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PREDICTION OF CALIFORNIA BEARING RATIO (CBR) VALUE FROM INDEX PROPERTIESOFSOIL FOR CASE OF AZEZO-GORGORA ROAD

By

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Abstract

At present ethiopia's infrastructure is expanding rapidly. A large number of new urban and lightly trafficked roads are planned or under construction. This in addition to maintenance of existing roads results in large amount of material testing.

The CBR is the most commonly used comprehensive test method for ensuring sub grade material quality in road design application.

As a result, this study evolved to find the correlation between CBR values with soil index properties specific to Azezo-Gorgora road sub grade soils. The study has examined the feasibility of single linear regression analysis and multiple linear regression analysis in correlating CBR value with soil index properties. Accordingly, thirty four disturbed samples collected from different parts of selected route and the required laboratory tests have been conducted in order to achieve the intended correlations.

Specific to this research, statistical software (SPSS) is employed to investigate the significance of individual independent variables. The correlation is established in the form of an equation of CBR as a function of grain size parameter, Atterberg limits and compaction parameters by considering the effect of an individual soil properties and effect of a combination of soil properties on the CBR value. The developed correlation entailed a moderate determination Coefficient of $R^2 =$0.588 using single regression analysis, while multiple regression analysis generated relatively an improved correlation of R^2= 0.631, for a sample size of thirty four. After validating the developed correlation with test results, it was noted that the correlation of CBR value with soil index properties is more applicable for preliminary characterizing the strength of sub grade soil.

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Lists of Symbols

c	Cohesion of Soil
c_u	Undrained Cohesion of Soil
D_{60}	Diameter on the Cumulative Size Distribution Curve where 60 percent of Particles are fines
I_P	Plasticity Index
M_R	Resilient Modulus
$P200$, F	Percent Passing Sieve No. 200 (0.075mm Sieve Size)
R	Pearson Product Moment Correlation Coefficient
R^2	Coefficient of Determination
τ	Shear Strength of Soil
w_l	Liquid Limit
w	Moisture Content
α	Standard Significant Error
α_1, α_2, α_3, α_n	Coefficients of the Multiple Linear Regression Equation
γ	Bulk density of Soil
β_1, β_2, β_3, βn	Coefficients of the Single Linear Regression Equation
σ_n	Normal Stress
σ^2	Statistical Variance
ϕ	Internal Friction Angle
ε	Statistical Random Error
σn	Normal stress
φ	Angle of shearing resistance

LIST OF ABBREVIATIONS

AASHTO	American Association of State Highway and Transportation Officials
ASTM	American Society for Testing and Materials
CBR	California Bearing Ratio
DCP	Dynamic Cone Penetro meter
FCBR	Field California Bearing Ratio
GI	Group Index
LI	Liquidity Index
LL	Liquid Limit
MDD	Maximum Dry Density
OMC	Optimum Moisture Content
PI	Plasticity Index
PL	Plasticity Limit
SPSS	Statistical Package for Social Science Software
SI	Suitability Index of de-Graft Johnson Equation
USCS	Unified Soil Classification System

CHAPTER ONE

INTRODUCTION

1.1 Background

California Bearing Ratio(CBR) is commonly used by civil engineers particularly those involved in pavement construction to assess the stiffness modulus and shear strength of sub grade[1]. It is actually an indirect measure, which represents comparison of the strength of sub grade material to the strength of standard crushed rock referred in percentage values. The method was originally developed at California Division of Highways in 1930s to provide an assessment of relative stability of fine crushed rock base material [1].

With an intention to adopt a more simplified test method to measure the stiffness modulus and shear strength of sub grade soil a simple test that can be used as an index test was devised. This is where CBR test comes into frame in measurement of sub grade strength. The CBR test is a simple strength test that compares the bearing capacity of a material with that of a well graded standard crushed stone base kept in California Division of Highways Laboratory [1]. This means that the standard crushed stone material should have a CBR value of 100%. The resistance of the crushed stone under standardized conditions is well established. Therefore, the purpose of a CBR test is to determine the relative resistance of the sub grade material under the same conditions.

Usually, the CBR values are used by road material engineers to design the thickness of pavement that will be laid on top of the sub grade. Sub grade that has lower CBR value will have thicker pavement compared with the sub grade that has higher CBR value. In other words, the design of pavement is very much dependent on the CBR value of sub grade. Different soil types give different values of CBR although it is compacted at the same amount of energy and rate of penetration. Conventionally, CBR value can be measured directly from field test in accordance BS1377:1990, ASTMD4429 and AASHTOT193.

CBR is actually an indirect measure which represents comparison of the strength of sub grade, sub-base and base-course material to the strength of standard crushed rock quoted in percentage values. Laboratory CBR test requires relatively large effort to conduct the test and it is time consuming.

The alternate method could be to correlate CBR with simpler tests results such as soil index properties. These tests are much economical and rapid than CBR test. This thesis gives an overview to obtain a correlation between CBR values with soil index properties that is suited for Azezo-Gorgora road sub grade soil.

Currently, many road construction projects and railway constructions are undergoing in the country. In light of this, the output of the proposed correlation will provide road authorities, railway authorities, consultants and contractors preliminary background information on the value of CBR, for localized sub grade material, from soil index properties with a benefit of time saving and without incurring any additional cost for carrying out laboratory CBR test.

1.2 Statement of the Problem

Soil is diverse information and in character and hence accurate prediction of its engineering behavior is of research interest in civil engineering area .As the Engineering behavior of soils vary from place to place and even with time, accurate prediction of parameters that properly characterize it depends on how much representative samples in terms of both space and time are gathered. Though various attempts have been made to predict the CBR value by different researchers from samples of their locality, adopting those developed prediction methods without adjustment leads us to misinterpretation of soil behavior.

Therefore, identification of factors that influence the soil strength, studying their relationship with CBR value and performing necessary tests on local representative soils sample can be considered as a good insight of soil behavior.

Since CBR test require large amount of material and time consuming to perform and Azezo-Gorgora road is 57km length road and the route pass trough different geological formation and need enormous amount of material sample to check the strength of sub grade and to check the strength of selected material for construction predicting CBR from index properties must be assess.

1.3 Objective

1.3.1 General Objective

The purpose of the research is to develop empirical relationship between CBR values and soil index properties (indices related to gradation characteristics, maximum dry density, and optimum moisture content, and Atterberg limit).

1.3.2 Specific Objective

- To predict CBR value from index properties of soil collected from Azezo-Gorgora road area using Statistical regression analysis.

1.4 Scope and limitation of the thesis

The samples collected were nearly representative of the soil along the selected route. The samples were taken from sub grade soil. In addition to sampling limitation the sampled soil was fine-grained soil subjected to limitations on the prediction and testing of granular material.

CHAPTER TWO

LITERATURE REVIEW

2.1 Definition of California Bearing Ratio (CBR)

The CBR is essentially a measure of the shear strength of a material at a known density and moisture content. The shear strength of soils can generally be considered in terms of Coulombs Law,as discussed by(Croney,1977).Failure of soil occurs when individual grains moves relative to one another (Rosenak,1963), as described in fundamental soil mechanices equation 2.1 illustrates the relationships between the shear strength (or resistance to shear) of the soil and its choesion and angle of shearing resistance (friction angle).

$$s = c + \sigma_n \tan\varphi \qquad \text{2.1}$$

where s = shear strength

c = cohesion

σ_n = normal stress

φ = angle of shearing resistance

It is clear that the shear strength of non chosive soils is determined solely by friction physical and inter locking of particles whilst in cohesive materials the shear strength depends on both choesion (the water bonds between clay particles) and internal friction. In roads construction material entirly choesive natural materials are not generally used. Natural material are usually found to be amixture of choesive and non choesive constituents.

The strength of a soil material therefore comprises two components. The frictional components, which depends on the friction and interlock between the soils grains is a function primarily affected by the particle size distribution (grading) of the material. This component is also affected by an applied stress normal to the shear plane. The effect of compaction on particle interlock must be anticipated,particularly when discussing compaction related tests carige (1997:28) states compaction is the process of increasing the density of soil by packing the particle closer together with a reduction in the volume of air there is no significat change in the volume of water in the soil (this statement must considered in the context of the CBR where the sample is not only compacted, but soaked for four days.

The second strength component is the cohesion of the materialthe effect of cohesion is influnced by the grain size (distribution), the affinity of the particles to moisture(plasticity) and the moisture content.

Cosidereing the above it is apparent why compaction of any tested material results in increased soils strength. The particle interlock and particle packing is modified during compaction resulting in forced inter locking and denser packing. However,with three compactive efforts being used thoughout(i.e 95%,98% and 100% Mod AASHTO),the prediction of CBR values would therfore require analysis of parameters representing interlock friction and cohesion. In the absence of thermometer resukts in the data available for the research. The constituent finer than 0.075mm (p075) will be considered as representative of cohesive materials. Atterberg Limits,reflecting the relationship between amaterials moisture content and placticity, are also associated with the cohesion of such a material the grading and atterberg limits are therfore demmed the critical parameters in the prediction of CBR.

2.1.1 History of California Bearing Ratio

By definition CBR can be considered as follow: The California bearing ratio of a material, is the load in Newton's expressed as a percentage of California standard values, required to allow a circular piston of 1935mm to penetrate the surface of a compacted material at rate of 1.27mm per minute to a depth of of 2.54mm, 5.08mm and 7.62mm.the California standard value for depths are 13344N, 20016N and 25355N respectively (TMH1, 1986:35).In order to appreciate the development of CBR, a short description of its history, as described by Otte, 1977 is included.

The use of grading and atteberg limits alone were not sufficient in qualifying material for road construction use due to the fact that such materials behave differently under different moisture and density condition. Using proctor original compaction technique,porter devloped the CBR penetration and swell test around 1930(otte,1977). The pentration test was devloped in order to establish the material shear strength ,whilst the swell test would indicate the material (potentially worest state) post compaction behaviour i.e. whem wetted (and ultimately saturated)

Initially the test used static compaction of 1378 MPa to simulate densities achieved by year of service operation. The compaction saw a 150mm diameter sample compacted at roughly 1.25mm per minute. This was followed by the 1378MPa load which was applied and held for one minute and then removed. The method, however, proved impractical because static compaction devices were notreadily available. For this reason the falling hammer setup was introduced, as it was more practical and obtainable.

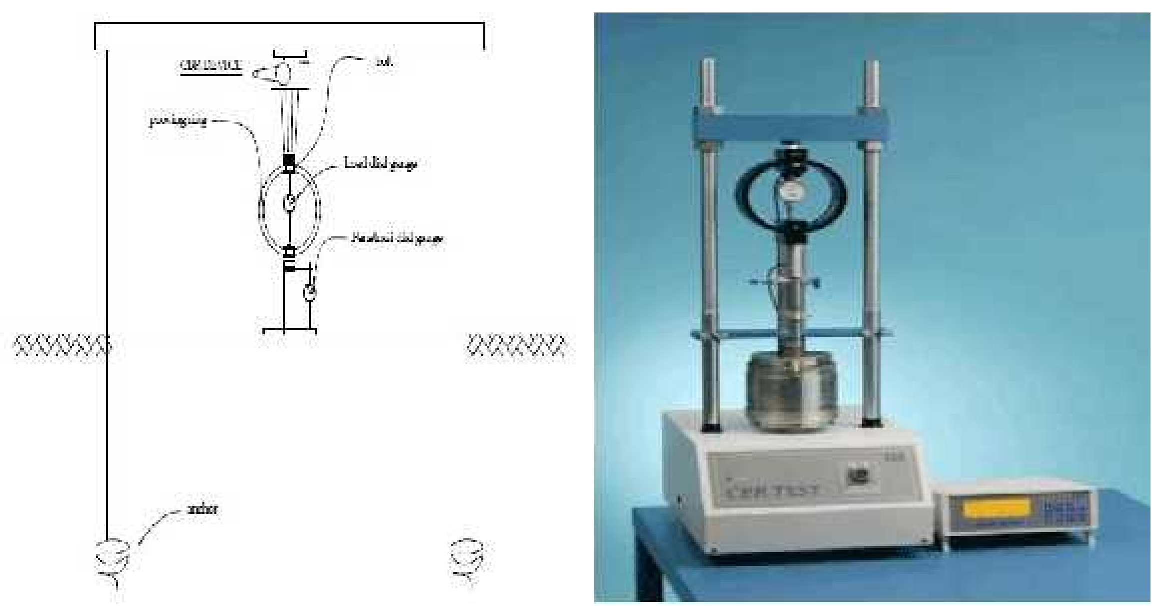
The compactive effort initially used with the falling hammer (per 25mm layer) involved twenty drops using a 4,53kg hammer falling a distance of 457mm.The falling hammer method proved more practical and consequently the static compaction method was discontinued.After the static compaction method was discontinued, the falling hammer method was further adapted and modified in an effort to fine tune its performance. The four day soaking period was also introduced,after which the amount of swelling could be determined and the penetration test could be conducted.

The test setup and equipment used for the original test is not dissimilar in nature from what is used currently. The apparatus consistes of $19935mm^2$ penetration piston penetrating at 1.27mm per minute.

The effort required to pentrate interval of 2.54mm was recored and compared with the force required to penetrate a standard broken sample.As is practice today the recored force is expressed as percentage of the required force for teting the standard sample. The standards for 2.54mm, 5.08mm and 7.62mm penetration were established at 6895kPa, 10342kPa and 13100kPa, respectively.

2.2 Field and laboratory CBR test

California bearing ratio (CBR) test can be done at both field and laboratory .A typical in-situ CBR testing apparatus is shown in Figure 2.1 (a).



a. Field CBR Apparatus **b.** Laboratory CBR Apparatus

Figure 2.1: California Bearing Ratio Testing Apparatus

2.2.1 Field Test

2.2.1.1 Significance and Use

Field in-place CBR tests are used for evaluation and design of flexible pavement components such as base course, sub base, sub grade other applications (such as un surfaced roads) under for which CBR is the desired strength parameter if the field CBR is to be used directly for evaluation, or design without consideration for variation due to change in water content the test result should be conducted under one of the following conditions [ASTMD4429]:

(a)When the degree of saturation (percentage of voids filled with water) is 80% or greater,

(b)When the material is coarse grained and cohesion-less so that it is not significantly affected by changes in water content, or

(c) When the soil has not been modified by construction activities during, the two years preceding the test.

In this case, the water content does not actually become constant, but generally fluctuates with in a rather narrow range. Taking account the above conditions, the field in-place test data may be used to satisfactorily indicate the average load-carrying capacity.

Any construction activities such as grading or compacting, carried out subsequent to the bearing ratio test will probably invalidate the result of the test.

The field test is applicable to determine the relative strength of soils, sub-base and some base material in the condition at which they exist at the time of testing. Such results have direct application in test section work and in some expedient construction, military, or similar operation In addition, field in-place tests can be used for design under conditions of nominal stability of water, density and general characteristics of the material tested. However, any significant treating, disturbing, handling, compaction, or water change can affect the soil strength and make the previous test determination inapplicable, leading to the need for retest and re analysis.

2.2.1.2Scope of Field CBR Test

This test method covers the determination of the California Bearing Ratio (CBR) of soil tested in place by comparing the penetration load of the soil to that of a standard material. The method is used for evaluation of the relative quality of sub grade, sub base and some base-course in-situ materials corresponding to test MethodASTMD4429.

2.2.2 Laboratory Test

CBR test in the laboratory is carried out as per the procedure outlined in AASHTOT193-63 or ASTM1883-73 CBR tests are usually made on test specimens at optimum moisture value for the soil as determined using the standard (modified) compaction test using method 2 or 4 of ASTMD698-70 orD1557-70(for the 152.cm diameter mold).the specimens are made using compaction energy shown in table 2.1 below

Table 2.1 the number of blows and corresponding number of layers for different grade of soils [1].

Method	Blows	Layers	Hammer weight(N)
D698:2(fine grained soil)	56	3	24.5
D698:4(coarse grained soil)	56	3	24.5
D1557:2(fine grained soil)	56	5	24.5
D1557:4(coarse grained soil)	56	5	24.5

Two molds of soil are often compacted-one for immediate penetration testing and one for testing after soaking for a period of 96h.The second specimen is soaked for a period of 96h with a surcharge approximately equal to the pavement weight used in the field but in no case the surcharge weight is less than4.5kg.Swell readings are taken during this period at arbitrary selected times At the end of the soaking period ,the CBR penetration test is made to obtain a CBR value for the soil in saturated condition.

In both penetration tests for the CBR values, surcharge of the same magnitude as for the swell test is placed on the soil sample. The test on soaked sample accomplishes two things.

I) It gives information concerning expected soil expansion beneath the pavement when the soil becomes saturated.

II) It gives an indication of strength loss from field saturation

Penetration testing is accomplished in a compression machine using strain rates of 1.27mm/min reading of load vs. penetration are taken at each 0.5mm of penetration to include the value of 5.08mm, and then at2.54mm increment thereafter until the total penetration is12.7mm.

2.3 Influencing Properties

A range of factors influences the CBR of a particular material Carter and Bentley (1991) mentioned the soil type density, moisture content and method of sample preparation as playing an important role. Apart from the material properties themselves moisture conditions are also pivotal.

The moisture conditions at which the material is to be used vary according to climatic region and as such the CBR test is used to simulate the worst likely conditions in service.

2.4 Index Properties of Soil

Index properties of soil are properties, which are used to characterize soils and determine their basic properties such as moisture content, specific gravity, particle size distribution consistency and moisture-density relationships.

2.5 Soil Classification Systems

Numerous classification systems are in existence in the road construction industry at present**.** Some systems are original,while some are modifications or fusion of other system. Such systems attempt to relate specific factors (e.g. soil description) to properties **,** such as engineering parameters (Croney,1977). Below is a short description of two classification systems of which are commonly used**.**

2.5 .1 Casagrande Soil Classification System

The casagrande system divides soils material in to classes based on grain size distribution (e.g. gravel and gravelly soil). Each class is complemented with description that aids in field identification.

The classes are then sub divided in to sub-groups **(**e.g. well-graded, gravels and with samll clay content) and awarded a group symbol. From here each sub group is supplied with generally applicable test methods and observation associated with it. This is followed by a generazied description of expected characteristics associated with each sub group including value as a road foundation material,shrinkage or swelling properties,drainage characteristics and maximum dry density at optimum compaction.The scheme provides avery useful indication for making aprelimnary decisions concerning material use(croney 1997)

2.5 .2 Unified Soil Classification System

The Unified Soil Classification System (USCS) was developed from the Casagrande system and shows many similarities although it is more thorough and considered as more complete.In this system fine and coarse grained soils are classified based on their particle size distribution and placticity.The system distinguishes between silts and clays by a graphical relationship between placticity index and liquid limit as determined by Casagrande, using empirical data (Carter and Bentley, 1991). In the USCS system, soils are divided into three major categories coarse-grained materials, fine- grained materials, and highly organic soils. These categories are further divided into soil groups the coarse-grained soils as either gravel or sand and the fine- grained soils as either silt or clay. A letter symbol represents each of these four main soil groups ,as shown in Table2.2.These soil group letters are combined with a second letter,(shown in the lower half of Table2.2) which is used to further describe the soil’s characteristics. These descriptors include symbols to differentiate among grain size distribution, plasticity characteristics that describe cohesive behavior, and the nature of the organic material in a soil. For example a sandy soil with few fines and a uniform grain size would be classified as a SP, or poorly graded and. Fifteen classes of these two letter combinations comprise the major soil types defined under the USCS system .Further designation for “borderline” soils are described by combinations of two of these fifteen major soil types. This occurs in cases where the fine material maybe a combination of a clay and a silt (for example SC- SM design at a silty-clay sand) or cases in which the amount of fines in a coarse grained soil fall between 5 and 12 percent (for example GW-GM is well-graded gravel with silt) Eleven of these combinations for border line soils are generally recognized by the USCS system. It should be stressed that the USCS is a systematic and strictly based on test measurement values defined in the ASTM standard [6] and not a qualitative assessment of a soil based on subjective judgments .As such, the USCS class of a soil is inherently tied to the soil properties by which it is defined, and in the absence of these original classification test results can give some indication as to the range of grain sizes and plastic behavior that the soil is bounded by.

Table2.2Letter Symbols in the Unified Soil Classification System [5, 6, 7]

Soil groups	**Symbol**
Gravel	G
Sand	S
Silt	M
Clay	C
Soil Characteristics	**Symbol**
Well-graded	W
Poorly-graded	P
Low plasticity(liquid limit under50)	L
High plasticity(liquid limit over 50)	H
Organic(silts and clays)	O
Organic(peat)	Pt

2.6Existing Correlation

Seeing as the CBR test is time-consuming, a good indication of CBR values from index tests would be beneficial. To this end attempts have been made to relate index test parameters to CBR values.Some examples are given below

2.6.1 Kleyn

The system introduced by Kleyn (1955) is probably the first worth while attempt at relating index parameter CBR values, though the method was developed in an attempt to verfiy or confirm confirmation the CBR, rather than predict it. Kleyn (1955) derived this method to adress inconsistance in the CBR test. He uses grading modulus and placticity index in an attempet to drive CBR value and achieved some success.

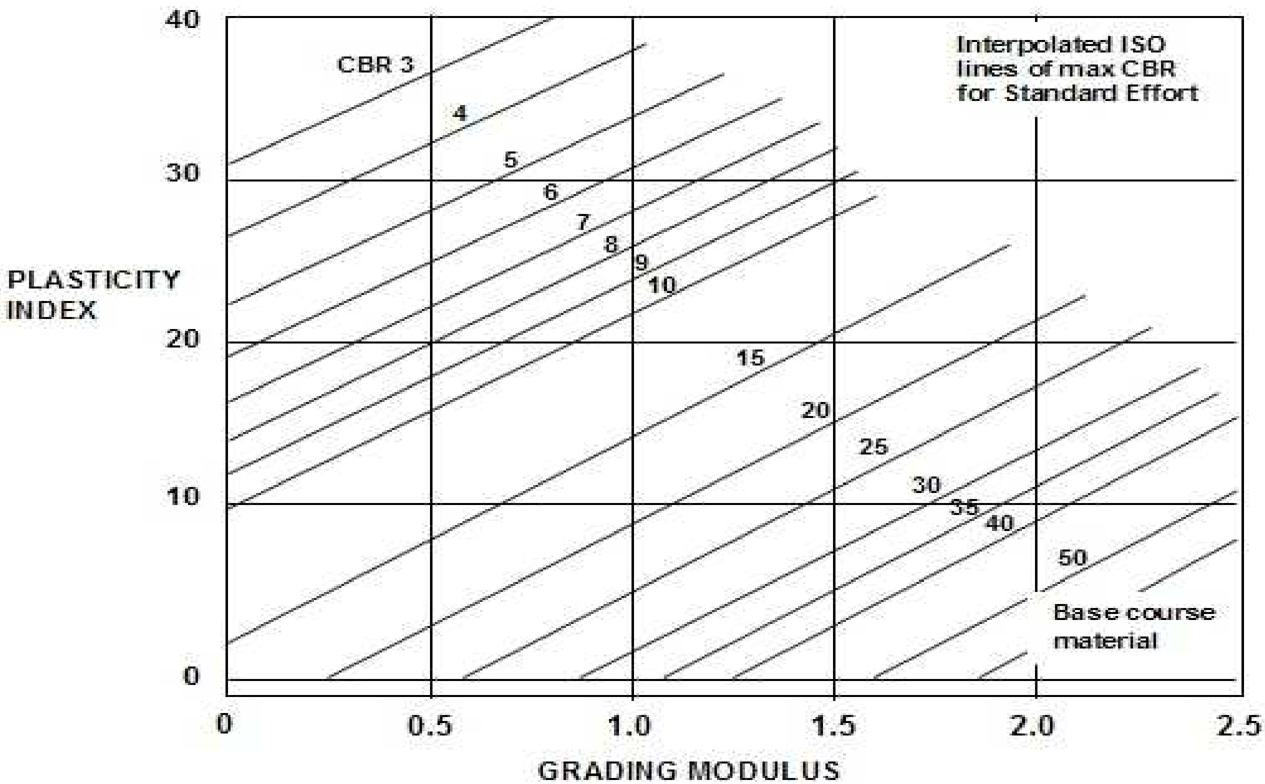


Figure2.2 Relationship between the ratio of grading modulus to plasticity index and CBR (kleyn,1955)

2.6.2. Stephens

Stephens (1988) uses the chart derived by kleyn (1955) in his research and drives the following equation.

log eCBR = (12GMPI)/(18,5) + loge16,7……………………………………………..2.3

Stephens(1988,1990) concludes that the method developed by kleyn (1955) yields fairly poor results when applied to soils kwazulunatal.bearing this in mind,stephens(1992) continues his reserch,focussing on clay soil. The result of his research,however,are limited use due to tha fact he has problem relating the result obtained from ideally mixed soilto real soil. He concludes that the so called dilution effect impedes the corelation.stephens(1988,1990) excuted extensive research comparing other authors work with his own. It is interesting to note that he find poor correlation in most instance where he apply other authors model to soils from Kwazulu-Natal.

2.6.3 De Graft-Johnson et al.

Extensive research has been performed to developed empirical relationship between DCP (Dynamic cone penetrometer) resistance and CBR measurements. e.g kleyn,1975;Harison,1987; Livneh,1987; Livneh,1994;Eseet.al.,1994;and Coonse,1999). Based on the results of past studies many of the relationships between DCP and CBR have the following form.

Log(CBR)=*a*+ *b*log(DCPI)…………………………………………………….……2.4

Where:-

DCPI=DCP penetration resistance (mm/blow);

a=constant that ranges from 2.44to2.60;

b=constant that ranges from 1.07to1.16.

A summary of some of these correlations with corresponding authors is presentedinTable2.3

Table2.3 summary of correlation between CBR and DCPI by various authors [13]

Correlation Equation	Material tested	Reference
log(CBR)=2.56-1.16log(DCPI)	Granular and cohesive	Livneh (1987)
log(CBR)=2.55-1.14log(DCPI)	Granular and cohesive	Harison (1987)
log(CBR)=2.45-.1.12log(DCPI)	Granular and cohesive	Livnehetal.(1992)
log(CBR)=2.46-1.12log(DCPI)	Various soil types	Websteretal.(1992)
log(CBR)=2.62-1.27log(DCPI)	Unknown	Kleyn (1975)
log(CBR)=2.44-1.07log(DCPI)	Aggregate base course	Eseetal.(1995)
Log(CBR)=2.60-1.07log(DCPI)	Aggregate base course and cohesive	NCDOT (Pavement,1998)
Log(CBR)=2.53-1.14log(DCPI)	Piedmont residual soil	Coonse (1999)

2.6.4 Mechanistic-Empirical Design Guide

Another general approach to the problem of estimating CBR has been developed as a part of the highway pavement community's recently released Mechanisitic-Emperical design guide for New and rehabilitated pavement structures [9]. The design guide methodology includes three levels of confidence in the resulting pavement designs, depending on the quality of input data provided to the model. This ranges from the highest level, where the design is based on a detailed, project-specific series of laboratory characterization tests on the construction materials, to the lowest level where default values based on simple material characterization tests and/or regional norms are used as model inputs. One of the parameters needed to perform flexible pavement design using this system is resilient modulus, which is specific type of modulus of elasticity that is based on the recoverable strain instead of the total stain [10]. In order to provide an estimate of the resilient modulus parameter, an appendix to mechanistic-Empirical design guide was developed that relates resilient modulus to much simpler soil characterization tests by way of CBR as an intermediary step. The correlation between soil index properties and California bearing ratio for this method is based on a simple regression approach. Separate relationships were determined for coarse-grained soils that exhibit no cohesive behavior (GW, GP, SW and SP) and for soils with more than 12 percent fines that exhibit plastic behavior (GM, GC, SM, SC, ML, MH, CL and CH).The CBR values were selected by choosing average values for each USCS soil type based upon sources that provide typical CBR values by classification, as illustrated in the previous section. The index property values were selected by examining the USCS classification criteria for each soil type, and choosing atypical value for USCS soil type. The index properties chosen to correlate with CBR included:

D_{60}=Diameter on the cumulative size distribution curve where 60 percent of particles are finer (in millimeters)

P_{200} =percent passing (finer than) the number 200 sieve size (in decimal form)

PI=plasticity index (in percent)

The last two properties were combined into composite index called the weighted plasticity index. This term, denoted by WPI is defined in the method by:

WPI= P_{200*} PI (if PI>0)……………………………………………………………….2.5

For clean, coarse-grained, non plastic soils such as GW, GP, SW, SP and A-1-a, A-1-b and A-3 soils where WPI=0 the CBR were correlated with $D_{60.}$ The method provides the following prediction relationships below [9].

$$CBR = \begin{cases} 5 & (if\ D_{60} \leq 0.01mm) \\ 28.09(D_{60})^{0.358} & (if\ 0.01\text{mm} < D_{60} < 30mm) \\ 95 & (if\ D_{60} \geq 30mm) \end{cases} \quad \text{……………2.6}$$

For second group of soils that exhibit plastic behavior, such as GM, GC, SM, SC, ML, MH, CL and CH a different correlation for CBR was determined. In cases where the soil has fines content ($P_{200)}$ greater than twelve percent and we the weighted plasticity index (WPI) is non zero, the prediction equation is

$$CBR = \frac{75}{1 + 0.728(wPI)} \quad \text{……………………………………………………………………....2.7}$$

The R^2 value of the regression for these two resulting equations was reported as 0.84 for coarse grained materials and 0.67 for the fine grained materials [9].

2.7 Conversion Factors for the CBR

2.7.1 Mod AASHTO vs. Proctor

In an attempt to correlate CBR tests done at different densities, Haupt (1980) derived an equation that converted maximum soaked Proctor CBR values to maximum soaked Mod AASHTO CBR values

$$CBR_p = 0{,}37CBR_M \quad \text{………………………………………………………………………….2.8}$$

where

CBR_p = maximum Proctor soaked CBR (2.54mm)

2.7.2 Soaked vs Un soaked

Haupt (1980) also attempted to correlate soaked CBR values and unsoaked CBR values using relative proctor density result. Although it is not of particular interest to this dissertation. The following equation resulted from his analysis.

$CBR_{uP} = 1,15\ CBR_{SP} + 1.2$……………………………………………………………….…..2.9

where CBR_{UP} = unsoaked CBR at Proctor compaction (at OMC)

CBR_{SP} = four days soaked CBR at Proctor compaction.

CHAPTER THREE

METHODOLOGY

3.1 Study Area

The Azezo-Gorgora road is the subject of this study.The Azezo-Gorgora road is located in the northern part of Amhara regional state of Ethiopia. It is one of the major south-north road links of the country. The project road is a major road link providing access to large area of Amhara region.The road route is flat. The climate in the project area lies predominantly within the cool zone. In day time temperatures rarely rise above 30°C in Gondar and 35°C in Gorgora and rarely fall below 10°C and 16°C respectively; the average mean temperature is 21°C in Gondar and 25°C in Gorgora. The start of the road at Gondar is at an altitude of about 2,300 m.

Figure 3.1 Map showing study area (Google map)

3.2Methodology

Primarily, in order to address the intended objectives of the study, basic theories and descriptions of CBR test in general and in relation to soil index property of sub grade soil is reviewed. Subsequently, previous works of different researchers with regard to prediction of CBR value from basic soil index properties were assessed.

In order to have satisfactory data for utilizing the correlations, laboratory tests were conducted by the researcher on samples collected from different place of Azezo-Gorgora road, accordingly the following test are conducted.

- Atterberg limit test (AASHTOT89-90)
- Compaction test (AASHTOT99)
- California bearing ratio test(AASHTOT193)
- Sieve analysis (AASHTOT27)

After having the test result of the above tests then, discussions on sample collection and summary of laboratory test results were presented and the data base for Statistical regression analysis were prepared, the following parameters were included .

- Grading analysis (percentage passing 4.75mm,2mm,0.425mm,0.075mm screens)
- Atterberg limit(plastic limit, liquid limit and plasticity index)
- Compaction(optimum moisture content and maximum dry density)
- CBR value
- Material classification

Linear and multiple regression analyses of test results were carried out and correlations were developed and also analyzed to fit the test results. Under the discussions of the obtained results the suitability of the developed correlations were examined. Finally, a generalized conclusion and recommendation were made.

CHAPTER FOUR
DATA COLLECTION, LABORATORY TESTS AND RESULTS

4.1 General overview

In order to have sufficient and reliable data for the target analysis, laboratory tests conducted on soil samples obtained from different localities of selected route (Azezo-Gorgora road). Most of the samples collected from undergoing road construction projects during the excavation stage. A total of thirty four disturbed samples were gathered within a reasonable sampling interval. The representative samples selected on the basis of visual identification of a suitable sub-grade soil.

4.2 Laboratory Tests and Results

4.2.1 Discussion on Laboratory Tests

Based on the samples retrieved from the sites, laboratory tests on the thirty four samples were conducted in the geotechnical laboratory of Azezo-Gorgora road project. Accordingly, the following different kinds of tests have been performed

- Atterberg limit test (AASHTOT89-90)
- Compaction test (AASHTOT99)
- California bearing ratio test(AASHTOT193)
- Sieve analysis (AASHTOT27)

The above conventional tests were conducted on the thirty four soil samples and a range of test results achieved. Based on the obtained test results of plasticity and grain size distribution the soil classification was made and the result shows that all the sample are classified as fine grained soil. In accordance to the AASHTO classification system the soil is mainly classified as A-7-5 and A-7-6. From the conventional Atterberg limit tests, a liquid limit value ranging from 34 up to 134, plasticity limit value of 16 up to 45 and a plasticity index value of 18 up to 89 were obtained. Similarly, the CBR test was carried out, on samples remolded with OMC using 10, 30 and 65 blows of modified proctor density and soaked for four days. Consequently, after the penetration test were carried out a CBR value ranging from 1.70 up to 38 is obtained at 95% MDD of modified AASHTO proctor density.

For the sake of illustration and easy of reference, the typical test results of a soil sample have been demonstrated hereunder from Figures 4.1 up to 4.4:

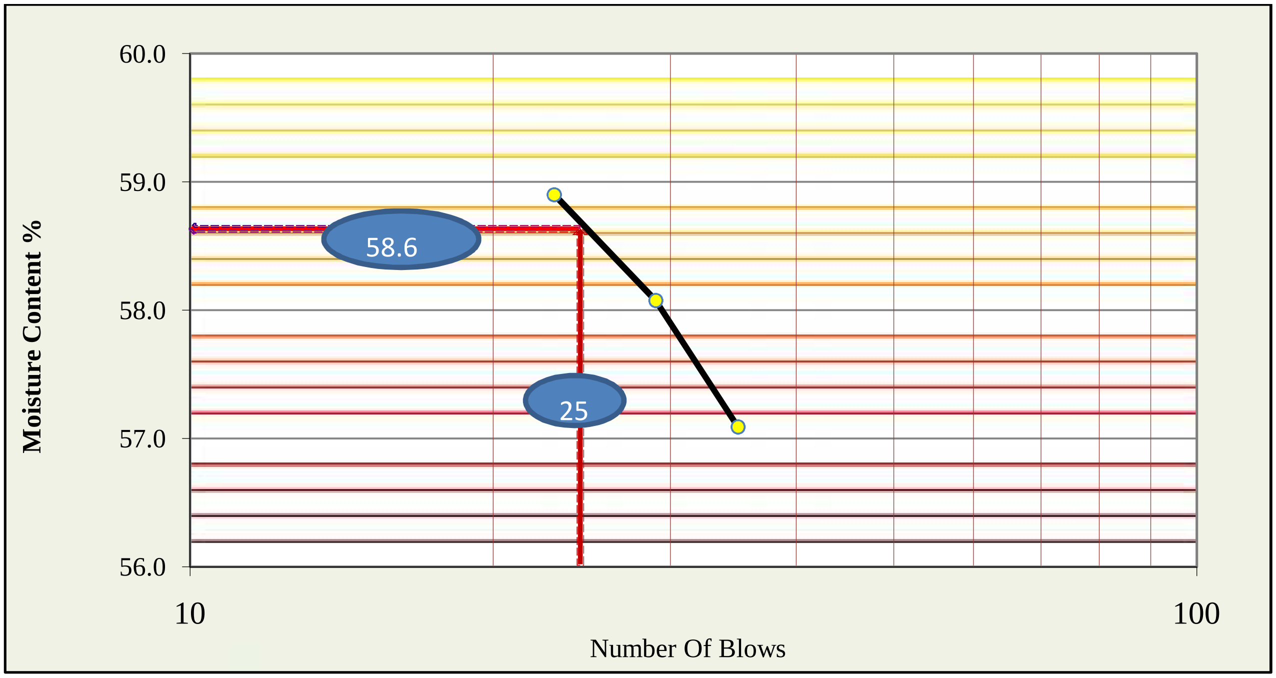


Figure 4.1 Typical Liquid Limit Graph (Flow Curve)

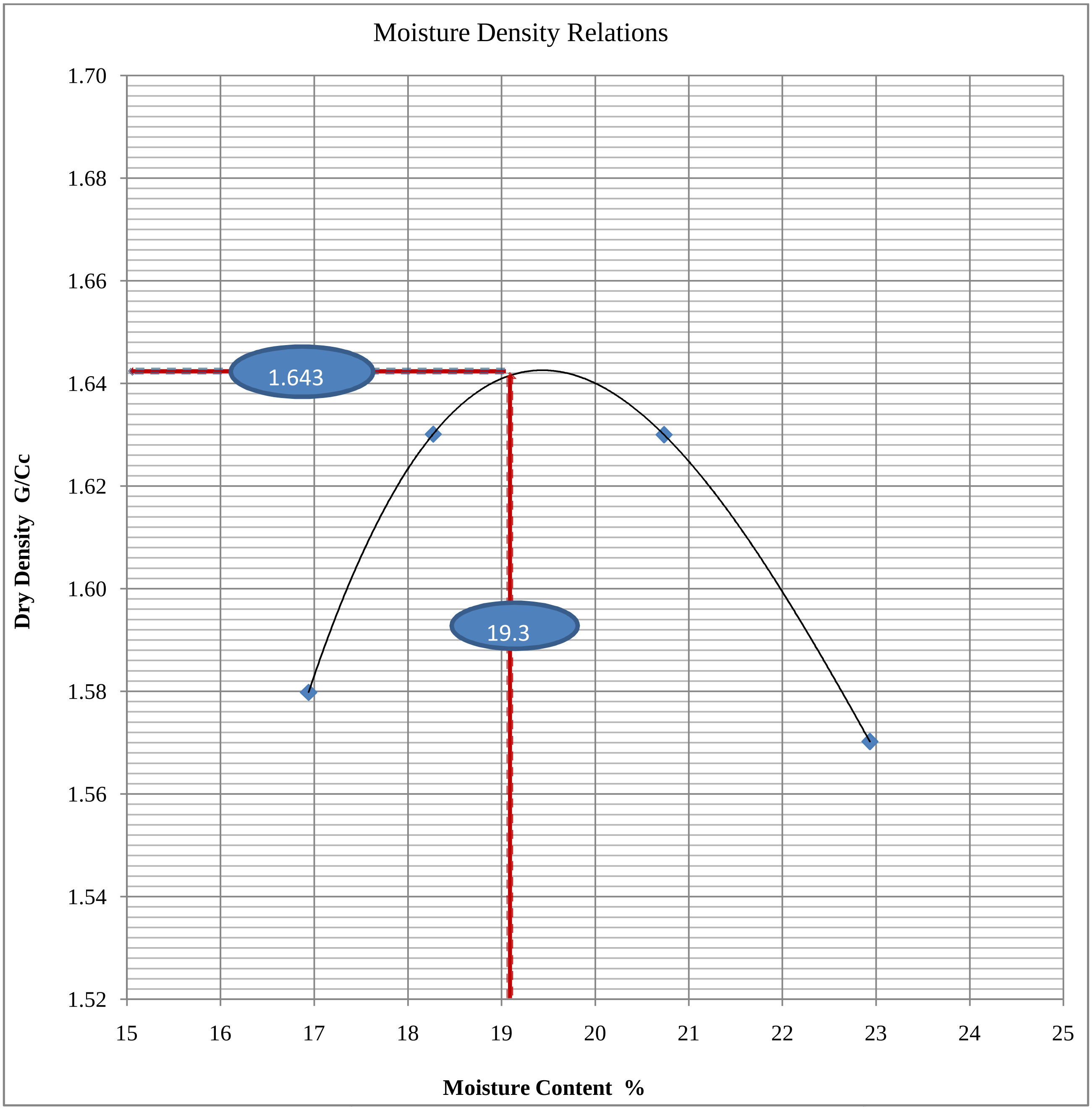


Figure 4.2 Typical Density vs. Moisture Content Relationship Graph

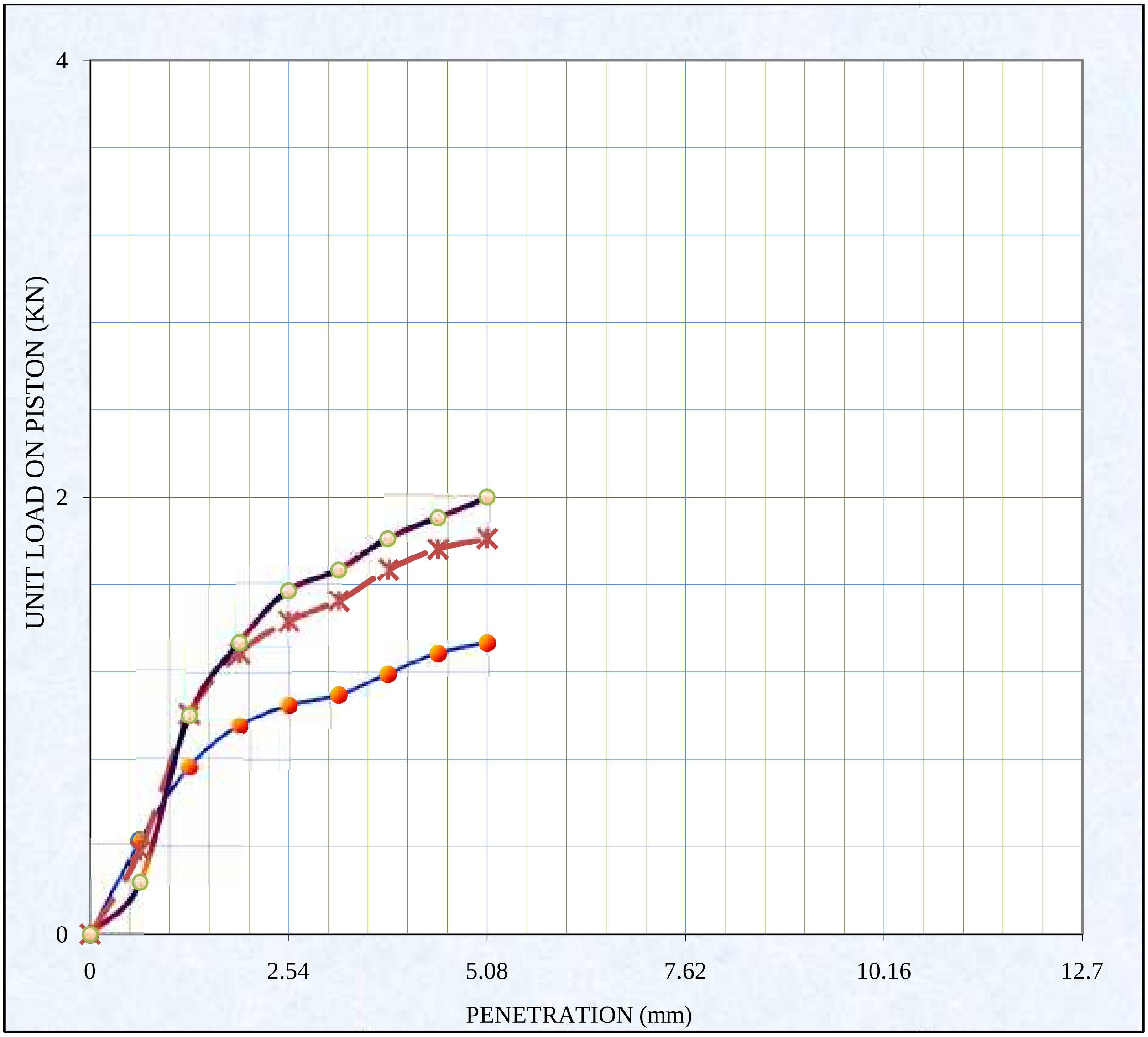


Figure 4.3 Typical Penetration Load vs. Penetration Depth Graph

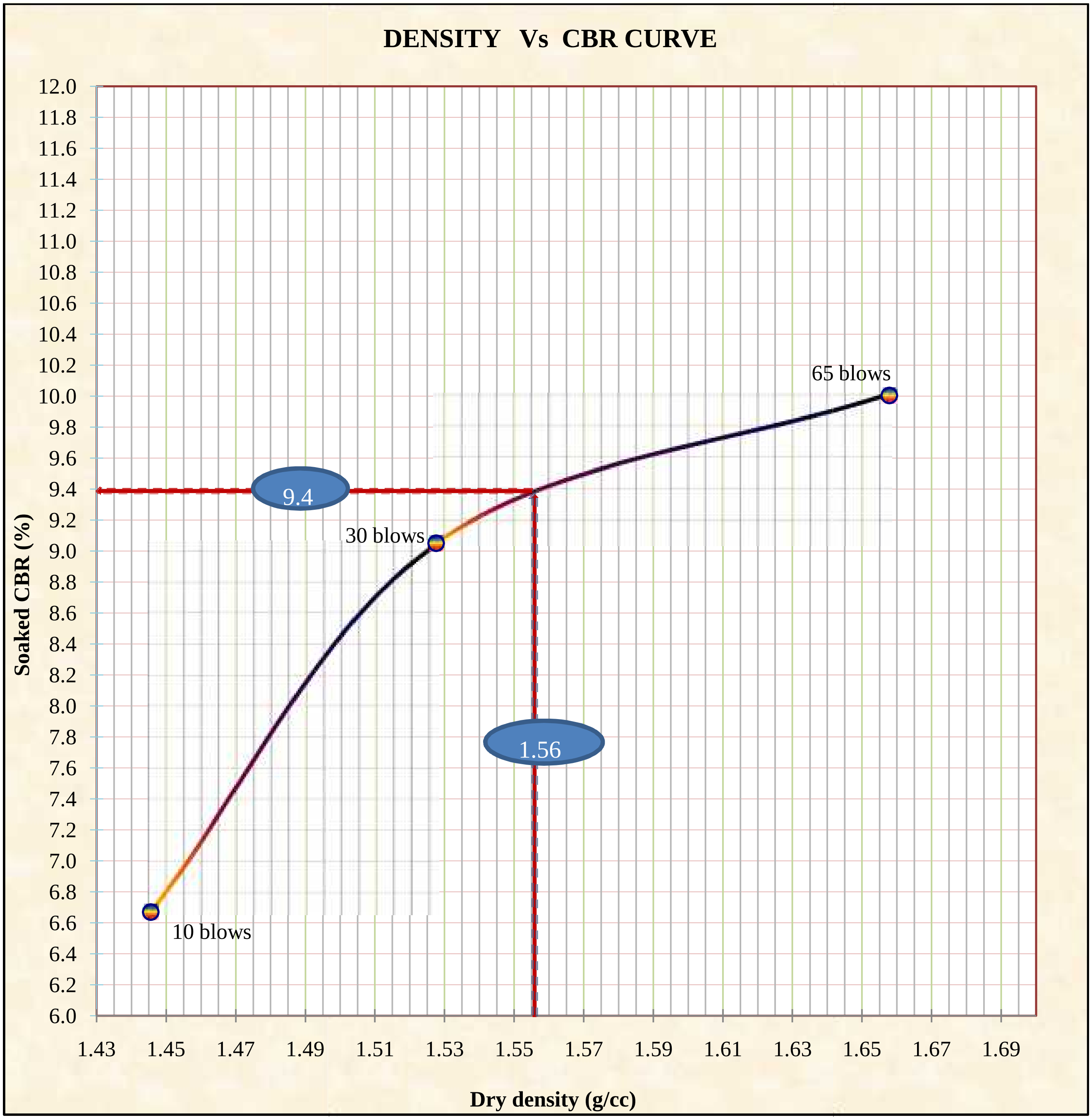


Figure 4.4: Typical Density vs. CBR Graph

For further reference, the details of all the laboratory tests results of the thirty four soil samples and related calculations including graphs have been enclosed under Appendix B of this thesis.

In order to analyze the intended correlation, the test results were compiled and summarized in a way that the SPSS Software inputs the data

Table4.1 Summary of laboratory test results

Sample Code	Percent passing %				compaction test		Atterberg limit Test			AASHTO Classification	CBR
	4.75	2	0.425	0.075	OMC	MDD	LL	PL	PI		
1	93.3	87.7	78.4	66.9	19.30	1.64	58.6	27.59	31	A-7- 5(19)	9.10
2	97.3	92	84.1	73.9	19.4	1.65	61	29	32	A-7- 5(20)	6.00
3	98.2	95.4	89.8	83.9	18.20	1.67	62	29.6	32.4	A-7- 5(17)	4.50
4	98.8	98.6	96.9	93.4	17.50	1.76	53.2	25.4	27.8	A-7- 6(20)	5.50
5	94.7	91.9	89.2	83.8	13.50	1.71	77	32	45	A-7- 5(20)	24.8
6	85.6	74.4	66.0	58.4	13.5	1.96	66	25.20	40.8	A-7- 5(9)	24.8
7	81.4	78.9	73.3	66.8	19.5	1.55	43	22.10	20.9	A-7- 5(19)	10.50
8	81.4	78.9	73.3	66.8	16.5	1.71	55.20	27.80	27.40	A-7-5(19)	7.10
9	99.9	97.9	92.50	89.20	17.60	1.76	43	33	10	A-2- 5(10)	1.39
10	77.4	67.7	55.2	42.5	16.5	1.87	48	19.40	28.6	A-7- 6(15)	18.8
11	85.9	79.5	76.5	68.2	14.5	1.70	62	25.90	36.10	A-7- 5(20)	6.40
12	92.7	88	82.5	75.6	18.5	1.74	63	26.70	36.30	A-7- 5(20)	1.90
13	94.9	91.1	86.6	81.2	17.3	1.69	64	26.4	37.6	A-7- 5(20)	1.70
14	96.4	87.6	77.7	69.6	20.60	1.66	60	22	38	A-7- 5(20)	2.40
15	99.0	98.10	95.9	91.9	17.50	1.70	76	30.8	45.20	A-7- 5(20)	2.40
16	99.9	99.6	99.3	98.5	18.00	1.71	79	33.3	45.7	A-7- 5(20)	1.70
17	97.8	96.5	96.10	94.70	19.50	1.69	82	32.5	49.5	A-7- 5(20)	1.70
18	99.7	98.8	94.8	87.5	29.50	1.31	134	44.75	89.25	A-7- 5(20)	1.70
19	100	95	90.6	83.10	19	1.71	55	23.8	31.2	A-7- 6(19)	3.60
20	93.5	84.5	77.9	66.9	18.50	11.75	51	23	28	A-7- 6(17)	3.60
21	93.6	87.3	79.2	70.2	22.30	1.51	81	31	50	A-7- 5(20)	1.60
22	81.3	62.5	54.3	44.2	24.60	1.50	84	22	62	A-7- 5(20)	2.68
23	99.9	97.3	95.9	92.4	29.50	1.47	76	31	45	A-7- 5(20)	1.60
24	99.2	97.4	96.3	93.5	26.20	1.45	63	33	30	A-7- 6(16)	1.60

Sample Code	Percent passing %				compaction test		Atterberg limit Test			AASHTO Classification	CBR
	4.75	**2**	**0.425**	**0.075**	**OMC**	**MDD**	**LL**	**PL**	**PI**		
25	99.7	98.7	96.8	91.1	24.60	1.56	72	24	48	**A-7- 5(20)**	1.60
26	87.5	82.3	76.7	67.3	24.60	1.56	42	18	24	**A-7- 5(20)**	1.78
27	99.6	98.1	95.1	76.9	14.20	1.82	56	22	34	**A-7- 5(20)**	1.73
28	88.1	72.2	61.5	50.6	15.40	1.82	49	22	27	**A-7- 5(20)**	11.00
29	64.1	57.5	49.3	34.0	10.30	1.98	34	20	14	**A-2- 6(1)**	38.0
30	74.9	66.6	58.10	51.4	18.00	1.71	60	28	32	**A-7- 5(20)**	5.00
31	96.8	94.3	91.4	77.7	11.50	1.75	43	16	27	**A-7- 5(14)**	2.20
32	47.4	41.8	38.5	35.6	24.60	1.56	61	24	37	**A-7- 5(20)**	1.60
33	98.2	93.2	87.4	77.5	24.60	1.56	59	19	40	**A-7- 6(19)**	1.60
34	83.5	73.7	60.4	51.1	24.60	1.56	52	20	32	**A-7- 6(18)**	1.60

4.3 REGRESSION ANALYSIS

4.3.1 General Overview

Regression analysis is a statistical technique that is very useful in the field of engineering and science in modeling and investigating relationships between two or more variables. The method of regression analysis is used to develop the line or curve which provides the best fit through a set of data points. This basic approach is applicable in situations ranging from single linear regression to more sophisticate nonlinear multiple regressions. The best fit model could be in the form of linear, parabolic or logarithmic trend. A linear relationship is usually practiced in solving different engineering problems because of its simplicity.

Fitting a regression model requires several assumptions. The method of least squares is used in order to choose the best fitting line for a set of data. Estimation of the model parameters requires the assumption that, the residuals (actual values less estimated values) corresponding to different observations are uncorrelated random variables with zero mean and constant variance (σ^2). In most practical situation, the variance (σ^2) of the random error (ε) will be unknown and must be estimated from the sample data [17]. The standard error of an estimate gives some idea about the precision of an estimate. During modeling, a variable that shows the least standard error of estimates is the one to be chosen.

A convenient way of measuring how well the regression model performs as a predictor of the dependent variable is to compute the reduction in the sum of squares of deviations that can be attributed to regressor variables and this quantity termed the coefficient of determination, $R^{2.}$The value of R^2 is always between 0 and 1, because *R* is between -1 and +1, whereby a negative value of R indicates inversely relationship and positive value implies direct relationship. Many problems in engineering require that we decide whether to accept or reject a statement about some correlations. A number of techniques can be used to judge the adequacy of a regression model some of which are standard error (α), R-squared value (R^2) R-adjusted and the t-test [18].

4.3.2 Scatter plot

In this work, the CBR value is the dependent variable whereas LL, PL, PI, P200, MDD and OMC the regressor variables. In carrying out the whole statistical analysis, a statistical software program called SPSS software was used. Using the 34 soil samples collected from the Azezo-Gorgora road area. Different kinds of relationships between CBR and other soil index properties were studied. The scatter plot of the dependent variable CBR with the regressor variable is shown below.

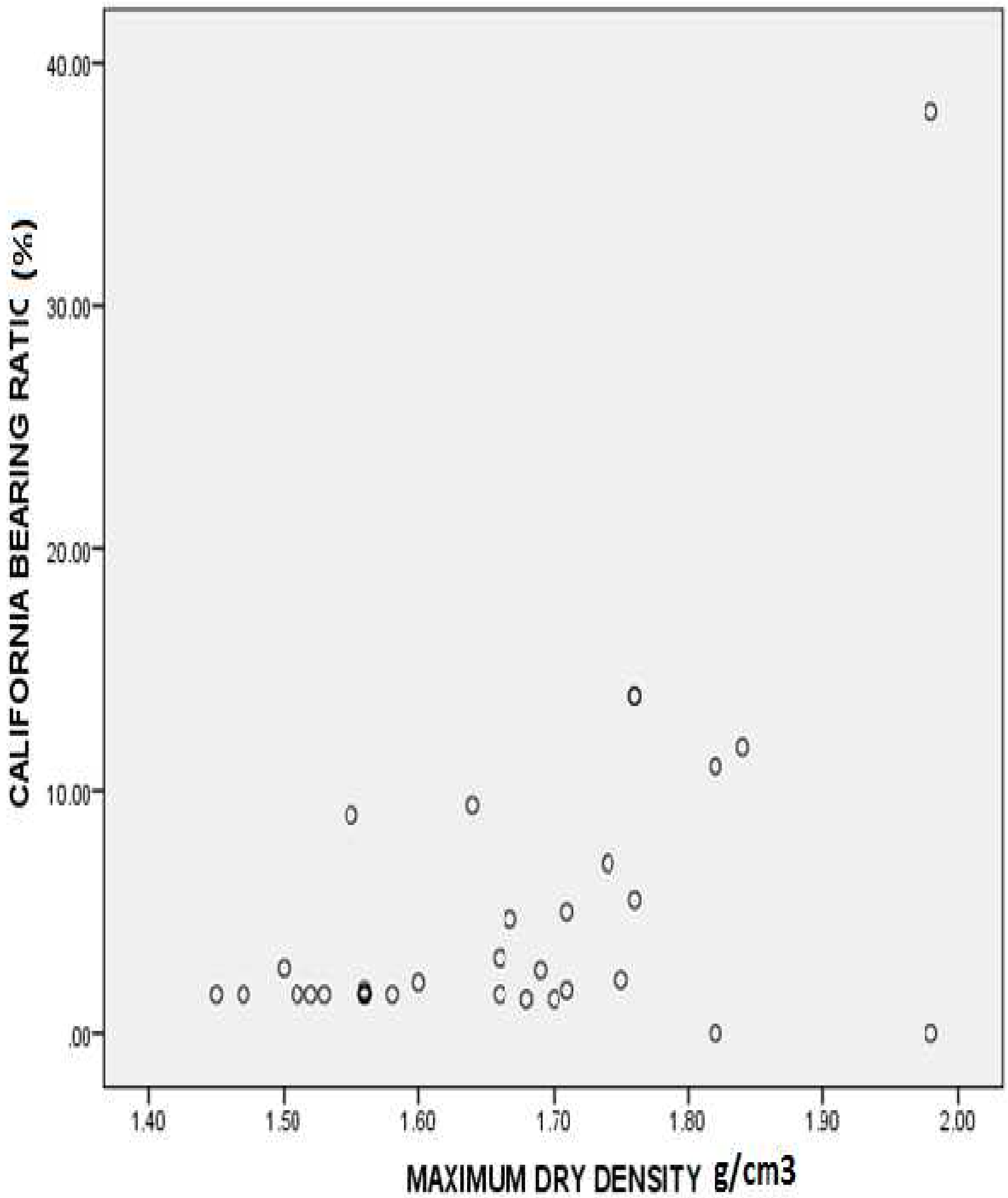


Figure4.5 Scatter diagram of CBR versus MDD

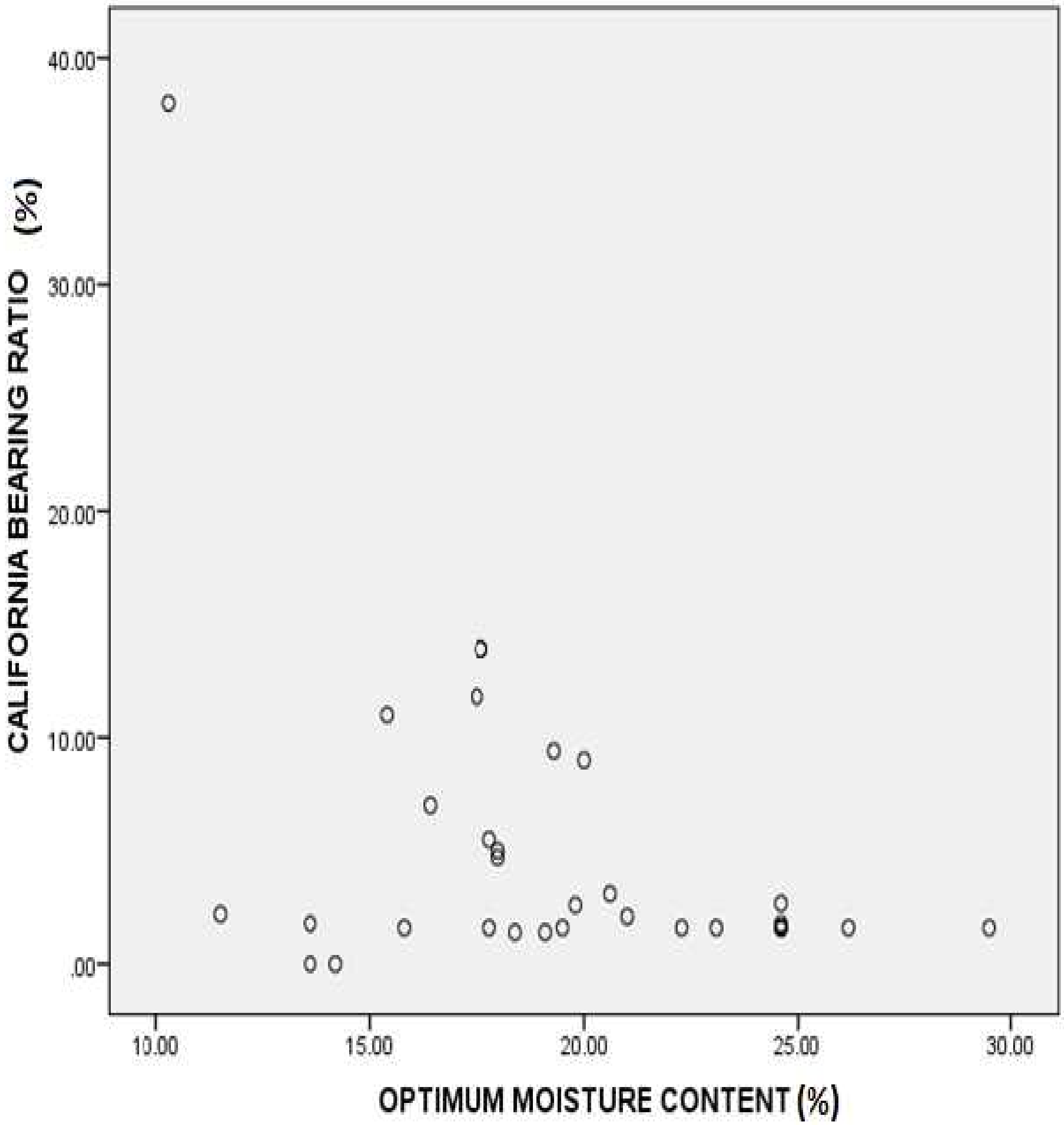


Figure4.6 Scatter diagram of CBR versus OMC

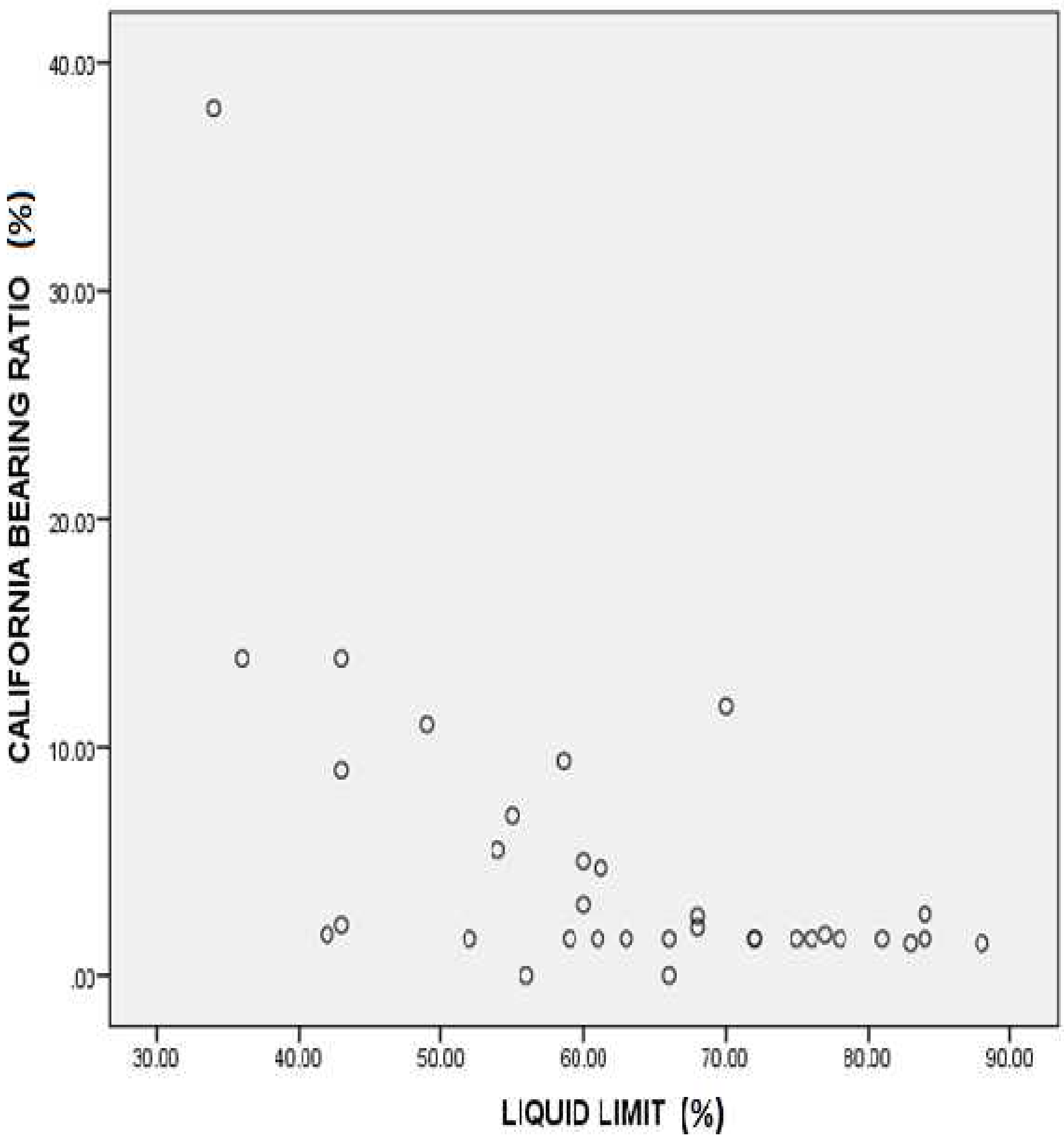


Figure4.7Scatter diagram of CBR versus LL

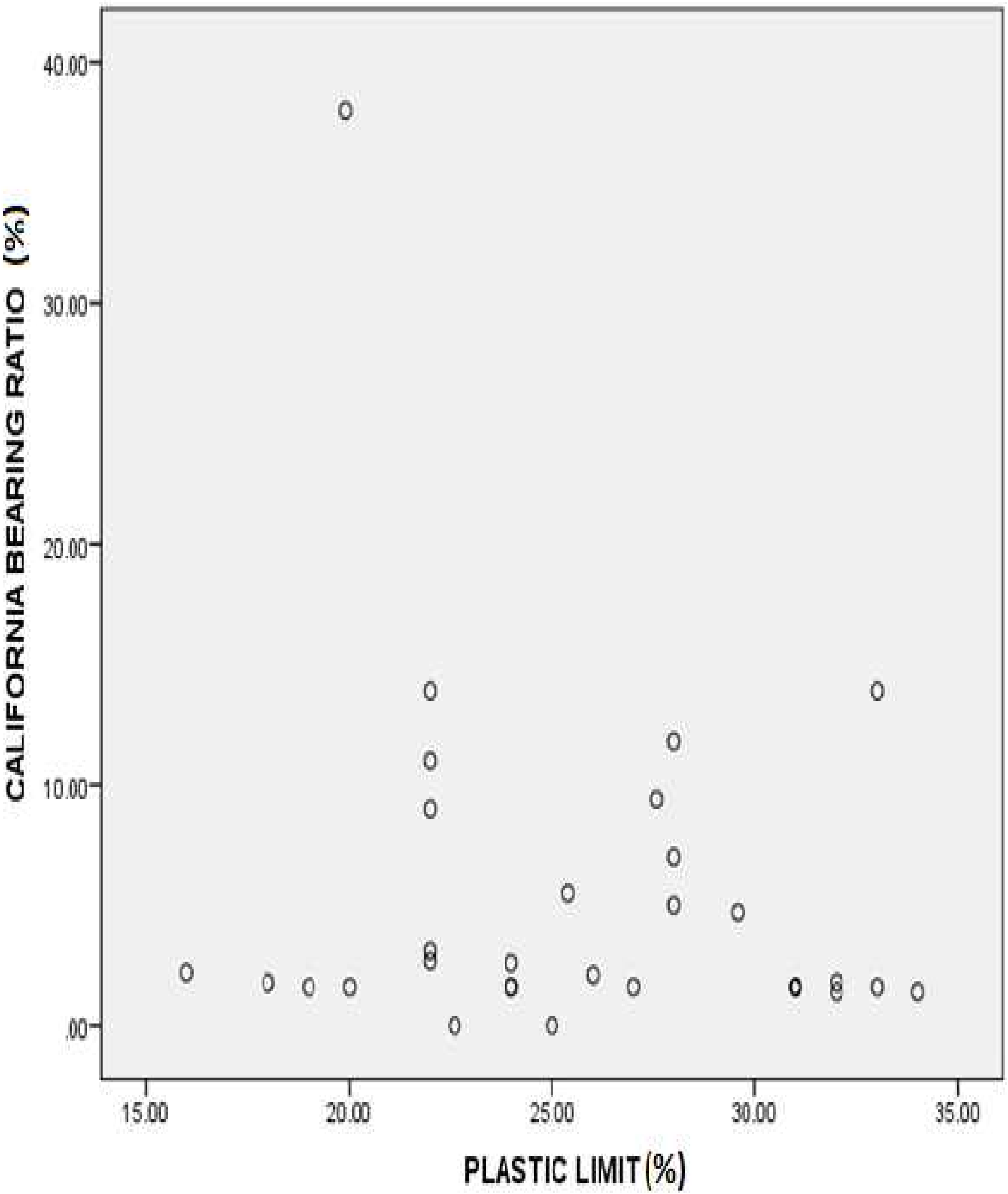


Figure4.8Scatter diagram of CBR versus PL

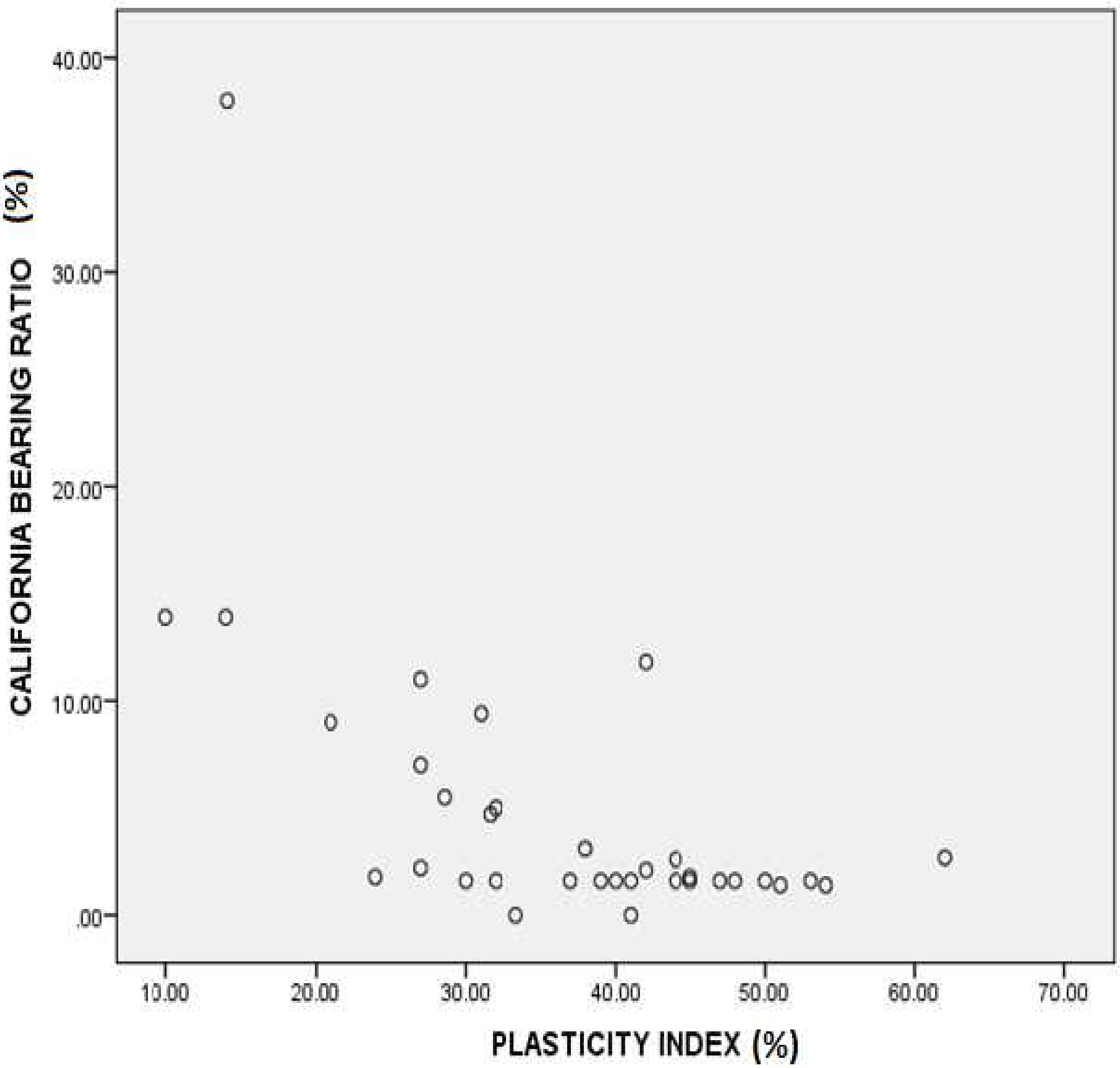


Figure4.9 Scatter diagram of CBR versus PI

The above scatter diagrams provide a visual method of displaying a relationship between variables as plotted in a two dimensional coordinate system. Inspection of the scatter diagrams indicate that, although no simple curve will pass exactly through all the points, there is a reasonable indication that the points lie scattered randomly around a straight line, particularly for the liquid limit and plasticity index.

4.3.3 Regression Analysis

In this research work, an attempt is made to apply single linear regression model and multiple linear regression models to characterize the strength of sub grade soil from soil index parameters using a statistical approach. The general representation of a probabilistic single and multiple linear regression models are presented in the following forms:

$$Y = \beta_0 + \beta_1 x + \varepsilon \qquad (4.1)$$

$$Y = \alpha_0 + \alpha_1 x_1 + \alpha_2 x_2 \ldots + \alpha_n x_n + \varepsilon \qquad (4.2)$$

Where, the slope (β_1) and intercept (β_0) of the single linear regression model are called regression coefficients. Similarly, coefficients α_0, α_1, α_2 and α_n are termed multiple regression coefficients. The appropriate way to generalize this to a probabilistic linear model is to assume that the actual value of Y is determined by the mean value function (the linear model) plus the random error term, ε [17]. The basic assumption to estimate the regression coefficients of the single and multiple regression models is based on the least square method.

Specific to this research, a statistical package for social science software (SPSS) is employed to investigate the significance of individual regressor variables. Accordingly, the forty two laboratory test results of the independent and dependent variables are used in the following regression analysis. The statistical information's of the test results are presented in Table 5.1:

Table 4.2: Statistical Information of Dependent and Independent Variables

Variable Type	Variable Name	Unit of Measurement	No. of Samples	Ranges		Mean	Standard Deviation
				Min.	Max.		
Dependent	CBR	%	34	1.70	38	19.89	6.90
Independent	P200	%	34	34	98.5	66.25	3.81
	LL	%	34	34.0	134	84	11.44
	PL	%	34	16	45	30.5	4.62
	PI	%	34	18	89	53.5	16.26
	MDD	g/cc	34	1.45	1.98	1.72	0.055
	OMC	%	34	10.3	29.5	19.90	2.84

To identify the influence of one variable on the other, a stepwise linear regression has been analyzed and as a result, the respective correlation coefficients and level of significance determined. Hereunder, the Pearson correlation coefficient matrix is shown in Table 4.3:

Pearson	**CBR**	**P_{200}**	**LL**	**PL**	**PI**	**MDD**	**OMC**
CBR	1.000	0.268	-0.728	-0.700	-0.766	0.368	-0.378
P_{200}	0.268	1.000	0.007	-0.251	0.168	0.179	-0.027
LL	-0.728	0.007	1.000	0.800	0.844	-0.355	0.374
PL	-0.700	-0.251	0.800	1.000	-0.284	-0.229	0.278
PI	-0.766	0.168	0.844	-0.284	1.000	-0.194	0.205
MDD	0.268	0.179	-0.355	-0.229	-0.194	1.000	-0.379
OMC	-0.378	-0.027	0.374	0.278	0.205	-0.379	1.000

From the above linear relationships, it is shown that the correlation between CBR with liquid limit and plasticity index has relatively moderate correlation coefficient. Basically, the strength of fine grained soil has a greater association with the consistency of the soil. As a result, liquid limit and plasticity index has resulted relatively a better correlation with the strength parameter.

4.3.1.1 Single Linear Regression Analysis

Model 1: Correlation between CBR and Maximum Dry Density (MDD)

The resulting regression analysis after correlating CBR with MDD is expressed by the following single linear equation with its corresponding correlation coefficients:

$CBR = -0.038 + 2.019*MDD^2$, with $R^2 = 0.136$, n = 34

The details of the statistical out-put indicates that the relationship developed between MDD and CBR is not significant (α>0.05) as shown in Model-1 of Appendix A.

Model 2: Correlation between CBR and Optimum Moisture Content (OMC)

The resulting regression analysis after correlating CBR with OMC is expressed by the following single linear equation with its corresponding correlation coefficients:

$CBR = 3.207 + 0.004OMC^2$ with $R^2 =0.143$, n = 34

The details of the statistical out-put indicates that the relationship developed between OMC and CBR is not significant (α>0.05) and also a weak relationship exists between correlation variables.

Model 3: Correlation between CBR and P200

The resulting regression analysis after correlating CBR with P200 is expressed by the following single linear equation with its corresponding correlation coefficients:

$CBR =0.643 +0.582*P200-0.05* P200^2$ with $R^2 =0.265$, n = 34

The details of the statistical out-put indicates that the relationship developed between P200 and CBR is not significant (α>0.05) and also a weak relationship exists between correlation variables.

Model 4: Correlation between CBR and Liquid Limit (LL)

The resulting regression analysis after correlating CBR with LL is expressed by the following single linear equation with its corresponding correlation coefficients:

$CBR = 5.294- 0.072* LL^2$, with $R^2 =0.531$, n = 34

The details of the statistical out-put indicates that the relationship developed between LL and CBR is shown in Model-4 of Appendix A.

Model 5: Correlation between CBR and Plastic Limit (PL)

The resulting regression analysis after correlating CBR with PL is expressed by the following single linear equation with its corresponding correlation coefficients:

CBR = 10.16-0.106PL, with R^2 =0.490, n = 34

The details of the statistical out-put indicates that the relationship developed between PL and CBR is shown in Model-5 of Appendix A.

Model 6: Correlation between CBR and Plasticity Index (PI)

The resulting regression analysis after correlating CBR with PI is expressed by the following single linear equation with its corresponding correlation coefficients:

CBR = 8.727- 0.147*PI with R^2 = 0.588, n = 34

The details of the statistical out-put indicates that the relationship developed between PI and CBR is shown in Model-6 of Appendix A.

From the above developed single linear regression models, based on the significant standard error (α) and coefficient of determination (R^2),it was noted that the CBR value correlates relatively better with liquid limit and plasticity index which is an indication for these variables to form the multiple regression variables that could yield a better correlation result. While the remaining parameters showed a weak relationship with CBR.

4.3.2 Multiple Linear Regression Analysis

During analyzing the multiple linear regressions, after going through a number of alternative combinations of predictors the following results are obtained for the thirty four samples and the significant relationships are presented here under:

Model A: Correlation between CBR with PL and PI

The resulting regression analysis after correlating CBR with PL and PI is expressed by the following multiple linear equations with its corresponding correlation coefficients:

CBR = 4.580 - 0.197*PI - 0.112*PL, with R^2 = 0.484, Adj. R^2 = 0.458, n = 34

The details of the statistical out-put of Model A indicates that the relationship developed between CBR with PL and PI is not significant. Besides, the R^2 value of the multiple regression analysis is improved than the R^2 value of the individual parameters, i.e. PI and PL. For further reference, the detail of Model A is shown in Appendix A.

Model B: Correlation between CBR with LL and PI or (LL and PI)

The resulting regression analysis after correlating CBR with LL and PI is expressed by the following multiple linear equations with its corresponding correlation coefficients:

CBR = -19.734 - 0.003*LL - 0.137*PI with $R^2 = 0.631$, Adj. $R^2 = 0.601$, n = 34

Or

CBR = -19.522 - 0.141*LL + 0.137*PI, with $R^2 = 0.631$, Adj. $R^2 = 0.601$, n = 34

The details of the statistical out-put of Model C indicates that the relationship developed between CBR with LL and PI is significant ($\alpha<0.05$). Besides, the R^2 value of Model B is better than the above stated models. Furthermore, the detail of Model B is shown in Appendix

The above correlations result is summarized and presented in Table 5.3 as shown below:

Table 4.4: Summary of the Regression Analysis

Regression Type	Model Name	R	R^2	Std. Error (α)	Significance Order Depending on α and R^2
Single Linear Regression Model	Model 1	0.368	0.136	.>0.05	6
	Model 2	- 0.378	0.143	>0.05	5
	Model 3	- 0.514	0.265	>0.05	4
	Model 4	-0.728	0.531	< 0.05	2
	Model 5	-0.700	0.490	< 0.05	3
	Model 6	- 0.766	0.588	< 0.05	1
Multiple Regression model	Model A	0.695	0.484	< 0.05	2
	Model B	0.794	0.631	< 0.05	1

4.4 Comparisons between the Existing and the Developed Equations

Table4.5 Comparisons between the actual and developed relation

Sample Code	OMC	MDD	P200	LL	PL	PI	Actual CBR Value	Developed
Sample1	19.30	1.64	66.9	58.6	27.59	31	9.10	4.08
Sample2	19.4	1.65	73.9	61	29	32	6.00	4.52
Sample3	18.20	1.67	83.9	62	29.6	32.4	4.50	2.11
Sample4	17.50	1.76	93.4	53.2	25.4	27.8	5.50	2.70
Sample5	13.50	1.71	83.8	77	32	45	24.8	5.64
Sample6	13.5	1.96	58.4	66	25.20	40.8	24.8	4.76
Sample7	19.5	1.55	66.8	43	22.10	20.9	10.50	6.67
Sample8	16.5	1.71	66.8	55.20	27.80	27.40	7.10	7.26
Sample9	17.60	1.76	89.20	43	33	10	1.39	1.23
Sample10	16.5	1.87	42.5	48	19.40	28.6	18.8	0.79
Sample11	14.5	1.70	68.2	62	25.90	36.10	6.40	2.55
Sample12	18.5	1.74	75.6	63	26.70	36.30	1.90	2.26
Sample 13	17.3	1.69	81.2	64	26.4	37.6	1.70	3.14
Sample14	20.60	1.66	69.6	60	22	38	2.40	2.55
Sample15	17.50	1.70	91.9	76	30.8	45.20	2.40	0.94
Sample 16	18.00	1.71	98.5	79	33.3	45.7	1.70	2.70
Sample 17	19.50	1.69	94.70	82	32.5	49.5	1.70	2.26
Sample18	29.50	1.31	87.5	134	44.75	89.25	1.70	1.82
Sample 19	19	1.71	83.10	55	23.8	31.2	3.60	2.99
Sample 20	18.50	11.75	66.9	51	23	28	3.60	1.38
Sample 21	22.30	1.51	70.2	81	31	50.00	1.60	0.39
Sample 22	24.60	1.50	44.2	84	22	62.00	2.68	2.11
Sample 23	29.50	1.47	92.4	76	31	45.00	1.60	4.32
Sample 24	26.20	1.45	93.5	63	33	30.00	1.60	4.08

Sample Code	OMC	MDD	P200	LL	PL	PI	Actual CBR Value	Developed
Sample25	24.60	1.56	91.1	72	24	48.00	1.60	1.67
Sample26	24.60	1.56	67.3	42	18	24.00	1.78	5.20
Sample27	14.20	1.82	76.9	56	22.6	33.40	0.00	3.82
Sample28	15.40	1.82	50.6	49	22	27.00	11.00	4.76
Sample29	10.30	1.98	34.0	34	19.9	14.10	38.00	6.65
Sample30	18.00	1.71	51.4	60	28	32.00	5.00	4.02
Sample31	11.50	1.75	77.7	43	16	27.00	2.20	4.76
Sample32	24.60	1.56	35.6	61	24	37.00	1.60	3.29
Sample33	24.60	1.56	77.5	59	19	40.00	1.60	2.85
Sample34	24.60	1.56	51.1	52	20	32.00	1.60	4.02

Table4.6 Comparisons between the actual values newly developed and Mechanistic-Empirical Method

Sample Code	OMC (%)	MDD (g/cm3)	P200	LL	PL	PI	Actual CBR Value	From Developed relation	From mechanistic-Empirical method
Sample1	19.30	1.64	66.9	58.6	27.59	31	9.10	4.08	3.79
Sample2	19.4	1.65	73.9	61	29	32	6.00	4.52	3.81
Sample3	18.20	1.67	83.9	62	29.6	32.4	4.50	2.11	4.57
Sample4	17.50	1.76	93.4	53.2	25.4	27.8	5.50	2.70	2.97
Sample5	13.50	1.71	83.8	77	32	45	24.8	5.64	2.59
Sample6	13.5	1.96	58.4	66	25.20	40.8	24.8	4.76	3.43
Sample7	19.5	1.55	66.8	43	22.10	20.9	10.50	6.67	6.01
Sample8	16.5	1.71	66.8	55.20	27.80	27.40	7.10	7.26	11.79
Sample9	17.60	1.76	89.20	43	33	10	1.39	1.23	1.12
Sample10	16.5	1.87	42.5	48	19.40	28.6	18.8	10.79	2.19
Sample11	14.5	1.70	68.2	62	25.90	36.10	6.40	2.55	2.05
Sample12	18.5	1.74	75.6	63	26.70	36.30	1.90	2.26	3.43
Sample 13	17.3	1.69	81.2	64	26.4	37.6	1.70	3.14	2.97
Sample14	20.60	1.66	69.6	60	22	38	2.40	2.55	3.42
Sample15	17.50	1.70	91.9	76	30.8	45.20	2.40	1.94	2.90
Sample 16	18.00	1.71	98.5	79	33.3	45.7	1.70	2.70	2.05
Sample 17	19.50	1.69	94.70	82	32.5	49.5	1.70	2.26	2.61
Sample18	29.50	1.31	87.5	134	44.75	89.25	1.70	1.82	2.39
Sample 19	19	1.71	83.10	55	23.8	31.2	3.60	2.99	2.42
Sample 20	18.50	11.75	66.9	51	23	28	3.60	1.38	3.04
Sample 21	22.30	1.51	70.2	81	31	50.00	1.60	0.39	2.95
Sample 22	24.60	1.50	44.2	84	22	62.00	2.68	2.11	2.23
Sample 23	29.50	1.47	92.4	76	31	45.00	1.60	2.32	2.72
Sample 24	26.20	1.45	93.5	63	33	30.00	1.60	4.08	4.41

Sample Code	OMC (%)	MDD (g/cm3)	P200	LL	PL	PI	Actual CBR Value	Developed Relation	From mechanistic-Empirical method
Sample25	24.60	1.56	91.1	72	24	48.00	1.60	1.67	2.75
Sample26	24.60	1.56	67.3	42	18	24.00	1.78	5.20	5.92
Sample27	14.20	1.82	76.9	56	22.6	33.40	0.00	3.82	4.85
Sample28	15.40	1.82	50.6	49	22	27.00	11.00	8.76	6.24
Sample29	10.30	1.98	34.0	34	19.9	14.10	38.00	16.65	14.12
Sample30	18.00	1.71	51.4	60	28	32.00	5.00	4.02	4.24
Sample31	11.50	1.75	77.7	43	16	27.00	2.20	4.76	5.52
Sample32	24.60	1.56	35.6	61	24	37.00	1.60	3.29	3.62
Sample33	24.60	1.56	77.5	59	19	40.00	1.60	2.85	3.50
Sample34	24.60	1.56	51.1	52	20	32.00	1.60	4.02	4.64

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The research was conducted to find a localized relationship between CBR value and soil index properties within the scope of the study. Accordingly, the required laboratory tests were conducted on samples retrieved from different geographical area of Azezo-Gorgora road. Using the obtained thirty four test results a single and multiple linear regressions were analyzed and a relationship was developed that predict CBR value in terms of P200, LL, PL, PI, MDD and OMC.

From the results of this study the following conclusions are drawn:

1. Among the single linear regression analysis the correlation between CBR and plasticity index has resulted the following relationship:

   CBR = 8.727-0.147PI $\qquad$ R^2 = 0.588, n = 34

2. Relatively an improved correlation than the single regression is obtained when multiple regression is used as given below:

   CBR = -19.734 – 0.003*LL – 0.137*PI, $\qquad$ R^2 =0.631 n = 34

3. In light of the above, a combination of soil index properties correlates better with strength characteristic of CBR than individual soil properties.

4. From comparison made between the newly developed and the mechanistic-Empirical method, the newly developed one approximates California bearing ratio value in a better way.

5.2 Recommendation

The exposure encountered in trying to conduct the current research has revealed areas where further efforts may be proved in the future. Following are some of the recommendations in relation to the subject study:

1. It is recommended to carry out this correlation with a large number of samples
2. It is also recommended to carry out such a study in other parts of Ethiopia especially in regions where lateritic soil abundantly to be found.
3. It is advisable to conduct comparative correlations between soaked and unsoaked CBR value with soil index properties.
4. It would be interest to investigate the effect of compaction and moisture content on the value of CBR under varying density and moisture condition for coarse grained materials.

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APPENDIX A

Details of the SPSS regression analysis outputs

Appendix A-1: Single Linear Regression Analysis

Model 1 Relationship between CBR and MDD

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.077[a]	.006	.136	3.52810

a. Predictors: (Constant), maximum dry density

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig(α)
		B	Std. Error	Beta		
1	(Constant)	-.038	16.324		-.002	.998
	Maximum Dry Density	2.019	9.908	.077	.204	.844

a. Dependent Variable: CBR

The model equation is:

CBR=-0.038+2.019MDD^2 with adjusted R^2=0.136

Model 2 Relationship between CBR and OMC

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.006[a]	.000	-.143	3.53849

a. Predictors: (Constant), OMC

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig(α)
		B	Std. Error	Beta		
1	(Constant)	3.207	5.006		.641	.542
	OMC	.004	.242	.006	.015	.988

a. Dependent Variable: CBR

CBR=3.207+0.004OMC^2 with adjusted R^2=0.143

Model 3 Relationship between CBR and p200

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.0.529[a]	.279	.265	5.64

Predictors: (Constant),P 200

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig(α)
		B	Std. Error	Beta		
1	(Constant)	0.643	8.717		0.074	0.941
	P200	.582	.260	1.54	2.24	0.027

Model 4 Relationship between CBR and LL

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.662[a]	.439	.490	3.08762

a. Predictors: (Constant), LL

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig(α)
		B	Std. Error	Beta		
1	(Constant)	10.169	4.763		2.135	.020
	LL	-.106	.072	-.488	-1.481	.0182

a. Dependent Variable: CBR

CBR=10.16-0.106 LL with adjusted R^2=0.490

Model 5 Relationship between CBR and PL

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.74[a]	.551	-.531	3.51977

a. Predictors: (Constant), PL

Coefficients

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig(α)
		B	Std. Error	Beta		
1	(Constant)	5.294	7.453		.710	.0500
	PL	-.072	.262	-.103	-.274	.0392

a. Dependent Variable: CBR

The model equation becomes:

CBR=5.294-0.072PL^2 with adjusted R^2=0.531

Model 6 Relationship between CBR and PI

Model Summary

Model	**R**	**R Square**	**Adjusted R Square**	**Std. Error of the Estimate**
1	.78a	.610	.588	2.93919

a. Predictors: (Constant), PI

Coefficients

Model		Un standardized Coefficients		Standardized Coefficients	t	Sig(α)
		B	Std. Error	Beta		
1	(Constant)	8.727	3.223		2.707	.030
	PI	-.147	.083	-.557	-1.774	.0119

a. Dependent Variable: CBR

The model equation becomes:

CBR=8.727-0.147PI with adjusted R^2=0.588

Appendix A-2: Multiple Linear Regression Analysis

Model A: Correlation between CBR with PL and PI

Model	R	R Square	Adjusted R Square	Std. Error of the
A	.695(a)	.484	.458	1.31746

a. Predictors: (Constant), PI, PL

b. Dependent Variable: CBR

Model		Un standardized		Standardized		
		B	Std. Error	Beta	B	Std. Error
A	(Constant)	4.580	2.033		7.170	.000
	PI	-.197	.032	-.730	-6.145	.000
	PL	-.112	.050	-.266	-2.236	.031

a. Dependent Variable: CBR

Model B: Correlation between CBR with LL and PL

Model	R	R Square	Adjusted R Square	Std. Error of the
B	.794(a)	.631	.601	1.31746

a. Predictors: (Constant), PL, LL

b. Dependent Variable: CBR

Model		Un standardized		Standardized		
		B	Std. Error	Beta	B	Std. Error
A	(Constant)	19.73	9.927		-2.189	.035
	PI	-.141	.032	-.532	-4.429	.000
	PL	.137	.047	.325	2.936	.006

APPENDIX B

Details of the laboratory test results

APPENDIX B Test results

The various kinds of laboratory experimental tests that were performed on the soil samples we recorded.

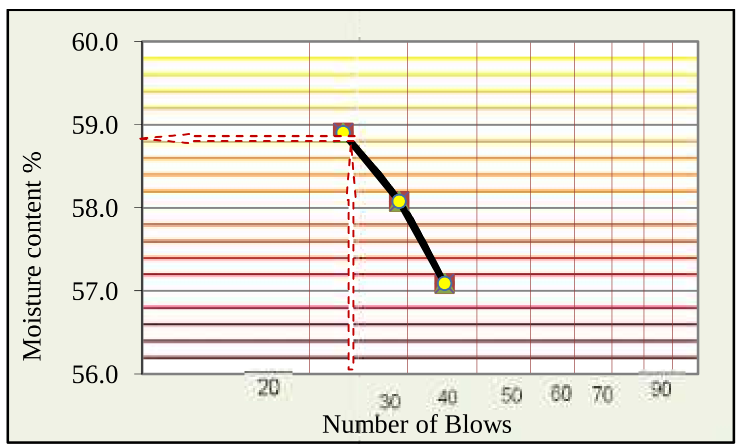
Sample 1

Experiment 1.1(Sieve Analysis for classification**)**

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	59.9	6.7	93.3	
No.10	50.4	5.6	87.7	
No.40	83.5	9.3	78.4	A-7-5(19)
No.200	103.4	11.5	66.9	

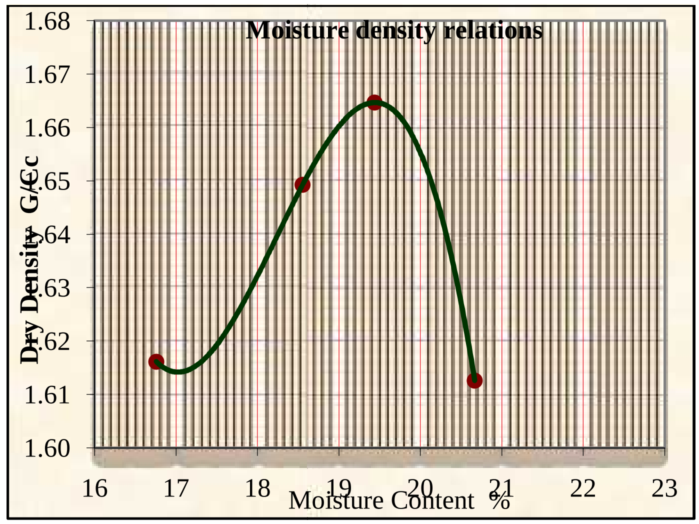
Experiment 1.2 Atterberg limit

	Liquid Limit			Plastic Limit	
No. of Blows	35	29	23		
Container Number	A-5	A-7	A-12	A-10	A-2
Wet Soil +con (g)= (W1)	16.27	17.70	17.05	12.02	13.28
Dry Soil +con(g) = (W_2)	13.29	14.14	13.51	11.16	12.15
Mass of Con (g) = (W_3)	8.07	8.01	7.5	8.00	8.11
Weight of Moisture (g)	2.98	3.56	3.54	0.86	1.13
Dry Soil (g)	5.22	6.13	6.01	3.16	4.04
Moisture Content (%)	57	58	59	27.2	28
LL at 25 blow &Avg. PL	58.6				27.6



Experiment 1.3(Moisture Density Relationship of Soil (Testmethod:AASHTO-99 Method

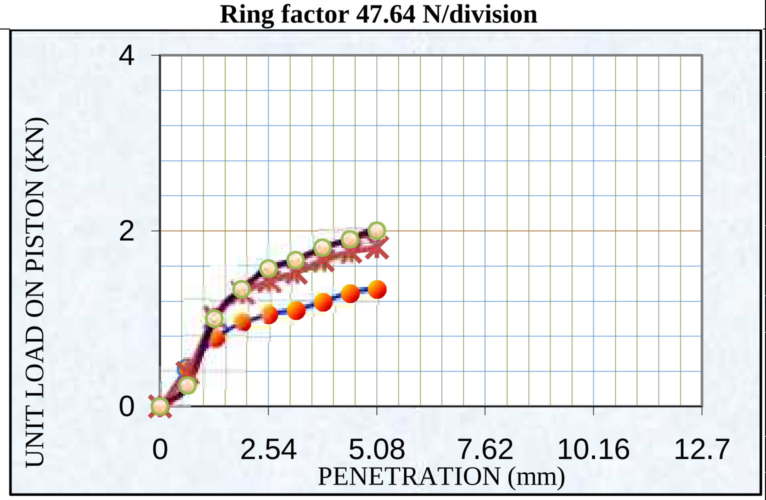
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,805	8,999	9,151	9,198	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,803	3,997	4,149	4,196	
	Wet Density (g/cm^3)	1.79	1.88	1.95	1.98	
Moisture	Container No.	13	B14	14	B6	B1
	Wet Soil + Con. (g)	170.0	164.4	138.5	195.9	185.8
	Dry Soil +Con. (g)	152.9	146.0	121.4	163.1	173.3
	Mass of Con. (g)	39.5	42.3	40.6	33.5	33.2
	Mass of Moisture (g)	17.1	18.4	17.1	32.8	12.5
	Dry Soil (g)	113.4	103.7	80.8	129.6	140.1
	Moisture cont. (g/cm^3)	15.08	17.74	21.16	25.31	8.92
Dry Density (g/cm^3)		1.56	1.60	1.61	1.58	



Experiment 1.4 CBR

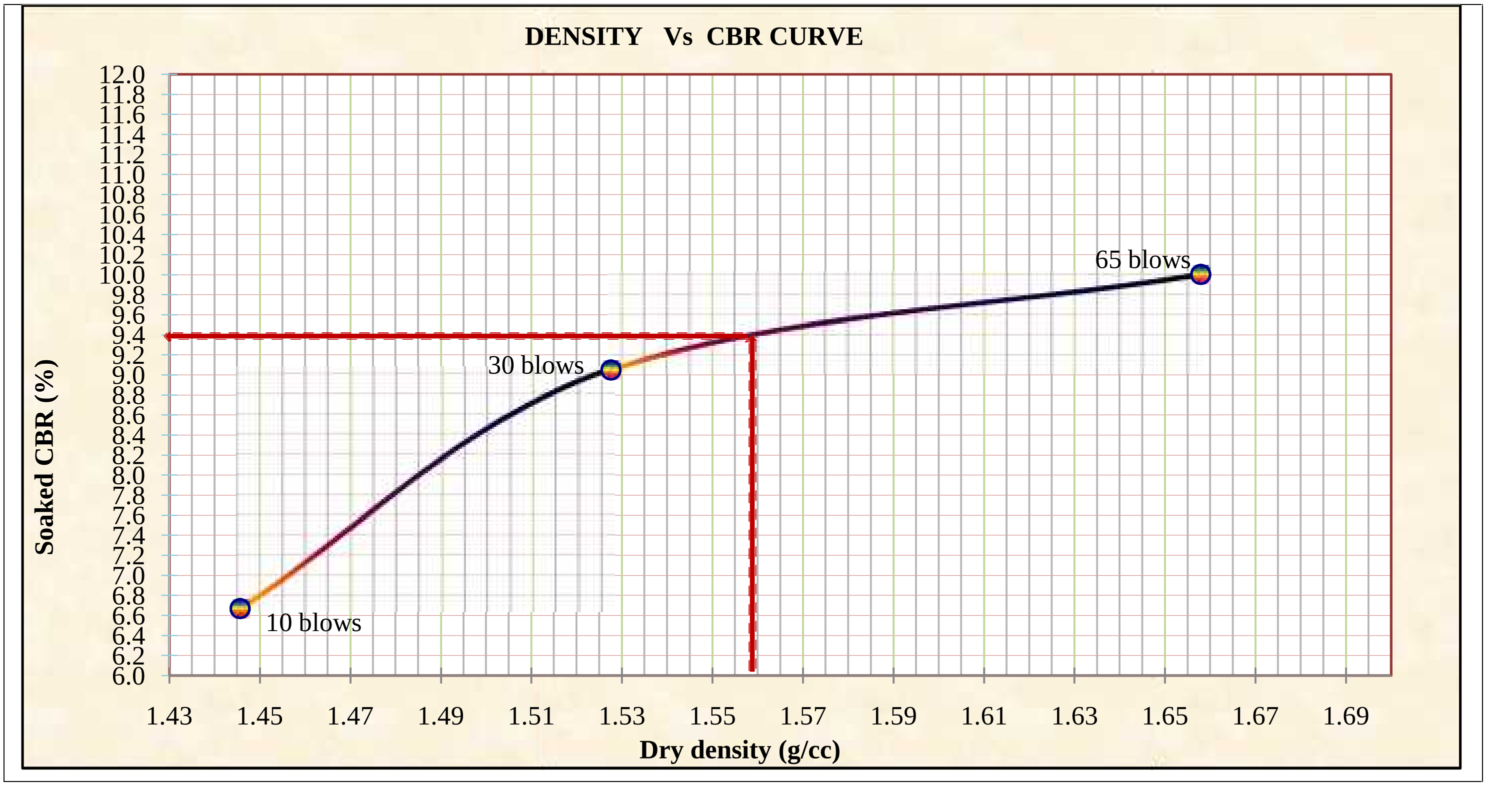
Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	9.0	0.42	8.0	0.38	5.0	0.24
1.27	16.0	0.76	21.0	1.00	21.0	1.00
1.91	20.0	0.95	27.0	1.28	28.0	1.33
2.54	22.0	1.04	30.0	1.43	33.0	1.57
3.18	23.0	1.09	32.0	1.52	35.0	1.67
3.81	25.0	1.19	35.0	1.67	38.0	1.81
4.45	27.0	1.28	37.0	1.76	40.0	1.90
5.08	28.0	1.33	38.0	1.81	42.0	2.00
7.62						

Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	1.05	1.33	7.90	6.7
30	1.43	1.81	10.7	9.10
65	1.57	2.00	11.8	10.0

Dry Density Vs Soaked CBR			
BLOWS	**10**	**30**	**65**
Dry density	1.45	1.53	1.66
Soaked CBR	6.70	9.10	10.00

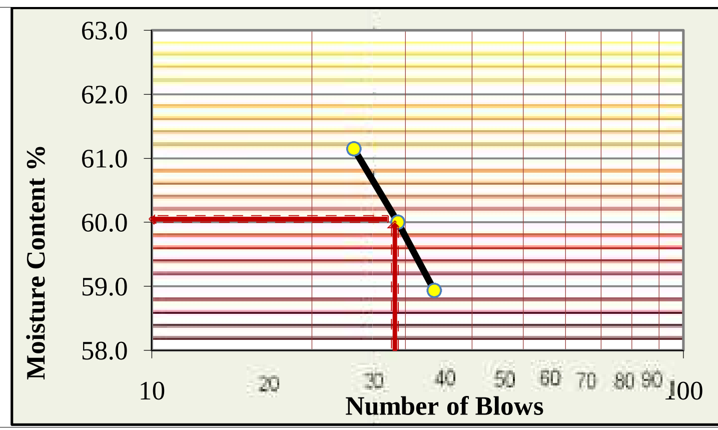

DENSITY Vs CBR CURVE
Soaked CBR (%)
Dry density (g/cc)
10 blows
30 blows
65 blows
12.0
11.8
11.6
11.4
11.2
11.0
10.8
10.6
10.4
10.2
10.0
9.8
9.6
9.4
9.2
9.0
8.8
8.6
8.4
8.2
8.0
7.8
7.6
7.4
7.2
7.0
6.8
6.6
6.4
6.2
6.0
1.43
1.45
1.47
1.49
1.51
1.53
1.55
1.57
1.59
1.61
1.63
1.65
1.67
1.69

Experiment 2.1(Sieve Analysis for classification**)**

Sieve Size	Wt. Retained	% Retained	% Pass	
No.4	23.48	2.7	97.3	Soil Classification A-7-5(20)
No.10	46.49	5.3	92.0	
No.40	69.11	7.9	84.1	
No.200	89.63	10.2	73.9	

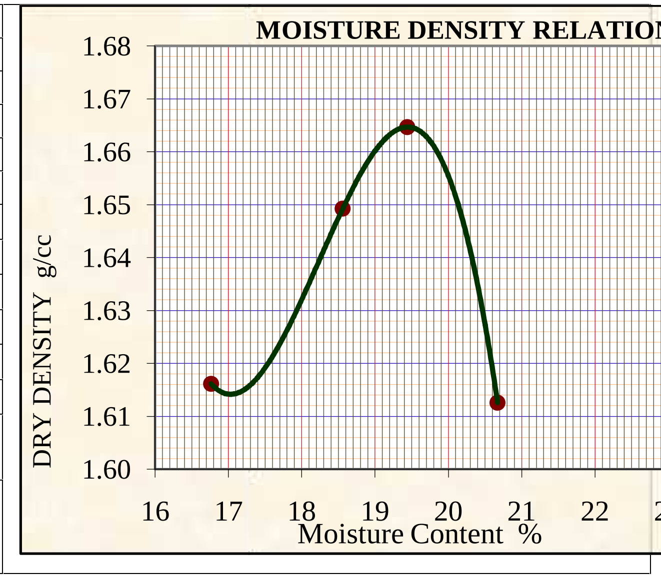
Experiment 2.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	34	29	24		
Container Number	A-11	A-4	A-6	A-8	A-3
Wet Soil +con (g)= (W1)	19.28	17.23	17.57	16.39	13.96
Dry Soil +con(g) = (W_2)	15.19	13.51	13.73	15.29	12.88
Mass of Con (g) = (W_3)	8.25	7.31	7.45	11.83	9.14
Weight of Moisture (g)	4.09	3.72	3.84	1.10	1.08
Dry Soil (g)	6.94	6.20	6.28	3.46	3.74
Moisture Content (%)	59	60	61	31.8	28.9
LL at 25 blow &Avg. PL	61				29



Experiment 2.2(Moisture Density Relationship of Soil (Test Method: AASHTO-99

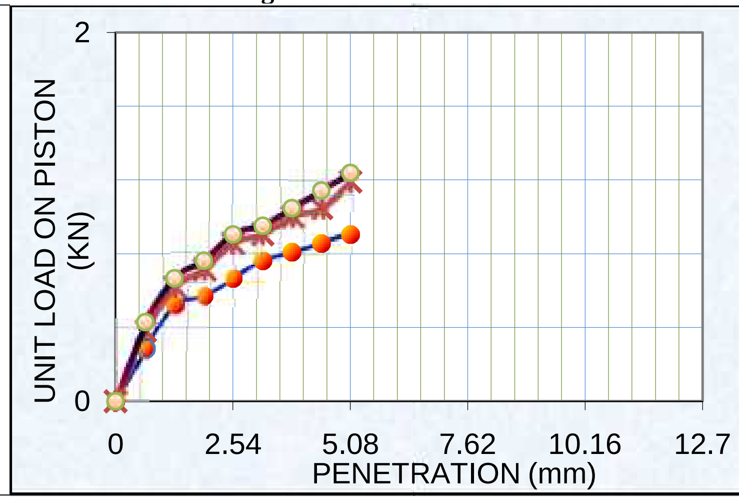
	Trial No.	1	2	3	4	nmc
Density	Mold + Wet soil (gm)	9,010	9,155	9,225	9,135	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	4,008	4,153	4,223	4,133	
	Wet Density (g/cm^3)	1.89	1.96	1.99	1.95	
Moisture	Container No.	B-5	A-4	B-6	B-7	B-4
	Wet Soil + Con. (g)	158.0	148.0	135.0	131.0	146.0
	Dry Soil +Con. (g)	140.2	130.0	118.4	113.7	135.0
	Mass of Con. (g)	34.0	33.0	33.0	30.0	30.0
	Mass of Moisture (g)	17.8	18.0	16.6	17.3	11.0
	Dry Soil (g)	106.2	97.0	85.4	83.7	105.0
	Moisture cont. (g/cm^3)	16.76	18.56	19.44	20.67	10.5
Dry Density (g/cm^3)		1.62	1.65	1.66	1.61	



Experiment 2.3 (CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	6.0	0.29	8.0	0.38	9.0	0.43
1.27	11.0	0.52	13.0	0.62	14.0	0.67
1.91	12.0	0.57	15.0	0.72	16.0	0.76
2.54	14.0	0.67	18.0	0.86	19.0	0.91
3.18	16.0	0.76	19.0	0.91	20.0	0.95
3.81	17.0	0.81	21.0	1.00	22.0	1.05
4.45	18.0	0.86	22.0	1.05	24.0	1.14
5.08	19.0	0.91	25.0	1.19	26.0	1.24
7.62						

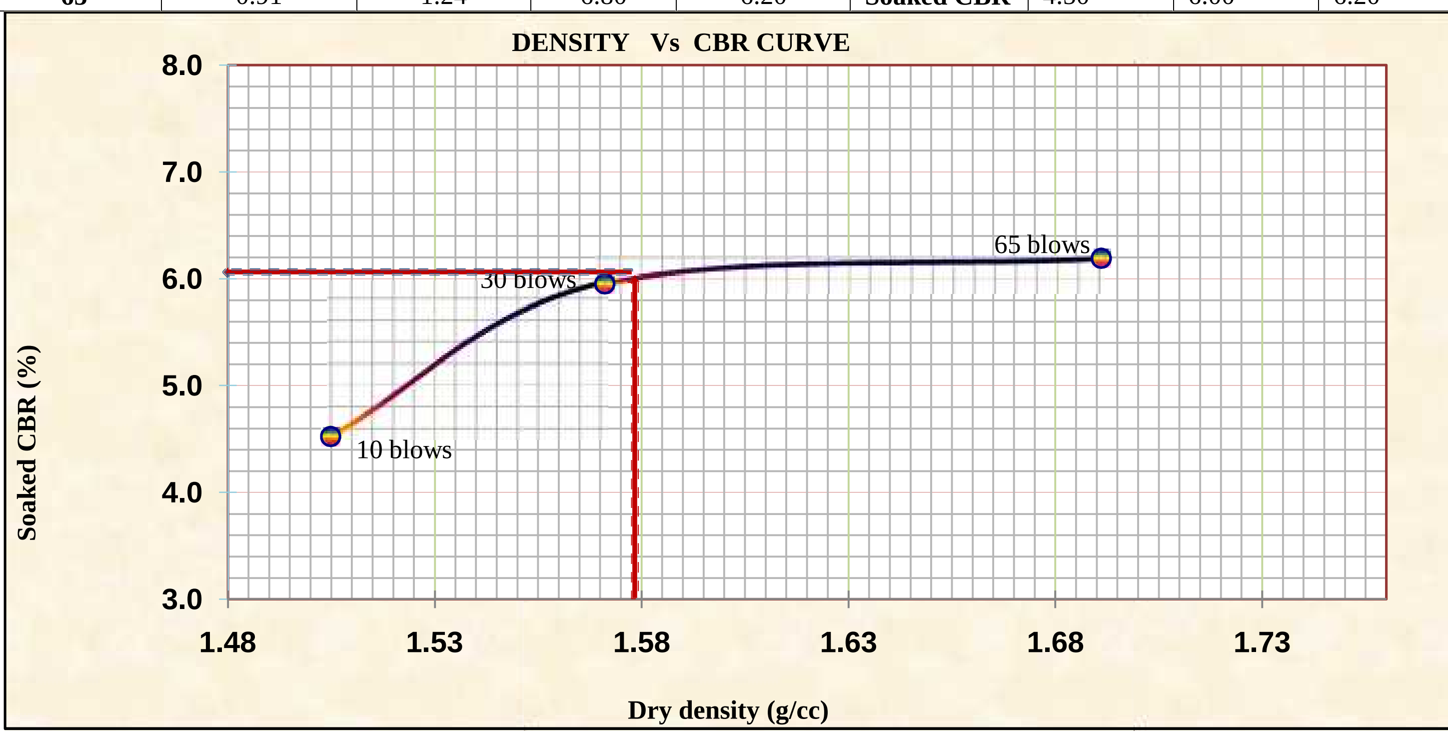
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.67	0.91	5.00	4.50
30	0.86	1.19	6.40	6.00
65	0.91	1.24	6.80	6.20

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.50	1.57	1.69
Soaked CBR	4.50	6.00	6.20

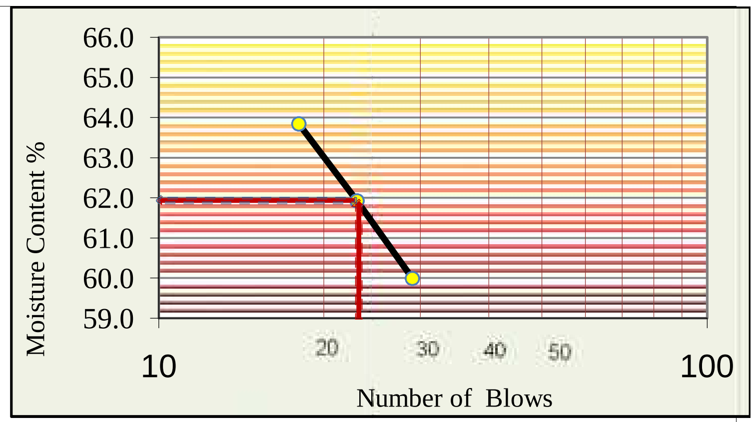


Experiment 3.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	34.75	1.8	98.2	A-7-5(17)
No.10	55.39	2.8	95.4	
No.40	110.21	5.6	89.8	
No.200	115.6	5.9	83.9	

Experiment 3.2(Atterberg limit)

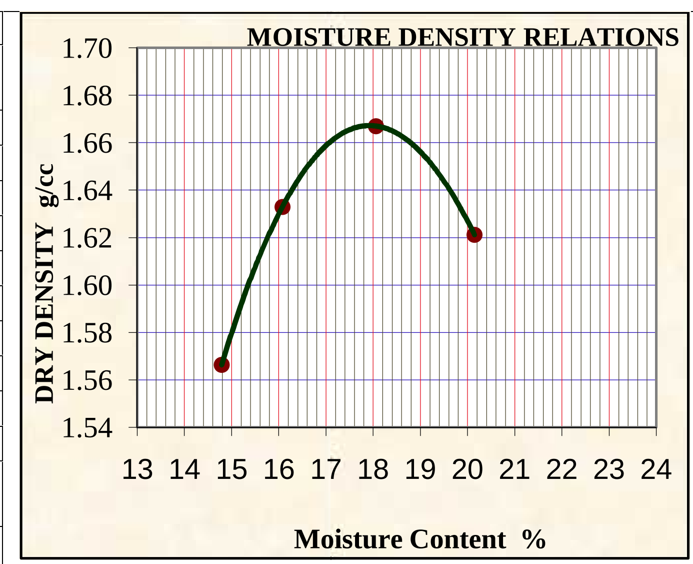
	Liquid Limit			Plastic Limit	
No. of Blows	29	23	18		
Container Number	D-6	D-1	D-2	D-8	D-2
Wet Soil +con (g)= (W1)	34.59	35.05	36.16	28.68	29.39
Dry Soil +con(g) = (W_2)	30.72	30.48	31.64	27.64	28.02
Mass of Con (g) = (W_3)	24.27	23.1	24.56	24.12	23.39
Weight of Moisture (g)	3.87	4.57	4.52	1.04	1.37
Dry Soil (g)	6.45	7.38	7.08	3.52	4.63
Moisture Content (%)	60	62	64	29.5	29.6
LL at 25 blow &Avg. PL	62				29.6



Plasticity Index = LL – PL = 62 – 29.6 = 32.40

Experiment 3.3(Moisture Density Relationship of Soil)

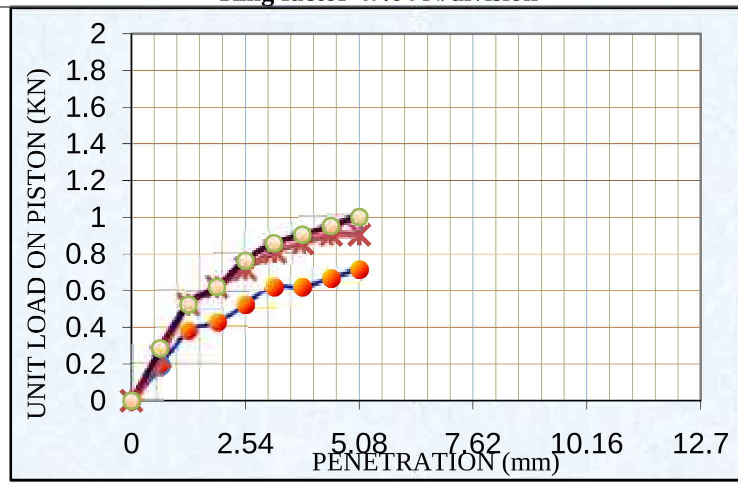
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,821	9,028	9,182	9,139	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,819	4,026	4,180	4,137	
	Wet Density (g/cm^3)	1.80	1.90	1.97	1.95	
Moisture	Container No.	S-1	A-6	A-3	B-3	E-13
	Wet Soil + Con. (g)	157.2	158.1	129.3	128.9	161.5
	Dry Soil +Con. (g)	142.6	140.8	114.6	112.1	153.4
	Mass of Con. (g)	43.9	33.2	33.2	28.7	39.1
	Mass of Moisture (g)	14.6	17.3	14.7	16.8	8.1
	Dry Soil (g)	98.7	107.6	81.4	83.4	114.3
	Moisture cont. (g/cm^3)	14.79	16.08	18.06	20.14	7.09
Dry Density (g/cm^3)		1.57	1.63	1.67	1.62	



Experiment 3.4(CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	4.0	0.19	5.0	0.24	6.0	0.29
1.27	8.0	0.38	11.0	0.52	11.0	0.52
1.91	9.0	0.43	13.0	0.62	13.0	0.62
2.54	11.0	0.52	15.0	0.72	16.0	0.76
3.18	13.0	0.62	17.0	0.81	18.0	0.86
3.81	13.0	0.62	18.0	0.86	19.0	0.91
4.45	14.0	0.67	19.0	0.91	20.0	0.95
5.08	15.0	0.72	19.0	0.91	21.0	1.00
7.62						

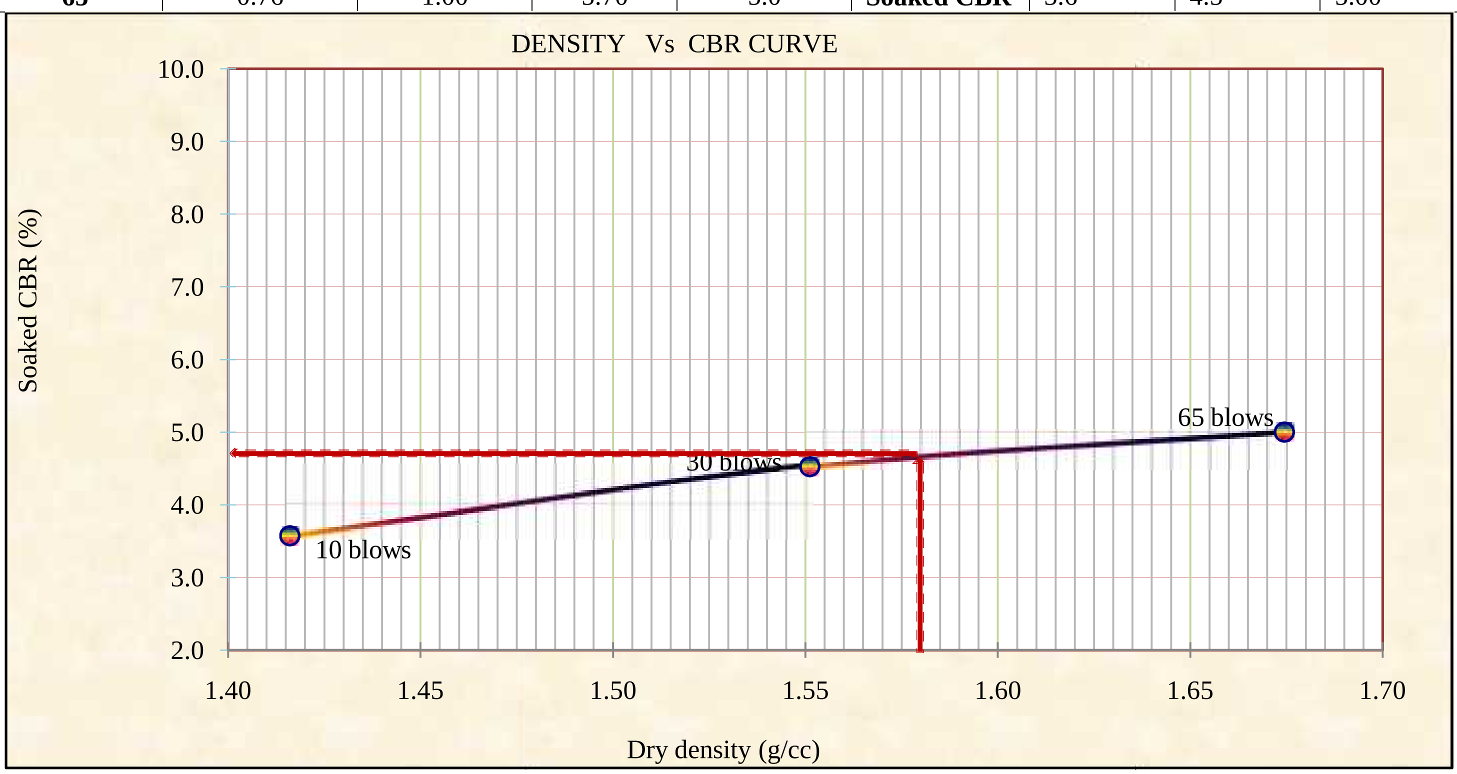
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.52	0.71	3.9	3.6
30	0.71	0.91	5.40	4.50
65	0.76	1.00	5.70	5.0

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.42	1.55	1.67
Soaked CBR	3.6	4.5	5.00



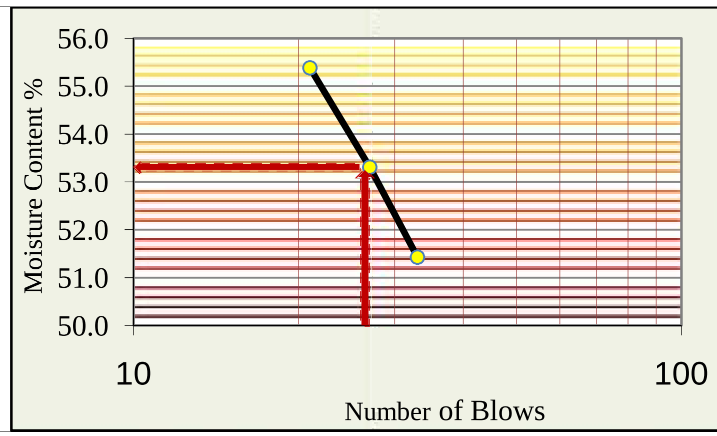
Experiment 4.1(Sieve Analysis for classification)

Weight of Sample before Washing (gm) = 1966

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	13.9	1.2	98.8	A-7-6(20)
No.10	2.5	0.2	98.6	
No.40	20.6	1.7	96.9	
No.200	41.1	3.5	93.4	

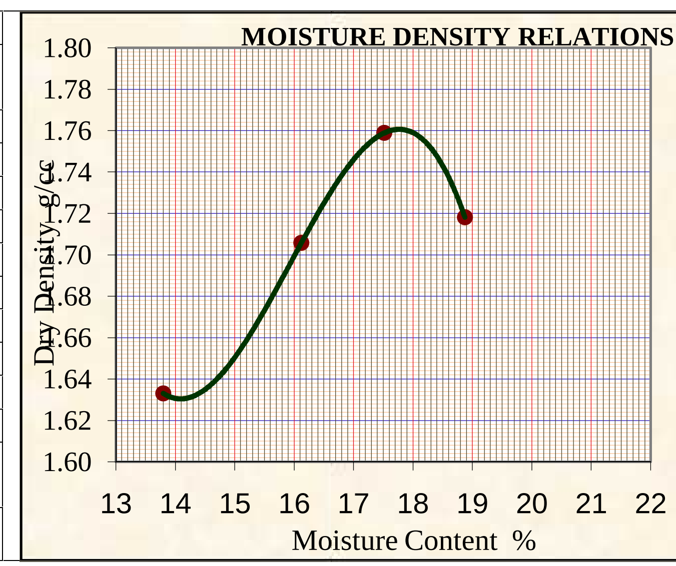
Experiment 4.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	33	27	21		
Container Number	D-3	D-4	D-5	D-7	D-10
Wet Soil +con (g)= (W1)	41.62	41.62	44.87	34.03	34.25
Dry Soil +con(g) = (W_2)	37.66	37.27	39.93	33.13	33.32
Mass of Con (g) = (W_3)	29.96	29.11	31.01	29.57	29.67
Weight of Moisture (g)	3.96	4.35	4.94	0.90	0.93
Dry Soil (g)	7.70	8.16	8.92	3.56	3.65
Moisture Content (%)	51	53	55	25.3	25.5
LL at 25 blow &Avg. PL	53.2			25.4	



Experiment 4.3(Moisture Density Relationship of Soil)

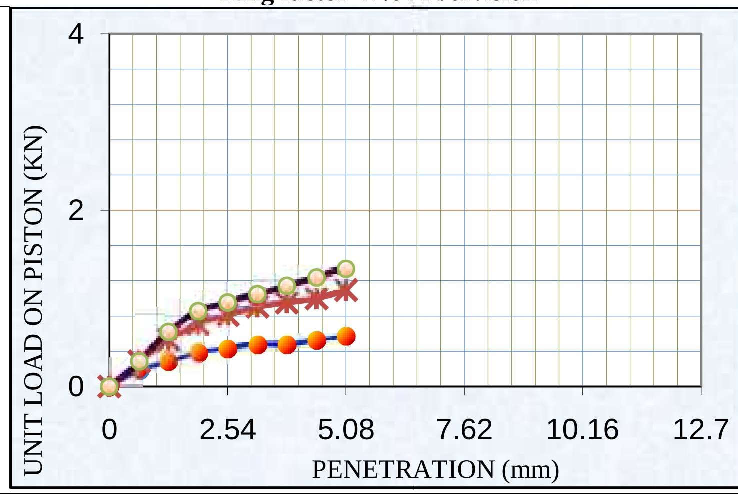
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,949	9,209	9,392	9,340	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,947	4,207	4,390	4,338	
	Wet Density (g/cm^3)	1.86	1.98	2.07	2.04	
Moisture	Container No.	A-6	B-7	B-4	B-8	10
	Wet Soil + Con. (g)	194.4	187.3	186.5	186.0	215.5
	Dry Soil +Con. (g)	173.4	165.5	163.2	161.0	199.9
	Mass of Con. (g)	21.0	30.0	30.2	28.5	40.1
	Mass of Moisture (g)	21.0	21.8	23.3	25.0	15.6
	Dry Soil (g)	152.4	135.5	133.0	132.5	159.8
	Moisture cont. (g/cm^3)	13.80	16.12	17.52	18.87	9.75
Dry Density (g/cm^3)			1.63	1.71	1.76	1.72



Experiment 4.4(CBR)

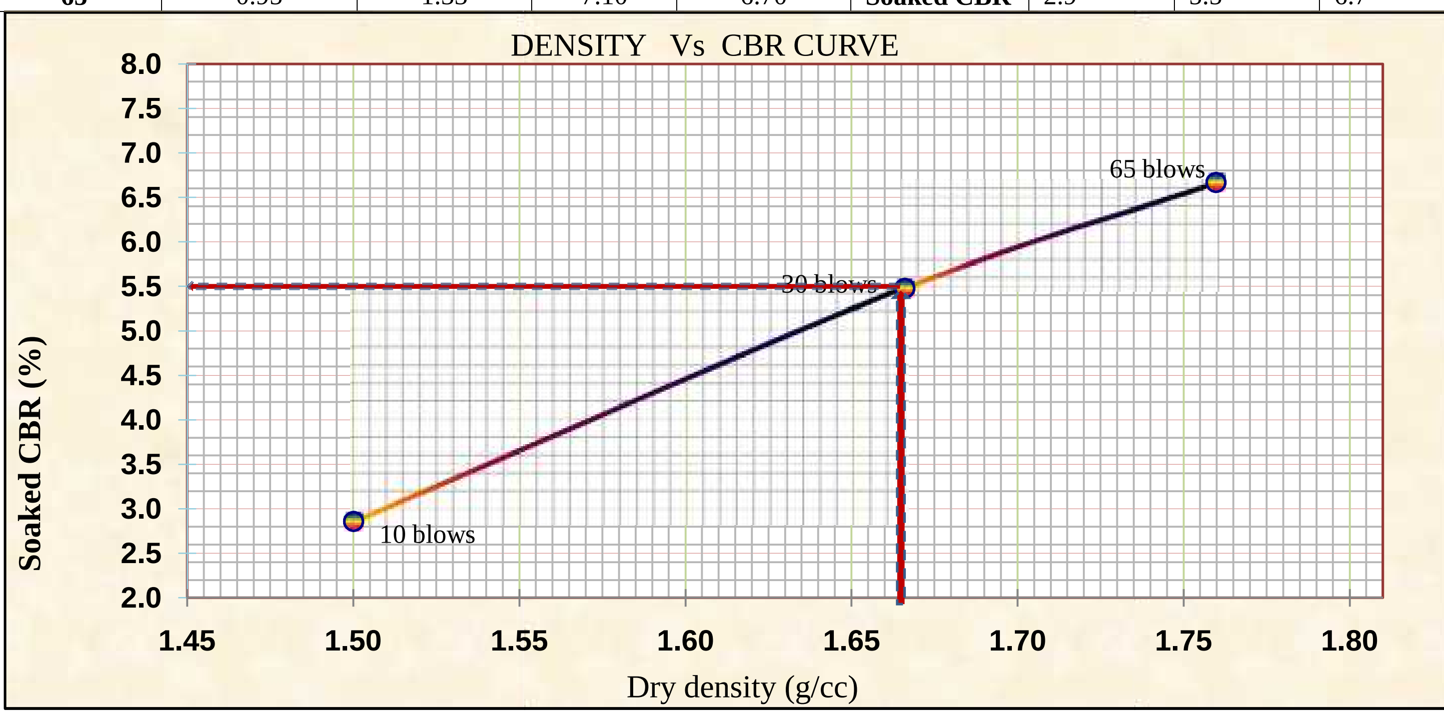
Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	4.0	0.19	6.0	0.29	6.0	0.29
1.27	6.0	0.29	11.0	0.52	13.0	0.62
1.91	8.0	0.38	15.0	0.72	18.0	0.86
2.54	9.0	0.43	17.0	0.81	20.0	0.95
3.18	10.0	0.48	19.0	0.91	22.0	1.05
3.81	10.0	0.48	20.0	0.95	24.0	1.14
4.45	11.0	0.52	21.0	1.00	26.0	1.24
5.08	12.0	0.57	23.0	1.09	28.0	1.33
7.62						

Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.43	0.57	3.20	2.90
30	0.81	1.10	6.10	5.50
65	0.95	1.33	7.10	6.70

Dry Density Vs Soaked CBR			
BLOWS	**10**	**30**	**65**
Dry density	1.50	1.67	1.76
Soaked CBR	2.9	5.5	6.7



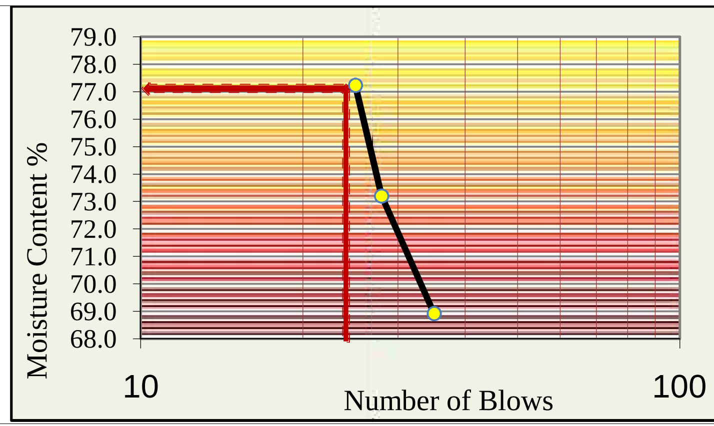
Experiment 5.1(Sieve Analysis for classification)

Weight of Sample Before Washing (gm)=1187

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	84	5.3	94.7	A-7-5(20)
No.10	44.7	2.8	91.9	
No.40	42.5	2.7	89.2	
No.200	86.2	5.4	83.8	

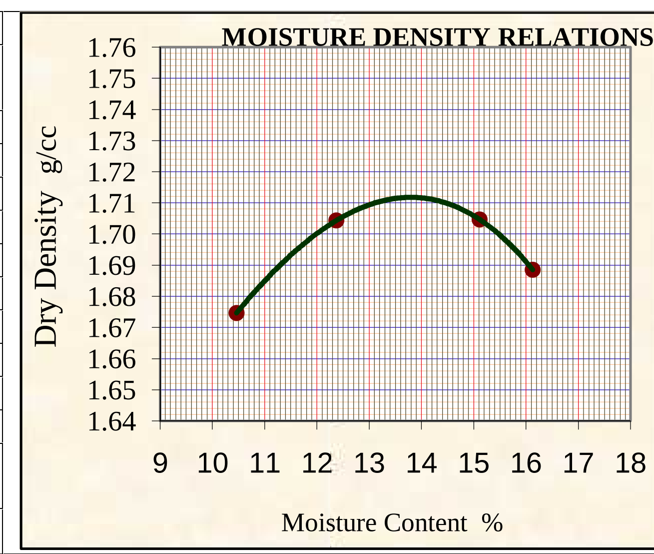
Experiment 5.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	35	28	25		
Container Number	A-2	A-5	A-8	A-10	A-12
Wet Soil +con (g)= (W1)	21.65	16.90	23.19	11.42	11.33
Dry Soil +con(g) = (W_2)	16.13	13.13	18.24	10.60	10.39
Mass of Con (g) = (W_3)	8.12	7.98	11.83	8.00	7.50
Weight of Moisture (g)	5.52	3.77	4.95	0.82	0.94
Dry Soil (g)	8.01	5.15	6.41	2.60	2.89
Moisture Content (%)	69	73	77	31.5	32.5
LL at 25 blow &Avg. PL	77				32



Experiment 5.3(Moisture Density Relationship of Soil

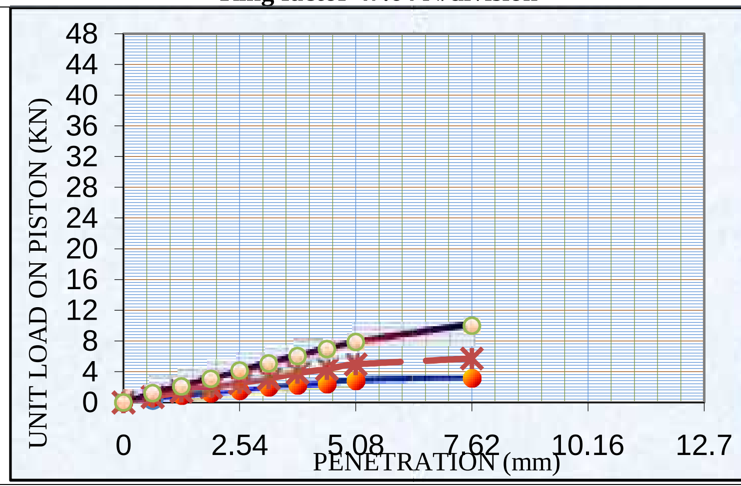
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,931	9,070	9,170	9,167	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,929	4,068	4,168	4,165	
	Wet Density (g/cm^3)	1.85	1.92	1.96	1.96	
Moisture	Container No.	B-4	B-6	B-9	A-2	2
	Wet Soil + Con. (g)	179.0	188.4	143.5	170.0	206.0
	Dry Soil +Con. (g)	164.9	171.4	128.6	150.0	199.6
	Mass of Con. (g)	30.1	34.0	30.0	26.0	41.0
	Mass of Moisture (g)	14.1	17.0	14.9	20.0	6.4
	Dry Soil (g)	134.8	137.4	98.6	124.0	158.6
	Moisture cont. (g/cm^3)	10.46	12.37	15.11	16.13	4.04
Dry Density (g/cm^3)		1.67	1.70	1.70	1.69	



Experiment 5.4(CBR)

Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	9.0	0.43	15.0	0.72	25.0	1.19
1.27	19.0	0.91	29.0	1.38	44.0	2.10
1.91	25.0	1.19	42.0	2.00	65.0	3.10
2.54	32.0	1.52	53.0	2.52	87.0	4.14
3.18	42.0	2.00	65.0	3.09	107.0	5.09
3.81	47.0	2.24	80.0	3.81	127.0	6.05
4.45	51.0	2.43	91.0	4.34	146.0	6.96
5.08	59.0	2.81	104.0	4.95	165.0	7.86
7.62	66.0	3.14	120.0	5.72	210.0	10.00

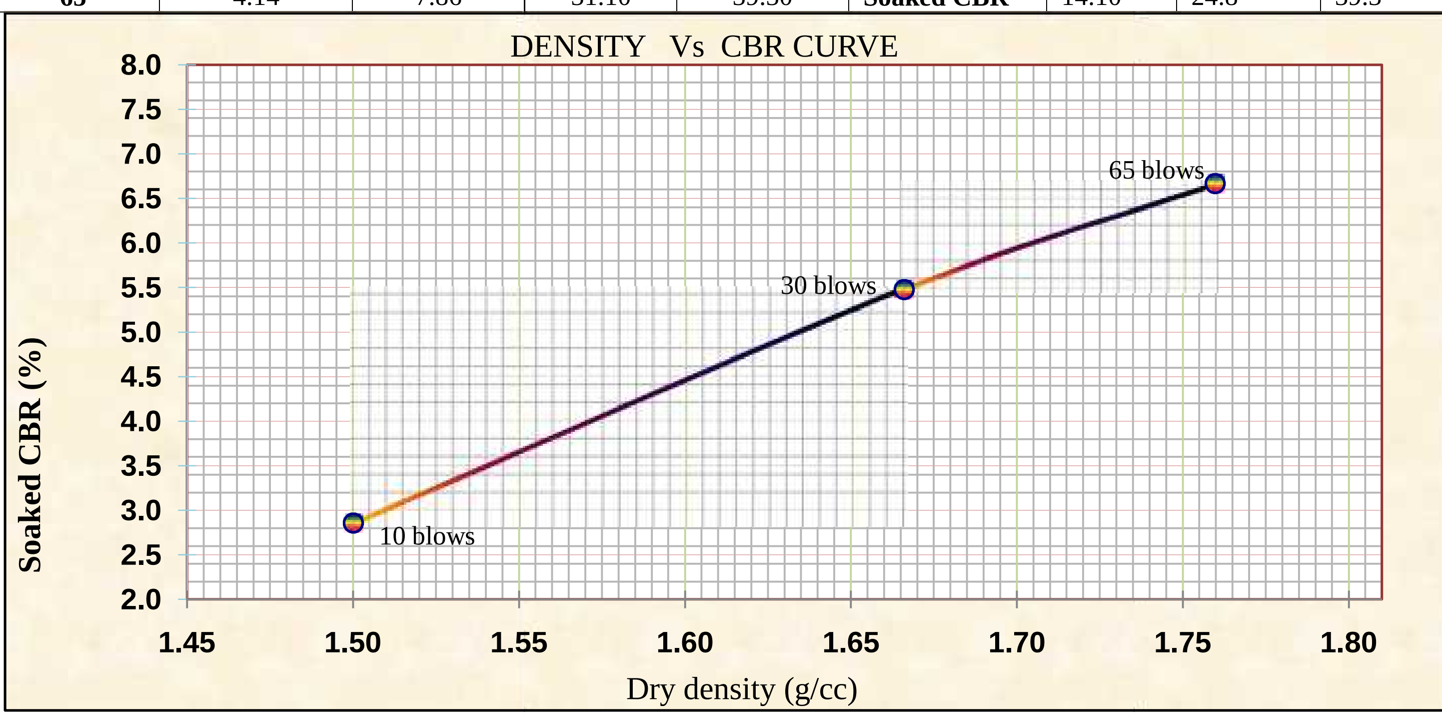
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	1.52	2.81	11.4	14.10
30	2.52	4.95	18.9	24.80
65	4.14	7.86	31.10	39.30

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	2.05	2.27	2.39
Soaked CBR	14.10	24.8	39.3



Experiment 6.1(Sieve Analysis for classification)

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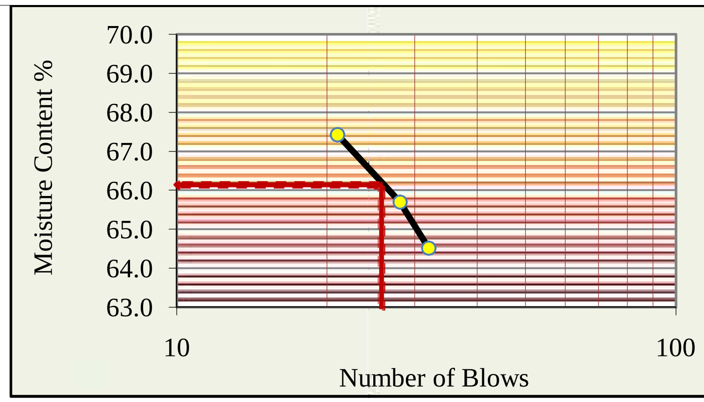
Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	109.2	14.4	85.6	
No.10	85	11.2	74.4	A-7-5(9)
No.40	64.3	8.5	66.0	
No.200	58	7.6	58.4	

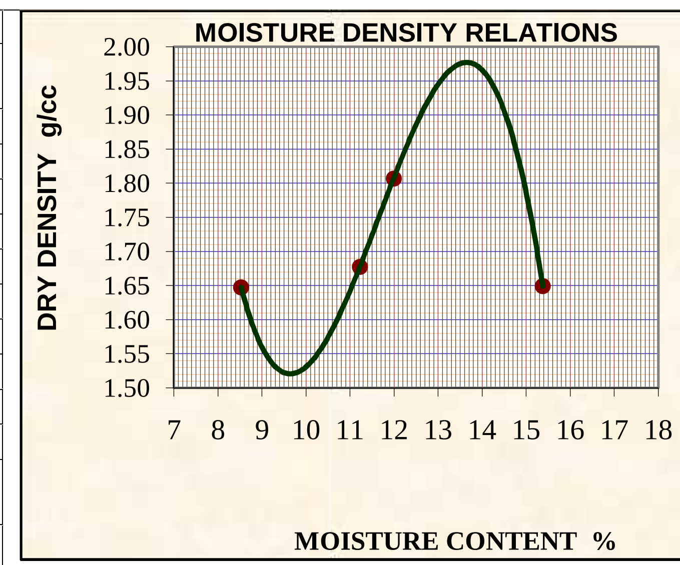
Experiment 6.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	32	28	21		
Container Number	A-2	A-9	A-7	A-10	A-8
Wet Soil +con (g)= (W1)	18.6	15.40	18.34	14.38	18.08
Dry Soil +con(g) = (W_2)	14.49	11.99	14.18	13.09	16.83
Mass of Con (g) = (W_3)	8.12	6.8	8.01	8.00	11.83
Weight of Moisture (g)	4.11	3.41	4.16	1.29	1.25
Dry Soil (g)	6.37	5.19	6.17	5.09	5.00
Moisture Content (%)	65	66	67	25.3	25.0
LL at 25 blow &Avg. PL	66				25.2



Experiment 6.3(Moisture Density Relationship of Soil

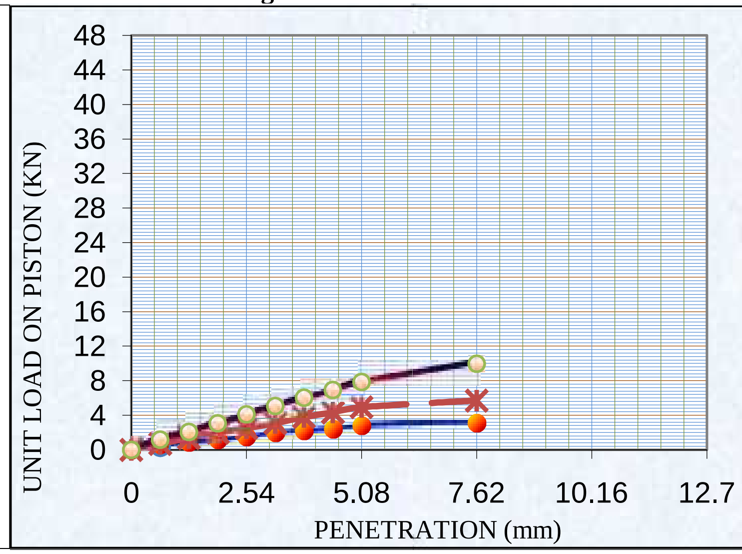
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,799	8,964	9,300	9,167	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,797	3,962	4,298	4,165	
	Wet Density (g/cm^3)	1.79	1.87	2.02	1.96	
Moisture	Container No.	E-7	18	B-2	A-2	13
	Wet Soil + Con. (g)	220.7	185.6	199.4	170.0	215.8
	Dry Soil +Con. (g)	206.5	171.1	182.3	150.0	209.3
	Mass of Con. (g)	40.0	41.9	39.7	26.0	39.5
	Mass of Moisture (g)	14.2	14.5	17.1	20.0	6.5
	Dry Soil (g)	166.5	129.2	142.6	124.0	169.8
	Moisture cont. (g/cm^3)	8.53	11.22	11.99	16.13	3.83
Dry Density (g/cm^3)		1.65	1.68	1.81	1.69	



Experiment 6.4(CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	9.0	0.43	15.0	0.72	25.0	1.19
1.27	19.0	0.91	29.0	1.38	44.0	2.10
1.91	25.0	1.19	42.0	2.00	65.0	3.10
2.54	32.0	1.52	53.0	2.53	87.0	4.15
3.18	42.0	2.00	65.0	3.10	107.0	5.10
3.81	47.0	2.24	80.0	3.81	127.0	6.05
4.45	51.0	2.43	91.0	4.34	146.0	6.95
5.08	59.0	2.81	104.0	4.96	165.0	7.86
7.62	66.0	3.14	120.0	5.72	210.0	10.00

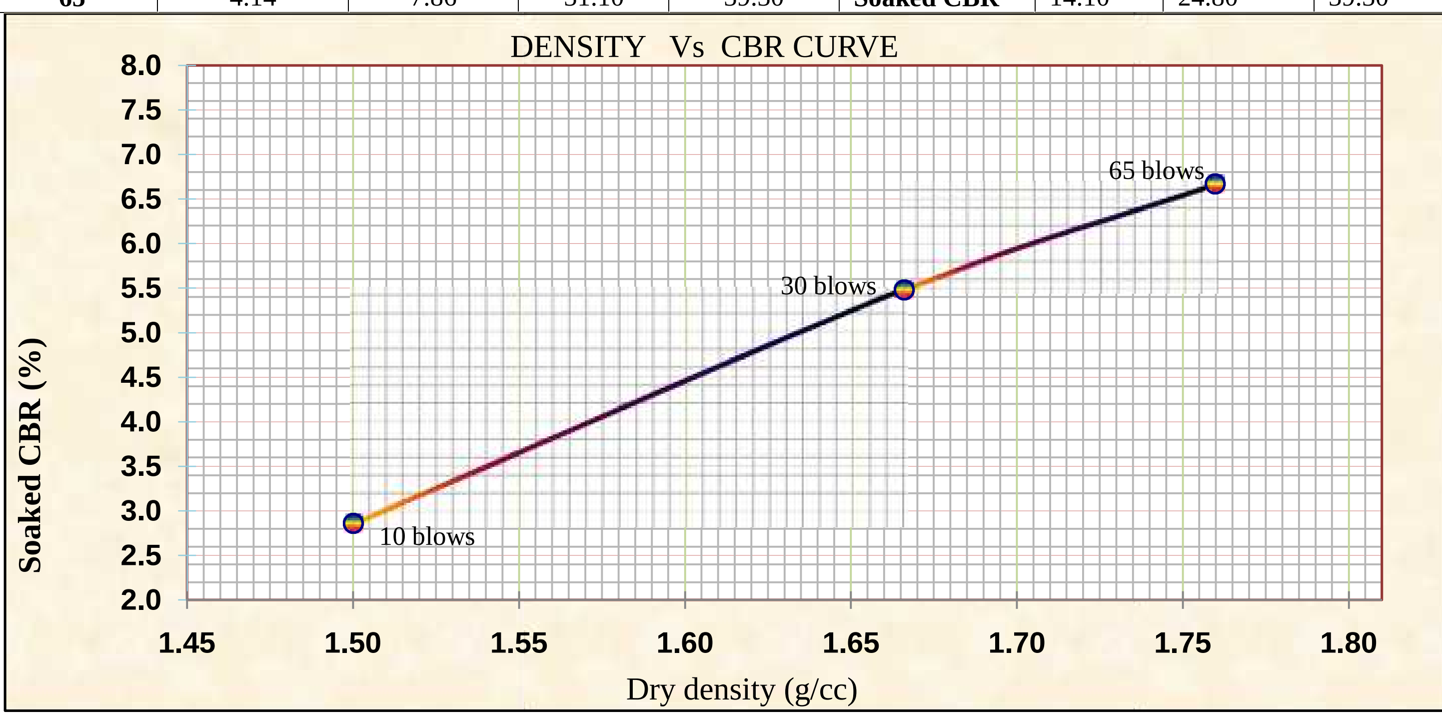
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	**Load (KN)**		**CBR (%)**	
	2.57 mm	**5.08mm**	**2.57 mm**	**5.08mm**
10	1.52	2.81	11.40	14.10
30	2.52	4.95	18.90	24.80
65	4.14	7.86	31.10	39.30

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	2.05	2.27	2.39
Soaked CBR	14.10	24.80	39.30

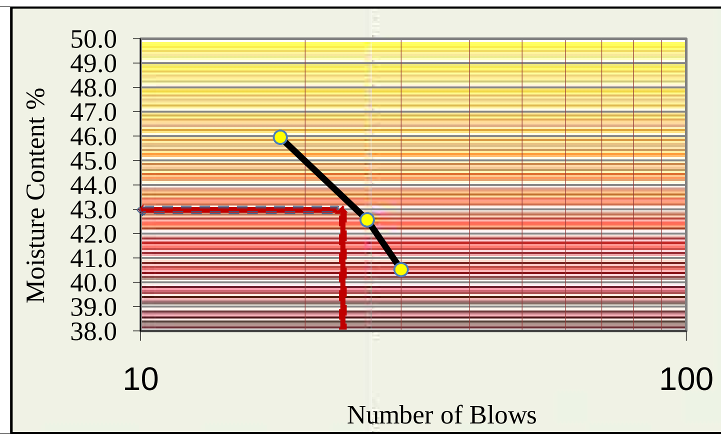


Experiment 7.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	176.3	18.6	81.4	A-7-5(19)
No.10	23.6	2.5	78.9	
No.40	52.3	5.5	73.3	
No.200	61.4	6.5	66.8	

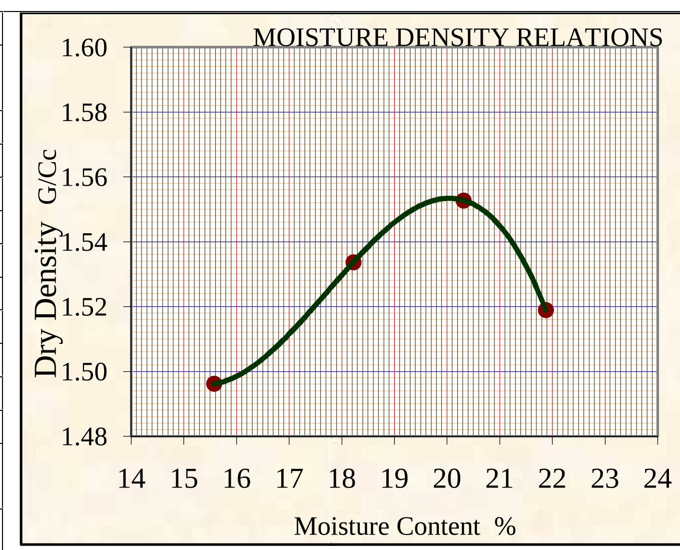
Experiment 7.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	26	18		
Container Number	A-9	A-7	A-6	A-8	A-1
Wet Soil +con (g)= (W1)	15.83	21.03	17.9	20.17	15.41
Dry Soil +con(g) = (W_2)	13.22	17.2	14.61	18.65	14.04
Mass of Con (g) = (W_3)	6.78	8.2	7.45	11.83	7.81
Weight of Moisture (g)	2.61	3.83	3.29	1.52	1.37
Dry Soil (g)	6.44	9.00	7.16	6.82	6.23
Moisture Content (%)	41	43	46	22.3	22.0
LL at 25 blow &Avg. PL	43				22.10



Experiment 7.3(Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,675	8,853	8,970	8,934	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,673	3,851	3,968	3,932	
	Wet Density (g/cm^3)	1.73	1.81	1.87	1.85	
Moisture	Container No.	S-1	T-3	T-2	I-2	A-1
	Wet Soil + Con. (g)	176.7	178.5	177.6	182.7	203.3
	Dry Soil +Con. (g)	158.8	157.8	154.5	157.1	188.6
	Mass of Con. (g)	43.9	44.2	40.8	40.1	42.8
	Mass of Moisture (g)	17.9	20.7	23.1	25.6	14.7
	Dry Soil (g)	114.9	113.6	113.7	117.0	145.8
	Moisture cont. (g/cm^3)	15.58	18.22	20.32	21.88	10.08
Dry Density (g/cm^3)		1.50	1.53	1.55	1.52	

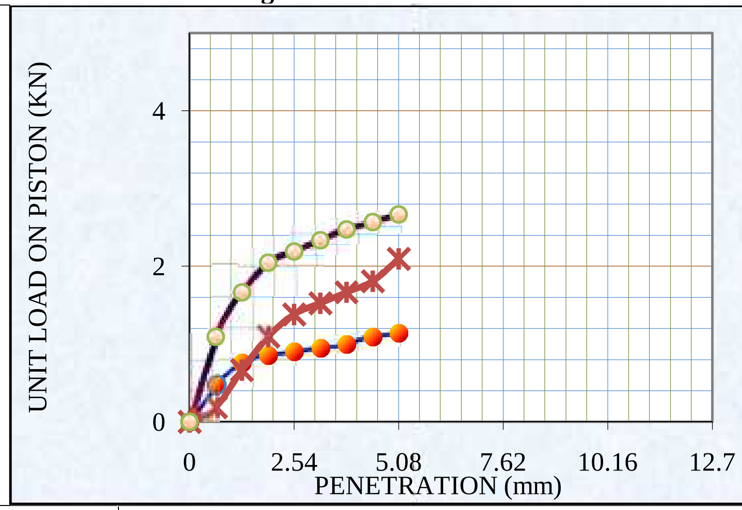


Experiment 7.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	10.0	0.47	4.0	0.19	23.0	1.10
1.27	16.0	0.76	14.0	0.67	35.0	1.67
1.91	18.0	0.86	23.0	1.10	43.0	2.50
2.54	19.0	0.91	29.0	1.38	46.0	2.19
3.18	20.0	0.95	32.0	1.52	49.0	2.33
3.81	21.0	1.00	35.0	1.67	52.0	2.47
4.45	23.0	1.10	38.0	1.81	54.0	2.57
5.08	24.0	1.14	44.0	2.10	56.0	2.67
7.62						

Ring factor 47.64 N/division

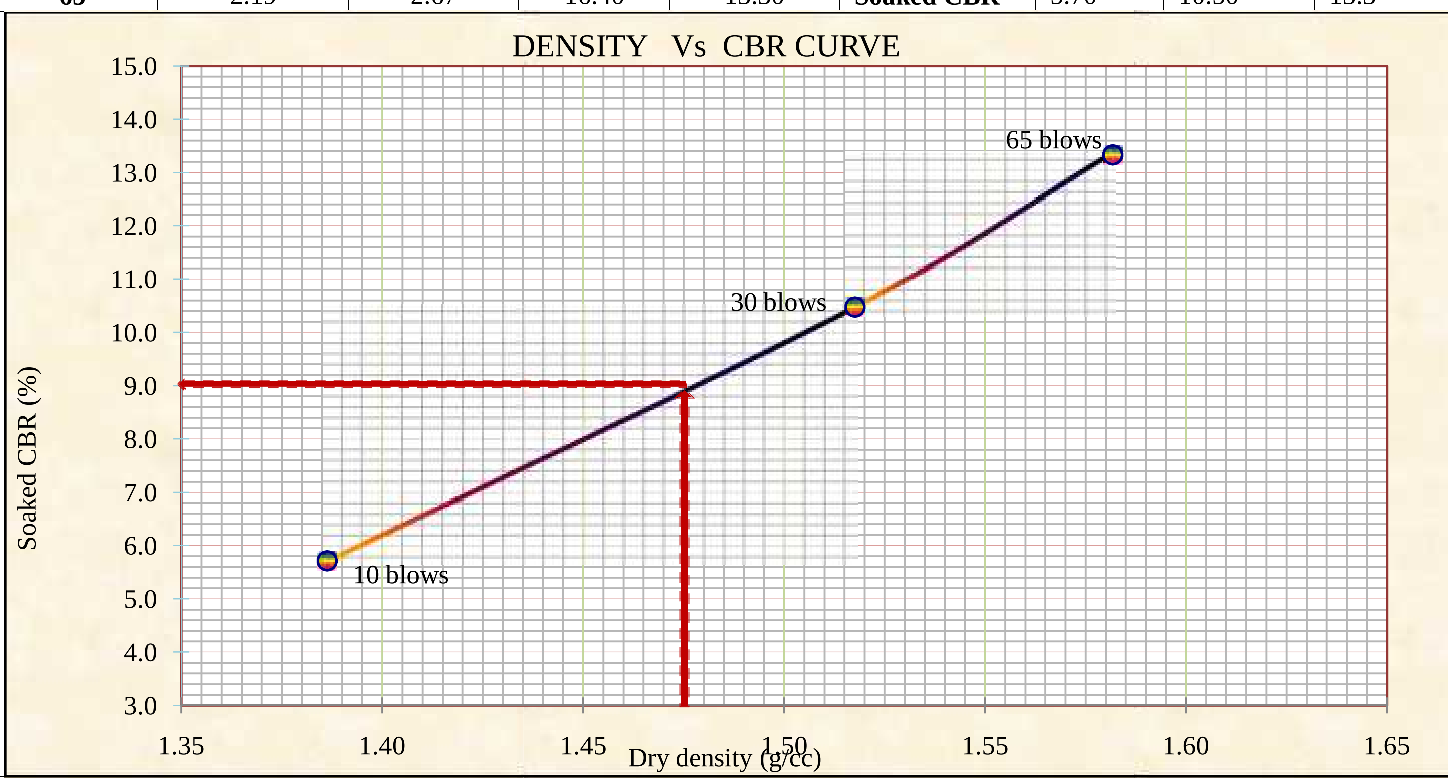


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.91	1.14	6.80	5.70
30	1.38	2.10	10.4	10.50
65	2.19	2.67	16.40	13.30

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.39	1.52	1.58
Soaked CBR	5.70	10.50	13.3

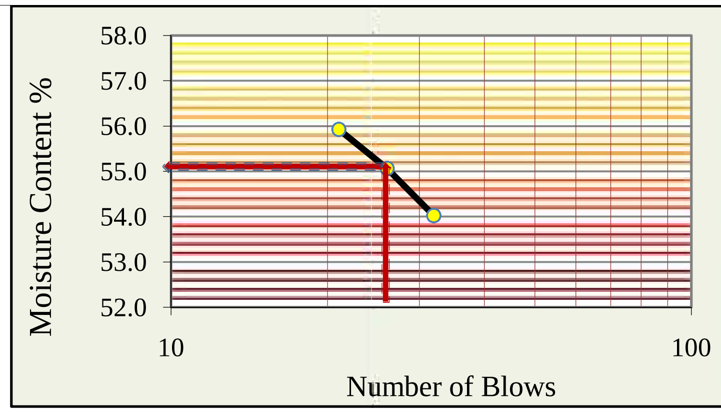


Experiment 8.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	176.3	18.6	81.4	A-7-5(19)
No.10	23.6	2.5	78.9	
No.40	52.3	5.5	73.3	
No.200	61.4	6.5	66.8	

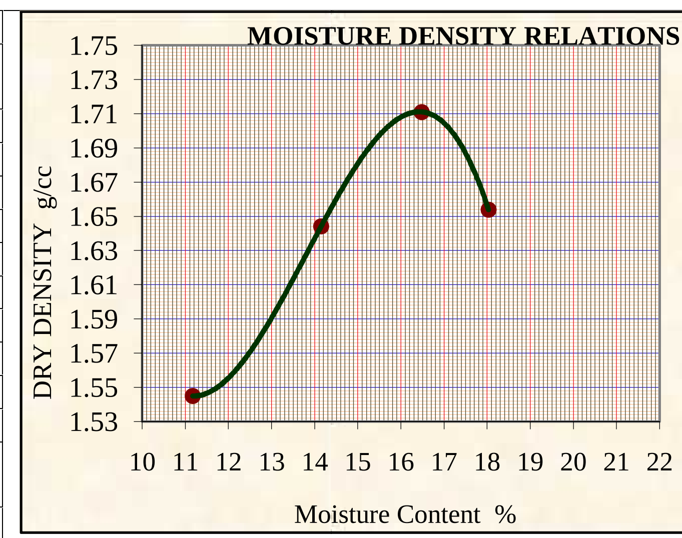
Experiment 8.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	32	26	21		
Container Number	A-5	A-8	A-9	A-7	A-2
Wet Soil +con (g)= (W1)	19.36	22.25	19.55	13.58	14.00
Dry Soil +con(g) = (W_2)	15.4	18.55	14.97	12.37	12.72
Mass of Con (g) = (W_3)	8.07	11.83	6.78	8.01	8.12
Weight of Moisture (g)	3.96	3.70	4.58	1.21	1.28
Dry Soil (g)	7.33	6.72	8.19	4.36	4.60
Moisture Content (%)	54	55	56	27.8	27.8
LL at 25 blow &Avg. PL	55.2			27.8	



Experiment8.3 (Moisture Density Relationship of Soil

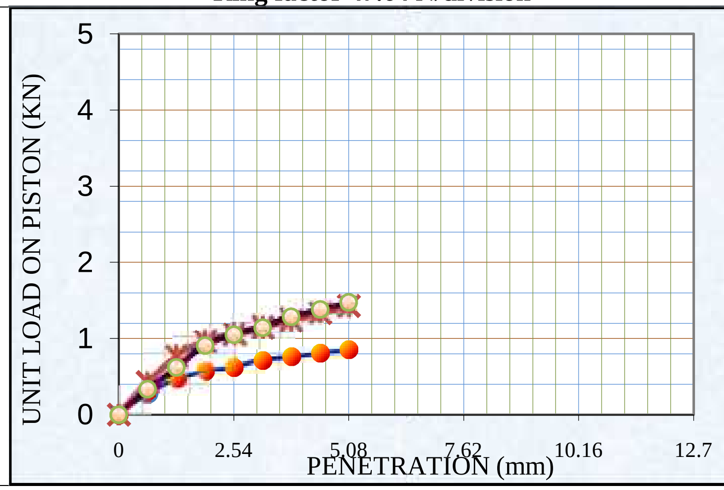
		1	2	3	4	NMC
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,650	8,988	9,235	9,148	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,648	3,986	4,233	4,146	
	Wet Density (g/cm^3)	1.72	1.88	1.99	1.95	
Moisture	Container No.	A-14	A-13	A10	S-5	F-2
	Wet Soil + Con. (g)	168.5	170.6	154.8	154.7	221.1
	Dry Soil +Con. (g)	156.0	154.5	138.5	136.2	210.2
	Mass of Con. (g)	44.1	40.7	39.6	33.6	42.3
	Mass of Moisture (g)	12.5	16.1	16.3	18.5	10.9
	Dry Soil (g)	111.9	113.8	98.9	102.6	167.9
	Moisture cont. (g/cm^3)	11.17	14.15	16.48	18.03	6.49
Dry Density (g/cm^3)		1.54	1.64	1.71	1.65	



Experiment 8.4(CBR)

Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	6.0	0.29	9.0	0.43	7.0	0.33
1.27	10.0	0.48	16.0	0.76	13.0	0.62
1.91	12.0	0.57	20.0	0.95	19.0	0.91
2.54	13.0	0.62	22.0	1.05	22.0	1.05
3.18	15.0	0.72	24.0	1.14	24.0	1.14
3.81	16.0	0.76	26.0	1.24	27.0	1.29
4.45	17.0	0.81	28.0	1.33	29.0	1.38
5.08	18.0	0.86	30.0	1.43	31.0	1.47
7.62						

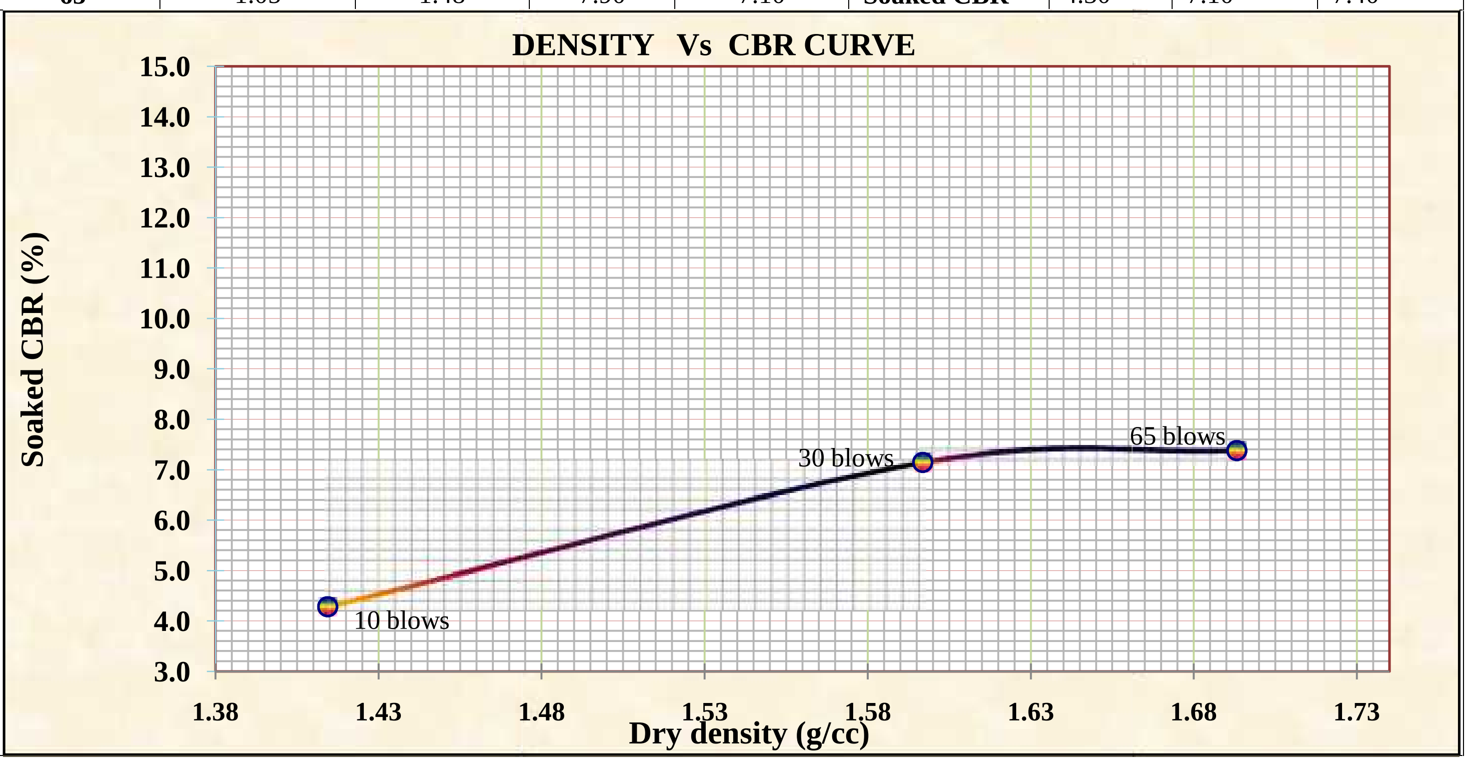
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.62	0.86	4.6	4.3
30	1.05	1.43	7.90	7.10
65	1.05	1.48	7.90	7.10

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.41	1.60	1.69
Soaked CBR	4.30	7.10	7.40



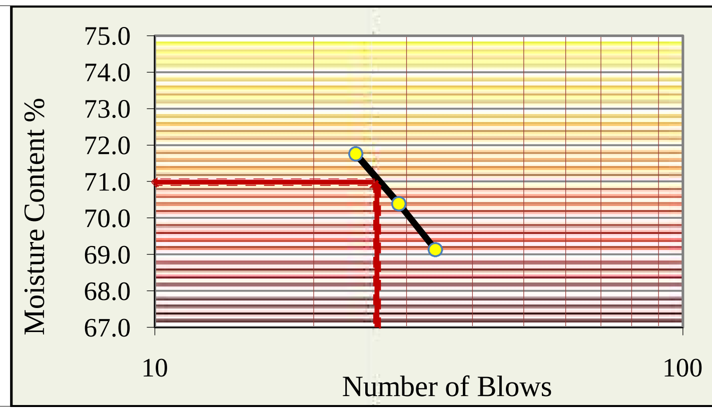
Experiment 9.1(Sieve Analysis for classification)

Weight of Sample Before Washing (gm)=1062.5

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	0.67	0.1	99.9	A-7-5(20)
No.10	21.63	2.0	97.9	
No.40	56.93	5.4	92.5	
No.200	35.63	3.4	89.2	

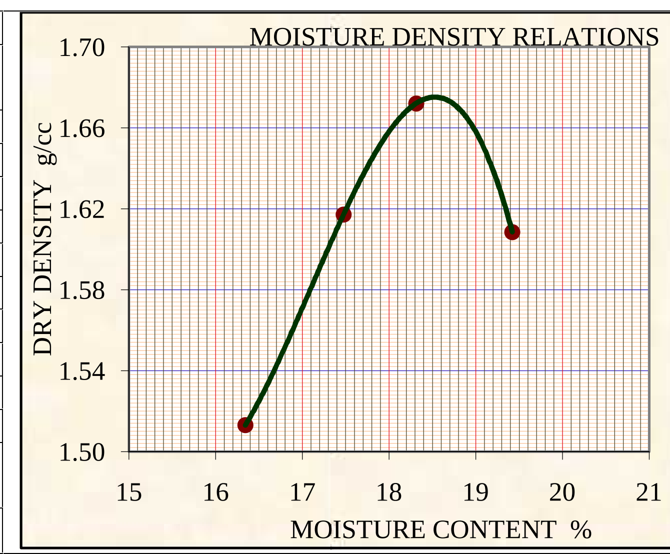
Experiment 9.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	34	29	24		
Container Number	A-2	A-8	A-4	A-7	A-1
Wet Soil +con (g)= (W1)	19.3	24.03	17.1	12.49	11.83
Dry Soil +con(g) = (W_2)	14.73	18.99	13.01	11.54	10.99
Mass of Con (g) = (W_3)	8.12	11.83	7.31	8.02	7.82
Weight of Moisture (g)	4.57	5.04	4.09	0.95	0.84
Dry Soil (g)	6.61	7.16	5.70	3.52	3.17
Moisture Content (%)	69	70	72	27.0	26.5
LL at 25 blow &Avg. PL	71				26.7



Experiment9.3 (Moisture Density Relationship of Soil

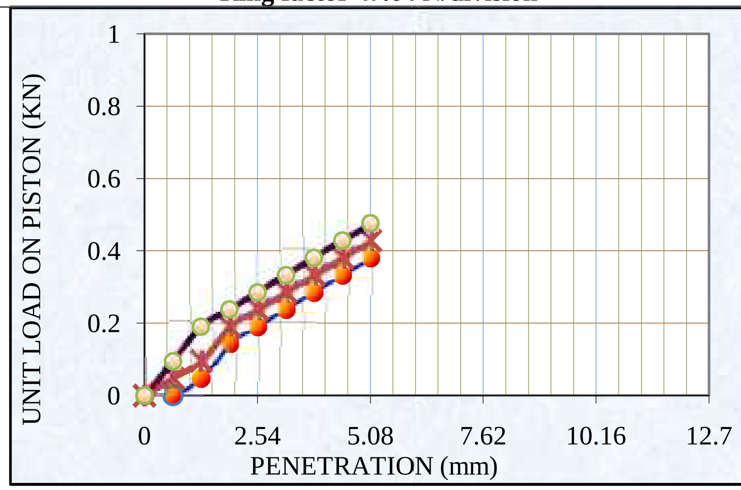
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,741	9,037	9,204	9,082	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,739	4,035	4,202	4,080	
	Wet Density (g/cm^3)	1.76	1.90	1.98	1.92	
Moisture	Container No.	E-13	13	B-14	E-7	A-4
	Wet Soil + Con. (g)	189.3	165.2	202.7	181.8	192.6
	Dry Soil +Con. (g)	168.2	146.5	177.9	158.9	173.6
	Mass of Con. (g)	39.1	39.5	42.5	41.0	33.5
	Mass of Moisture (g)	21.1	18.7	24.8	22.9	19.0
	Dry Soil (g)	129.1	107.0	135.4	117.9	140.1
	Moisture cont. (g/cm^3)	16.34	17.48	18.32	19.42	13.56
Dry Density (g/cm^3)		1.51	1.62	1.67	1.61	



Experiment 9.4(CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	0.0	0.00	1.0	0.05	2.0	0.10
1.27	1.0	0.05	2.0	0.10	4.0	0.19
1.91	3.0	0.14	4.0	0.19	5.0	0.24
2.54	4.0	0.19	5.0	0.29	6.0	0.29
3.18	5.0	0.24	6.0	0.29	7.0	0.33
3.81	6.0	0.29	7.0	0.33	8.0	0.38
4.45	7.0	0.33	8.0	0.38	9.0	0.43
5.08	8.0	0.38	9.0	0.43	10.0	0.48
7.62						

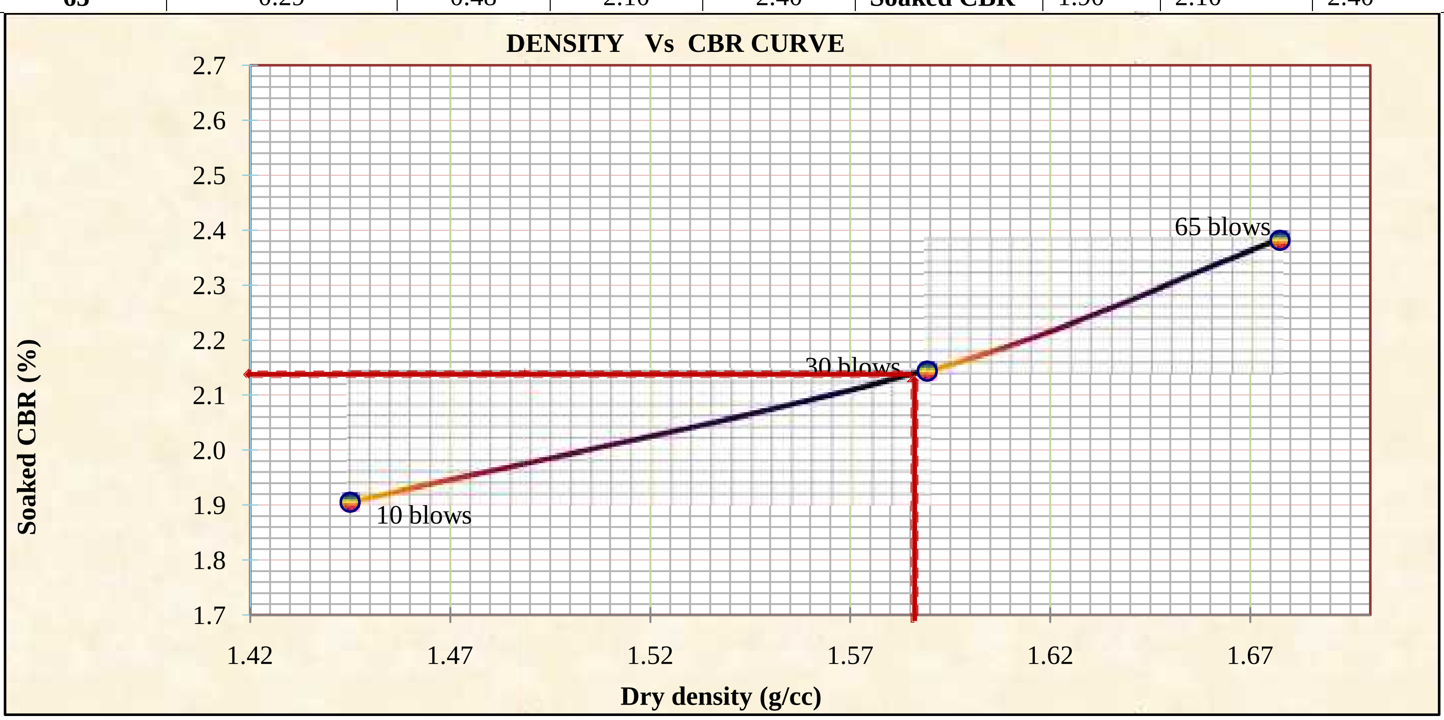
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.19	0.38	1.40	1.90
30	0.24	0.43	1.80	2.10
65	0.29	0.48	2.10	2.40

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.44	1.59	1.68
Soaked CBR	1.90	2.10	2.40



Experiment 10.1(Sieve Analysis for classification)

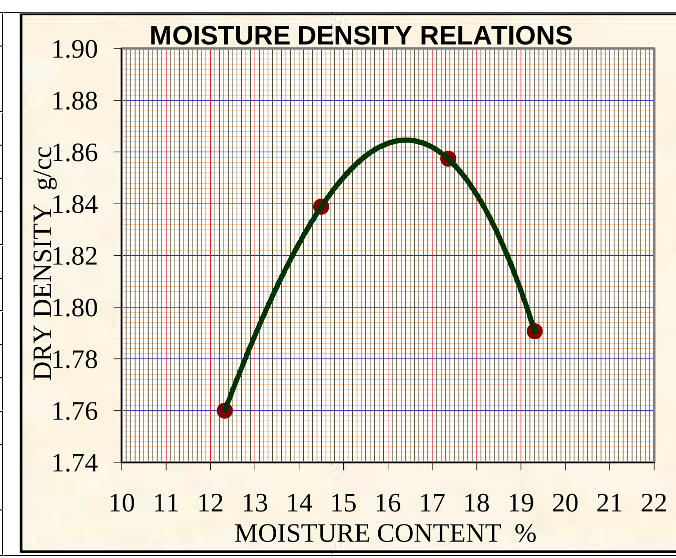
Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	189.7	22.6	77.4	A-7-6(15)
No.10	81.87	9.7	67.7	
No.40	104.61	12.5	55.2	
No.200	106.97	12.7	42.5	

Experiment 10.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	35	29	24		
Container Number	A-1	A-9	A-7	A-2	A-6
Wet Soil +con (g)= (W1)	20.88	19.88	20.37	16.53	14.40
Dry Soil +con(g) = (W_2)	16.87	15.74	16.37	15.17	13.27
Mass of Con (g) = (W_3)	7.82	6.78	8.02	8.12	7.45
Weight of Moisture (g)	4.01	4.14	4	1.36	1.13
Dry Soil (g)	9.05	8.96	8.35	7.05	5.82
Moisture Content (%)	44	46	48	19.3	19.4
LL at 25 blow &Avg. PL	48				19.4

Experiment10.3 (Moisture Density Relationship of Soil

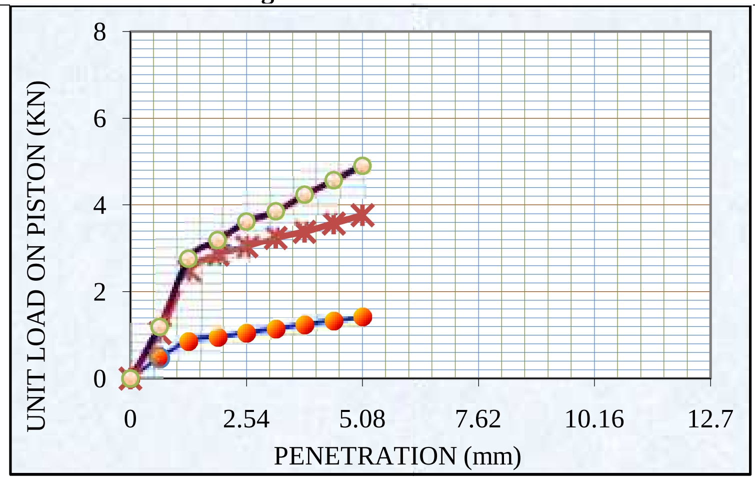
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	9,201	9,474	9,632	9,540	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	4,199	4,472	4,630	4,538	
	Wet Density (g/cm^3)	1.98	2.11	2.18	2.14	
Moisture	Container No.	18	I	B-2	T-3	B-3
	Wet Soil + Con. (g)	241.5	241.8	173.1	203.6	159.6
	Dry Soil +Con. (g)	219.6	216.4	153.4	177.8	148.1
	Mass of Con. (g)	41.9	41.2	39.9	44.2	28.7
	Mass of Moisture (g)	21.9	25.4	19.7	25.8	11.5
	Dry Soil (g)	177.7	175.2	113.5	133.6	119.4
	Moisture cont. (g/cm^3)	12.32	14.50	17.36	19.31	9.63
Dry Density (g/cm^3)		1.76	1.84	1.86	1.79	



Experiment 10.4(CBR)

Penetration data						
	10 Blows		**30 Blows**		**65Blows**	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	10.0	0.48	22.0	1.05	25.0	1.19
1.27	18.0	0.86	52.0	2.48	58.0	2.76
1.91	20.0	0.95	60.0	2.86	67.0	3.19
2.54	22.0	1.05	64.0	3.05	76.0	3.62
3.18	24.0	1.14	68.0	3.24	81.0	3.86
3.81	26.0	1.24	71.0	3.38	89.0	4.24
4.45	28.0	1.33	75.0	3.57	96.0	4.57
5.08	30.0	1.43	79.0	3.76	103.0	4.91
7.62						

Ring factor 47.64 N/division

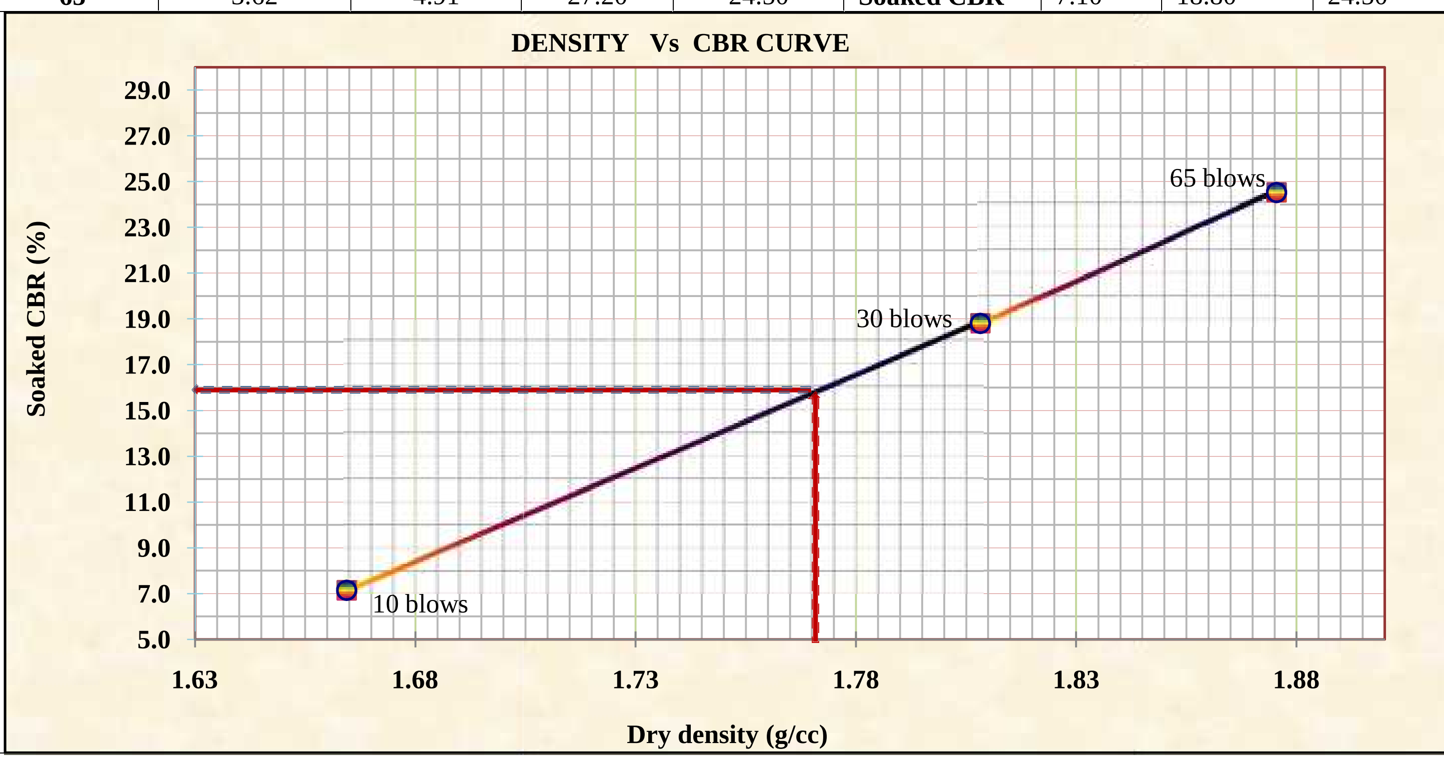


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	**5.08mm**	**2.57 mm**	**5.08mm**
10	1.05	1.43	7.90	7.10
30	3.05	3.76	22.90	18.80
65	3.62	4.91	27.20	24.50

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.66	1.81	1.88
Soaked CBR	7.10	18.80	24.50

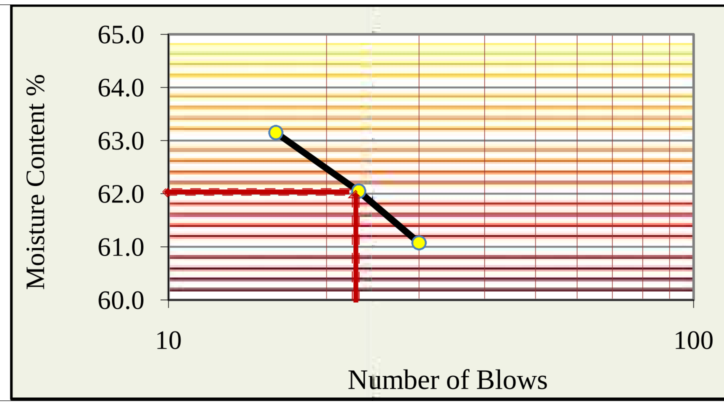


Experiment 11.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	130.35	14.1	85.9	A-7-5(20)
No.10	59.93	6.5	79.5	
No.40	26.93	2.9	76.5	
No.200	77.45	8.4	68.2	

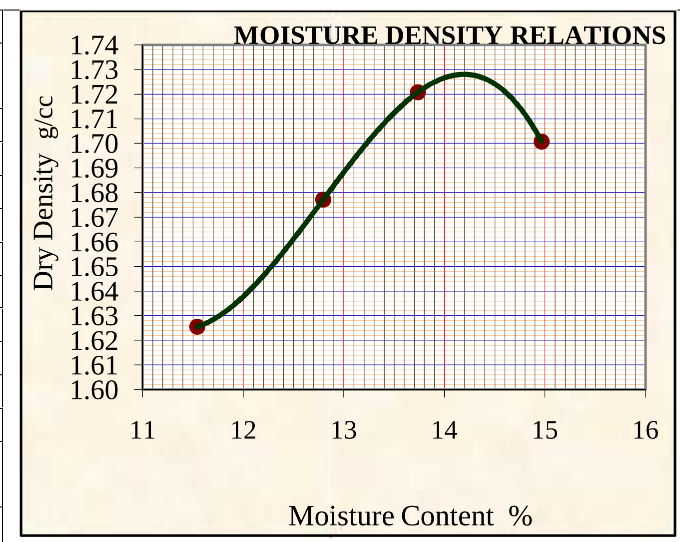
Experiment 11.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	23	16		
Container Number	D-1	D-6	D-10	D-3	D-5
Wet Soil +con (g)= (W1)	35.66	38.19	44.36	36.1	35.50
Dry Soil +con(g) = (W_2)	30.92	32.86	38.67	34.84	34.57
Mass of Con (g) = (W_3)	23.16	24.27	29.66	29.95	31.00
Weight of Moisture (g)	4.74	5.33	5.69	1.26	0.93
Dry Soil (g)	7.76	8.59	9.01	4.89	3.57
Moisture Content (%)	61	62	63	25.8	26.1
LL at 25 blow &Avg. PL	62				25.90



Experiment11.3 (Moisture Density Relationship of Soil

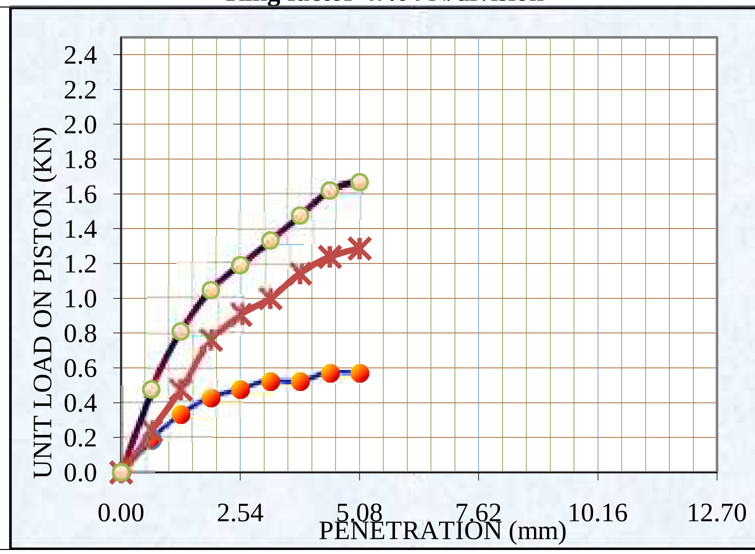
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,853	9,020	9,159	9,155	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,851	4,018	4,157	4,153	
	Wet Density (g/cm^3)	1.81	1.89	1.96	1.96	
Moisture	Container No.	B-2	S-1	I	18	10
	Wet Soil + Con. (g)	160.6	168.1	168.3	177.0	181.0
	Dry Soil +Con. (g)	148.1	154.0	152.9	159.4	172.0
	Mass of Con. (g)	39.8	43.8	40.8	41.8	40.1
	Mass of Moisture (g)	12.5	14.1	15.4	17.6	9.0
	Dry Soil (g)	108.3	110.2	112.1	117.6	131.9
	Moisture cont. (g/cm^3)	11.54	12.79	13.74	14.97	6.82
Dry Density (g/cm^3)		1.63	1.68	1.72	1.70	



Experiment 11.4(CBR)

Penetration data						
Penetration (mm)	**10 Blows**		**30 Blows**		**65Blows**	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	4.0	0.19	5.0	0.24	10.0	0.48
1.27	7.0	0.33	10.0	0.48	17.0	0.81
1.91	9.0	0.43	16.0	0.76	22.0	1.05
2.54	10.0	0.48	19.0	0.90	25.0	1.19
3.18	11.0	0.52	21.0	1.00	28.0	1.33
3.81	11.0	0.52	24.0	1.14	31.0	1.48
4.45	12.0	0.57	26.0	1.24	34.0	1.62
5.08	12.0	0.57	27.0	1.29	35.0	1.67
7.62						

Ring factor 47.64 N/division

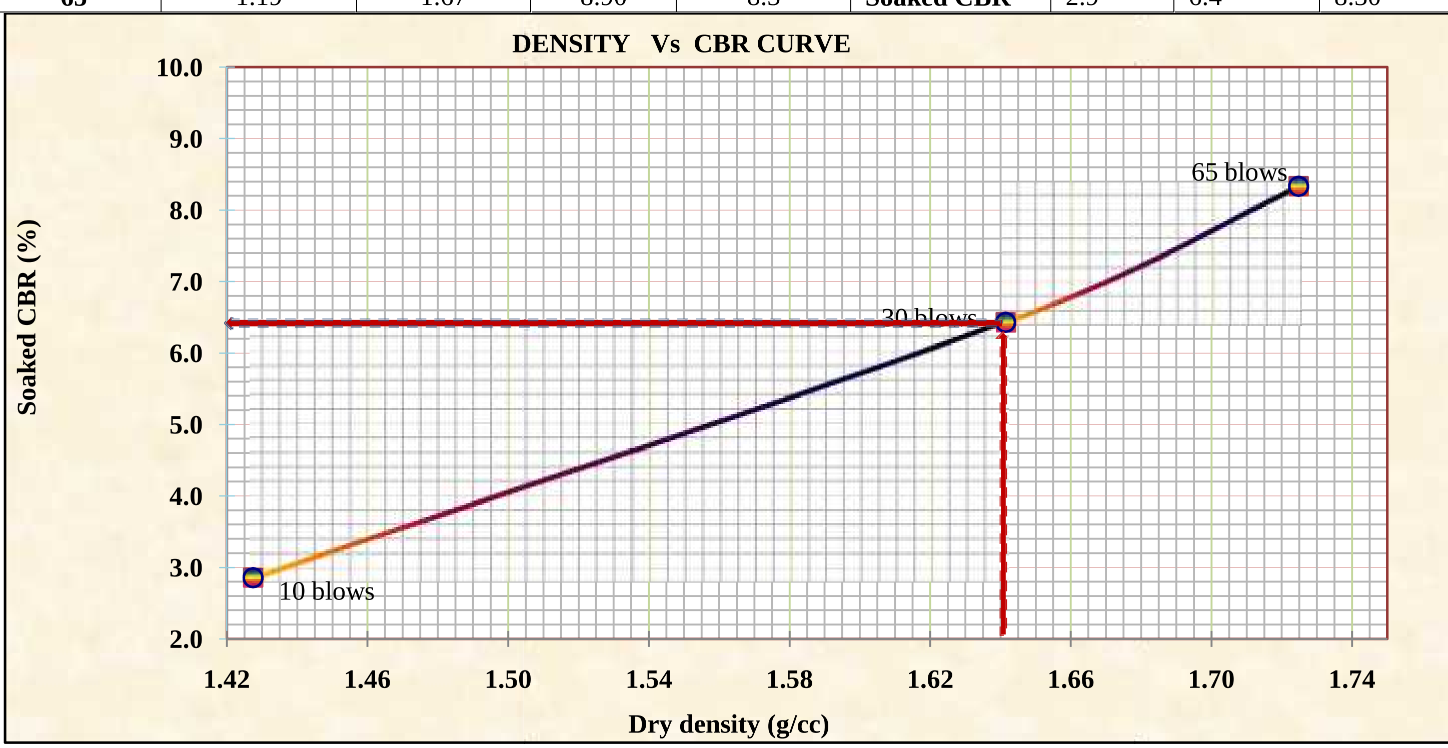


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.48	0.57	3.6	2.9
30	0.91	1.29	6.8	6.4
65	1.19	1.67	8.90	8.3

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.43	1.64	1.72
Soaked CBR	2.9	6.4	8.30



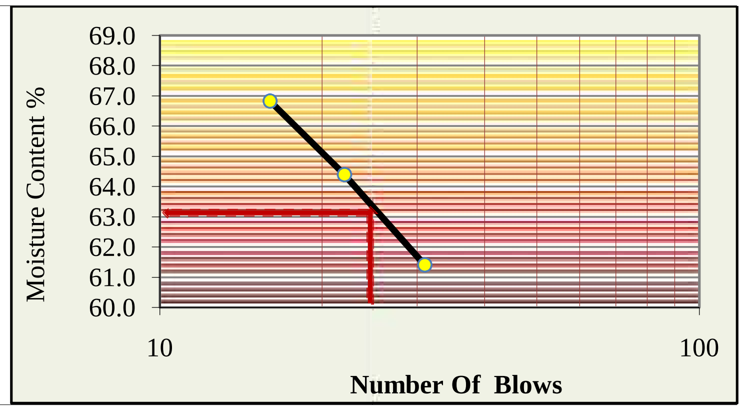
Experiment 12.1(Sieve Analysis for classification)

Weight of Sample Before Washing (gm)= 932

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	67.74	7.3	92.7	A-7-5(20)
No.10	36.46	3.9	88.8	
No.40	58.49	6.3	82.5	
No.200	65.14	7.0	75.6	

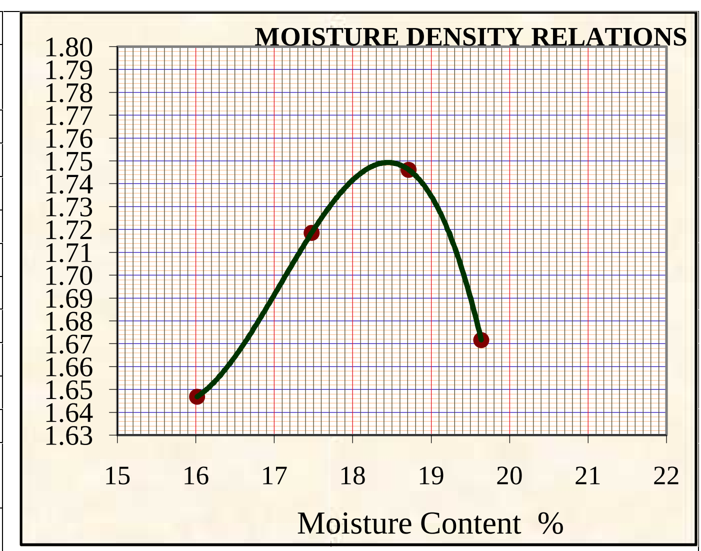
Experiment 12.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	31	22	16		
Container Number	A-4	A-3	A-2	A-11	A-12
Wet Soil +con (g)= (W1)	19.77	18.51	18.83	12.75	12.28
Dry Soil +con(g) = (W_2)	15.03	14.84	14.54	11.79	11.28
Mass of Con (g) = (W_3)	7.31	9.14	8.12	8.24	7.50
Weight of Moisture (g)	4.74	3.67	4.29	0.96	1.00
Dry Soil (g)	7.72	5.70	6.42	3.55	3.78
Moisture Content (%)	61	64	67	27.0	26.5
LL at 25 blow &Avg. PL	63				26.70



Experiment11.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	9,060	9,290	9,405	9,250	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	4,058	4,288	4,403	4,248	
	Wet Density (g/cm^3)	1.91	2.02	2.07	2.00	
Moisture	Container No.	10	B-2	S-1	I	18
	Wet Soil + Con. (g)	170.5	180.3	165.6	186.4	171.0
	Dry Soil +Con. (g)	152.5	159.4	146.4	162.5	156.1
	Mass of Con. (g)	40.1	39.8	43.8	40.8	41.8
	Mass of Moisture (g)	18.0	20.9	19.2	23.9	14.9
	Dry Soil (g)	112.4	119.6	102.6	121.7	114.3
	Moisture cont. (g/cm^3)	16.01	17.47	18.71	19.64	13.04
Dry Density (g/cm^3)			1.65	1.72	1.75	1.67

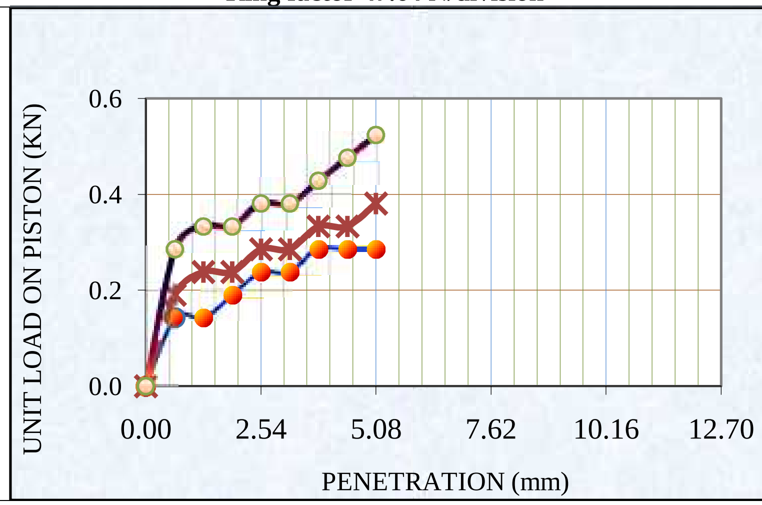


Experiment 12.4(<u>CBR)</u>

Penetration data

Penetration (mm)	**10 Blows** Dial RDG	**10 Blows** Load (KN)	**30 Blows** Dial RDG	**30 Blows** Load (KN)	**65Blows** Dial RDG	**65Blows** Load (KN)
0	0	0	0	0	0	0
0.64	3.0	0.14	4.0	0.19	6.0	0.29
1.27	3.0	0.14	5.0	0.24	7.0	0.33
1.91	4.0	0.19	5.0	0.24	7.0	0.33
2.54	5.0	0.24	6.0	0.29	8.0	0.38
3.18	5.0	0.24	6.0	0.29	8.0	0.38
3.81	6.0	0.29	7.0	0.33	9.0	0.43
4.45	6.0	0.29	7.0	0.33	10.0	0.48
5.08	6.0	0.29	8.0	0.38	11.0	0.52
7.62						

Ring factor 47.64 N/division

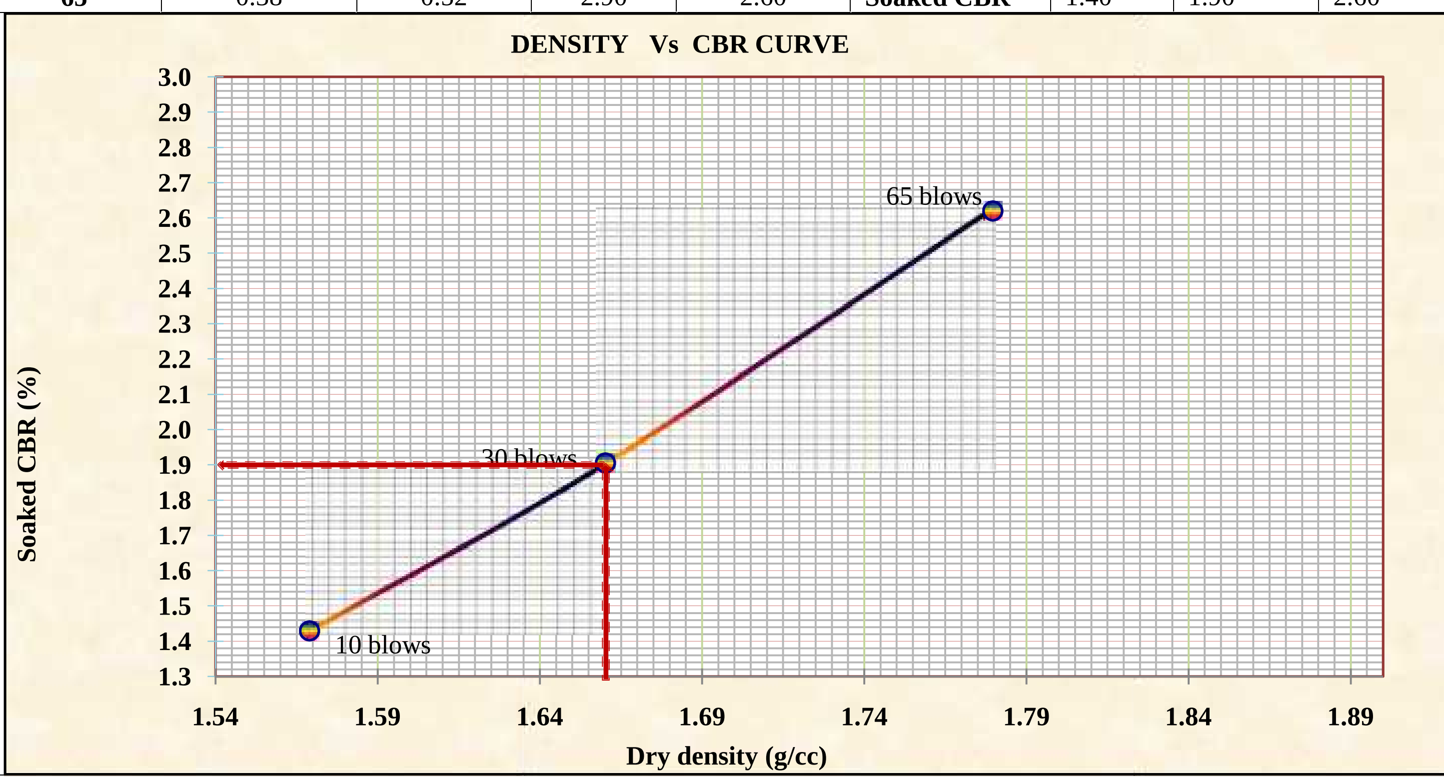


CBR Value at Standard Loads and CBR Test Summary

blows	**Load (KN)** 2.57 mm	**Load (KN)** 5.08mm	**CBR (%)** 2.57 mm	**CBR (%)** 5.08mm
10	0.24	0.29	1.8	1.40
30	0.29	0.38	2.10	1.90
65	0.38	0.52	2.90	2.60

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.57	1.66	1.78
Soaked CBR	1.40	1.90	2.60

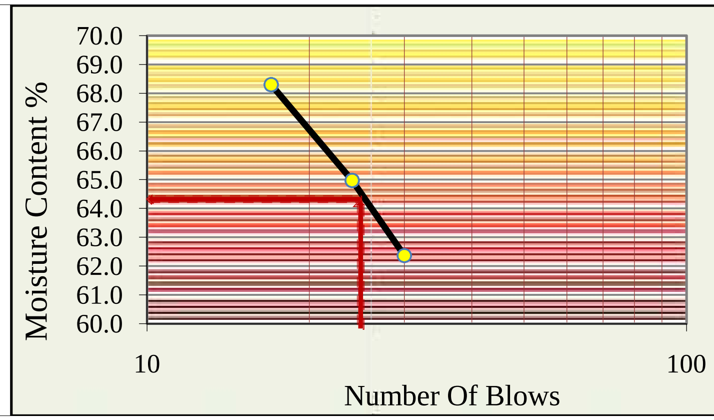


Experiment 13.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	48.57	5.1	94.9	A-7-5(20)
No.10	36.72	3.9	91.1	
No.40	42.06	4.4	86.6	
No.200	52.01	5.5	81.2	

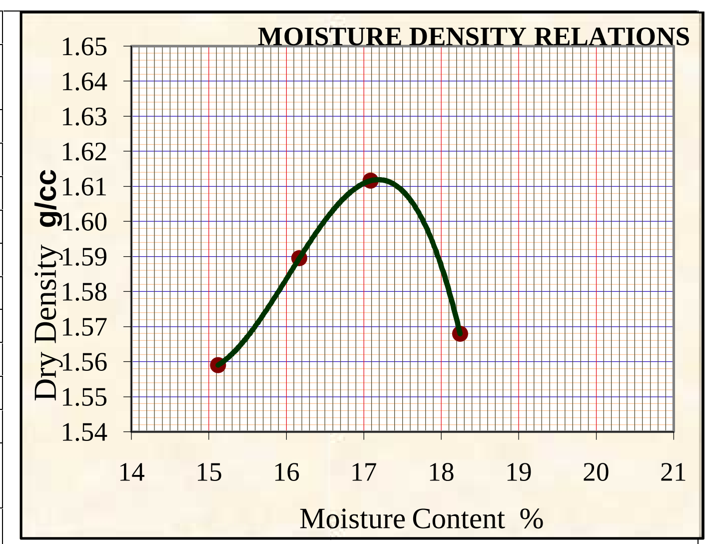
Experiment 13.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	24	17		
Container Number	A-11	A-8	A-6	A-12	A-4
Wet Soil +con (g)= (W1)	19.08	21.20	19.5	12.41	12.14
Dry Soil +con(g) = (W_2)	14.92	17.51	14.61	11.39	11.13
Mass of Con (g) = (W_3)	8.25	11.83	7.45	7.51	7.31
Weight of Moisture (g)	4.16	3.69	4.89	1.02	1.01
Dry Soil (g)	6.67	5.68	7.16	3.88	3.82
Moisture Content (%)	62	65	68	26.3	26.4
LL at 25 blow &Avg. PL	64				26.4



Experiment13.3 (Moisture Density Relationship of Soil

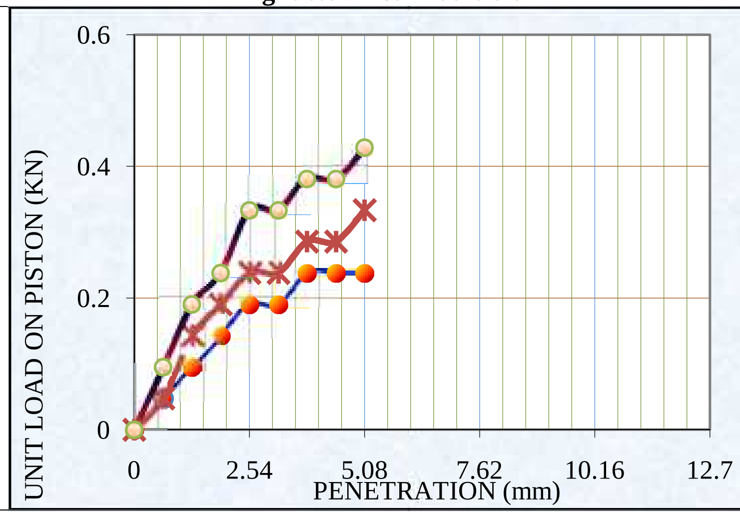
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,814	8,924	9,010	8,940	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,812	3,922	4,008	3,938	
	Wet Density (g/cm^3)	1.79	1.85	1.89	1.85	
Moisture	Container No.	B-4	B-7	E-1	B-10	B-8
	Wet Soil + Con. (g)	180.2	170.1	145.6	151.2	206.0
	Dry Soil +Con. (g)	160.5	150.6	130.1	132.5	193.6
	Mass of Con. (g)	30.2	30.0	39.4	30.0	28.5
	Mass of Moisture (g)	19.7	19.5	15.5	18.7	12.4
	Dry Soil (g)	130.3	120.6	90.7	102.5	165.1
	Moisture cont. (g/cm^3)	15.12	16.17	17.09	18.24	7.51
Dry Density (g/cm^3)		1.56	1.59	1.61	1.57	



Experiment 13.4(CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	1.0	0.050	1.0	0.05	2.0	0.10
1.27	2.0	0.10	3.0	0.14	4.0	0.19
1.91	3.0	0.14	4.0	0.19	5.0	0.24
2.54	4.0	0.19	5.0	0.24	7.0	0.33
3.18	4.0	0.19	5.0	0.24	7.0	0.33
3.81	5.0	0.24	6.0	0.29	8.0	0.38
4.45	5.0	0.24	6.0	0.29	8.0	0.38
5.08	5.0	0.24	7.0	0.33	9.0	0.43
7.62						

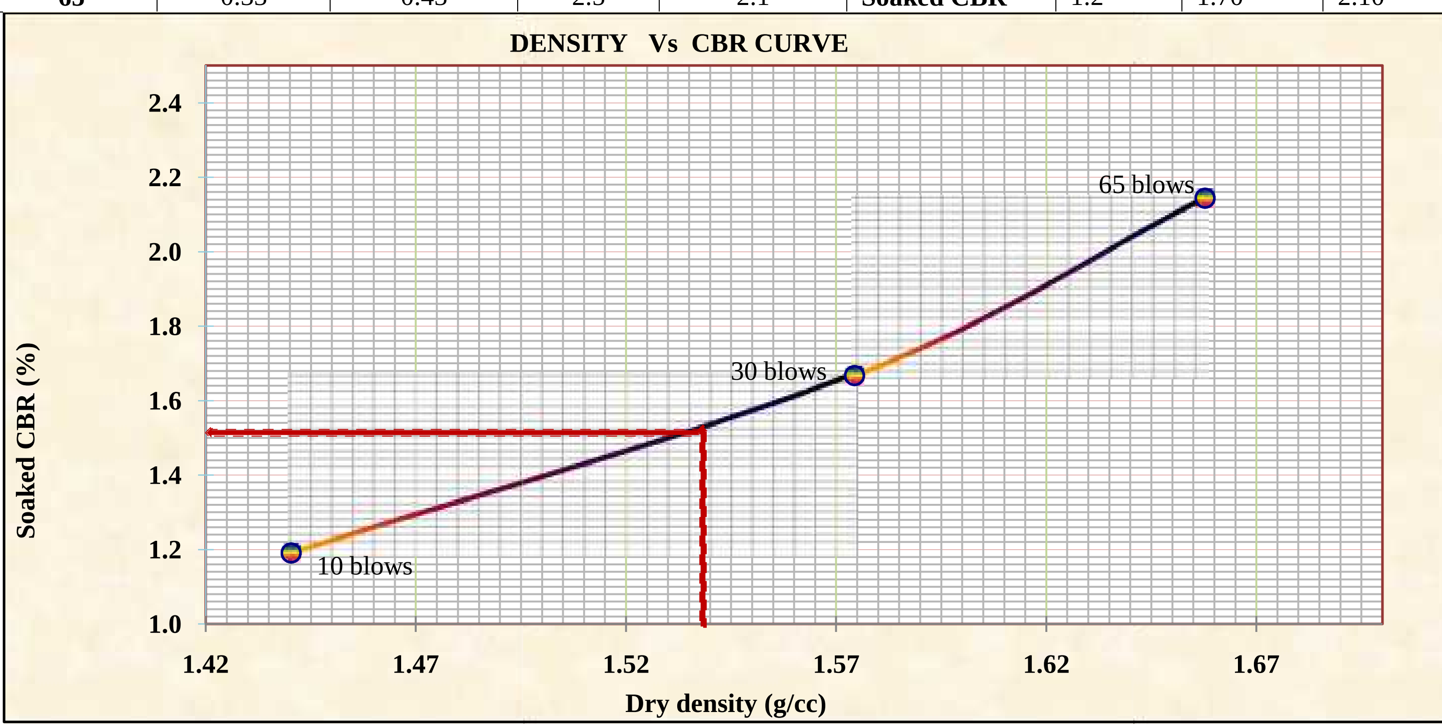
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.19	0.24	1.4	1.2
30	0.24	0.33	1.8	1.7
65	0.33	0.43	2.5	2.1

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.44	1.57	1.66
Soaked CBR	1.2	1.70	2.10

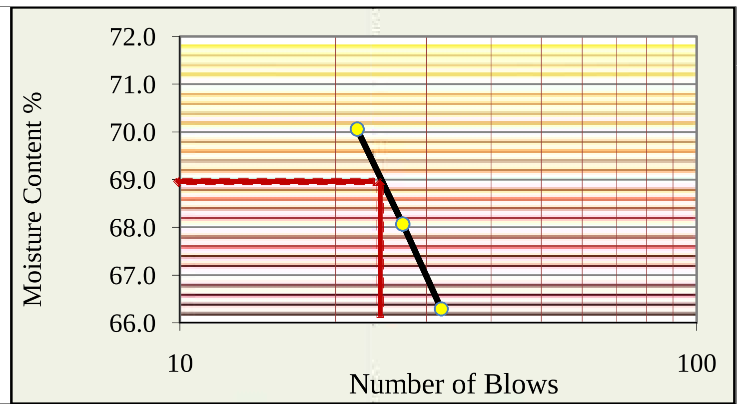


Experiment 14.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	6.85	0.7	99.3	A-7-5(20)
No.10	9.12	1.0	98.3	
No.40	33.95	3.7	94.6	
No.200	43.23	4.6	90.0	

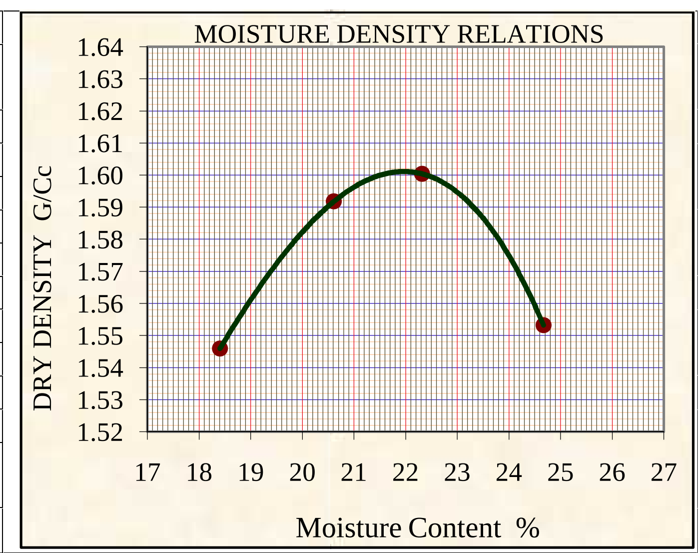
Experiment 14.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	32	27	22		
Container Number	D-1	D-9	D-6	D-9	D-8
Wet Soil +con (g)= (W1)	36.62	37.41	36.65	28.70	26.98
Dry Soil +con(g) = (W_2)	31.25	32.23	31.55	27.73	26.21
Mass of Con (g) = (W_3)	23.15	24.62	24.27	24.16	23.40
Weight of Moisture (g)	5.37	5.18	5.1	0.97	0.77
Dry Soil (g)	8.10	7.61	7.28	3.57	2.81
Moisture Content (%)	66	68	70	27.2	27.4
LL at 25 blow &Avg. PL	69				27.3



Experiment14.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,890	9,080	9,160	9,115	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,888	4,078	4,158	4,113	
	Wet Density (g/cm^3)	1.83	1.92	1.96	1.94	
Moisture	Container No.	10	E-7	T-3	14	19
	Wet Soil + Con. (g)	141.1	166.8	126.4	135.6	201.5
	Dry Soil +Con. (g)	125.4	145.3	111.4	116.8	186.0
	Mass of Con. (g)	40.1	41.0	44.2	40.6	40.2
	Mass of Moisture (g)	15.7	21.5	15.0	18.8	15.5
	Dry Soil (g)	85.3	104.3	67.2	76.2	145.8
	Moisture cont. (g/cm^3)	18.41	20.61	22.32	24.67	10.63
Dry Density (g/cm^3)		1.55	1.59	1.60	1.55	

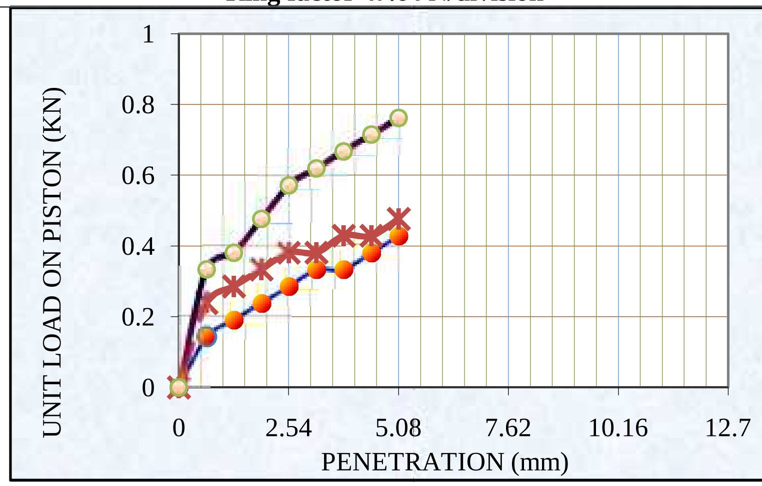


Experiment 14.4(<u>CBR)</u>

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	3.0	0.14	5.0	0.24	7.0	0.33
1.27	4.0	0.19	6.0	0.29	8.0	0.31
1.91	5.0	0.24	7.0	0.33	10.0	0.48
2.54	6.0	0.29	8.0	0.38	12.0	0.57
3.18	7.0	0.33	8.0	0.38	13.0	0.62
3.81	7.0	0.33	9.0	0.43	14.0	0.67
4.45	8.0	0.38	9.0	0.43	15.0	0.72
5.08	9.0	0.43	10.0	0.48	16.0	0.76
7.62						

Ring factor 47.64 N/division

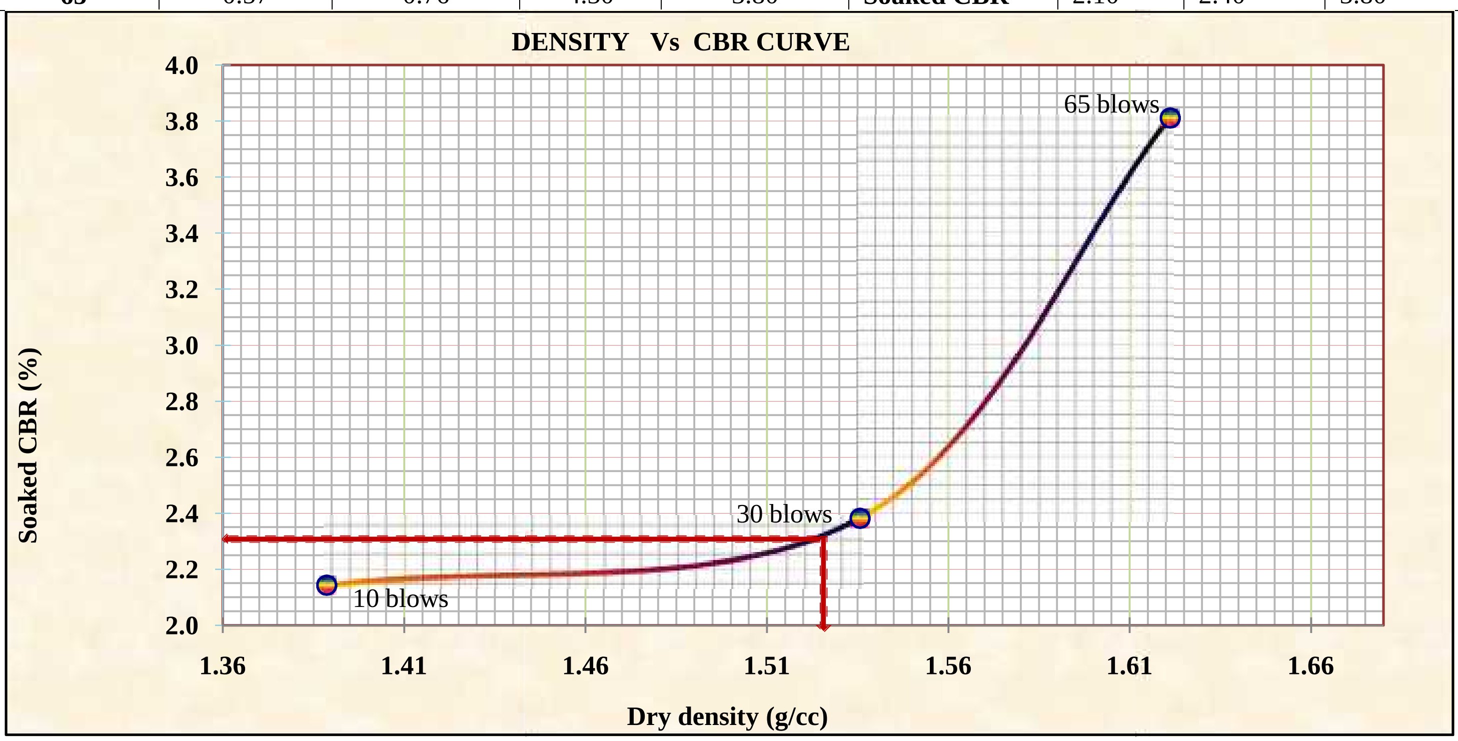


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.29	0.43	2.10	2.10
30	0.38	0.48	2.90	2.40
65	0.57	0.76	4.30	3.80

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.39	1.54	1.62
Soaked CBR	2.10	2.40	3.80

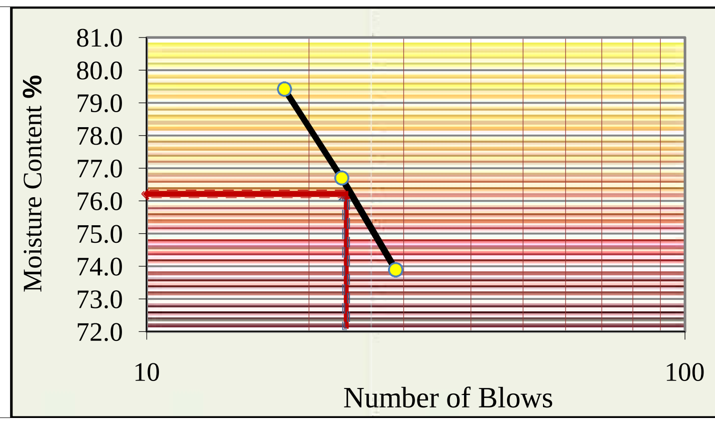


Experiment 15.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	9.22	1.0	99.0	
No.10	9.23	1.0	98.1	A-7-5(20)
No.40	21.35	2.2	95.9	
No.200	38.19	4.0	91.9	

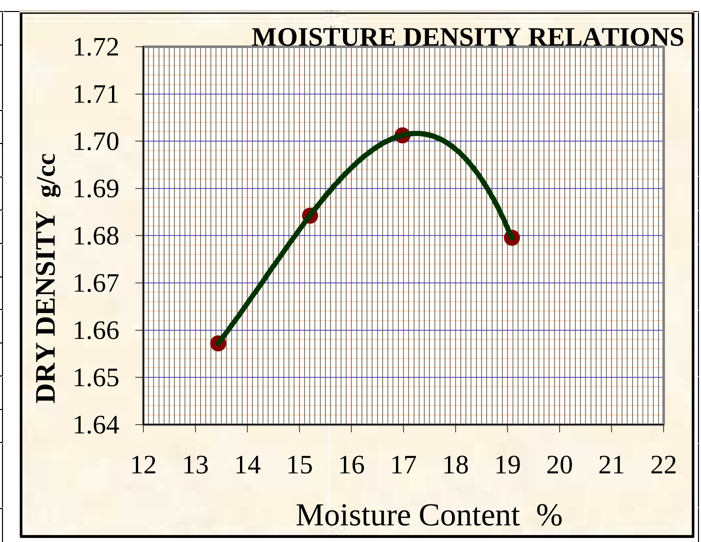
Experiment 15.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	29	23	18		
Container Number	A-11	A-8	A-4	A-12	A-6
Wet Soil +con (g)= (W1)	22.77	24.50	19.08	13.58	13.14
Dry Soil +con(g) = (W_2)	16.6	19.00	13.87	12.15	11.80
Mass of Con (g) = (W_3)	8.25	11.83	7.31	7.51	7.45
Weight of Moisture (g)	6.17	5.50	5.21	1.43	1.34
Dry Soil (g)	8.35	7.17	6.56	4.64	4.35
Moisture Content (%)	74	77	79	30.8	30.8
LL at 25 blow &Avg. PL	76				30.8



Experiment15.3 (Moisture Density Relationship of Soil

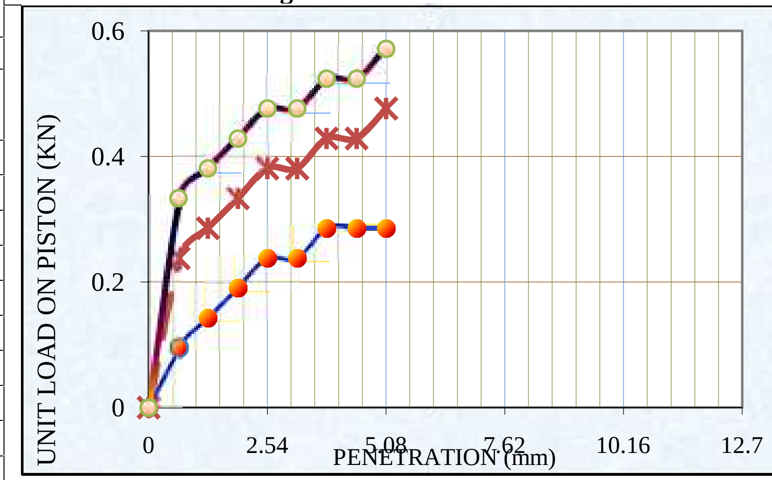
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,995	9,123	9,229	9,250	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,993	4,121	4,227	4,248	
	Wet Density (g/cm^3)	1.88	1.94	1.99	2.00	
Moisture	Container No.	B-9	B-8	B-10	A-2	B-7
	Wet Soil + Con. (g)	147.3	159.6	160.1	156.3	150.4
	Dry Soil +Con. (g)	133.4	142.3	141.2	135.5	138.2
	Mass of Con. (g)	30.0	28.5	29.9	26.5	30.0
	Mass of Moisture (g)	13.9	17.3	18.9	20.8	12.2
	Dry Soil (g)	103.4	113.8	111.3	109.0	108.2
	Moisture cont. (g/cm^3)	13.44	15.20	16.98	19.08	11.28
Dry Density (g/cm^3)		1.66	1.68	1.70	1.68	



Experiment 15.4(CBR)

Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	2.0	0.09	5.0	0.24	7.0	0.33
1.27	3.0	0.13	6.0	0.29	8.0	0.38
1.91	4.0	0.19	7.0	0.33	9.0	0.43
2.54	5.0	0.24	8.0	0.38	10.0	0.48
3.18	5.0	0.24	8.0	0.38	10.0	0.48
3.81	6.0	0.29	9.0	0.43	11.0	0.52
4.45	6.0	0.29	9.0	0.43	11.0	0.52
5.08	6.0	0.29	10.0	0.48	12.0	0.57
7.62						

Ring factor 47.64 N/division

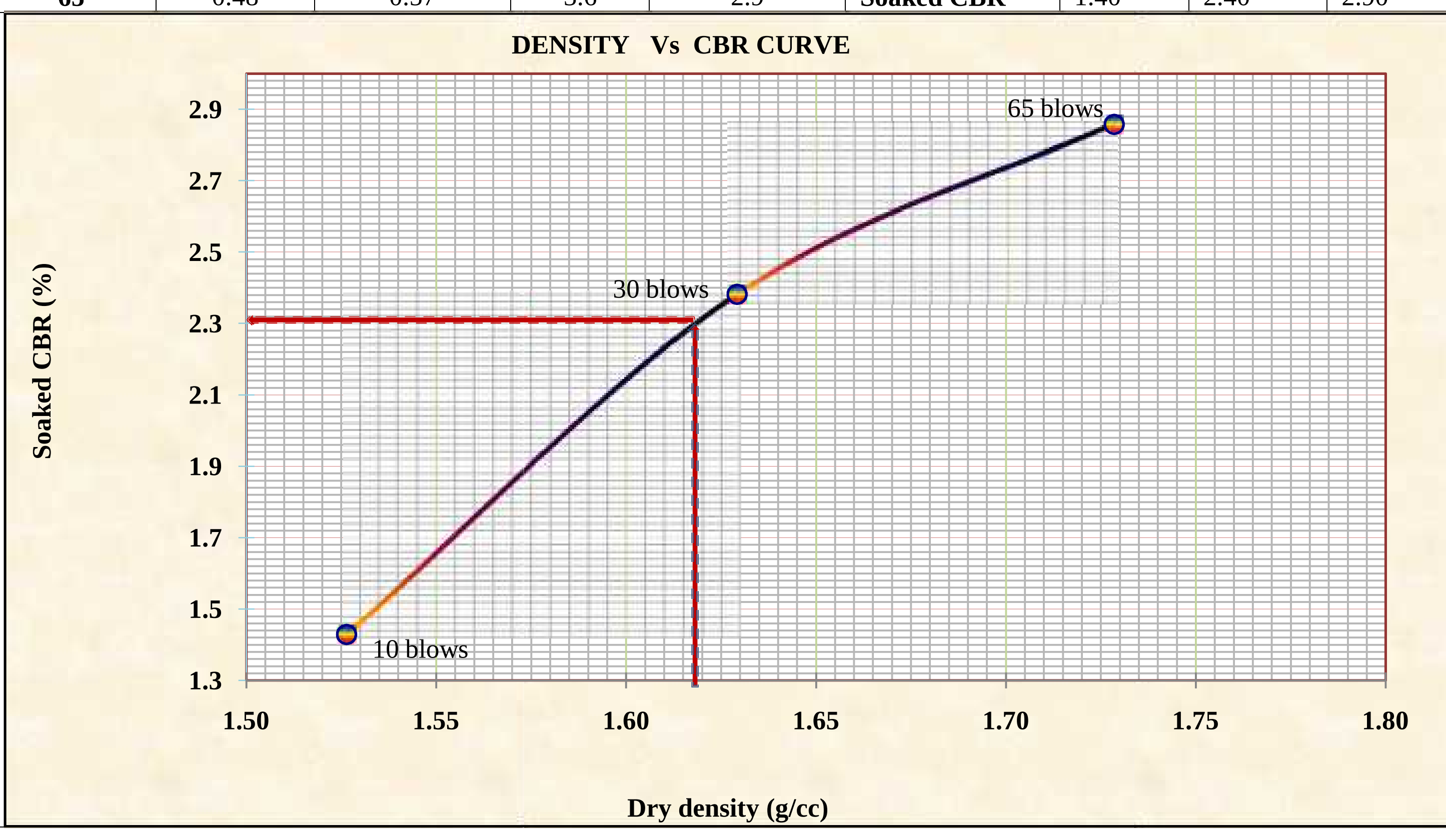


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.24	0.29	4.8	1.4
30	0.38	0.48	2.9	2.4
65	0.48	0.57	3.6	2.9

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.63	1.73
Soaked CBR	1.40	2.40	2.90

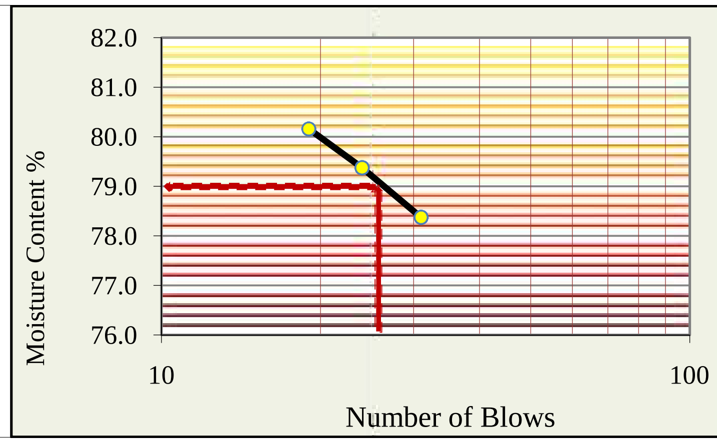


Experiment 16.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	1.5	0.1	99.9	A-7-5(20)
No.10	2.7	0.2	99.6	
No.40	3.93	0.3	99.3	
No.200	9.07	0.8	98.5	

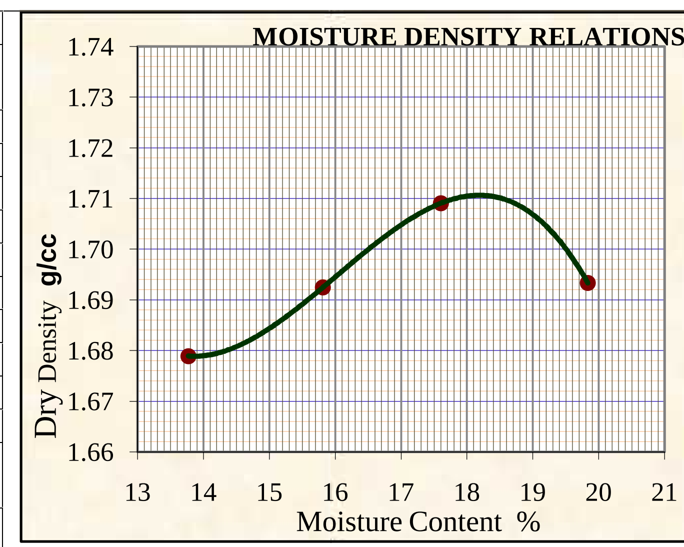
Experiment 16.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	31	24	19		
Container Number	D-1	D-6	D-8	D-9	D-2
Wet Soil +con (g)= (W1)	32.15	33.41	32.21	30.21	28.60
Dry Soil +con(g) = (W_2)	28.2	29.37	28.29	28.70	27.24
Mass of Con (g) = (W_3)	23.16	24.28	23.4	24.16	23.16
Weight of Moisture (g)	3.95	4.04	3.92	1.51	1.36
Dry Soil (g)	5.04	5.09	4.89	4.54	4.08
Moisture Content (%)	78	79	80	33.3	33.3
LL at 25 blow &Avg. PL	79				33.3



Experiment16.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	9,059	9,165	9,271	9,312	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	4,057	4,163	4,269	4,310	
	Wet Density (g/cm^3)	1.91	1.96	2.01	2.03	
Moisture	Container No.	B-8	A-6	B-7	B-4	A-5
	Wet Soil + Con. (g)	177.2	180.1	168.3	175.2	140.7
	Dry Soil +Con. (g)	159.2	160.1	147.6	151.2	128.4
	Mass of Con. (g)	28.5	33.6	30.0	30.2	27.2
	Mass of Moisture (g)	18.0	20.0	20.7	24.0	12.3
	Dry Soil (g)	130.7	126.5	117.6	121.0	101.2
	Moisture cont. (g/cm^3)	13.77	15.81	17.60	19.83	12.15
Dry Density (g/cm^3)		1.68	1.69	1.71	1.69	

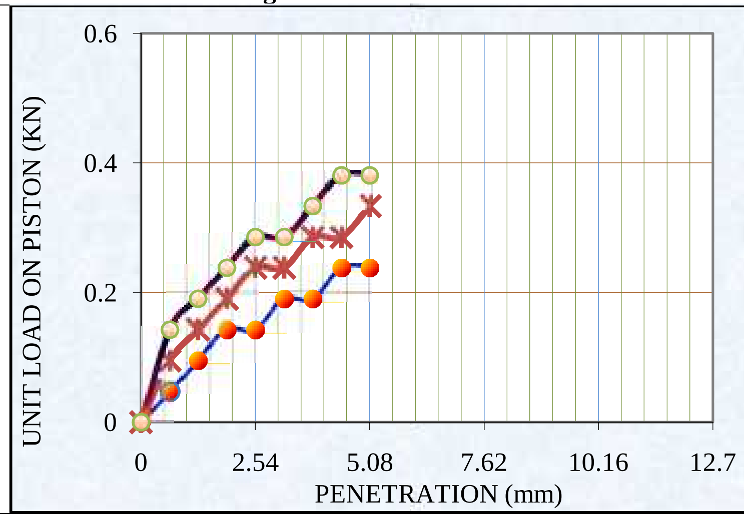


Experiment 16.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	1.0	0.05	2.0	0.09	3.0	0.14
1.27	2.0	0.09	3.0	0.14	4.0	0.19
1.91	3.0	0.14	4.0	0.19	5.0	0.24
2.54	3.0	0.14	5.0	0.24	6.0	0.29
3.18	4.0	0.19	5.0	0.24	6.0	0.29
3.81	4.0	0.19	6.0	0.29	7.0	0.3
4.45	5.0	0.24	6.0	0.29	8.0	0.38
5.08	5.0	0.24	7.0	0.33	8.0	0.38
7.62						

Ring factor 47.64 N/division

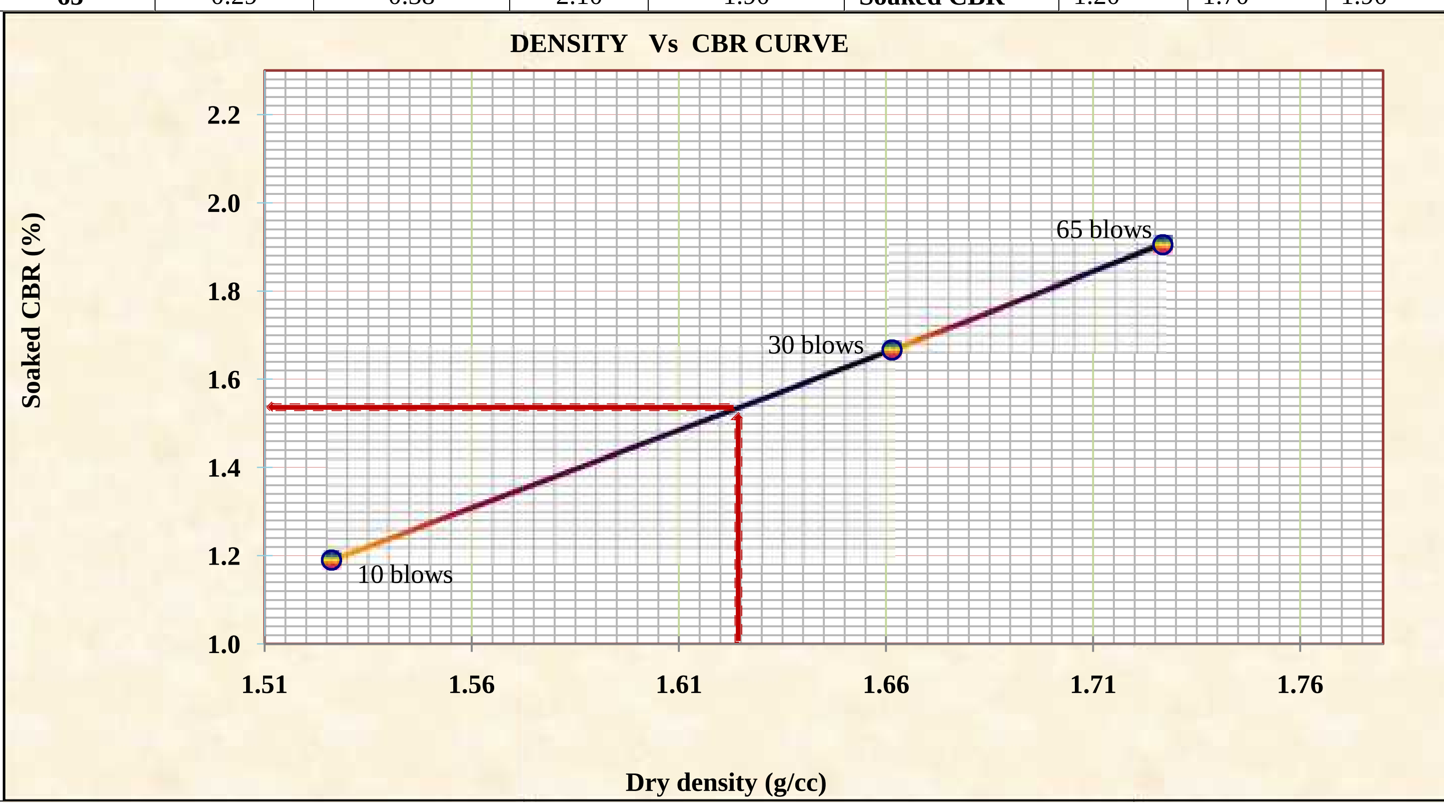


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.14	0.24	1.10	1.20
30	0.24	0.33	1.80	1.70
65	0.29	0.38	2.10	1.90

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.66	1.73
Soaked CBR	1.20	1.70	1.90

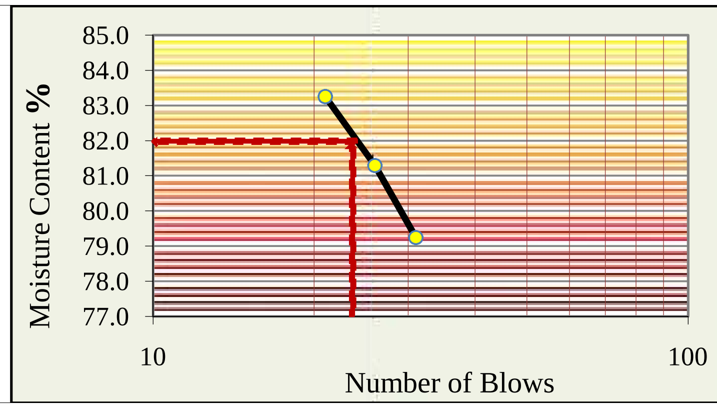


Experiment 17.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	23.29	2.2	97.8	A-7-5(20)
No.10	13.16	1.3	96.5	
No.40	4.5	0.4	96.1	
No.200	14.0	1.3	94.7	

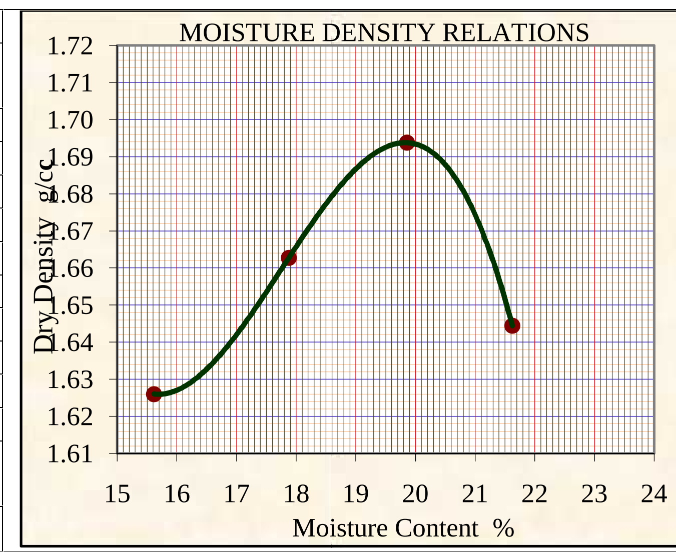
Experiment 17.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	31	26	21		
Container Number	A-6	A-7	A-2	A-9	A-1
Wet Soil +con (g)= (W1)	24.21	25.08	23.11	11.90	12.90
Dry Soil +con(g) = (W_2)	16.8	17.43	16.30	10.65	11.65
Mass of Con (g) = (W_3)	7.45	8.02	8.12	6.78	7.82
Weight of Moisture (g)	7.41	7.65	6.81	1.25	1.25
Dry Soil (g)	9.35	9.41	8.18	3.87	3.83
Moisture Content (%)	79	81	83	32.3	32.6
LL at 25 blow &Avg. PL	82				32.5



Experiment17.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,995	9,165	9,314	9,250	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,993	4,163	4,312	4,248	
	Wet Density (g/cm^3)	1.88	1.96	2.03	2.00	
Moisture	Container No.	A-4	F-2	E-7	B-14	B-5
	Wet Soil + Con. (g)	151.3	160.9	159.9	180.2	167.2
	Dry Soil +Con. (g)	135.4	142.7	140.2	155.7	153.7
	Mass of Con. (g)	33.6	40.9	41.0	42.4	34.3
	Mass of Moisture (g)	15.9	18.2	19.7	24.5	13.5
	Dry Soil (g)	101.8	101.8	99.2	113.3	119.4
	Moisture cont. (g/cm^3)	15.62	17.88	19.86	21.62	11.31
Dry Density (g/cm^3)		1.63	1.66	1.69	1.64	

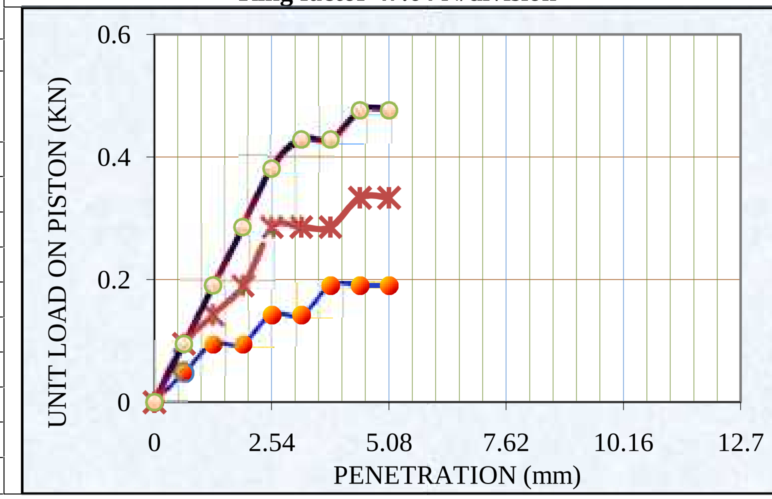


Experiment 17.4(<u>CBR</u>)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	1.0	0.05	2.0	0.10	4.0	0.19
1.27	2.0	0.10	3.0	0.14	5.0	0.24
1.91	2.0	0.10	4.0	0.19	6.0	0.29
2.54	3.0	0.14	5.0	0.24	7.0	0.33
3.18	3.0	0.14	5.0	0.24	7.0	0.33
3.81	4.0	0.19	5.0	0.24	8.0	0.38
4.45	4.0	0.19	6.0	0.29	8.0	0.38
5.08	4.0	0.19	6.0	0.29	9.0	0.43
7.62						

Ring factor 47.64 N/division

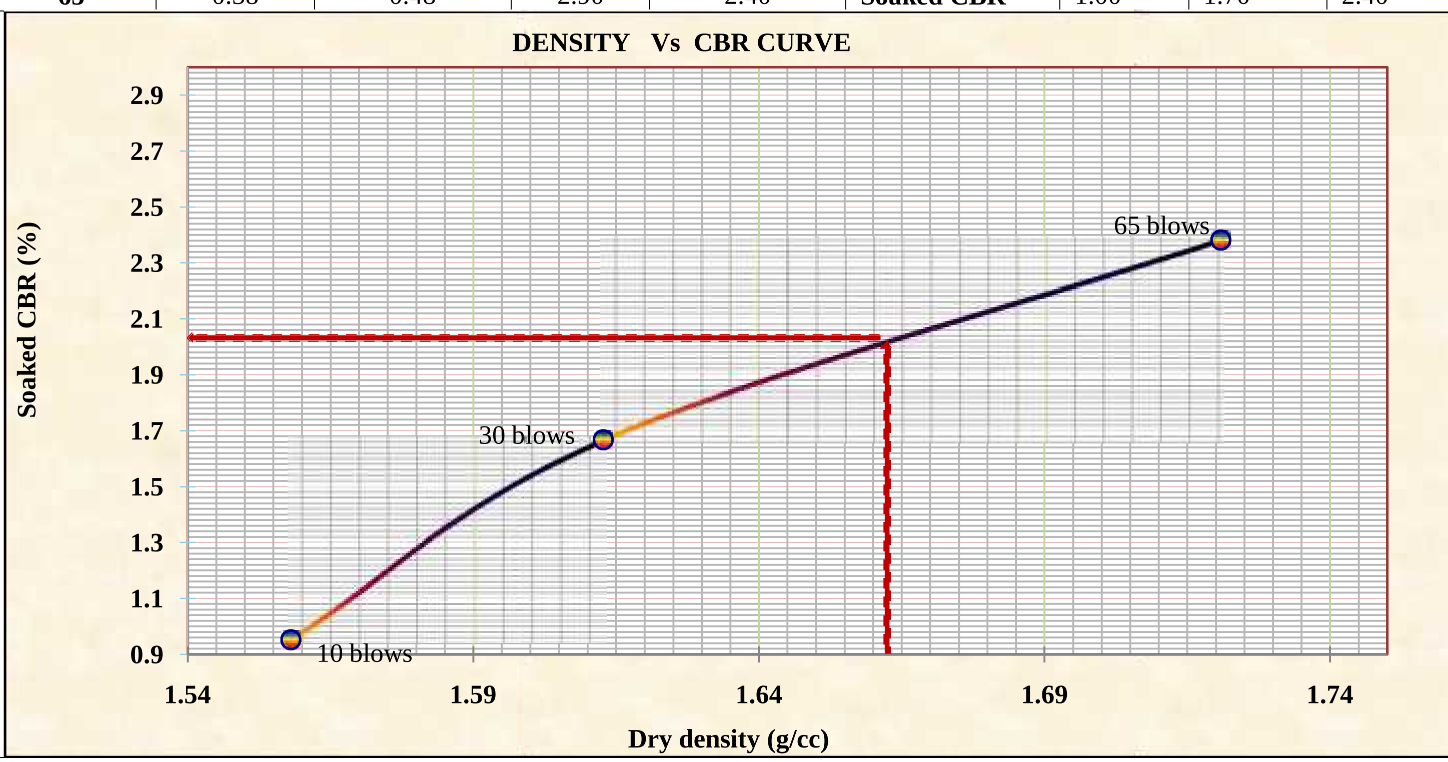


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.14	0.19	1.10	1.0
30	0.29	0.33	2.10	1.70
65	0.38	0.48	2.90	2.40

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.56	1.61	1.72
Soaked CBR	1.00	1.70	2.40

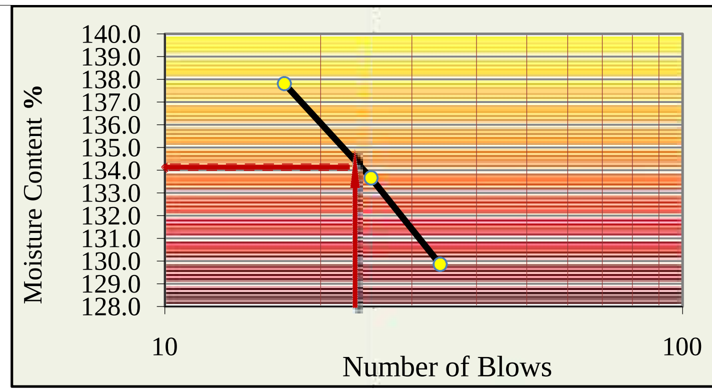


Experiment 18.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	2.41	0.3	99.7	A-7-5(20)
No.10	7.58	0.9	98.8	
No.40	34.75	4.0	94.8	
No.200	63.66	7.4	87.5	

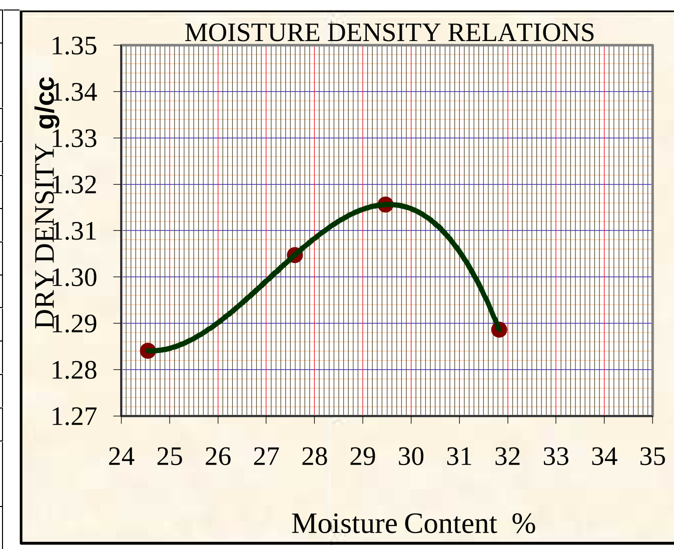
Experiment 18.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	34	25	17		
Container Number	A-12	A-9	A-7	A-1	A-11
Wet Soil +con (g)= (W1)	15.21	16.37	16.32	11.73	12.17
Dry Soil +con(g) = (W_2)	10.86	10.89	11.51	10.52	10.96
Mass of Con (g) = (W_3)	7.51	6.79	8.02	7.83	8.25
Weight of Moisture (g)	4.35	5.48	4.81	1.21	1.21
Dry Soil (g)	3.35	4.10	3.49	2.69	2.71
Moisture Content (%)	130	134	138	45.0	44.6
LL at 25 blow &Avg. PL	134				44.75



Experiment18.3 (Moisture Density Relationship of Soil

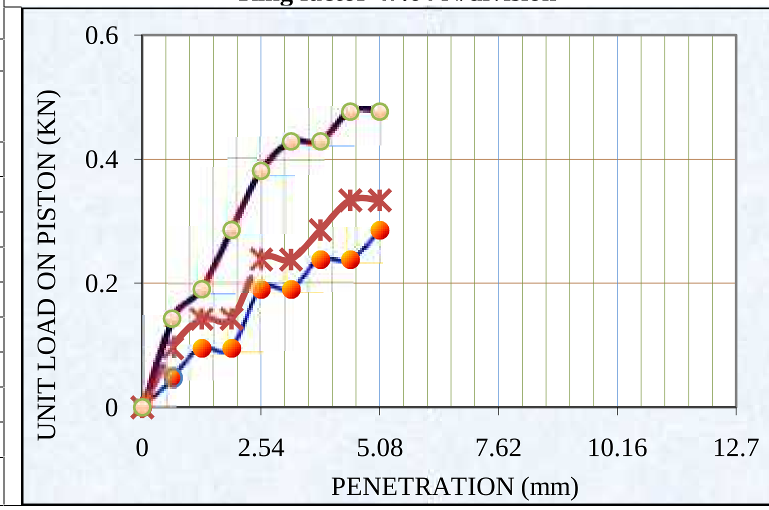
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,399	8,538	8,620	8,610	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,397	3,536	3,618	3,608	
	Wet Density (g/cm^3)	1.60	1.66	1.70	1.70	
Moisture	Container No.	B-1	A-6	A-3	B-10	A-1
	Wet Soil + Con. (g)	163.7	141.4	146.1	134.6	143.4
	Dry Soil +Con. (g)	137.6	118.0	120.4	109.3	125.0
	Mass of Con. (g)	31.3	33.2	33.2	29.8	34.0
	Mass of Moisture (g)	26.1	23.4	25.7	25.3	18.4
	Dry Soil (g)	106.3	84.8	87.2	79.5	91.0
	Moisture cont. (g/cm^3)	24.55	27.59	29.47	31.82	20.22
Dry Density (g/cm^3)		1.28	1.30	1.32	1.29	



Experiment 18.4(CBR)

Penetration data						
Penetration (mm)	**10 Blows**		**30 Blows**		**65Blows**	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	1.0	0.05	2.0	0.10	3.0	0.14
1.27	2.0	0.10	3.0	0.14	4.0	0.19
1.91	2.0	0.10	3.0	0.14	6.0	0.29
2.54	4.0	0.19	5.0	0.24	8.0	0.38
3.18	4.0	0.19	5.0	0.24	9.0	0.43
3.81	5.0	0.24	6.0	0.29	9.0	0.43
4.45	5.0	0.24	7.0	0.33	10.0	0.48
5.08	6.0	0.29	7.0	0.33	10.0	0.48
7.62						

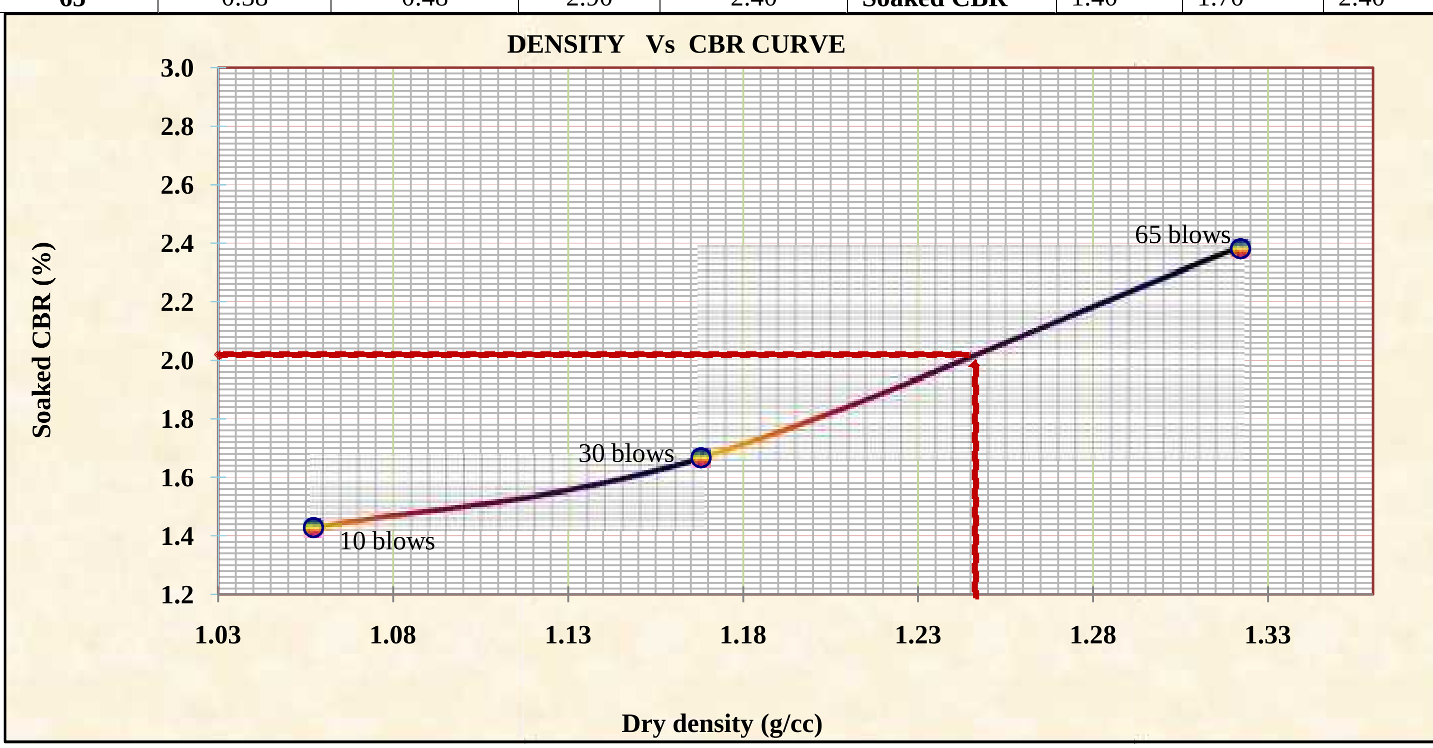
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	**Load (KN)**		**CBR (%)**	
	2.57 mm	**5.08mm**	**2.57 mm**	**5.08mm**
10	0.19	0.29	1.40	1.40
30	0.24	0.33	1.80	1.70
65	0.38	0.48	2.90	2.40

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.06	1.17	1.32
Soaked CBR	1.40	1.70	2.40

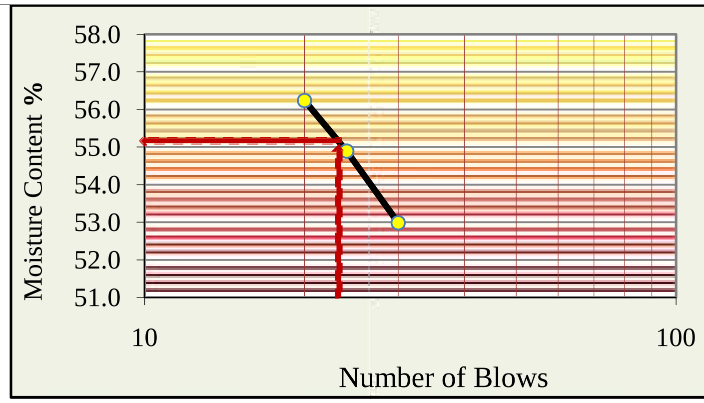


Experiment 19.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	0.21	0.0	100.0	A-7-6(19)
No.10	50.9	5.0	95.0	
No.40	44.54	4.4	90.6	
No.200	75.97	7.5	83.1	

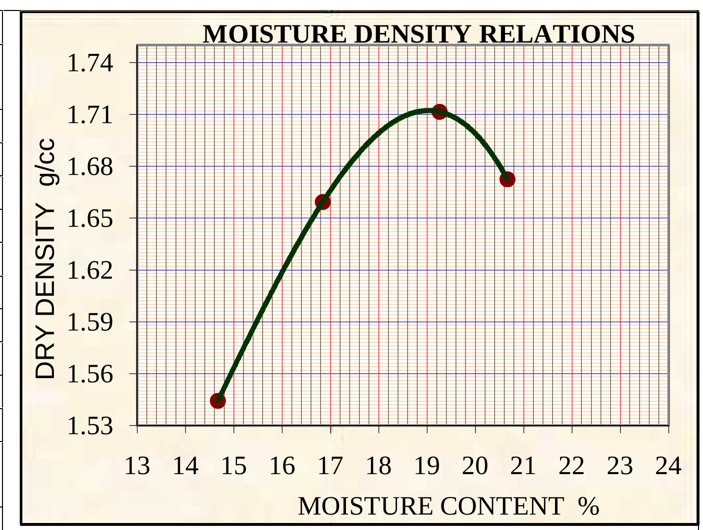
Experiment 19.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	24	20		
Container Number	A-5	A-8	A-4	A-10	A-2
Wet Soil +con (g)= (W1)	17.58	21.34	17.84	12.59	13.00
Dry Soil +con(g) = (W_2)	14.29	17.97	14.05	11.71	12.06
Mass of Con (g) = (W_3)	8.08	11.83	7.31	8.01	8.10
Weight of Moisture (g)	3.29	3.37	3.79	0.88	0.94
Dry Soil (g)	6.21	6.14	6.74	3.70	3.96
Moisture Content (%)	53	55	56	23.8	23.7
LL at 25 blow &Avg. PL	55				23.8



Experiment19.3 (Moisture Density Relationship of Soil

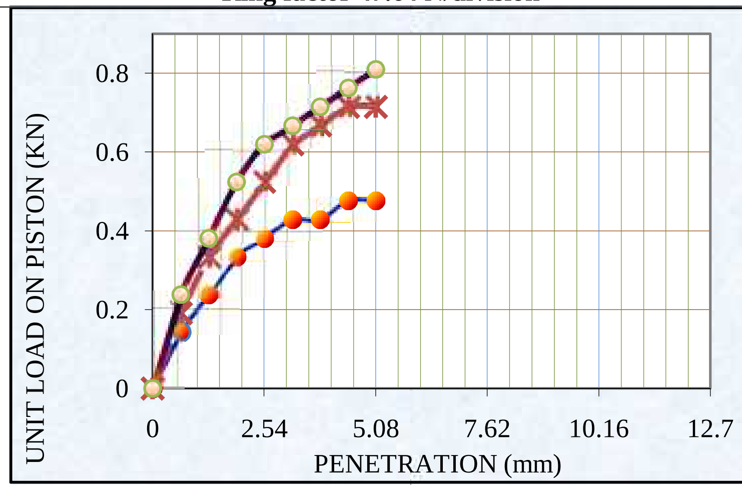
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,763	9,120	9,337	9,288	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,761	4,118	4,335	4,286	
	Wet Density (g/cm^3)	1.77	1.94	2.04	2.02	
Moisture	Container No.	B-5	19	28	61	10
	Wet Soil + Con. (g)	183.6	206.0	182.6	163.6	214.0
	Dry Soil +Con. (g)	164.5	182.1	159.7	143.0	196.4
	Mass of Con. (g)	34.3	40.2	40.8	43.3	40.1
	Mass of Moisture (g)	19.1	23.9	22.9	20.6	17.6
	Dry Soil (g)	130.2	141.9	118.9	99.7	156.3
	Moisture cont. (g/cm^3)	14.67	16.84	19.26	20.66	11.26
Dry Density (g/cm^3)		1.54	1.66	1.71	1.67	



Experiment 19.4(CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	3.0	0.14	4.0	0.19	5.0	0.24
1.27	5.0	0.24	7.0	0.33	8.0	0.38
1.91	7.0	0.33	9.0	0.43	11.0	0.52
2.54	8.0	0.38	11.0	0.52	13.0	0.62
3.18	9.0	0.43	13.0	0.62	14.0	0.67
3.81	9.0	0.43	14.0	0.67	15.0	0.72
4.45	10.0	0.48	15.0	0.72	16.0	0.76
5.08	10.0	0.48	15.0	0.72	17.0	0.81
7.62						

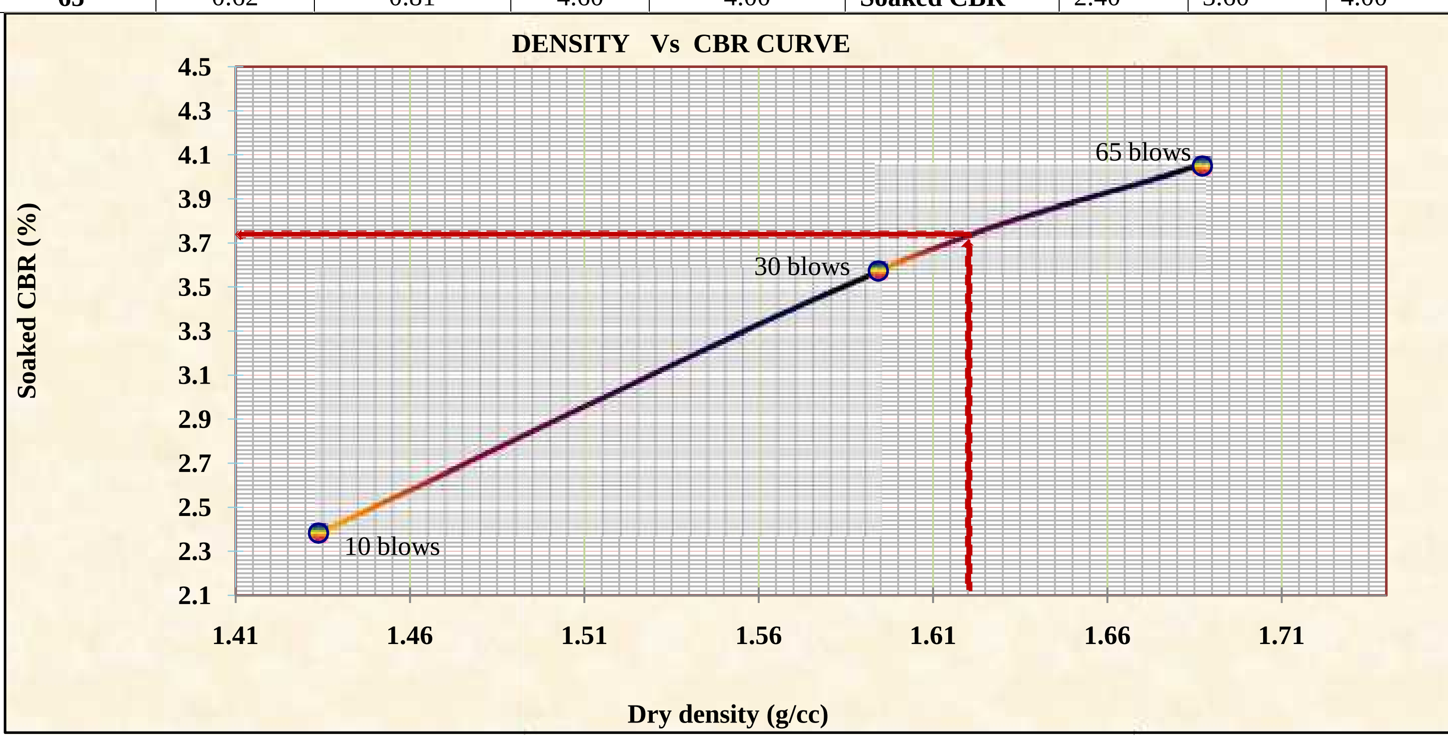
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.38	0.48	2.90	2.40
30	0.52	0.71	3.90	3.60
65	0.62	0.81	4.60	4.00

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.43	1.59	1.69
Soaked CBR	2.40	3.60	4.00

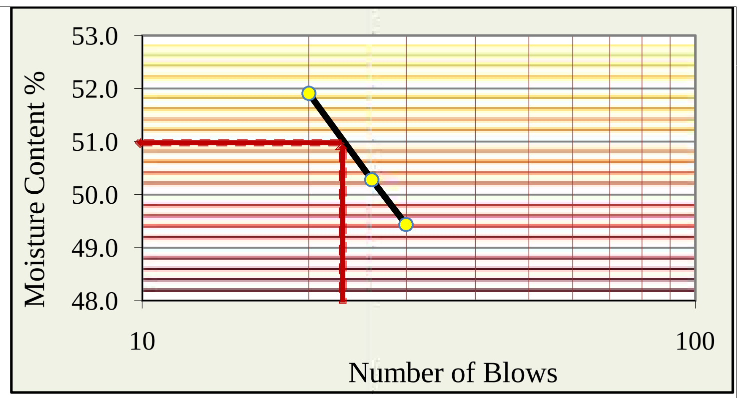


Experiment 20.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	59.37	6.5	93.5	A-7-6(17)
No.10	82.77	9.0	84.5	
No.40	59.98	6.6	77.9	
No.200	100.98	11.0	66.9	

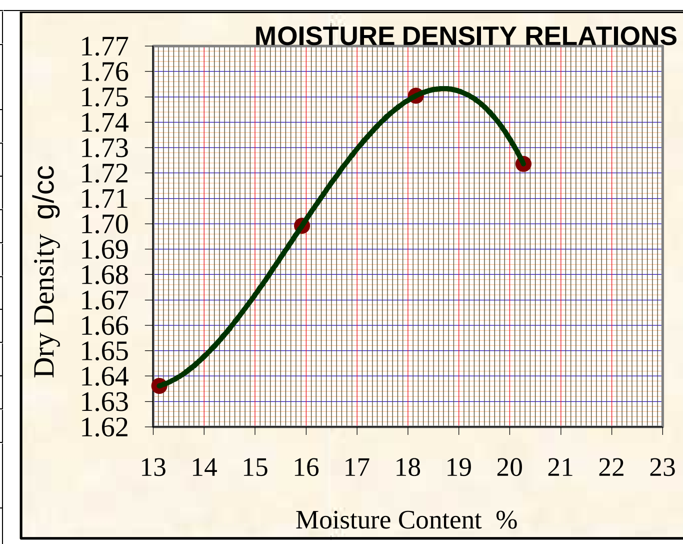
Experiment 20.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	26	20		
Container Number	A-5	A-4	A-2	A-8	A-11
Wet Soil +con (g)= (W1)	17.44	17.83	18.06	15.98	12.34
Dry Soil +con(g) = (W_2)	14.34	14.31	14.66	15.20	11.58
Mass of Con (g) = (W_3)	8.07	7.31	8.11	11.84	8.25
Weight of Moisture (g)	3.10	3.52	3.4	0.78	0.76
Dry Soil (g)	6.27	7.00	6.55	3.36	3.33
Moisture Content (%)	49	50	52	23.2	22.8
LL at 25 blow &Avg. PL	51			23	



Experiment20.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8,933	9,186	9,395	9,405	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3,931	4,184	4,393	4,403	
	Wet Density (g/cm^3)	1.85	1.97	2.07	2.07	
Moisture	Container No.	B-2	E-7	T-3	B-14	Z-1
	Wet Soil + Con. (g)	215.7	204.8	180.2	193.7	179.3
	Dry Soil +Con. (g)	195.3	182.3	159.3	168.2	165.7
	Mass of Con. (g)	39.8	41.0	44.2	42.4	41.4
	Mass of Moisture (g)	20.4	22.5	20.9	25.5	13.6
	Dry Soil (g)	155.5	141.3	115.1	125.8	124.3
	Moisture cont. (g/cm^3)	13.12	15.92	18.16	20.27	10.94
Dry Density (g/cm^3)		1.64	1.70	1.75	1.72	

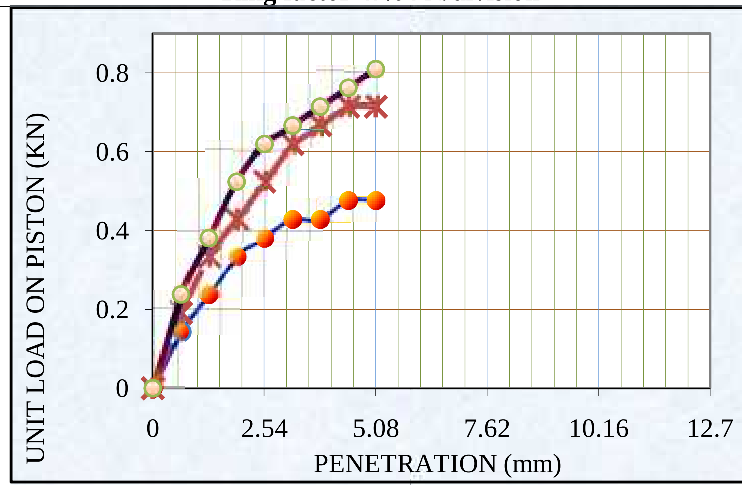


Experiment 20.4(CBR)

Penetration data

Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	4.0	0.19	6.0	0.29	7.0	0.33
1.27	5.0	0.24	7.0	0.33	9.0	0.43
1.91	7.0	0.33	9.0	0.43	11.0	0.52
2.54	8.0	0.38	9.0	0.43	12.0	0.57
3.18	8.0	0.38	11.0	0.52	14.0	0.67
3.81	9.0	0.43	11.0	0.52	15.0	0.75
4.45	9.0	0.43	12.0	0.57	16.0	0.76
5.08	10.0	0.48	13.0	0.62	17.0	0.81
7.62						

Ring factor 47.64 N/division

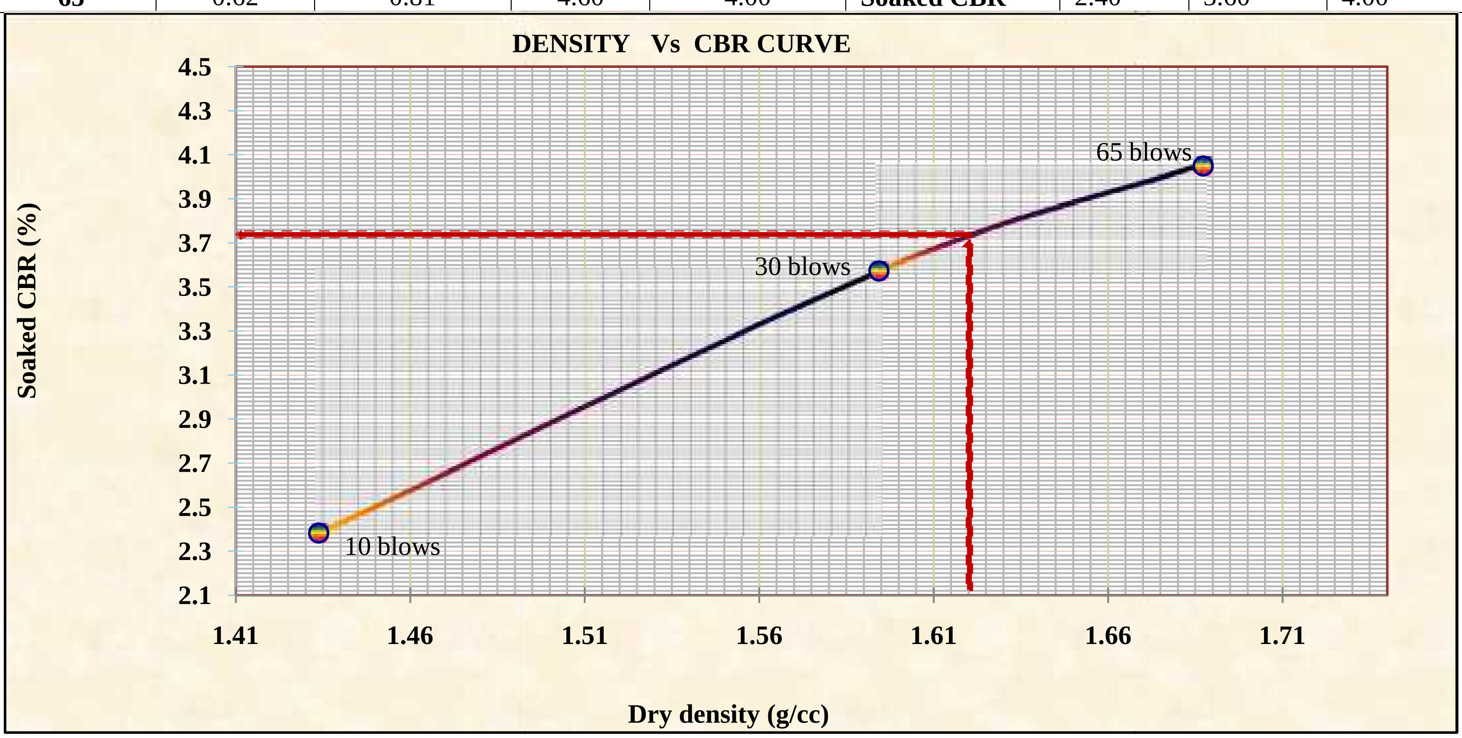


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.38	0.48	2.90	2.40
30	0.52	0.71	3.90	3.60
65	0.62	0.81	4.60	4.00

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.43	1.59	1.69
Soaked CBR	2.40	3.60	4.00

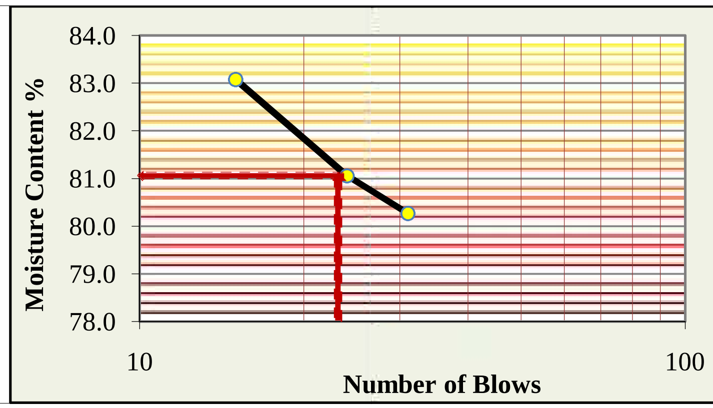


Experiment 21.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	63.49	6.4	93.6	A-7-6(20)
No.10	62.34	6.3	87.3	
No.40	80.03	8.1	79.2	
No.200	89.85	9.1	70.2	

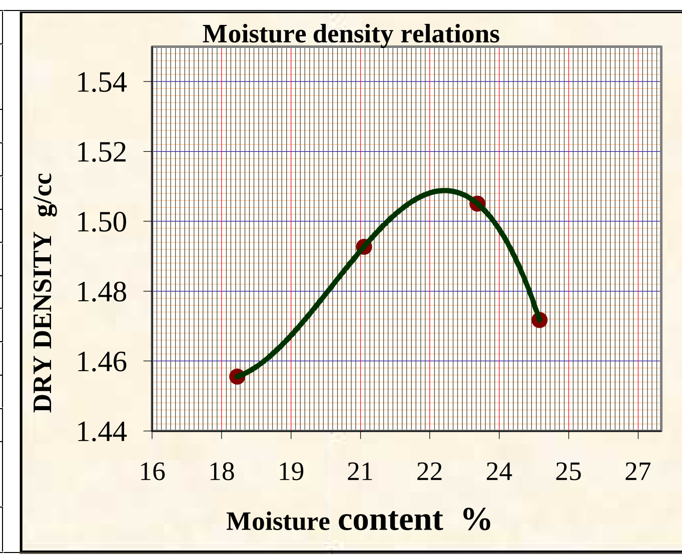
Experiment 21.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	31	24	15		
Container Number	A-11	A-4	A-10	A-2	A-12
Wet Soil +con (g)= (W1)	16.47	15.53	16.22	12.05	11.77
Dry Soil +con(g) = (W_2)	12.81	11.85	12.49	11.12	10.77
Mass of Con (g) = (W_3)	8.25	7.31	8.00	8.12	7.51
Weight of Moisture (g)	3.66	3.68	3.73	0.93	1.00
Dry Soil (g)	4.56	4.54	4.49	3.00	3.26
Moisture Content (%)	80	81	83	31.00	30.70
LL at 25 blow &Avg. PL	81				30.8



Experiment21.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8645	8825	8935	8890	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3643	3823	3933	3888	
	Wet Density (g/cm^3)	1.72	1.80	1.85	1.83	
Moisture	Container No.	B-7	Z-1	B-10	A-5	B-14
	Wet Soil + Con. (g)	154.2	166.8	143.6	141.4	174
	Dry Soil +Con. (g)	135.4	145.4	122.3	119	158
	Mass of Con. (g)	30	41.4	29.8	27.1	43
	Mass of Moisture (g)	18.8	21.4	21.3	22.4	16
	Dry Soil (g)	105.4	104	92.5	91.9	115
	Moisture cont. (g/cm^3)	17.84	20.58	23.03	24.37	13.9
Dry Density (g/cm^3)		1.46	1.49	1.51	1.47	

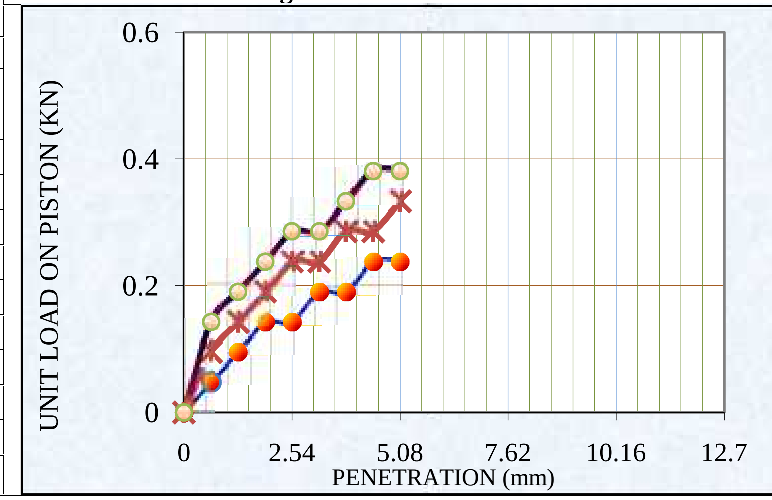


Experiment 21.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division

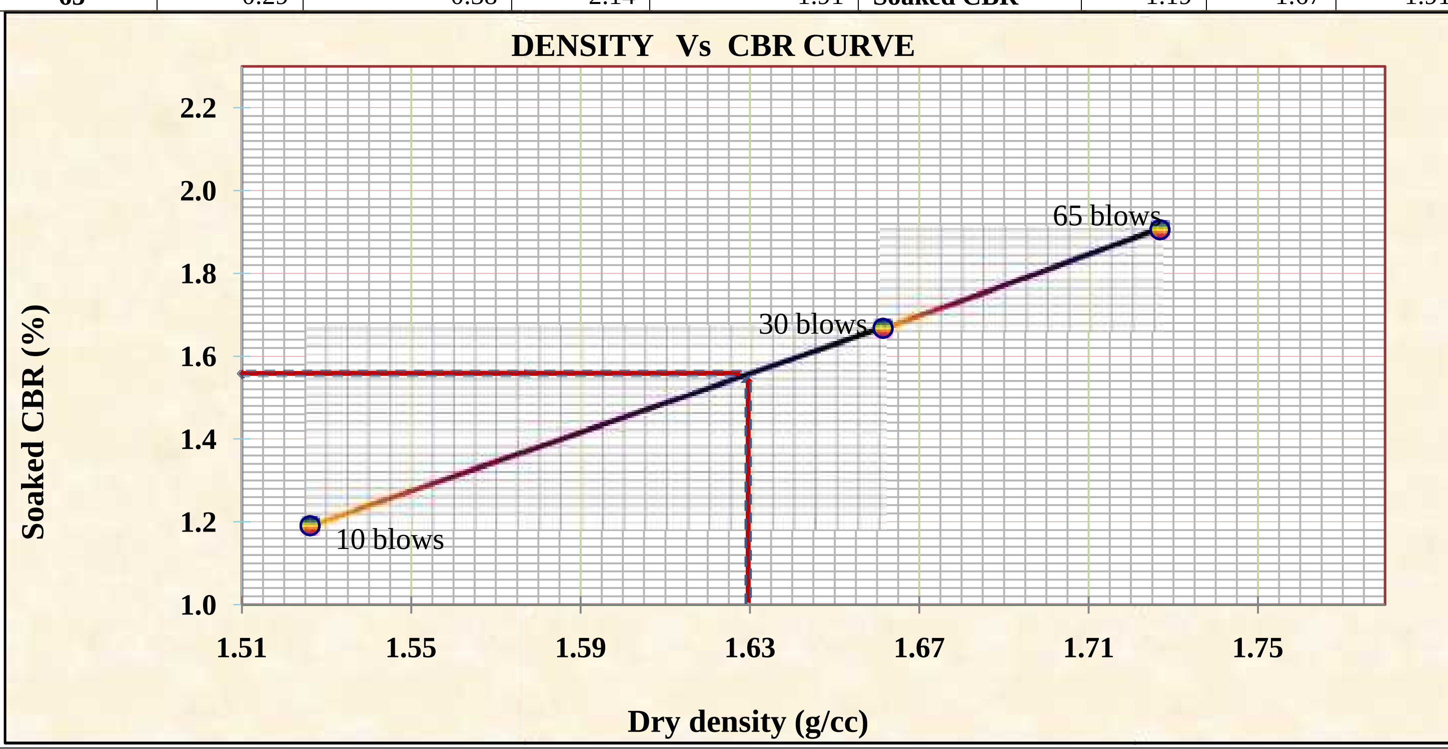


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91

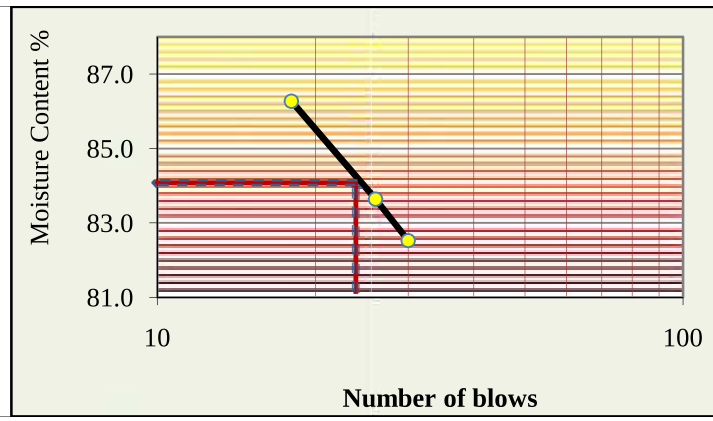


Experiment 22.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	219.2	18.67	81.33	
No.10	220.78	18.81	62.52	A-7-5(20)
No.40	96.41	8.21	54.31	
No.200	118.33	10.08	44.23	

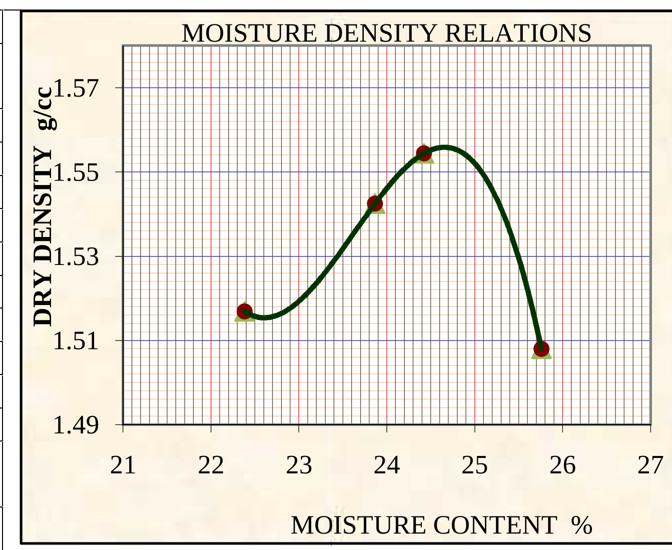
Experiment 22.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	26	18		
Container Number	D-10	D-5	D-9	A-3	A-4
Wet Soil +con (g)= (W1)	38.77	40.09	33.25	13.77	11.45
Dry Soil +con(g) = (W_2)	34.66	35.95	29.04	12.93	10.71
Mass of Con (g) = (W_3)	29.68	31	24.16	9.14	7.3
Weight of Moisture (g)	4.11	4.14	4.21	0.84	0.74
Dry Soil (g)	4.98	4.95	4.88	3.79	3.41
Moisture Content (%)	82.5	83.64	86.27	22.16	21.70
LL at 25 blow &Avg. PL	84			21.9	



Experiment22.3 (Moisture Density Relationship of Soil

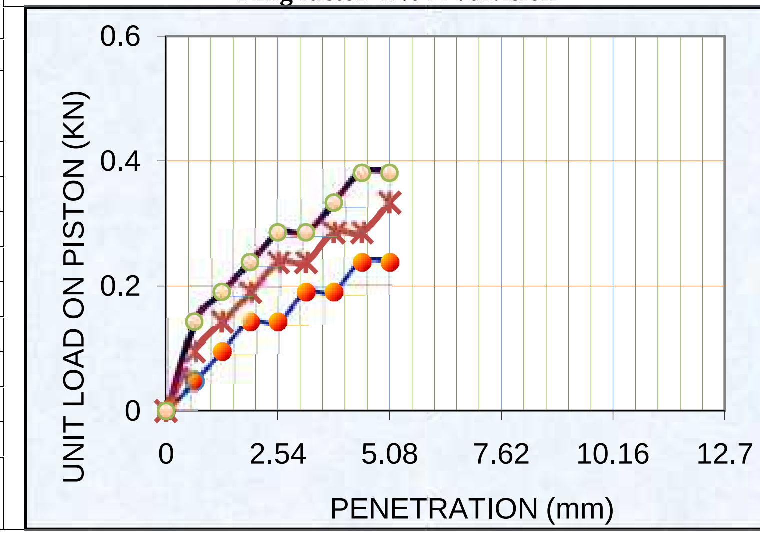
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8945	9060	9110	9030	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3943	4058	4108	4028	
	Wet Density (g/cm^3)	1.856	1.911	1.934	1.896	
Moisture	Container No.	13	28	I	E-1	B-14
	Wet Soil + Con. (g)	151	170.2	166.3	168.4	174
	Dry Soil +Con. (g)	130.7	145.5	141.9	142.1	158
	Mass of Con. (g)	40	42	42	40	43
	Mass of Moisture (g)	20.3	24.7	24.4	26.3	16
	Dry Soil (g)	90.7	103.5	99.9	102.1	115
	Moisture cont. (g/cm^3)	22.38	23.86	24.42	25.76	13.91
Dry Density (g/cm^3)		1.52	1.54	1.55	1.51	



Experiment 22.4(CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division

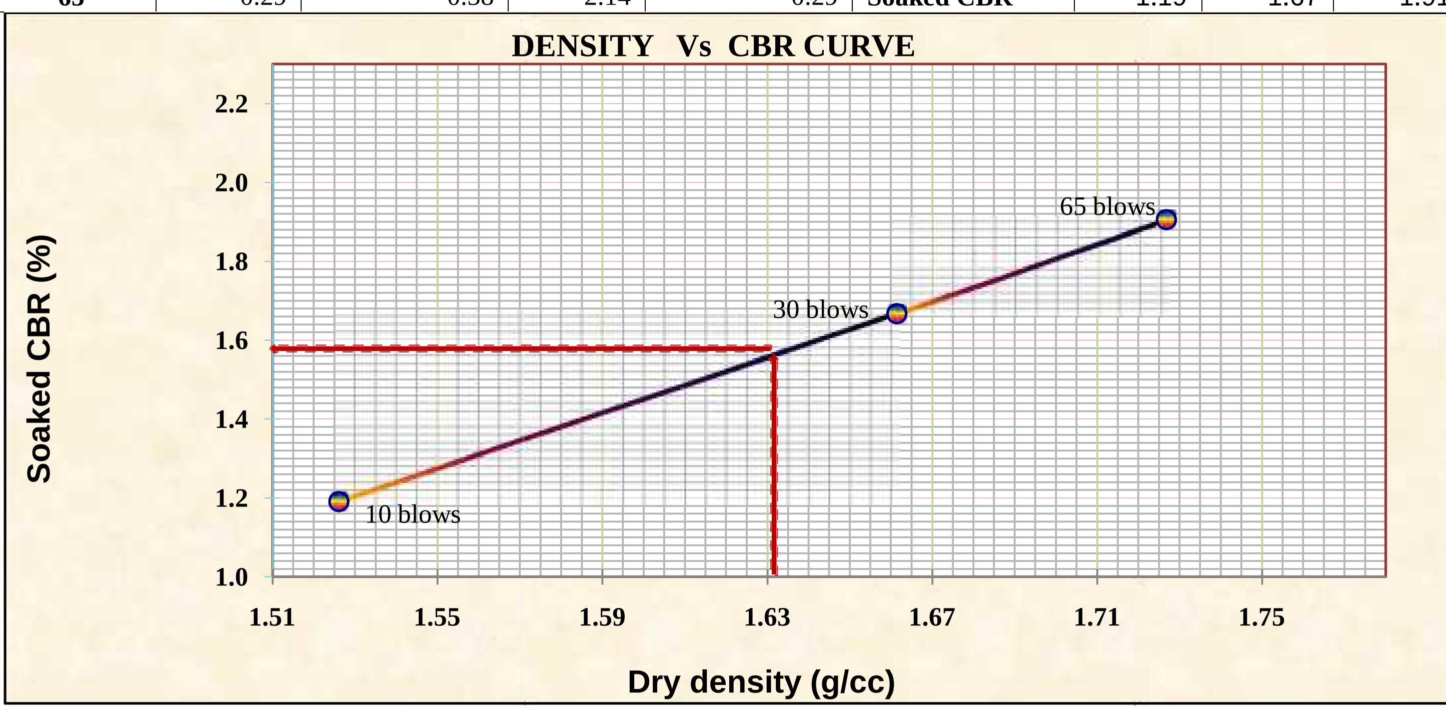


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.14	0.24	1.07	0.14
30	0.24	0.33	1.79	0.24
65	0.29	0.38	2.14	0.29

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91

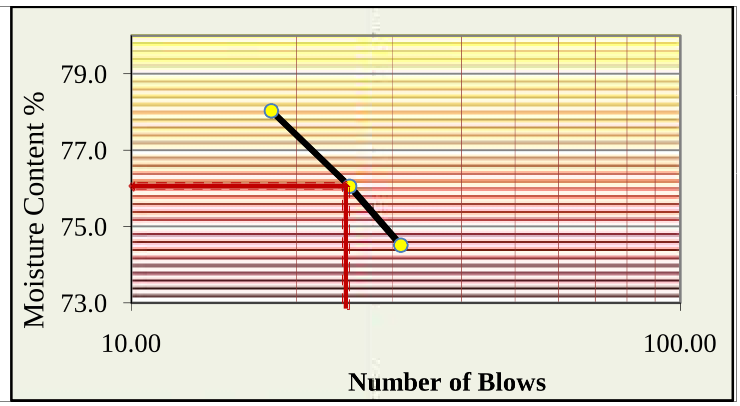


Experiment 23.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	0.75	0.07	99.93	A-7-5(20)
No.10	27.03	2.61	97.32	
No.40	14.91	1.44	95.88	
No.200	36.31	3.50	92.38	

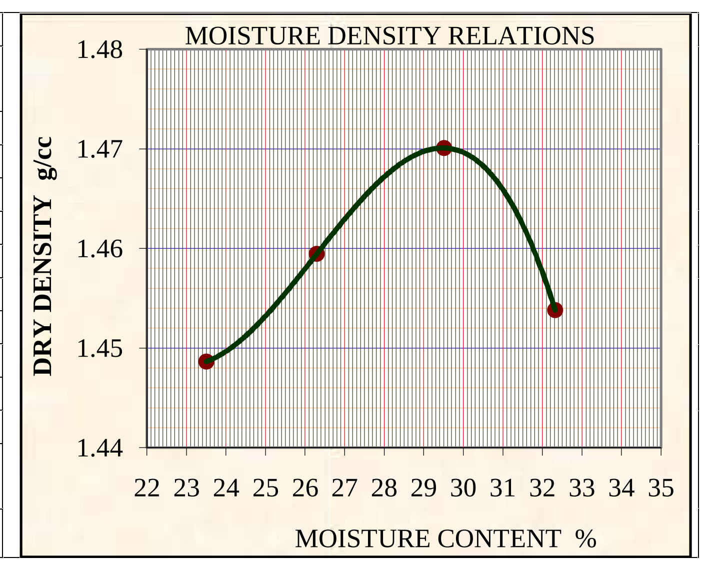
Experiment 23.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	31	25	18		
Container Number	A-10	A-11	A-8	A-6	A-9
Wet Soil +con (g)= (W1)	15.95	16.19	19.78	10.99	10.66
Dry Soil +con(g) = (W_2)	12.56	12.76	16.3	10.15	9.75
Mass of Con (g) = (W_3)	8.01	8.25	11.84	7.46	6.79
Weight of Moisture (g)	3.39	3.43	3.48	0.84	0.91
Dry Soil (g)	4.55	4.51	4.46	2.69	2.96
Moisture Content (%)	74.51	76.05	78.03	31.23	30.74
LL at 25 blow &Avg. PL	76				31



Experiment23.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8560	8675	8804	8846	
	Mold (gm)	4760	4760	4760	4760	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3800	3915	4044	4086	
	Wet Density (g/cm^3)	1.79	1.84	1.90	1.92	
Moisture	Container No.	B-2	A-2	A-3	B-8	B-14
	Wet Soil + Con. (g)	156	160.5	150.9	137.8	174
	Dry Soil +Con. (g)	131.7	132.6	124.1	111.1	158
	Mass of Con. (g)	28.3	26.5	33.3	28.5	43
	Mass of Moisture (g)	24.3	27.9	26.8	26.7	16
	Dry Soil (g)	103.4	106.1	90.8	82.6	115
	Moisture cont. (g/cm^3)	23.50	26.30	29.52	32.32	13.91
Dry Density (g/cm^3)		1.45	1.46	1.47	1.45	

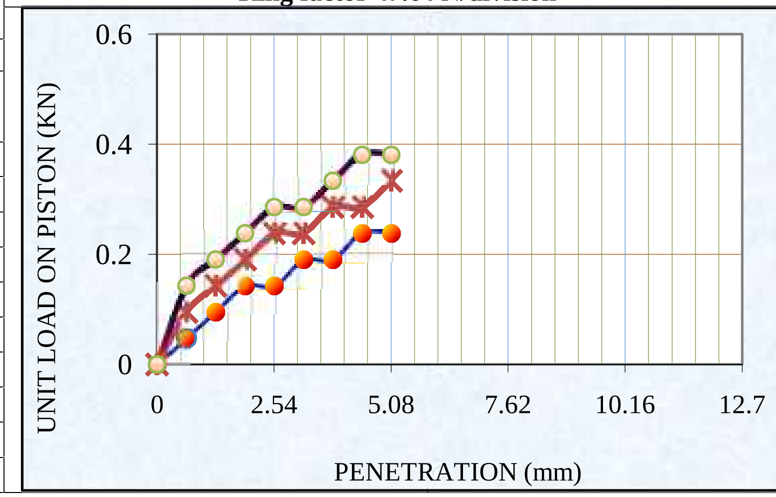


Experiment 23.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division

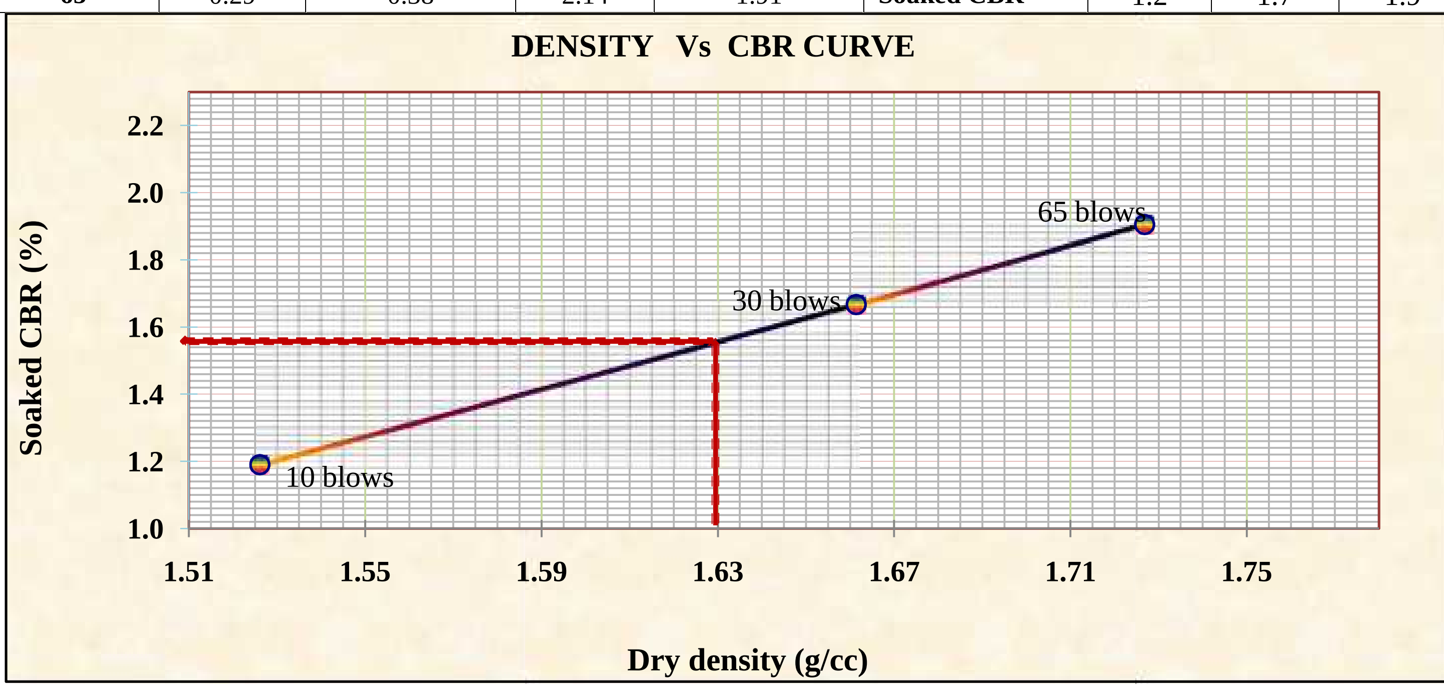


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.66	1.73
Soaked CBR	1.2	1.7	1.9

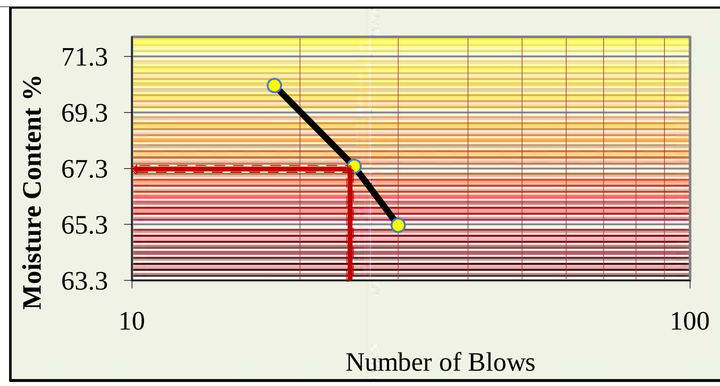


Experiment 24.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	8.79	0.82	99.18	A-7-6(16)
No.10	19.39	1.80	97.38	
No.40	11.52	1.07	96.31	
No.200	29.85	2.78	93.53	

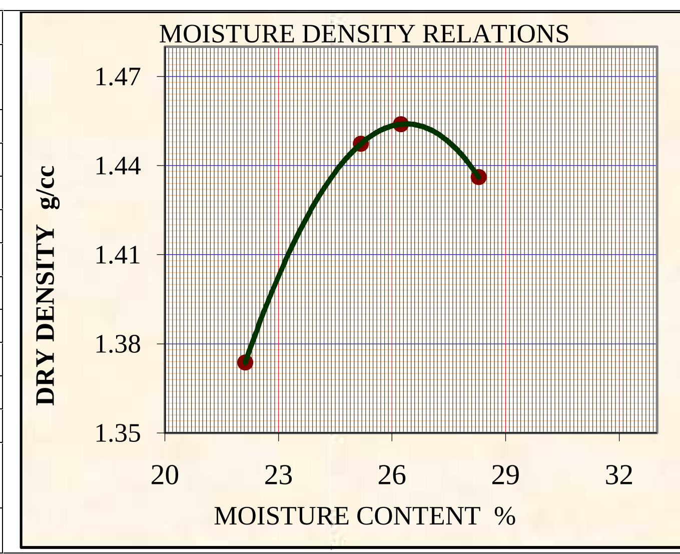
Experiment 24.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	25	18		
Container Number	A-8	A-5	A-7	A-2	A-11
Wet Soil +con (g)= (W1)	19.73	15.98	15.92	12.24	11.61
Dry Soil +con(g) = (W_2)	16.61	12.8	12.66	11.47	10.67
Mass of Con (g) = (W_3)	11.83	8.08	8.02	9.14	7.79
Weight of Moisture (g)	3.12	3.18	3.26	0.77	0.94
Dry Soil (g)	4.78	4.72	4.64	2.33	2.88
Moisture Content (%)	65.27	67.37	70.26	33.05	32.64
LL at 25 blow &Avg. PL	67			32.8	



Experiment24.3 (Moisture Density Relationship of Soil

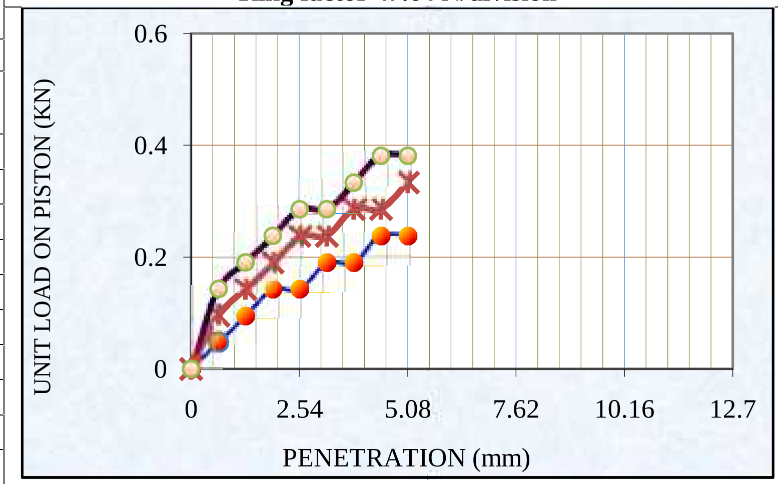
	Trial No.	1	2	3	4	N.M.C
Density	Mold + Wet soil (gm)	8565	8850	8900	8915	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3563	3848	3898	3913	
	Wet Density (g/cm^3)	1.68	1.81	1.84	1.84	
Moisture	Container No.	F-12	E-1	Z-1	F-2	B-14
	Wet Soil + Con. (g)	176.4	163.2	187.7	208.7	174
	Dry Soil +Con. (g)	152.2	138.3	157.3	171.7	158
	Mass of Con. (g)	42.8	39.4	41.4	40.9	43
	Mass of Moisture (g)	24.2	24.9	30.4	37	16
	Dry Soil (g)	109.4	98.9	115.9	130.8	115
	Moisture cont. (g/cm^3)	22.12	25.18	26.23	28.29	13.91
Dry Density (g/cm^3)		1.37	1.45	1.45	1.44	



Experiment 24.4(CBR)

Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division

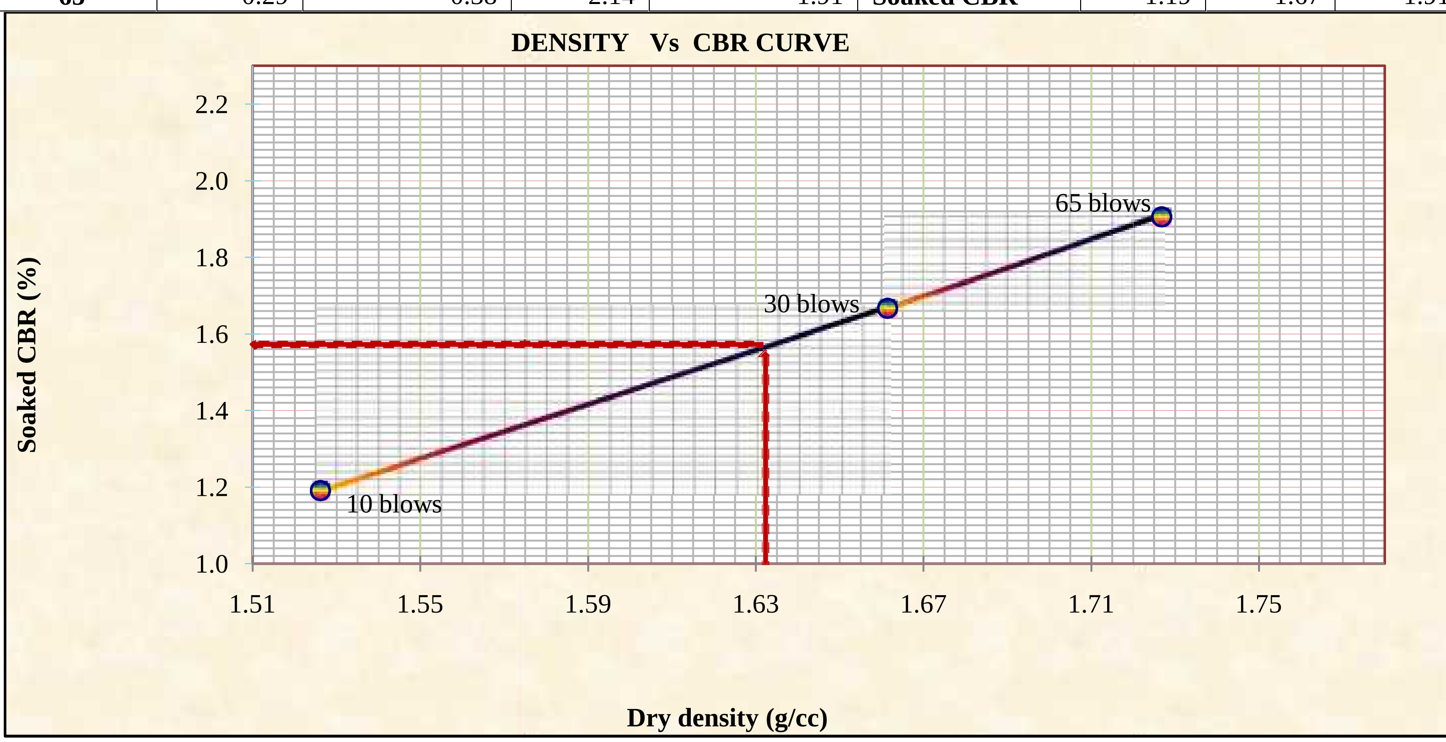


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	**5.08mm**	**2.57 mm**	**5.08mm**
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91

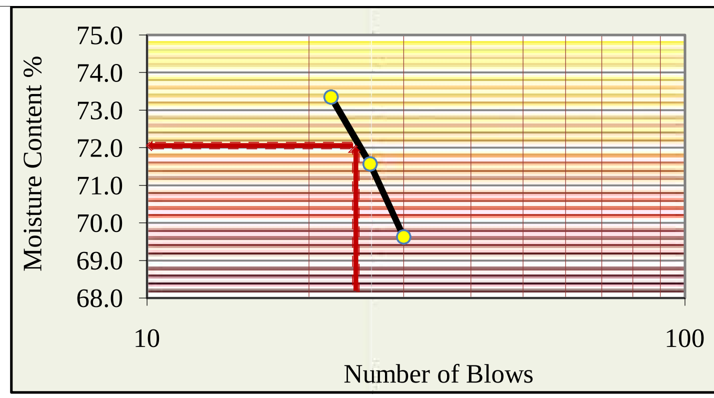


Experiment 25.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	3.29	0.30	99.70	A-7-5(20)
No.10	10.44	0.96	98.74	
No.40	21.06	1.94	96.80	
No.200	61.58	5.67	91.13	

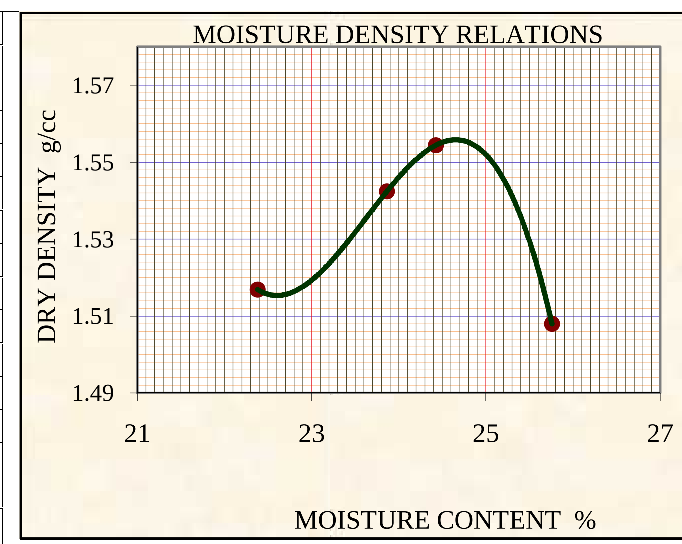
Experiment 25.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	26	22		
Container Number	A-9	A-5	A-2	A-8	A-6
Wet Soil +con (g)= (W1)	15.78	17.07	17.03	16.8	12.31
Dry Soil +con(g) = (W_2)	12.09	13.32	13.26	15.81	11.37
Mass of Con (g) = (W_3)	6.79	8.08	8.12	11.8	7.46
Weight of Moisture (g)	3.69	3.75	3.77	0.99	0.94
Dry Soil (g)	5.3	5.24	5.14	4.01	3.91
Moisture Content (%)	69.62	71.56	73.35	24.69	24.04
LL at 25 blow &Avg. PL	72				24.36



Experiment25.3 (Moisture Density Relationship of Soil

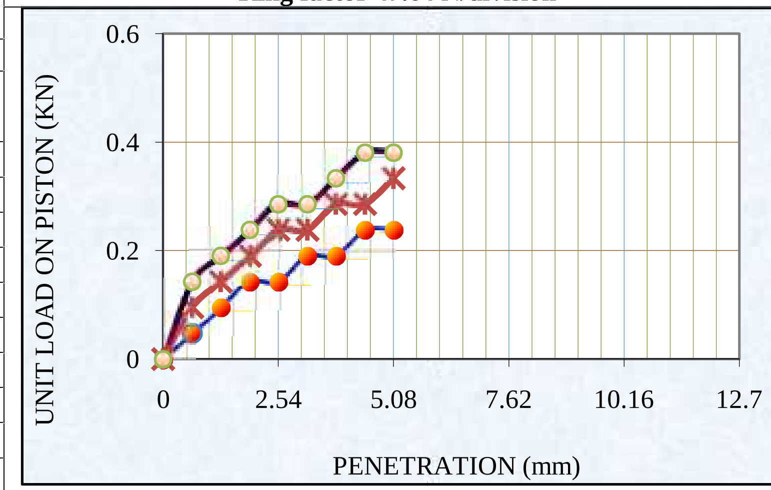
	Trial No.	1	2	3	4	N.M.C
Density	Mold + Wet soil (gm)	8945	9060	9110	9030	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3943	4058	4108	4028	
	Wet Density (g/cm^3)	1.86	1.91	1.93	1.90	
Moisture	Container No.	13	28	I	E-1	B-14
	Wet Soil + Con. (g)	151	170.2	166.3	168.4	174
	Dry Soil +Con. (g)	130.7	145.5	141.9	142.1	158
	Mass of Con. (g)	40	42	42	40	43
	Mass of Moisture (g)	20.3	24.7	24.4	26.3	16
	Dry Soil (g)	90.7	103.5	99.9	102.1	115
	Moisture cont. (g/cm^3)	22.38	23.86	24.42	25.76	13.91
Dry Density (g/cm^3)		1.52	1.54	1.55	1.51	



Experiment 25.4(CBR)

Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

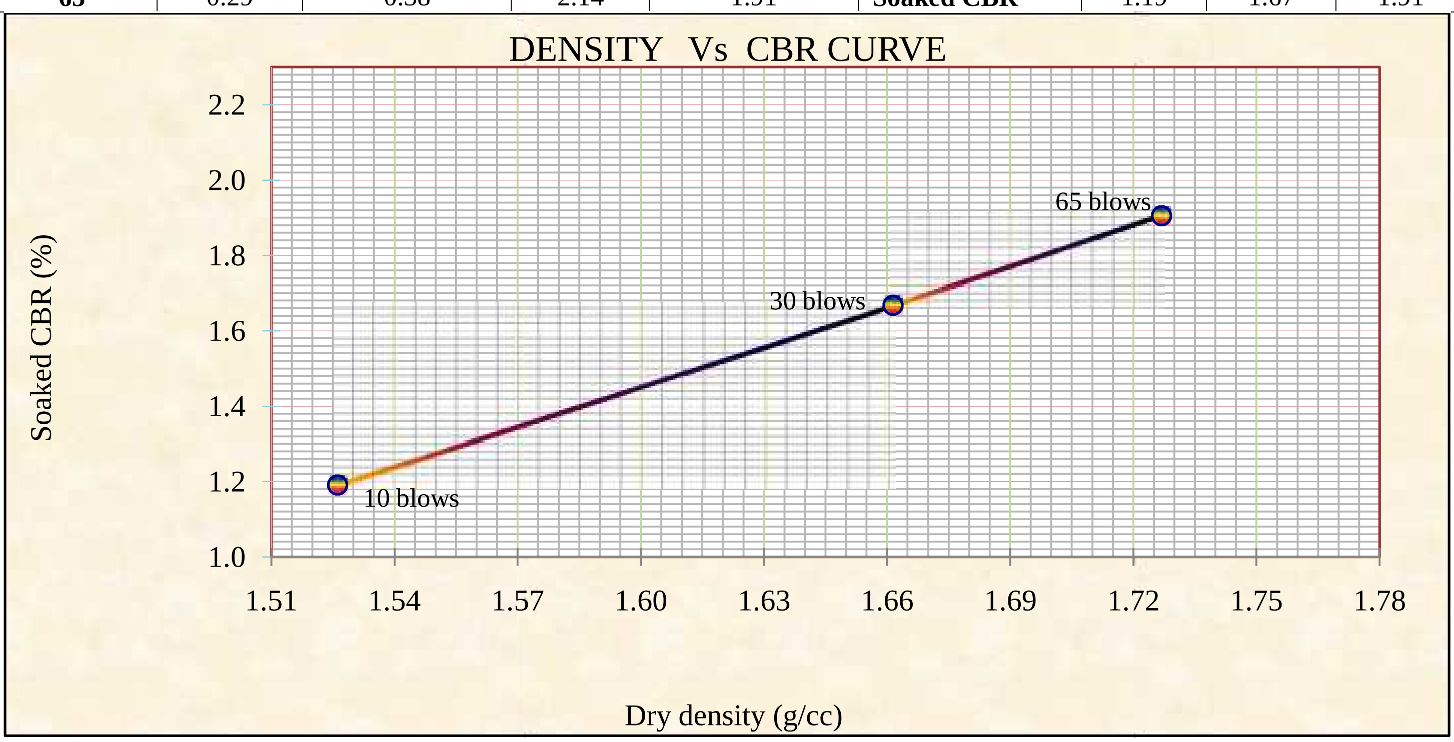
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	**Load (KN)**		**CBR (%)**	
	2.57 mm	**5.08mm**	**2.57 mm**	**5.08mm**
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91

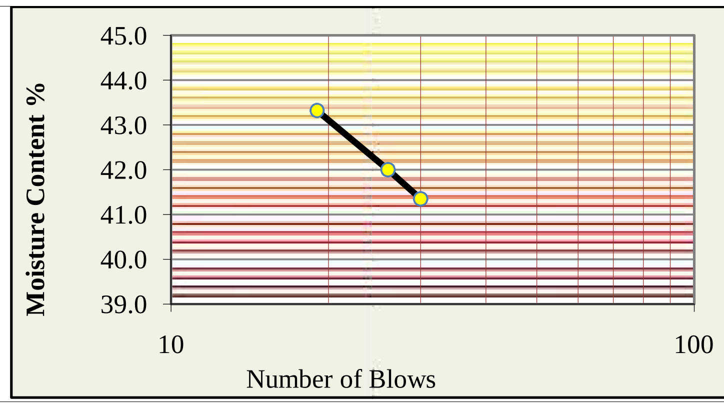


Experiment 26.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	156.05	12.45	87.55	A-7-6(14)
No.10	66.28	5.29	82.26	
No.40	69.70	5.56	76.70	
No.200	117.21	9.35	67.34	

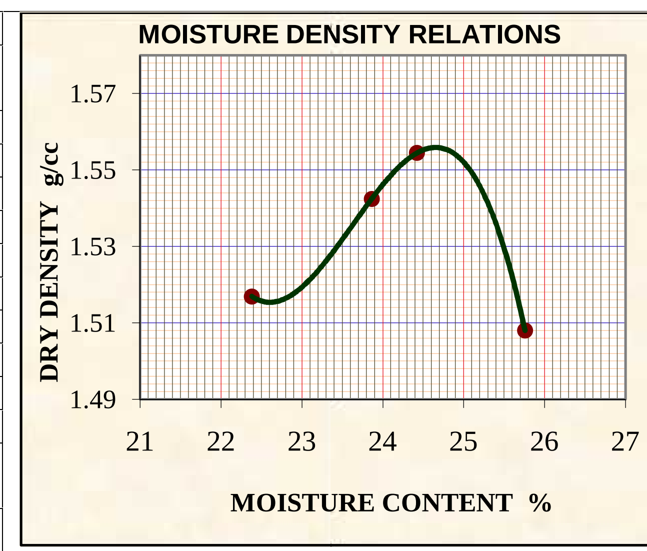
Experiment 26.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	26	19		
Container Number	D-6	D-7	D-1	D-9	D-10
Wet Soil +con (g)= (W1)	33.51	38.73	32.37	28.17	32.78
Dry Soil +con(g) = (W_2)	30.81	36	29.58	27.56	32.3
Mass of Con (g) = (W_3)	24.28	29.5	23.14	24.16	29.68
Weight of Moisture (g)	2.7	2.73	2.79	0.61	0.48
Dry Soil (g)	6.53	6.5	6.44	3.4	2.62
Moisture Content (%)	41.35	42.00	43.32	17.94	18.32
LL at 25 blow &Avg. PL	42				18.13



Experiment26.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	
Density	Mold + Wet soil (gm)	8945	9060	9110	9030	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3943	4058	4108	4028	
	Wet Density (g/cm^3)	1.856	1.911	1.934	1.896	
Moisture	Container No.	13	28	I	E-1	B-14
	Wet Soil + Con. (g)	151	170.2	166.3	168.4	174
	Dry Soil +Con. (g)	130.7	145.5	141.9	142.1	158
	Mass of Con. (g)	40	42	42	40	43
	Mass of Moisture (g)	20.3	24.7	24.4	26.3	16
	Dry Soil (g)	90.7	103.5	99.9	102.1	115
	Moisture cont. (g/cm^3)	22.38	23.86	24.42	25.76	13.91
Dry Density (g/cm^3)		1.52	1.54	1.55	1.51	

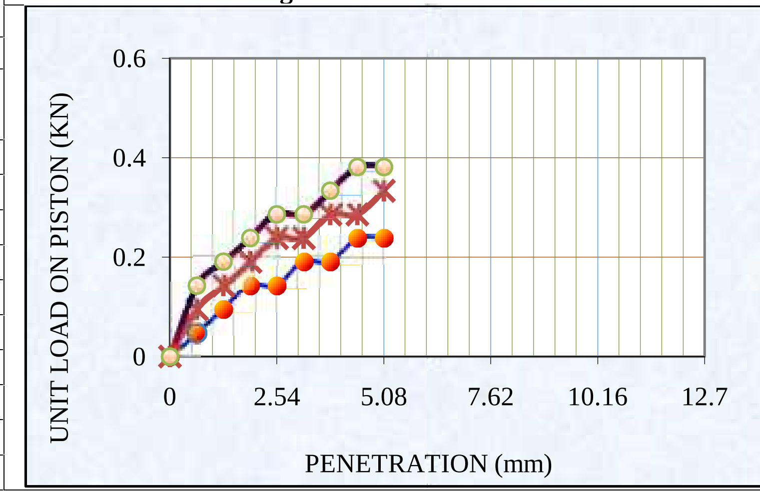


Experiment 26.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division

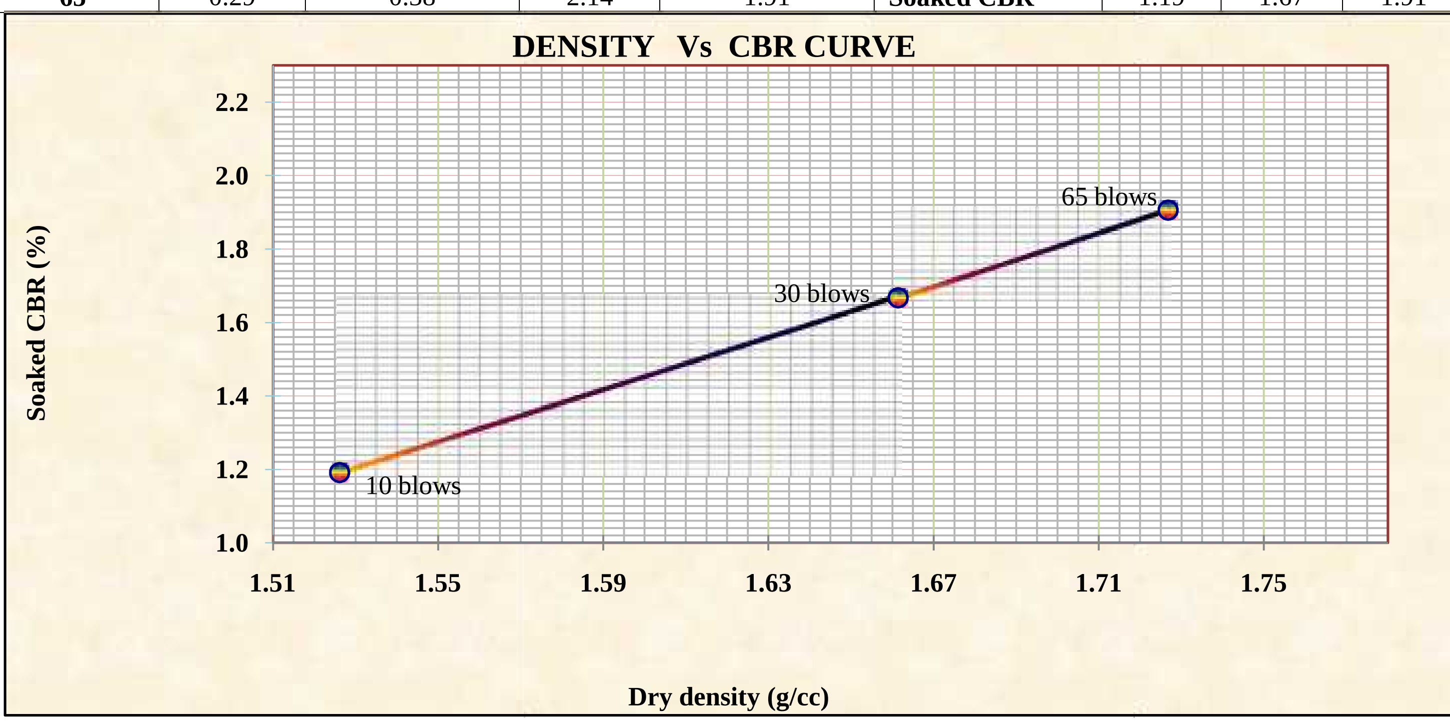


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91

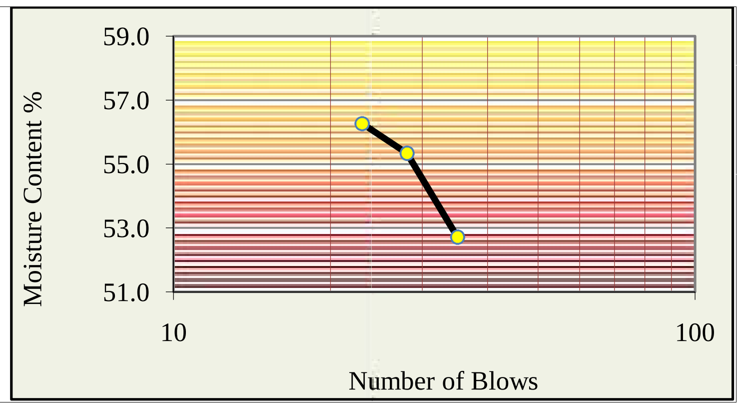


Experiment 27.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	2.2	0.36	99.64	A-7-6(20)
No.10	9.3	1.51	98.14	
No.40	18.6	3.01	95.12	
No.200	112.6	18.25	76.87	

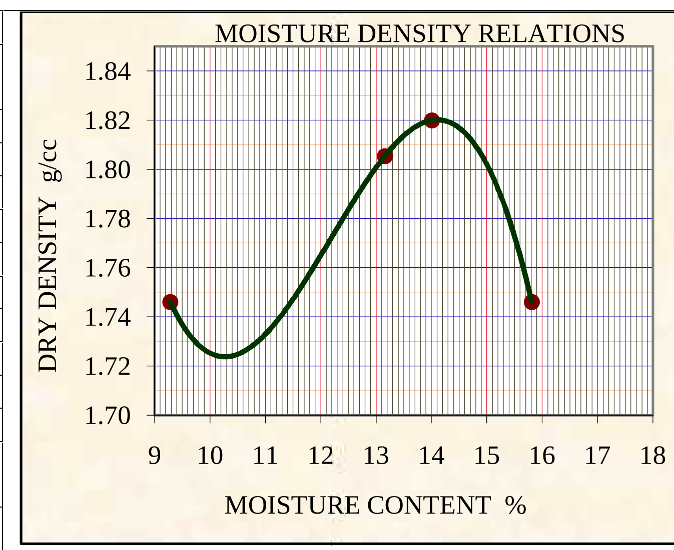
Experiment 27.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	35	28	23		
Container Number	D-8	D-6	D-1	D-2	D-4
Wet Soil +con (g)= (W1)	33.46	32.72	34.32	29.85	34.86
Dry Soil +con(g) = (W_2)	30.16	29.71	30.37	28.89	33.8
Mass of Con (g) = (W_3)	23.9	24.27	23.35	24.6	29.15
Weight of Moisture (g)	3.3	3.01	3.95	0.96	1.06
Dry Soil (g)	6.26	5.44	7.02	4.29	4.65
Moisture Content (%)	52.72	55.33	56.27	22.38	22.80
LL at 25 blow &Avg. PL	56				22.59



Experiment27.3 (Moisture Density Relationship of Soil

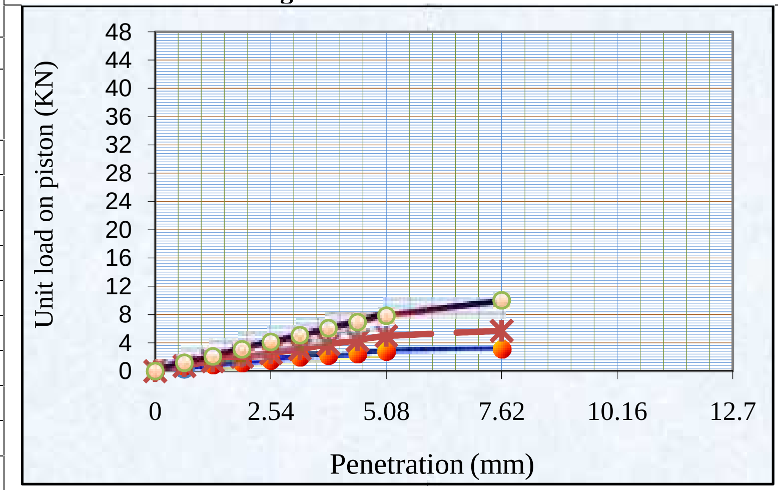
		1	2	3	4	NMC
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	9055	9341	9409	9297	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	4053	4339	4407	4295	
	Wet Density (g/cm^3)	1.91	2.04	2.07	2.02	
Moisture	Container No.	B-6	B-3	B-1	B-2	I-2
	Wet Soil + Con. (g)	187	201	184	174	205
	Dry Soil +Con. (g)	174	181	165.2	154.2	193.9
	Mass of Con. (g)	34	29	31	29	40.1
	Mass of Moisture (g)	13	20	18.8	19.8	11.1
	Dry Soil (g)	140	152	134.2	125.2	153.8
	Moisture cont. (g/cm^3)	9.29	13.16	14.01	15.81	7.22
Dry Density (g/cm^3)		1.75	1.81	1.82	1.75	



Experiment 27.4(CBR)

Penetration data						
Penetration (mm)	10 Blows		30 Blows		65Blows	
	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	9	0.43	15	0.71	25	1.19
1.27	19	0.91	29	1.38	44	2.10
1.91	25	1.19	42	2.00	65	3.10
2.54	32	1.52	53	2.52	87	4.14
3.18	42	2.00	65	3.10	107	5.10
3.81	47	2.24	80	3.81	127	6.05
4.45	51	2.43	91	4.34	146	6.96
5.08	59	2.81	104	4.95	165	7.86
7.62	66	3.14	120	5.72	210	10.00

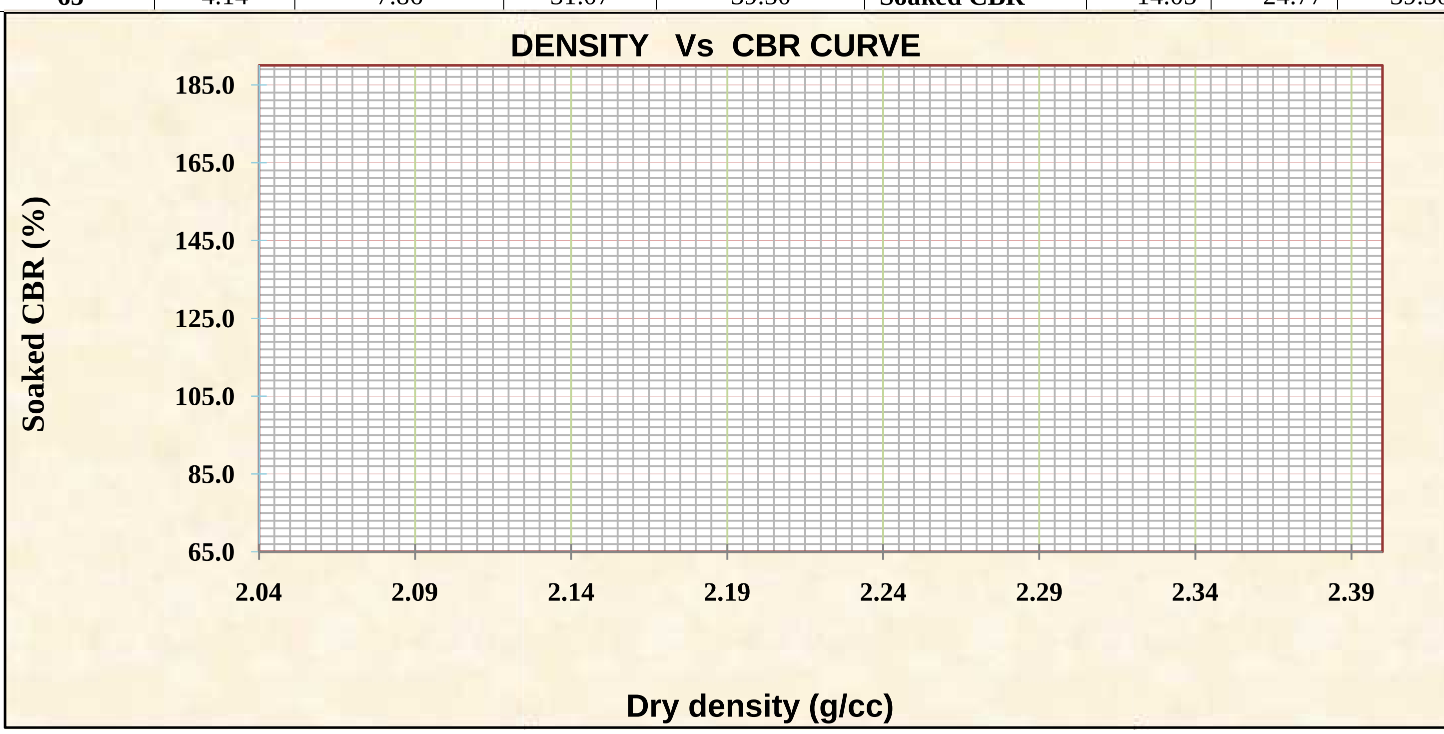
Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary				
blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	1.52	2.81	11.43	14.05
30	2.52	4.95	18.93	24.77
65	4.14	7.86	31.07	39.30

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.37	1.52	1.61
Soaked CBR	14.05	24.77	39.30

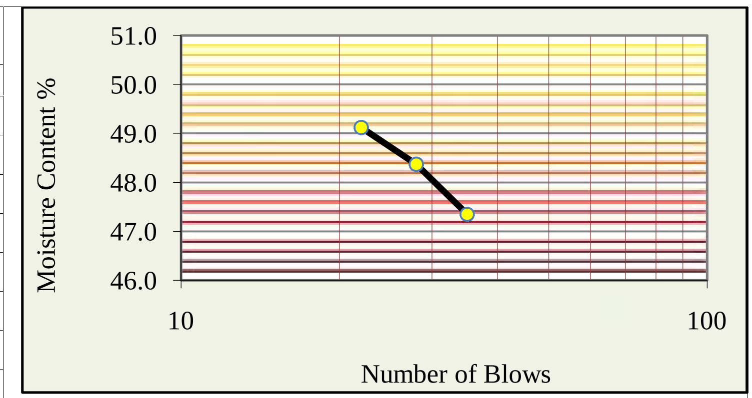


Experiment 28.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	96	11.88	88.12	A-7-5(10)
No.10	128.4	15.88	72.24	
No.40	87	10.76	61.48	
No.200	87.6	10.84	50.64	

Experiment 28.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	35	28	22		
Container Number	A-1	A-12	A-10	A-6	A-8
Wet Soil +con (g)= (W1)	17.82	20.23	21.54	13.25	18.99
Dry Soil +con(g) = (W_2)	14.6	16.08	17.08	12.19	17.69
Mass of Con (g) = (W_3)	7.8	7.5	8	7.5	11.8
Weight of Moisture (g)	3.22	4.15	4.46	1.06	1.3
Dry Soil (g)	6.8	8.58	9.08	4.69	5.89
Moisture Content (%)	47.35	48.37	49.12	22.60	22.07
LL at 25 blow &Avg. PL	49			22	



Experiment28.3 (Moisture Density Relationship of Soil

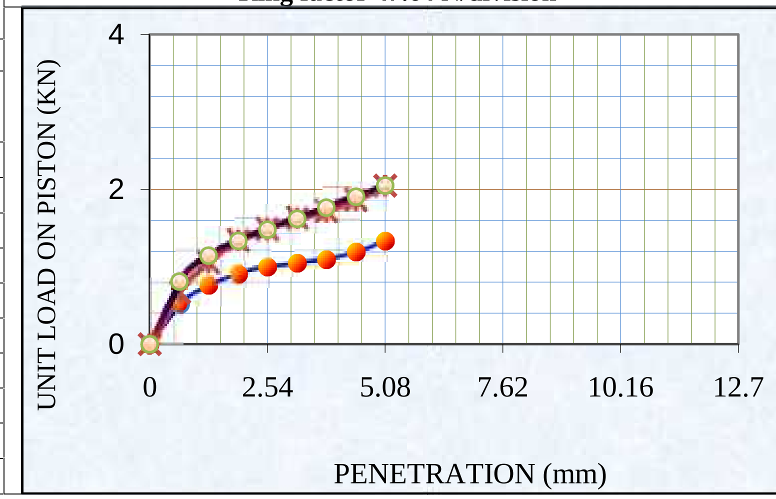
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	9080	9279	9435	9404	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	4078	4277	4433	4402	
	Wet Density (g/cm^3)	1.920	2.014	2.087	2.073	
Moisture	Container No.	B-6	B-3	B-1	B-2	B-3
	Wet Soil + Con. (g)	197.4	182	207.2	191.9	213.8
	Dry Soil +Con. (g)	182.1	164.6	184	166.1	199.6
	Mass of Con. (g)	33.2	29.8	33.2	25.8	33.1
	Mass of Moisture (g)	15.3	17.4	23.2	25.8	14.2
	Dry Soil (g)	148.9	134.8	150.8	140.3	166.5
	Moisture cont. (g/cm^3)	10.28	12.91	15.38	18.39	8.53
Dry Density (g/cm^3)		1.74	1.78	1.81	1.75	

Experiment 28.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	11	0.52	14	0.67	17	0.81
1.27	16	0.76	22	1.05	24	1.14
1.91	19	0.91	28	1.33	28	1.33
2.54	21	1.00	31	1.48	31	1.48
3.18	22	1.05	34	1.62	34	1.62
3.81	23	1.10	36	1.72	37	1.76
4.45	25	1.19	39	1.86	40	1.91
5.08	28	1.33	43	2.05	43	2.05
7.62						

Ring factor 47.64 N/division

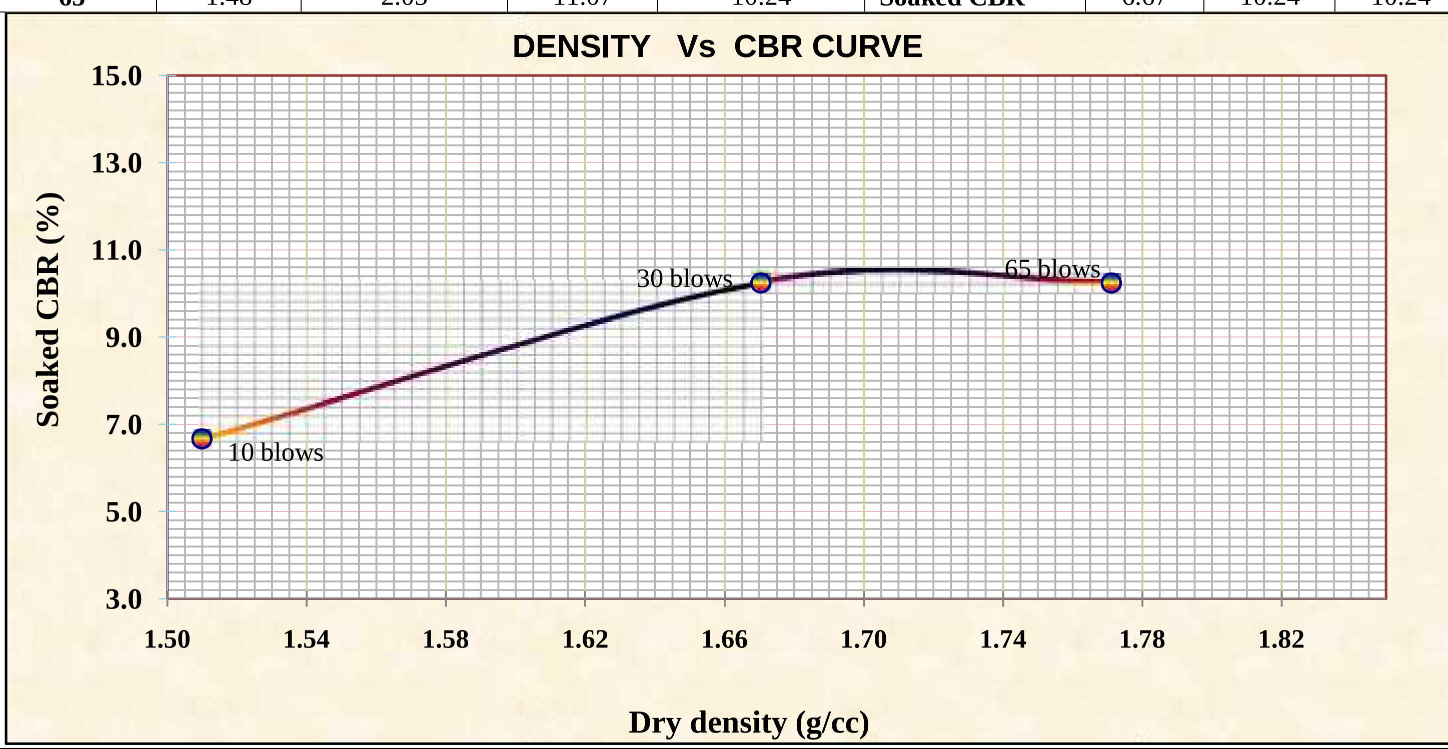


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	1.00	1.33	7.50	6.67
30	1.48	2.05	11.07	10.24
65	1.48	2.05	11.07	10.24

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.51	1.67	1.77
Soaked CBR	6.67	10.24	10.24

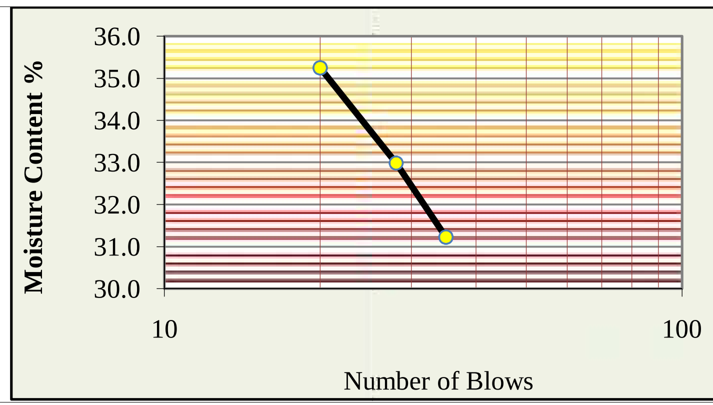


Experiment 29.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	899.9	35.91	64.09	A-2-6(1)
No.10	165.4	6.60	57.49	
No.40	205.8	8.21	49.28	
No.200	382.6	15.27	34.01	

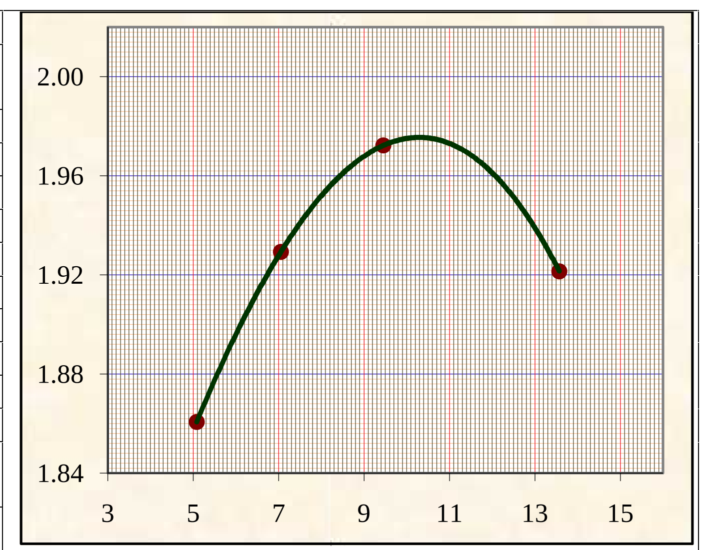
Experiment 29.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	35	28	20		
Container Number	A-8	A-7	A-5	A-2	A-9
Wet Soil +con (g)= (W1)	19.66	19.62	21.03	15.23	11.8
Dry Soil +con(g) = (W_2)	16.9	16.74	18.63	14.06	10.96
Mass of Con (g) = (W_3)	8.06	8.01	11.82	8.11	6.77
Weight of Moisture (g)	2.76	2.88	2.4	1.17	0.84
Dry Soil (g)	8.84	8.73	6.81	5.95	4.19
Moisture Content (%)	31.22	32.99	35.24	19.66	20.05
LL at 25 blow &Avg. PL	34			20	



Experiment28.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	9155	9389	9587	9637	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	4153	4387	4585	4635	
	Wet Density (g/cm^3)	1.96	2.07	2.16	2.18	
Moisture	Container No.	B-6	B-3	B-1	B-2	B-13
	Wet Soil + Con. (g)	257.1	218.7	209.6	219.6	262
	Dry Soil +Con. (g)	246.1	206.5	194.4	196.9	254.4
	Mass of Con. (g)	29.8	33.6	33.6	29.6	40.5
	Mass of Moisture (g)	11	12.2	15.2	22.7	7.6
	Dry Soil (g)	216.3	172.9	160.8	167.3	213.9
	Moisture cont. (g/cm^3)	5.09	7.06	9.45	13.57	3.55
Dry Density (g/cm^3)		1.86	1.93	1.97	1.92	

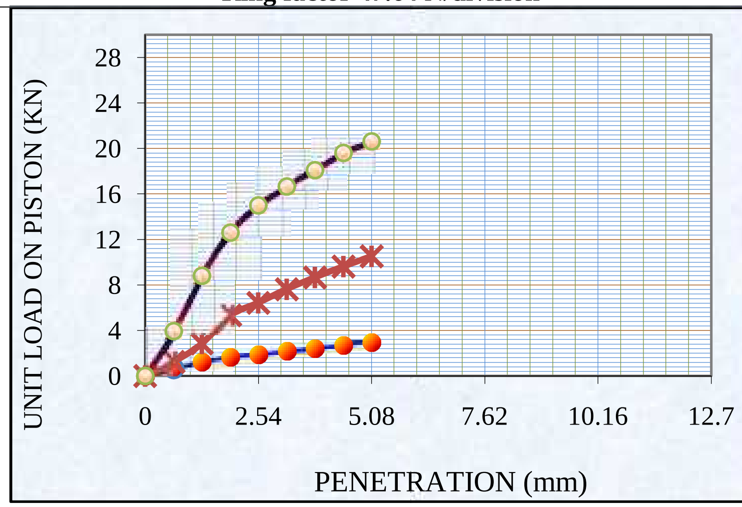


Experiment 28.4(<u>CBR)</u>

Penetration data

Penetration (mm)	**10 Blows** Dial RDG	Load (KN)	**30 Blows** Dial RDG	Load (KN)	**65Blows** Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	14	0.67	26	1.24	83	3.95
1.27	26	1.24	60	2.86	185	8.81
1.91	35	1.67	112	5.34	265	12.62
2.54	40	1.91	135	6.43	315	15.01
3.18	46	2.19	160	7.62	350	16.67
3.81	51	2.43	182	8.67	380	18.10
4.45	57	2.72	202	9.62	412	19.63
5.08	62	2.95	221	10.53	433	20.63
7.62						

Ring factor 47.64 N/division

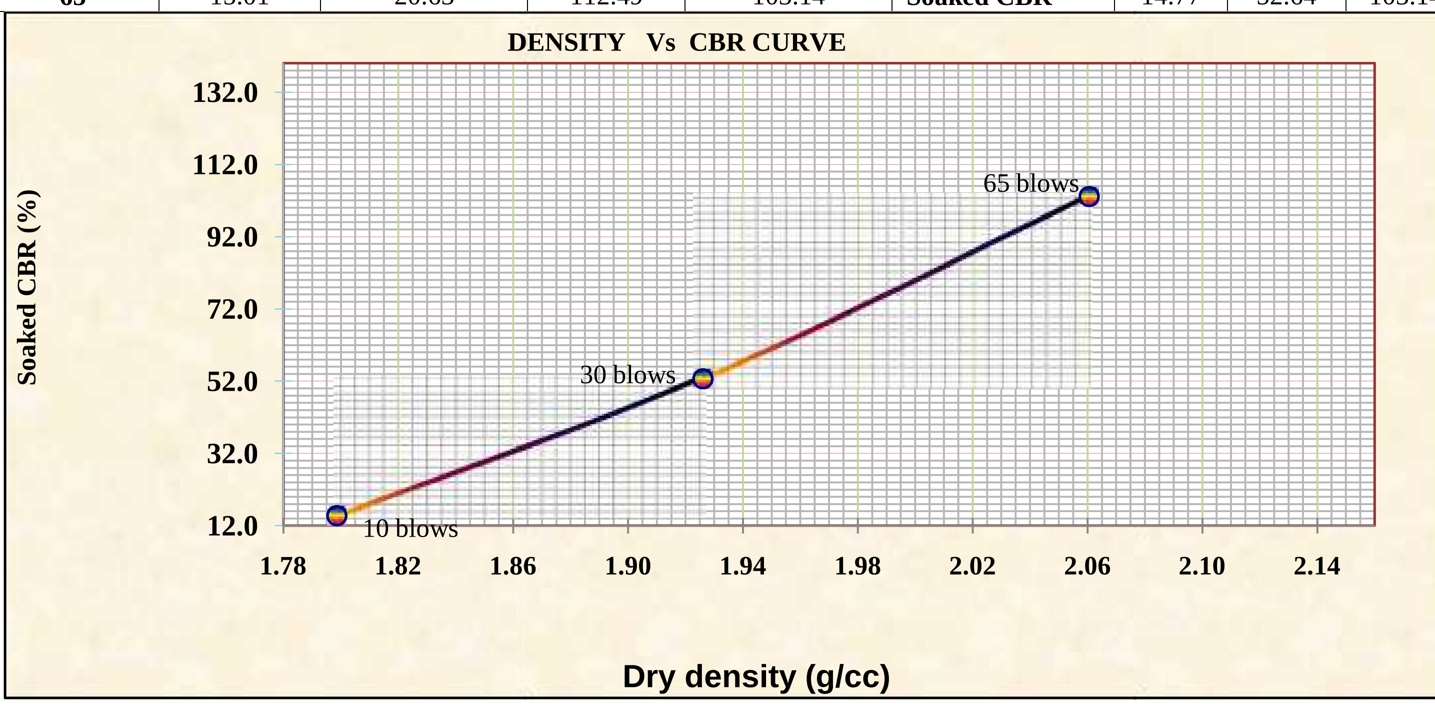


CBR Value at Standard Loads and CBR Test Summary

blows	**Load (KN)** 2.57 mm	5.08mm	**CBR (%)** 2.57 mm	5.08mm
10	1.91	2.95	14.28	14.77
30	6.43	10.53	48.21	52.64
65	15.01	20.63	112.49	103.14

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.80	1.93	2.06
Soaked CBR	14.77	52.64	103.14

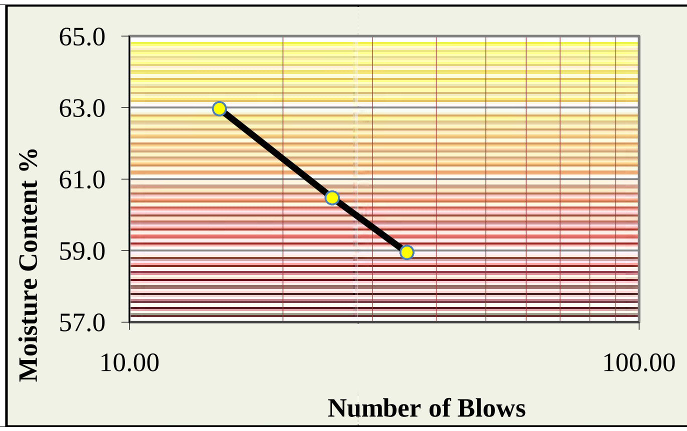


Experiment 30.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	431.2	25.07	74.93	A-7-5(20)
No.10	144.1	8.38	66.55	
No.40	145.5	8.46	58.09	
No.200	114.5	6.66	51.44	

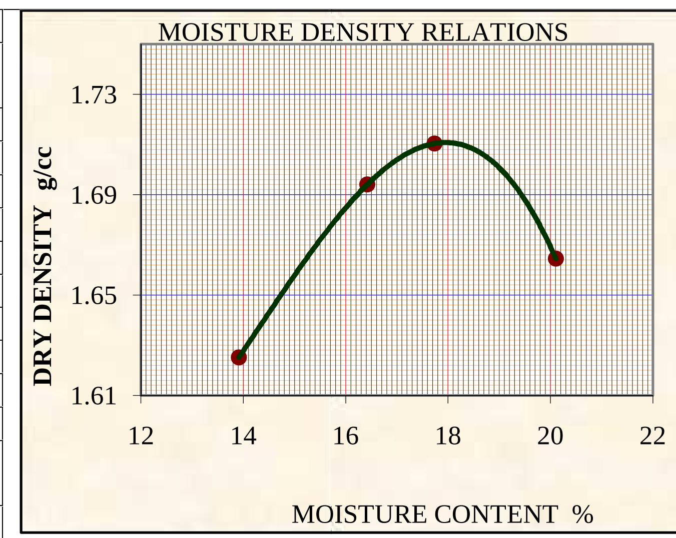
Experiment 30.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	35	25	15		
Container Number	D-7	D-3	D-10	D-5	D-9
Wet Soil +con (g)= (W1)	38.6	42.57	38.76	35.29	29.69
Dry Soil +con(g) = (W_2)	35.24	37.81	35.24	34.33	28.49
Mass of Con (g) = (W_3)	29.54	29.94	29.65	30.99	24.15
Weight of Moisture (g)	3.36	4.76	3.52	0.96	1.2
Dry Soil (g)	5.7	7.87	5.59	3.34	4.34
Moisture Content (%)	58.95	60.48	62.97	28.74	27.65
LL at 25 blow &Avg. PL	60			28.19	



Experiment30.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8934	9191	9279	9248	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3932	4189	4277	4246	
	Wet Density (g/cm^3)	1.85	1.97	2.01	2.00	
Moisture	Container No.	B-8	A-1	100	B-5	I
	Wet Soil + Con. (g)	220	215.5	204.8	177.1	238.5
	Dry Soil +Con. (g)	196.6	189.9	180.1	153.2	228.7
	Mass of Con. (g)	28.4	34	40.8	34.3	41.7
	Mass of Moisture (g)	23.4	25.6	24.7	23.9	9.8
	Dry Soil (g)	168.2	155.9	139.3	118.9	187
	Moisture cont. (g/cm^3)	13.91	16.42	17.73	20.10	5.241
Dry Density (g/cm^3)		1.63	1.69	1.71	1.66	

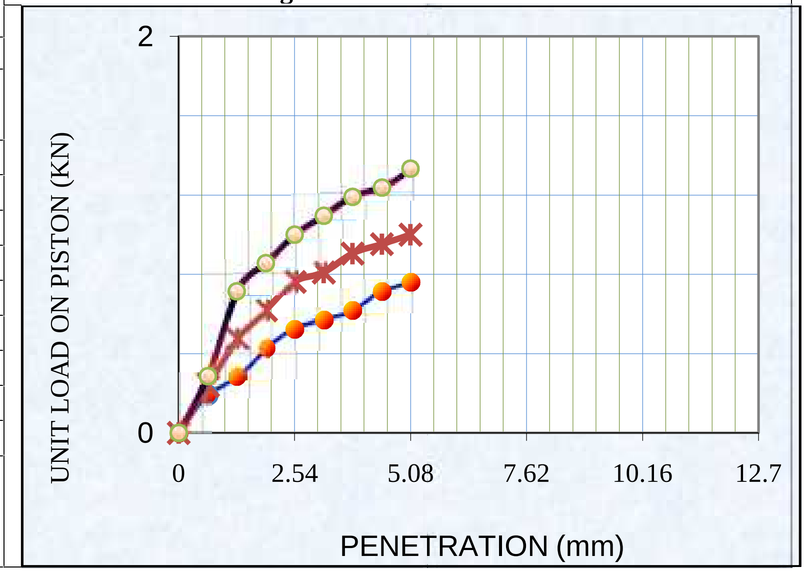


Experiment 30.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	4	0.19	5	0.24	6	0.29
1.27	6	0.29	10	0.48	15	0.71
1.91	9	0.43	13	0.62	18	0.86
2.54	11	0.52	16	0.76	21	1.00
3.18	12	0.57	17	0.81	23	1.10
3.81	13	0.62	19	0.91	25	1.19
4.45	15	0.71	20	0.95	26	1.24
5.08	16	0.76	21	1.00	28	1.33
7.62						

Ring factor 47.64 N/division

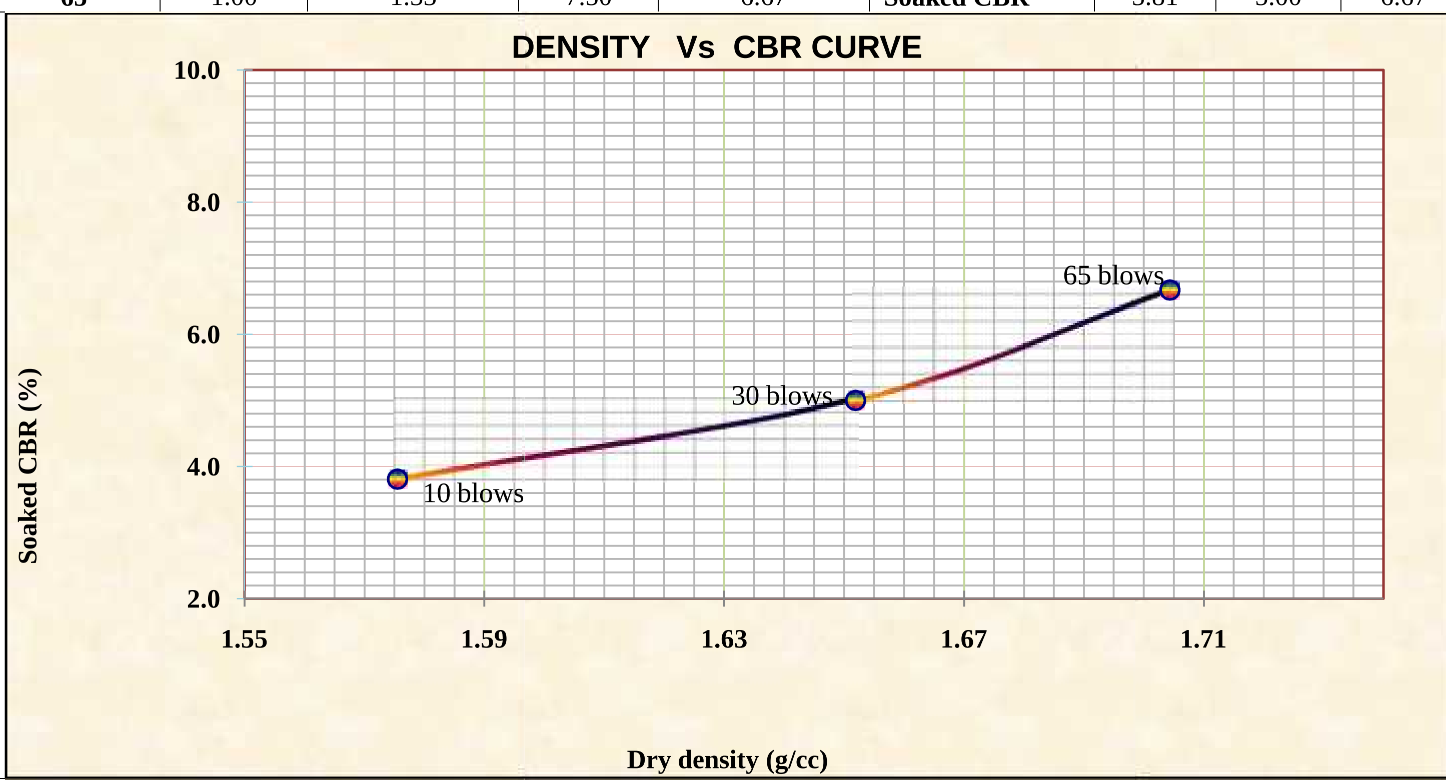


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.52	0.76	3.93	3.81
30	0.76	1.00	5.71	5.00
65	1.00	1.33	7.50	6.67

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.58	1.65	1.70
Soaked CBR	3.81	5.00	6.67

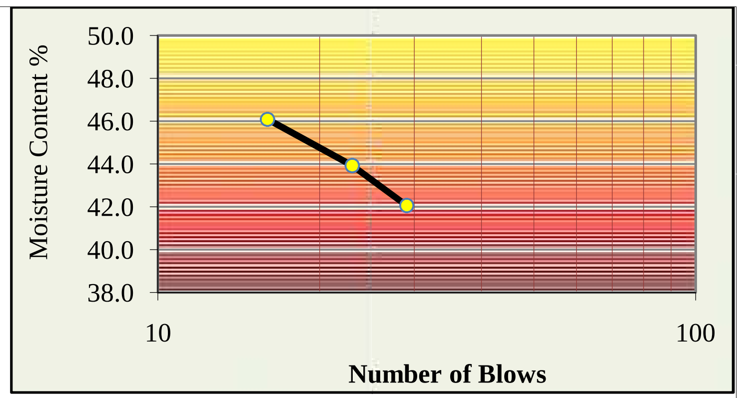


Experiment 31.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	29.5	3.25	96.75	A-7-5(14)
No.10	22.2	2.44	94.31	
No.40	26.7	2.94	91.38	
No.200	124.2	13.66	77.71	

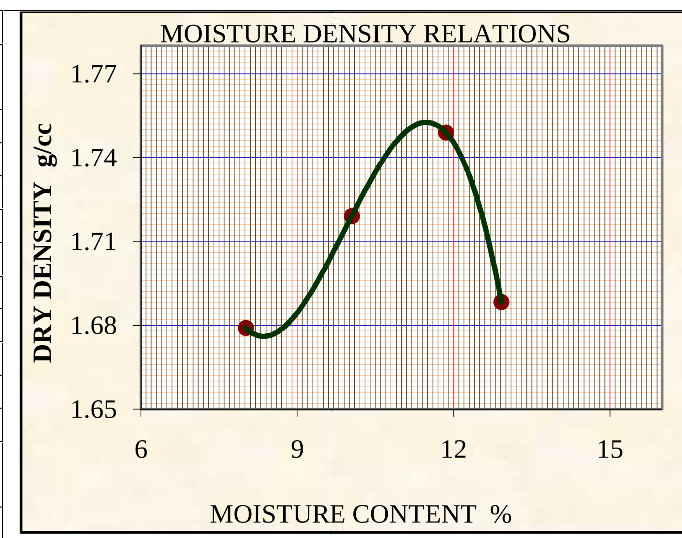
Experiment 31.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	29	23	16		
Container Number	D-1	D-8	D-6	D-2	D-4
Wet Soil +con (g)= (W1)	34.33	35.68	36.24	31.15	35.64
Dry Soil +con(g) = (W_2)	31.02	31.92	32.46	30.2	34.77
Mass of Con (g) = (W_3)	23.15	23.36	24.26	24.58	29.08
Weight of Moisture (g)	3.31	3.76	3.78	0.95	0.87
Dry Soil (g)	7.87	8.56	8.2	5.62	5.69
Moisture Content (%)	42.06	43.93	46.10	16.90	15.29
LL at 25 blow &Avg. PL	43				16.09



Experiment31.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8854	9020	9157	9051	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3852	4018	4155	4049	
	Wet Density (g/cm^3)	1.81	1.89	1.96	1.91	
Moisture	Container No.	A-5	I-3	A-8	B-2	E-7
	Wet Soil + Con. (g)	214.4	213.7	182.7	209.5	241
	Dry Soil +Con. (g)	200.5	197.8	167.8	190.1	233
	Mass of Con. (g)	27.1	39.5	42.1	39.9	40.9
	Mass of Moisture (g)	13.9	15.9	14.9	19.4	8
	Dry Soil (g)	173.4	158.3	125.7	150.2	192.1
	Moisture cont. (g/cm^3)	8.02	10.04	11.85	12.92	4.16
Dry Density (g/cm^3)		1.68	1.72	1.75	1.69	

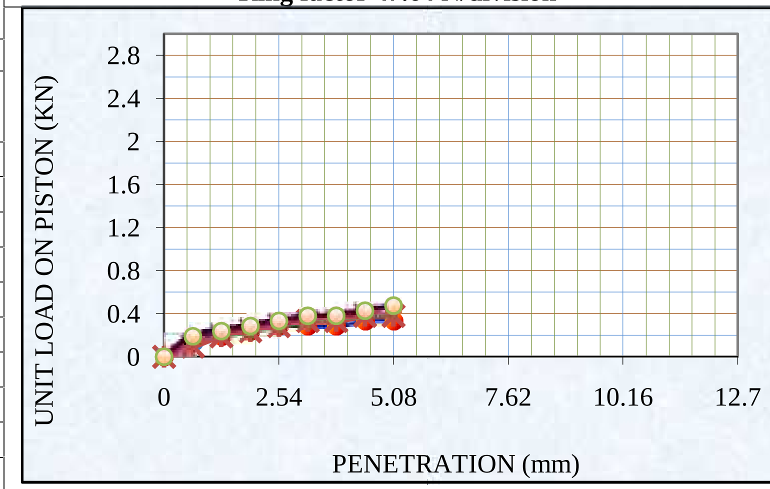


Experiment 31.4(CBR)

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	3	0.14	2	0.10	4	0.19
1.27	4	0.19	4	0.19	5	0.24
1.91	5	0.24	5	0.24	6	0.29
2.54	6	0.29	6	0.29	7	0.33
3.18	6	0.29	7	0.33	8	0.38
3.81	6	0.29	7	0.33	8	0.38
4.45	7	0.33	8	0.38	9	0.43
5.08	7	0.33	8	0.38	10	0.48
7.62						

Ring factor 47.64 N/division

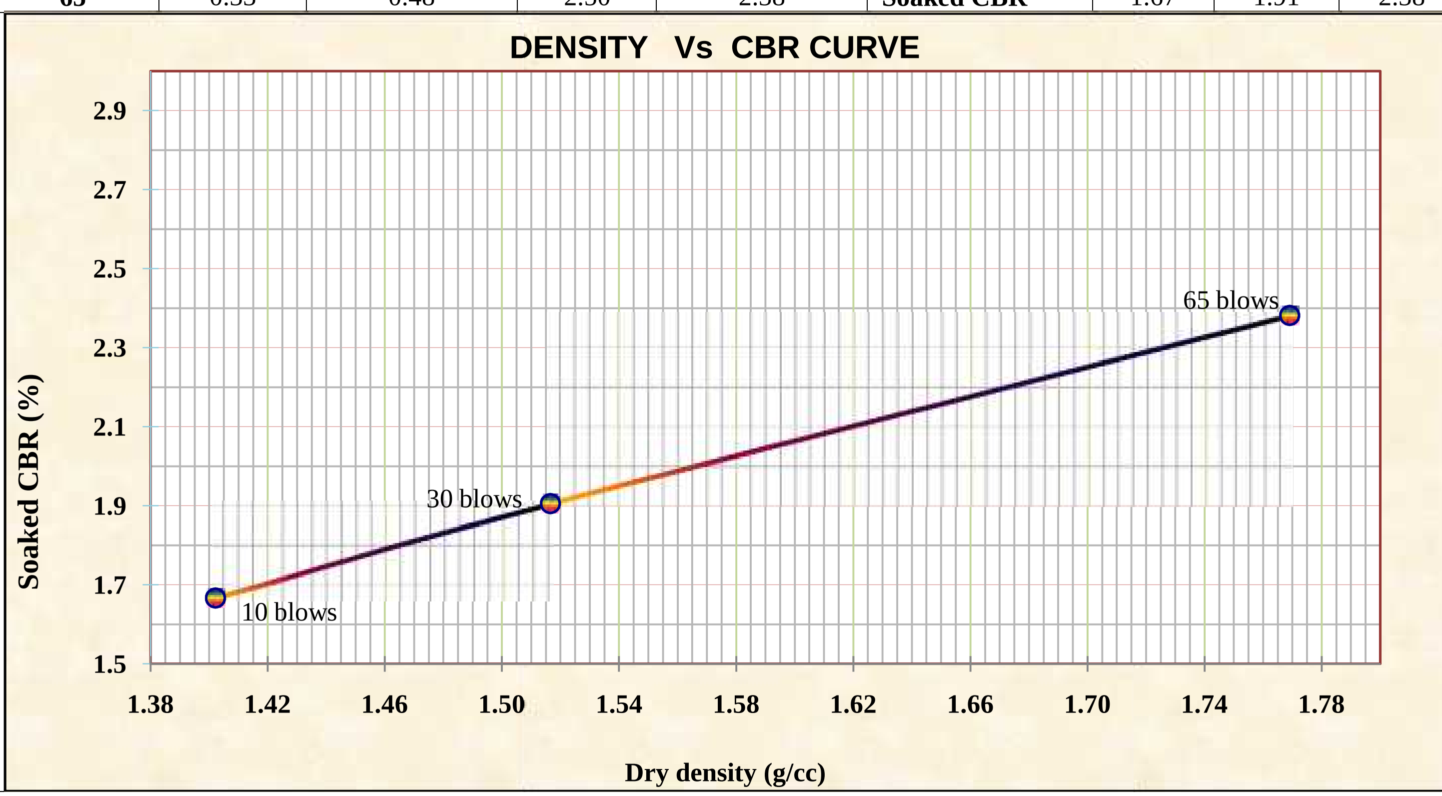


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.29	0.33	2.14	1.67
30	0.29	0.38	2.14	1.91
65	0.33	0.48	2.50	2.38

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.40	1.52	1.77
Soaked CBR	1.67	1.91	2.38

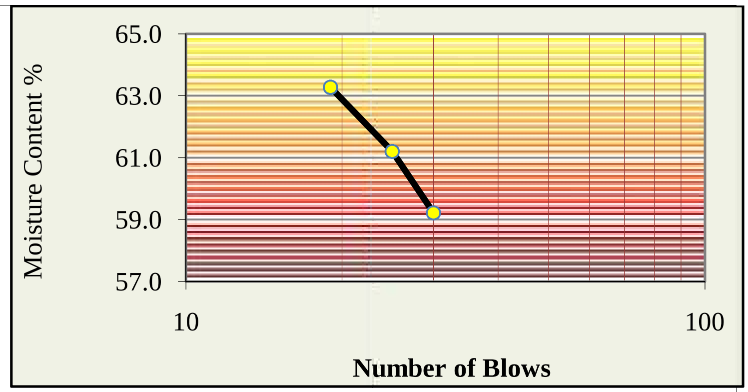


Experiment 32.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	562.91	52.56	47.44	A-7-5(20)
No.10	68.75	6.42	41.02	
No.40	26.89	2.51	38.51	
No.200	31	2.89	35.62	

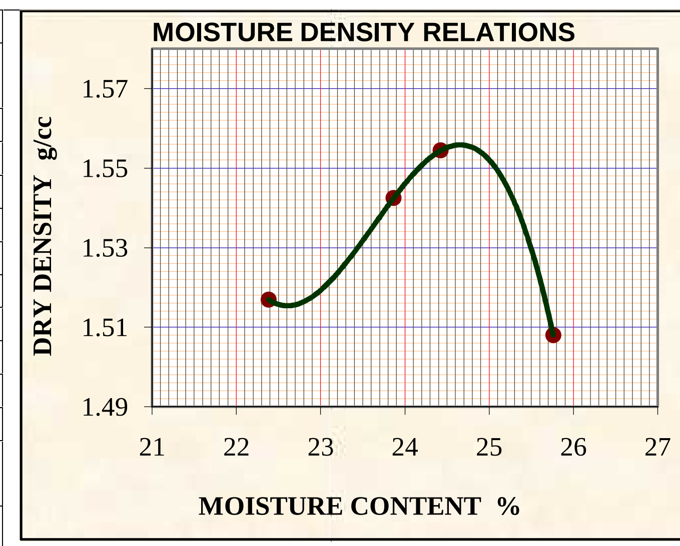
Experiment 32.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	30	25	19		
Container Number	D-1	D-8	D-6	D-9	D-10
Wet Soil +con (g)= (W1)	32.2	32.5	31.66	13.04	10.47
Dry Soil +con(g) = (W_2)	28.83	29.06	28.8	12.07	9.89
Mass of Con (g) = (W_3)	23.14	23.44	24.28	8.1	7.51
Weight of Moisture (g)	3.37	3.44	2.86	0.97	0.58
Dry Soil (g)	5.69	5.62	4.52	3.97	2.38
Moisture Content (%)	59.23	61.21	63.27	24.43	24.37
LL at 25 blow &Avg. PL	61			24.4	



Experiment32.3 (Moisture Density Relationship of Soil

	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8945	9060	9110	9030	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3943	4058	4108	4028	
	Wet Density (g/cm^3)	1.86	1.91	1.93	1.90	
Moisture	Container No.	13	28	I	E-1	
	Wet Soil + Con. (g)	151	170.2	166.3	168.4	
	Dry Soil +Con. (g)	130.7	145.5	141.9	142.1	
	Mass of Con. (g)	40	42	42	40	
	Mass of Moisture (g)	20.3	24.7	24.4	26.3	
	Dry Soil (g)	90.7	103.5	99.9	102.1	
	Moisture cont. (g/cm^3)	22.38	23.86	24.42	25.76	
Dry Density (g/cm^3)		1.52	1.54	1.55	1.51	

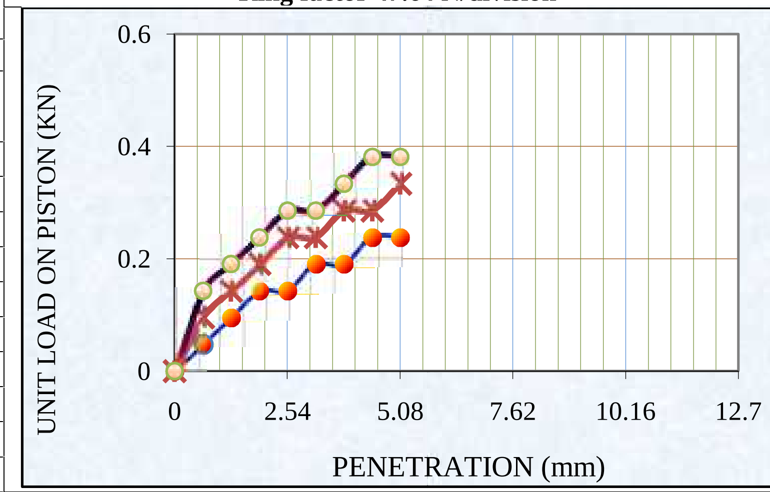


Experiment 32.4(<u>CBR)</u>

Penetration data

Penetration (mm)	10 Blows Dial RDG	10 Blows Load (KN)	30 Blows Dial RDG	30 Blows Load (KN)	65Blows Dial RDG	65Blows Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division

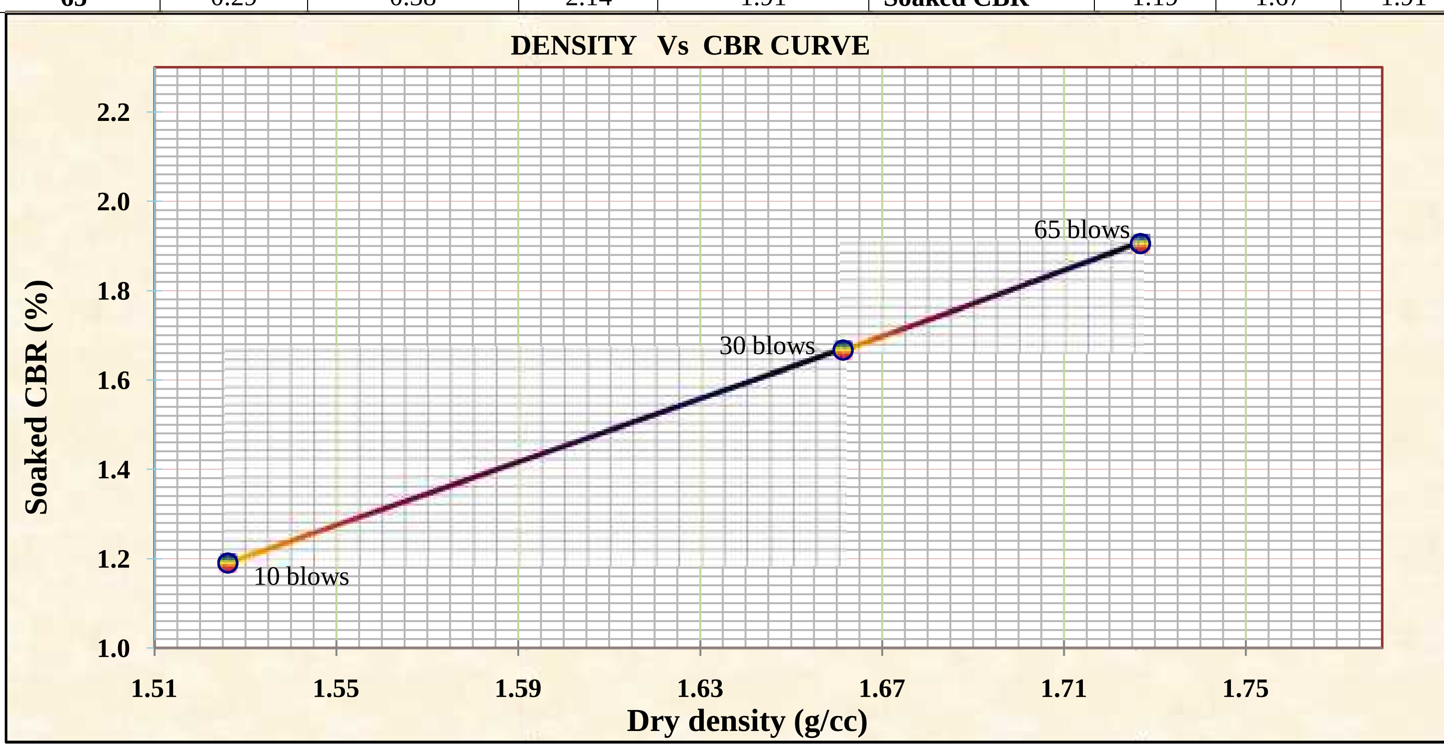


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN) 2.57 mm	Load (KN) 5.08mm	CBR (%) 2.57 mm	CBR (%) 5.08mm
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	**10**	**30**	**65**
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91

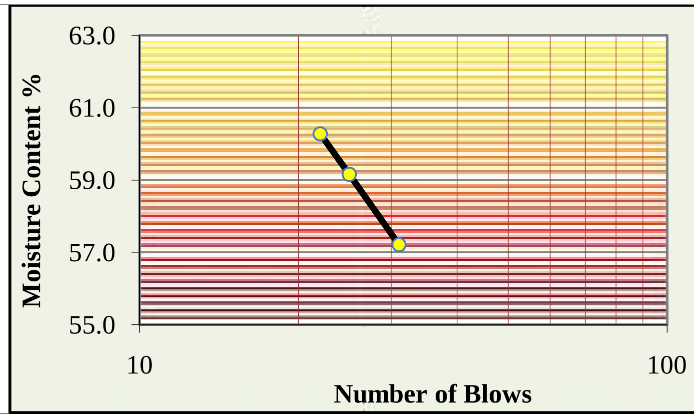


Experiment 33.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	18.17	1.83	98.17	A-7-6(19)
No.10	49.29	4.97	93.19	
No.40	57.32	5.78	87.41	
No.200	97.86	9.87	77.53	

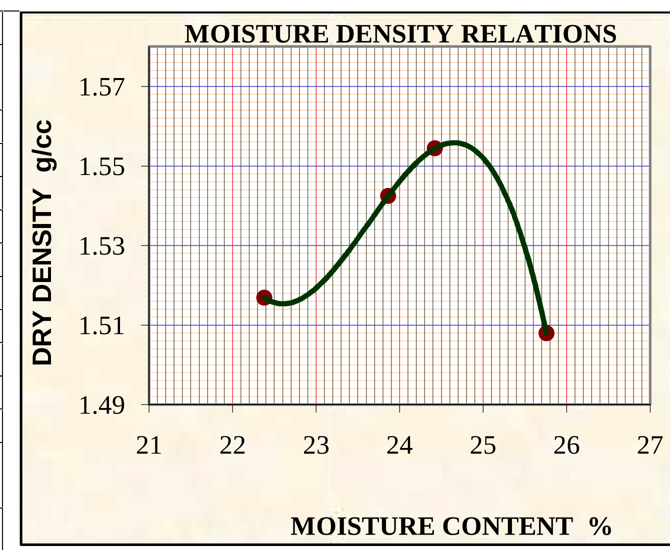
Experiment 33.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	31	25	22		
Container Number	A-1	A-10	A-7	A-3	A-9
Wet Soil +con (g)= (W1)	16.87	17.05	17.06	13.24	10.34
Dry Soil +con(g) = (W_2)	13.58	13.69	13.66	12.6	9.78
Mass of Con (g) = (W_3)	7.83	8.01	8.02	9.14	6.79
Weight of Moisture (g)	3.29	3.36	3.4	0.64	0.56
Dry Soil (g)	5.75	5.68	5.64	3.46	2.99
Moisture Content (%)	57.22	59.15	60.28	18.50	18.73
LL at 25 blow &Avg. PL	59				18.60



Experiment33.3 (Moisture Density Relationship of Soil

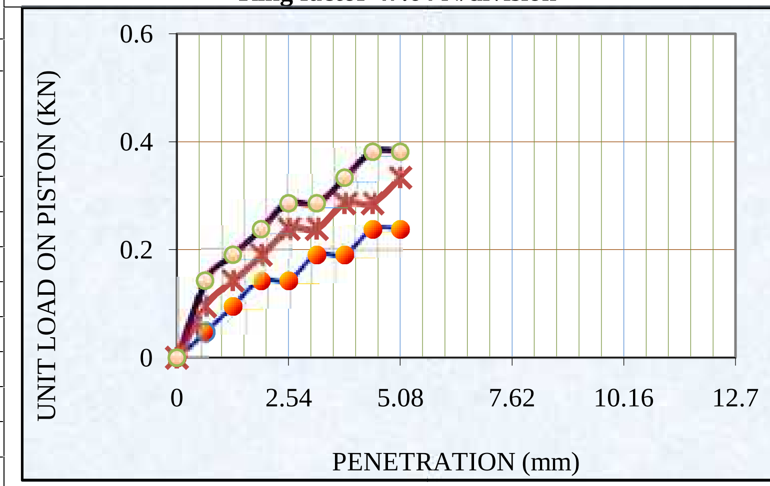
	Trial No.	1	2	3	4	
Density	Mold + Wet soil (gm)	8945	9060	9110	9030	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3943	4058	4108	4028	
	Wet Density (g/cm^3)	1.86	1.91	1.93	1.90	
Moisture	Container No.	13	28	I	E-1	B-14
	Wet Soil + Con. (g)	151	170.2	166.3	168.4	174
	Dry Soil +Con. (g)	130.7	145.5	141.9	142.1	158
	Mass of Con. (g)	40	42	42	40	43
	Mass of Moisture (g)	20.3	24.7	24.4	26.3	16
	Dry Soil (g)	90.7	103.5	99.9	102.1	115
	Moisture cont. (g/cm^3)	22.38	23.86	24.42	25.76	13.91
Dry Density (g/cm^3)		1.52	1.54	1.55	1.51	



Experiment 33.4(CBR)

Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division

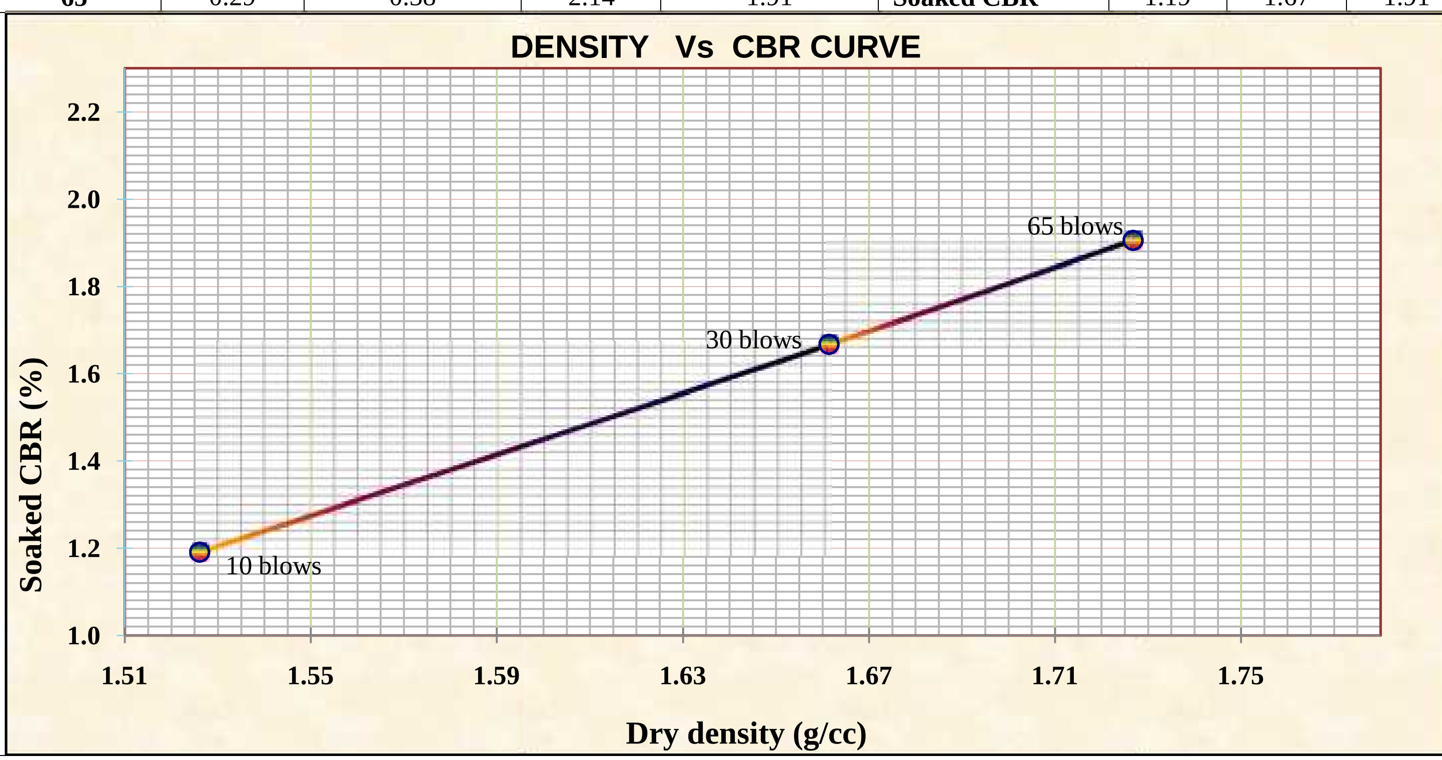


CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91

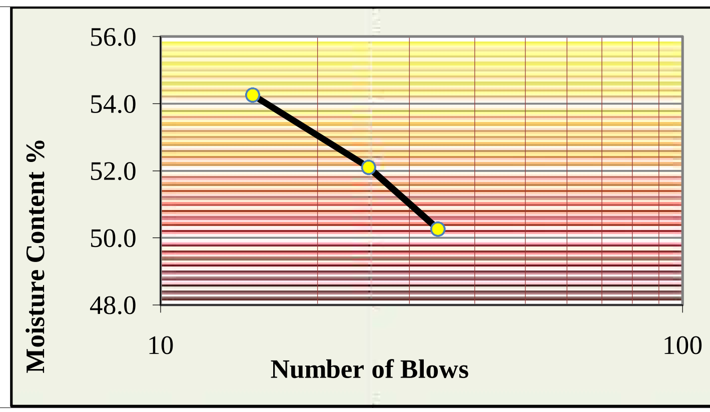


Experiment 34.1(Sieve Analysis for classification)

Sieve Size	Wt. Retained	% Retained	% Pass	Soil Classification
No.4	178.98	16.45	83.55	
No.10	107.16	9.85	73.70	A-7-6(18)
No.40	144.96	13.32	60.38	
No.200	100.76	9.26	51.12	

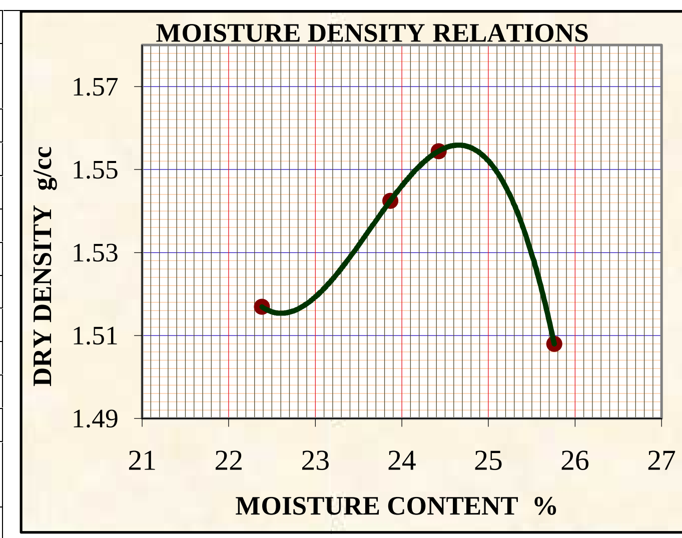
Experiment 34.2(Atterberg limit)

	Liquid Limit			Plastic Limit	
No. of Blows	34	25	15		
Container Number	A-4	A-7	A-1	A-11	A-10
Wet Soil +con (g)= (W1)	16.01	16.72	16.52	13.23	13.03
Dry Soil +con(g) = (W_2)	13.1	13.74	13.46	12.4	12.19
Mass of Con (g) = (W_3)	7.31	8.02	7.82	8.25	8.01
Weight of Moisture (g)	2.91	2.98	3.06	0.83	0.84
Dry Soil (g)	5.79	5.72	5.64	4.15	4.18
Moisture Content (%)	50.26	52.10	54.26	20	20.10
LL at 25 blow &Avg. PL	52				20.04



Experiment34.3 (Moisture Density Relationship of Soil

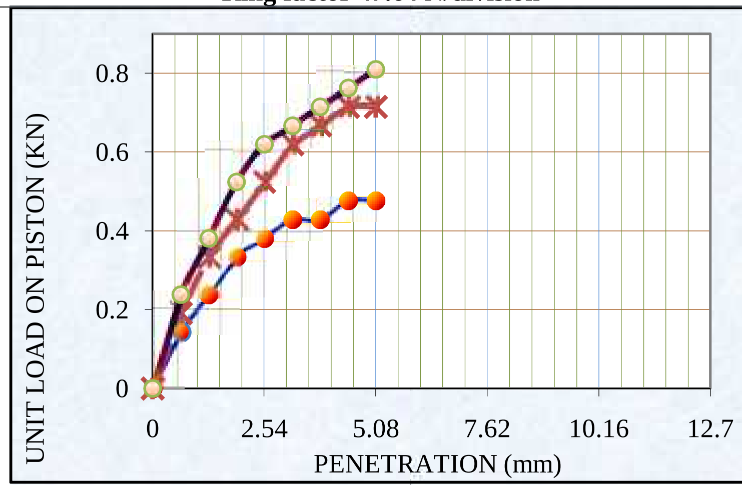
	Trial No.	1	2	3	4	NMC
Density	Mold + Wet soil (gm)	8945	9060	9110	9030	
	Mold (gm)	5002	5002	5002	5002	
	Volume (cm^3)	2124	2124	2124	2124	
	Wet Soil (gm)	3943	4058	4108	4028	
	Wet Density (g/cm^3)	1.86	1.91	1.93	1.90	
Moisture	Container No.	13	28	I	E-1	B-14
	Wet Soil + Con. (g)	151	170.2	166.3	168.4	174
	Dry Soil +Con. (g)	130.7	145.5	141.9	142.1	158
	Mass of Con. (g)	40	42	42	40	43
	Mass of Moisture (g)	20.3	24.7	24.4	26.3	16
	Dry Soil (g)	90.7	103.5	99.9	102.1	115
	Moisture cont. (g/cm^3)	22.38	23.86	24.42	25.76	13.91
Dry Density (g/cm^3)		1.52	1.54	1.55	1.51	



Experiment 34.4(CBR)

Penetration data						
	10 Blows		30 Blows		65Blows	
Penetration (mm)	Dial RDG	Load (KN)	Dial RDG	Load (KN)	Dial RDG	Load (KN)
0	0	0	0	0	0	0
0.64	1	0.05	2	0.10	3	0.14
1.27	2	0.10	3	0.14	4	0.19
1.91	3	0.14	4	0.19	5	0.24
2.54	3	0.14	5	0.24	6	0.29
3.18	4	0.19	5	0.24	6	0.29
3.81	4	0.19	6	0.29	7	0.33
4.45	5	0.24	6	0.29	8	0.38
5.08	5	0.24	7	0.33	8	0.38
7.62						

Ring factor 47.64 N/division



CBR Value at Standard Loads and CBR Test Summary

blows	Load (KN)		CBR (%)	
	2.57 mm	5.08mm	2.57 mm	5.08mm
10	0.14	0.24	1.07	1.19
30	0.24	0.33	1.79	1.67
65	0.29	0.38	2.14	1.91

Dry Density Vs Soaked CBR

BLOWS	10	30	65
Dry density	1.53	1.66	1.73
Soaked CBR	1.19	1.67	1.91