“SOIL STABILIZATION USING PLASTIC WASTE (PET BOTTLES)”

A

PROJECT

Submitted in partial fulfilment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

By

Surendra Netra

(131641)

&

Raman Sharma

(131643)

Under the supervision of

Mr. Aakash Gupta

(ASSISTANT PROFESSOR)

&

Mr. Anirban Dhulia

(ASSISTANT PROFESSOR)

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

WAKNAGHAT, SOLAN – 173234

HIMACHAL PRADESH, INDIA

MAY-2017

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **" SOIL STABILIZATION USING PLASTIC WASTE (PET BOTTLES)"** in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by SURENDRA NETRA (Enrolment no. 131641) and RAMAN SHARMA (Enrolment no. 131643) during a period from July 2016 to May 2017 under the supervision of **Mr. Aakash Gupta** (Assistant Professor) and **Mr. Anirban Dhulia(**Assistant Professor), Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of our knowledge.

Date: - ………………………

Dr. Ashok Kumar Gupta	Mr. Aakash Gupta	Mr.Anirban Dhulia
Head of Department	Assistant Professor	Assistant Professor
Civil Engineering		

ACKNOWLEDGEMENT

It is our duty to acknowledge the help and guidance received from several people in this project. It would not have been possible to prepare this report in this form without their valuable help, cooperation and guidance.

Our sincere thanks to our Project Guides **Mr. Aakash Gupta** (Assistant Professor) and **Mr. Anirban Dhulia (**Assistant Professor) who guided us throughout this project and without them this project report would have been a set of blank papers.

We are also thankful to **Mr. Saurabh Rawat (**Assistant Professor**)** for his valuable insights in this project.

We are grateful to the staff and members of the **Geotechnical Engineering Laboratory** and **Highway Laboratory** for their relentless service and cooperation with us.

ABSTRACT

The study is conducted with the purpose of investigating whether plastic waste finds any usage in soil stabilization. The scope of this study also deals with the effects of waste polyethylene terephthalate (PET) fibres on soil strength. Effects on soil properties by carrying out proctor tests, direct shear tests and California Bearing Ratio tests is the primary concern of this study. The outcomes are analysed for various tests and inferences and conclusions are drawn towards the suitability, usefulness and effectiveness of fibre reinforcement as a mean for soil stabilization. In this present study a series of tests were conducted on soil samples without and with plastic reinforcement. The maximum dry density increases by 4.41 % from soil with no plastic to plastic with 1 % by weight with aspect ratio of 3. Also, optimum moisture content of soil with plastic decreases by 2.21 % from soil with no plastic. From Direct Shear Test, Cohesion increases from 0.1 kg/cm^2 to 0.16 kg/cm^2 from no reinforcement to reinforcement with aspect ratio of 2 with 1 % of plastic content by weight of sample. Angle of internal friction increases from 41° to 43.5° from no reinforcement to reinforcement of aspect ratio 2. Increase in CBR value is 4.86 % for unsoaked sample and increase in CBR value is 6.81 % for soaked sample.

Keywords: plastic waste, pet bottles, soil stabilization.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND SYMBOLS

Abbreviations

PET	Polyethylene terephthalate
CBR	California Bearing Ratio
AR	Aspect Ratio
RDFS	Randomly distributed fibre in soil
HDPE	High Density Polyethylene
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
DST	Direct Shear Test

Symbols

s	Shear Strength
c	Cohesion
σ	Normal Force
ϕ	Angle of Internal Friction
sr	Shear strength of the root reinforced soil
ΔS	Increase in shear strength
C_u	Coefficient of Uniformity
Υ_b	Bulk Density
Υ_d	Dry Density
τ	Shear Strength

CHAPTER-1

INTRODUCTION

1.1 General

Soil properties changes from place to place and required strength and properties may not always be present at every construction site. Replacement is very costly and makes the project inefficient. In these cases, methods like soil stabilization come very handy. Ancient civilization of Romans, Chinese etc. had used the idea of soil stabilization. The evident use of enhancing soil properties and increasing its strength can be seen in these ancient civilizations. They had successfully utilized various methods to improve soil properties and strength and some of these methods were so effective that their buildings and roads still remain to exist. In India, soil stabilization came into picture around 1970s. During those times poor soil was replaced with soil of required properties which in turn lead to extensive use of petroleum and aggregates. Thus general shortage was experienced of these fuels and materials. To completely remove this replacement method new idea of soil stabilization was used by the engineers. Soil stabilization was applied but inefficient and lack of better understanding and technology made soil stabilization lose its favour. Now again with extensive researches and modern technology and also the ever increasing need of infrastructure has given soil stabilization importance. It is now the need of hour for cost effective construction.

1.2 Waste Plastic Fibre

The plastic bottled water industry has grown leaps and bounds in the whole world. Plastic bottles are seen in every corner of the world as no proper alternative is present to carry water. Many surveys have given the proof of the enormous increase in the sales of plastic bottled water. One of the studies done by the international bottled water association is evident of the above statement. It said that increment in sales of bottled water is 500 percent over the last decade and usage of plastic for this purpose is 1.5 million tons. The problem is that the recycling of plastic bottles has not been keeping up the pace with the dramatic increase of their manufacturing. Every second the world sees 1500 bottles being dumped. Annual consumption is around 10 million in the whole world as was reported in 2007. This number grows by 15 % every year. This has lead to PET being the most abundant waste in solid urban waste. The problem arrives when the recycled or returned bottle is very low relatively. Consumption of plastic is very high in world as every Indian uses 1 kg of plastics every year and world annual average is an alarming 18 kg.

1.3 Soil Stabilization

Soil stabilization improves the engineering performance of soil. For this it includes various methods for modifying the properties of a soil. Stabilization is being used for a variety of engineering works. The most common application being in the construction of road and air field pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of locally available materials. Stabilized soil is soil with increased strength and durability. Such modified soil is aimed to hold good under design use conditions and for the designed life of project. As the soil properties vary too much, various methods employed for stabilization may also vary so it is tested on lab first.

1.4 Needs and Advantages

Soil stabilization improves load bearing capacity of soil reduces by making significant changes to its properties. It removes variations and imparts strength to soil. Due to lesser variations bearing capacity can be predicted easily hence it is advantageous to do soil stabilization. Well graded soils are desirable as they may offer lesser number of voids so it is optimal to mix different types of soils to increase strength. In these cases inferior quality soil is too expensive to be wholly replaced thus soil stabilization is of need here.

Some advantages are-

- Soil stabilization improves the strength of the soil, thus, increasing the soil bearing capacity.
- Increased bearing capacity is more cost and energy effective than going for deep foundations.
- Soil stabilization may also increase stability of slopes.
- Soil erosion and formation of dust may be prevented using soil stabilization especially in dry and arid weather.
- Soil stabilization may also be used for water proofing as it may in return it will not let soil loose its strength by not letting water enter into it.
- Soil stabilization helps in reducing the soil volume change due to change in temperature or moisture content.
- Stabilization improves the workability and the durability of the soil.

1.5 Methods

a) Mechanical method of stabilization

Mechanical method of stabilization incorporates the procedure of mixing different graded soil. Thus doing this will lead to attain the desired properties. This method may be used in situ or at any place of convenience. Compaction of the final mixture will give the required properties.

b) Additive method of stabilization

It refers to the addition of manufactured products into the soil, which in proper quantities enhances the quality of the soil. Materials such as cement, lime, bitumen, fly ash etc. are used as chemical additives. Sometimes different fibres are also used as reinforcements in the soil. The addition of these fibres takes place by two methods;

1) Oriented fibre reinforcement

The fibres are arranged in some order and all the fibres are placed in the same orientation. The fibres are laid layer by layer in this type of orientation. Continuous fibres in the form of sheets, strips or bars etc. are used systematically in this type of arrangement.

2) Random fibre reinforcement

The fibres are randomly arranged with the soil mass. Mixing is then followed until a more or less homogeneous mixture is made. Materials used in this type of reinforcements are generally derived from paper, nylon, metals or other materials having varied physical properties. Randomly distributed fibres have some advantages over the systematically distributed fibres. The reinforcement by this method is easy to add and mix and it is somehow similar to addition of admixtures such as cement, lime etc. This method also offers strength isotropy, decreases chance of potential weak planes which occur in the other case and provides ductility to the soil.

1.6 Soil Reinforced With Waste Plastic

Soil when mixed with plastic waste behaves like a fibre reinforced soil. Strength isotropy is imparted when plastic waste/fibres are distributed throughout a soil mass. This addition may also reduce the chance of developing potential planes of weakness. Mixing of plastic waste fibres with soil can be carried out in a concrete mixing plant or with a self-propelled rotary mixer. Plastic fibres could be added either in layers or can be mixed randomly throughout the soil. An earth mass stabilized with discrete, randomly distributed plastic waste/fibres resembles earth reinforced with chemical compounds such as lime, cement etc. in its engineering properties. The latest and popular technique of fibre mixing is Randomly distributed fibres in soil (RDFS) in which fibres of preferred type and quantity are added into the soil mix. The composite material is called 'ply soil'. In reinforced earth, the reinforcement in the form of sheets etc. is laid horizontally at specific intervals, where as in RDFS, fibres are mixed randomly in soil thus making a homogeneous mass and maintain the isotropy in strength. Improvement of soil by tree roots is similar to the work of fibres. Fibre reinforced soil can be used effectively in embankment, subgrade, subbase and other such cases.

The fibres themselves should be readily available, non-degradable capable of being easily blended into the soils and compacted. As of recent times, different synthetic fibres like polypropylene, plastic, nylon, glass, asbestos, metallic fibres etc. and natural fibres like coir, sisal, bamboo etc. are being used as soil reinforcement. Various researches have shown beyond doubt that addition of fibre in soil improves the overall engineering performance of soil. Notable properties that improve are shear strength, ductility, toughness, isotropy in strength, CBR values etc. with reduction of compressibility characteristics.

CHAPTER-2

LITERATURE REVIEW

Chandrakaran proposed utilization of waste plastic in strips form in the pavement construction. The waste plastic was obtained from milk pouches. After doing tests and studying the results he indicated the increase in shear strength and tensile strength. Also CBR value of soil saw increment in value. The waste plastic (milk pouches) used in the experiment was of thickness 0.5mm. Also plastic was of high density. Other than this, it was also observed that the plastic strips have properties like high tensile strength, low permeability etc

Waldron in his experiment carried out direct shear test. For this experiment he used a large direct shear device. His objective was to study the effect plant roots has on soil shearing resistance. The soil he used for this purpose was a mix of clay, sand and silt. He described the load-deformation characteristics with a force equilibrium model. He used the original Mohr-Coulomb's equation of shear strength ($s = c + \sigma \tan \phi$) in a modified form, for root reinforced soil as

$$sr = c + \sigma \tan \phi + \Delta S$$

where, sr is the shear strength of root reinforced soil.
ΔS is increase in shear strength on account of root reinforcement.
C and ϕ are the shear strength parameters of the soil.

In the experiment done by Gray and Ohashi many direct shear tests were done on dry sand with different reinforcements. The reinforcements included synthetic (PVC), natural (reed), and metallic (copper wire) fibres. Objective was to evaluate the effect of parameters such as fibre orientation, fibre content, fibre area ratio, fibre stiffness on contribution to shear strength.
Based on the experimental results, Gray and Ohashi concluded that

(i) Shear strength increases are directly proportional to the fibre area ratio, fibre content and fibre stiffness.

(ii) Fibre reinforcement with relatively low modulus, behave as ''ideally extensible''. They do not rupture during shear. Their main role is to limit the amount of post peak reduction in shear resistance in dense sand.

(iii) Shear strength envelopes for fibre reinforced sand clearly showed the existence of a threshold confining stress below which the fibres tend to slip or pull out. Envelopes are parallel to each other for confining stresses above this threshold stress. This behaviour in turn indicates that the fibres do not affect the angle of internal friction of soil above this stress.

Setty and Rao conducted triaxial tests. Along with it CBR tests and tensile strength tests on silty sand, reinforced with randomly distributed polypropylene fibres were also done. The test results indicated that the soils showed increase in cohesion intercept (5.7 times) and a slight decrease in angle of internal friction implying overall effect to increase shear strength. This increment was with an increase in fibre content upto 3% by weight. Adding fibres upto 2% improved dry strength, but afterwards there was a decrease in dry strength.

Maher and Gray carried out triaxial compression tests. The soil used was sand. Randomly distributed fibres were introduced as reinforcement. The purpose was to observe the effects of fibres in sol behaviour. They observed that sand with reinforcement increase in coefficient of uniformity (Cu), have lower sphericity and smaller average grain size (D50), result in higher fibre contribution to strength. They also proposed a force equilibrium model based on statistical analysis for randomly distributed discrete fibre reinforced sand. The failure plane was observed to be the same as given by Mohr-Coulomb failure criteria i.e. at an angle of ($45^o + \phi/2$) with horizontal.

Choudhary et al proposed adding HDPE as reinforcement in soil. They added reinforcement to study the effect of fibres has on soil by adding them in different proportions and in different percentages by weight. The following conclusions were drawn from the results-

(i) Addition of HDPE strips to local sands increases the CBR value.

(ii) The maximum improvement in CBR is obtained when the strip contents 4% and the aspect ratio 3.

(iii) The reinforcement benefit increases with an increase in waste plastic strip content and length.

(iv) The maximum CBR value of a reinforced system is approximately 3 times that of an unreinforced system.

Sivakumar Babu and Chouksey conducted experiments by adding plastic waste to soil. By doing this they observed stress-strain response of plastic waste mixed soil. They observed that by adding plastic strength is improved. Addition to this compressibility also reduced significantly even with small addition of plastic amount. As a result many other observations were recorded like improvement in bearing capacity and reduction in settlement in the design of shallow foundations. Based on test results, it is observed that the strength of soil is improved and compressibility reduced significantly with addition of a small percentage of plastic waste to the soil and thereby bearing capacity improvement and settlement reduction in the design of shallow foundation.

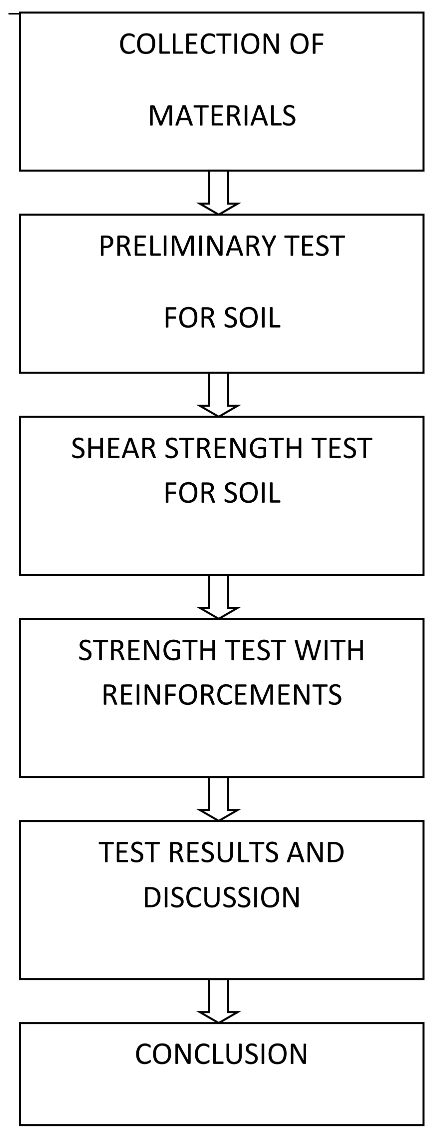
Hence it appears that there is scope of study behaviour of clay mixed with randomly distributed plastic fibre obtained from waste PET bottle lies in recycling of plastic waste to reduce environmental hazard.

CHAPTER 3

METHODOLOGY

3.1 General

The following tests are being carried out well before the reinforcement is added to properly determine the properties of soil. These tests are used to find out the various characteristics of the soil. These tests help in determining properties such as size of soil, specific gravity, cohesiveness, Atterberg's limit etc.



3.2 Tests Conducted

The experimental work consists of the following steps:

1. Specific gravity of soil
2. Determination of soil index properties (Atterberg Limits)
   (i) Liquid limit by Casagrande's apparatus
3. Particle size distribution by sieve analysis
4. Preparation of reinforced soil samples.
5. Determination of the maximum dry density (MDD) and the corresponding optimum moisture content (OMC) of the soil by Proctor compaction test with and without reinforcement.
6. Determination of the shear strength by:
   Direct shear test (DST).
7. California Bearing Ratio Test.
   I) Soaked
   II) Unsoaked

3.3 Materials

Soil sample Location: From Dumehar Bani village, waknaghat, solan (H.P.)

The properties of soil were determined by standard test procedures and tabulated as per provision of IS codes of practice. The routine tests were done for characterization of soil.

Reinforcement: Randomly oriented waste plastic (PET Bottles) fibres 1% of weight of sample with aspect ratios 1, 2, 3 and 4.

Preparation of samples

Following steps are carried out while mixing the fibre to the soil,

- All the soil samples are compacted at their respective maximum dry density (MDD) and optimum moisture content (OMC), corresponding to the standard proctor compaction tests.
- The different values adopted in the present study for the Aspect ratio of fibre reinforcement are 1, 2,3and 4 with constant weight of 1% of weight of sample.

CHAPTER 4

TEST RESULTS AND OBSERVATIONS

4.1 Specific Gravity

Specific gravity of a substance denotes the number of times that substance is heavier than water. In simpler words we can define it as the ratio between the mass of any substance of a definite volume divided by mass of equal volume of water.

Table 1: Values of Specific Gravity for Different Soils

1.	SAND	2.63-2.65
2.	SILT	2.65-2.67
3.	CLAY AND SILTY CLAY	2.67-2.9
4.	ORGANIC SOIL	<2.00

Test was conducted three times for better accuracy of the value. It was measured by the help of a volumetric flask in experimental setup where the volume of the soil is found out and its weight is divided by the weight of equal volume of water.

Table 2 : Calculation of Specific Gravity

Sample No.	1	2	3
Weight of Pycnometer (W1) (gm)	461.9	461.9	461.9
Weight of Pycnometer + soil(W2) (gm)	660.3	660.3	660.3
Weight of Pycnometer + soil + water (gm)	1340.1	1337.4	1342.2
Wt. of Pyconometer + Water(W4) (gm)	1216.4	1215.9	1217
Specific gravity	2.65	2.58	2.68

Average specific gravity comes out to be 2.64. As from Table 1 it can be hinted that soil is of sand type.

4.2 Liquid Limit

It can be defined as the minimum water content at which the soil, though in liquid state, shows small shearing strength against flowing. It is measured by the Casagrande's apparatus and is denoted by w_L. The Casagrande's tool cuts a groove of size 2mm wide at the bottom and 11 mm wide at the top and 8 mm high. The number of blows used for the two soil samples to come in contact is noted down. Graph is plotted taking number of blows on a logarithmic scale on the abscissa and water content on the ordinate. Liquid limit corresponds to 25 blows from the graph.

Table 3 : Calculation of Liquid Limit

Sample No.	1	2	3	4
Mass of empty container(gm)	20	20	20	20
Mass of container + wet soil (gm)	150.1	90	85	92.2
Mass of container + dry soil (gm)	120.3	74.6	73.3	80.9
Water content (%)	29.71	28.2	21.9	18.5
No. of blows	17	22	40	55

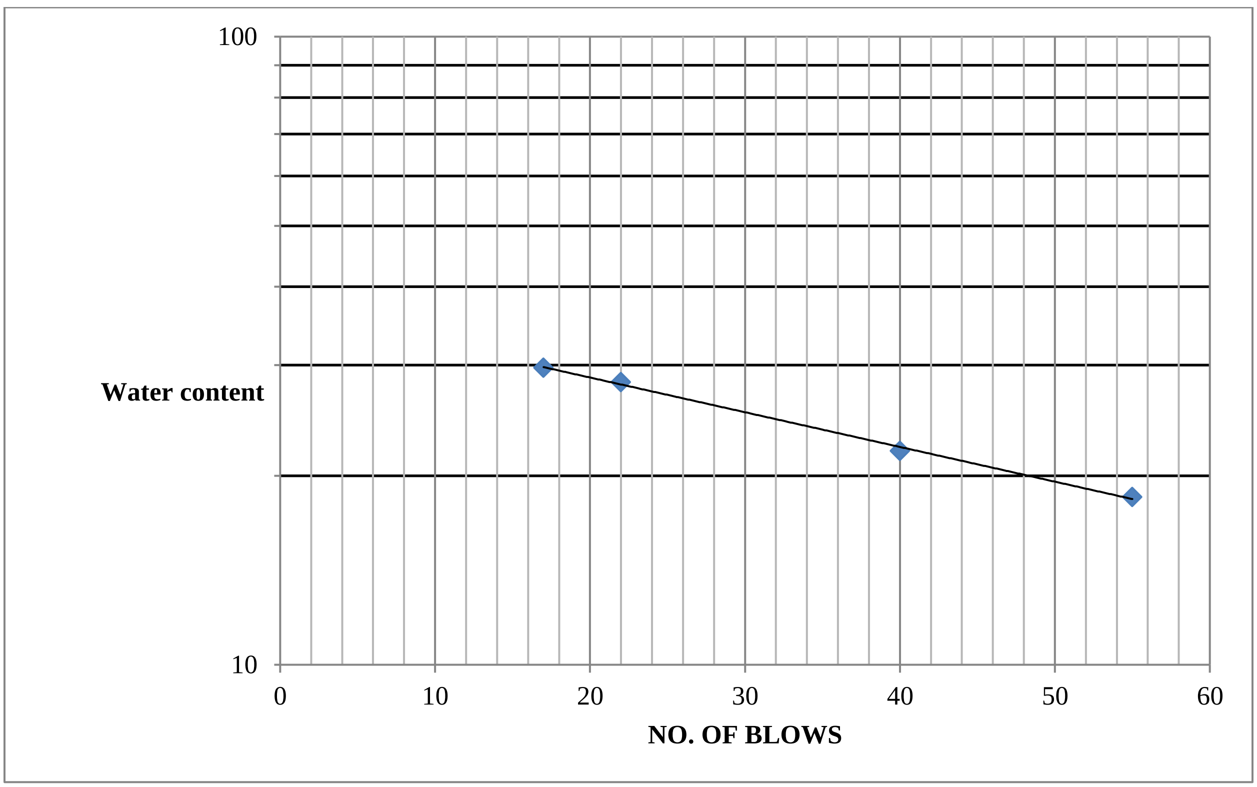


Figure 1: Semi-logarithmic Graph Plot between No. of Blows and Water Content

From the graph, water content at 25 blows is 27.14 %. Hence Liquid Limit is 27.14 %.

4.3 Particle Size Distribution

The percentage of various sizes of particles in a given dry soil sample is found by a particle-size analysis or mechanical analysis. Mechanical analysis means the separation of a soil into its different size fractions. The mechanical analysis is performed in two stages : (i) sieve analysis and (ii) sedimentation analysis or wet mechanical analysis.

The first stage is meant for coarse grained soils only, while the second stage is performed for fine grained soils. In general, a soil sample may contain both coarse as well s fine grained particles and hence both stages may be necessary. The sieve analysis is however, the true representative as it is not affected by the temperature. Both are followed by plotting the results on a semi-log graph. The percentage finer *N* as the ordinate and the particle diameter i.e. sieve size as the abscissa on a logarithmic scale. The curve tells us about the type and gradation of soil.

Table 4: Calculation of Percentage Finer

Sieve size	Retained (g)	Retained (%)	Cumulative retained (%)	Cumulative finer (%)
20 mm	0	0.00	0.00	100.00
10 mm	5.50	5.50	0.46	99.54
4.75 mm	92.00	97.50	8.13	91.88
2 mm	296.70	394.20	32.85	67.15
1.18 mm	294.90	689.10	57.43	42.58
600 microns	215.70	904.80	75.40	24.60
425 microns	96.90	1001.70	83.48	16.53
300 microns	16.20	1017.90	84.83	15.18
150 microns	89.00	1106.90	92.24	7.76
75 microns	55.10	1162.00	96.83	3.17
Pan	35	1197.00	99.75	0.25

For analysis of the particle distribution, we sometimes use D_{10}, D_{30}, and D_{60} etc. terms which represents a size in mm such that 10 %, 30 % and 60 % of particles respectively are finer than that size. The size of D_{10} also called the effective size or diameter is a very useful data. There is a term called uniformity coefficient Cu which comes from the ratio of D_{60} and D_{10}, it gives a measure of the range of the particle size of the soil sample.

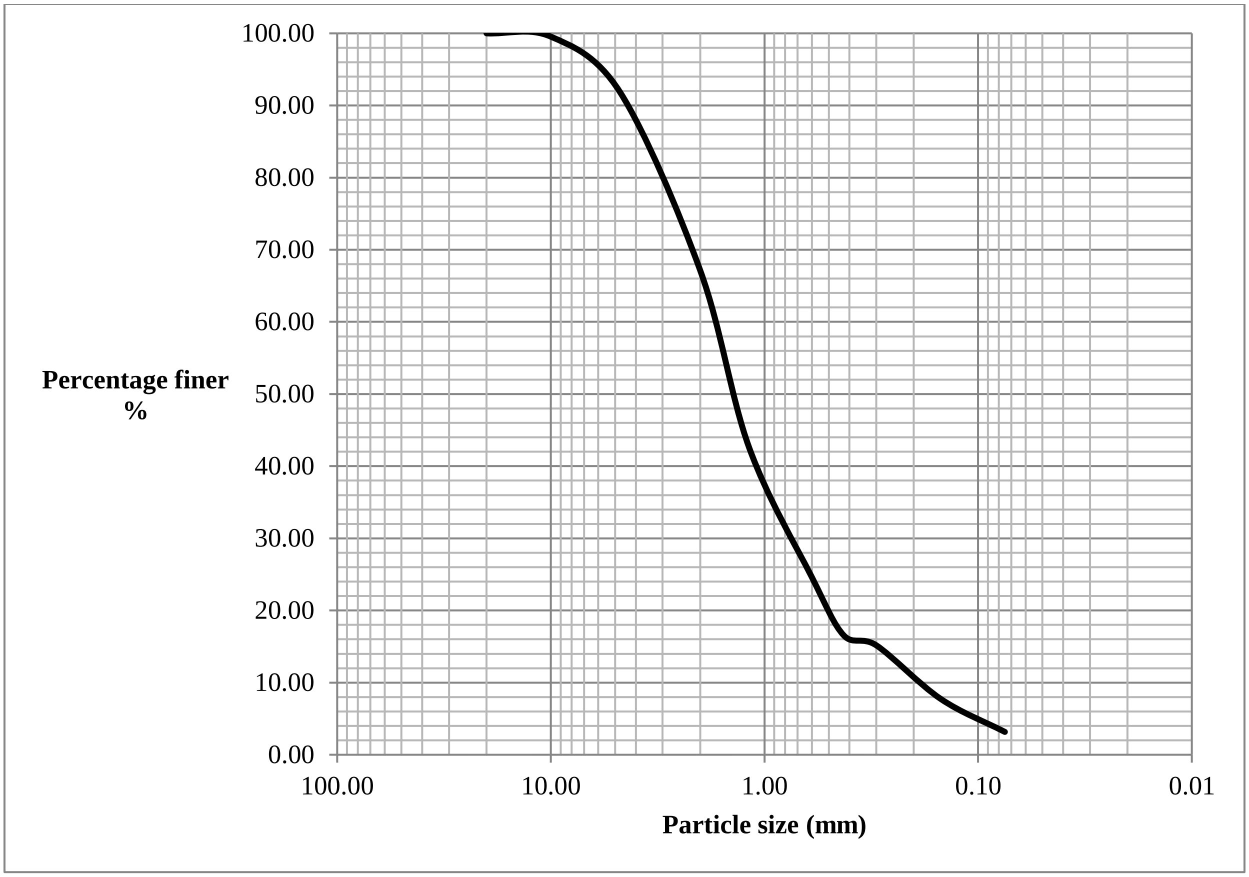


Figure 2 : Semi-logarithmic Graph Plot between Particle Size and Percentage Finer

From Graph-
D_{10} =0.2mm
D_{30} =0.75mm
D_{60} =1.8mm

Uniformity Coefficient= D_{60}/D_{10}
=1.8/0.2
=9
Coefficient of curvature =$D_{30}^2/D_{10}*D_{60}$
=$0.75^2/0.2*1.8$
=1.56

So according to the gradation curve, we can say that the soil is of type SW(well graded sand), as the percentage fine passing thru the #200 sieve (0.075mm) is less than 5 % (by IS code).

4.4 Standard Proctor Compaction

Standard proctor test is a test in which soil is compacted in a standardized mould in three equal layers , each layer being given 25 blows of the 2.5 kg rammer dropped from a height of 31 cm.Nearly 5 setups with different moisture content is done to know optimum moisture content and maximum dry density. The compactive energy used for this test is 6065 kg cm per 1000 ml of soil. The experimental setup consists of

(i) cylindrical metal mould (internal diameter- 10.15 cm and internal height- 11.7 cm),
(ii) detachable base plate,
(iii) collar (5 cm effective height),
(iv) rammer (2.5 kg).

Our test includes light weight proctor test with and without reinforcement. Reinforcement used is 1 % by weight of the sample with varying aspect ratio from 1 to 4.

4.4.1 Without reinforcement

Table 5: Calculation of Optimum Moisture Content and Maximum Dry Density without Reinforcement.

TEST NO.	1.00	2.00	3.00	4.00
Weight of empty mould+ Weight of base plate(W_m) gm	4321.00	4321.00	4321.00	4321.00
Internal diameter of mould (d) cm	10.00	10.00	10.00	10.00
Height of mould (h) cm	12.70	12.70	12.70	12.70
Volume of mould (V)=(π/4) d^2h cc	1000.00	1000.00	1000.00	1000.00
Weight of mould + compacted soil + Base plate (W1) gm	6297.40	6449.10	6557.40	6553.22
Weight of Compacted Soil (W1-Wm) gm	1976.40	2128.10	2236.40	2232.22
Bulk Density γ_b	1.98	2.13	2.24	2.23
For Water Content				
Weight of Container (X1) gm	20.00	20.00	20.00	20.00
Weight of Container + Wet Soil (X2) gm	142.40	151.00	134.00	163.00
Weight of Container + dry soil (X3) gm	132.20	138.00	119.20	141.90
Weight of dry soil (X3-X1) gm	112.20	118.00	99.20	121.90
Weight of water (X2-X3) gm	10.20	13.00	14.80	21.10
Water content W%= (X2-X3/X3-X1)*100	9.09	11.02	14.92	17.31
Dry density Υ_d = Υ_b/1 + (W/100) gm/cc	1.81	1.92	1.95	1.90

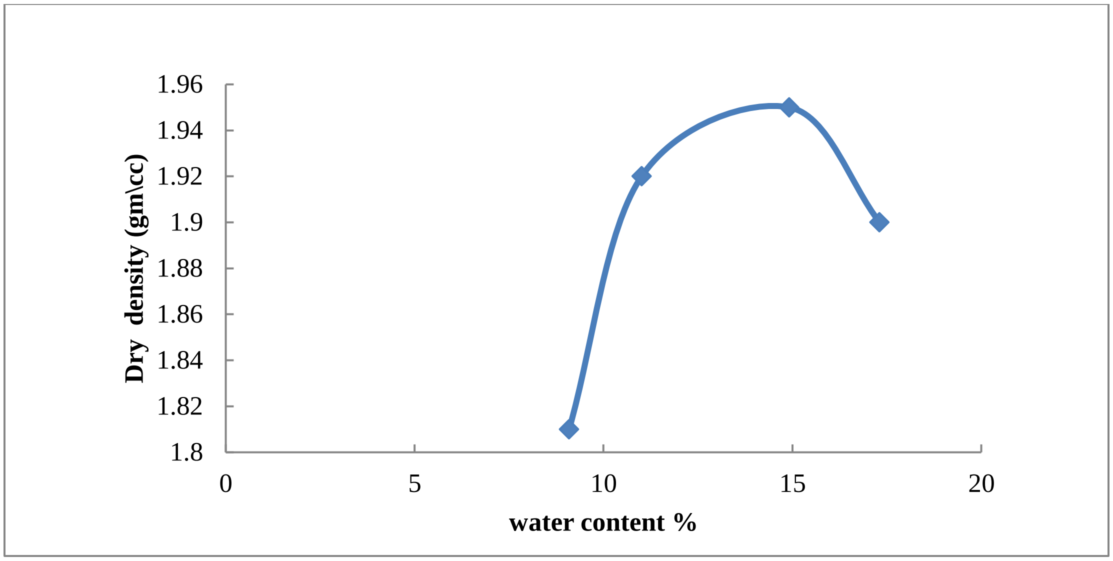


Figure 3 : Graph Plot between Water Content and Dry Density

Optimum Moisture Content (OMC): 14.9 % .Max. Dry Density (gm/cc) (MDD): 1.95 gm/cc

4.4.2 With 1 % reinforcement Aspect Ratio=1

Table 6 : Calculation of Optimum Moisture Content and Maximum Dry Density With 1 % Reinforcement and AR=1

Test No.	1	2	3	4
Weight of empty mould+ Weight of base plate(Wm) gm	4321.00	4321.00	4321.00	4321.00
Internal diameter of mould (d) cm	10.00	10.00	10.00	10.00
Height of mould (h) cm	12.70	12.70	12.70	12.70
Volume of mould (V)=(π/4) d2h cc	1000.00	1000.00	1000.00	1000.00
Weight of mould + compacted soil + Base plate (W1) gm	6332.50	6459.05	6566.80	6567.06
Weight of Compacted Soil (W1-Wm) gm	2011.50	2138.05	2245.80	2246.06
Bulk Density γ_b	2.01	2.14	2.25	2.25
For Water Content				
Weight of Container (X1) gm	8.00	20.00	20.00	20.00
Weight of Container + Wet Soil (X2) gm	46.30	118.60	118.20	144.10
Weight of Container + dry soil (X3) gm	43.00	109.00	106.50	126.25
Weight of dry soil (X3-X1) gm	35.00	89.00	86.50	106.25
Weight of water (X2-X3) gm	3.30	9.60	11.70	17.85
Water content W%= (X2-X3/X3-X1)*100	9.43	10.79	13.53	16.80
Dry density $\Upsilon_d = \Upsilon_b/1 + (W/100)$ gm/cc	1.84	1.93	1.98	1.92

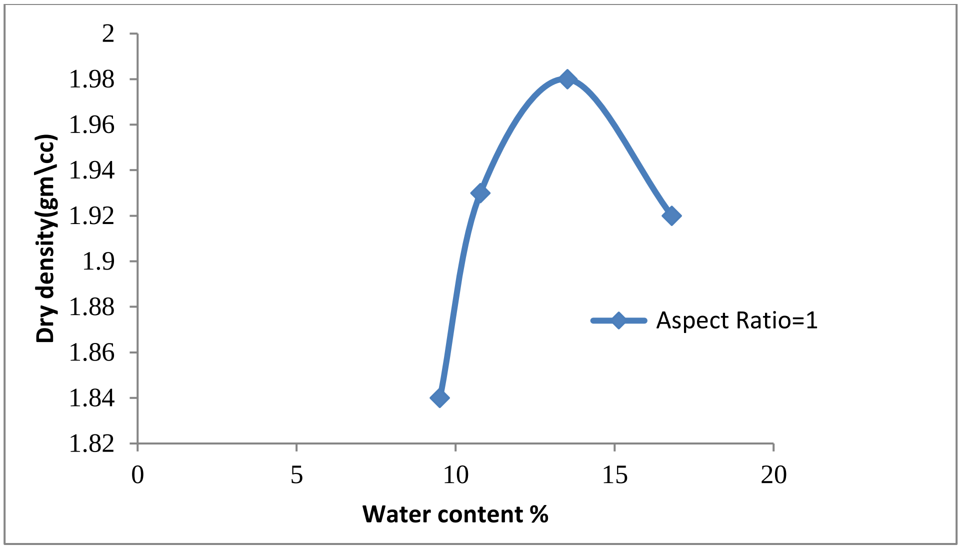


Figure 4 : Graph Plot between Water Content and Dry Density for AR=1

Optimum Moisture Content (OMC): 13.52 %, Maximum Dry density (MDD) = 1.98 gm/cc

4.4.3 With 1% reinforcement Aspect Ratio=2

Table 7 : Calculation of Optimum Moisture Content and Maximum Dry Density with 1% Reinforcement and AR=2

TEST NO.	1.00	2.00	3.00	4.00
Weight of empty mould+ Weight of base plate(Wm) gm	4321.00	4321.00	4321.00	4321.00
Internal diameter of mould (d) cm	10.00	10.00	10.00	10.00
Height of mould (h) cm	12.70	12.70	12.70	12.70
Volume of mould (V)=(π/4) d2h cc	1000.00	1000.00	1000.00	1000.00
Weight of mould + compacted soil + Base plate (W1) gm	6359.18	6484.60	6583.63	6546.15
Weight of Compacted Soil (W1-Wm) gm	2038.18	2163.60	2262.63	2225.15
Bulk Density γ_b	2.04	2.16	2.26	2.23
For Water Content				
Weight of Container (X1) gm	20.00	20.00	20.00	20.00
Weight of Container + Wet Soil (X2) gm	72.60	154.40	113.40	123.80
Weight of Container + dry soil (X3) gm	68.00	140.50	102.30	109.09
Weight of dry soil (X3-X1) gm	48.00	120.50	85.30	89.09
Weight of water (X2-X3) gm	4.60	13.90	11.10	14.71
Water content W%= (X2-X3/X3-X1)*100	9.58	11.54	13.01	16.51
Dry density Υ_d= Υ_b/1 + (W/100) gm/cc	1.86	1.94	2	1.91

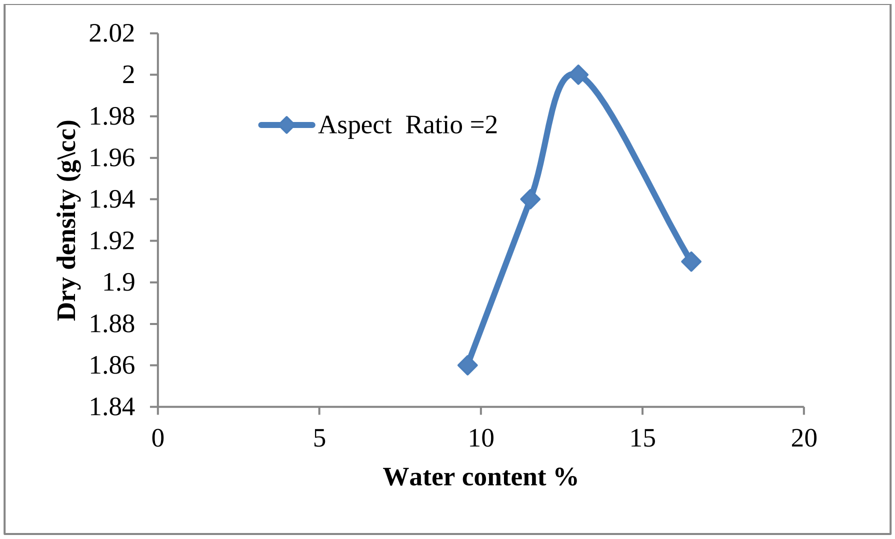


Figure 5 : Graph Plot between Water Content and Dry Density for AR=2

Optimum Moisture Content (OMC): 13.01 %, Maximum Dry density (MDD) = 2.00 gm/cc

4.4.4 With 1 % reinforcement Aspect Ratio= 3

Table 8 : Calculation of Optimum Moisture Content and Maximum Dry Density with 1 % Reinforcement and ar= 3

TEST NO.	1.00	2.00	3.00	4.0
Weight of empty mould+ Weight of base plate(Wm) gm	4321.00	4321.00	4321.00	4321.00
Internal diameter of mould (d) cm	10.00	10.00	10.00	10.00
Height of mould (h) cm	12.70	12.70	12.70	12.70
Volume of mould (V)=(π/4) d2h cc	1000.00	1000.00	1000.00	1000.00
Weight of mould + compacted soil + Base plate (W1) gm	6150.00	6320.00	6618.96	6600.55
Weight of Compacted Soil (W1-Wm) gm	1829.00	1999.00	2297.96	2279.55
Bulk Density γ_b	1.83	2.00	2.30	2.28
For Water Content				
Weight of Container (X1) gm	20.00	20.00	20.00	20.00
Weight of Container + Wet Soil (X2) gm	99.70	125.30	128.30	114.20
Weight of Container + dry soil (X3) gm	95.00	115.50	116.09	100.60
Weight of dry soil (X3-X1) gm	75.00	95.50	96.09	80.60
Weight of water (X2-X3) gm	4.70	9.80	12.21	13.60
Water content W%= (X2-X3/X3-X1)*100	6.27	10.26	12.71	16.87
Dry density $\Upsilon_d = \Upsilon_b/1 + (W/100)$ gm/cc	1.72	1.81	2.04	1.95

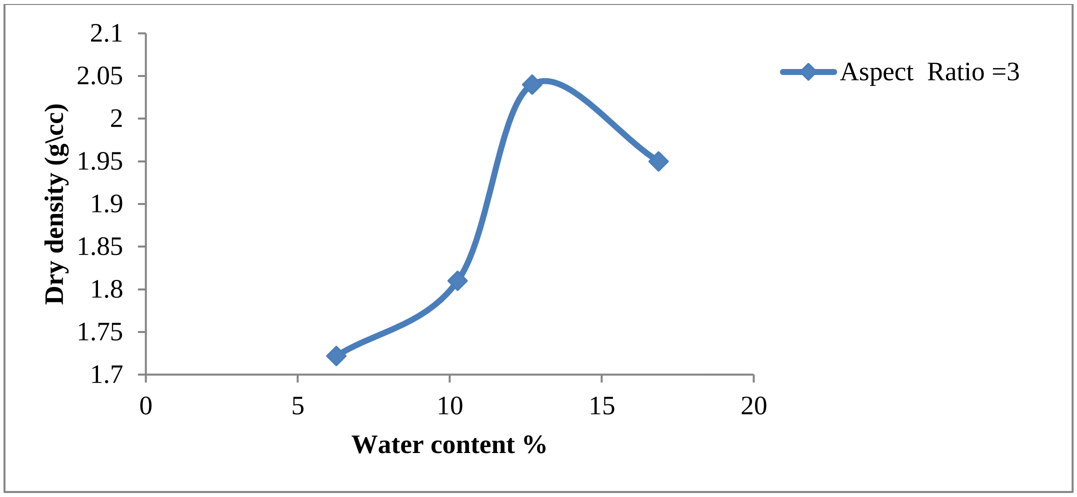


Figure 6 : Graph Plot between Water Content and Dry Density for AR=3

Optimum Moisture Content (OMC): 12.7 %, Maximum Dry density (MDD) = 2.04 gm/cc

4.4.5 With 1 % reinforcement Aspect Ratio= 4

Table 9 : Calculation of Optimum Moisture Content and Maximum Dry Density with 1 % Reinforcement and AR= 4

TEST NO.	1.00	2.00	3.00	4.00
Weight of empty mould+ Weight of base plate(Wm) gm	4321.00	4321.00	4321.00	4321.00
Internal diameter of mould (d) cm	10.00	10.00	10.00	10.00
Height of mould (h) cm	12.70	12.70	12.70	12.70
Volume of mould (V)=(π/4) d2h cc	1000.00	1000.00	1000.00	1000.00
Weight of mould + compacted soil + Base plate (W1) gm	6184.00	6395.20	6589.60	6605.60
Weight of Compacted Soil (W1-Wm) gm	1863.00	2074.20	2268.60	2284.60
Bulk Density γ_b	1.86	2.07	2.27	2.28
For Water Content				
Weight of Container (X1) gm	20.00	20.00	20.00	20.00
Weight of Container + Wet Soil (X2) gm	80.70	121.20	121.20	117.10
Weight of Container + dry soil (X3) gm	77.00	110.26	109.08	103.30
Weight of dry soil (X3-X1) gm	57.00	90.26	94	83.30
Weight of water (X2-X3) gm	3.70	10.94	12.12	13.80
Water content W%= (X2-X3/X3-X1)*100	6.49	12.12	12.89	16.57
Dry density Υ_d= Υ_b/1 + (W/100) gm/cc	1.75	1.85	2.01	1.96

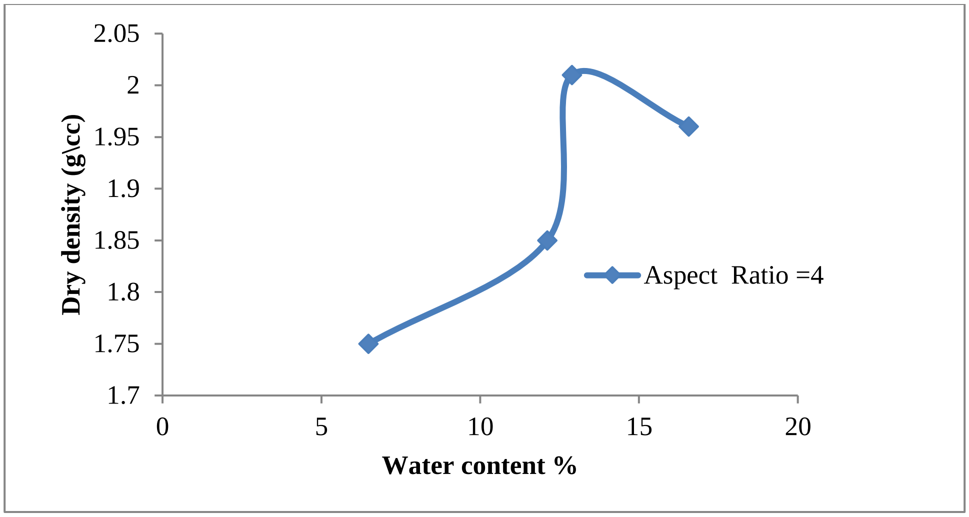


Figure 7 : Graph Plot between Water Content and Dry Density for AR=4

Optimum Moisture Content (OMC): 12.89 %, Maximum Dry density (MDD) = 2.01g/cc

4.5 Comparative Analysis of Proctor Tests

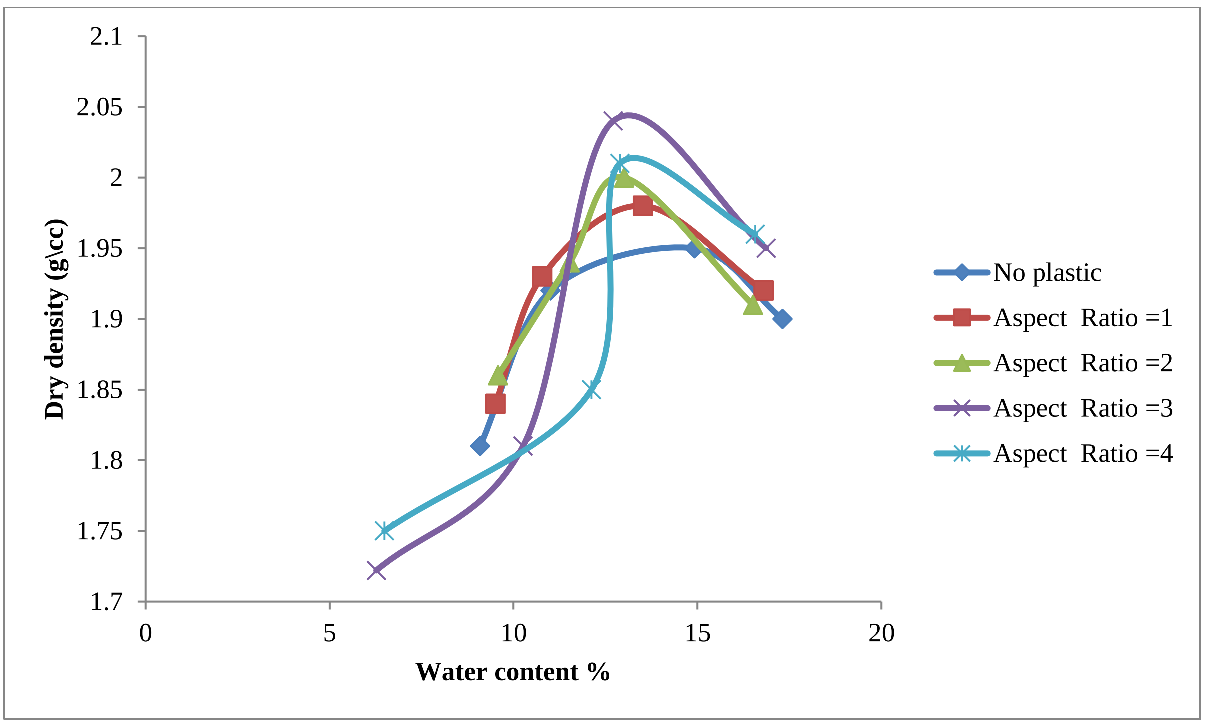


Figure 8 : Graph Plot between Water Content and Dry Density for No Plastic, Plastic with AR=1, AR=2, AR=3, AR=3, AR=4

4.6 Direct Shear Test

This test helps to find out the strength parameters of soil at that time and the these parameters are cohesion(C) and internal friction angle(φ).These parameters concludes in knowing the shear strength of soil. Shear strength is important to know for any structure which depends on soil shearing resistance. In this test, the specimen of the shear box is sheared under a normal load(N).The shearing strain is made to increase at a constant rate. Then the shear force (F) at failure, corresponding to the normal load is measured with the help of proving ring.

The equation goes as follows:

$$\tau = c + \sigma * \tan(\varphi)$$

Our study includes DST with and without reinforcement. Reinforcement used is 1 % by weight of the sample with varying aspect ratio from 1 to 4.

Experimental Setup

Area of box: 36 cm^2
Strain rate: 0.625mm/minute
Reinforcement is 1% by weight of sample.
Shear load = proving ring reading*proving ring constant (0.2784kg/div.)
Shear stress at failure =shear load/corrected area

4.6.1 Unreinforced soil

Table 10 : Direct Shear Test – Unreinforced Soil

Sample No.	Normal stress(kg/cm^2)	Shear load (kg)	Shear Stress at failure(kg/cm^2)
1	0.2	8.21	0.25
2	0.4	13.9	0.41
3	0.6	18.09	0.55

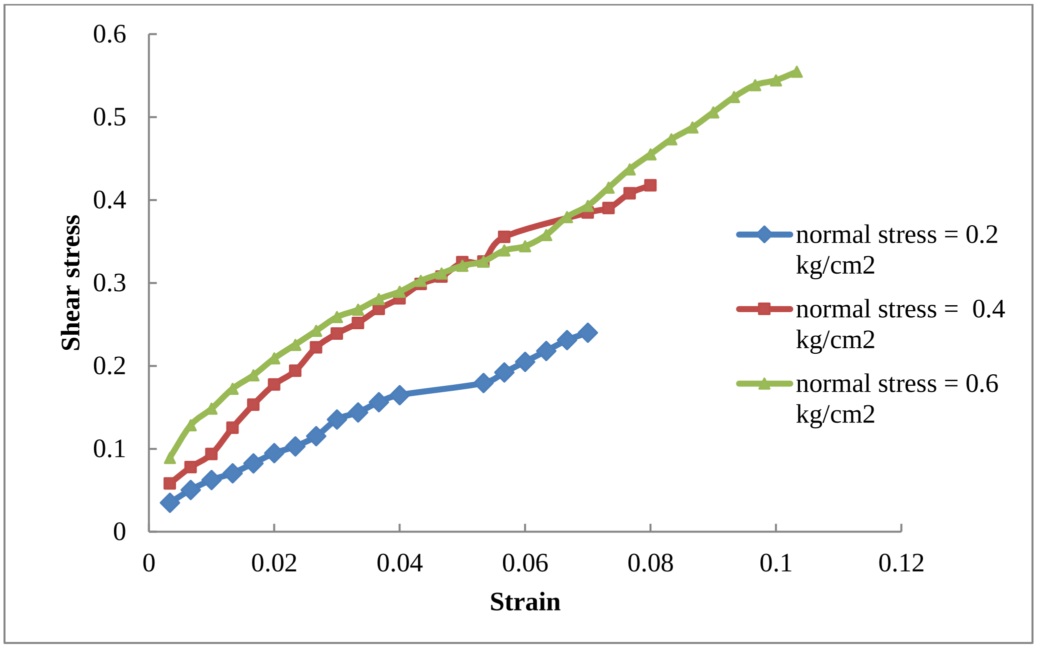


Figure 9 : Shear Stress vs. Strain for Unreinforced Soil Sample

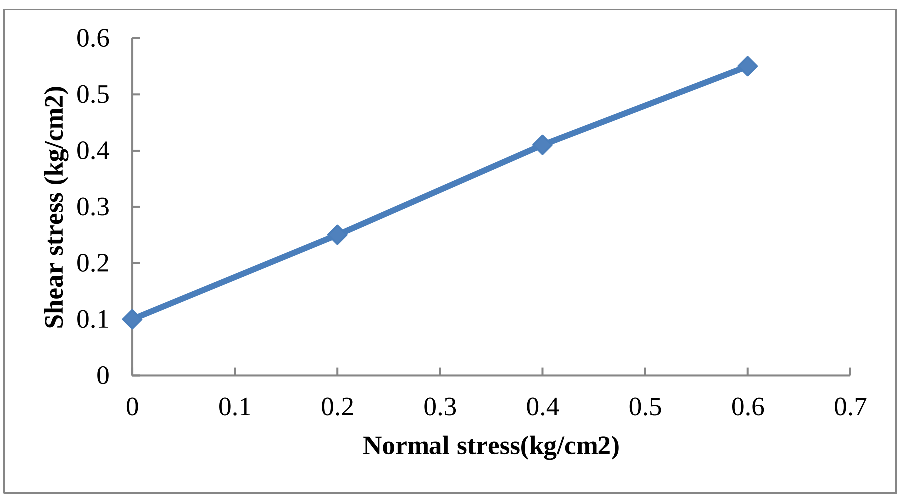


Figure 10 : Normal Stress vs. Shear Stress for Unreinforced Soil Sample

Computing from graph,

Cohesion (C) = 0.1 kg/cm^2;

Angle of internal friction (φ) = 41°

4.6.2 Reinforced soil 1% by weight Aspect Ratio= 1

Table 11 : Direct Shear Test –Reinforced Soil AR= 1

Sample No.	Normal stress(kg/cm^2)	Shear load (kg)	Shear Stress at failure(kg/cm^2)
1	0.2	9.8	0.3
2	0.4	15.45	0.47
3	0.6	10.07	0.60

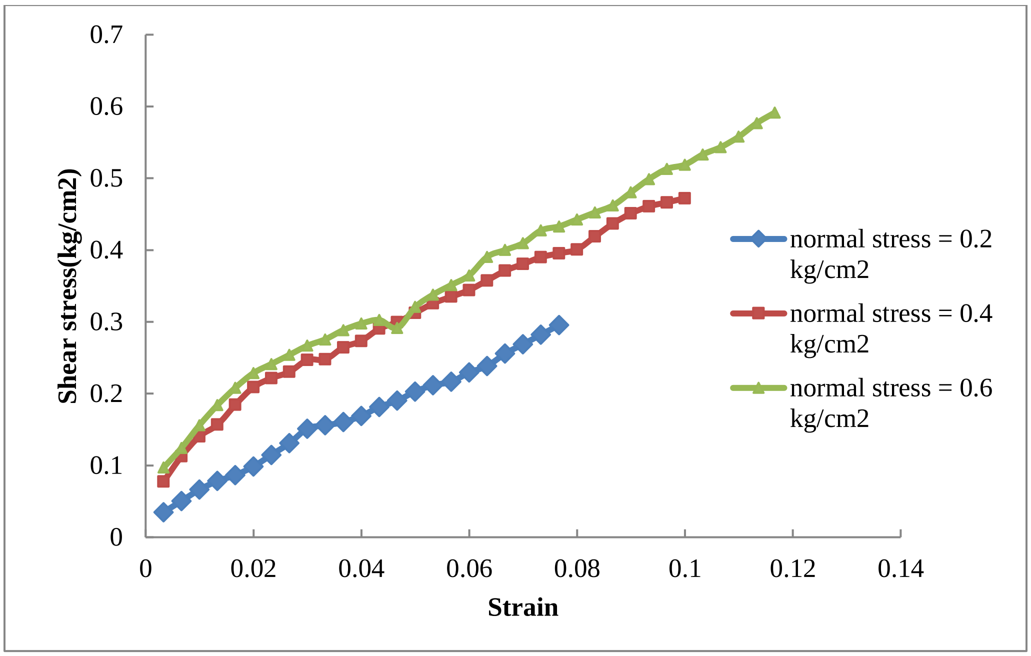


Figure 11 : Shear Stress vs. Strain for Reinforced Sample with Aspect Ratio 1

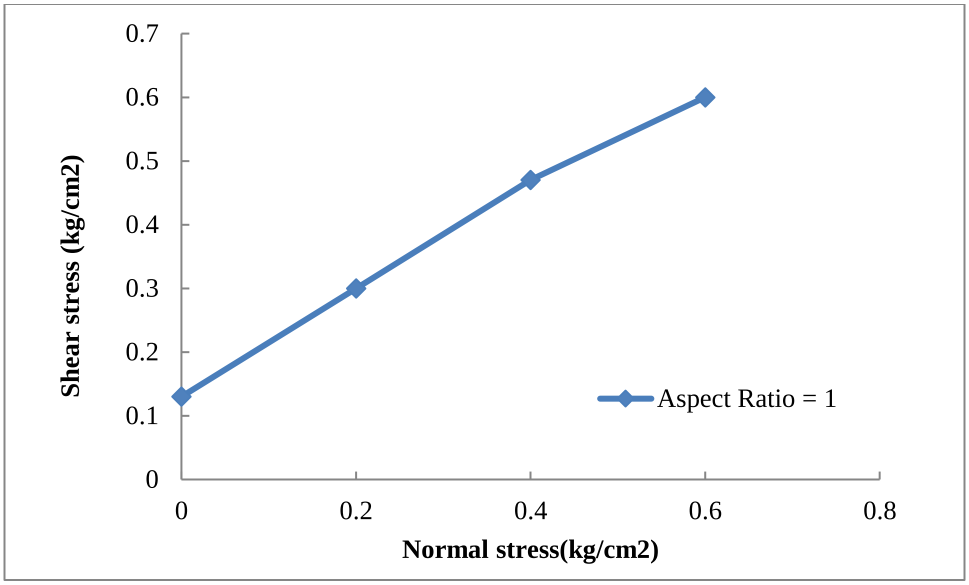


Figure 12 : Normal Stress vs. Shear Stress for Reinforced Sample with Aspect Ratio 1

Computing from graph,

Cohesion (C) = 0.13 kg/cm^2; Angle of internal friction (φ) = 43^o

4.6.3 Reinforced soil 1% by weight Aspect Ratio= 2

Table 12 : Direct Shear Test –Reinforced Soil AR= 2

Sample No.	Normal stress(kg/cm^2)	Shear load (kg)	Shear Stress at failure(kg/cm^2)
1	0.2	12.2	0.37
2	0.4	19.07	0.59
3	0.6	20.07	0.65

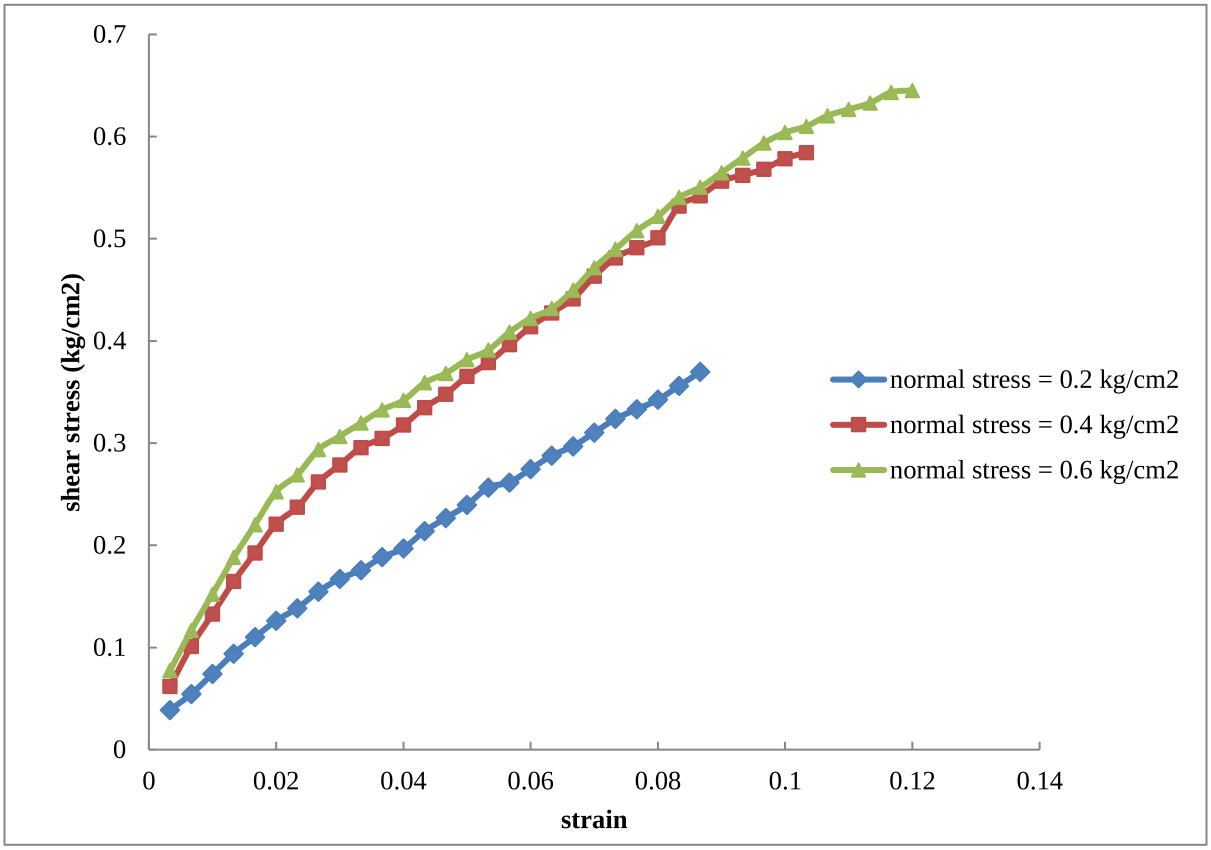


Figure 13 : Shear Stress vs. Strain for Reinforced Sample with Aspect Ratio 2

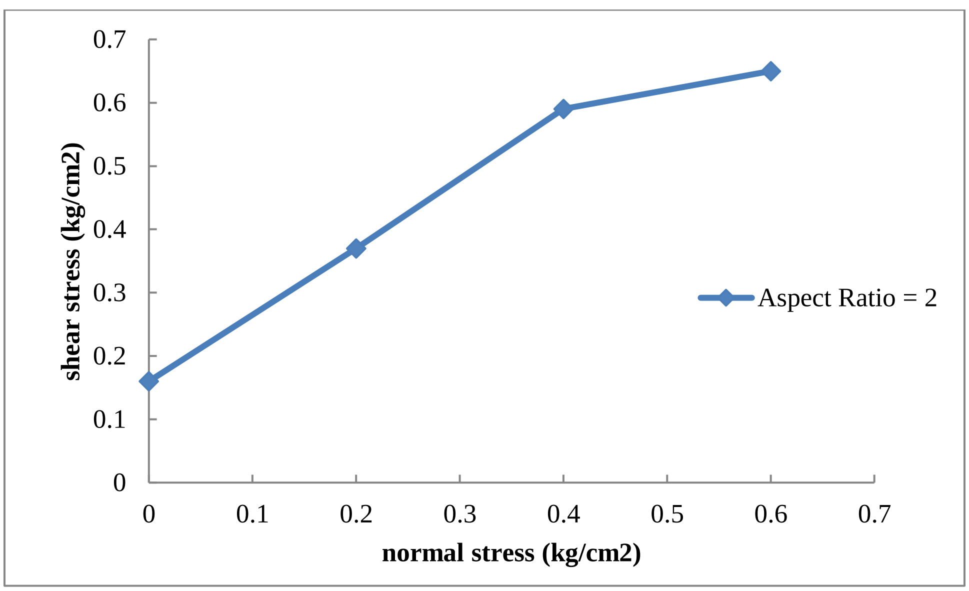


Figure 14 : Shear Stress vs. Normal Stress for Reinforced Sample with Aspect Ratio 2

Computing from graph,

Cohesion (C) = 0.16 kg/cm^2; Angle of internal friction (φ) = 43.5^o

4.6.4 Reinforced soil 1% by weight Aspect Ratio=3

Table 13 : Direct Shear Test –Reinforced Soil AR=3

Sample No.	Normal stress(kg/cm^2)	Shear load (kg)	Shear Stress at failure(kg/cm^2)
1	0.2	10.71	0.31
2	0.4	16.7	0.50
3	0.6	19.48	0.60

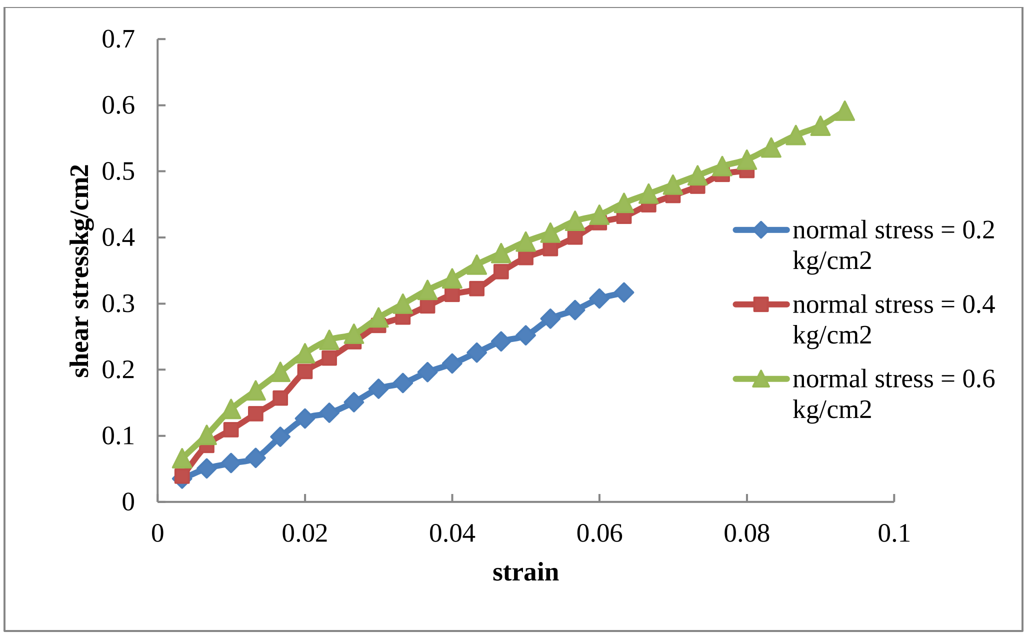


Figure 15 : Shear Stress vs. Strain for Reinforced Sample with Aspect Ratio 3

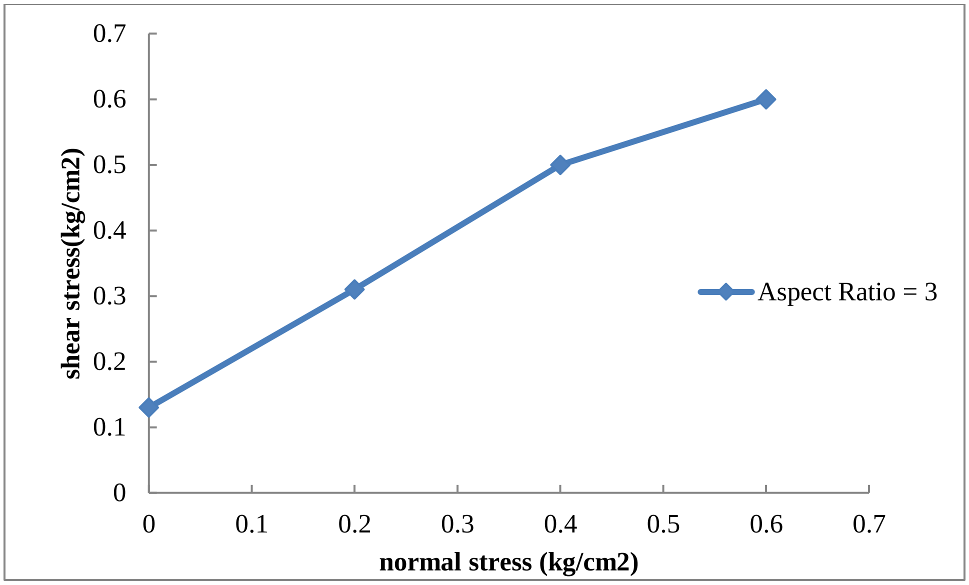


Figure 16 : Shear Stress vs. Normal Stress for Reinforced Sample with Aspect Ratio 3

Computing from graph,

Cohesion (C) = 0.135 kg/cm^2 ; Angle of internal friction (φ) = 43°

4.6.5 Reinforced soil 1% by weight Aspect Ratio= 4

Table 14: Direct Shear Test –Reinforced Soil AR= 4

Sample No.	Normal stress(kg/cm^2)	Shear load (kg)	Shear Stress at failure(kg/cm^2)
1	0.2	10.8	0.32
2	0.4	17.3	0.52
3	0.6	19.34	0.59

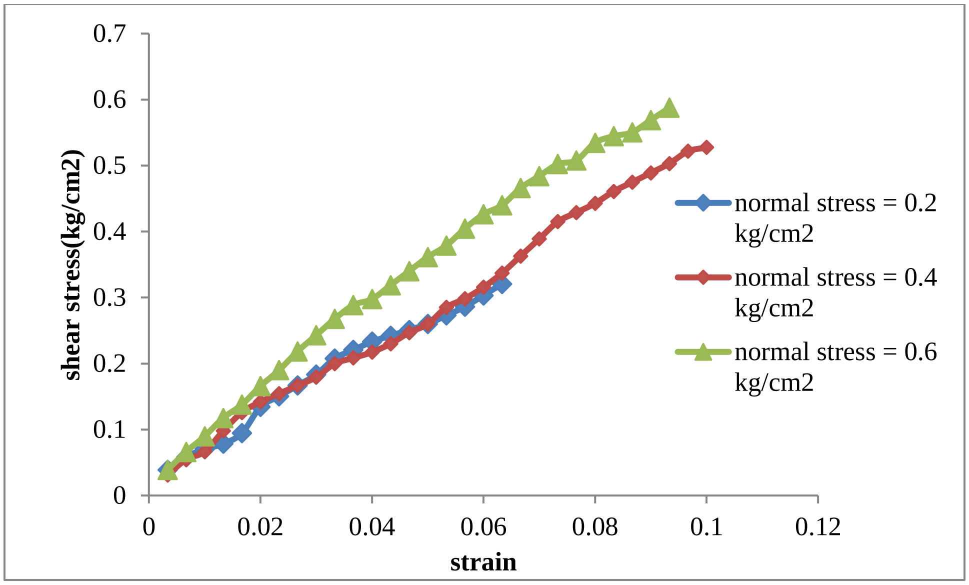


Figure 17 : Shear Stress vs. Strain for Reinforced Sample with Aspect Ratio 4

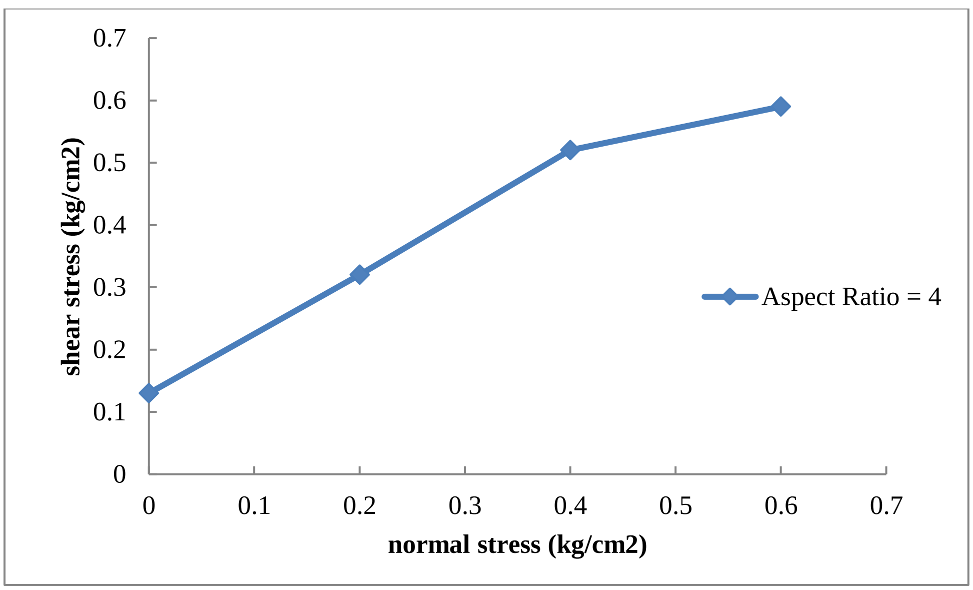


Figure 18 : Shear Stress vs. Normal Stress for Reinforced Sample with Aspect Ratio 4

Computing from graph,

Cohesion (C) = 0.12 kg/cm^2; Angle of internal friction (φ) = 42.5^o

4.7 CALIFORNIA BEARING RATIO (CBR) TEST

CBR method combines a load penetration test in which a cylindrical plunger of 5 cm cross-section is penetrated into a soil mass. Observations are taken between the penetration resistance (called the test load) versus the penetration of plunger. The penetration resistance of the plunger into a standard sample of crushed stone for the corresponding penetration is called the standard load.

$$CBR = \frac{TEST\ LOAD}{STANDARD\ LOAD}$$

Our study includes CBR soaked as well as unsoaked with and without reinforcement. Reinforcement used is 1 % by weight of the sample with varying aspect ratio from 1 to 4.

Experimental Setup

Diameter of cylindrical plunger = 5 cm.
Penetration rate = 1.25 mm/min.
Diameter of mould = 150 mm
Height of mould = 175 mm
Depth of displacer disc = 50 mm
Reinforcement is 1 % by weight of sample.
Proving ring constant =26.66 kg/div.

Table 15 : Standard Loads of Penetrations

Penetration of plunger (mm)	Standard Load(kg)
2.5	1370
5	2055
7.5	2630
10	3180
12.5	3600

4.7.1 Unreinforced soil

Table 16 : CBR Test Unsoaked–Unreinforced Soil

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	3	6	9	11.5	13.5	15	18	20	26	32.5	38
Load (kg)	0	79.98	159.96	239.94	306.59	359.91	399.9	479.88	533.2	693.16	866.45	1013.08

CBR (at 2.5 mm penetration) = $\frac{359.9 \times 100}{1370}$ = 26.27 %

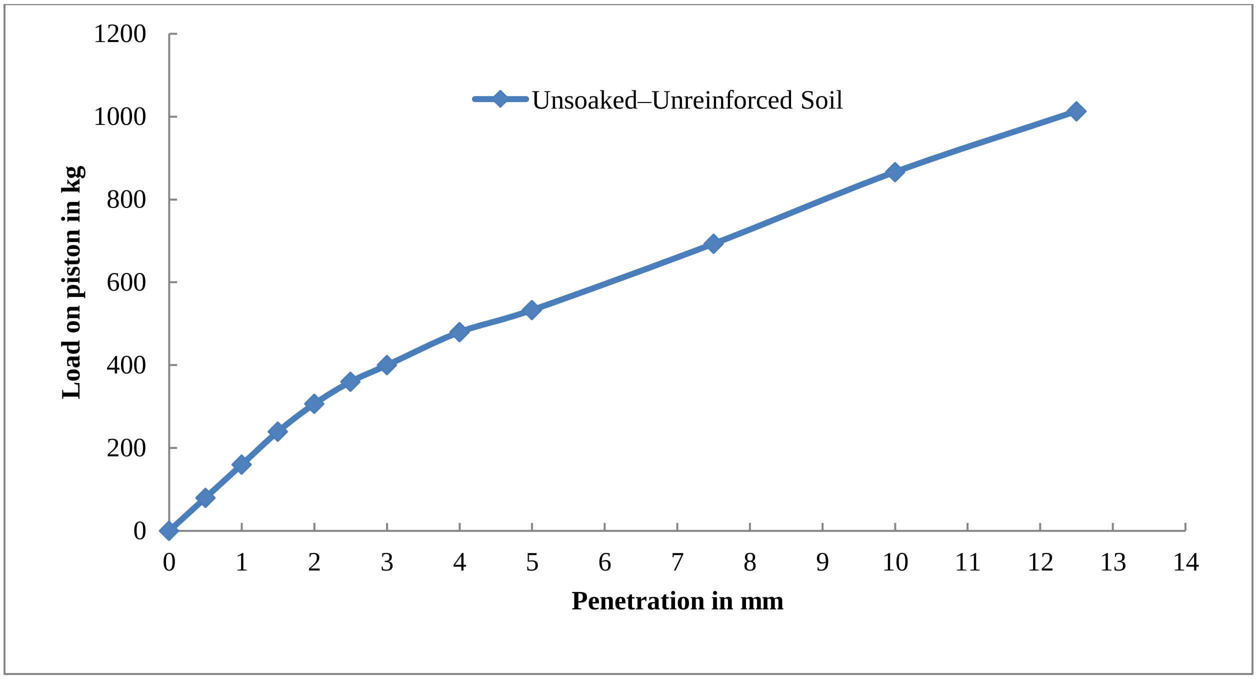


Figure 19 : Load-penetration Curve for Unsoaked Unreinforced Sample

4.7.2 Reinforced soil 1 % by weight Aspect Ratio= 1

Table 17: CBR Test Unsoaked –Reinforced Soil with AR = 1

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	3	5.5	8.5	11	14	16	18.5	21.5	27	34	40.5
Load (kg)	0	79.98	146.63	226.61	293.26	373.24	426.56	493.21	573.19	719.82	906.44	1079.73

CBR (at 2.5 mm penetration) = $\frac{373.24 \times 100}{1370}$ = 27.24 %

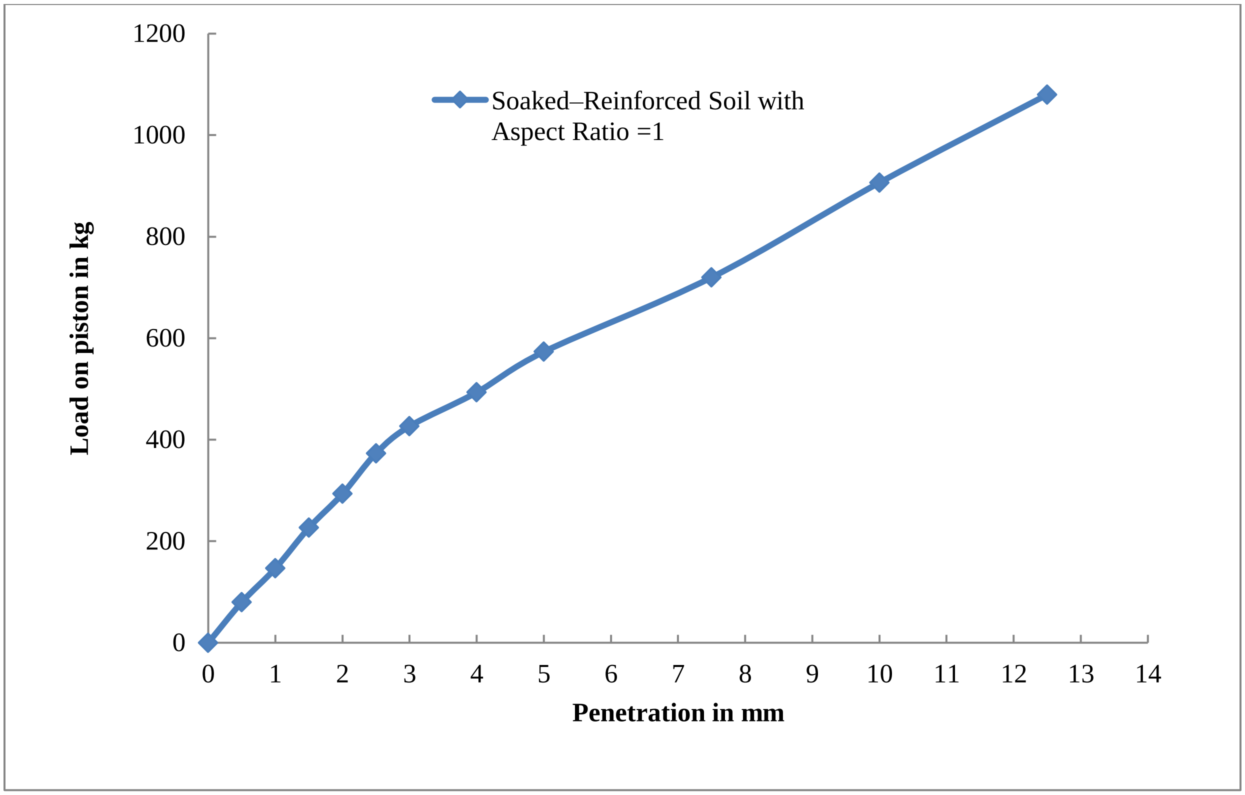


Figure 20 : Load-Penetration Curve for Unsoaked Reinforced Sample with AR= 1

4.7.3 Reinforced soil 1 % by weight Aspect Ratio= 2

Table 18 : CBR Test Unsoaked – Reinforced Soil with AR = 2

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	3.5	6.5	10.5	12.5	15	17.5	20	22	29.5	37	44
Load (kg)	0	93.31	173.29	279.93	333.25	399.9	466.55	533.2	586.52	786.47	986.42	1173.04

$$\text{CBR (at 2.5 mm penetration)} = \frac{399.9 \text{ X } 100}{1370} = 29.18\ \%$$

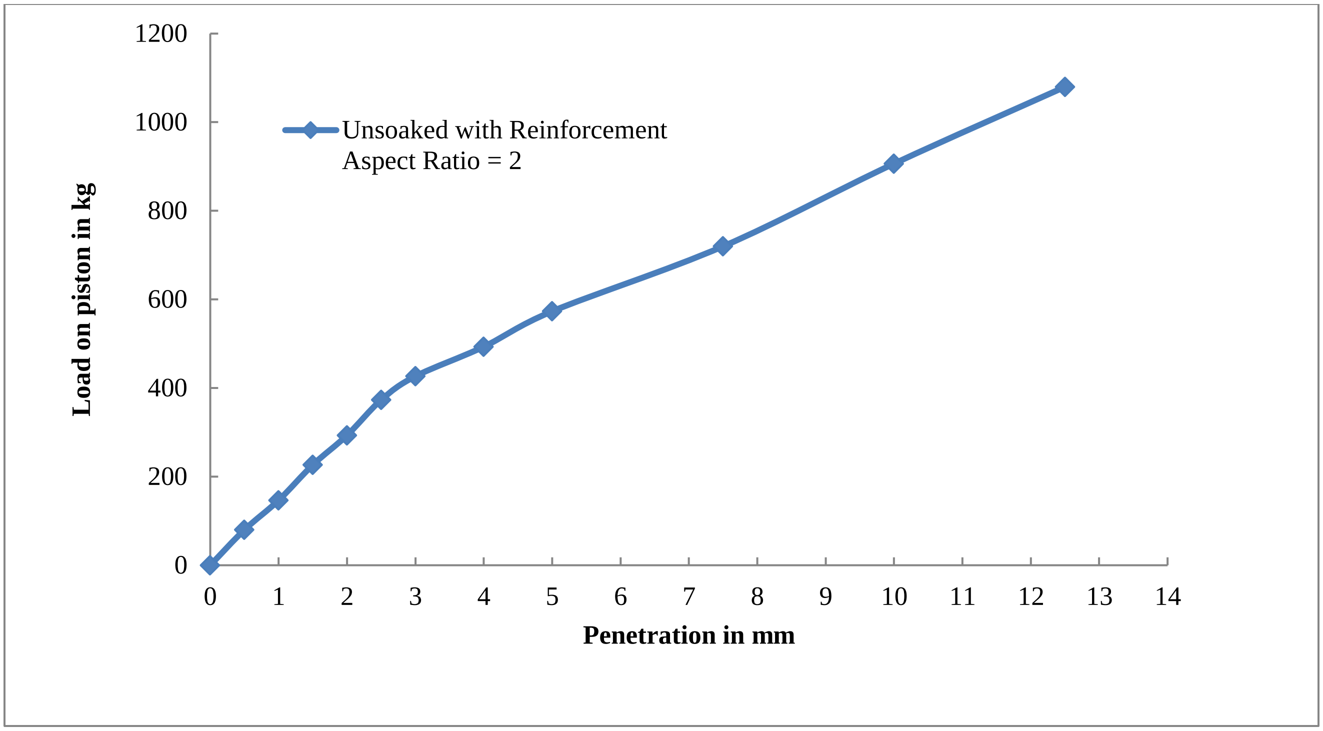


Figure 21 : Load-Penetration Curve for Unsoaked Reinforced Sample with AR= 2

4.7.4 Reinforced soil 1 % by weight Aspect Ratio= 3

Table 19 : CBR Test Unsoaked –Reinforced Soil with AR = 3

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	4	6.5	9.5	13	15.5	17.5	20	22	26.5	33.5	39
Load (kg)	0	106.64	173.29	253.27	346.58	413.23	466.55	533.2	586.52	706.49	893.11	1039.74

CBR (at 2.5 mm penetration) = $\frac{413.2 \text{ X } 100}{1370}$ = 30.16 %

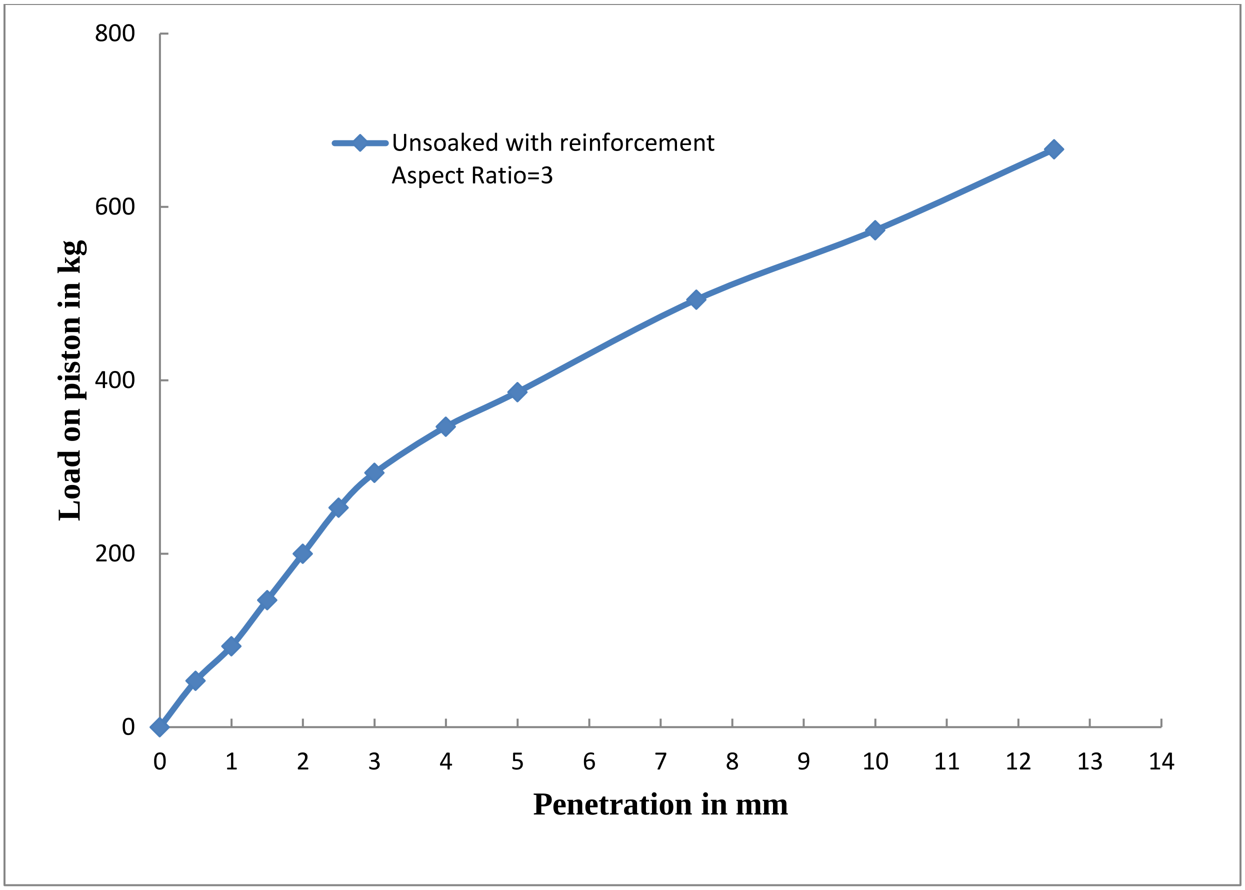


Figure 22 : Load-Penetration Curve for Unsoaked Reinforced Sample with AR= 3

4.7.5 Reinforced soil 1 % by weight Aspect Ratio= 4

Table 20 : CBR Test Unsoaked –Reinforced Soil with AR = 4

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	3.5	6.5	9.5	12.5	16	18.5	22	24.5	32	39	45.5
Load (kg)	0	93.31	173.29	253.27	333.25	426.56	493.21	586.52	653.17	853.12	1039.74	1213.03

$$\text{CBR (at 2.5 mm penetration)} = \frac{426.5 \times 100}{1370} = 31.13\%$$

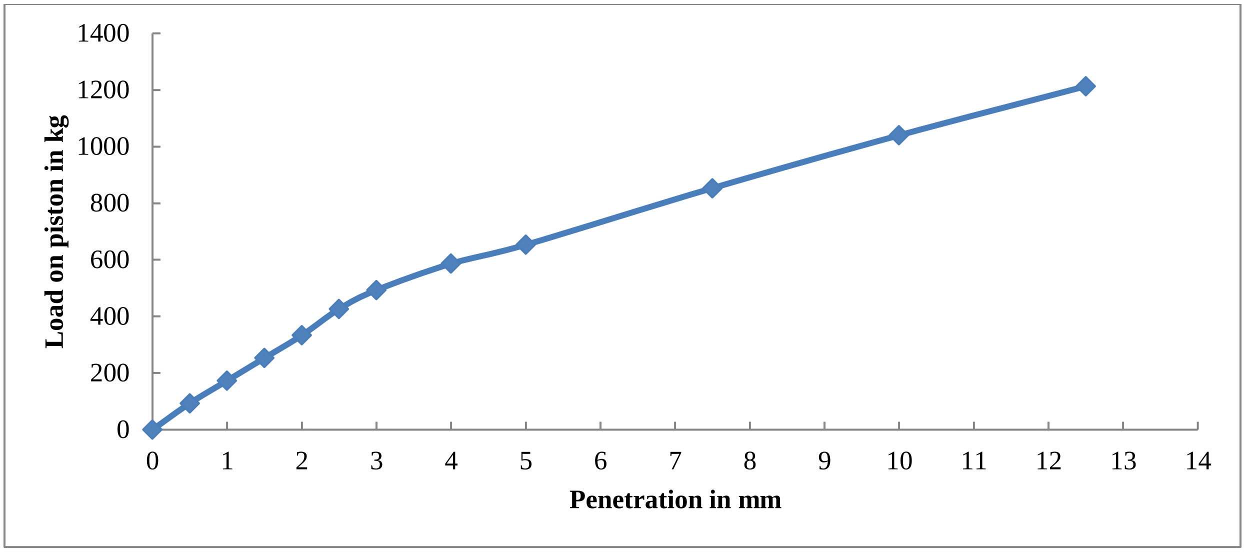


Figure 23 : Load-Penetration Curve for Unsoaked Reinforced Sample with AR= 4

4.7.6 Soaked unreinforced soil

Table 21 : CBR Test Soaked–Unreinforced Soil

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	2	3.5	5.5	7.5	9.5	11	13	14.5	18.5	21.5	25
Load (kg)	0	53.32	93.31	146.63	199.95	253.27	293.26	346.58	386.57	493.21	573.19	666.5

$$\text{CBR (at 2.5 mm penetration)} = \frac{253.27 \text{ X } 100}{1370} = 18.48\ \%$$

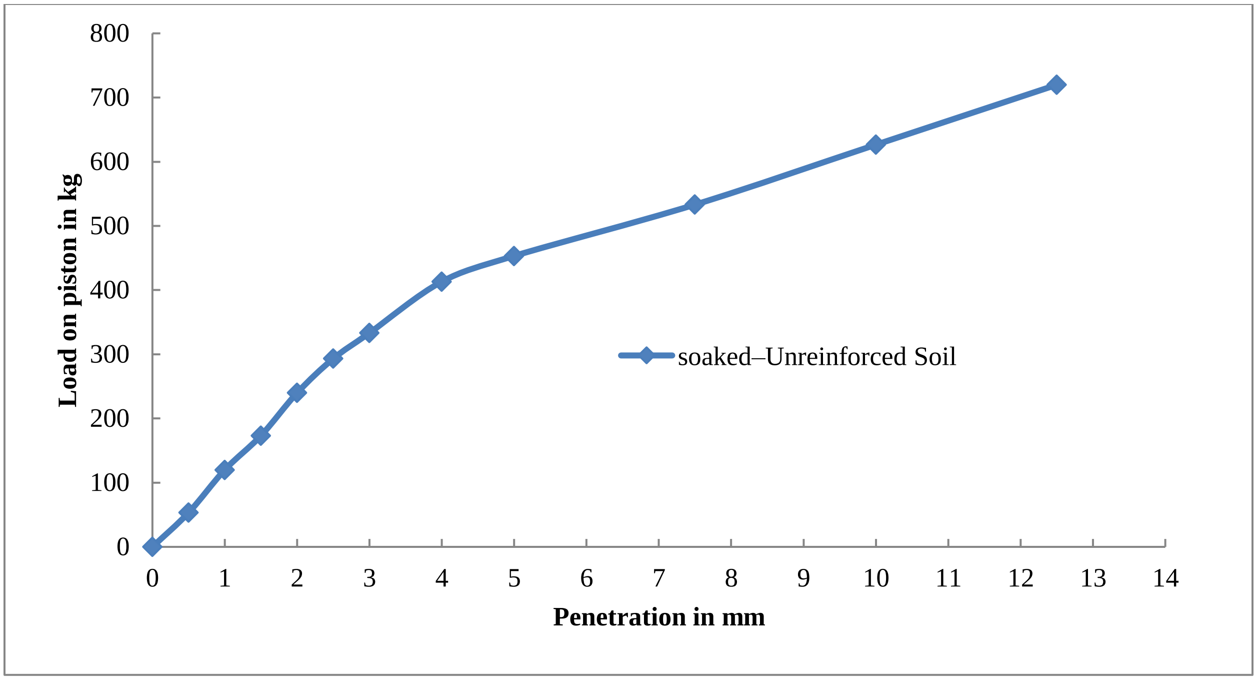


Figure 24 : Load-Penetration Curve for Soaked Unreinforced Sample

4.7.7 Soaked reinforced soil 1% by weight with AR= 1

Table 22 : CBR Test Soaked–Reinforced Soil with AR = 1

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	2	4	6.5	9	10.5	12	14.5	15.5	19.5	23	26
Load (kg)	0	53.32	106.64	173.29	239.94	279.93	319.92	386.57	413.23	519.87	613.18	693.16

CBR (at 2.5 mm penetration) = $\frac{279.93 \text{ X } 100}{1370}$ = 20.43 %

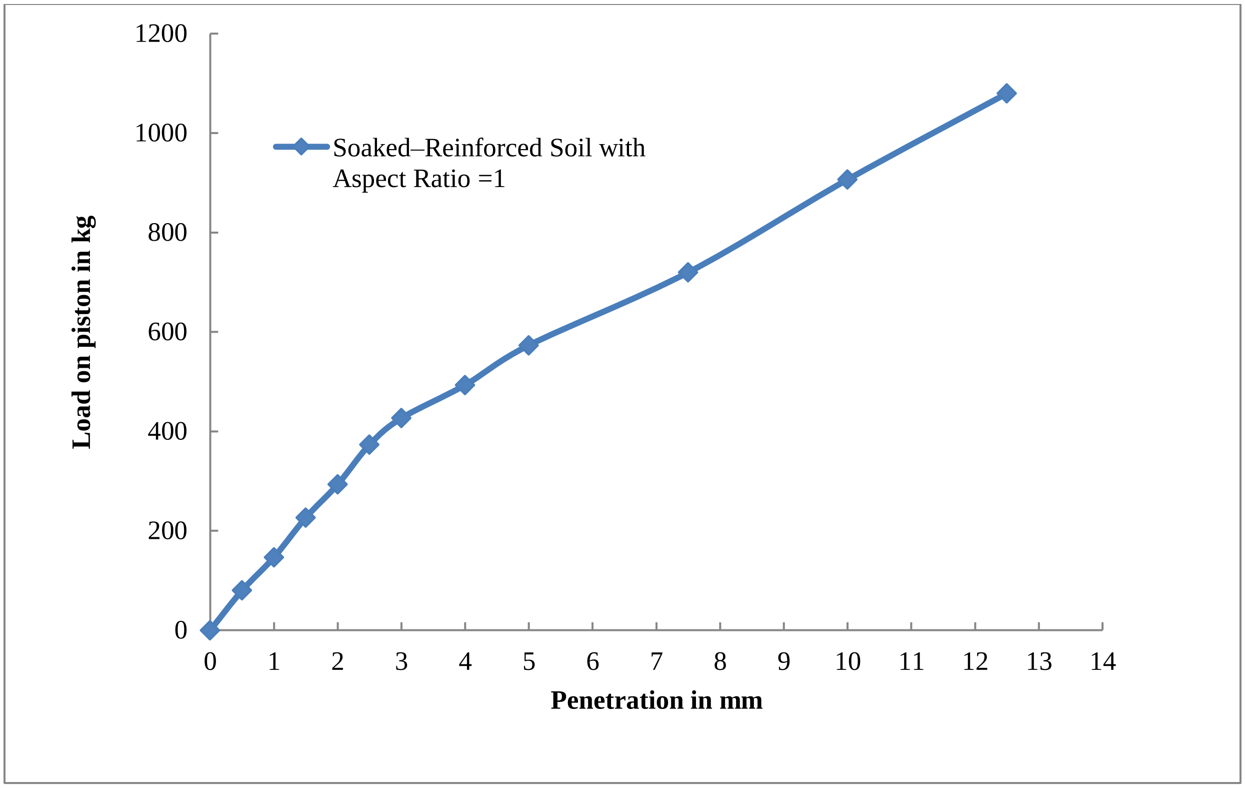


Figure 25 : Load-Penetration Curve for Soaked Reinforced Sample with AR= 1

4.7.8 Soaked reinforced Soil 1 % by weight with AR= 2

Table 23 : CBR Test Soaked–Reinforced Soil with AR = 2

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	2	4.5	6.5	9	11	12.5	15.5	17	20	23.5	27
Load (kg)	0	53.32	119.97	173.29	239.94	293.26	333.25	413.23	453.22	533.2	626.51	719.82

CBR (at 2.5 mm penetration) = $\frac{293.26 \times 100}{1370}$ = 21.40 %

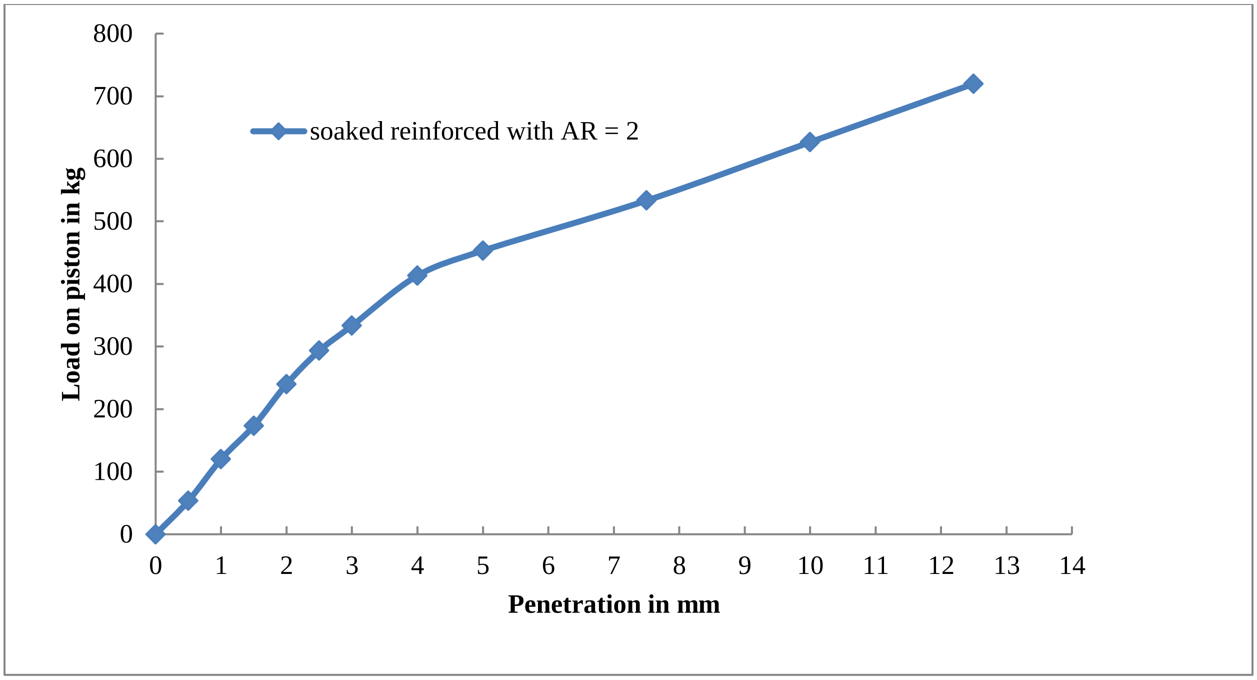


Figure 26 : Load-Penetration Curve for Soaked Reinforced Sample with AR= 2

4.7.9 Soaked reinforced soil 1 % by weight with AR= 3

Table 24 : CBR Test Soaked–Reinforced Soil with AR = 3

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	2.5	5	7	9.5	12	13.5	15.5	17.5	20	23	26
Load (kg)	0	66.65	133.3	186.62	253.27	319.92	359.91	413.23	466.55	533.2	613.18	693.16

$$CBR \text{ (at 2.5 mm penetration)} = \frac{319.92 \times 100}{1370} = 23.35\ \%$$

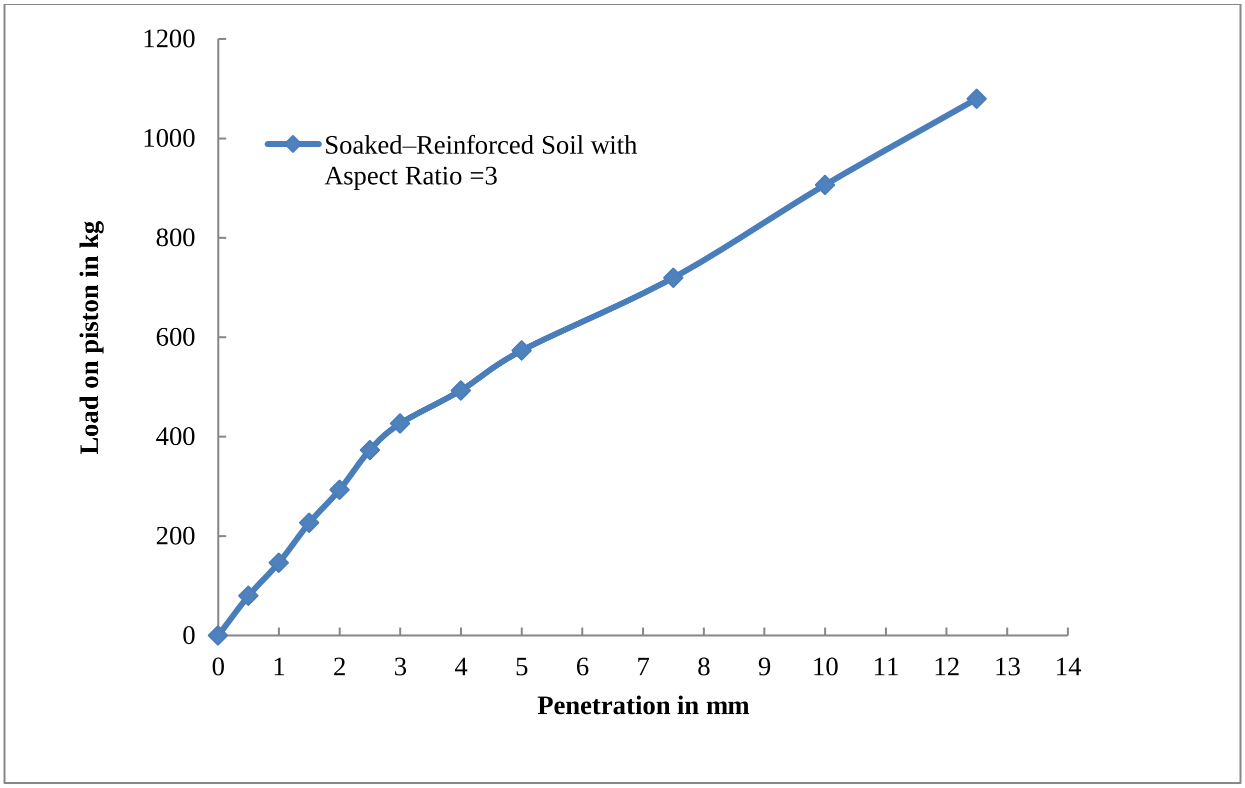


Figure 27 : Load-Penetration Curve for Soaked Reinforced Sample with AR= 3

4.7.10 Soaked reinforced soil 1 % by weight with AR= 4

Table 25 : CBR Test Soaked–Reinforced Soil with AR = 4

Penetration (mm)	0	0.5	1	1.5	2	2.5	3	4	5	7.5	10	12.5
Proving Ring value	0	2.5	5.5	8.5	10.5	13	15	17.5	19	23	28	31
Load (kg)	0	66.65	146.63	226.61	279.93	346.58	399.9	466.55	506.54	613.18	746.48	826.46

$$\text{CBR (at 2.5 mm penetration)} = \frac{346.58 \times 100}{1370} = 25.29\ \%$$

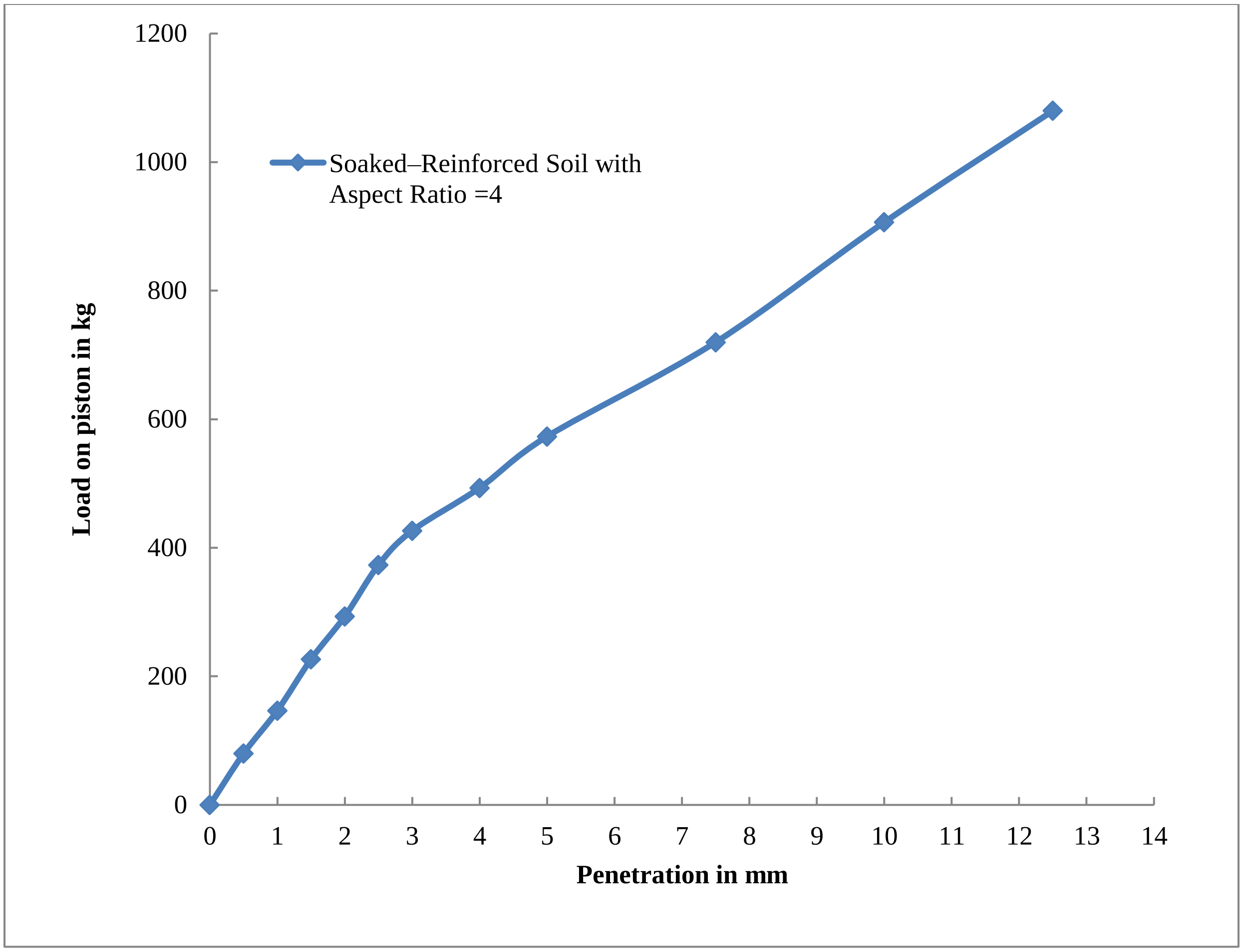


Figure 28 : Load-Penetration Curve for Soaked Reinforced Sample with AR= 4

CONCLUSONS

Following conclusions can be drawn on the basis of present experimental study:

a) Maximum dry density of fibre mix increases with increase in fibre aspect ratio from aspect ratio 0 i.e. without reinforcement to reinforcement with aspect ratio = 3,then decreases at aspect ratio = 4.

b) Optimum moisture content of fibre mix decreases with increase in fibre aspect ratio from aspect ratio 0 i.e. without reinforcement to aspect ratio = 3,then increases at aspect ratio = 4.

c) Increase in maximum dry density from no reinforcement to aspect ratio = 1 is 1.95 g/cc to 1.98 g/cc i.e. 1.01 % and decrease in optimum moisture content is from 14.92 % to 13.53 % i.e. decrease of 1.39 %.

d) Increase in maximum dry density from reinforcement aspect ratio = 1 to aspect ratio = 2 is 1.98 g/cc to 2.00 g/cc i.e. 1.01 % and decrease in optimum moisture content is from 13.53 % to 13.01 % i.e. decrease of 0.52 %.

e) Increase in maximum dry density from reinforcement aspect ratio = 2 to aspect ratio = 3 is 2.00 g/cc to 2.04 g/cc i.e. 1.02 % and decrease in optimum moisture content is from 13.01 % to 12.71 % i.e. decrease of 0.3 %.

f) Decrease in maximum dry density from reinforcement aspect ratio = 3 to aspect ratio = 4 is 2.04 g/cc to 2.01 g/cc i.e. 1.01 % and increase in optimum moisture content is from 12.71 % to 12.89 % i.e. increase of 0.18 %.

g) Hence it can be said, at 1 % plastic content maximum dry density and optimum moisture content are influenced hence can be used for soil improvement as per requirement.

h) From Direct Shear Test, Cohesion increases from 0.1 kg/cm^2 to 0.16 kg/cm^2 from no reinforcement to reinforcement with AR= 2 and then decreases thereafter.

i) Angle of internal friction increases from 41° to 43.5° from no reinforcement to reinforcement of AR= 2 and then decreases thereafter with increase in aspect ratio.

j) Thus it can be concluded from various graphs plotted above between stress and strain that shear strength changes with addition of plastic waste and is maximum at aspect ratio of 2.

k) CBR value for unsoaked sample is 26.27 % which increases to 31.13 % at aspect ratio of 4 of the plastic added of 1 % by weight.

l) Increase in CBR value is 4.86 % for unsoaked sample.

m) CBR value for soaked sample is 18.48 % which increases to 25.29 % at aspect ratio of 4 of the plastic added of 1 % by weight.

n) Increase in CBR value is 6.81 % for soaked sample.

REFERENCES

1. Waldron, L. J (1977), "The Shear Resistance of Root-Permeated Homogeneous and Stratified Soil", J. Soil Science Soc.Amer.,41,843-849.

2. Gray, D. H. and Ohashi, H (1983) "Mechanics of fibre reinforcement in sand" Journal of Geotechnical Engineering, ASCE, Vol. 109, pp.335-351.

3. Gray, D. H. and AL-Refeai, T. (1986), "Behaviour of Fabric Versus Fibre-reinforced Sand" ,Journal of Geotechnical Engg., ASCE, Vol. 112, No. 8, pp.804-820.

4. Setty K.R.N.S. and Rao S.V.G. (1987) "Characterisation of fibre reinforced lateritic soil" , Proc. Indian Geotechnical Conference, Vol. 1, pp.329-333.

5. Maher, M.H and Gray, D. H. (1990) "Static response of sand reinforced with randomly distributed fibres " Journal of Geotechnical Engineering, ASCE, Vol. 116, pp. 1661-1677.

6. Ranjan, G., Vasan, R.M. and Charan, H.D. (1996) "Probabilistic analysis of randomly distributed fibre-reinforced soil". Journal of Geotechnical Engineering, ASCE, Vol. 122, pp. 419-426.

7. Punmia B.C. 2007, " Soil Mechanics & Foundations" ,Sixteenth edition ,Laxmi Publications, New Delhi.

8. Yadav Parit, Meena Kuldeep Kumar, (2011)" A comparative study in soil plasticity of Hall area and lecture complex area of NIT Rourkela" B.tech thesis, NIT,Rourkela.

9. IS: 2720(Part 2), 1973 Methods of Test for Soils, Determination of water content.

10. IS 2720(III/SEC-I): 1980 Methods of Test for Soils, Determination of specific gravity.

11. IS 2720(VII):1980 Methods of Test for Soils, Determination of water content dry density relation using light compaction.

12. IS 2720(XIII):1986 Methods of Test for Soils, direct shear test.

13. IS 2720(IV):1985 Methods of Test for Soils, determination of grain size analysis.

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT
LEARNING RESOURCE CENTER

PLAGIARISM VERIFICATION REPORT

Date: 26/April/2017

Type of Document (Tick): Thesis | M.Tech Dissertation/ Report | B.Tech Project Report ✓ | Paper

Name: Raman Sharma, Surendra Netra Department: CIVIL

Enrolment No. 131643, 131641 Registration No. ____

Phone No. 9882203404 Email ID. sharmaraman162@gmail.com

Name of the Supervisor: Mr. Anirban Dhulia and Mr. Aakash Gupta

Title of the Thesis/Dissertation/Project Report/Paper (In Capital letters): SOIL STABILIZATION USING PLASTIC WASTE (PET BOTTLES)

Kindly allow me to avail Turnitin software report for the document mentioned above.

Raman
(Signature)

FOR ACCOUNTS DEPARTMENT:

Amount deposited: Rs. 600/- Dated: 26/4/17 Receipt No. CRV1702/178
(Enclosed payment slip)

(Account Officer)

FOR LRC USE:

The above document was scanned for plagiarism check. The outcome of the same is reported below:

Copy Received on	Report delivered on	Similarity Index in %	Submission Details	
11:00 AM 27/04/2017	1:30 PM 27/04/2017	26%	Word Counts	8248
			Character Counts	51520
			Page counts	51
			File Size	225.02K

Checked by
Name & Signature 27/4/17

Librarian

Submission Info

SUBMISSION ID	805744279
SUBMISSION DATE	27-Apr-2017 13:36
SUBMISSION COUNT	1
FILE NAME	Project_Report_Surendra...
FILE SIZE	225.02K
CHARACTER COUNT	51520
WORD COUNT	8248
PAGE COUNT	51
ORIGINALITY	
OVERALL	26%
INTERNET	22%
PUBLICATIONS	7%
STUDENT PAPERS	17%
GRADEMARK	
LAST GRADED	N/A
COMMENTS	0
QUICKMARKS	