure of strong squanders like broken glass, squander tires, spent atomic energizes, plastics; fluid squanders like leachates, general compound and vaporous waste, for example, methane produced from landfills, carbon monoxide and so forth

Squander elastic tires are those which have been utilized for a long haul and have harmed sides, harmed grooves, have swells and can't be retreaded because of unreasonable utilization.

Presently a day's measure of vehicles is rising step by step, each day you move out of your home you will discover a new kind of vehicle out and about. Discussing Pakistan which is under agricultural nation, complete number of enlisted vehicles as indicated by overview led by Global Health Organization (GHO) in 2011 is 9080,437 (Holíková, Jelemenský, Annus, and Markoš, 2005). So, with this progressing ascend being used of engine vehicles, hundreds and millions of tires are disposed of every year around the world. The overall creation of waste tires is about 5.0×106 tons each year, which is 2% of the absolute yearly strong waste. A significant number of these disposed of tires are added to existing tire dumps or landfills, and minimal number are assembled for reusing. This enormous measure of scrap tires, rather in dumps or in reusing offices, present genuine fire insurance difficulties to fire divisions. Tires ignite with a high measure of per-pound heat yield than the vast majority of the coal, what's more, the high warmth creation of tire elastic makes extinguishment extremely troublesome. ("Uncommon Report: Scrap and Shredded Tire Fires," 1998). When the tires burst into flames a lot of combustible oil is yielded, this oil isn't just combustible yet in addition climate debasing. Synthetic delivered during open consuming of Tires. (Consumed, Released, and Hazard, 2005).

The complex multi cell animal like man. Likewise, the volume of wastes made by these living species depends on their size, cutoff and unpredictability. Before this forefront current period the creation and sort of waste was one of a kind, if we return in nineteenth century, we will find that generally results were soot from devouring wood, cultivating and creature squander, likewise, in those days evacuation of this essential waste was not a troublesome they were used to be dumped in ground and later in years this waste winds up being significant to the extent extravagance of land. By and by the time has changed, industry is turning out to be more noteworthy and more prominent, world is moving towards modernization and lifestyle has moreover improved. However, have we anytime envisioned that this modernization and assumption for ordinary solaces is equipped with different kind of wastes, and a part of these results are furthermore destructive to our prosperity and environment. These wastes may be in design of solid wastes like broken glass, waste tires, spent nuclear fills, plastics; liquid wastes like leachates, general manufactured and vaporous waste, for instance, methane transmitted from landfills, carbon monoxide, etc.

As worldwide wellsprings of petrol are diminishing, so their legitimate and suitable usage is required. So, it is important to create strategies for reusing or second removal of the waste tires the act of unloading waste tires in landfills and open consuming is turning out to be unsuitable, as the tires are non-biodegradable material. As the number of inhabitants in our planet is additionally expanding step by step and at this point, we have reached to seven billion, so this expanding populace need some land to live and if continue filling our accessible land by unloading the waste where our people in the future will go. Squander elastic tires are those which have been utilized for a 3

Figure1: Satellite picture Kuwait Sea

long haul and have harmed sides, harmed layering, have swells and can't be retreaded because of inordinate use. Presently a day's measure of vehicles is rising step by step, each day you move out of your home you will track down another kind of vehicle out and about. Discussing Pakistan which is under non-industrial nation, absolute number of enrolled vehicles as indicated by review directed by Global Health Organization (GHO) in 2011 is 9080,437. So, with this continuous ascend being used of engine vehicles, hundreds and millions of tires are disposed of every year around the world. The overall creation of waste tires is about 5.0×106 tons each year, which is 2% of the absolute yearly strong waste. The European Union creates more than 2.5×106 huge loads of waste tires each year. (Holíková, Jelemenský, Annus, and Markoš, 2005). A large number of these waste tires are added to existing tire dumps or landfills, and minimal number are gathering for reusing. This tremendous measure of scrap tires, rather in dumps or in reusing offices, on the grounds that genuine fire security difficulties to local groups of fire-fighters. Tires ignite with a high measure of per-pound heat yield than the vast majority of the coal, and the high warmth creation of tire elastic makes extinguishment very troublesome. ("Exceptional Report: Scrap and Shredded Tire Fires," 1998). When the tires burst into flames a huge measure of combustible oil is yielded, this oil isn't just combustible yet additionally climate polluting. Compound delivered during open consuming of Tires. (Consumed, Released, and Hazard, 2005).

Rice husk is a byproduct of rice milling. About 100 million ton of rice husk is generated in Rice industry worldwide. We cannot use it as feed for animals because it has indigestible protein, on other way we have to burn it in open heaps to dispose of that is not easy and also cause environmental hazards and also need fuel combustion to dispose of so if we use this natural stabilizer in subgrade soil then we can save and minimize its health and environmental hazards and its construction cost is also very low as compared to other stabilizers i.e., cement, lime etc.

1.2 SOIL STABILIZATION

Soil stabilization is the process of changing the physical properties of soil. Weak subgrade soil requires the technique of soil stabilization due to extensive loading on it. There are two types of soil stabilization.

- Mechanical stabilization.
- Chemical stabilization.

1.3 PROBLEM STATEMENT

1.3.1 Case in study:

We are considering "MCE soil" as case in point. To avoid damage to structure, it is important to improve the properties of soil.

S/NO	Test	Crumb Rubber and Rise Husk Ash %	No of samples
1	Compaction test	0%	
		2.5%	
		5%	
		7.5%	
2	LL and PL	0%	3
		2.5%	3
		5%	3
		7.5%	3
3	CBR	0%	
		2.5%	
		5%	
		7.5%	
4	UCC	0%	
		2.5%	
		5%	
		7.5%	

Table 1: Mix Ratio of Crumb Rubber & RHA

1.4 RESEARCH OBJECTIVES

- To enhance the bearing capacity of soil and enlist its effects by adding stabilizers.
- To effect of different proportions of stabilizers on CBR on pavement sub grade material.

1.5 RESEARCH QUESTIONS

Q). How can we improve the properties of weak sub grade soil?

Q). How can we protect the environmental component?

1.6 SCOPE OF THESIS

- Evaluation of Atterberg's limits (Liquid limit, plastic limit).
- For California bearing ratio (CBR), the virgin and modified specimens were tested following test.
- Determination of unconfined compression test
- Determination of optimum moisture content & maximum dry unit weight.

1.7 ORGANIZATION OF THESIS

Thesis is divided in five chapters; detail of each chapter is given below.

Chapters 1 gives a brief overview of Subgrade soil stabilization (SSS) along with stabilizer's (rice husk ash & crumb rubber). It also gives information about properties and advantages of Crumb rubber and rice husk ash. Effect of crumb rubber and rice husk ash modification on stability, flow, volumetric and moisture sensitivity

Chapters 2 includes literature review on findings of the previous studies related to the utilization of Crumb rubber, and different fibers in asphalt mix. It also includes previous studies on SSA g, Crumb rubber, and rice husk ash.

Chapters 3 gives a bird's eye view that how the work is accomplished. This also tells which type of techniques is adopted for preparing samples of SSS, from where the material was collected, which standard was adopted to perform a certain test.

Chapter 4 presents the experimental results and their analysis using the software Microsoft Excel 2016.

Chapter 5 summarizes the findings and conclusions of laboratory testing. The future work and suggestions are also discussed.

Chapter 2

LITERATURE REVIEW

2.1 INTRODUCTION

In this part we learn about some writing and brief depiction about the utilization of scrap elastic and rice husk debris for subgrade soil adjustment. Sub-grade soil adjustment is one of the essential and significant cycles in the development of any expressway.

2.2 BACKGROUND

In 2020, Juliana idrus used crumb rubber by 2%, 4%, 6% and 8% to check the CBR value of sub grade soil. CBR values for calculated for (2% CR), (4% CR), (6% CR) and (8% CR) are 17.12%, 36.09%, 29.70%, 21.90% respectively. The results indicate that the highest CBR values are from (4% CR) which is 36.09%. The lowest CBR values are proved at (8% CR) which is 21.90%. The decrease in the result is due to the presence of high crumb rubber which resulting in high compressibility and the rubber elasticity is quite high compared to the soil. Thus, 4% Crumb Rubber is recommended to be implemented for subgrade soil stabilization. From the results obtained, it can be concluded that the industrial waste of crumb rubber had proved increase the subgrade soil strength.

In 2011, Athanas and G. Kollaros used fly by 4%, 8%,12% to determine Atterberg Limits and Compaction Characteristics. Casagrande apparatus used for LL and PL. Proctor test was conducted for compaction. As result, LL were 69%, 64%, 59% and PL were 32%, 35%, 39% for 4%, 8%, and 12% of fly ash respectively. MDD was recorded as1526, 1487, 1422 and OMC was recorded as 25.6, 26.4, and 31.2 at respective percentage. The admixture fly ash resulted in a reduction of the maximum dry density (MDD) of the soils. On the other hand, an increase in optimum moisture content (OMC) was observed for the same compaction effort. The reduction in maximum dry density, following the treatment with lime and/or fly ash, reveals the increased resistance to the compaction effort offered by the flocculated soil-structure.

(Trivedi, Cpm, and Near 2013) explored fly debris to figure a model dependent on Genetic Calculation which can be utilized to anticipate change in the upsides of CBR of the Sub-grade Soil with the expansion of a fitting rates of fly debris. The information esteems for this investigation were those which straightforwardly influence the CBR esteems i.e., straightforwardly corresponding to CBR. It incorporates Liquid Breaking point (LL), Plasticity Index (PI), and Optimum Moisture Content (OMC). For examination of adjustment of soil utilizing fly debris. CBR value recorded were 10.51, 9.11, 20.53 %. Subsequently it very well may be seen that dirt containing 20% Fly debris gave the best and fitting consequences of Soil Stabilization when contrasted with different extents. Soil is the inception of everything. As we know everything is reliant upon nature, and as a common engineer we realize that dirt assumes an indispensable part in development. At the point when we erect any construction over the dirt, initially we check the conduct and quality of soil that how much strength is available in the dirt so it can tolerate structuring load which will be raised over this dirt. There are a few kinds of soil which have distinctive various characteristics, a few soils have more noteworthy strength and some have lower, assuming the strength of soil is lower than our prerequisite, we compelled to increment the strength of the dirt according to our construction prerequisite. soil. She likewise researched that CBR is most extreme at 3& lime by weight. OMC& MDD moreover increments with the expanding level of morsel elastic.

In 2017, Fazl-e-jalal, from used marble industrial waste to check the OMC and MDD of soil. Percentage for the marble he used are 2, 4, 6, 8, and 10. The OMC recorded were 12, 9, 10, 13 and 15 and MDD recorded were 1.87, 1.97, 1.9, 1.93, and 1.8 respectively. It is depicted that by using MIW the Maximum Dry Density (MDD) increases up to addition of 4% content. increase in MDD corresponds to improvement of expansive soil. Also, the reduction in MDD illustrates that in order to attain its MDD it will require low comp active energy. The maximum OMC recorded at 10%.

In 2017 Ms.L.Kokila, and G.Bhavithra, did experimental investigation on soil stabilization using crumb rubber at 5%, 10%, 15% with 3% of constant lime on expansive soil. As a result, it has been observed that CBR value recorded were 4.9%, 5%, 5.2%. OMC found at 17.5%, 18.32%, 19.75%. and MDD found at 15.79, 17.2, 18. The increased CBR value leads reduced pavement thickness and increased stability.

Sr.No	Reference	Year	Work Record
1	Ms.L.Kokila, G.Bhavithra,	2017	Use of crumb rubber on expansive soil at (4%,8%,12).[1]
2	Athanas, Kollaros	2011	Used fly by 4%, 8%,12% to determine Atterberg Limits and Compaction Characteristics
3	Juliana idrus	2020	Used crumb rubber by 2%, 4%, 6% and 8% to check CBR value
4	JyotiS.Trivedia	2013	Use of fly ash and check CBR variation on different proportions at 10,20,30%.[6]
5	Magdi M. E. Zumrawi	2015	Use fly ash by 5%,10%,15%,20 % with constant cement content of 5%
6	F, Jalal	2017	experimental investigation on soil stabilization using crumb rubber at 5%, 10%, 15% with 3% of constant lime

Table 2: Scholar studies table

2.3 FINDINGS ON USING CRUMB RUBBER AND RICE HUSK IN SUBGRADE SOIL STABILIZATION

(Zumrawi 2015) So, for this regard study the effect by the combined action of fly ash and cement stabilization on the geotechnical characteristics of weak subgrade soils. Expansive or problematic soil treated with varying percentages of fly ash, 0, 5, 10, 15, and 20 percent combined with 5% cement content were studied. From the results, it is clearly understood that there is a great improvement in strength and a significant reduction in swelling of expansive soils treated with 5% cement and 15% fly ash. Hence, 5% cement with 15% fly ash can be adopted in stabilization of weak soils as road layers without much cost. (Pandey and Rabbani 2017) conducted a study on cement to improve the geotechnical properties of soil such as plasticity, compaction and California bearing ratio. These properties were determined before as well as after the stabilization of soil. In this work it was found that increasing the quantity of cement added to the soil, dry density of soil decreases and OMC increased.

The primary goals of the dirt adjustment are to upgrade the bearing limit of the dirt, its protection from enduring activity and soil penetrability property. The drawn-out exhibition of any development project relies upon the strength of the basic soils. Un stabilized soils can make colossal issues for asphalts or constructions, therefore soil adjustment methods are important to guarantee the great strength of soil so it can effectively supported the heap of the superstructure (traffic loads) particularly if there should be an occurrence of soil which are profoundly dynamic, likewise it saved a ton of time and a huge number of cash when contrasted with the strategy for cutting of street layers and supplanting the flimsy soil with non-costly soil. Lime acts promptly and improves various properties of soil, for example, conveying capacity of soil, protection from shrinkage during sodden conditions, decrease in pliancy file, and expansion in CBR esteem and enormously expansion in the pressure opposition with the progression of time.We utilized the crumb rubber to improve the property of feeble soil so for this reason (Ravichandran and Krishnan 2016) Used crumb rubber of different rates to check the property of frail soil so he utilizes two kinds of tricky mud of different rates (5, 10, 15 also, 20%). He saw that the strength of delicate soil increments up to the 10% of CR. He too seen that the penetrability esteem shows a quick increment with the expansion in scrap elastic rate for the both the dirt's. From the test outcomes it was seen that the coefficientof penetrability of soil expands 3 to 75 folds in soil class A1 and 4 to 100 folds in soil class A2. (Nasiri et al. 2015) Rice husk debris is by result of rice processing. So,MehranNasiri, MajidLotfalian, Amir Modarres, Wei Wu utilized rice husk debris stabilizer to improve the property of feeble sub-base woods street. Woods's streets assume a huge part in timberland the board framework, wood transportation and timberland insurance measures. Nonetheless, least norms are considered for asphalt materials because of the traffic volume and monetary circumstance of various ranger service projects. Lab concentrates on soil A–6 (AASHTO characterization) shows an overall 12 declining in the most extreme dry thickness (MDD) and an expanded at (21.9%) in ideal dampness content (OMC) with expansion in RHA content. Adding RHA (9%) causes a declining (13.3%) in L.L and versatility record (PI) of soil. In any case, this improving impact isn't so a lot when contrasted with lime. The California bearing proportion (CBR) of balanced out soil in both soaked condition and ideal water content (OWC) was 28% and 37.5% more than the normal soil separately.

Chapter 3

RESEARCH METHODOLOGY

3.1 Introduction:

The following chapter discusses the research methodology used to study the behavior of additives on virgin soil. It includes characterization of material, preparation of specimen, conduction of tests, their results and analysis of various important factors. The project study was conducted to analyze the effects of crumb rubber and rice husk ash (as fillers) in the stabilization of sub grade soil. In first part of the research properties of virgin soil were studied. The tests for various properties included liquid limit, plastic limit, and compaction tests (Proctor and UCC). California bearing ratio was also determined. The experiments were then repeated on samples of soil of same origin mixed with crumb rubber of waste tires and rice husk ash mixed at 2.5%, 5%, 7.5% by weight. The results were noted, and Comparisons drawn. Conclusions and recommendations were prepared subsequently.

3.2 MATERIAL SELECTION

Soil sample, crumb rubber, rice husk ash and distilled water are the materials which are used in project. Soil sample was collected from Risalpur Cantonment. After removal of top layer, the soil underneath was obtained to get an undisturbed natural sample, free of unnecessary impurities. Crumb rubber is taken from scrap tires, cut into tiny pieces, and sieved. Rice husk is taken from husk depots, burnt (turned to ash), subsequently allowed to cool, and sieved.

Figure 1: Soil sampling

3.3 CRUMB RUBBER

Crumb Rubber is recycled rubber taken from car, motorcycle tires. During recycling process, steel cords in the tires are taken out and removed to maintain the granular consistency in the tire rubber. The used crumb rubber is obtained from a local tire recycling factory in Taxila. Crumb rubber was then cut into tiny pieces in such a fashion that it passes through #30 sieve and retains on #40 sieve.

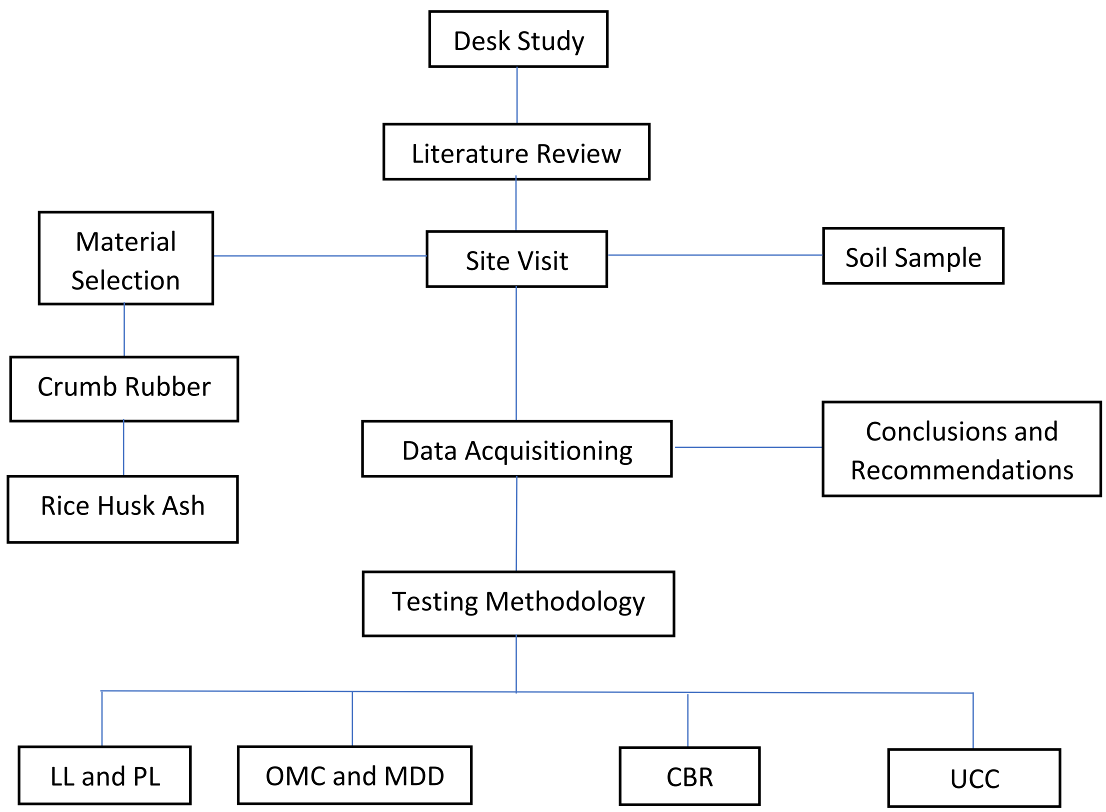
Figure 2: Crumb Rubber

3.4 RICE HUSK ASH:

Rice husk is a derivative of rice crop. During the cleaning process, rice and its husk are separated by the rotary machine. Rice husk has the filler properties. It also acts as a decent binding agent and its specific gravity is also not as much as the natural soil. To obtain rice husk ash, we burnt the husk, cooled it, sieved it through #40 sieve.

Figure 3: Rice Husk Ash

3.5 TESTING METHODOLOGY:



3.5.1 Sieve analysis of soil and draw gradation curve

3.5.1.1 Significance:

Soil properties and classification are affected by the grain size distribution. It is distributed between well graded and poorly graded particles which are ranged as follows:

3.5.1.2 Formulae:

Cu=D60/D10

Cc= $(D30)^2$/(D60xD10)

3.5.1.3 For well graded soil:

A) Cu ≥4 & 1<Cc<3 for gravels

B) Cu≥6 & 1<Cc<3 for sand

If Cu becomes greater it means that soil have different range of particle sizes.

Source:https://www.google.com/url?sa=i&source=images&15

3.5.2 Classification of soil according to AASHTO M-145

Source:https://www.google.com/url?sa=i&source=images&

3.5.2.1 Significance:

This test is carried out to determine soil class (in which class our soil lies). The soil which passes >35% from #200 sieve lies in range from A-4 to A-7 class and which passes <35% lies in range from A-1 TO A-2-7. Class A-4 TO A-7 soil is silty clayey and is considered weak sub grade soil. It requires further stabilization because it is not suitable for heavy load vehicles. So before proceeding with any test we must exactly know that the soil class. Liquid limit and plastic limit of soil are the prerequisites through which we determine the soil type. By Subtracting plastic limit from liquid limit, we get the plasticity index.

Figure 4: Sieve Analysis Of soil

4 sieves are used in experimentation in ascending fashion from #4, #10, #40, #200 & pan.

3.5.3 Liquid limit and plastic limit of soil:

3.5.3.1 Significance:

Liquid limit: It is the water content at which soil changes from plastic to liquid states. Clay is in liquid form at liquid limit but does retain little shear strength.

Plastic limit: The water content at which soil sample changes from plastic state to semi-solid state. If a soil sample has high liquid limit, it will be more fluid and hence will have less bearing capacity but if the liquid limit of soil is low it indicates that it requires great amount of water to become fluid and results in greater bearing capacity.

Figure 5: L.L & P.L of Modified Soil

3.5.4 OMC & MDD OF SOIL

3.5.4.1 Significance

OMC: The water content at which a soil can be compacted to the maximum dry unit weight by a given compactive effort.

Source:https://www.mindat.org/glossary/optimum_moisture_content#:~:text=The%20water%20content%20at%20which,Also%20called%20optimum%20water%20content

MDD: The dry density obtained by the compaction of soil at its optimum moisture content.

Source:https://www.mindat.org/glossary/maximum_dry_density#:~:text=The%20dry%20density%20obtained%20by,at%20its%20optimum%20moisture%20content.

Significance:

Voids between the soils are removed by compaction.

When the soil voids are filled with water, it weakens the soil. Careful compaction of soil decreases the porosity of soil thereby strengthening and improving its bearing capacity.

By adding rice husk ash and crumb rubber as stabilizers, dry density of soil starts decreasing gradually, indicating lowering water content in the soil sample. This lower of dry density consequently improves the bearing capacity of soil.

Figure 6: OMC & MDD OF SOIL

3.5.5 UNCONFINED COMPRESSION TEST (UCC)

In this test, the assumption is that during placement or shearing process no pore water is lost from the soil sample. Therefore, no change in the volume, water content, or void ratio will occur and the sample will remain saturated.

The effective confining stress will hold the sample together resulting from the negative pore water pressure. In UCC pore pressures are not measured so the effective stress remains undetermined. Thus, in UCC Pore pressures are not measured in terms of the total stress. Axial and lateral deformation are commonly measured during testing along with the axial load to determine the elastic modulus and Poisson’s ratio and the Internal Cohesion Angle of the soil sample.

3.5.5.1 Significance:

The purpose of this laboratory is to determine the unconfined compressive strength of a cohesive soil sample. We will measure this with the unconfined compression test, which is an unconsolidated undrained (UU or Q-type) test where the lateral confining pressure is equal to zero (atmospheric pressure).

Source: https://www.cyut.edu.tw/~jrlai/CE7334/Unconfined.pdf

3.5.6 CBR of soil (unsoaked)

3.5.6.1 Significance:

CBR stands for California bearing ratio. To maintain a standard benchmark for all road of a same kind, this method was developed by the US Department of Transportation along with AASHTO system. CBR is used for measuring load bearing capacity of roads and highways, to determine traffic loads. It's an important check for the maintenance of quality roads and pavements. It includes soaked and unsoaked tests. Soaked test, as the name suggests involves keeping the soil sample soaked in water for a day before experimentation while the unsoaked test can be performed immediately without soaking the sample.

Penetration of Plunger (mm)	**Standard Load (KG)**
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

Table 3: CBR loads

CBR values of clayey soil reside in the scale of 3-5%. During experimentation we note the load against penetration from dial gauge. OMC is taken from compaction and at that OMC we set the W.C which is then blown down in 5 layers with 57 blows per layer.

Note:

Standard load at 2.5=1370kg

Standard load at 5.0=2055kg

3.6 LIMITATIONS OF STUDY

- Due to changes in atmospheric & temperature conditions, there was disturbance during soil sample collection and performance of tests.
- Indication of weak zone area where this study will only be evaluated.
- Time duration of study, project.
- Validity & reliability of laboratory gadgets.
- Human errors.

Chapter 4

RESULTS & DISCUSSION

4.1 CASAGRANDE'S TEST

a) **Liquid limit of soil**

Virgin soil

LOCATION **MCE**

BH **1**

Depth **2m**

NO. OF BLOWS	**34**	**21**	**16**	**PLASTIC LIMIT**
MASS OF WET SOIL+CAN	**99.00**	**116.00**	**114.00**	**64.00**
MASS OF DRY SOIL+CAN	**89.00**	**107.00**	**105.00**	**63.00**
MASS OF CAN	**50.00**	**74.00**	**75.00**	**57.00**
MASS OF WATER	10.00	9.00	9.00	1.00
MASS OF SOLIDS	39.00	33.00	30.00	6.00
WATER CONTENT	**25.6**	**27.3**	**30.0**	**16.7**

Table 4: LL&PL (virgin soil)

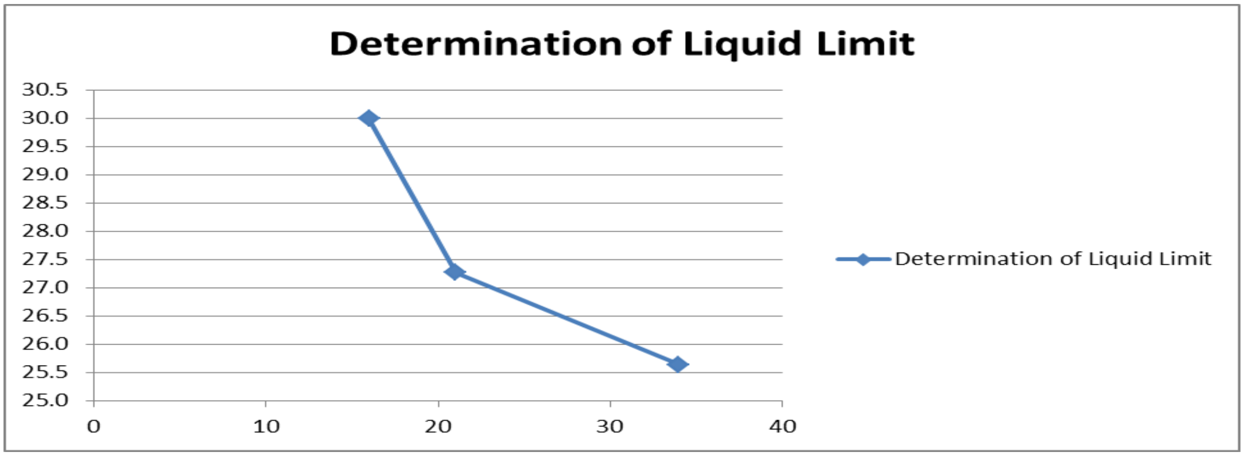


Figure 7: LL (Virgin Soil)

LIQUID LIMIT = 27.4%

PLASTIC LIMIT= 16.7% CL

PI 10.7

1. **Modified L.L and PL by CR and rice husk (2.5%)**

NO. OF BLOWS	26	28	20	PLASTIC LIMIT
MASS OF WET SOIL+CAN	**97.00**	**111.00**	**107.00**	**64.00**
MASS OF DRY SOIL+CAN	**88.00**	**101.00**	**99.00**	**63.00**
MASS OF CAN	**54.00**	**62.00**	**71.00**	**57.00**
MASS OF WATER MASS OF SOLIDS	9.00 34.00	10.00 39.00	8.00 28.00	1.00 6.00
WATER CONTENT	**26.5**	**25.6**	**28.6**	**16.7**

Table 5: LL & PL (2.5% additives)

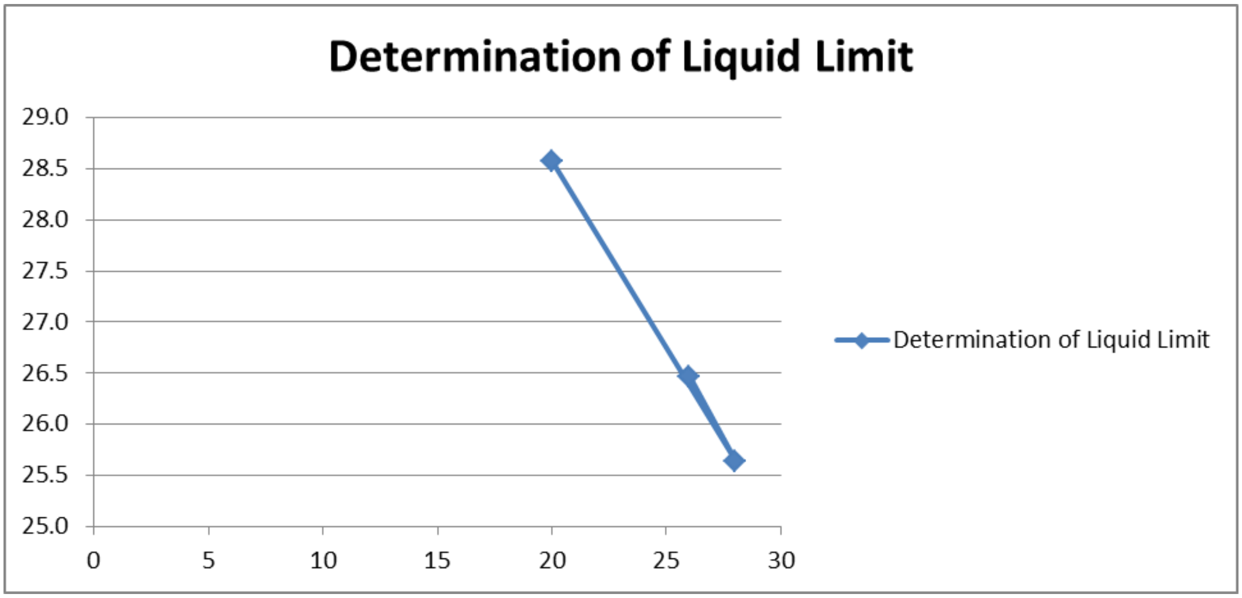


Figure 8: LL (2.5%)

LIQUID LIMIT=	**26.4**	**%**	
PLASTIC LIMIT=	**16.7**	**%**	**CL**
PI	9.7		

2. Modified L.L and PL by CR and rice husk (5%)

NO. OF BLOWS	12	18	28	PLASTIC LIMIT
MASS OF WET SOIL+CAN	**95.00**	**107.00**	**101.00**	**64.00**
MASS OF DRY SOIL+CAN MASS OF CAN	**86.00** **57.00**	**96.00** **50.00**	**94.00** **68.00**	**63.00** **56.00**
MASS OF WATER	9.00	11.00	7.00	1.00
MASS OF SOLIDS	29.00	46.00	26.00	7.00
WATER CONTENT	**31.0**	**23.9**	**26.9**	**14.3**

Table 6: LL&PL (5%)

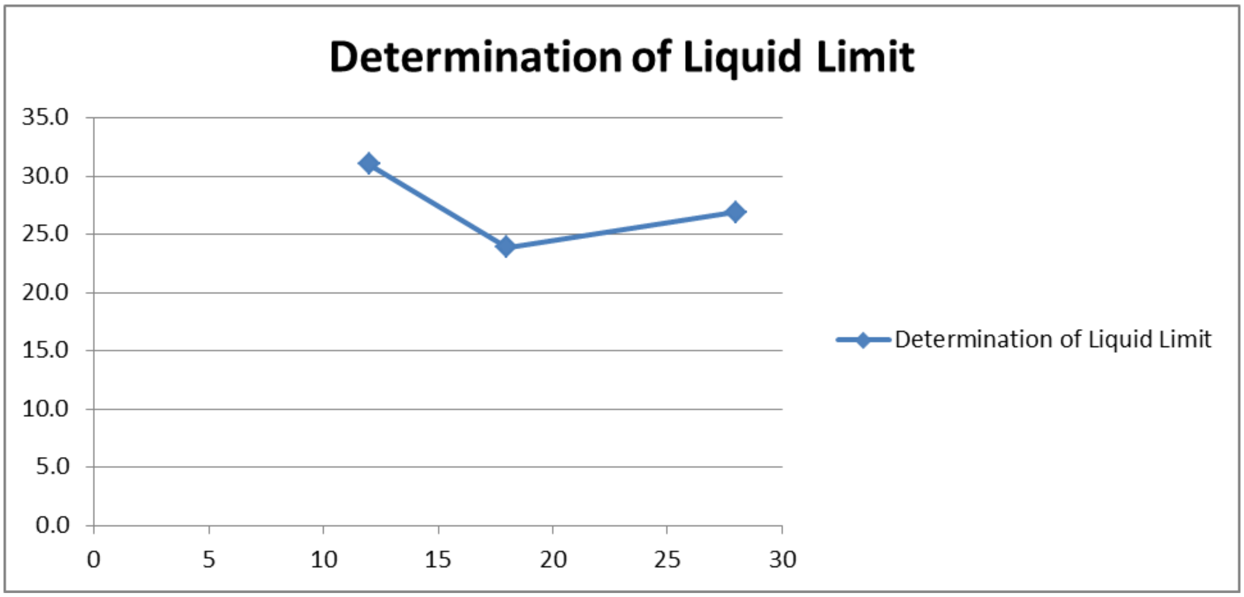


Figure 9: LL (5%)

LIQUID LIMIT= **23.9 %**

PLASTIC LIMIT= **14.3 %** **CL**

PI 9.6

3. Modified L.L and PL by CR and rice husk (7.5%)

NO. OF BLOWS	**17**	**30**	**29**	**PLASTIC LIMIT**
MASS OF WET SOIL+CAN	**92.00**	**103.00**	**98.00**	**62.00**
MASS OF DRY SOIL+CAN	**83.00**	**93.00**	**91.00**	**61.00**
MASS OF CAN	**55.00**	**53.00**	**63.00**	**54.00**
MASS OF WATER	8.00	10.00	7.00	1.00
MASS OF SOLIDS	29.00	39.00	28.00	7.00
WATER CONTENT	**27.6**	**25.6**	**25.0**	**14.3**

Table 7: LL&PL (7.5%)

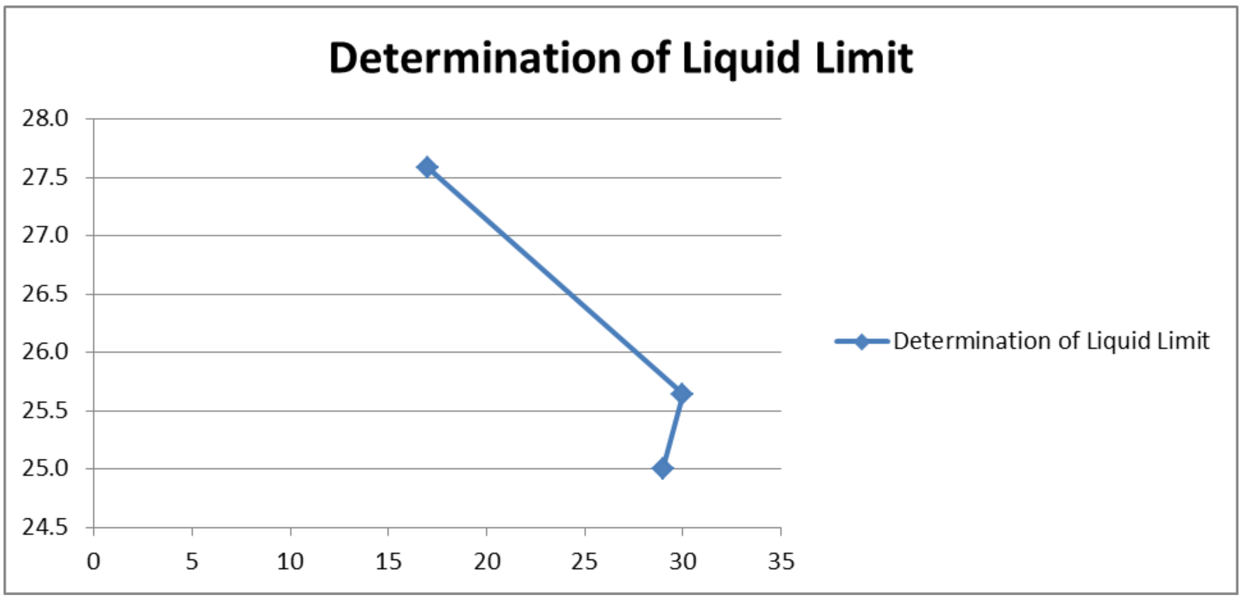


Figure 10: LL (7.5%)

LIQUID LIMIT= **25.6 %**

PLASTIC LIMIT= **14.3 %** **CL**

PI 11.3

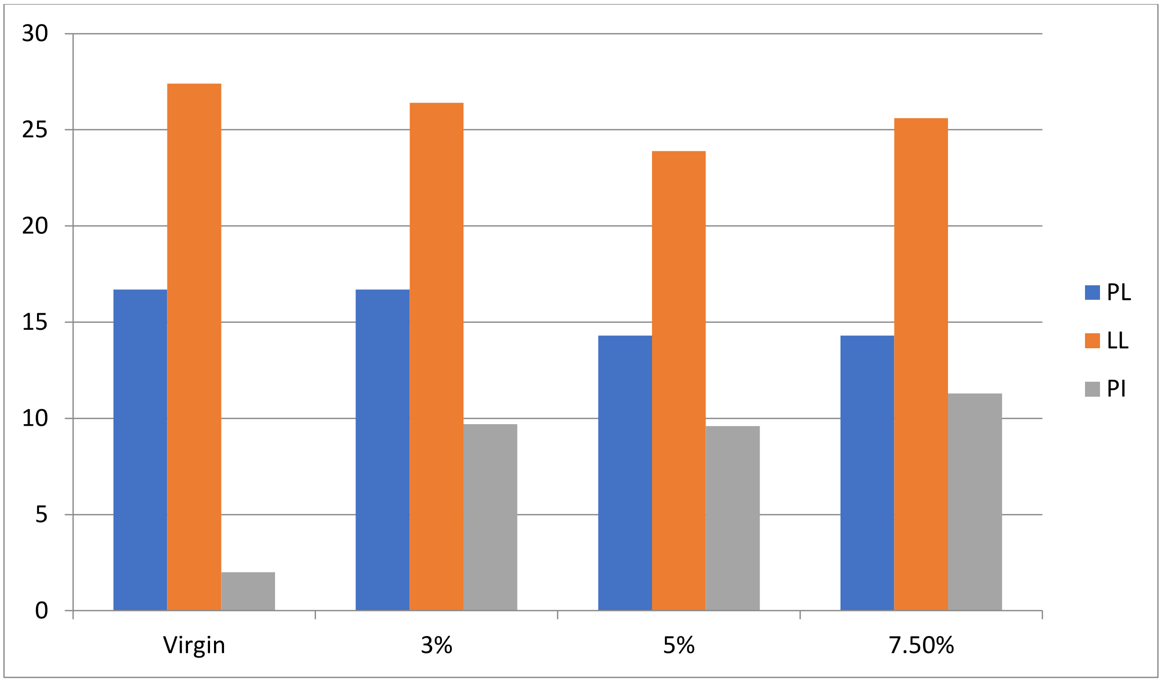


Figure 11: LL (Comparison chart)

Modified L.L and P.L of soil

RESULTS: liquid limit of soil got decreased by adding different proportions of stabilizers liquid limit becomes decreases up to 5% after it increased become when we add high percentage of crumb rubber it shows elasticity, it means that tendency the soil to become flow decreases, same plastic limit increases that means that tendency to going from plastic to semi-solid state got increased. Both stabilizers act as a filler material and replace the soil.

4.2 'OMC' & 'MDD' OF SOIL

4.4.1 Observations & Calculations

1) Soil weight: 5kg

2) No. of layers:03

3) No. of blows for each layer:25

4) Weight of rammer:2.5 kg

5) Diameter of rammer:2 inch

6) Diameter of standard proctor mold:4 inch

7) height of standard proctor mold:4.584 inch

8) Height of hammer:12 inch

9) Diameter of collar:

10) Total energy for drop:12375 lb./ft3

11) Weight of cylinder:1716g

12) Weight of base plate:1900g

13) Weight of mold + plate=3616g

14) Volume of mold=1435.60 cm

4.4.2 Formulae Used:

1) Bulk Density = γb = wv

2) Dry Density = γd = γb1+w100

Lab. Compaction Test (virgin soil)

Trial No.	1	2	3	4	5
W1= wt of Mold + Soil (lbs)	6106.90	6281.20	6401.60	6416.50	6372.40
W2= wt of Mold (lbs)	4424.50	4424.50	4424.50	4424.50	4424.50
W3= wt of Soil(W1-W2) (lbs)	1682.40	1856.70	1977.10	1992.00	1947.90
Vol. of Mold (cft)	934.000	934.000	934.000	934.000	934.000
Wet Density of Soil (w3/vol) (lbs/cft)	1.80	1.99	2.12	2.13	2.09
Dry Density of Soil wet D/(1+m.c/100) (lbs/cft)	1.7	1.8	1.9	1.8	1.8

Table 8: OMC&MDD (Virgin)

Moisture Content

w1= wt of wet soil+cont. (gm)	114.60	122.70	128.10	140.50	116.00
w2= wt of dry soil +cont (gm)	108.90	114.70	115.40	124.30	101.40
w3= wt of cont. (gm)	20.60	20.10	20.10	21.90	21.40
Ww= wt of water (w1-w2) (gm)	5.70	8.00	12.70	16.20	14.60
Ws= wt of dry soil (w2-w3) (gm)	88.30	94.60	95.30	102.40	80.00
M.C= Ww/Wsx100 (%)	6.46	8.46	13.33	15.82	18.25

Table 9: MDD (Virgin)

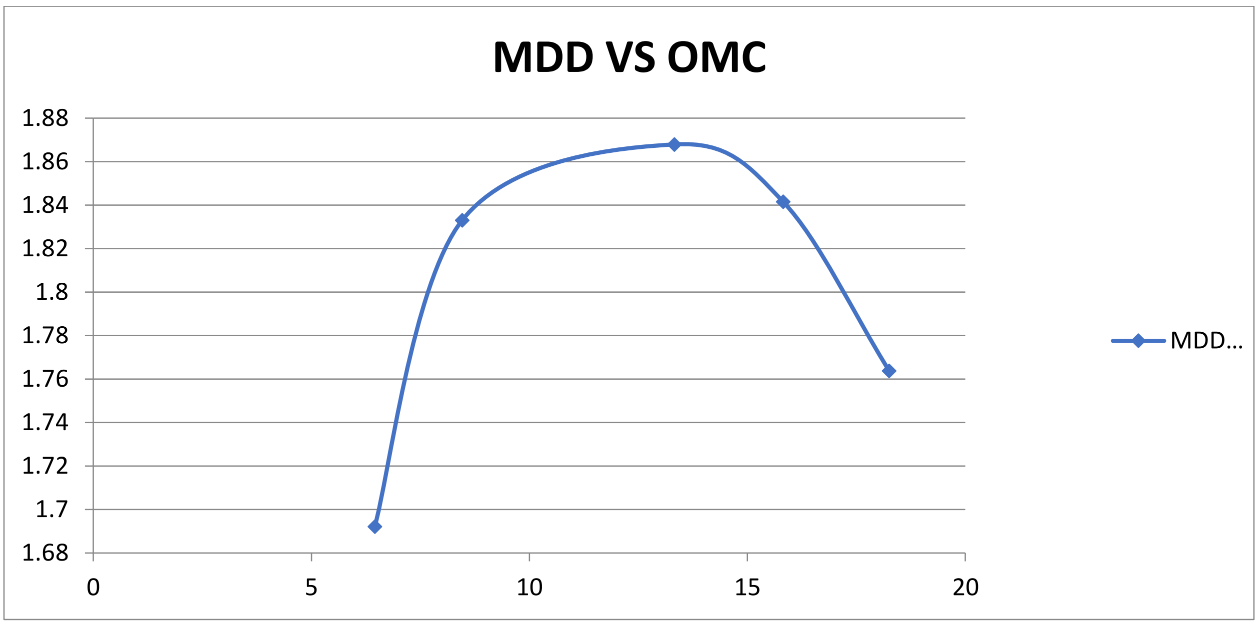


Figure 12: LL (MDD vs OMC Virgin)

M.D.D (Pcf) **118.0**
OMC (%) **13.3**

Lab. Compaction Test (2.5%)

Trial No.	1	2	3	4	5
W1= wt of Mold + Soil (lbs)	6034.00	6155.00	6304.00	6318.00	6264.00
W2= wt of Mold (lbs)	4424.50	4424.50	4424.50	4424.50	4424.50
W3= wt of Soil(W1-W2) (lbs)	1609.50	1730.50	1879.50	1893.50	1839.50
Vol. of Mold (cft)	934.000	934.000	934.000	934.000	934.000
Wet Density of Soil (w3/vol) (lbs/cft)	1.72	1.85	2.01	2.03	1.97
Dry Density of Soil wet D/(1+m.c/100) (lbs/cf	1.6	1.7	1.8	1.8	1.7
M.C= Ww/Wsx100 (%)	6.83	8.49	11.48	15.82	18.25

Table 10: OMC&MDD (2.5% additives)

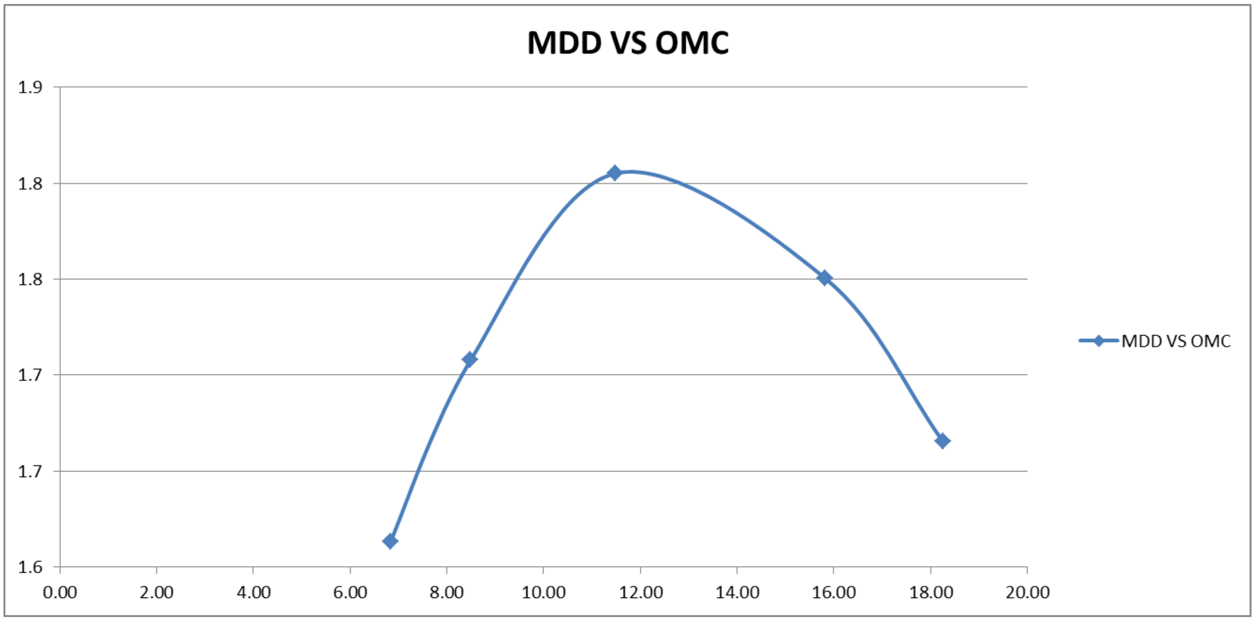


Figure 13: LL (MDD vs OMC 2.5%)

M.D.D (Pcf) **113.6**

OMC (%) **11.5**

Lab. Compaction Test (5%)

Trial No.	1	2	3	4	5
W1= wt of Mold + Soil (gms)	5956.50	6025.50	6203.50	6215.50	6160.50
W2= wt of Mold (gms)	4424.50	4424.50	4424.50	4424.50	4424.50
W3= wt of Soil(W1-W2) (gms)	1532.00	1601.00	1779.00	1791.00	1736.00
Vol. of Mold (cc)	934.000	934.000	934.000	934.000	934.000
Wet Density of Soil (w3/vol) (gms/cc)	1.64	1.71	1.90	1.92	1.86
Dry Density of Soil wet D/(1+m.c/100) (gms/cc)	1.5	1.6	1.7	1.6	1.5
M.C= Ww/Wsx100 (%)	6.56	8.33	10.00	16.79	20.9

Table 11: OMC&MDD (5% additives)

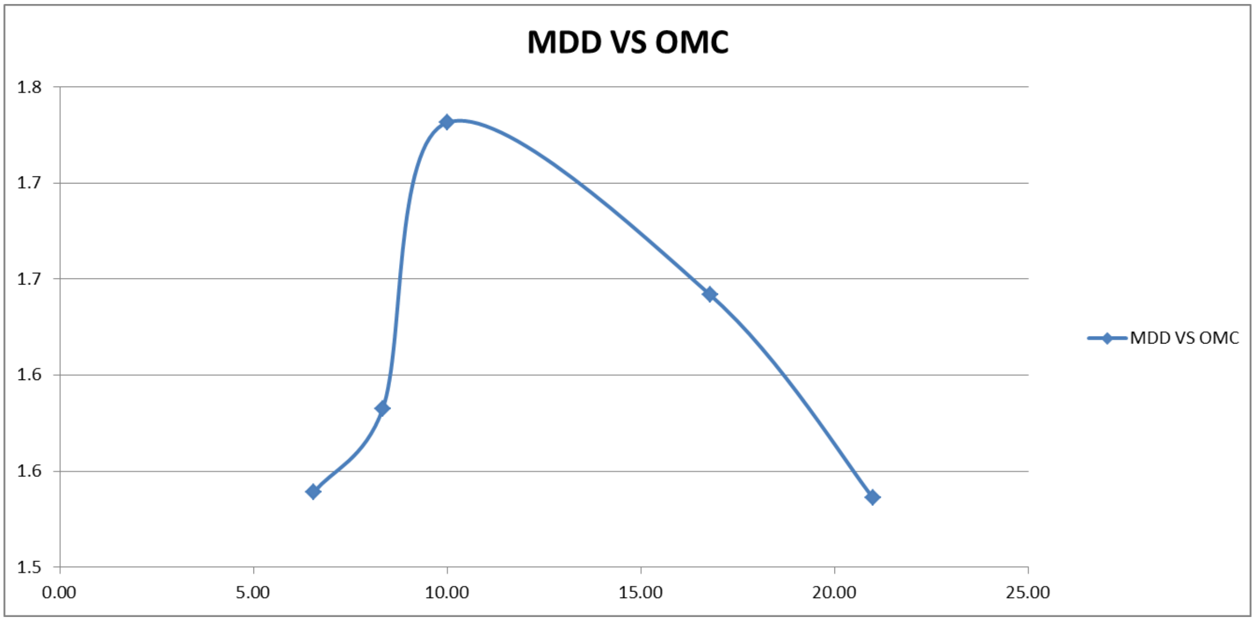


Figure 14: LL (MDD vs OMC 5%)

M.D.D (Pcf)	**111.1**
OMC (%)	**10.0**

Lab. Compaction Test (7.5%)

Trial No.	1	2	3	4	5
W1= wt of Mold + Soil (gms)	5918.00	5984.00	6165.00	6178.00	6123.00
W2= wt of Mold (gms)	4424.50	4424.50	4424.50	4424.50	4424.50
W3= wt of Soil(W1-W2) (gms)	1493.50	1559.50	1740.50	1753.50	1698.50
Vol. of Mold (cc)	934.000	934.000	934.000	934.000	934.000
Wet Density of Soil (w3/vol) (gms/cc)	1.60	1.67	1.86	1.88	1.82
Dry Density of Soil wet D/(1+m.c/100) (gms/cc)	1.4	1.5	1.6	1.6	1.5
M.C= Ww/Wsx100 (%)	10.31	11.86	14.02	19.26	24.14

Table 12: OMC&MDD (7.5% additives)

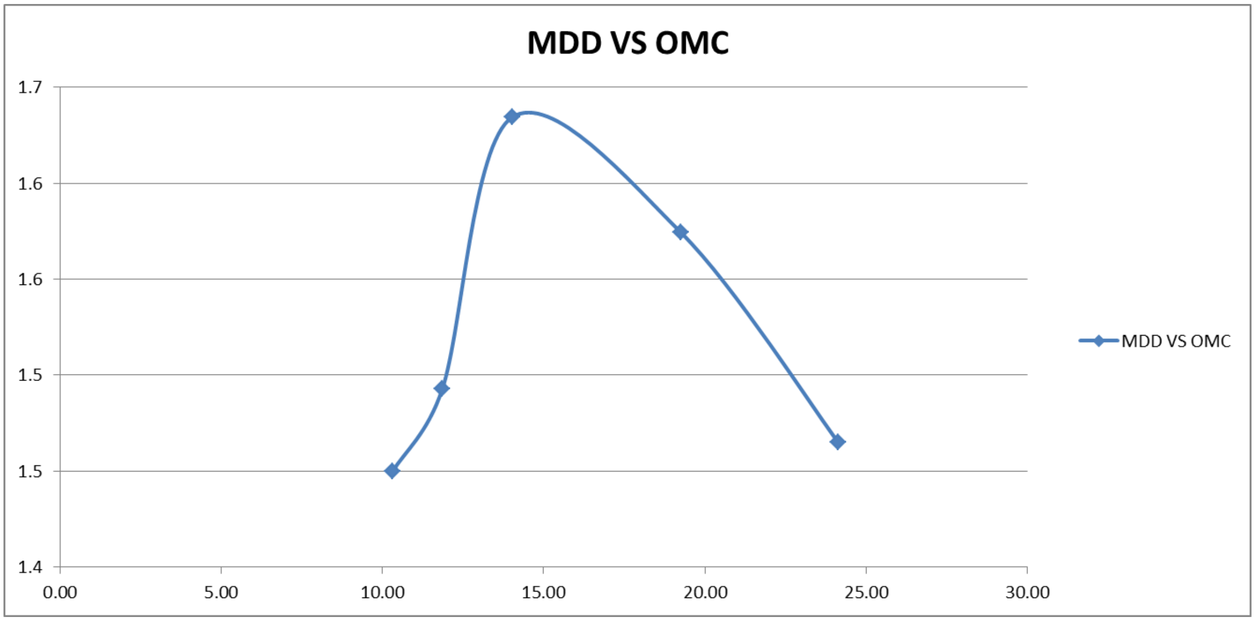


Figure 14: LL (MDD vs OMC 7.5%)

M.D.D (Pcf)	**105.5**
OMC (%)	**14.0**

Modified OMC & MDD of soil

Results: From the compaction characteristics (standard proctor test) it was observed that maximum dry density of soil become decreases as due to light weight of both stabilizers (crumb rubber & rice husk ash) i.e. (1.136 to 1.055) . Compaction is done to remove voids from the soil dry density decreases by adding stabilizers that means compactive effort minimized, no of passes for roller also decreased and stabilization become economical because both stabilizers act as a filler material and filled the pores of soil because pores are either filled with water or air.

4.3 "CBR" TEST OF SOIL

4.3.1 OBSERVATIONS & CALCULATIONS

1. Soil weight: 5kg

2. No. of layers: 05

3. No. of blows for each layer: 57

4. Weight of rammer: 5.0 kg

5. Diameter of rammer:

6. Diameter of standard proctor mold:6 inch

7. Height of standard proctor mold:

8. Height of hammer: 18 inch

9. Diameter of collar: 16 inch

10. Total energy for drop: 56250 lb./ft3

11. Weight of cylinder: 2762.6g

12. Soil samples
    a) Virgin soil
    b) 2.5% RHA and 2.5% Crumb rubber
    c) 5% RHA and 5% Crumb Rubber
    d) 7.5% RHA and 7.5% Crumb Rubber

13. Weight of base plate: 4192.6g

14. Weight of mold + plate= 6955.6g

15. Volume of mold= cm3

Penetration of Plunger
0
0.025
0.05
0.075
0.1
0.125
0.15
0.175
0.2
0.225
0.25
0.275
0.3

4.3.2 Formulae used:

1) $CBR = \frac{\text{CORRECTED LOAD VALUE}}{\text{STANDARD LOAD}} \times 100$

4.3.3 For virgin soil sample:

OMC 13.3%	
MDD 118 Pcf	
65Blows	
DR	**Stress**
0	0.0
8.0	26.7
17.0	56.7
27.0	90.0
43.0	143.3
62.0	206.7
81.0	270.0
98.0	326.7
110.0	366.7
128.0	426.7
145.0	483.3
166.0	553.3
187.0	623.3

Table 13: CBR (Virgin)

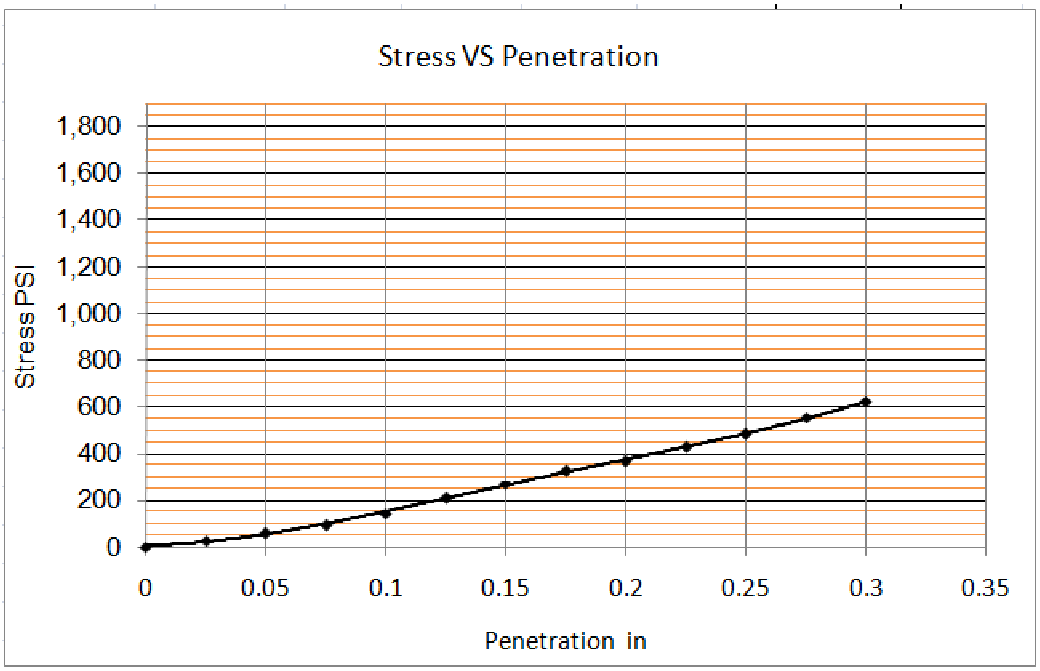


Figure 15: CBR (Stress vs Penetration virgin)

From graph	***65blows***
Stress at 0.1"	143.3
Stress at 0.2"	366.7

CBR (%) at 0.1"	14.33
CBR (%) at 0.2"	24

4.3.4 CRUMB RUBBER (STABILIZER)

4.3.4.1 AT 2.5 % (CRP& RHA)

OMC 11.5%	
MDD 113.6 Pcf	
65Blows	
DR	**Stress**
0	0.0
10.0	33.3
21.0	70.0
33.5	111.7
51.0	170.0
71.0	236.7
86.0	286.7
101.0	336.7
113.0	376.7
134.5	448.3
153.5	511.7
174.5	581.7
192.5	641.7

Table 14: CBR (2.5% additives)

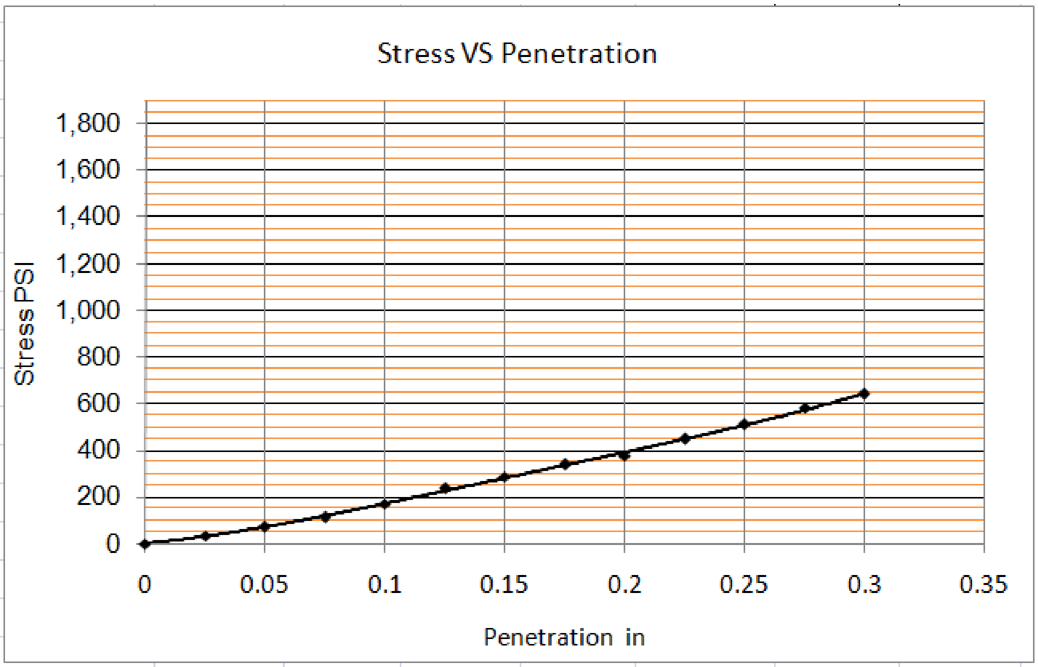


Figure 16: CBR (Stress vs Penetration 2.5%)

From graph	***65blows***
Stress at 0.1"	170.0
Stress at 0.2"	376.7

CBR (%) at 0.1"	17
CBR (%) at 0.2"	25

4.3.4.2 AT 5% (CRP& RHA)

OMC 10%	
MDD 111.1 Pcf	
65Blows	
DR	**Stress**
0	0.0
12.0	40.0
23.0	76.7
40.0	133.3
59.0	196.7
78.0	260.0
93.0	310.0
104.0	346.7
123.0	410.0
141.0	470.0
162.0	540.0
183.0	610.0
198.0	660.0

Table 15: CBR (5% additives)

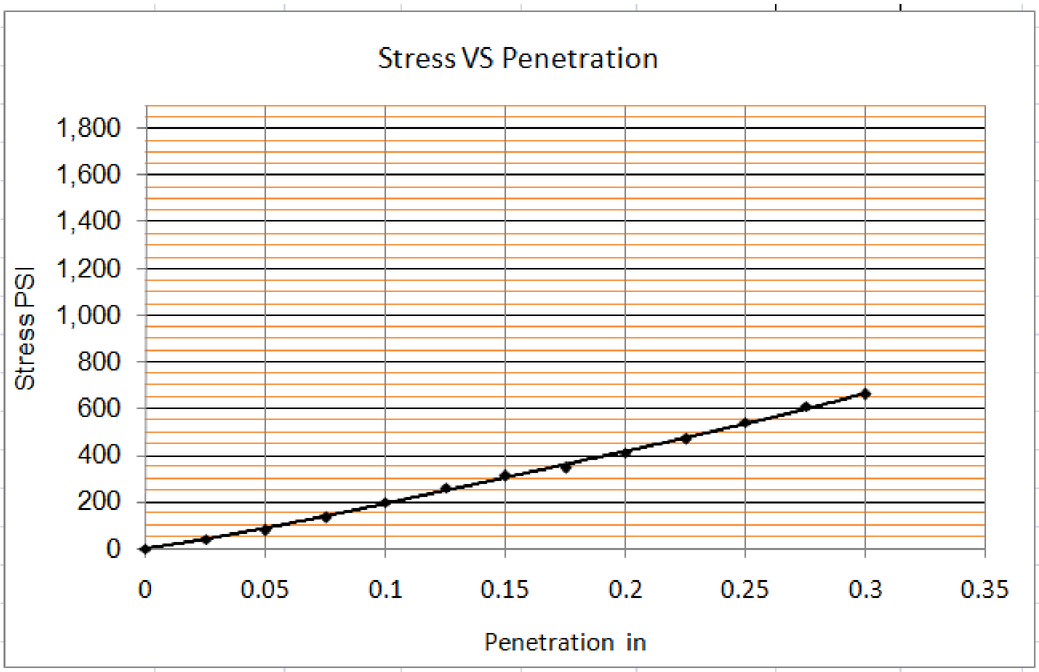


Figure 17: CBR (Stress vs Penetration 5%)

From graph	***65blows***
Stress at 0.1"	196.7
Stress at 0.2"	410

CBR (%) at 0.1"	19.67
CBR (%) at 0.2"	27

4.3.4.3 AT 7.5 % (CRP& RHA)

OMC 14%	
MDD 105.5 Pcf	
65Blows	
DR	**Stress**
0	0.0
16.0	53.3
28.0	93.3
43.0	143.3
64.0	213.3
81.0	270.0
98.0	326.7
112.0	373.3
132.0	440.0
156.0	520.0
178.0	593.3
190.0	633.3
204.0	680.0

Table 16: CBR (7.5% additives)

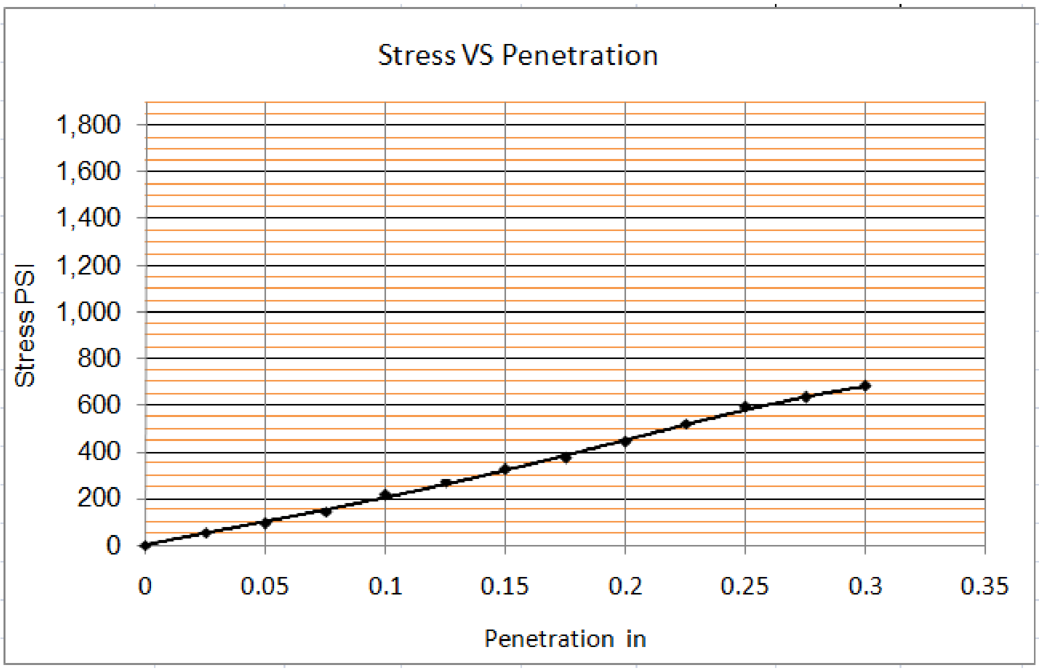


Figure 18: CBR (Stress vs Penetration 7.5%)

From graph	*65blows*
Stress at 0.1"	213.3
Stress at 0.2"	440

CBR (%) at 0.1"	21.33
CBR (%) at 0.2"	29

4.3.6 CBR value of soil mixed with RHA and Crumb Rubber shows a significant amount of increase at 0.1 in and 0.2 in penetration. In comparison, CBR of normal soil vs Soil with (7.5% RHA and 7.5 Crumb Rubber) at 0.1 in penetration increases from 14.33 % to 21.33% and at 0.2 in penetration, increases from 24% to 29%.

4.4 "UCC" TEST OF SOIL

4.4.1 OBSERVATIONS & CALCULATIONS

1. Original specimen length Lo = 130 mm
2. Diameter of specimen = 51.55 mm
3. Proving ring constant = 0.31Kg/Div
4. Soil samples
   e) Virgin soil
   f) 2.5% RHA and 2.5% Crumb rubber
   g) 5% RHA and 5% Crumb Rubber
   h) 7.5% RHA and 7.5% Crumb Rubber

4.4.2

For virgin soil sample:

Wt of Sample	366.3
Dia (cm)	3.8
height(Cm)	7.5
Area(cm2)	11.35
V0lume(cm3)	196.4
density(gm/cm3)	1.85

Strain

DR	**Deformation**	**Axial Strain**
	(mm)	
0	0	0
25	0.25	0.002
50	0.5	0.004
75	0.75	0.005
100	1	0.007
125	1.25	0.009
150	1.5	0.011
175	1.75	0.013
200	2	0.014

225	2.25	0.016
250	2.5	0.018
275	2.75	0.020
300	3	0.021
325	3.25	0.023
350	3.5	0.025
375	3.75	0.027
400	4	0.029
425	4.25	0.030
450	4.5	0.032
475	4.75	0.034
500	5	0.036
525	5.25	0.038
550	5.5	0.039
575	5.75	0.041

Table 17: UCC Strain (Virgin)

Stress

Proving ring dial Reading	**Load Kgf**	**Axial Load Kg/Cm2**
1	0	0
3	0.93	0.08
7	2.17	0.19
10	3.10	0.27
16	4.96	0.43
20	6.20	0.53
25	7.75	0.66
31	9.61	0.81
39	12.09	1.01
49	15.19	1.26
58	17.98	1.48
72	22.32	1.82
57	17.67	1.43
50	15.50	1.25
47	14.57	1.16
35	10.85	0.86

Table 18: UCC Stress (Virgin)

Graph

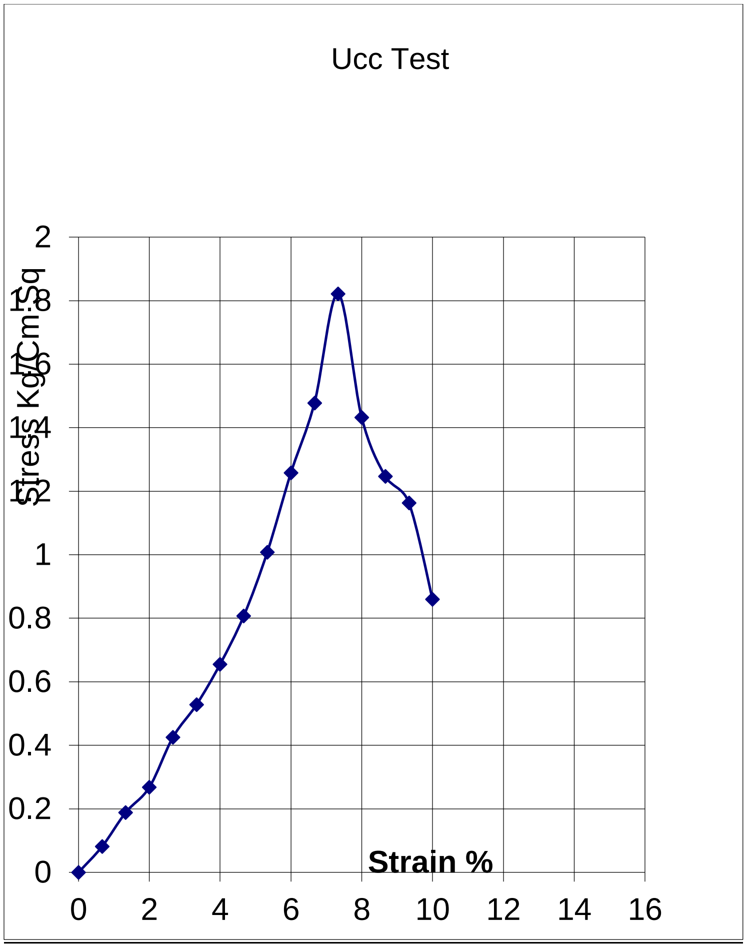


Figure 19: UCC (Stress vs Strain Virgin)

Max Axial Load	22.32
cohesion	0.070
Angle of internal friction	28

For Soil (2.5% Crumb Rubber & 2.5% RHA:

Wt of Sample	369.3
Dia(cm)	3.8
height(Cm)	7.5
Area(cm2)	11.35
V0lume(cm3)	196.4
density(gm/cm3)	1.88

Strain

Deformation		Axial Strain
DR	Deformation	
	(mm)	
25	0	0
50	0.5	0.007
100	1	0.013
150	1.5	0.020
200	2	0.027
250	2.5	0.033
300	3	0.040
350	3.5	0.047
400	4	0.053
450	4.5	0.060
500	5	0.067
550	5.5	0.073
600	6	0.080
650	6.5	0.087
700	7	0.093
750	7.5	0.100

Table 19: UCC Strain (2.5%)

Stress

Proving ring dial reading	Load Kgf	Axial Load Kg/Cm2
1	0	0
4	1.24	0.11
8	2.48	0.22
16	4.96	0.43
22	6.82	0.58
28	8.68	0.74
35	10.85	0.92
44	13.64	1.15
55	17.05	1.42
62	19.22	1.59
70	21.70	1.78
82	25.42	2.08
93	28.83	2.34
80	24.80	2.00
72	22.32	1.78
68	21.08	1.67

Table 20: UCC Stress (2.5%)

Graph

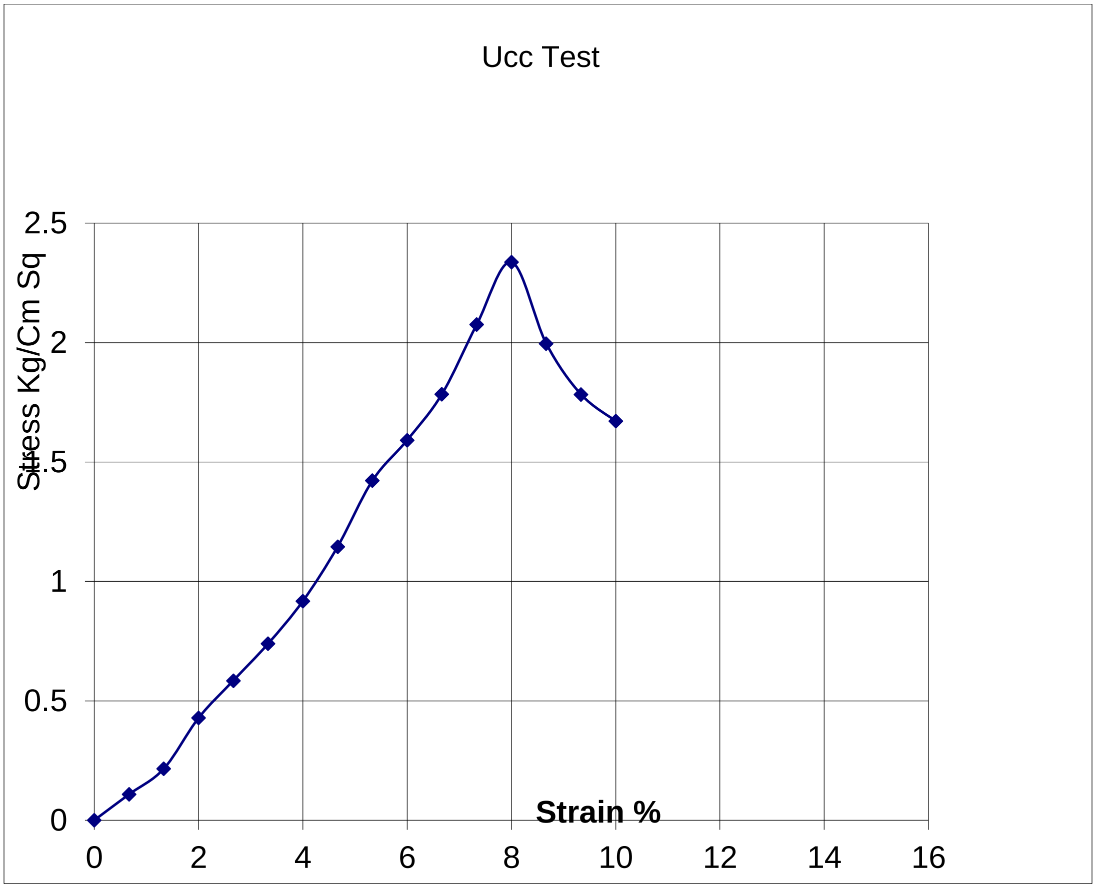


Figure 20: UCC (Stress vs Strain 2.5%)

Max Axial Load	28.33
cohesion	0.074
Angle of internal friction	20

For Soil (5% Crumb Rubber & 5% RHA:

Wt of Sample	371.3
Dia(cm)	3.8
height(Cm)	7.5
Area(cm2)	11.35
V0lume(cm3)	196.4
density(gm/cm3)	1.89

Strain

Deformation		**Axial Strain**
DR	**Deformation**	
	(mm)	
25	0	0
50	0.5	0.007
100	1	0.013
150	1.5	0.020
200	2	0.027
250	2.5	0.033
300	3	0.040
350	3.5	0.047
400	4	0.053
450	4.5	0.060
500	5	0.067
550	5.5	0.073
600	6	0.080
650	6.5	0.087
700	7	0.093
750	7.5	0.100

Table 21: UCC Strain (5%)

Stress

Proving ring dial reading	Load Kgf	Axial Load Kg/Cm2
2	0	0
6	1.86	0.16
13	4.03	0.35
21	6.51	0.56
29	8.99	0.77
39	12.09	1.03
50	15.50	1.31
63	19.53	1.64
77	23.87	1.99
91	28.21	2.34
104	32.24	2.65
112	34.72	2.83
106	32.86	2.66
98	30.38	2.44
85	26.35	2.10
70	21.70	1.72

Table 22: UCC Stress (5%)

Graph

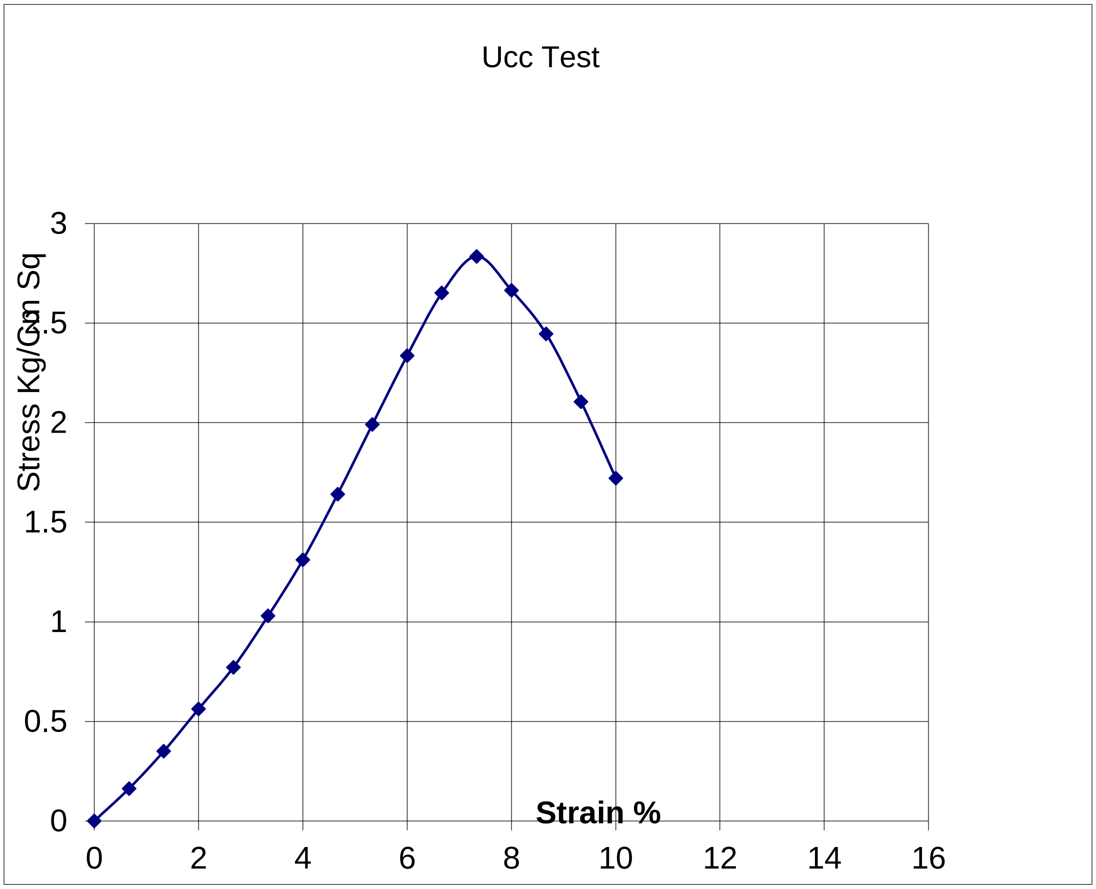


Figure 21: UCC (Stress vs Strain 5%)

Max Axial Load	34.72
cohesion	0.075
Angle of internal friction	18

For Soil (7.5% Crumb Rubber & 7.5% RHA:

Wt of Sample	373.8
Dia(cm)	3.8
height(Cm)	7.5
Area(cm2)	11.35
V0lume(cm3)	196.4
density(gm/cm3)	1.90

Strain

Deformation		Axial Strain
DR	Deformation (mm)	
25	0	0
50	0.5	0.007
100	1	0.013
150	1.5	0.020
200	2	0.027
250	2.5	0.033
300	3	0.040
350	3.5	0.047
400	4	0.053
450	4.5	0.060
500	5	0.067
550	5.5	0.073
600	6	0.080
650	6.5	0.087
700	7	0.093
750	7.5	0.100

Table 23: UCC Strain (7.5%)

Stress

Proving ring dial reading	Load Kgf	Axial Load Kg/Cm2
4	0	0
10	3.10	0.27
20	6.20	0.54
35	10.85	0.94
40	12.40	1.06
50	15.50	1.32
62	19.22	1.63
82	25.42	2.14
90	27.90	2.33
101	31.31	2.59
120	37.20	3.06
126	39.06	3.19
110	34.10	2.76
100	31.00	2.49
95	29.45	2.35
90	27.90	2.21

Table 24: UCC Stress (7.5%)

Graph

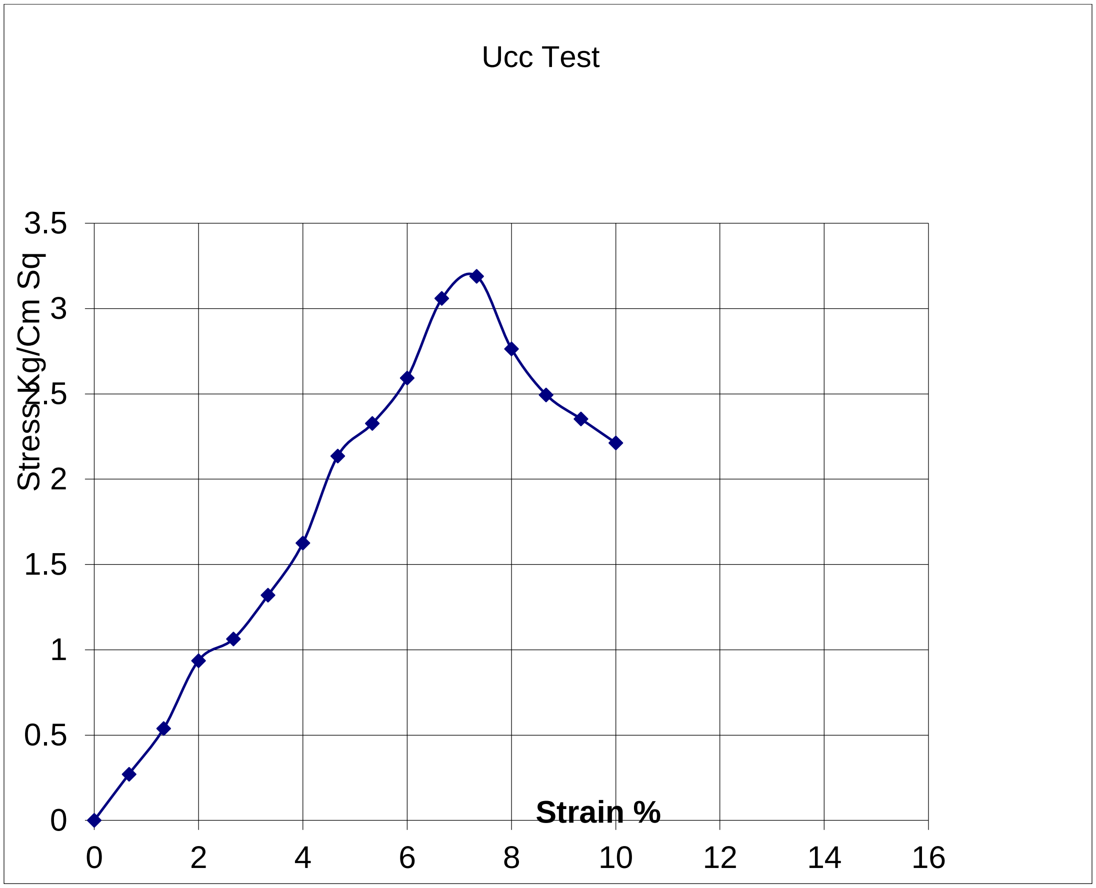


Figure 22: UCC (Stress vs Strain 7.5%)

Max Axial Load	39.06
cohesion	0.076
Angle of internal friction	16

Chapter 5

CONCLUSIONS & RECOMMENDATIONS

CONCLUSIONS

- Use of crumb rubber and rice husk ash in soil will reduce the environmental pollution in terms of disposal problem.
- The use of crumb rubber and rice husk ash as a stabilizer introduces an economical construction cost for sub grade soil stabilization
- As per Casagrande's test, all the specimens lie in clay of low plasticity range of Atterberg limit. A very less change was observed in various specimens as far as PI and LL are concerned.
- It is concluded from proctor test that least moisture content is required to reach MDD at 5% of additives. However, MDD values at (7.5% of additives) are least at 14% OMC. Hence the MDD has a decreasing trend when we increase percentage of additives.
- CBR % increased from 24% to 29%. Percentage improvement in CBR value of stabilized soil can greatly reduce the overall thickness of pavement and hence the overall cost in the construction of road can be decreased.
- As deduced from UCC test the overall compressive strength of the sample increased from 1.82 KG/cm2 to 3.19 KG/cm2 when we added 7.5% additives, which is 1.75 times greater than normal soil. Hence 7.5% of additives will give the maximum strength.
- The cohesion has increased from 0.070 Kg/cm sq to 0.076 Kg/cm sq for soil with 7.5% in comparison with normal soil. Similarly, the internal angle of friction has decreased from 28 to 16 degrees. These factors show that the shear strength will be maximum at 7.5% additives.

RECOMMENDATIONS

- It is recommended that 7.5% of Crumb rubber and rice husk ash by weight of soil should be used. It will reduce pavement thickness and increase overall strength of sub grade.
- Addition of crumb rubber & rice husk ash with different Sieve sizes should be evaluated. This test was carried out after passing additives through sieve no 4.
- Tests can also be carried out by separately adding rice husk ash and crumb rubber.
- Further tests can also be performed at increased percentages of additives to find the optimum value for each test i.e., proctor test, CBR, UCC.
- All the tests were carried out on low plastic clay, Tests can also be carried out on different soil conditions to see the effects of additives.

FUTURE AVENUES

- Fly ash is the waste released from power plants and its quantity is very high so, we can use it for soil stabilization in future.
- The paper industry produces a lot of Organic matter rich waste which is either burned or buried. If mixed with other additives it can be used in waterproofing and stabilization of soil.
- Cement Kiln dust is produced in large quantities and readily available. This can be used to stabilize sub grade.
- Recycle Asphalt Pavement (RAP) is produced during the milling process of existing pavements. It can be used to increase strength of Sub grade.

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