
# ADDIS ABABA UNIVERSITY

## SCHOOL OF GRADUATE STUDIES

## ADDIS ABABA INSTITUTE OF TECHNOLOGY
## SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

**PREDICTION OF SOAKED CBR VALUE FROM INDEX PROPERTIES AND COMPACTION CHARACTERISTICS OF SUBGRADE SOIL (FOR THE CASE OF JINKA-MENDIR DESIGN AND BUILD ROAD PROJECT)**

**By**

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# ABSTRACT

*The subgrade provides the foundation for the pavement material and should be well compacted to utilize its full strength. The subgrade strength is related to the CBR value of soil. The CBR test is laborious and time consuming and must always be performed on remolded soil samples. The CBR values depend on the type of soil as well as other soil properties. Hence, it is important to develop correlations between CBR and index properties for the subgrade soils.*

*In this research work, an attempt has been made to establish a correlation of CBR values as function of different index properties and compaction characteristics of soil specific to Jinka-Mendir design and build road project subgrade soils.*

*In order to achieve the intended correlations, a series of laboratory tests have been conducted on forty one soil samples. Based on the laboratory test results, the collected soil samples are categorized into two groups, namely coarse-grained and fine-grained soils. Accordingly, twenty five of the soil samples are classified as coarse-grained soils and the remaining sixteen soil samples are classified as fine-grained soils. This research work was done on twenty three coarse-grained soils and fourteen fine-grained soils with two control tests for both of the coarse-grained and fine-grained soils. For this research work, statistical software (SPSS) was employed to investigate the significance of individual independent variables.*

*Using multiple linear regression analyses, good correlations were obtained between soaked CBR and index properties test results for coarse-grained and fine-grained soils with coefficient of determinations of 0.866 and 0.931 respectively. After validating the developed correlation with control test results, it was noted that the correlations of CBR values with soil index properties are more applicable for preliminary characterizing of the strength of subgrade soils.*

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| | |
|---|---|
| D 60 | Diameter on the cumulative size distribution curve where 60 percent of particles are finer (mm) |
| PI | Plasticity Index |
| MR | Resilient Modulus |
| P200, | Percent Passing Sieve No. 200 (0.075mm Sieve Size) |
| R | Pearson Product Moment Correlation Coefficient |
| $R^2$ | Coefficient of Determination |
| wl | Liquid Limit |
| Wp | plastic limit |
| ws | shrinkage limit |
| w | Moisture Content |
| wPI | Weighted Plasticity Index |
| A | Standard Significant Error |
| ε | Statistical Random Error |
| $\sigma^2$ | Statistical Variance |

# LIST OF ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| AASHTO | American Association of State Highway and Transportation Officials |
| AMSL | Above Mean Sea Level |
| ASTM | American Society for Testing and Materials |
| CBR | Californian Bearing Ratio |
| CH | Clay of High Plasticity |
| CL | Low to Medium Plasticity of Inorganic Silts |
| FCBR | Field California Bearing Ratio |
| FDD | Field Dry Density |
| GC | Clayey Gravels |
| GI | Group Index |
| GM | Silty Gravels |
| GP | Poorly Graded Gravels |
| GW | Well-Graded Gravel |
| LI | Liquidity Index |
| LL | Liquid Limit |
| MDD | Maximum Dry Density |
| MIT | Massachusetts Institute of Technology |
| ML | Low Plasticity of Inorganic Silts |
| MH | High Plasticity of Inorganic Silts |
| NCHRP | National Cooperative Highway Research Program |
| OMC | Optimum Moisture Content |
| PI | Plastic Index |
| PL | Plastic Limit |
| S2 | ERA Subgrade class with a CBR Range of 3 to 4 |
| S3 | ERA Subgrade class with a CBR Range of 5 to 7 |
| S4 | ERA Subgrade class with a CBR Range of 8 to 14 |
| S5 | ERA Subgrade class with CBR Range of 15 to 29 |
| SI | Suitability Index of de-Graft Johnson Equation |
| USCS | Unified Soil Classification System |

# 1. INTRODUCTION

## 1.1 Background

California bearing ratio (CBR) is performed to determine the shear strength of subgrade soil which is used for the design of flexible pavement of runways of airfields, highways, etc. The subgrade provides the foundation for the pavement material and should be well compacted to utilize its full strength. The subgrade strength is related to the CBR value of the soil. The CBR is a standard and common test presently used in road construction [8].

CBR is actually an indirect measure that represents a comparison of the strength of subgrade, sub-base and base course material to the standard strength of crushed rock or limestone quoted in percentage values. CBR value is inversely proportional to the thickness of the pavement layers. If the subgrade is stronger, the CBR value is higher, so lesser pavement thickness is required and the lower CBR value of the subgrade can have a lot of thickness of pavement as compared to the subgrade that has higher CBR value [3]. The factor that affect CBR value of soil are maximum dry density, optimum moisture content and plastic index, etc.

To get soaked CBR value of a soil sample, it required around 4 days (96 hours), which makes CBR test time taking, costly and relatively requires large effort to conduct the test and it must always be performed on remolded soil samples. Due to these difficulties, the alternate method could be to correlate CBR with simpler test results such as soil index properties and compactions characteristics. These tests are much economical and rapid than CBR test. This thesis gives an overview to obtain a correlation between CBR value with soil index properties that are suited for Jinka-Mendir design and build road project subgrade soil [13].

Currently, many road construction projects and railway constructions are undergoing in the country. In light of this, the output of the proposed prediction will provide road authorities, railway authorities, consultants and contractors preliminary background information on the value of CBR, for a localized subgrade 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 Research Objective

### 1.2.1 General Objective

The objective of this thesis is to develop correlations to predict soaked California Bearing Ratio (CBR) value from soil index properties (i.e. liquid limit, plastic limit, plastic index, plastic product, plastic modulus and percent passing No.200 sieve) and compaction characteristics (i.e. optimum moisture content, maximum dry density) for representative soil samples recovered from different localities of Jinka-Mendir design and build road project.

### 1.2.2 Specific Objective

- To establish correlations between California Bearing Ratio and soil index properties.
- To identify soil properties that have a significant influence on the CBR values.
- To identify the model that can best predict CBR values from the index properties and compaction characteristics of soils.

## 1.3 Scope of the Study

In order to establish the correlation, forty one laboratory test results are used in this thesis work. The required correlation is carried out by applying regression analysis with the aid of SPSS Software. Furthermore, the scope of the developed correlation is limited to the test procedures followed in the subject research work.

The size of statistical data is the main factor that limits the applicability of the results obtained. The other limitation would be the location of sample collection. The limitation would be the location of sol sample. Since the CBR result is highly dependent on the moisture contents, maximum dry density of the material and the fact that the field moisture content keeps changing over time, the applicability will also be limited to the areas of the study. This is, therefore, the results obtained from these studies should be applied to the study area and the soil with similar classification with this study area.

## 1.4. Thesis Organization

The thesis is organized into seven Chapters. In the first chapter, "Introduction", the objective of the thesis is briefly outlined. The second Chapter, "Literature review", provides a summary of available information which is used for further experimental development in this research program. In the third Chapter, "Description of the study area", the study area is briefly described. In the fourth Chapter, "methods, data collection and laboratory test", discussions on sample collection and test results were outlined in detail for the experimental program for achieving the designated objective. Typical results of the tests are presented. In the fifth Chapter, "correlation and regression analyses were conducted", the results of the data analyses using the proposed model are discussed in detail. The sixth Chapter, "focuses on discussion, validating and evaluating the obtained correlation", the results of the developed correlation using the proposed model are discussed in detail. The seventh Chapter, "summary and conclusion", summarizes the findings from this research program and provides conclusion and recommendations regarding the direction for future.

## 1.6 Methodology

In order to achieve the objectives of the study the following methodology were adopted.

- Different litirature were assessed and reviewed.
- Satisfactory soil samples were collected from different locations of the road for utilizing the correlations and laboratory tests conducted.
- The index properties tests of the soils, compaction characteristics tests and CBR tests are carried out on soil samples selected from the road.
- The entire tests were performed according to AASHTO standard specifications and analysis of the same is performed accordingly.
- Statistical regression analyses and correlation were carried out and developed for the laboratory test result respectively and also the analyzed to fit the test results was performed.
- On the basis of the obtained results the discussion and suitability of correlation developed was evaluated
- Lastly, the conclusions and recommendations based on the result were done.

# 2: LITERATURE REVIEW

## 2.1 General

Ethiopia is currently undertaking massive infrastructural development (including roads and railway), urban development & extensive natural resources management. Roads are necessary for transportation and economic development of a country. In our Country many of the road network is flexible pavement. Typical flexible pavement have different layer from top to bottom such as surface layer, base course, sub-base and subgrade. The strength of subgrade material is used to design flexible pavement. Therefore, California Bearing Ratio (CBR) is one of the most commonly methods used to determine the strength subgrade material. The load transferred from the pavement surface is not exceeded the elastic limit. Hence, the suitability and stability of subgrade material are evaluated before construction of pavement. California bearing ratio value is considered as strength parameter in the design of pavement structure.

Among the various methods of evaluating the subgrade strength, a quick estimate of CBR is very important for highway engineer/geotechnical engineer so a simple test that can be used as an index test was devised. Thus index test is an indirect measure of stiffness and shear strength.

## 2.2 Subgrade Soil

Subgrade constitutes the foundation material for the pavement structures as highway pavements ultimately rest on the native soil (subgrade). Hence, the performance of the pavement affected by the characteristics of the subgrade. The subgrade properties are important in the pavement design structure. The main function of the subgrade is to provide support to the pavement against traffic loading and the subgrade used for this purpose should possess sufficient stability under adverse climate and heavy loading conditions. When soil is used in the embankment construction, the stability incompressibility is also an important factor due to the differential settlement may cause failures. Compacted and stabilized soil is often used as a sub base or base course. The soil or subgrade is therefore considered as one of the principal highway materials [3].

## 2.3. Properties of Soil

### 2.3.1 Index Properties of Soil

In nature, soil occurs in a large variety. Engineers are continually searching for simplified tests that will increase their knowledge of soils by employing a simple and rapid soil test. These simplified tests which are indicative of the engineering properties of soils are called index properties [8]. Index properties of cohesive soils are used to characterize the physical and mechanical behavior of soils by making use of parameters such as moisture content, specific gravity, particle size distribution, Atterberg limits, and moisture-density relationships. Such parameters are useful to classify cohesive soils and provide correlations with engineering soil properties [9].

### 2.3.2 Natural Moisture Content

Natural moisture content is the quantity of water contained in a soil such as the ratio of the weight of water to the weight of solid particles in a given soil mass expressed in percentage. The value of natural moisture content will vary depending on the nature of the soil, climate, and location of the groundwater table and the location of the soil sample, i.e. at or near the ground surface, deep in the ground. It is used to express its relative consistency or liquidity index. The moisture content test is carried out in the laboratory accordance with AASHTO T 265 or ASTM D 2216 procedure and in the field accordance with AASHTO T217 procedure.

### 2.3.3 Atterberg Limits

Basedon their mode of formation and mineralogical composition different soils respond differently for the same moisture content. Albert Atterberg, a Swedish Scientist in 1911 gave an idea of the consistency limit of cohesive soils and proposed a number of tests for defining their properties. The three Atterberg limits which are the liquid limit, plastic limit, and shrinkage limits are the boundary between each of the two consecutive states of the soil water phases [8].

The liquid limit is defined as the moisture content at which soil begins to behave as a liquid material and begins to flow on the application of a very small shearing force. Liquid limit is the moisture content were soil change from liquid state to a plastic state, plastic limit is the moisture contents were soil changes from a plastic to a semisolid state and Shrinkage Limit is the moisture content were soil change from a semisolid state to a solid state [8].

Their test is performed only on that portion of a soil which passes the 0.425mm (No.40) sieve [4]. A description of phases of the soil-water system is shown with a schematic diagram in Table 2. 1 TAtterberg limits Table **[4]**

| States | Limit | Consistency | Volume change |
|---|---|---|---|
| Liquid (Wi) | Liquid limit | Very soft | Decrease in Volume |
| Plastic (Wp) | Plastic Limit | soft | ↓ |
| Semi Solid (Ws) | | Very Stiff | |
| Solid | Shrinkage Limit | Extremely stiff and hard | Constant Volume |

### 2.3.4 Derived Plasticity Parameters

Derived plasticity parameters such as plasticity modulus (PM), plasticity product (PP) and shrinkage modulus (SM) are used to represent the effective contribution of the plasticity of the fines to the performance of the whole material and they depend on the proportion of fines in the material [22].

Plasticity modulus (PM) is defined as the product of plasticity index (PI) and percentages of soil fraction passing BS No 40 sieve (i.e., %< 0.425mm): %< 0.425mm = percentages of particle sizes less than 0.425mm

$$PM=PI \times (\%< 0.425mm)$$

Plasticity product (PP) is defined as the product of plasticity index (PI) and percentages of soil fraction passing BS No 200 sieve (i.e., % < 0.075mm): % < 0.075mm= percentages of particle sizes less than 0.425mm

$$PM=PI \times (\%< 0.075mm)$$

Shrinkage modulus (SM) is defined as the product of linear shrinkage (LS) and percentages of soil fraction passing BS No 400 sieve (i.e., % < 0.425mm):

$$PM=LS \times (\%< 0.425mm)$$

### 2.3.5 Grain Size Distribution Analysis

Grain size analysis is a process in which the proportion of material of each grain size present in a given soil is determined. The grain size test is conducted in order to obtain different grain sizes distribution of particles within the soil. It is expressed in terms of particles by weight finer than specified sizes. Gradation (sieve analysis) is carried out for soil particles larger than 0.075mm or coarser.

Sedimentation (hydrometer test) is conducted for smaller (finer) soil particles. Two methods are used to determine grain size distribution: 100 behiru

- ✓ Wet Sieve analysis for a coarse grained portion of the soil
- ✓ Hydrometer analysis for fine-grained portions.

**A) A wet sieve analysis (sieve analysis)**

For coarse-grained materials, the grain size distribution is determined by passing soil samples either by wet or dry shaken through a series of sieves placed in order of decreasing standard opening sizes and a pan at the bottom of the stock. Then the percent passing on each sieve is used for further identifying the distribution and gradation of different grain sizes [10]. Particle size analysis tests are carried out in accordance with AASHTO T-88 and ASTM D 422-63.

**B) Hydrometer analysis**

The distribution of different soil particles in a given soil is determined by a sedimentation process using a hydrometer test for soil passing 0.075mm sieve size. For a given cohesive soil having the same moisture content, as the percentage of finer material or clay content decreases the shear strength of the soil possibly increases.

## 2.4 Moisture-Density Relationship

Compaction is one of the most significant components in the construction of roads, airfields, embankments, and foundations. The durability and stability of most structures depends up on the achievement of proper soil compaction. Compaction increases the strength characteristics of soils, which in turn increases the bearing capacity of foundations, decreases the amount of excessive settlement of structures, and increases the stability of slopes of embankments.

Compaction characteristics of soils depend up on many factors such as water content of the soils, amount of compaction energy, soil type and method of compaction. The moisture content of a soil affects its dry density [8]. A soil with very low water content is difficult to compress into close state of particles. This results in higher void ratio and hence lower dry density for the same compaction effort. On the other hand when the water content increases excessively, the soil grain tends to move apart and the total void ratio continues to increase whereas the dry density falls. However, if the moisture content of the soil is of some intermediate specific value, the water acts as lubricant causing the soil to soften and become more workable. In this case the soil grains are close packed thus lowering the void content and increasing the dry density [8]. This specific value of moisture is called optimum water content and the corresponding dry density termed as maximum dry density.

The laboratory standard proctor and modified Proctor tests are performed as per (AASHTO T 99 or ASTM D 698) and (AASHTO T 180 or ASTM D 1557) respectively. The tests are performed on disturbed samples of soil particles passing sieve sizes 4.75mm or 19mm mixed with water to form samples at various moisture contents ranging from the dry state to wet state. These samples are compacted in three or five layers at 25 blows or 56 blows per layer in accordance with the specified nominal compaction energy of standard or modified proctor test respectively. Dry density is determined based on the moisture content and the unit weight of compacted soil. The corresponding water content at which the maximum dry density occurs is termed as the optimum moisture content [11].

Grading and Atterberg limits alone are not sufficient to qualify the performance of construction materials since the variation of moisture content and density play a considerable role. Different researches show that the moisture content and density conditions have a greater influence, on the value of shear strength of soil, on coarser materials than fine-grained materials

## 2.5 Soil Classifications

Soils are widely varied in their grain-size distribution. Also, depending on the type and quantity of clay minerals present, the plastic properties of soils may be very different. Various types of engineering works require the identification and classification of soils in the field. In the design of foundations and earth retaining structures, construction of highways, and so on, it is necessary for soils to be arranged in specific groups and/or subgroups based on their grain-size distribution and plasticity. The process of placing soils into various groups and/or subgroups is called soil classification[8]. Classifying soils into groups with similar behavior, in terms of simple indices, can provide geotechnical engineers general guidance about engineering properties of the soils through the accumulated experience. Soils may be classified as follows:

- ✓ Soil classification based on grain- size
- ✓ Soil classification based on both grain- size and Atterberg limits

## 2.6 California Bearing Ratio

The CBR values obtained from either laboratory tests or in-situ (field tests) have been correlated with flexible pavement thickness requirements for highways and airfields. Its purpose was to provide an assessment of the relative stability of fine crushed rock base materials. The test has been modified since then and extended to subgrades. It is now widely used for evaluating the stability or strength of subgrade soil and other flexible pavement materials for pavement design throughout the world[13].

The load is applied by cylindrical metal plunger of 50 mm diameter, the standard penetration rate used is 1.27mm/minute and readings of the applied load are taken at appropriate intervals of penetration (0.5mm, 1.27mm (0.5")) up to a total penetration of usually not more than 7.5 mm 12.7mm. The CBR is then determined by reading off from the curve the load that causes a penetration of 2.54 mm and 5.08mm dividing this value by the standard load (13.34kN) and 20kN required to produce the same penetration in the standard crushed stone as

$$CBR = \left\{ \frac{\text{Test load penetration in test specimen}}{\text{Standard penetration in crushed rock)}} \right\} *100$$

### 2.6.1 Test Methods

The California Bearing Ratio (CBR) test can be carried out both in the laboratory and field. The samples may be prepared in three different ways. Accordingly,

(i) The test can be performed on a remolded sample in the laboratory,

(ii) On undisturbed sample carefully extracted from the field and trimmed to closely fit the standard mould in the laboratory and,

(iii) An in-situ sample which is entirely tested on the field.

### 2.6.2 Laboratory Testing

The laboratory test of CBR is carried out in accordance AASHTO T 193-63 or ASTM D 1883-73. The laboratory test can be performed on a remolded sample or on the undisturbed sample. Remolded samples are prepared from the values obtained from modified proctor test result such as optimum moisture content and maximum dry density.

While performing laboratory CBR test, load is applied by cylindrical metal plunger of 50 mm diameter, the standard penetration rate is 1.27mm/minute and readings of the applied load are taken at appropriate intervals of penetration 0.5mm up to a total penetration of 12.7mm

The CBR is then determined by reading off from the curve the load that causes a penetration of 2.54 mm and 5.08mm dividing this value by the standard load (13.34kN) and 20kN required to produce the same penetration in the standard crushed stone multiplied by 100. The CBR value ranges from Zero to Hundred. Zero (0) CBR value shows the worst case and hundred (100%) shows best value

If the CBR at 5.08 mm penetration is greater than that at 2.54mm penetration the entire test should be repeated on a fresh sample. If the 5.08 mm pen. CBR in the repeat test is still greater, then it is accepted as the CBR of the soil where as if the bearing ratio of 2.54 mm is greater than 5.08mm the design bearing ratio is the value at 2.54 mm penetration. A typical laboratory CBR apparatus is shown in Figure 2.1.

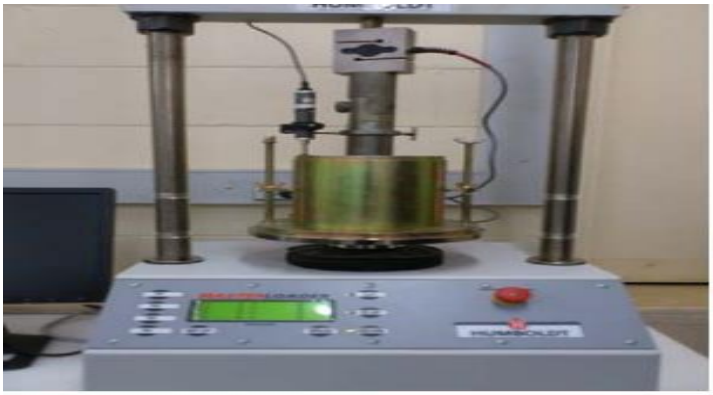

Figure 2. 1 Laboratory CBR Test Apparatus

## 2.7 Previously Established Correlation Equations

Correlations are very important to estimate engineering property of soils, especially for preliminary investigation of projects. Correlations may be also used for projects where there is a financial limitation, lack of test equipment and limited time [13, 15].

Several investigators attempted to develop correlations for prediction of CBR in terms of either index properties, compaction characteristics of soil or combination of both for specific region and soil type. For universally accepted soil classification systems such as American Association of State Highway and Transportation Officials (AASHTO) and the Unified Soil Classification System (USCS) general relationships were also developed. These correlation methods guide general approach and attempt to encompass many possible soil types. The predicted and experimental values of CBR of various soils have been used to check the applicability and limitation of available methods [21].

### 2.7.1 Typical Values Based on the Unified Soil Classification System

The simplest approach to appropriate the CBR values for soil centers on typical values associated with soil classification. The Unified Soil Classification System is a standardized technique for classifying soils for engineering purposes [10]. Within this system, soils are classified based on the distribution of their grain sizes and the plasticity characteristics of the cohesive material such as liquid limit, plasticity index. The Unified Soil Classification (USC) system, soils are divided in three categories; coarse-grained (either gravel or sand), fine-grained (either silt or clay) and highly organic soils and it shall be used when precise classification is required. The USCS system uses to represent the soil types, symbols and the index properties of the soil are shown under Table 2.2.

Table 2. 2 Unified Soil Classification System Symbol and Index Properties [**3]**

| Soil Type | Symbol | Symbol | Index Property |
|---|---|---|---|
| Gravel | G | W | Well-Graded (for grain size distribution) |
| Sand | S | | |
| Silt | M | P | Poorly-Graded |
| Clay | C | | |
| Organic Silts and Clay | O | L | Low to Medium plasticity |
| Highly Organic Soil and Peat | Pt | H | High Plasticity |

Soil groups are developed by combining symbols for two categories listed in Table 2.2, such as GW, SM, and so forth.

Guidelines for choosing CBR values based solely on USCS soil type are found throughout different literature. A variety of USCS class soils are associated with a range of CBR values by different researchers and research institutes. A summary of reported values from several of these sources is shown in Table 2.3. Generally, these are consistent for each soil type, with minor differences among the reported values. Part of this variation may be due to the fact that some refer to compacted soils, others refer to field-measured CBR values, while some do not specify test conditions [5].

Table 2. 3: Typical California Bearing Ratio Values by USCS [5]

| USCS Soil Type | USACE, US Army and Air Force | Yoder & Witczalk | US Army, Air Force and Navy and PCA | Rollings & Rollings | NCHRP* |
|---|---|---|---|---|---|
| GW | 40 – 80 | 60 – 80 | 60 – 80 | 60 – 80 | 60 – 80 |
| GP | 30 – 60 | 35 – 60 | 25 – 60 | 35 – 60 | 35 – 60 |
| GM | 20 – 60 | 40 – 80 | 20 – 80 | 40 – 80 | 30 – 80 |
| GC | 20 – 40 | 20 – 40 | 20 – 40 | 20 - 40 | 20 – 40 |
| SW | 20 – 40 | 20 – 40 | 20 – 40 | 20 - 50 | 20 – 40 |
| SP | 10 – 40 | 15 – 25 | 10 – 25 | 10 - 25 | 15 – 30 |
| SM | 10 – 40 | 20 – 40 | 10 – 40 | 20 - 40 | 20 – 40 |
| SC | 5 – 20 | 10 – 20 | 10 – 20 | 10 - 20 | 10 – 20 |
| ML | 15 or less | 5 – 15 | 5 – 15 | 5 – 15 | 8 – 16 |
| CI | 15 or less | 5 – 15 | 5 – 15 | 5 – 15 | 5 – 15 |
| OL | 5 or less | 4 – 8 | 4 – 8 | 4 – 8 | -- |
| MH | 10 or less | 4 – 8 | 4 – 8 | 4 – 8 | 2 - 8 |
| CH | 15 or less | 3 – 5 | 3 – 5 | 3 – 5 | 1 - 5 |
| OH | 5 or less | 3 – 5 | 3 – 5 | 3 – 5 | -- |
| Pt | -- | -- | -- | < 1 | -- |
| CL-ML | -- | -- | -- | -- | -- |
| GW-GM | -- | -- | -- | -- | 35 - 70 |
| GW-GC | -- | -- | -- | -- | 20 - 60 |
| GP-GM | -- | -- | -- | -- | 25 - 60 |
| GP-GC | -- | -- | -- | -- | 20 - 50 |
| GC-GM | -- | -- | -- | -- | |
| SW-SM | -- | -- | -- | -- | 15 – 30 |
| SW-SC | -- | -- | -- | -- | 10 – 25 |
| SP-SM | -- | -- | -- | -- | 15 – 30 |
| SP-SC | -- | -- | -- | -- | 10 – 25 |
| SC-SM | -- | -- | -- | -- | -- |

### 2.7.2 National Cooperative Highway Research Program [2001]

The National Cooperative Highway Research Program of the United States of America through Mechanistic-Empirical Design Guide and Rehabilitated Pavement Structure had developed correlations that describes the relation among soil index properties and CBR values based on a simple regression approach. Separate relationships were determined for coarse-grained soils that exhibit non-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) [14].

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 a typical value for that USCS soil type. The percent passing sieve number 200 and the plasticity index parameters were combined into a composite index called the weighted plasticity index (plastic product) [3]. This term, denoted by wPI, is defined as shown in equation (2.1).

$$wPI = (\text{Percent passing No. 200 Sieve}) \times (\text{Plasticity Index}) = P200 \times PI \quad (2.1)$$

For the clean, coarse-grained, non-plastic soils where wPI = 0, the CBR were correlated with D60. The best-fitted equation proposed by NCHRP for clean, coarse-grained soil provides the following prediction relationship:

$$CBR = \begin{cases} 5 & (\text{if } D60 \le 0.01\text{mm}) \\ 28.09(D60)^{0.358} & (\text{if } 0.01\text{mm} < D60 < 30\text{mm}) \\ 95 & (\text{if } D60 \ge 30\text{mm}) \end{cases} \quad (2.2)$$

Where: - $D_{60}$ Diameter of the cumulative size distribution 60% of particles are finer (mm)

- $P_{200}$ Percent passing (finer than) the number 200 sieve size (in decimal form)

For the second group of soils that exhibit plastic behavior, a different correlation for CBR was determined. In cases where the soil has fine content, percent passing sieve No. 200 greater than twelve percent and the weighted plasticity index (wPI) value is different from zero, the prediction equation will be:

$$CBR = \frac{75}{1+0.728(wPI)} \quad (2.3)$$

Where: - wPI Weighted Plasticity Index

- PI Plasticity index (in percent)

The coefficient of determination $R^2$, values of the above stated two equations were reported as 0.84 for the coarse-grained materials of equation (2.2) and 0.67 for the fine grained materials of equation (2.3) [14].

### 2.7.3 Correlation Specific to a Region and Soil Type

Now days, many attempts to correlating the California Bearing Ratio with index properties for a specific region and soil type has been found in different literature. The under listed published correlations regarding to correlate the CBR value of a given soil with its index properties of specific location and soil type.

Correlations of CBR with different index properties have been made by different researchers. However, the validity and applicability of such correlations need to be established for their acceptance in general practices. The predicted and experimental values of CBR of various soils have been used to check the applicability and limitation of available methods.

The model developed from simple multiple regression analysis recently developed by different investigators as CBRs= f (F, S, G, LL, PL, MDD, and OMC) and a typical Model equation is as follows.

$$CBRs= 0.064F+0.082S+0.033G-0.069LL+0.157PL-1.810MDD-0.016OMC \quad (2.4)$$

From the above developed correlation equation (2.4) the CBR values were predicted. The predicted CBR values and experimental CBR value are close to each other. The developed Correlations are very important to estimate engineering property of soils, especially for preliminary investigation of projects and rapid method of determining CBR value of the subgrade soil [17].

The correlation developed by **Agarwal and Ghanekar** is defined as follows:

$$CBR = 2 - 16Log (OMC) + 0.07LL \quad (2.5)$$

Where: - OMC Optimum Moisture Content of the soil
- LL Liquid Limit of the soil

The 48 soil samples tested by them had CBR values not more than 9% and the standard deviation obtained was 1.8. Hence, they suggested that the correlation is only of sufficient accuracy for preliminary identification of material. They also recommended that this correlation may be of more use of derived for specific geological regions [14].

A correlation of CBR with plasticity and grading using the concept of suitably index was developed by de Graft-Johnson and Bhatia (1969) on the Ghana lateritic soil. In this case, the relationship between CBR and suitability index is shown as follows [14]

$$CBR = (35*SI) - 8 \quad (2.6)$$

$$SI = A/LL (LogPI) \quad (2.7)$$

**Leliso Y. [10]:-** The suitable correlation between CBR values and index properties of subgrade soils in the Northern, North-East and North-West parts of Addis Ababa was carried by Leliso Y. [10]. The previous research [10] performed his research on 42 samples of fine-grained soils found in Addis Ababa, on the basis of which he has developed a correlation between CBR values and index properties. For the developed correlation the single regression analysis and multiple regression analysis are performed. From the developed single regression model by the researcher, based on the coefficient of determination ($R^2$), CBR values correlates relatively better with liquid limit than the plasticity index.

$$CBR=16.27-0.179*LL, \text{ with } R^2=0.458, \quad N=42 \tag{2.8}$$

From the multiple regression model developed by the researcher, on the basis of the coefficient of determination ($R^2$), CBR values of a given soil relatively better correlation with combined maximum dry density, liquid limit and plastic index,. From the researcher's findings, Model C indicated that the relationship developed between CBR with LL, PL, and MDD is moderately correlated than all the rest of the model.

$$CBR= -21.734-0.190*LL-0.137*PL+20.244*MDD, \text{ With } R^2 =0.629, N=42 \tag{2.9}$$

**Bekele A [21]:** The suitable correlation between CBR values and index properties of the Sululta Town soils was carried by Bekele A. [21]. The researcher performed his research using 31 samples of laboratory test results of fine-grained soils, the soil samples collected from different locations in Sululta Town. The soils samples categorized into red and black/gray clay soils depending on laboratory test results and the correlations were done independently for two categories. Using the obtained Thirty one test results a single and multiple regressions model were performed and a correlation was developed that predicts CBR value on the basis $PP_{200}$, LL, and LI.

Among Thirty one soil samples, eighteen of the soil samples are classified as Red clay soils and the remaining nine samples are classified as black/gray clay soils. His research work is done on eighteen red clay soils and nine black/gray clay soils with two control tests for both of the red clay and black/gray clay soils.

From the results of linear and multiple regression analysis, an improved correlation of multiple regressions than single regression is obtained as given below:

$$CBR = -0.050LL - 0.50LI + 0.021PP_{200} + 4.625 \quad R^2 = 0.319 \quad N = 18 \text{ (for red clay)} \qquad (2.7)$$

$$CBR = -0.049LL - 0.910LI - 0.015PP_{200} + 0.46PP_{200} + 8.205$$

$$R^2 = 0.720 \quad N = 9 \text{ (for Black/Gray clay)} \qquad (2.8)$$

Based on critical observation the previous researcher has done correlations of CBR with index properties for fine grained soils, and the current research tried to fill a gap of research similarly on fine-grained and coarse-grained soils of forty one samples in the study area in our country.

# 3. DESCRIPTION OF STUDY AREA

## 3.1 Location of Study Area

The location of the study area of the road project is entirely located in the Southern parts of Ethiopia, SNNP regional state, South Omo Zone, South Ari Wereda. It starts at Jinka town (E=232231, N=638234) and ends at Mendir village(E=221822, N=661068) and is part of the Jinka – Hana road which links the existing Sodo-Arbaminch-Jinka and Sodo-Sawla-Laska-Salayish-(Hana)-Omo Roads.

The first section of the road from Jinka town to Tolta village is part of the existing DS6 standard gravel road that connects Jinka town (administrative seat for South Omo zone) with Laska town (administrative seat for neighboring Basketo woreda) while the section between Tolta and Mendir village is a recently constructed URRAP road. The purpose of the road project is to provide fully upgraded asphalt concrete standard road that will connect Jinka town with Minder village and provide access to villages and large rural settlement areas in between these towns. It also serves the traffic that transports sugar from Kuraz Sugar Factories to the central parts of the country. The project road provides access to towns and villages along the project road such as Jinka town, Yetnebersh village, Gazer town, Mitsir town, Tolta town and Mendir village.

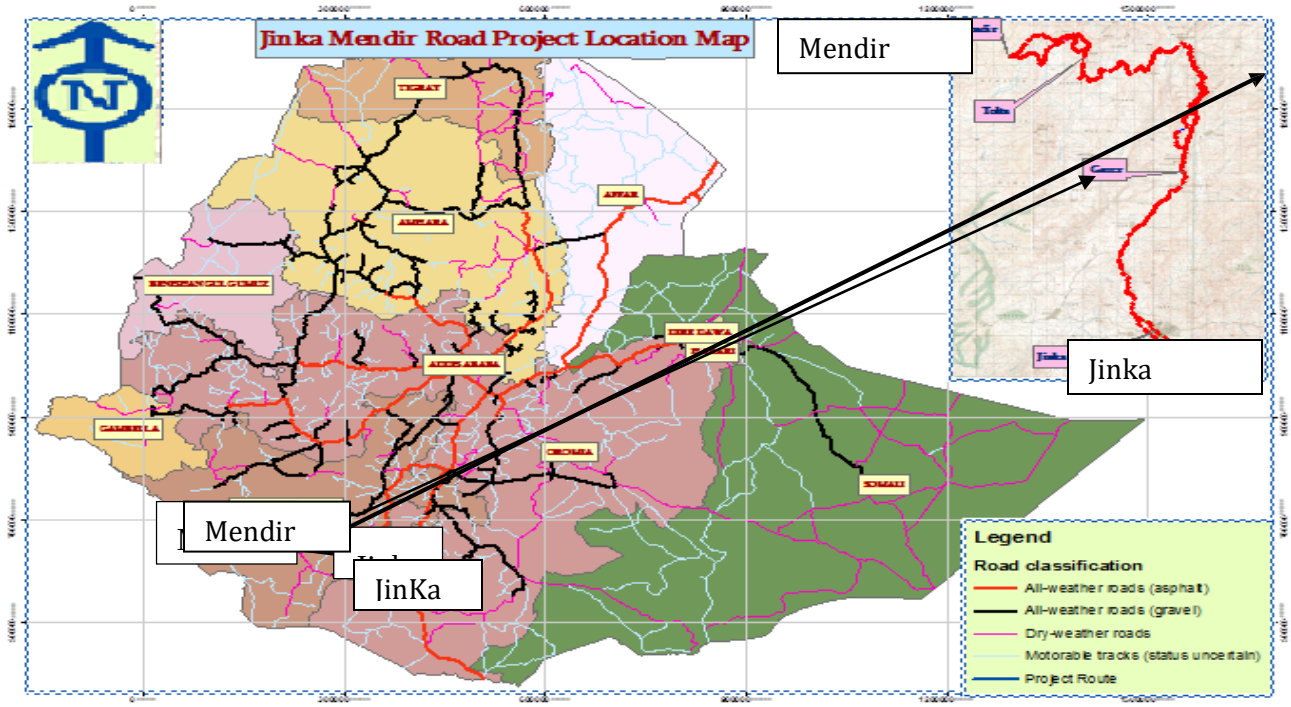


Figure 3. 1 Location Map of the Project

### 3.2.2 Temperature

Monthly maximum and minimum temperature recorded data in the vicinity of the project route, at Jinka Town are presented in the following tables.

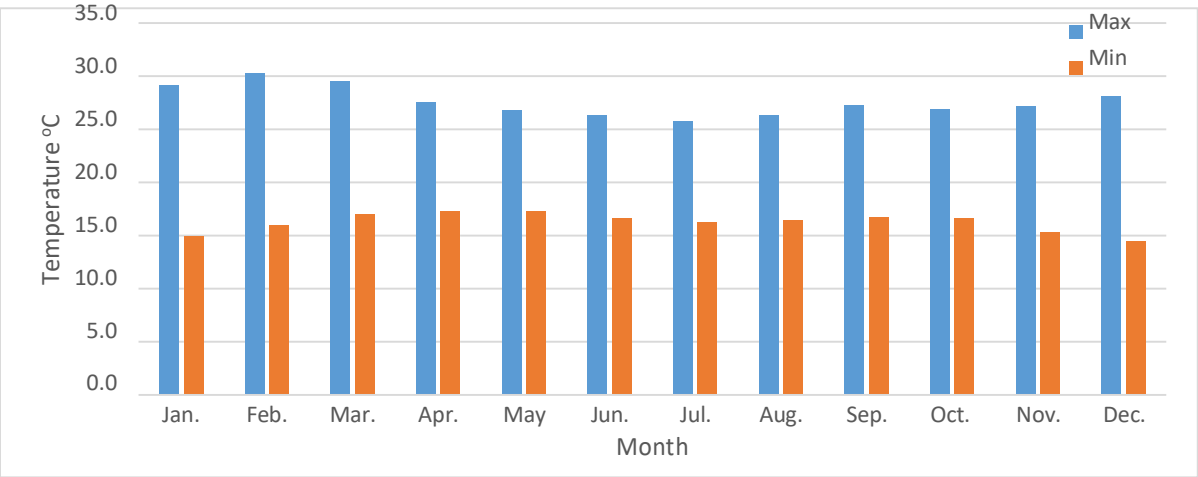


Figure 3. 2: Maximum and Minimum Temperature at Jinka **[19]**

### 3.2.3 Rainfall

The temperature of the study area normally varies from warm to moderately cold (cool) in most of the times of the year depending on the elevation difference between the sections of the road. The maximum mean monthly rainfall occurs in the project area in the months of April and October.

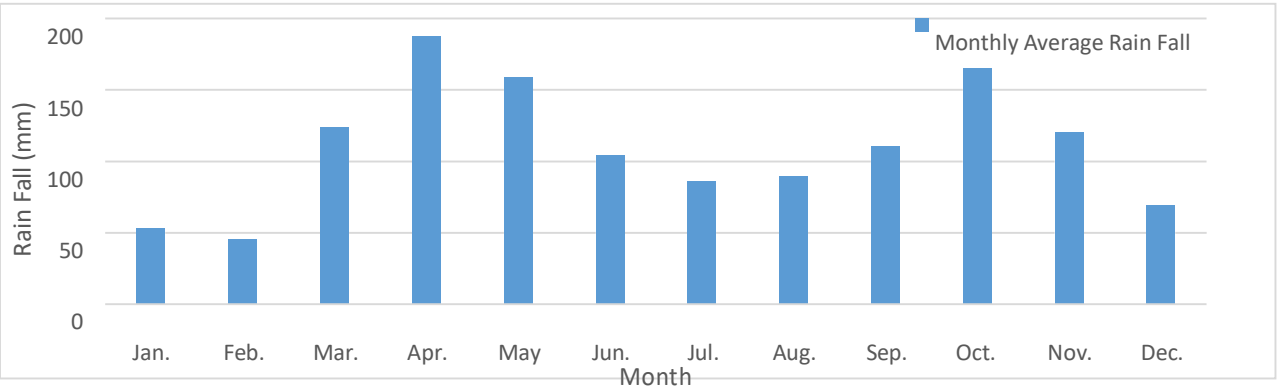


Figure 3. 3: Mean Monthly Rainfall of the Project Area **[19]**

# 4. METHODS, DATA COLLECTION, AND LABORATORY TESTS

## 4.1 General

Detailed site survey and investigation works have been conducted to assess the overall condition of the project road corridor and to collect the relevant information required for the target analysis. The site investigation is mainly required to determine the physical characteristics of alignment soil for road construction. The detailed field investigation work of the road project includes the soil extension survey and sampling of existing subgrade material for appropriate testing [3].

## 4.2 Sample Collection

To determine the engineering properties and target analysis, laboratory tests were conducted on soil samples obtained from different locations along the road alignment of the Jinka-Mendir design and build road project. In order to have sufficient and reliable data for the target analysis representative disturbed samples were collected by digging test pits along the road alignment, the depth of excavation was dependent on the existing condition of the ground. In some places, boulder is encountered and in other places the projects already have been excavated, on average the sample was taken at the appropriate level of the subgrade which means below 1.2m and designed subgrade level.

A total of forty one disturbed samples were gathered within a reasonable sampling interval on the basis of soil extension survey, visual identification of suitable subgrade soil and the lithological soil formations and properly logged.

## 4.3 Laboratory Test Methods

Samples of the materials retrieved from the road project were transported to Bocumar Camp Laboratory found at Jinka Town. The Bocumar Camp of Jinka Town laboratory is constructed for Jinka-Minder design and build road project for the joint material testing laboratory of United Consulting Engineers Plc. (UNICONE) is the supervision consultant and Ethiopian Construction Works Corporation (ECWC) is the Contractor. All laboratory tests on the forty one samples were conducted at the Bokumar Camp laboratory. All tests conducted during my stay on monthly basis site visits on the above mentioned road projects by representing ERA as counterpart engineer to

monitor and manage the project and parties to each contract to ensure that it realizes the projects as conceived and ensure that the engineer supervises the works in accordance with the contract. The following tests were conducted on existing subgrade soil samples as indicated in Table 4.1.

Table 4. 1: Laboratory Test Description and Procedure Used

| TEST DESCRIPTION | TEST PROCEDURE |
|---|---|
| LIQUID LIMIT | AASHTO T-89 |
| PLASTIC LIMIT | AASHTO T-90 |
| SIEVE ANALYSIS | AASHTO T-88 |
| MOISTURE DENSITY RELATIONSHIPS | AASHTO T-180 |
| CBR (MODIFIED, 4 DAYS SOAKING WITH 4.5KG HAMMER) | AASHTO T-193 |

## 4.4 Laboratory Test Results and Interpretation

The above conventional tests were conducted on the forty one soil samples during my stay on monthly basis site visits on the above mentioned road projects by representing ERA as counterpart engineer and a range of test results achieved. Using the Atterberg limit and grain size analysis test results, the soil samples are classified as fine-grained soil and coarse-grained soil in accordance with AASHTO soil classification system. This system is generally used for classification of subgrade soils for the highway pavements.

Among forty one soil samples, twenty five of the soil samples are classified as coarse grained soils and the remaining sixteen samples are classified as fine grained soils. This research work is done on twenty three coarse grained soils and fourteen fine grained soils with two control tests for both of the coarse grained and fine grained soils.

In accordance with AASHTO soil classification, the soil is mainly classified as A-2-7, A-7-5,A-4 and also pursuant to USCS classification system about 30 samples have been classified as SM and the remaining soils classified as MH, CH, SC, and CL. Out of the three groups of AASHTO classification, A-2-7 comprise 61% of the subgrade material (the largest proportion) which is followed by A-7-5 and A-4 materials which constituent 34.1% and 4.9% of the subgrade soil respectively.

From the conventional Atterberg limit tests, the variation of plasticity index (PI) and liquid limit (LL) along the project road are presented in Table 4.6. It can be seen from the table that the values of PI range from 8% to 30%, while that of the Liquid limit range from 24% to 73%.

Compaction tests were carried out for all soil samples collected from the site. The test was carried out in accordance with AASHTO T180. The maximum dry density (MDD) value along the alignment ranges between 1.33 g/cm$^3$ to 1.97 g/cm$^3$ and the optimum moisture content (OMC) along the road alignment varies from 10.3% to 33.5%.

Soaked CBR tests were carried out on disturbed soil samples recovered from the pits along the road alignment to determine the shear strength of the sub-grade material. Three-point CBRs were undertaken in accordance with AASHTO T-193 to determine the variation of subgrade strength with increasing compaction effort. The CBR values at 95% of MDD along the road alignment vary between 3.2% to 23.8%. 75.61% of the CBR values were greater than or equal to 5% and the remaining 24.39% of the CBR values were less than 5%. This implies that the majority of the road section has a subgrade class of S3, S4, and S5 as per the ERA subgrade class.

For the purpose of illustration and ease of reference, typical test results of soil samples are presented hereunder from Figures 4.1 to 4.4 and Table 4.2 to 4.5.

Table 4. 2: Typical Soil Consistency Test Result

| **Description** | **1.1 LL** | | | | **1.2 PL** | |
|---|---|---|---|---|---|---|
| Blows No. | **33** | **28** | **23** | **20** | | |
| Can No. | **12** | **16** | **22** | **93** | **22.00** | **96.00** |
| Wt. of Can + Wet Soil (g) = (W1) | **50.10** | **49.10** | **43.80** | **46.40** | **25.00** | **25.60** |
| Wt. of Can + Dry Soil (g) = (W2) | **41.00** | **40.20** | **35.03** | **36.70** | **23.45** | **23.75** |
| Wt. of Can (g) = (W3) | **23.20** | **23.80** | **19.10** | **19.70** | **19.10** | **18.70** |
| Wt. of Moisture (g) = (W1 - W2) = A | **9.10** | **8.90** | **8.77** | **9.70** | **1.55** | **1.85** |
| Wt. of Dry Soil (g) = (W2 - W3) = B | **17.80** | **16.40** | **15.93** | **17.00** | **4.35** | **5.05** |
| *W* (%) = (A / B )x 100 | **51.12** | **54.27** | **55.05** | **57.06** | **35.63** | **36.63** |
| **1.3 PI =LL-PL=54-36=18** | | | | | | |

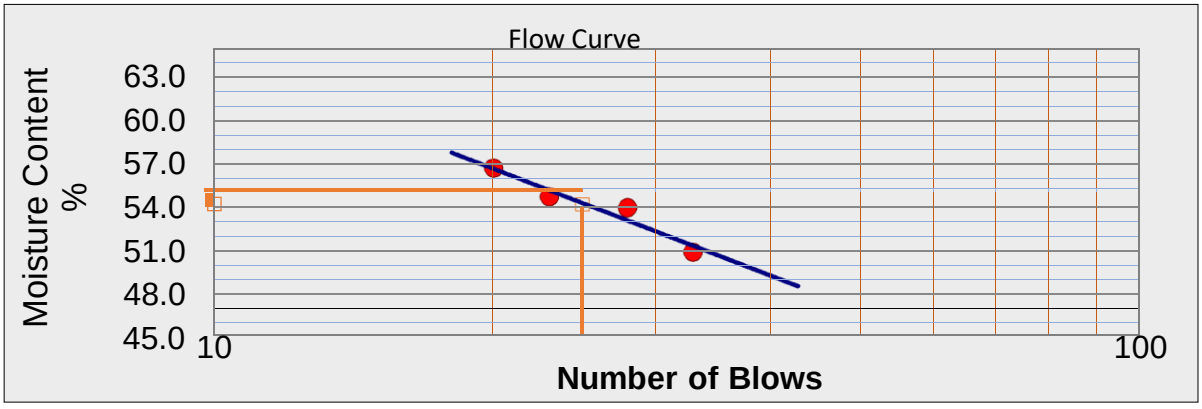


Figure 4. 1: Typical Liquid Limit Plot (Flow Curve)

Table 4. 3 Typical Moisture Density Relationship of Soil

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. of Soil + MOULD (g) $W_1$ | 8640.0 | 9020.0 | 9285.0 | 9120.0 | |
| | Wt. of MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | Vol. of MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. of wet Soil (g) $W_3 = W_1-W_2$ | 3,680 | 4,060 | 4,325 | 4,160 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.73 | 1.91 | 2.04 | 1.96 | **NMC** |
| **1.3.2 Moisture Content and Dry Density Determination** | | | | | | |
| MOISTURE | Can No. | Y | W | K | J | X |
| | WET SOIL + Can (g) a | 250.1 | 232.8 | 235.9 | 222.4 | 218.7 |
| | DRY SOIL + Can (g) b | 230.1 | 208.6 | 203.7 | 188.0 | 214.0 |
| | Wt. of Can (g) c | 26.0 | 28.4 | 22.9 | 28.4 | 28.9 |
| | Wt. of Water (g) d = a-b | | | 20.0 | 24.2 | 32.2 |
| | Wt. of Dry Soil (g) e =b-c | 204.1 | 180.2 | 180.8 | 159.6 | 185.1 |
| | ***W*** **(%) m= (d/e)*100** | 9.80 | 13.43 | 17.81 | 21.55 | 2.54 |
| **DRY DENSITY ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.58 | 1.69 | 1.73 | 1.61 | |

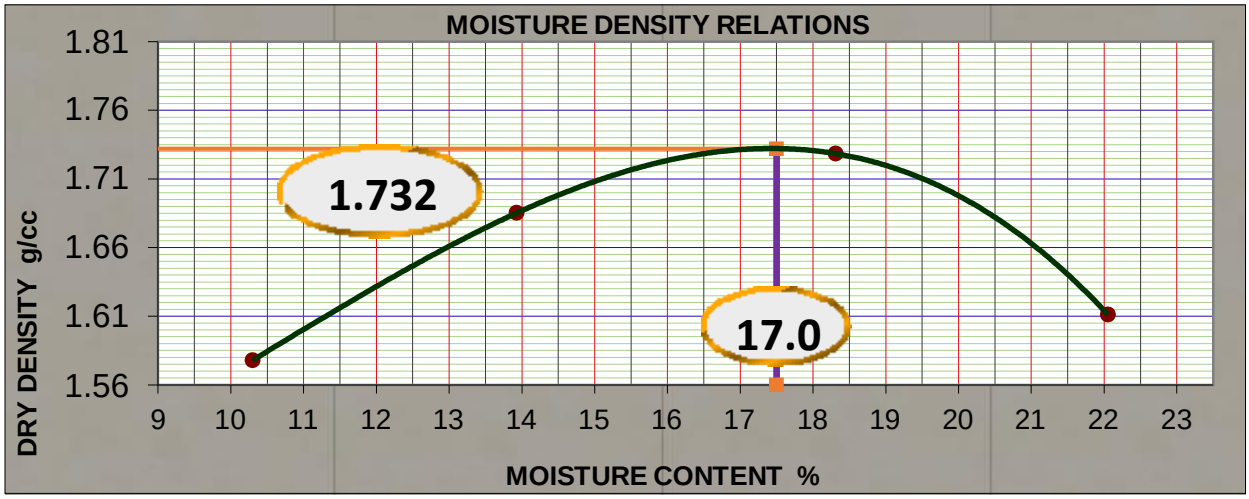


Figure 4. 2: Typical Density vs. Moisture Content Relationship Plot

Table 4. 4: Typical Penetration Test Data

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 32.0 | 0.542 | 52.0 | 0.880 |
| 1.27 | 17.0 | 0.288 | 60.0 | 1.016 | 89.0 | 1.507 |
| 1.91 | 22.0 | 0.372 | 83.0 | 1.405 | 120.0 | 2.032 |
| 2.54 | 26.0 | 0.440 | 100.0 | 1.693 | 143.0 | 2.421 |
| 3.18 | 29.0 | 0.491 | 115.0 | 1.947 | 160.0 | 2.709 |
| 3.81 | 32.0 | 0.542 | 123.0 | 2.082 | 174.0 | 2.946 |
| 4.45 | 35.0 | 0.593 | 133.0 | 2.252 | 188.0 | 3.183 |
| 5.08 | 37.0 | 0.626 | 138.0 | 2.336 | 202.0 | 3.420 |
| 6.35 | 41.0 | 0.694 | 145.0 | 2.455 | 213.0 | 3.606 |

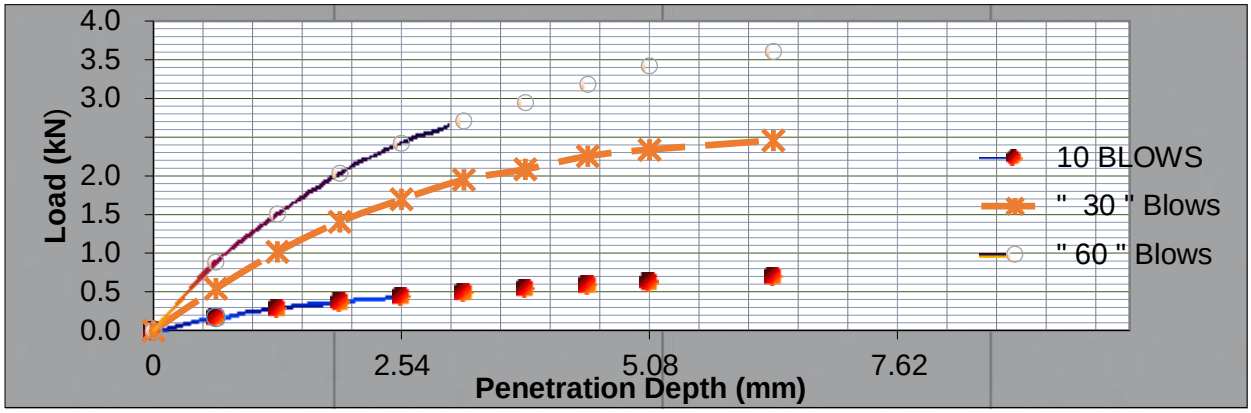


**Figure 4. 3:** Typical Penetration Load vs. Penetration Depth Plot

Table 4. 5: Typical Density versus CBR Values

| BLOWS | DD (g/cm3) | LOAD (KN) | | Standard Load (kN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54mm | 5.08 mm | |
| **10** | **1.47** | 0.44 | 0.63 | 13.40 | 20.00 | 3.3 | 3.1 | 3.3 |
| **30** | **1.70** | 1.69 | 2.34 | 13.40 | 20.00 | 12.7 | 11.7 | 12.7 |
| **65** | **1.73** | 2.42 | 3.42 | 13.40 | 20.00 | 18.1 | 17.1 | 18.1 |

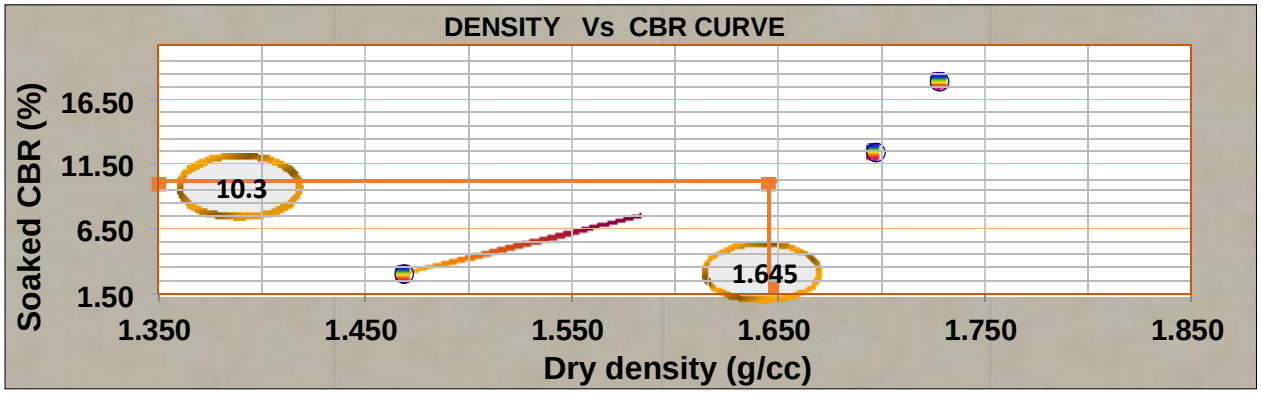


Figure 4. 4**:** Typical Density vs. CBR Plot

The tests are conducted and the results are analyzed with respect to AASHTO Standard Specification and USCS. The details of all the laboratory test results of the forty one soil samples and related calculations including graphs have been summarized and presented under Appendix C of this thesis.

## 4.5 Summary of Laboratory Test Results

For the required analyze, the test results were collected, compiled and summarized in Table herein under.

Table 4. 6: Summarized Laboratory Test Results

| S. No. | Station | Grain Size Analysis Percent Passing (%) | | | Atterberg Limits | | | Soil Classification | | Modified Proctor Test | | CBR Test | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2.00 mm | 0.475 mm | 0.075 mm | LL (%) | PL (%) | PI (%) | AASHTO Class. | USCS Class | MDD (g/cc) | OMC (%) | No. of Blows | Density (g/cc) | Load in (MPa) at 2.54 | Load in (MPa) at 5.08 | CBR at 95% MDD (%) |
| 1 | 1+500 | 93 | 58.9 | 19.86 | 54 | 39 | 15 | A-2-7(0) | SM | 1.732 | 17 | 10 | 1.47 | 3.30 | 3.13 | 10.3 |
| | | | | | | | | | | | | 30 | 1.70 | 12.69 | 11.68 | |
| | | | | | | | | | | | | 65 | 1.73 | 18.15 | 17.10 | |
| 2 | 2+500 | 95 | 47.5 | 12 | 44 | 30 | 14 | A-2-7(0) | SM | 1.81 | 13.6 | 10 | 1.53 | 3.93 | 3.64 | 14.7 |
| | | | | | | | | | | | | 30 | 1.7 | 15.99 | 15.58 | |
| | | | | | | | | | | | | 65 | 7.86 | 33.12 | 32.59 | |
| 3 | 3+000 | 97 | 78 | 68 | 56 | 43 | 13 | A-7-5 (9) | MH | 1.51 | 25 | 10 | 1.33 | 3.68 | 3.39 | 7.64 |
| | | | | | | | | | | | | 30 | 1.500 | 11.17 | 9.57 | |
| | | | | | | | | | | | | 65 | 1.5 | 25.51 | 20.15 | |
| 4 | 4+000 | 97 | 91 | 53 | 24 | 16 | 8 | A-4 (4) | CL | 1.97 | 10.3 | 10 | 1.71 | 6.85 | 6.09 | 23.8 |
| | | | | | | | | | | | | 30 | 1.89 | 25. | 25.40 | |
| | | | | | | | | | | | | 65 | 1.98 | 33.76 | 33.44 | |
| 5 | 5+500 | 98 | 62.8 | 36 | 34 | 25 | 9 | A-4 (0) | SC | 1.88 | 13 | 10 | 1.61 | 4.31 | 4.32 | 17.3 |
| | | | | | | | | | | | | 30 | 1.75 | 15.86 | 15.07 | |
| | | | | | | | | | | | | 65 | 1.89 | 20.56 | 20.32 | |
| 6 | 7+000 | 98 | 85.5 | 62 | 60 | 37 | 23 | A-7-5 (9) | MH | 1.53 | 24 | 10 | 1.36 | 4.31 | 3.39 | 7.7 |
| | | | | | | | | | | | | 30 | 1.50 | 10.03 | 9.31 | |
| | | | | | | | | | | | | 65 | 1.59 | 20.18 | 18.96 | |

| S. No. | Sample Code | 2.00 mm | 0.475 mm | 0.075 mm | LL (%) | PL (%) | PI (%) | AASHTO Class. | USCS Class. | MDD (g/cc) | OMC (%) | No. of Blows | Density (g/cc) | Load at 2.54 mm | Load at 5.08 mm | CBR at 95% MDD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 8+000 | 99.8 | 74.6 | 51 | 59 | 44 | 15 | A-7-5(7) | MH | 1.44 | 31 | 10 | 1.16 | 2.03 | 2.12 | 8.8 |
| | | | | | | | | | | | | 30 | 1.33 | 7.23 | 7.11 | |
| | | | | | | | | | | | | 65 | 1.46 | 15.74 | 12.87 | |
| 8 | 9+000 | 98 | 92 | 73 | 55 | 30 | 25 | A-7-5(10) | CH | 1.61 | 21.8 | 10 | 1.34 | 4.19 | 4.15 | 8.10 |
| | | | | | | | | | | | | 30 | 1.51 | 8.00 | 7.96 | |
| | | | | | | | | | | | | 65 | 1.60 | 8.88 | 8.80 | |
| 9 | 10+000 | 98 | 91.6 | 74 | 72 | 42 | 30 | A-7-5 (14) | MH | 1.51 | 30.7 | 10 | 1.27 | 2.79 | 2.37 | 3.25 |
| | | | | | | | | | | | | 30 | 1.41 | 3.05 | 2.79 | |
| | | | | | | | | | | | | 65 | 1.45 | 3.43 | 3.13 | |
| 10 | 11+000 | 100 | 93 | 43 | 62 | 39 | 23 | A-7-5(5) | SM | 1.44 | 28.3 | 10 | 1.33 | 3.43 | 3.81 | 3.85 |
| | | | | | | | | | | | | 30 | 1.46 | 5.08 | 6.01 | |
| | | | | | | | | | | | | 65 | 1.54 | 5.71 | 6.94 | |
| 11 | 12+000 | 100 | 75 | 30 | 62 | 41 | 21 | A-2-7(2) | SM | 1.48 | 28 | 10 | 1.33 | 3.43 | 3.39 | 4.52 |
| | | | | | | | | | | | | 30 | 1.46 | 5.08 | 4.91 | |
| | | | | | | | | | | | | 65 | 1.54 | 5.71 | 5.84 | |
| 12 | 12+500 | 93 | 76 | 22 | 60 | 42 | 18 | A-2-7(1) | SM | 1.38 | 33.5 | 10 | 1.13 | 3.24 | 3.13 | 6.13 |
| | | | | | | | | | | | | 30 | 1.26 | 5.77 | 5.76 | |
| | | | | | | | | | | | | 65 | 1.39 | 6.28 | 6.09 | |
| 13 | 13+000 | 99 | 60.8 | 19 | 70 | 45 | 25 | A-2-7(1) | SM | 1.44 | 29.5 | 10 | 1.33 | 3.43 | 3.39 | 3.93 |
| | | | | | | | | | | | | 30 | 1.46 | 5.08 | 4.99 | |
| | | | | | | | | | | | | 65 | 1.54 | 5.71 | 5.50 | |
| 14 | 14+000 | 99 | 51 | 18 | 66 | 49 | 17 | A-2-7(0) | SM | 1.41 | 32.9 | 10 | 1.13 | 3.05 | 3.05 | 7.25 |
| | | | | | | | | | | | | 30 | 1.29 | 6.09 | 6.01 | |
| | | | | | | | | | | | | 65 | 1.39 | 8.50 | 8.55 | |
| 15 | 14+500 | 98 | 74.4 | 33 | 65 | 46 | 19 | A-2-7(2) | SM | 1.45 | 29 | 10 | 1.15 | 2.47 | 2.37 | 5.44 |
| | | | | | | | | | | | | 30 | 1.33 | 4.89 | 4.83 | |
| | | | | | | | | | | | | 65 | 1.43 | 6.03 | 5.84 | |

| S. No. | Sample Code | 2.00 mm | 0.475 mm | 0.075 mm | LL (%) | PL (%) | PI (%) | AASHTO Class. | USCS Class. | MDD (g/cc) | OMC (%) | No. of Blows | Density (g/cc) | Load at 2.54 mm | Load at 5.08 mm | CBR at 95% MDD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 16 | 15+000 | 94 | 73 | 52 | 65 | 41 | 24 | A-7-5(11) | MH | 1.5 | 21 | 10 | 1.32 | 2.92 | 2.54 | 3.31 |
| | | | | | | | | | | | | 30 | 1.51 | 3.81 | 3.39 | |
| | | | | | | | | | | | | 65 | 1.57 | 5.58 | 5.25 | |
| 17 | 16+000 | 95 | 77 | 49 | 54 | 39 | 15 | A-7-5 (5) | SM | 1.52 | 25.6 | 10 | 1.32 | 3.68 | 3.64 | 8.1 |
| | | | | | | | | | | | | 30 | 1.43 | 8.00 | 7.62 | |
| | | | | | | | | | | | | 65 | 1.62 | 9.65 | 9.31 | |
| 18 | 17+000 | 99 | 80.8 | 61 | 65 | 48 | 17 | A-7-5(12) | MH | 1.4 | 29.5 | 10 | 1.28 | 2.67 | 2.54 | 3.2 |
| | | | | | | | | | | | | 30 | 1.44 | 4.31 | 4.15 | |
| | | | | | | | | | | | | 65 | 1.48 | 5.46 | 4.99 | |
| 19 | 20+000 | 87 | 60 | 30 | 55 | 36 | 19 | A-2-7(1) | SM | 1.49 | 23.8 | 10 | 1.33 | 4.19 | 3.89 | 5 |
| | | | | | | | | | | | | 30 | 1.46 | 5.46 | 5.84 | |
| | | | | | | | | | | | | 65 | 1.54 | 6.09 | 6.77 | |
| 20 | 24+000 | 88 | 60.2 | 20 | 54 | 42 | 12 | A-2-7(0) | SM | 1.47 | 24.6 | 10 | 1.20 | 3.81 | 3.72 | 7.73 |
| | | | | | | | | | | | | 30 | 1.37 | 7.36 | 7.96 | |
| | | | | | | | | | | | | 65 | 1.49 | 8.88 | 8.63 | |
| 21 | 25+000 | 92 | 62.8 | 33 | 48 | 33 | 15 | A-2-7(1) | SM | 1.36 | 29.4 | 10 | 1.20 | 3.05 | 3.05 | 4.66 |
| | | | | | | | | | | | | 30 | 1.32 | 5.08 | 5.08 | |
| | | | | | | | | | | | | 65 | 1.36 | 6.09 | 5.93 | |
| 22 | 25+500 | 88 | 67.6 | 28 | 51 | 36 | 15 | A-2-7(1) | SM | 1.57 | 19.6 | 10 | 1.33 | 3.05 | 3.05 | 9 |
| | | | | | | | | | | | | 30 | 1.47 | 8.63 | 8.55 | |
| | | | | | | | | | | | | 65 | 1.5 | 9.52 | 9.48 | |
| 23 | 26+000 | 96 | 86.8 | 56 | 59 | 37 | 22 | A-7-5 (11) | MH | 1.55 | 22.1 | 10 | 1.33 | 4.89 | 4.38 | 6.7 |
| | | | | | | | | | | | | 30 | 1.4 | 6.9 | 7.38 | |
| | | | | | | | | | | | | 65 | 1.54 | 8.49 | 8.84 | |
| 24 | 29+000 | 91 | 66 | 24 | 59 | 43 | 16 | A-2-7(1) | SM | 1.53 | 21.8 | 10 | 1.28 | 3.30 | 3.22 | 5.2 |
| | | | | | | | | | | | | 30 | 1.48 | 5.46 | 5.42 | |
| | | | | | | | | | | | | 65 | 1.54 | 5.96 | 5.84 | |

| S. No. | Sample Code | 2.00 mm | 0.475 mm | 0.075 mm | LL (%) | PL (%) | PI (%) | AASHTO Class. | USCS Class. | MDD (g/cc) | OMC (%) | No. of Blows | Density (g/cc) | Load at 2.54 mm | Load at 5.08 mm | CBR at 95% MDD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 29+500 | 93 | 65 | 21 | 61 | 37 | 24 | A-2-7(1) | SM | 1.53 | 20.5 | 10 | 1.28 | 3.43 | 3.22 | 5.56 |
| | | | | | | | | | | | | 30 | 1.46 | 5.58 | 5.42 | |
| | | | | | | | | | | | | 65 | 1.49 | 7.74 | 7.45 | |
| 26 | 30+000 | 94 | 58.6 | 26 | 63 | 42 | 21 | A-2-7(1) | SM | 1.51 | 25 | 10 | 1.36 | 3.55 | 3.56 | 4.94 |
| | | | | | | | | | | | | 30 | 1.47 | 5.58 | 5.50 | |
| | | | | | | | | | | | | 65 | 1.53 | 7.36 | 7.20 | |
| 27 | 30+500 | 92 | 70 | 43 | 73 | 52 | 21 | A-7-5 (6) | SM | 1.33 | 33.5 | 10 | 1.17 | 1.90 | 1.78 | 3.95 |
| | | | | | | | | | | | | 30 | 1.31 | 4.95 | 4.74 | |
| | | | | | | | | | | | | 65 | 1.40 | 5.46 | 5.33 | |
| 28 | 31+000 | 98 | 60 | 14 | 64 | 42 | 22 | A-2-7(0) | SM | 1.51 | 26.6 | 10 | 1.22 | 3.55 | 3.64 | 6.5 |
| | | | | | | | | | | | | 30 | 1.41 | 8.38 | 8.38 | |
| | | | | | | | | | | | | 65 | 1.50 | 9.26 | 9.14 | |
| 29 | 31+500 | 92 | 65 | 16 | 42 | 29 | 13 | A-2-7(0) | SM | 1.5 | 25 | 10 | 1.34 | 5.28 | 4.72 | 7.67 |
| | | | | | | | | | | | | 30 | 1.49 | 9.91 | 8.24 | |
| | | | | | | | | | | | | 65 | 1.53 | 10.68 | 9.44 | |
| 30 | 33+000 | 91 | 42 | 15 | 58 | 40 | 18 | A-2-7(0) | SM | 1.487 | 22 | 10 | 1.07 | 2.54 | 2.79 | 9.5 |
| | | | | | | | | | | | | 30 | 1.15 | 8.00 | 7.62 | |
| | | | | | | | | | | | | 65 | 1.44 | 9.65 | 9.31 | |
| 31 | 34+000 | 98 | 95.4 | 57 | 62 | 52 | 10 | A-7-5(7) | MH | 1.457 | 23.7 | 10 | 1.15 | 2.54 | 2.54 | 9.23 |
| | | | | | | | | | | | | 30 | 1.37 | 9.01 | 9.06 | |
| | | | | | | | | | | | | 65 | 1.46 | 10.41 | 10.3 | |
| 32 | 34+500 | 94 | 64.1 | 21 | 68 | 53 | 15 | A-2-7(0) | SM | 1.47 | 29.6 | 10 | 1.36 | 3.93 | 3.98 | 6.82 |
| | | | | | | | | | | | | 30 | 1.43 | 8.38 | 8.13 | |
| | | | | | | | | | | | | 65 | 1.60 | 9.90 | 9.82 | |
| 33 | 35+000 | 99 | 89.3 | 29 | 57 | 30 | 27 | A-2-7(3) | SC | 1.44 | 27.7 | 10 | 1.33 | 3.43 | 3.39 | 4.5 |
| | | | | | | | | | | | | 30 | 1.46 | 5.08 | 4.91 | |
| | | | | | | | | | | | | 65 | 1.54 | 5.71 | 5.84 | |

| S. No. | Sample Code | 2.00 mm | 0.475 mm | 0.075 mm | LL (%) | PL (%) | PI (%) | AASHTO Class. | USCS Class. | MDD (g/cc) | OMC (%) | No. of Blows | Density (g/cc) | Load at 2.54 mm | Load at 5.08 mm | CBR at 95% MDD |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34 | 35+500 | 100 | 69.1 | 21 | 48 | 38 | 10 | A-2-5(0) | SM | 1.66 | 19.2 | 10 | 1.31 | 2.60 | 2.50 | 12.5 |
| | | | | | | | | | | | | 30 | 1.52 | 10.60 | 9.69 | |
| | | | | | | | | | | | | 65 | 1.62 | 13.39 | 12.06 | |
| 35 | 36+000 | 92 | 56 | 12 | 54 | 39 | 15 | A-2-7(0) | SM | 1.54 | 22.9 | 10 | 1.26 | 3.43 | 3.30 | 9.5 |
| | | | | | | | | | | | | 30 | 1.43 | 8.38 | 8.21 | |
| | | | | | | | | | | | | 65 | 1.51 | 11.80 | 11.60 | |
| 36 | 37+000 | 90.4 | 51 | 21 | 64 | 41 | 23 | A-2-7(1) | SM | 1.498 | 23 | 10 | 1.19 | 2.28 | 2.29 | 5.75 |
| | | | | | | | | | | | | 30 | 1.38 | 5.20 | 5.08 | |
| | | | | | | | | | | | | 65 | 1.46 | 6.22 | 6.01 | |
| 37 | 37+500 | 93 | 55 | 19 | 64 | 45 | 19 | A-2-7(0) | SM | 1.503 | 23 | 10 | 1.23 | 2.47 | 2.33 | 5.4 |
| | | | | | | | | | | | | 30 | 1.39 | 5.01 | 4.87 | |
| | | | | | | | | | | | | 65 | 1.46 | 5.71 | 5.54 | |
| 38 | 39+000 | 95 | 75.4 | 38 | 72 | 45 | 27 | A-7-5(5) | SM | 1.516 | 27.5 | 10 | 1.20 | 2.3 | 2.1 | 5.2 |
| | | | | | | | | | | | | 30 | 1.3 | 4.8 | 4.7 | |
| | | | | | | | | | | | | 65 | 1.45 | 5.5 | 5.4 | |
| 39 | 39+500 | 96 | 66.2 | 50 | 61 | 45 | 16 | A-7-5(7) | SM | 1.547 | 26.5 | 10 | 1.28 | 3.55 | 3.39 | 7.1 |
| | | | | | | | | | | | | 30 | 1.46 | 6.98 | 6.86 | |
| | | | | | | | | | | | | 65 | 1.5 | 7.6 | 7.53 | |
| 40 | 40+000 | 96 | 76 | 30 | 65 | 44 | 21 | A-2-7(2) | SM | 1.467 | 28 | 10 | 1.31 | 4.06 | 4.15 | 6.1 |
| | | | | | | | | | | | | 30 | 1.40 | 6.35 | 6.18 | |
| | | | | | | | | | | | | 65 | 1.50 | 8.25 | 7.70 | |
| 41 | 41+000 | 96 | 72.8 | 27 | 50 | 38 | 12 | A-2-7(0) | SM | 1.59 | 22.8 | 10 | 1.35 | 3.17 | 3.30 | 8.75 |
| | | | | | | | | | | | | 30 | 1.48 | 8.25 | 7.96 | |
| | | | | | | | | | | | | 65 | 1.58 | 8.88 | 8.63 | |

# 5. DATA ANALYSIS AND CORRELATION

## 5.1. Introduction

Many problems in engineering and science involve exploring the relationships between two or more variables. Regression analysis is one of the statistical method that is convenient for these types of problems and also used to modeling and investigating the relationship between two or more variables. Regression analysis is concerned with the procedure how the values of Y depend on the corresponding values of X. Y, whose value is to be predicted, is known as dependent variable and X, which is used in predicting the value of dependent variable, is called independent variable. A regression model containing one independent variable is termed as a simple regression model. Alternatively, the regression model that contain two or more regressor/predictor variable is known as multiple regression models.

A number of techniques can be used to indicate the adequacy of a multiple regression model; some of these are standard error and the coefficient of regression (R2) values. The standard error of a statistic gives some idea about the precision of an estimate.

In this study, CBR value are the dependent variables whereas the LL, PL, PI, MDD, OMC, PP and PM are regressor/predictor variables. To carry out statistical analysis, Microsoft excel and SPSS were used. A total of forty one numbers of samples are used in correlating CBR with LL, PL, PI, MDD, OMC, PP and PM and six numbers of samples are used in correlating Γ with LL, PL, and PI. While caring out the statistical analysis different regression models are used and those models with a higher value of coefficient of determination are accepted.

## 5.2. Data Analysis Methods

There are many methods that one can be used to check the validity of the relationships between two or more variables [20]. However, in this study two common methods are used, namely: scatter plot using Microsoft excel and regression analysis using SPSS. Before the application of the analysis methods, some important terms are discussed below.

1. **Level of significance**: The probability of making an error to reject a hypothesis while it happens to be true is called the level of significance. In practice, it is customary to use a 5% level of significance. This means the 95% confidence could make the right decision and could be wrong with a probability of 5% [20].

**2. One-tailed and two-tailed tests:** When a hypothesis is tested assuming that one process is better or worse than the other, then it is called a one-tailed or one-sided test. However, if the hypothesis is tested assuming that the extreme values of the statistics score on both sides of the mean in both tails of the distribution, the tests are called two-tailed or two-sided tests [20].

**3. Standard error:** standard error is the average measure of the error of each sample point about the best-fit line. Out of all curves, the best-fit curve has the smallest standard error [20].

**4. Correlation coefficient(R):** the coefficient of correlation (sometimes called the coefficient of regression) is the measures of how well the least-square regression line (best-fit line) fits the sample data.

Value of R= 1 or -1 ($R^2$=1) shows that there is a perfect linear correlation and also perfect linear regression, whereby a negative value of R indicates inversely relationship and positive value implies a direct relationship. On the other hand R = 0 or approaches to zero shows, no valid relationship can be obtained between the variables [20]. The standard error (α), R-squared value ($R^2$), $R^2$-adjusted and the t-test are some of techniques used to judge adequacy of the regression model [20].

### 5.2.1. Scatter Plot and Best-Fit Curve for Soils Classified According to AASHTO Classification System

The scatter diagrams is plotted in the X and Y coordinate system used to visualize the relationship between variables. In developing correlations, the first step is creating a scatter plot of the data, to visually assess the strength and form of the relationship. A scatter diagram is generated by applying the Microsoft Excel. Scatter plot enable as to determine the model that best suits for the relationships developed between the dependent variable and the predictor variables.

In carrying out the statistical analysis, both SPSS and MS Excel spreadsheet are used to determine the scatter plot, correlation, and regression. The MS Excel spreadsheet is found to be the most powerful and manageable tool for scatter plot analysis and determination of correlation between two variables. However, when the determination of the correlation between more than two variables is required (the dependent variable requires two or more independent variables)

regression analysis is used and the SPSS software is found to be the most powerful and descriptive tool [20].

The parameters considered as the principal component of analysis in this subject study consist of the California Bearing Ratio which is taken as the dependent variable, whereas the percent passing 0.075mm sieve size, MDD, LL, PL, PI, OMC, PP, and P M are independent variables. Subsequently, the soils in the study area are classified as coarse-grained soil and fine-grained soil by the AASHTO soil classification system, the scatter plots of the same presented for coarse-grained soil and fine-grained soil in Figures 5.1 to 5.6 and 5.9 to 5.14 respectively.

### 5.2.2 Scatter Plot for Coarse-Grained Soil

**Scatter Plot CBR versus MDD**

The scatter plot and best fitting linear trend line for the relationship between CBR and MDD is CBR = 22.667MDD-27.317, as the strength of the correlation is $R^2$ =0.6849.

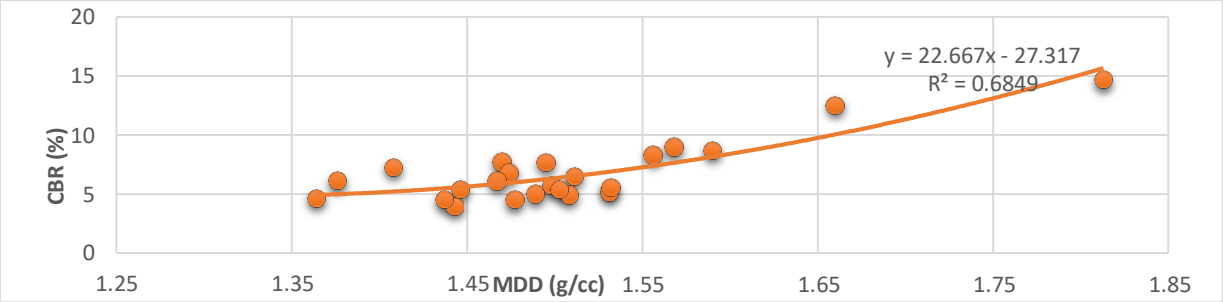


**Figure 5. 1:** Scatter Plot and best-fit line of MDD vs. CBR for Coarse-Grained Soils

**Scatter Plot CBR versus OMC**

The scatter plot and best fitting trend line for the relationship between CBR and OMC is CBR= 0.0448OMC² - 2.5429OMC + 41.457, as the strength of the correlation $R^2$ =0.6764

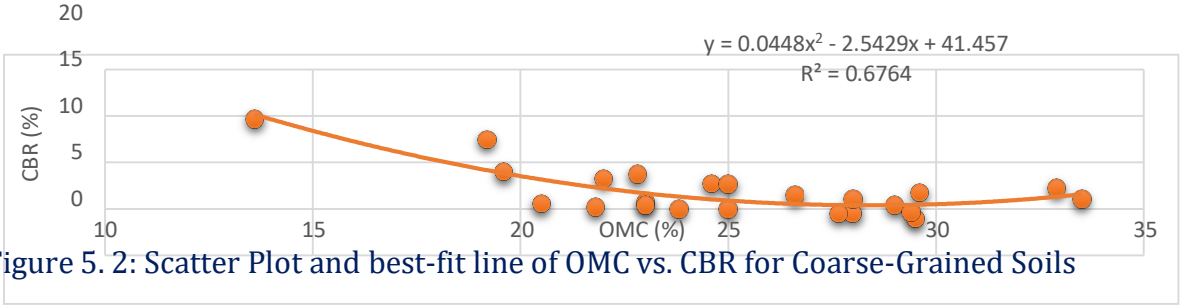


Figure 5. 2: Scatter Plot and best-fit line of OMC vs. CBR for Coarse-Grained Soils

### Scatter Plot CBR versus PP

The scatter plot and best fitting trend line for the relationship between CBR and PP is CBR= $0.3276PP^2 - 4.0401PP + 17.303$, as the strength of the correlation is $R^2 = 0.5834$.

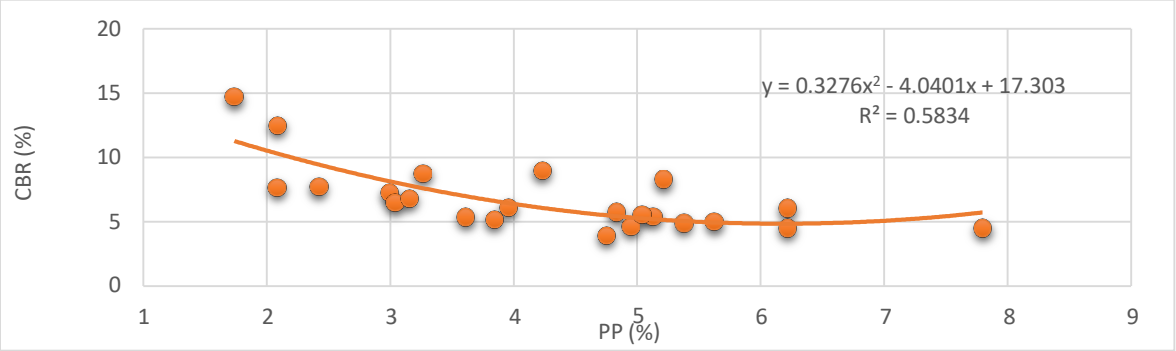


Figure 5. 3: Scatter Plot and best-fit line of PP vs. CBR for Coarse-Grained Soils

### Scatter Plot CBR versus PM

The scatter plot and best fitting trend line for the relationship between CBR and PM is CBR= $0.0405PM^2 - 1.5194PM + 18.481$, as the strength of the correlation is $R^2 = 0.4856$.

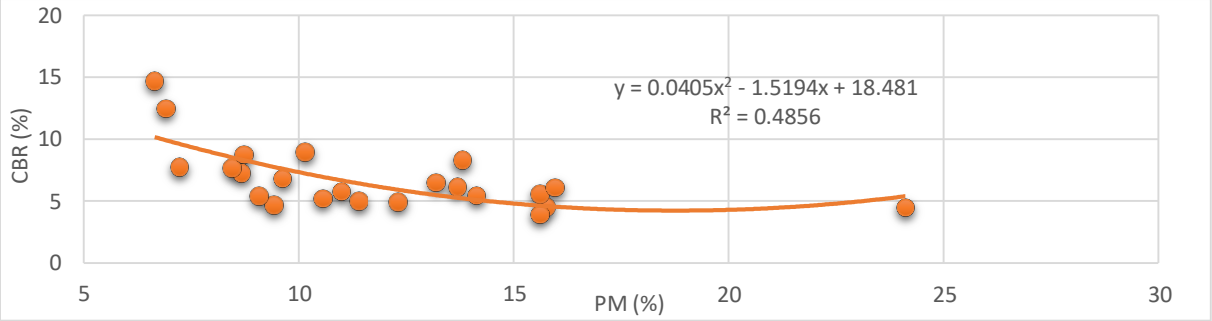


Figure 5. 4: Scatter Plot and best-fit line of PM vs. CBR for Coarse-Grained Soils

### CBR versus Plastic Index

The scatter plot and best fitting trend line for the relationship between CBR and plastic Index is CBR = $89.301PI^{-0.919}$, as the strength of the correlation is $R^2 = 0.5306$

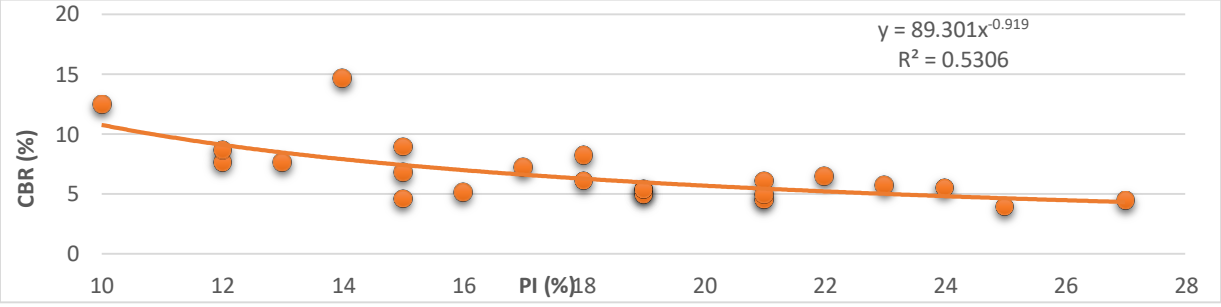


Figure 5. 5: Scatter Plot and best-fit line of PI vs. CBR for Coarse-Grained Soils

**CBR versus Percent Passing Sieve No.200**

The scatter plot and best fitting trend line for the relationship between CBR and % passing sieve No.200 is CB= $0.0199P_{200}^2$ -$1.0979P_{200}$ + 20.94, as the strength of the correlation is $R^2$ =0.2264

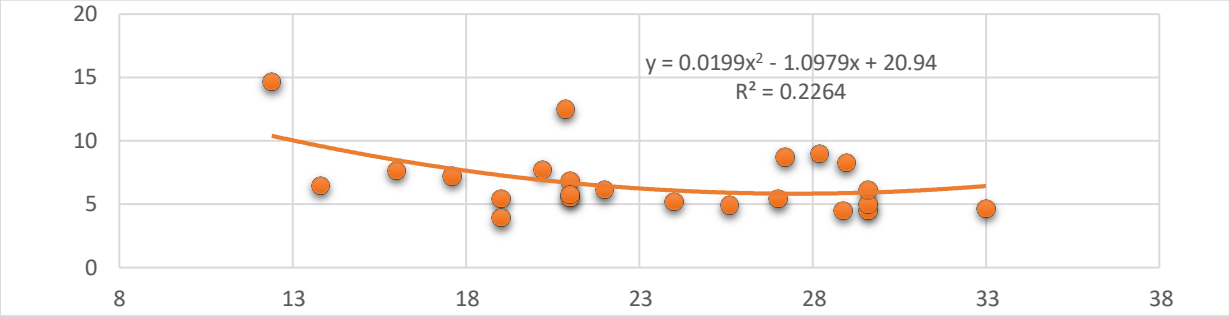


Figure 5. 6: Scatter Plot and best-fit line of P 200 vs. CBR for Coarse-Grained Soils

Note that the assessment from the above scatter plots of coarse grained soils indicate that, no simple curve that passed exactly through all point and it reasonable indicated that most of the points scattered around a curved line, particularly liquid limit, plastic index, plastic product, plastic modulus, plastic limit, optimum moisture content, and maximum dry density. The Graphs were plotted CBR values versus soil index values such as LL, PL, PI, PP, PM, OMC and MDD. The above drawn trend lines of non-linear regression analyzes enable as to obtain suitable goodness fit. The $R^2$ value obtain here in above quantifies goodness fit of non-linear regression analyzes.

The California Bearing Ratio has a strong correlation with plastic index, optimum moisture content, plastic product and maximum dry density than the plastic modulus and liquid limit. On the other hand, as shown in Figure 5.6, the relationship between CBR and the percent passing 0.075mm sieve size and plastic limit is the weakest of all of the index properties.

In addition to this, California Bearing Ratio is a direct relationship with maximum dry density and inversely proportional to other index properties i.e. optimum moisture content, plastic index, plastic product, plastic modulus, and percent passing 0.075mm sieve. However, the effect of the maximum dry density on the CBR is clearly observed with the proportional relationship. The CBR increases as the maximum dry density increases for the coarse grained soils.

### 5.2.3 Scatter Plot for Fine-Grained Soils

**Scatter Plot of CBR versus MDD**

The scatter plot and best fitting trend line for the relationship between CBR and MDD is CBR = 38.863MDD² - 99.686MDD + 68.503, as the strength of the correlation is R² =0.8878.

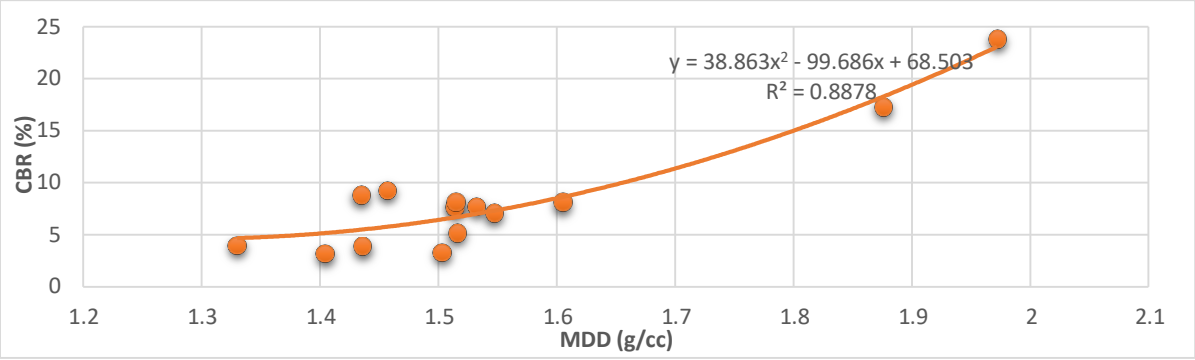


Figure 5. 7: Scatter Plot and best-fit line of MDD vs. CBR for Fine-Grained Soils

**Scatter Plot CBR versus OMC**

The scatter plot and best fitting trend line for the relationship between CBR and OMC is CBR= 0.0352OMC² - 2.1588OMC + 38.45, as the strength of the correlation is R² =0.7952.

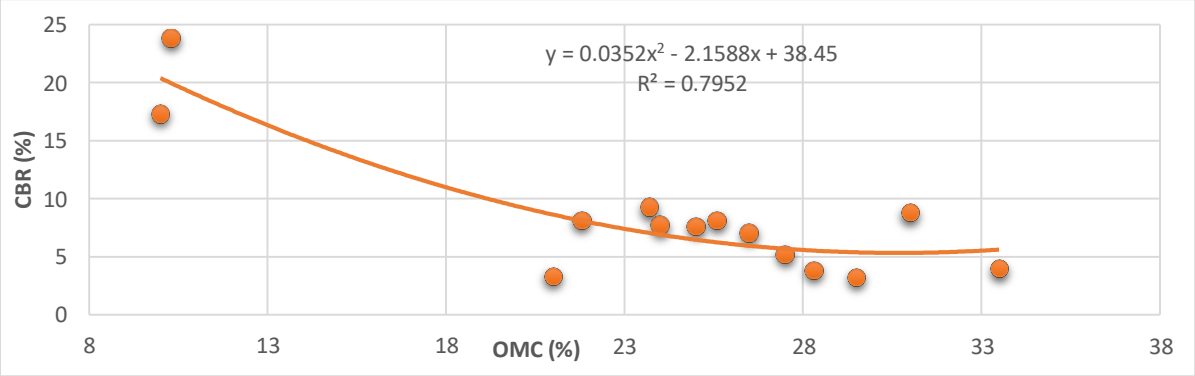


Figure 5. 8: Scatter Plot and best-fit line of OMC vs. CBR for fine-grained soils

**Scatter Plot CBR versus PP**

The scatter plot and best fitting trend line for the relationship between CBR and PP is CBR = 0.1905PP² - 4.8092PP + 33.817, as the strength of the correlation is R² =0.7778.

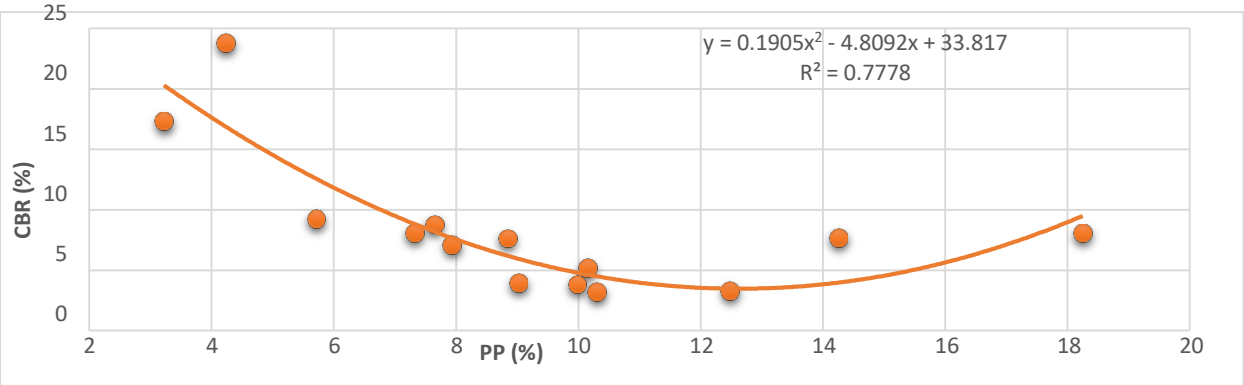


Figure 5. 9: Scatter Plot and best-fit line of OMC vs. CBR for fine-grained soils

### Scatter Plot CBR versus PM

The scatter plot and best fitting trend line for the relationship between CBR and PM is CBR= $0.1399PM^2 - 4.7318PM + 43.224$, as the strength of the correlation is $R^2 = 0.7637$.

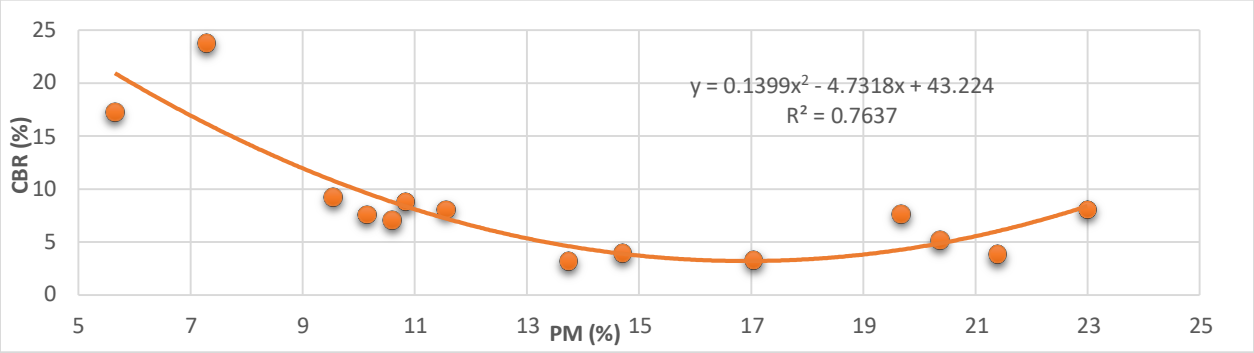


Figure 5. 10: Scatter Plot and best-fit line of OMC vs. CBR for fine-grained soils

### Scatter Plot of CBR versus Plastic Index

The scatter plot and best fitting trend line for the relationship between CBR and plastic Index is CBR= $0.0961PI^2 - 3.9806PI + 45.12$, as the strength of the correlation is $R^2 = 0.7853$.

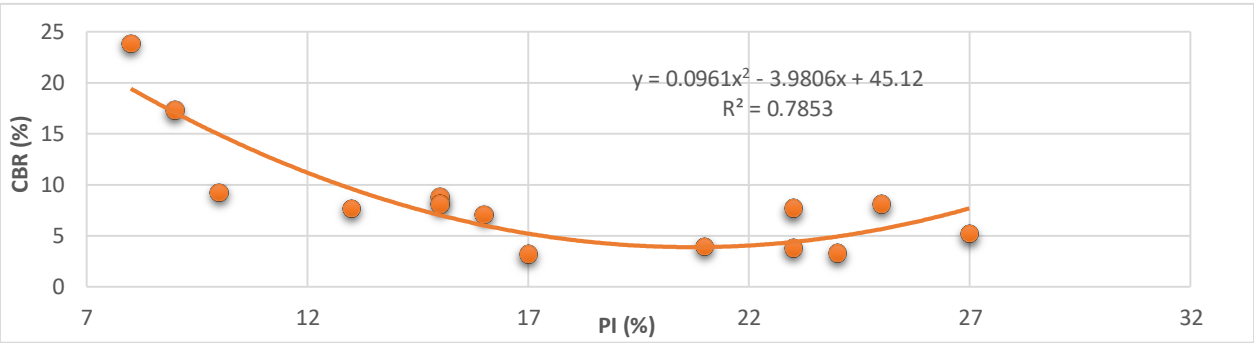


Figure 5. 11: Scatter Plot and best-fit line of PI vs. CBR for Fine-Grained Soils

### CBR versus Liquid Limit

The scatter plot and best fitting trend line for the relationship between CBR and the liquid limit is CBR= $0.0049LL^2 - 0.8811LL + 41.948$, as the strength of the correlation is $R^2 = 0.9295$

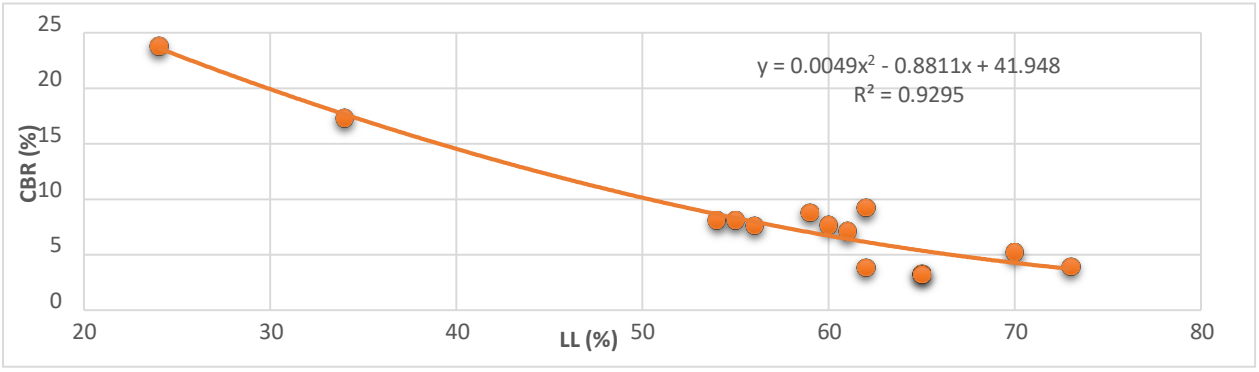


Figure 5. 12: Scatter Plot and best-fit line of LL vs. CBR for Fine-Grained Soils

### Scatter Plot of CBR versus Plastic Limit

The scatter plot and best fitting linear trend line for the relationship between CBR and plastic Limit is CBR= $0.0217PL^2 - 1.966PL + 50.226$, as the strength of the correlation is $R^2 = 0.839$.

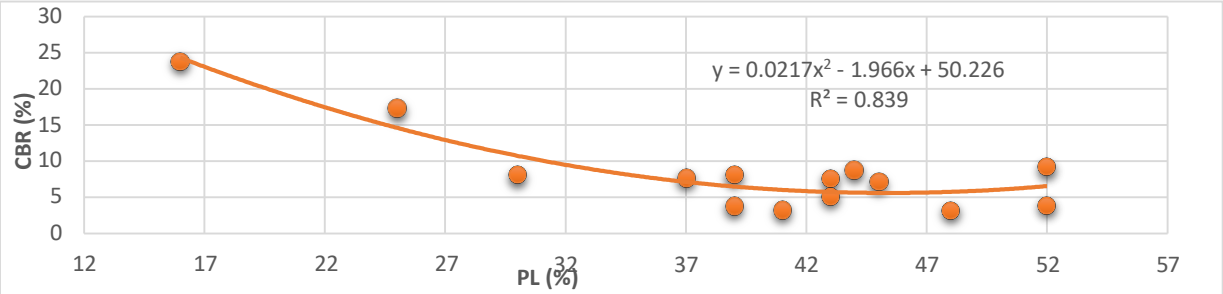


Figure 5. 13: Scatter Plot and best-fit line of PL vs. CBR for Fine-Grained Soils

### Scatter Plot of CBR versus $P_{200}$

The scatter plot and best fitting trend line for the relationship between CBR and P200 is CBR = $0.0024\ P_{200}^2 - 0.2999\ P_{200} + 17.277$, as the strength of the correlation is $R^2 = 0.0094$.

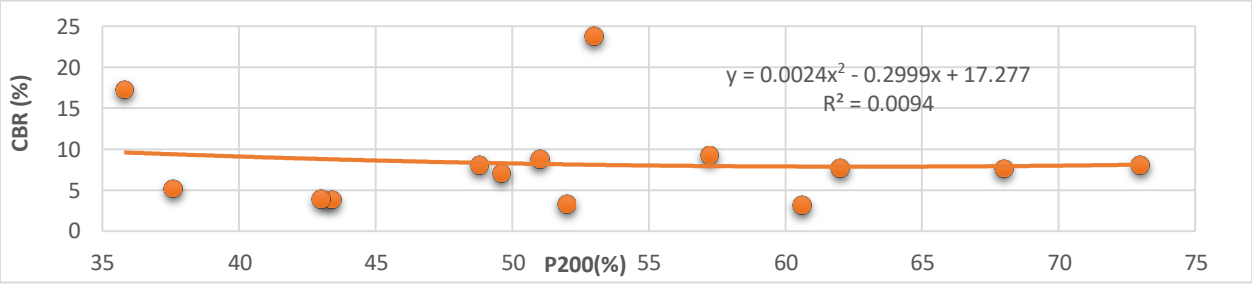


Figure 5. 14: Scatter Plot and best-fit line of $P_{200}$ vs. CBR for Fine-Grained Soils

Note that the assessment from the above scatter plots of fine grained soils indicate that, no simple curve that passed exactly through all point and it reasonable indicated that most of the points scattered around a curved line, particularly liquid limit, plastic index, plastic product, plastic modulus, plastic limit, optimum moisture content, and maximum dry density. The Graphs were plotted CBR values versus soil index values such as LL, PL, PI, PP, PM, OMC and MDD. The above drawn trend lines of non-linear regression analyzes enable as to obtain suitable goodness fit. The $R^2$ value obtain here in above quantifies goodness fit of non-linear regression analyzes.

The California Bearing Ratio has a strong correlation with liquid limit, plastic index, plastic product, plastic modulus, plastic limit, optimum moisture content, and maximum dry density than the percent passing 0.075mm sieve size. On the other hand, as shown in Fig. 5.14, the relationship

between CBR and the percent passing 0.075mm sieve size is the weakest of all of the index properties.

## 5.3 Simple Non-linear Regression and Multiple Linear Regression Analysis

For predicting soaked CBR value from soil index properties and compaction characteristic single non-linear regression and multiple linear regression mode were developed in this research work. The Graphs were plotted CBR values versus soil index values such as LL, PL, PI, PP, PM, OMC and MDD. The above drawn trend lines of non-linear regression analyzes enable as to obtain suitable goodness fit. The $R^2$ value obtain here in above quantifies goodness fit of non-linear regression analyzes. Single non-linear regression carried out by Microsoft excel whereas multiple linear regression analysis was carried out by SPSS. The $R^2$ value for the MLRA used know how well the outcomes were predicted by the model.

Specific to this research, a statistical package for social science software (SPSS) is employed to investigate the significance of individual regress or variables. The total of twenty three coarse-grained soils and fourteen fine-grained soils are used in correlating dependent variable (CBR) with independent variable (LL, PL, PI, OMC, PP, PM, and MDD), while caring out the statistical analysis different regression models are used and those models with a higher value of coefficient of determination are accepted. The statistical information of the test results is presented in the table below.

Table 5. 1: Statistical Information of the Variables of Coarse grained soil

| Variable Type | Variable Name | Units of Measurement | No. of Samples | Ranges | | Mean | Standard Deviation |
|---|---|---|---|---|---|---|---|
| | | | | Min | Max | | |
| Dependent | CBR | % | 25 | 3.93 | 14.7 | 7.046 | 2.63 |
| Independent | P200 | % | 25 | 12 | 33.36 | 22.95 | 6.2 |
| | LL | % | 25 | 42 | 70 | 57.84 | 7.61 |
| | PL | % | 25 | 23 | 53 | 39.88 | 5.826 |
| | PI | % | 25 | 18 | 27 | 17.96 | 4.354 |
| | MDD | g/cc | 25 | 1.364 | 1.813 | 1.515 | 0.1015 |
| | OMC | % | 25 | 13.6 | 33.5 | 24.72 | 4.8 |
| | PP | % | 25 | 1.736 | 7.79 | 4.16 | 1.603 |
| | PM | % | 25 | 6.64 | 24.11 | 11.64 | 3.904 |

Table 5. 2 : Statistical Information of the Variables of fine-grained soil

| Variable Type | Variable Name | Units of Measurement | No. of Samples | Ranges | | Mean | Standard Deviation |
|---|---|---|---|---|---|---|---|
| | | | | Min | Max | | |
| Dependent | CBR | % | 16 | 3.2 | 23.8 | 7.75 | 5.49 |
| Independent | P200 | % | 16 | 35.8 | 73.6 | 54.01 | 11.41 |
| | LL | % | 16 | 24 | 73 | 58.18 | 12.83 |
| | PL | % | 16 | 16 | 52 | 39.56 | 9.43 |
| | PI | % | 16 | 8 | 30 | 18.625 | 6.69 |
| | MDD | g/cc | 16 | 1.33 | 1.972 | 1.54 | 0.163 |
| | OMC | % | 16 | 10.3 | 33.5 | 24.41 | 6.602 |
| | PP | % | 16 | 3.22 | 22.08 | 10.23 | 4.89 |
| | PM | % | 16 | 5.65 | 27.48 | 15.13 | 6.23 |

In order to know the influence of one variable over the other, a stepwise non-linear regression has been analyzed and as a result, the respective correlation coefficients and level of significance determined. The detail outputs of the SPSS for multiple linear regression analysis presented under Appendix A of this thesis and also the summarized correlation results are presented hereinafter:

### 5.3.1: SNLRA for Coarse Grained Soils Classified According to AASHTO Classification System

Table 5. 3: Input data for SPSS Computer Program for Coarse-grained soil

| Station | CBR | MDD | OMC | LL | PL | PI | $P_{200}$ | PM | PP |
|---|---|---|---|---|---|---|---|---|---|
| **2+500** | 14.7 | 1.813 | 13.6 | 44 | 30 | 14 | 12.4 | 6.64 | 1.74 |
| **12+000** | 4.52 | 1.477 | 28 | 62 | 41 | 21 | 29.6 | 15.75 | 6.2 |
| **12+500** | 6.13 | 1.376 | 33.5 | 60 | 42 | 18 | 22 | 13.68 | 3.96 |
| **13+000** | 3.93 | 1.443 | 29.5 | 70 | 45 | 25 | 19 | 15.6 | 4.75 |
| **14+000** | 7.25 | 1.408 | 32.9 | 66 | 49 | 17 | 17.6 | 8.67 | 2.99 |
| **14+500** | 5.44 | 1.446 | 29 | 65 | 46 | 19 | 27 | 14.14 | 5.13 |
| **20+000** | 5 | 1.489 | 23.8 | 55 | 36 | 19 | 29.6 | 11.4 | 5.62 |
| **24+000** | 7.73 | 1.47 | 24.6 | 54 | 42 | 12 | 20.2 | 7.22 | 2.42 |
| **25+000** | 4.66 | 1.364 | 29.4 | 48 | 33 | 15 | 33 | 9.42 | 4.95 |
| **25+500** | 9 | 1.568 | 19.6 | 51 | 36 | 15 | 28.2 | 10.14 | 4.23 |
| **29+000** | 5.2 | 1.531 | 21.8 | 59 | 43 | 16 | 24 | 10.56 | 3.84 |
| **29+500** | 5.56 | 1.532 | 20.5 | 61 | 37 | 24 | 21 | 15.6 | 5.04 |
| **30+000** | 4.94 | 1.508 | 25 | 63 | 42 | 21 | 25.6 | 12.31 | 5.38 |
| **31+000** | 6.5 | 1.511 | 26.6 | 64 | 42 | 22 | 13.8 | 13.2 | 3.04 |
| **31+500** | 7.67 | 1.495 | 25 | 42 | 29 | 13 | 16 | 8.45 | 2.08 |
| **33+000** | 8.3 | 1.556 | 26.2 | 58 | 40 | 18 | 28.96 | 13.8 | 5.21 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **34+500** | 6.82 | 1.474 | 29.6 | 68 | 53 | 15 | 21 | 9.621 | 3.15 |
| **35+000** | 4.5 | 1.437 | 27.65 | 57 | 30 | 27 | 28.88 | 24.12 | 7.7976 |
| **35+500** | 12.5 | 1.66 | 19.18 | 48 | 38 | 10 | 20.86 | 6.91 | 2.09 |
| **37+000** | 5.75 | 1.498 | 23 | 64 | 41 | 23 | 21 | 10.994 | 4.83 |
| **37+500** | 5.4 | 1.503 | 23 | 64 | 45 | 19 | 19 | 9.08 | 3.61 |
| **40+000** | 6.1 | 1.467 | 28 | 65 | 44 | 21 | 29.6 | 15.96 | 6.21 |
| **41+000** | 8.75 | 1.59 | 22.8 | 50 | 38 | 12 | 27.2 | 8.74 | 3.26 |

Table 5. 4: Input data for the control test of coarse grained soils

| **Station** | **CBR** | **MDD** | **OMC** | **LL** | **PL** | **PI** | **$P_{200}$** | **PM** | **PP** |
|---|---|---|---|---|---|---|---|---|---|
| **1+500** | 10.25 | 1.733 | 17 | 54 | 36 | 18 | 15.04 | 13.995 | 2.98 |
| **36+000** | 9.5 | 1.54 | 22.9 | 54 | 39 | 15 | 12 | 18.4 | 2.4 |

After carefully studying the data trend on the scatter plot of the single regression analysis, the resulting regression analysis of the correlations of CBR with LL, PL, PI, MDD, OMC, PP, PM, and $P_{200}$ are expressed by the following single non- linear equations.

Table 5. 5: Summary SNLRA for coarse-grained soils classified according to the AASHTO classification system.

| **Regression Type** | **Model Name** | **Equation Developed** | **Correlation between** | **$R^2$** | **Sample No.** | **(α)** | **Significance Order Depending on (α) and$R^2$** |
|---|---|---|---|---|---|---|---|
| **Single Regression** | Model I | $CBR=0.0084LL^2-1.141LL+44.3$ | CBR and LL | 0.409 | 23 | <0.05 | **5** |
| | Model II | $CBR=0.008PL^2-0.7678PL+24.406$ | CBR and PL | 0.112 | | >0.05 | **8** |
| | Model III | $CBR=89.301PI^{-0.919}$ | CBR and PI | 0.531 | | <0.05 | **3** |
| | Model IV | CBR=22.67MDD-27.32 | CBR and MDD | 0.685 | | <0.05 | **1** |
| | Model V | $CBR=0.0448OMC^2-2.5429OMC+41.457$ | CBR and OMC | 0.676 | | <0.05 | **4** |
| | Model VI | $CBR=0.0199P_{200}^2-1.0979P_{200}+20.94$ | CBR and $P_{200}$ | 0.226 | | >0.05 | **7** |
| | Model VII | $CBR=0.3276PP^2-4.0401PP+17.303,$ | CBR and PP | 0.583 | | <0.05 | 2 |
| | Model VII | $CBR=0.0405PM^2-1.5194PM+18.481,$ | CBR and PM | 0.486 | | <0.05 | **6** |

Generally the above developed single non-linear regression models of coarse grained soils, depend to on the values significant standard error and coefficient of regression, CBR value has strong correlation with maximum dry density, plastic product, plasticity index, optimum moisture content and plastic modulus whereas the $P_{200}$ and PL have weak relationship with CBR. In addition to this, correlation obtained from these variable such as MDD, OMC, PP and PI could yield a better correlation during the multiple regression variables

The CBR is essentially a measure of the shear strength of a material at a known density and moisture content and the CBR value coarse grained comparatively depend on the maximum dry density, optimum moisture content, and plastic product.

### 5.3.2 MLRA for Coarse-Grained Soils Classified According to AASHTO Classification System

To examine the combined effect of these parameters of the CBR with $P_{200}$, LL, PL, PI, OMC, PP, PM and MDD, a multiple regression analysis is conducted. The basic form of the equation is as follows the single regression discussed previously had shown that the California Bearing Ratio is a significantly strong relationship by some parameters like optimum moisture content, maximum dry density and plastic product.

Among the numbers of different alternatives analyzing of the multiple linear regressions of the twenty three coarse-grained soil samples and the following significant correlation were presented.

#### Model 1: Correlation between CBR with MDD and OMC

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD and OMC are expressed by the following equations of MLR.

$$\mathbf{CBR=35.014MDD+0.2788OMC-52.874 \quad with\ R^2=0.7349 \quad N=23}$$

The details of the statistical output of Model 1 indicates that the relationship developed between CBR with MDD and OMC is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD and OMC. For further reference, the detail of Model 1 is shown in Appendix A

### Model 2: Correlation between CBR with MDD, OMC, and LL

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD, OMC, and LL are expressed by the equations of MLR here in under.

$$\mathbf{CBR=35.099MDD+0.391OMC-0.124LL-48.67 \quad with \quad R^2=0.834 \quad N=23}$$

The details of the statistical output of Model 2 indicates that the relationship developed between CBR with MDD, OMC, and LL is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD, OMC, and LL. For further reference, the detail of Model 2 is shown in Appendix A.

### Model 3: Correlation between CBR with LL and PI

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with LL and PI are expressed by the equations MLR here in under.

$$\mathbf{CBR=17.596-0.1033LL-0.265\ PI \quad with\ R^2=0.496 \quad N=23}$$

The details of the statistical output of Model 3 indicates that the relationship developed between CBR with LL and PI is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. LL and PI. For further reference, the detail of Model 3 is shown in Appendix A.

### Model 4: Correlation between CBR with MDD, OMC, and PI

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD, OMC, and PI are expressed by the equation of MLR here in under.

$$\mathbf{CBR=29.17MDD+0.2365OMC-0.225PI-38.975 \quad with \quad R^2=0.8657 \quad N=23}$$

The details of the statistical output of Model 4 indicate that the relationship developed between CBR with MDD, OMC, and PI is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD, OMC, and PI. For further reference, the detail of Model 4 is shown in Appendix A.

### Model 5: Correlation between CBR with MDD, PP and PI

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD, PP, and PI are expressed by the equations MLR here in under.

**CBR=17.579MDD-0.272PP-0.174PI-15.36 with $R^2$=0.8403 N=23**

The details of the statistical output of Model 5 indicate that the relationship developed between CBR with MDD, PP, and PI is significant (α<0.05). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD, PP, and PI. For further reference, the detail of Model 5 is shown in Appendix A.

Generally, it can be noted that the CBR value correlates relatively better with plastic index, plastic product, optimum moisture content and maximum dry density whereas the left of the parameters showed a slightly moderate relationship with CBR. The above multiple correlation result is summarized and presented in Table 5.8.

Table 5. 6: Summary for MLRA for coarse grained soils classified according to the AASHTO classification system.

| Regression Type | Modal Name | Equation Developed | $R^2$ | Standard Error (α) | Significance Order Depending on(α)and $R^2$ |
|---|---|---|---|---|---|
| Multiple Regression | Model 1 | CBR=35.014MDD+0.2788OMC-52.874 | 0.734 | <0.05 | **4** |
| | Model 2 | CBR=35.099MDD+0.391OMC-0.124LL-48.67 | 0.834 | <0.05 | **2** |
| | Model 3 | CBR=17.596-0.1033LL-0.265 PI | 0.496 | <0.05 | **5** |
| | Model 4 | CBR=29.17MDD+0.2365OMC-0.225PI-38.975 | 0.865 | <0.05 | **1** |
| | Model 5 | CBR=17.579MDD-0.272PP-0.174PI-15.36 | 0.840 | <0.05 | **3** |

### 5.3.3 SNLRA for Fine Grained Soils Classified According to AASHTO Classification System

**Table 5. 7: Input data for SPSS Computer Program of Fine-grained soils**

| Station | CBR | MDD | OMC | LL | PL | PI | P200 | PP | PM |
|---|---|---|---|---|---|---|---|---|---|
| **3+000** | 7.64 | 1.51 | 25 | 56 | 43 | 13 | 68 | 8.84 | 10.14 |
| **4+000** | 23.8 | 1.97 | 10.3 | 23 | 16 | 7 | 53 | 4.24 | 7.28 |
| **5+500** | 17.3 | 1.88 | 13 | 34 | 25 | 9 | 35.8 | 3.222 | 5.652 |
| **7+000** | 7.7 | 1.53 | 24 | 60 | 37 | 23 | 62 | 14.26 | 19.665 |
| **8+000** | 8.8 | 1.44 | 31 | 59 | 44 | 15 | 51 | 7.65 | 10.83 |
| **9+500** | 8.1 | 1.61 | 21.8 | 55 | 30 | 25 | 73 | 18.25 | 23 |
| **11+000** | 3.85 | 1.44 | 28.3 | 62 | 39 | 23 | 43.4 | 9.982 | 21.39 |
| **15+000** | 3.31 | 1.5 | 21 | 65 | 41 | 24 | 52 | 12.48 | 17.04 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **16+000** | 8.1 | 1.52 | 25.6 | 54 | 39 | 15 | 48.8 | 7.32 | 11.55 |
| **17+000** | 3.2 | 1.4 | 29.5 | 65 | 48 | 17 | 60.6 | 10.302 | 13.736 |
| **30+500** | 3.95 | 1.33 | 33.5 | 73 | 52 | 21 | 43 | 9.03 | 14.7 |
| **34+000** | 9.23 | 1.457 | 23.7 | 62 | 52 | 10 | 57.2 | 5.72 | 9.54 |
| **39+000** | 5.2 | 1.516 | 27.5 | 70 | 43 | 27 | 37.6 | 10.152 | 20.358 |
| **39+500** | 7.1 | 1.547 | 26.5 | 61 | 45 | 16 | 49.6 | 7.936 | 10.592 |

Table 5. 8: Input data for the control test of fine-grained soils classified according to AASHTO classification system

| Station | CBR | MDD | OMC | LL | PL | PI | P200 | PP | PM |
|---|---|---|---|---|---|---|---|---|---|
| **10+000** | 3.25 | 1.507 | 30.72 | 72.1 | 42 | 30 | 73.6 | 22.816 | 28.396 |
| **26+000** | 6.7 | 1.548 | 22.1 | 59 | 37 | 22 | 55.6 | 12.232 | 19.096 |

After carefully studying the data trend on the scatter plot of the single regression analysis, the resulting regression analysis of the correlation of CBR with its LL, PL, PI, MDD, OMC, and $P_{200}$ is expressed by the following single non-linear equation.

Table 5. 9: Summary SNLRA for fined grained soils classified according to the AASHTO classification system

| Regression Type | Model Name | Equation Developed | Correlation between | $R^2$ | S. No. | The standard error (α) | Significance Order by on (α) and $R^2$ |
|---|---|---|---|---|---|---|---|
| **Single Regression** | Model I' | $CBR=0.0049LL^2 - 0.8811LL + 41.948$ | CBR and LL | 0.9295 | 14 | <0.05 | **1** |
| | Model II' | $CBR=0.0217PL^2 - 1.966PL + 50.226,$ | CBR and PL | 0.839 | | <0.05 | **3** |
| | Model III' | $CBR=0.0961PI^2 - 3.9806PI + 45.12$ | CBR and PI | 0.7853 | | <0.05 | **5** |
| | Model IV' | $CBR=38.863MDD^2 - 99.686MDD + 68.503$ | CBR and MDD | 0.8878 | | <0.05 | **2** |
| | Model V' | $CBR=0.0352OMC^2 - 2.1588OMC + 38.45$ | CBR and OMC | 0.7952 | | <0.05 | **4** |
| | Model VI' | $CBR=0.0024P_{200}^2 - 0.2999\ P_{200} + 17.277$ | CBR and $P_{200}$ | 0.0094 | | >0.05 | **8** |
| | Model VII' | $CBR=0.1399PM^2 - 4.7318PM + 43.224,$ | CBR and PM | 0.7637 | | <0.05 | **7** |
| | Model VIII' | $CBR=0.1905PP^2 - 4.8092PP + 33.817,$ | CBR and PP | 0.7778 | | <0.05 | **6** |

Generally, the above developed single non-linear regression models of fine-grained soils, depend on the values significant standard error (α) and coefficient of regression (R2), the CBR has strong correlation with liquid limit, plastic limit, plasticity index, optimum moisture content, plastic product, plastic modulus and maximum dry density which Whereas the percent passing No.200 sieve showed a weak correlation with CBR.

It is well known that the shear strength or CBR of fine-grained soils varies mainly with cohesion or consistency limit. A fine-grained soil that is at high consistency limit has very little shearing strength, whereas the same fine-grained at lower moisture content may have considerable shearing strength or CBR value.

Fine-grained soils contain a high quantity of air voids. This soil group requires more water to minimize air voids and therefore the optimum moisture content is high. Adding water makes this soil plastic and requires more compaction effort. If the compaction increased, the maximum dry density soils increase and the optimum moisture content decrease.

### 5.3.4 MLRA for Fine Grained Soils Classified According to AASHTO Classification System.

To examine the combined effect of these parameters of the CBR with $P_{200}$, LL, PL, PI, OMC, PP, PM and MDD, a multiple regression analysis is conducted. The basic form of the equation is as follows. The single regression discussed previously had shown that the California bearing ratio is significantly affected by some parameters like maximum dry density, liquid limit, plastic limit, plastic index and optimum moisture conten

Among the numbers of different alternatives combinations analyzing of the multiple linear regressions of the fourteen fine-grained soil samples, the following six model of MLR model most significant correlation were presented here in under.

#### Model 1': Correlation between CBR with MDD and OMC

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD and OMC are expressed by the equations of MLR herein under.

**$CBR=39.65MDD+0.263OMC-59.253$ with $R^2=0.853$, N=14**

The details of the statistical output of Model 1' indicates that the relationship developed between CBR with MDD and OMC is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD and OMC. For further reference, the detail of Model 1' is presented in Appendix B.

### Model 2': Correlation between CBR with MDD, OMC, and LL

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD, OMC, and LL are expressed by the equations of MLR herein under.

**$CBR=15.49MDD+0.2215OMC-0.319LL-2.67$ with $R^2=0.9155$, N=14**

The details of the statistical output of Model 2' indicate that the relationship developed between CBR with MDD, OMC and LL is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD, OMC, and LL. For further reference, the detail of Model 2' is presented in Appendix B.

### Model 3': Correlation between CBR with LL and PI

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with LL, PL, and PI are expressed by the equations of MLR herein under.

**$CBR=31.786-0.376LL-0.1103PI$ with $R^2=0.911$ N=14**

The details of the statistical output of Model 3' indicates that the relationship developed between CBR with LL and PI is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. LL and PI. For further reference, the detail of Model 3' is presented in Appendix B.

### Model 4': Correlation between CBR with MDD and LL

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD and LL are expressed by the equations of MLR herein under.

**$CBR=16.494+6.810MDD-0.326LL$ with $R^2=0.9084$ N=14**

The details of the statistical output of Model 4' indicates that the relationship developed between CBR with MDD and OMC is significant ($\alpha<0.05$). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD and OMC. For further reference, the detail of Model 4' is shown in Appendix B.

### Model 5': Correlation between CBR with OMC and LL

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with OMC and LL are expressed by the equations of MLR herein under.

**$CBR=31.902+0.0145OMC-0.4178LL$ with $R^2=0.903$ N=14**

The details of the statistical output of Model 5' indicates that the relationship developed between CBR with OMC and LL is significant (α<0.05). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. OMC and LL. For further reference, the detail of Model 5' is shown in Appendix B.

### Model 6': Correlation between CBR with MDD, LL and PL

From the multiple regression analysis, the resulting correlation coefficient with its corresponding CBR with MDD, LL and PL are expressed by the equations of MLR herein under.

**CBR=15.843MDD-0.361LL+0.2179PI-4.082 with $R^2$=0.9306 N=14**

The details of the statistical output of Model 6' indicates that the relationship developed between CBR with MDD, LL and PL is significant (α<0.05). Besides, the $R^2$ value of the multiple regression analysis is improved than the $R^2$ value of the individual parameters, i.e. MDD, LL and PL. For further reference, the detail of Model 6' is shown in Appendix B. The above multiple correlations of fine-grained soil results are summarized and presented in Table 5.10.

Table 5. 10: Summary for MLRA for fine grained soils classified according to the AASHTO classification system.

| Regression Type | Modal Name | Equation Developed | $R^2$ | Standard Error (α) | Significance Order Depending on (α)and $R^2$ |
|---|---|---|---|---|---|
| Multiple Regression | Model 1' | CBR=39.65MDD+0.263OMC-59.25 | 0.853 | <0.05 | **6** |
| | Model 2' | CBR=15.49MDD+0.22OMC-0.319LL-2.67 | 0.9155 | <0.05 | **2** |
| | Model 3' | CBR=31.78-0.376LL-0.1103PI | 0.9111 | <0.05 | **3** |
| | Model 4' | CBR=16.49+6.81MDD-0.326LL | 0.908 | <0.05 | **4** |
| | Model 5' | CBR=31.9+0.0145OMC-0.326LL | 0.903 | <0.05 | **5** |
| | Model 6' | CBR=15.84MDD-0.36LL+0.218PL-4.08 | 0.9306 | <0.05 | **1** |

# 6. DISCUSSIONS

## 6.1 General

The validation of the developed correlation is conducted by using the control test in order to evaluate the suitable equation, the CBR value were calculated for both input soil data and control samples soil data using newly developed equations.

## 6.2 Discussion on Regression Result for Soils Classified According AASHTO Classification System

Table 5.5 and 5.6 show the summarized results of the regression analysis in predicting the CBR from the corresponding index properties of soils and compaction characteristics of coarse grained soil. In the same way Table 5.9 and 5.10 show the summarized results of regression analysis in predicting CBR from the index properties and compaction characteristics of fine grained soil. An attempt was made to obtain which one of the predictors can be strongly related to dependent variables. This has been done in two stages; the first stage was to analyze the relationship between the predictors and the dependent variable one by one interchangeably using single regression analysis.

The single regression analysis for the coarse-grained soils and fine-grained soils are presented in Tables 5.5 and 5.9 respectively. As one can see the data trend of the coarse grained soils in Table 5.5, CBR values are significantly influenced by maximum dry density, optimum moisture content and plastic product with a coefficient of determinations of 68.5%, 67.6% and 58.3% respectively. Whereas as from Table 5.9, it can be observed that the CBR values of fine grained soils are significantly influenced by LL, PL, MDD, and OMC by achieving a coefficient of determination of 92.95%, 83.9 %, 88.78% and
79.52% respectively. The CBR of coarse grained soils is significantly influenced by maximum dry density whereas it significantly influenced by a liquid limit in the case of fine grained soils.

The second stage was done to predict the CBR from two or more independent variables using multiple linear regression analysis. The multiple linear regression analysis for the coarse-grained soils and fine grained soils are presented in Tables 5.6 and 5.10 respectively. Depending on the relative significance order the coarse grained soils and fine grained soils are preferably selected

Model 4 (CBR=29.17MDD+0.2365OMC+0.2254PI-38.975) with a coefficient of determination of 0.866 and Model 6' (CBR=15.84MDD - 0.361LL + 0.2179PL - 4.082) with a coefficient of determination of 0.931 respectively among the different alternative correlations for further verifications.

According to the principles of multiple linear regressions, the value of the coefficient of determination ($R^2$) should be between 0.8 and 1 for the perfect fit. So in this regard, since the coefficient of determinations of the two proposed models for the two groups of soils is above 0.8, the models can predict with high accuracy the soaked CBR values for the two groups of soils.

The validations of the developed correlations for the coarse-grained and fine grained soils are conducted by using two control known test results. The validation of the developed correlation and predicted CBR values using the newly developed correlation equations shown in Table 6.1 and 6.4 for the coarse grained and fine grained soils respectively.

Table 6. 1: Validation of newly developed equation for coarse grained soils classified according to AASHTO classification system

| Station | **Actual CBR value** | MDD | OMC | LL | PL | PI | P200 | **Predicted CBR Value** |
|---|---|---|---|---|---|---|---|---|
| 2+500 | 14.7 | 1.813 | 13.6 | 44 | 30 | 14 | 12.4 | 13.971 |
| 12+000 | 4.52 | 1.477 | 28 | 62 | 41 | 21 | 29.6 | 5.997 |
| 12+500 | 6.13 | 1.376 | 33.5 | 60 | 42 | 18 | 22 | 5.029 |
| 13+000 | 3.93 | 1.443 | 29.5 | 70 | 45 | 25 | 19 | 4.4591 |
| 14+000 | 7.25 | 1.408 | 32.9 | 66 | 49 | 17 | 17.6 | 6.045 |
| 14+500 | 5.44 | 1.446 | 29 | 65 | 46 | 19 | 27 | 5.781 |
| 20+000 | 5 | 1.489 | 23.8 | 55 | 36 | 19 | 29.6 | 5.81 |
| 24+000 | 7.73 | 1.47 | 24.6 | 54 | 42 | 12 | 20.2 | 7.02 |
| 25+000 | 4.66 | 1.364 | 29.4 | 48 | 33 | 15 | 33 | 4.385 |
| 25+500 | 9 | 1.568 | 19.6 | 51 | 36 | 15 | 28.2 | 8.018 |
| 29+000 | 5.2 | 1.531 | 21.8 | 59 | 43 | 16 | 24 | 7.234 |
| 29+500 | 5.56 | 1.532 | 20.5 | 61 | 37 | 24 | 21 | 5.152 |
| 30+000 | 4.94 | 1.508 | 25 | 63 | 42 | 21 | 25.6 | 6.192 |
| 31+000 | 6.5 | 1.511 | 26.6 | 64 | 42 | 22 | 13.8 | 6.433 |
| 31+500 | 7.67 | 1.495 | 25 | 42 | 29 | 13 | 16 | 7.62 |
| 33+000 | 8.3 | 1.556 | 26.2 | 58 | 40 | 18 | 28.96 | 7.56 |
| 34+500 | 6.82 | 1.474 | 29.6 | 68 | 53 | 15 | 21 | 7.641 |
| 35+000 | 4.5 | 1.437 | 27.65 | 57 | 30 | 27 | 28.88 | 3.396 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 35+500 | 12.5 | 1.66 | 19.18 | 48 | 38 | 10 | 20.86 | 11.73 |
| 37+000 | 5.75 | 1.498 | 23 | 64 | 41 | 23 | 21 | 4.98 |
| 37+500 | 5.4 | 1.503 | 23 | 64 | 45 | 19 | 19 | 6.02 |
| 40+000 | 6.1 | 1.467 | 28 | 65 | 44 | 21 | 29.6 | 5.706 |
| 41+000 | 8.75 | 1.59 | 22.8 | 50 | 38 | 12 | 27.2 | 10.093 |

Subsequently, using the control test results and the developed correlation equation of the model 4, the predicted CBR is determined so as to compare it with the actual CBR value in Table 6.2.

Table 6. 2: Validation of newly developed correlation (for coarse grained control test)

| **Station** | **Actual CBR Value** | **MDD** | **OMC** | **LL** | **PL** | **PI** | **P200** | **Predicted CBR Value** |
|---|---|---|---|---|---|---|---|---|
| 1+500 | 10.3 | 1.733 | 17 | 54 | 36 | 18 | 19.86 | 11.54 |
| 36+000 | 9.5 | 1.54 | 22.9 | 54 | 39 | 15 | 12 | 7.98 |

Table 6. 3: Checking the accuracy of the newly developed formula for control samples

| **Station** | **Actual CBR Value** | **Predicted CBR Value** | **Variation of CBR Value** |
|---|---|---|---|
| 1+500 | 10.3 | 11.54 | -12.03 |
| 36+000 | 9.5 | 7.98 | 15.98 |
| **Average** | **9.9** | **9.76** | **14.01** |

From the values, in Table 6.3, the percentages of variation of the newly developed formula for the control test of the accuracy ranges of an average of 14.01% deviated from the actual CBR values.

Table 6. 4: Validation of newly developed equation for fine grained soil classified according to AASHTO classification system

| Station | **Actual CBR Value** | MDD | OMC | LL | PL | PI | P200 | **Predicted CBR Value** |
|---|---|---|---|---|---|---|---|---|
| 3+000 | 7.64 | 1.51 | 25 | 56 | 43 | 13 | 68 | 9.056 |
| 4+000 | 23.8 | 1.97 | 10.3 | 23 | 16 | 7 | 53 | 21.98 |
| 5+500 | 17.3 | 1.88 | 13 | 34 | 25 | 9 | 35.8 | 18.811 |
| 7+000 | 7.7 | 1.53 | 24 | 60 | 37 | 23 | 62 | 6.59 |
| 8+000 | 8.8 | 1.44 | 31 | 59 | 44 | 15 | 51 | 6.94 |
| 9+000 | 8.1 | 1.61 | 21.8 | 55 | 30 | 25 | 73 | 8.026 |
| 11+000 | 3.85 | 1.44 | 28.3 | 62 | 39 | 23 | 43.4 | 4.78 |
| 15+000 | 3.31 | 1.5 | 21 | 65 | 41 | 24 | 52 | 5.197 |
| 16+000 | 8.1 | 1.52 | 25.6 | 54 | 39 | 15 | 48.8 | 8.92 |
| 17+000 | 3.2 | 1.4 | 29.5 | 65 | 48 | 17 | 60.6 | 5.154 |
| 30+500 | 3.95 | 1.33 | 33.5 | 73 | 52 | 21 | 43 | 1.966 |
| 34+000 | 9.23 | 1.457 | 23.7 | 62 | 52 | 10 | 57.2 | 7.95 |
| 39+000 | 5.2 | 1.516 | 27.5 | 70 | 43 | 27 | 37.6 | 4.034 |
| 39+500 | 7.1 | 1.547 | 26.5 | 61 | 45 | 16 | 49.6 | 8.21 |

Table 6. 5: Validation of newly developed equation (Control test of fine-grained soil

| Station | Actual CBR Value | MDD | OMC | LL | PL | PI | $P_{200}$ | Predicted CBR Value |
|---|---|---|---|---|---|---|---|---|
| 10+000 | 3.25 | 1.507 | 30.72 | 72 | 42 | 30 | 73.6 | 2.95 |
| 26+000 | 6.7 | 1.548 | 22.1 | 59 | 37 | 22 | 55.6 | 7.204 |

Table 6. 6: checking the accuracy of the newly developed formula for control samples

| Station | Actual CBR Value | Predicted CBR Value | Variation of CBR Value |
|---|---|---|---|
| 10+000 | 3.25 | 2.95 | 9.17 |
| 26+000 | 6.7 | 7.204 | -7.53 |
| **Average** | **4.64** | **5.077** | **8.35** |

From the values, in Table 6.6, the percentages of variation of the newly developed formula of the model 6' for the control test the accuracy ranges of an average of 8.35% deviated from the actual CBR values.

## 6.1 Graphical Representation of Experimental and Predicted CBR Values

The Graphical representation of Experimental and predicted CBR value based on the newly developed formulas of model 4 and 6' of the best-fitted equation for the coarse and fine-grained are shown respectively on the figure 6.1 and 6.2

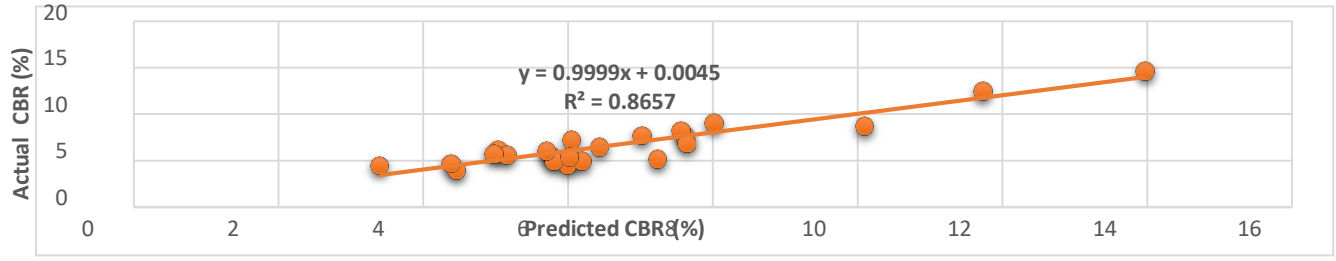


Figure 6. 1: Scattered plot of experimental vs Predicted CBR (coarse grained AASTHO)

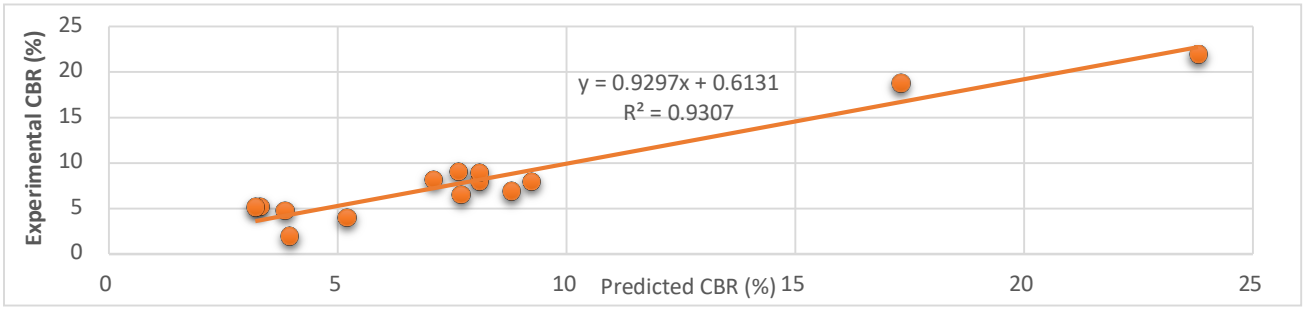


Figure 6. 2: Scattered plot of experimental vs Predicted CBR (fine grained AASHTO)

As one can see in the above consecutive figures, about 86.6 % and 93.06% of the total samples scattered near the straight line through which the experimental and predicted CBR value is equal, whereas relatively 13.4% and 6.94 % of the test results slightly deviated from the possible line for coarse-grained and fine-grained soils respectively.

Model 4 and Model 6' for the coarse grained soils and fine-grained soils have respectively described the relation better than all others established model. This is, therefore, it has good regression analysis with a coefficient of determination 0.836 for coarse grained soils whereas 0.9306 for fine grained soils and the accuracy of experimental CBR values from predicted CBR value for control sample is 14.01% difference for coarse grained soils and 8.35% for fine grained soils. Hence, one may use this suggested equation for the estimation of the CBR value of the study area.

## 6.3 Evaluation of the Developed and Existing Correlations

The suitability of existing correlations particularly the NCHR's [14] and Leliso Y. [10] correlations, along with the developed correlation are calculated using a control test results obtained from the subject study area. The evaluated results of the correlations which are obtained by using the control test results are presented in Table 6.7.

Table 6. 7: The developed and existing correlation for fine-grained soils of the control test

| Station | Actual CBR Value(A) | Developed Correlation | | NCHR | | Leliso Y. | |
|---|---|---|---|---|---|---|---|
| | | Predicted CBR value(B) | Variation %(A-B)/A*100 | Predicted CBR value(C) | Variation %(A-C)/A*100 | Predicted CBR value(D) | Variation %(A-D)/A*100 |
| 10+000 | 3.25 | 2.95 | 9.17 | 4.39 | -35.15 | 4.447 | -36.85 |
| 26+000 | 6.70 | 7.204 | -7.15 | 7.57 | 13.01 | 6.413 | 4.28 |
| **Average** | **4.98** | **5.17** | **8.35** | **5.98** | **24.86** | **5.43** | **20.57** |

As shown in Tables 6.7, the NCHR's correlation resulted in an average variation of 24.086% from the actual CBR values. Similarly, Leliso Y. correlation resulted in an average variation of 20.57% and the developed correlation resulted in an average of 8.35% from the Laboratory (actual) CBR values.

In light of the above it is worth note that the test results obtained from the study area are relatively suited by the above developed correlation.

# 7. CONCLUSION AND RECOMMENDATION

Based on the analysis of data obtained from laboratory soil testing and correlation developed the following conclusions and recommendations are drawn.

## 7.1 Conclusion

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

- Among the developed models, model 4 with 0.866 coefficient of determination was proposed to predict the soaked CBR values of coarse-grained soils. Hence, using the developed relationship, one can indirectly determine soaked CBR values from maximum dry density optimum moisture content and plastic index, as one can see compared with all other models of coarse-grained soils.
- Among developed models, model 6' with 0.9306 coefficient of determination was proposed to predict the soaked CBR values of fine-grained soils. Therefore, using the developed relationship, one can indirectly determine soaked CBR values of fine-grained soils from maximum dry density, liquid limit and plastic index.
- The multiple linear regression analysis of the soil index properties yields a better coefficient of determination than single linear regression analysis for predicting the CBR values.
- It common that there is a positive relation between CBR Vs MDD and negative relation between CBR versus OMC, PP, PM, LL, PL, PI, and $P_{200}$.
- In general, it can be concluded that for preliminary soil investigation the CBR values of soils compacted at predetermined optimum moistures content and maximum dry densities with modified Proctor compaction, can be predicted from liquid limit, optimum moisture content and maximum dry density without significant errors for the study area.

## 7.2 Recommendation

This work can be further extended to correlate the CBR values with index properties and compaction characteristics of soil such as standard Proctor test, un-soaked CBR value, varying the moisture content, varying the soaking days and modified reduced Proctor test. In addition to this, further studies have to be carried out to check the applicability the equation for other types of soil.

Based on regression analysis, it is recommended that a good measure of quality control of PI, MDD, OMC and LL variables are significant during field compaction and incorporation of these variables into a measure of quality control and specification will help to achieve durable road pavement.

Extending this research by the research institute to published the guidance manual for the road authorities, railway authorities, consultants and contractors as preliminary background information on the value of CBR, for a localized subgrade material, from soil index properties for the benefit of saving time and additional cost for carrying out laboratory CBR test and equipment.

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# APPENDIX A and B: Details of the SPSS Analysis Output

# Appendix A: Multiple Regression Analysis for coarse grained soils

## Model 1: Correlation between CBR with MDD and OMC

Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .857a | .735 | .708 | 1.39879 |

a. Predictors: (Constant), OMC, MDD

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -52.874 | 13.980 | | -3.782 | .001 |
| | MDD | 35.014 | 7.091 | 1.278 | 4.938 | .000 |
| | OMC | .278 | .143 | .503 | 1.944 | .066 |

a. Dependent Variable: CBR

## Model 2: Correlation between CBR with MDD, OMC and LL

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .913a | .834 | .808 | 1.13489 |

a. Predictors: (Constant), LL, MDD, OMC

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -48.672 | 11.411 | | -4.265 | .000 |
| | MDD | 35.100 | 5.753 | 1.282 | 6.101 | .000 |
| | OMC | .392 | .121 | .710 | 3.245 | .004 |
| | LL | -.124 | .037 | -.375 | -3.374 | .003 |

a. Dependent Variable: CBR

## Model 3: Correlation between LL and PI

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .705 | .497 | .446 | 1.92804 |

a. Predictors: (Constant), PI, LL

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 17.596 | 3.097 | | 5.682 | .000 |
| | PL | -.103 | .069 | -.313 | -1.506 | .148 |
| | PI | -.265 | .120 | -.460 | -2.211 | .039 |

a. Dependent Variable: CBR

### Model 4: Correlation between CBR with MDD, OMC and PI

**Modal Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .930 | .866 | .845 | 1.02161 |

a. Predictors: (Constant), OMC,PI and MDD

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 127.830 | 3 | 42.610 | 40.827 | .000b |
| | MDD | 19.830 | 19 | 1.044 | | |
| | LL | 147.660 | 22 | | | |

a. Dependent Variable: CBR

### Model 5: Correlation between CBR with MDD, PP and PI

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .917a | .840 | .815 | 1.11415 |

a. Predictors: (Constant), MDD, PP and PI

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 124.075 | 3 | 41.358 | 33.318 | .000b |
| | OMC | 23.585 | 19 | 1.241 | | |
| | LL | 147.660 | 22 | | | |

a. Dependent Variable: CBR

## Appendix B: Multiple Linear Regression Analysis for Fine Grained Soils

### Model 1': Correlation between CBR with MDD and OMC

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .923a | .853 | .826 | 2.38225 |

a. Predictors: (Constant), OMC, MDD

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -59.253 | 24.765 | | -2.393 | .036 |
| | MDD | 39.650 | 11.574 | 1.215 | 3.426 | .006 |
| | OMC | .263 | .296 | .314 | .887 | .394 |

a. Dependent Variable: CBR

### Model 2': Correlation between CBR with MDD, OMC and LL

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .957 | .916 | .890 | 1.89216 |

a. Predictors: (Constant), LL, OMC, MDD

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -2.670 | 28.592 | | -.093 | .927 |
| | MDD | 15.491 | 12.768 | .475 | 1.213 | .253 |
| | OMC | .222 | .236 | .265 | .940 | .370 |
| | LL | -.319 | .117 | -.738 | -2.727 | .021 |

a. Dependent Variable: CBR

### Model 3': Correlation between LL and PI

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .959[a] | .920 | .905 | 1.795047 |

a. Predictors: (Constant), PI, PL

**Coefficients**

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 31.786 | 2.180 | | 14.584 | .000 |
| | PL | -.407 | .048 | -.728 | -8.517 | .000 |
| | PI | -.423 | .063 | -.575 | -6.719 | .000 |

a. Dependent Variable: CBR

### Model 4': Correlation between CBR with MDD and LL

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .953 | .908 | .891 | 1.88205 |

a. Predictors: (Constant), LL, MDD

Coefficients

| Model | | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | 16.494 | 19.928 | | .828 | .425 |
| | MDD | 6.810 | 8.765 | .209 | .777 | .454 |
| | LL | -.326 | .116 | -.754 | -2.808 | .017 |

a. Dependent Variable: CBR

## Model 5': Correlation between CBR with OMC and LL

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .950 | .903 | .885 | 1.93234 |

a. Predictors: (Constant), LL, OMC

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -4.082 | 21.434 | | -.190 | .853 |
| | MDD | 15.842 | 9.422 | .485 | 1.681 | .124 |
| | LL | -.144 | .146 | -.332 | -.980 | .350 |
| | PI | -.218 | .121 | -.240 | -1.805 | .101 |

a. Dependent Variable: CBR

## Model 6': Correlation between MDD LL and PI

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | .965a | .931 | .910 | 1.71430 |

a. Predictors: (Constant), MDD,PI, LL

Coefficient

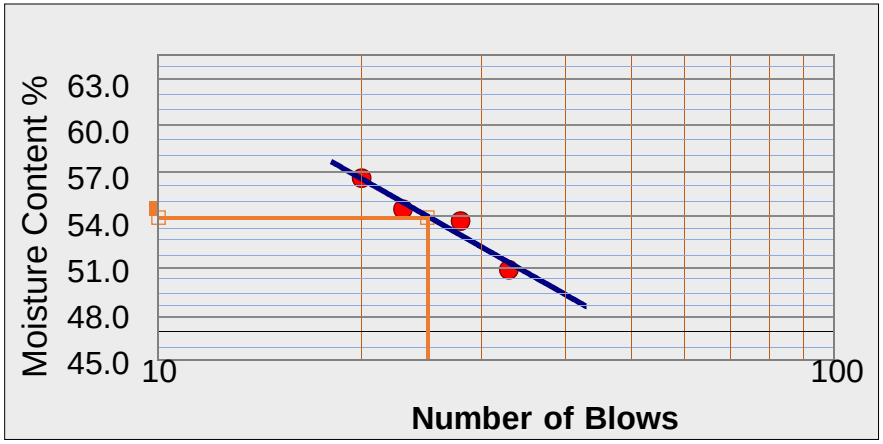
| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 1 | (Constant) | -4.082 | 21.434 | | -.190 | .853 |
| | MDD | 15.842 | 9.422 | .485 | 1.681 | .124 |
| | LL | -.144 | .146 | -.332 | -.980 | .350 |
| | PI | -.218 | .121 | -.240 | -1.805 | .101 |

a. Dependent Variable: CBR

# APPENDIX C: Details of the Laboratory Test Results

## Sample No.: 1 Station of Sample: 1+500km, Visual Soil Description: Red brown clay soil

| 1. SOIL CONSISTENCY TEST RESULT(AASHTO T89,T90 | | | | | | |
|---|---|---|---|---|---|---|
| **Description** | **1.1 Liquid Limit** | | | | **1.2 Plastic Limit** | |
| No. of Blows | 33 | 28 | 23 | 20 | | |
| Can No. | 12 | 16 | 22 | 93 | 22.00 | 96.00 |
| Wt. of Can + Wet Soil (g) | 50.10 | 49.10 | 43.80 | 46.40 | 25.00 | 25.60 |
| Wt. of Can + Dry Soil (g) | 41.00 | 40.20 | 35.03 | 36.70 | 23.45 | 23.75 |
| Wt. of Container (g) | 23.20 | 23.80 | 19.10 | 19.70 | 19.10 | 18.70 |
| Weight of Moisture (g) | 9.10 | 8.90 | 8.77 | 9.70 | 1.55 | 1.85 |
| Weight of Dry Soil (g) | 17.80 | 16.40 | 15.93 | 17.00 | 4.35 | 5.05 |
| Moisture Content (%) | 51.12 | 54.27 | 55.05 | 57.06 | 35.63 | 36.63 |
| **1.3 Plastic Index(PI)=LL-PL=54-36=18** | | | | | | |




**1.2 Particle size Distribution(TEST METHOD AASHTO T-88)**

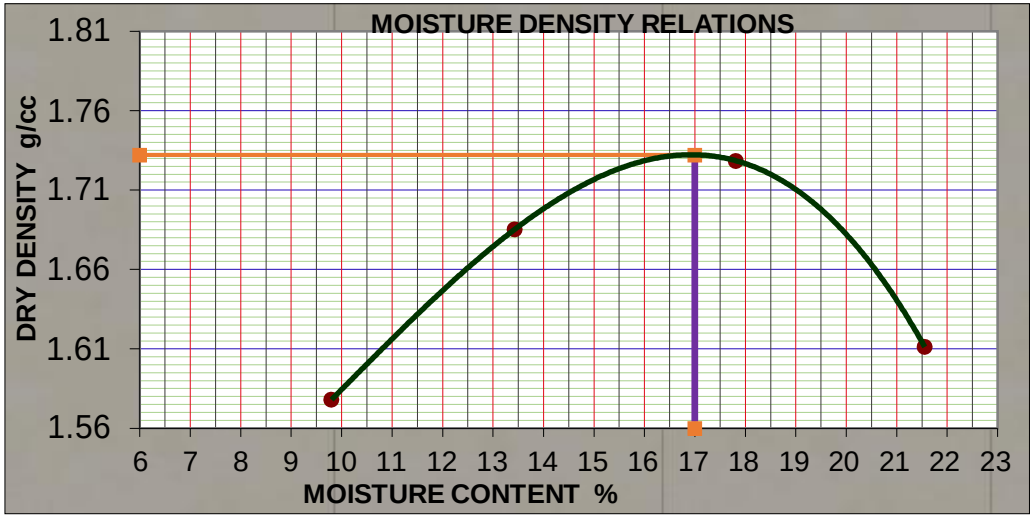
| sieve size(mm) | weight retained | % retained | % pass | SOIL CLASSIFICATION; A-7-5(3) | | |
|---|---|---|---|---|---|---|
| 2.00 mm | 33.5 | 6.70 | 93.30 | AASHTO | USCS | ERA subgrade |
| 0.425 | 171.8 | 34.36 | 58.94 | **A-2-7-(0)** | **SH** | **S4** |
| 0.075 | 195.4 | 39.08 | 19.86 | | ` | |
| Total Weight Before wash | 500 | | | | | |

### 1.3.1 Moisture Content Determination

| | Trial No. | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| DENSITY | Wt. of Soil + Mould | 8640.0 | 9020.0 | 9285.0 | 9120.0 | |
| | Wt. OF Mould | 4960 | 4960 | 4960 | 4960 | |
| | Vol. of Mould | 2124 | 2124 | 2124 | 2124 | |
| | Wt. WET SOIL (g) | 3,680 | 4,060 | 4,325 | 4,160 | |
| | WET density OF SOIL | 1.73 | 1.91 | 2.04 | 1.96 | **NMC** |

### 1.3.2 Dry Density Determination

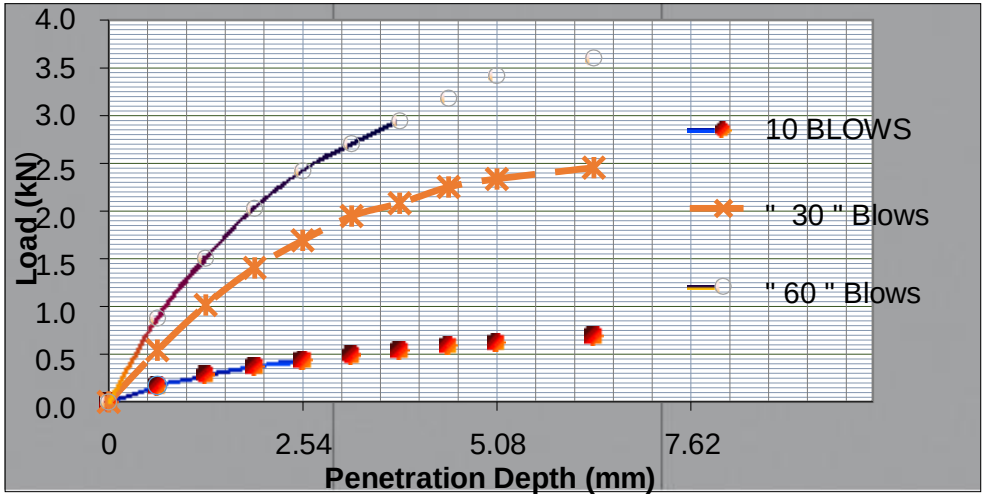
| | Can No. | Y | W | K | J | X |
|---|---|---|---|---|---|---|
| MOISTURE | WET SOIL + Can. | 250.1 | 232.8 | 235.9 | 222.4 | 218.7 |
| | DRY SOIL + Can | 230.1 | 208.6 | 203.7 | 188.0 | 214.0 |
| | Wt. of Can | 26.0 | 28.4 | 22.9 | 28.4 | 28.9 |
| | Wt. of Water (g) | 20.0 | 24.2 | 32.2 | 34.4 | 4.7 |
| | Wt. OF DRY SOIL (g) | 204.1 | 180.2 | 180.8 | 159.6 | 185.1 |
| | **W content (%)** | 9.80 | 13.43 | 17.81 | 21.55 | 2.54 |
| **DRY DENSITY OF SOIL ( g/Cm3 )** | | 1.58 | 1.69 | 1.73 | 1.61 | |



## 1.4 CALIFORNIA BEARING RATIO TEST (AASHTO T-193)

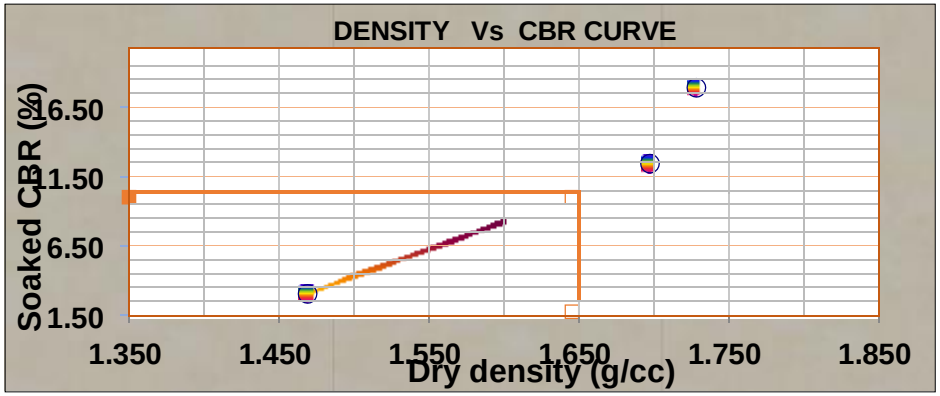
**1.4.1 PENETRATION TEST DATA**

| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 32.0 | 0.542 | 52.0 | 0.880 |
| 1.27 | 17.0 | 0.288 | 60.0 | 1.016 | 89.0 | 1.507 |
| 1.91 | 22.0 | 0.372 | 83.0 | 1.405 | 120.0 | 2.032 |
| 2.54 | 26.0 | 0.440 | 100.0 | 1.693 | 143.0 | 2.421 |
| 3.18 | 29.0 | 0.491 | 115.0 | 1.947 | 160.0 | 2.709 |
| 3.81 | 32.0 | 0.542 | 123.0 | 2.082 | 174.0 | 2.946 |
| 4.45 | 35.0 | 0.593 | 133.0 | 2.252 | 188.0 | 3.183 |
| 5.08 | 37.0 | 0.626 | 138.0 | 2.336 | 202.0 | 3.420 |
| 6.35 | 41.0 | 0.694 | 145.0 | 2.455 | 213.0 | 3.606 |




**1.4.2 CBR Value at Standard**

| BLOWS | DD (g/cm3) | LOAD (KN) | | Standard Load (kN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 mm | 2.54 | 5.08 | |
| **10** | **1.47** | 0.44 | 0.63 | 13.40 | 20.00 | 3.3 | 3.1 | 3.3 |
| **30** | **1.70** | 1.69 | 2.34 | 13.40 | 20.00 | 12.7 | 11.7 | 12.7 |
| **65** | **1.73** | 2.42 | 3.42 | 13.40 | 20.00 | 18.1 | 17.1 | 18.1 |




Ring Factor =0.01693kN/Div

**From the compaction curve: MDD = 1.732 g/cm3 and OMC = 17%**

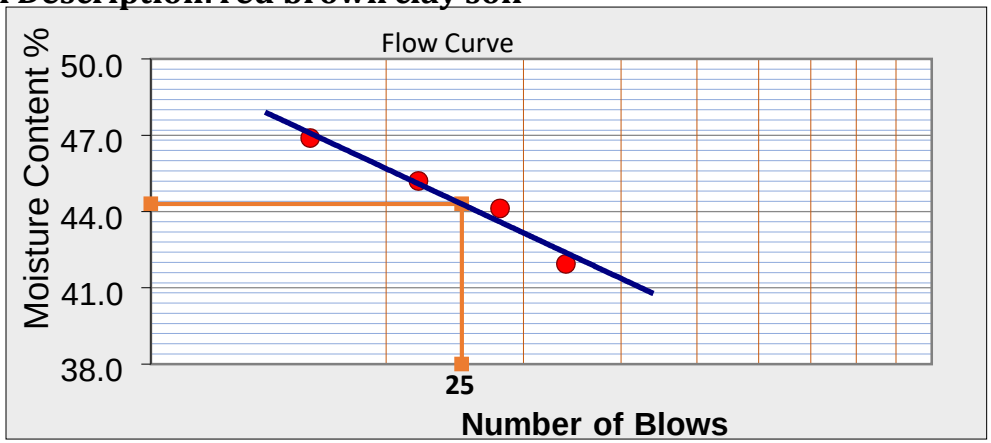
**From the Density-CBR Curve at 95% MDD (1.644 g/cm3): CBR = 10.25**

**Sample No.: 2, Location of Sample @ Station 2+500K: Visual Soil Description: red brown clay soil**

**1.1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | 1.1 LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 28 | 22 | 16 | | |
| Can No. | 2 | 12 | 13 | 22 | 91 | 92 |
| Wt. of Can + Wet Soil (g) | 37.40 | 42.90 | 39.50 | 33.30 | 25.60 | 30.80 |
| Wt. of Can + Dry Soil (g) | 32.20 | 36.90 | 34.80 | 28.80 | 24.20 | 29.30 |
| Wt. of Can (g) | 19.80 | 23.30 | 24.40 | 19.20 | 19.60 | 24.40 |
| Wt. of Moisture (g) | 5.20 | 6.00 | 4.70 | 4.50 | 1.40 | 1.50 |
| Wt. of Dry Soil (g) | 12.40 | 13.60 | 10.40 | 9.60 | 4.60 | 4.90 |
| W (%) | 41.94 | 44.12 | 45.19 | 46.88 | 30.43 | 30.61 |

**1.3 PI=LL-PL=45-31=14**



**1.2 Particle size Distribution(TEST METHOD AASHTO T-88)**

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | **USCS** | ERA Subgrade |
| 2.00 mm | 26.5 | 5.30 | 94.70 | | | |
| 0.425 | 236.1 | 47.22 | 47.48 | A-2-7(0) | **SM** | S5 |
| 0.075 | 175.4 | 35.08 | 12.40 | | | |
| Total Weight Before wash | 500 | | | | | |

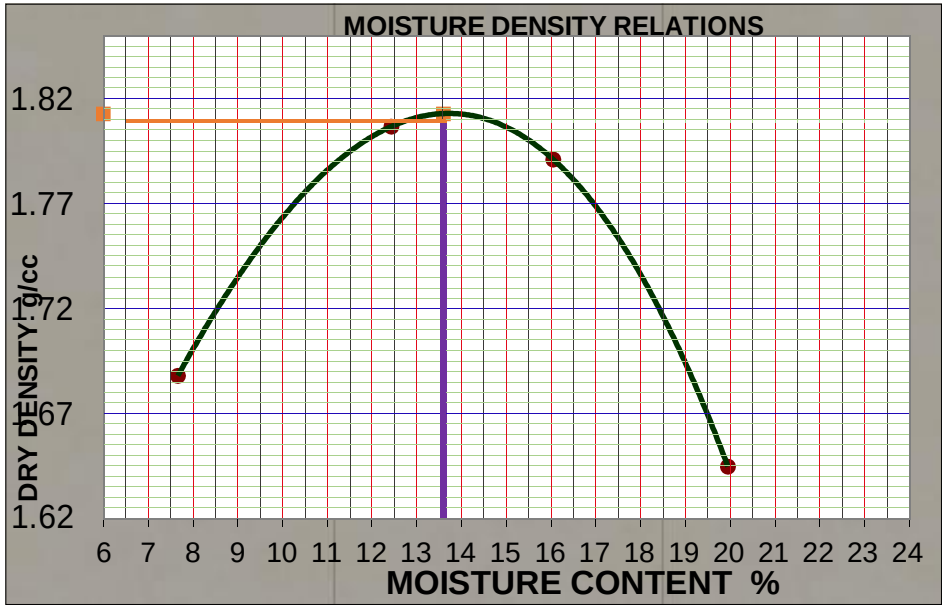
**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

**1.3.1 Bulk Density Determination**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | Trial No. | 1 | 1 | 2 | 3 | |
| | Wt. Soil +Mould (g) | 8820.0 | 9275.0 | 9375.0 | 9150.0 | |
| | Wt. of Moild (g) | 4960 | 4960 | 4960 | 4960 | |
| | Volume of Mould ($Cm^3$) | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) | 3,860 | 4,315 | 4,415 | 4,190 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) | 1.82 | 2.03 | 2.08 | 1.97 | **NMC** |

**1.3.2 Dry Density Determination**

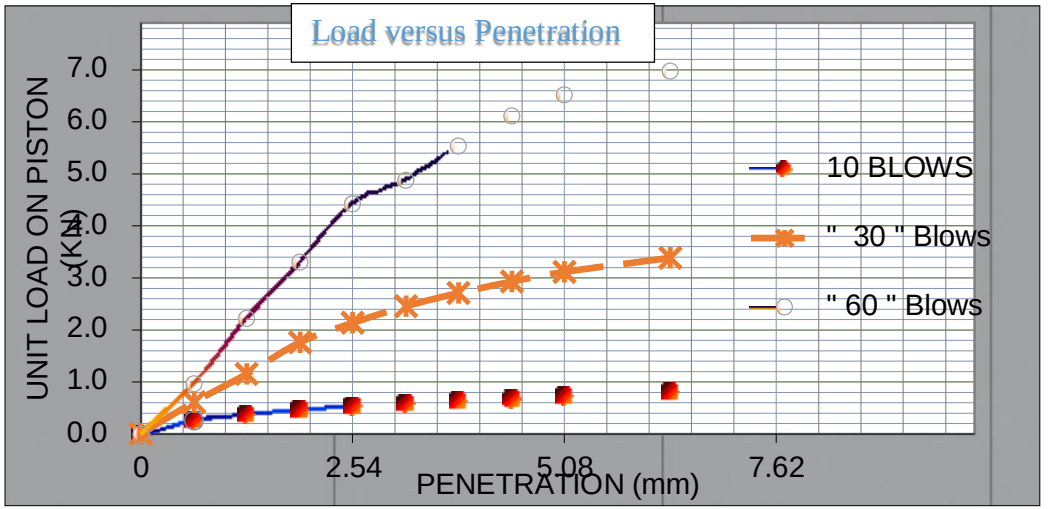
| | | | | | | |
|---|---|---|---|---|---|---|
| MOISTURE | Can No. | M | G | H | 35 | E |
| | WET SOIL + Can (g) | 261.9 | 209.6 | 199.0 | 248.3 | 248.3 |
| | DRY SOIL + Can (g) | 245.2 | 189.4 | 174.8 | 211.2 | 236.6 |
| | Wt. of Can (g) | 27.3 | 26.9 | 24.0 | 25.2 | 26.8 |
| | Wt. of Water (g) | 16.7 | 20.2 | 24.2 | 37.1 | 11.7 |
| | WEIGHT OF DRY SOIL (g) | 217.9 | 162.5 | 150.8 | 186.0 | 209.8 |
| | **W (%)** | 7.66 | 12.43 | 16.05 | 19.95 | 5.58 |
| **DRY DENSITY OF SOIL ( g/Cm3 )** | | 1.69 | 1.81 | 1.79 | 1.64 | |




**1.4 CALIFORNIA BEARING RATIO TEST (AASHTO T-193)**

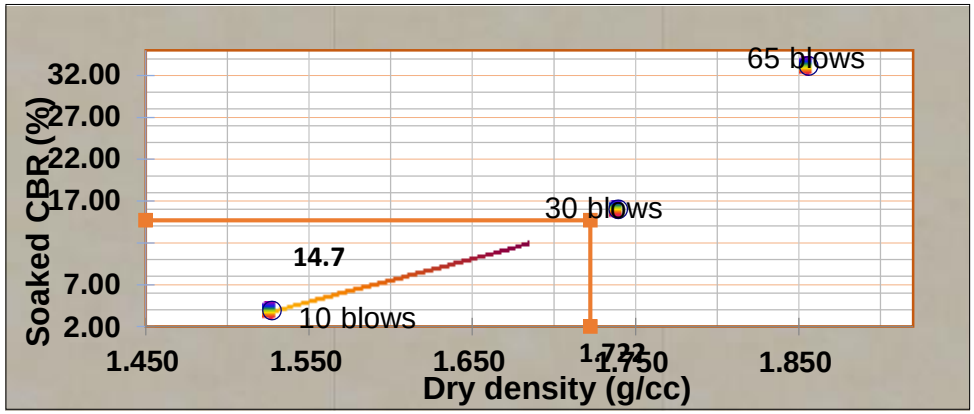
**1.4.1 PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 15.0 | 0.254 | 36.0 | 0.609 | 57.0 | 0.965 |
| 1.27 | 22.0 | 0.372 | 68.0 | 1.151 | 131.0 | 2.218 |
| 1.91 | 27.0 | 0.457 | 104.0 | 1.761 | 195.0 | 3.301 |
| 2.54 | 31.0 | 0.525 | 126.0 | 2.133 | 261.0 | 4.419 |
| 3.18 | 34.0 | 0.576 | 145.0 | 2.455 | 288.0 | 4.876 |
| 3.81 | 37.0 | 0.626 | 160.0 | 2.709 | 327.0 | 5.536 |
| 4.45 | 40.0 | 0.677 | 173.0 | 2.929 | 361.0 | 6.112 |
| 5.08 | 43.0 | 0.728 | 184.0 | 3.115 | 385.0 | 6.518 |
| 6.35 | 48.0 | 0.813 | 200.0 | 3.386 | 412.0 | 6.975 |



### 1.4.2 CBR Value at Standard Loads

| BLOWS | DD (g/cm 3) | LOAD (KN) | | Standard Load (kN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.53** | 0.52 | 0.73 | 13.40 | 20.00 | 3.9 | 3.6 | 3.9 |
| **30** | **1.74** | 2.13 | 3.12 | 13.40 | 20.00 | 16.0 | 15.6 | 16.0 |
| **65** | **1.86** | 4.42 | 6.52 | 13.40 | 20.00 | 33.1 | 32.6 | 33.1 |

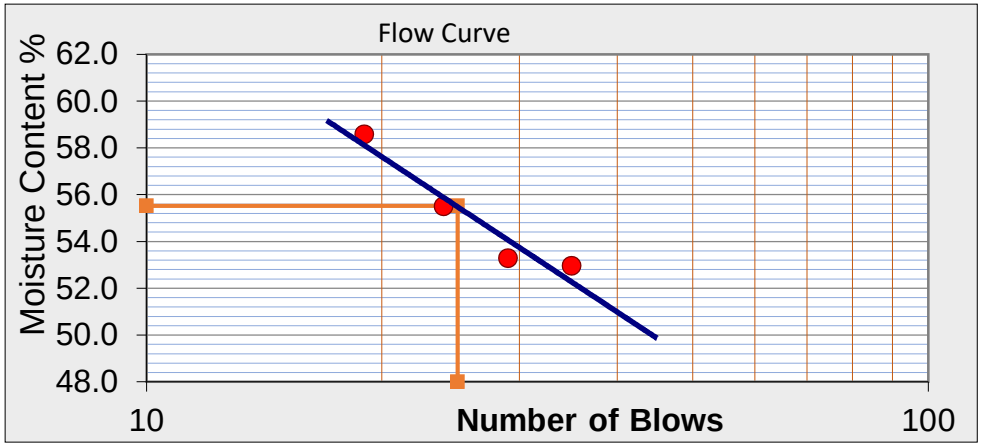



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.81 g/cm3 and OMC = 13.6%** |
| **From the Density-CBR Curve at 95% MDD (1.72 g/cm3): CBR = 14.7** |

## Sample No.: 3 Location of Sample @ Station 3+000Km, Visual Soil Description: brown clay soil

**1.1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | 1.1LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 29 | 24 | 19 | | |
| Can No. | 14 | 78 | 96 | 97 | B | DD |
| Wt. of Can + Wet Soil (g) | 51.50 | 49.42 | 46.46 | 52.21 | 28.58 | 31.71 |
| Wt. of Can + Dry Soil (g) | 41.83 | 40.66 | 36.84 | 40.40 | 26.08 | 29.40 |
| Wt. of Can (g) | 23.58 | 24.21 | 19.53 | 20.26 | 20.31 | 23.99 |
| Wt . of Moisture (g) | 9.67 | 8.76 | 9.61 | 11.80 | 2.50 | 2.31 |
| Wt. of Dry Soil (g) | 18.26 | 16.44 | 17.32 | 20.15 | 5.77 | 5.41 |
| W (%) | 52.95 | 53.28 | 55.50 | 58.58 | 43.25 | 42.61 |
| **Plastic Index(PI)=LL-Pl=56-43=13** | | | | | | |




1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.00 mm | 15 | 3.00 | 97.00 | AASHTO | **USCS** | **ERA SUBGRADE** |
| 0.425 | 95 | 19.00 | 78.00 | A-7-5(9) | **MH** | **S3** |
| 0.075 | 50 | 10.00 | 68.00 | | | |
| Total Weight Before wash | 500 | | | | | |

## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

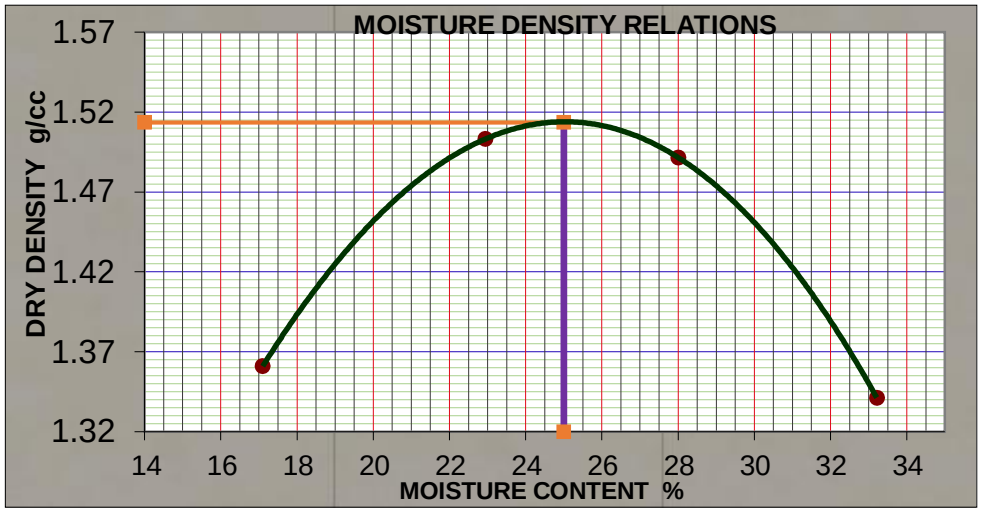
**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

**1.3.1 Moisture Content Determination**

| | TRIAL No. | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| DENSITY | Wt OF SOIL + Mould (g) | 8345.0 | 8885.0 | 9015.0 | 8755.0 | |
| | Wt. of Mould (g) | 4960 | 4960 | 4960 | 4960 | |
| | Vol. of Mould ($Cm^3$) | 2124 | 2124 | 2124 | 2124 | |
| | Wt of Wet Soil (g) | 3,385 | 3,925 | 4,055 | 3,795 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) | 1.59 | 1.85 | 1.91 | 1.79 | **NMC** |

1.3.1 dry Density Determination

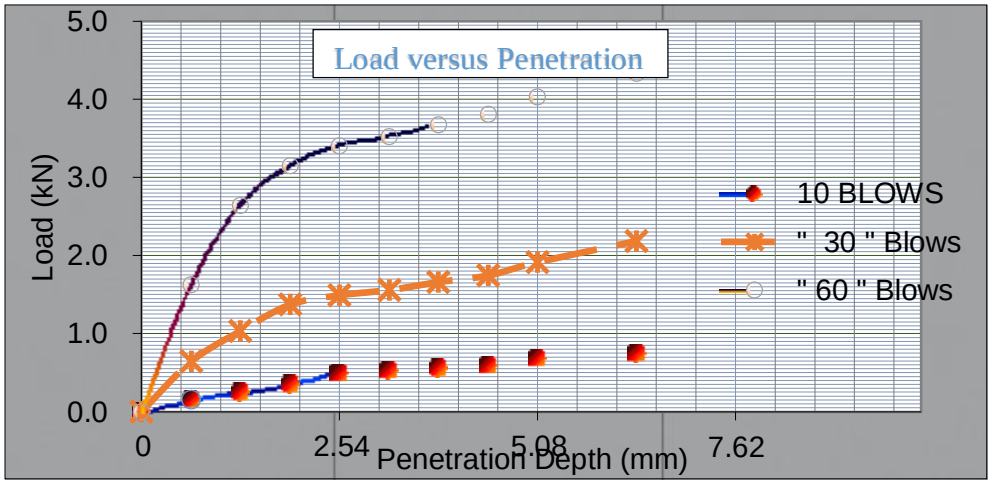
| | Can No. | J | C | G | T | I |
|---|---|---|---|---|---|---|
| MOISTURE | WET SOIL + Can (g) | 233.7 | 218.8 | 203.0 | 213.0 | 218.5 |
| | DRY SOIL + Can (g) | 203.5 | 183.1 | 164.8 | 166.8 | 201.4 |
| | Wt. of Can (g) | 26.9 | 27.5 | 28.4 | 27.7 | 28.4 |
| | Wt. OF WATER (g) | 30.2 | 35.7 | 38.2 | 46.2 | 17.1 |
| | Wt. OF DRY SOIL (g) | 176.6 | 155.6 | 136.4 | 139.1 | 173.0 |
| | **w (%)** | 17.10 | 22.94 | 28.01 | 33.21 | 9.88 |
| **DRY DENSITY OF SOIL ( g/Cm3 )** | | 1.36 | 1.50 | 1.49 | 1.34 | |




**1.4 CALIFORNIA BEARING RATIO TEST (AASHTO T-193)**

**1.4.1 PENETRATION TEST DATA**

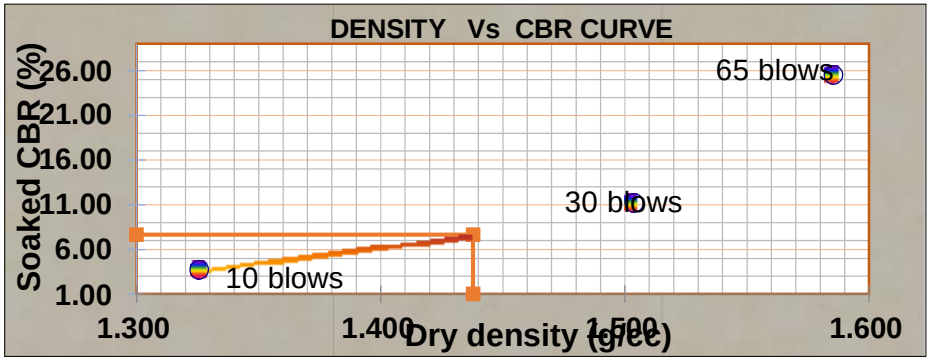
| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 9.0 | 0.152 | 38.0 | 0.643 | 96.0 | 1.625 |
| 1.27 | 15.0 | 0.254 | 61.0 | 1.033 | 156.0 | 2.641 |
| 1.91 | 21.0 | 0.356 | 81.0 | 1.371 | 186.0 | 3.149 |
| 2.54 | 29.0 | 0.491 | 88.0 | 1.490 | 201.0 | 3.403 |
| 3.18 | 31.0 | 0.525 | 92.0 | 1.558 | 208.0 | 3.521 |
| 3.81 | 33.0 | 0.559 | 98.0 | 1.659 | 217.0 | 3.674 |
| 4.45 | 35.0 | 0.593 | 103.0 | 1.744 | 225.0 | 3.809 |
| 5.08 | 40.0 | 0.677 | 113.0 | 1.913 | 238.0 | 4.029 |
| 6.35 | 44.0 | 0.745 | 129.0 | 2.184 | 256.0 | 4.334 |




| BLOWS | DD (g/cm3) | LOAD (KN) | | Standard Load | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54mm | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| 10 | 1.33 | 0.491 | 0.6772 | 13.4 | 20.00 | 3.68 | 3.39 | 3.68 |
| 30 | 1.50 | 1.4898 | 1.91309 | 13.4 | 20.00 | 11.17 | 9.57 | 11.17 |
| 65 | 1.59 | 3.4029 | 4.02934 | 13.4 | 20.00 | 25.51 | 20.15 | 25.51 |

Ring Factor =0.01693kN/Div

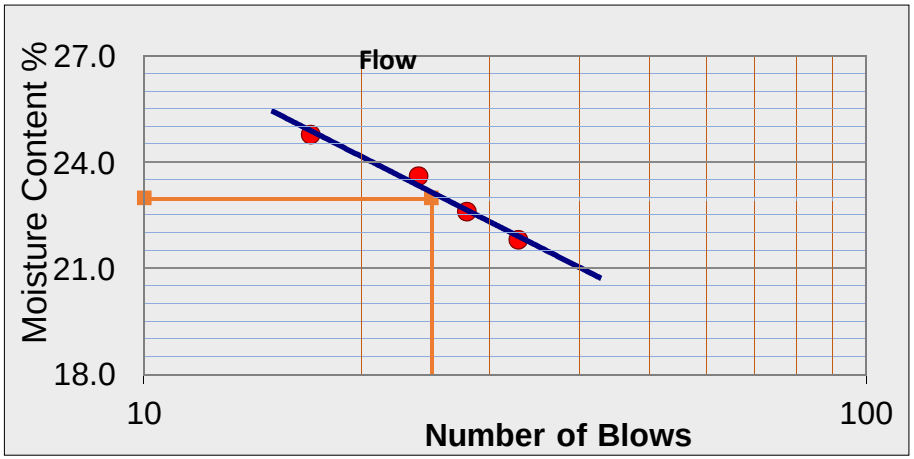
**From the comp. curve: MDD = 1.51 g/cm3 and OMC = 25% From the De-CBR Curve at 95% MDD (1.434 g/cm3): CBR = 7.64**



## Sample No.: 4 Location of Sample @ Station 4+000Km, Visual Soil Description: brown silt soil

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 28 | 24 | 17 | | |
| Can No. | 7 | 8 | 9 | 10 | 11 | 12 |
| Wt. of Can + Wet Soil (g) | 75.06 | 78.79 | 74.88 | 76.52 | 45.64 | 45.81 |
| Wt. of Can + Dry Soil (g) | 68.10 | 70.97 | 67.50 | 68.47 | 44.37 | 44.50 |
| Wt. of Can (g) | 36.20 | 36.38 | 36.25 | 36.00 | 36.41 | 36.31 |
| Wt. of Moisture (g) | 6.96 | 7.82 | 7.38 | 8.05 | 1.27 | 1.31 |
| Wt of Dry Soil (g) | 31.90 | 34.59 | 31.25 | 32.47 | 7.96 | 8.19 |
| w (%) | 21.82 | 22.61 | 23.62 | 24.79 | 15.95 | 16.00 |
| **PI=LL-PL=23-16=7** | | | | | | |

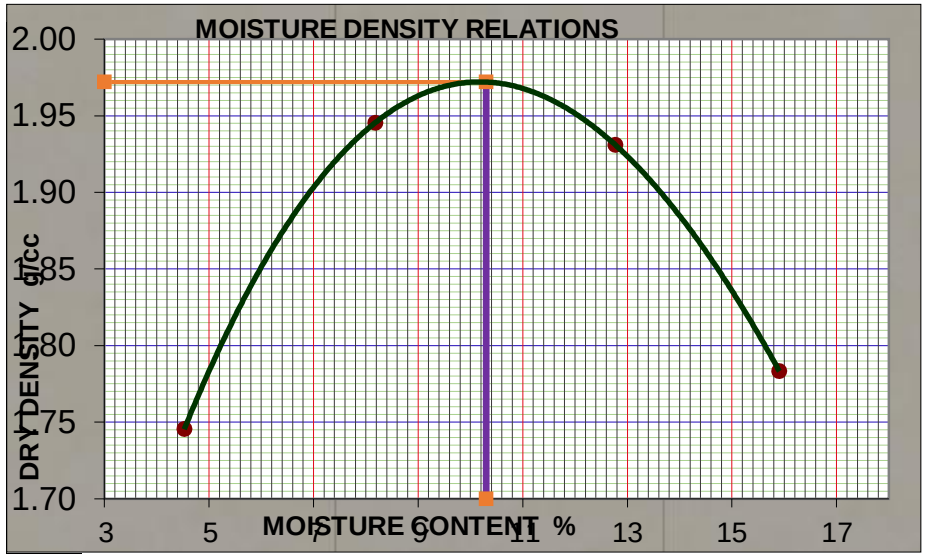



1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 15 | 3.00 | 97.00 | | | |
| 0.425 | 30 | 6.00 | 91.00 | | | |
| 0.075 | 190 | 38.00 | 53.00 | | | |
| Total sample before wash | 500 | | | A-4(4) | **CL** | **S5** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)1.3.1 Bulk Density Determination**

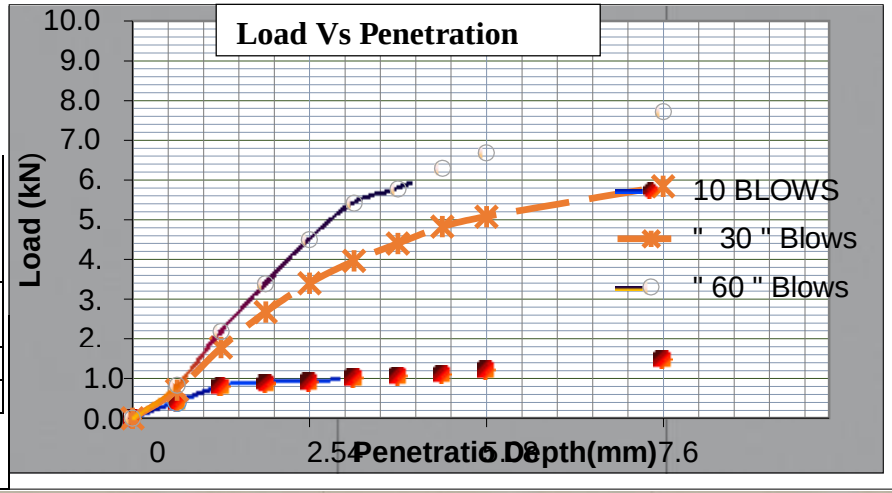
| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL No. | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + Mould (g) $W_1$ | 8840.0 | 9435.0 | 9590.0 | 9355.0 | |
| | Wt. of Mould (g) $W_2$ | 4965 | 4965 | 4965 | 4965 | |
| | Vol. of Mould ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,875 | 4,470 | 4,625 | 4,390 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ = | 1.82 | 2.10 | 2.18 | 2.07 | NMC |
| 1.3.2 Dry Density Determination | | | | | | |
| MOISTURE | Can No. | T | E | M | D | J |
| | WET SOIL + Can (g) a | 232.1 | 229.4 | 209.7 | 208.3 | 227.8 |
| | DRY SOIL + Can (g) b | 223.7 | 215.2 | 190.6 | 185.3 | 226.3 |
| | WEIGHT OF Can (g) c | 38.2 | 41.6 | 41.0 | 40.7 | 37.4 |
| | Wt of Water (g) d = a-b | 8.4 | 14.2 | 19.1 | 23.0 | 1.5 |
| | Wt. of Dry Soil (g) e =b-c | 185.5 | 173.6 | 149.6 | 144.6 | 188.9 |
| | **W (%) m=** | 4.53 | 8.18 | 12.77 | 15.91 | 0.79 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ = $W_d$ /(100+m)*100** | | 1.75 | 1.95 | 1.93 | 1.78 | |



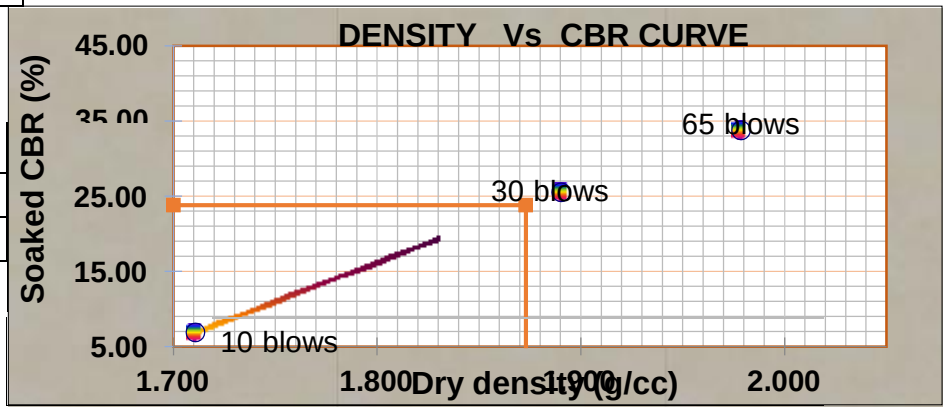
**1.4 CALIFORNIA BEARING RATIO TEST (AASHTO T-193)**

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 24.0 | 0.406 | 42.0 | 0.711 | 49.0 | 0.830 |
| 1.27 | 36.0 | 0.804 | 105.0 | 1.778 | 129.0 | 2.184 |
| 1.91 | 40.0 | 0.893 | 158.0 | 2.675 | 200.0 | 3.386 |
| 2.54 | 54.0 | 0.914 | 201.0 | 3.403 | 266.0 | 4.503 |
| 3.18 | 60.0 | 1.016 | 234.0 | 3.962 | 320.0 | 5.418 |
| 3.81 | 63.0 | 1.067 | 260.0 | 4.402 | 341.0 | 5.773 |
| 4.45 | 66.0 | 1.117 | 285.0 | 4.825 | 372.0 | 6.298 |
| 5.08 | 72.0 | 1.219 | 300.0 | 5.079 | 395.0 | 6.687 |
| 7.62 | 88.0 | 1.490 | 345.0 | 5.841 | 456.0 | 7.720 |




| BLOWS | DD(g/Cm3) | LOAD | | Standard Load | | CBR (%) | | CBR |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 Mm | 5.08 mm | |
| **10** | **1.71** | 0.91 | 1.22 | 13.40 | 20.00 | 6.9 | 6.1 | 6.9 |
| **30** | **1.89** | 3.40 | 5.08 | 13.40 | 20.00 | 25.5 | 25.4 | 25.5 |
| **65** | **1.98** | 4.50 | 6.69 | 13.40 | 20.00 | 33.8 | 33.4 | 33.8 |




Ring Factor =0.01693kN/Div

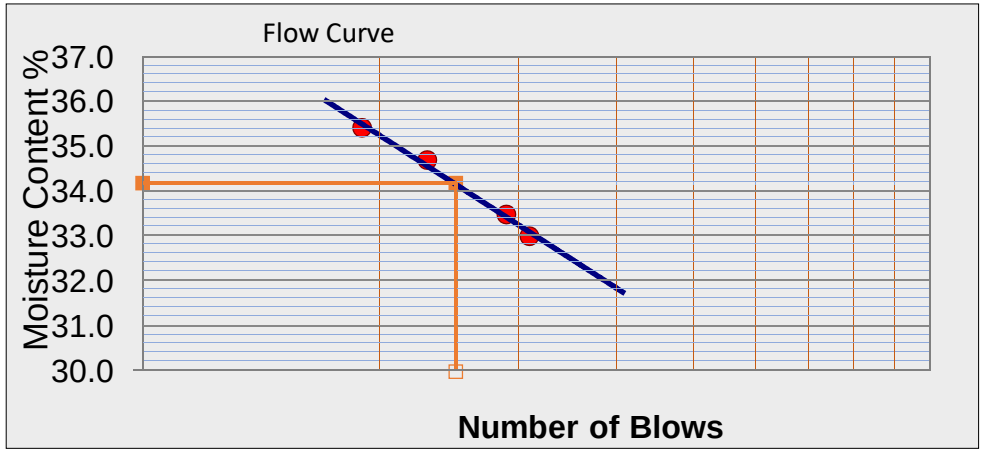
**From the compaction curve: MDD = 1.972 g/cm3 and OMC = 10.3%**

**From the Density-CBR Curve at 95% MDD (1.873 g/cm3): CBR = 23.8**

**Sample No.: 5 Location of Sample @ Station 5+500Km, Visual Soil Description: Dark clay soil**

**1.1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 31 | 29 | 23 | 19 | | |
| Can No. | 14 | 12 | 16 | F2 | 7 | 18 |
| Wt. of Can + Wet Soil (g) = ($W_1$) | 42.42 | 44.10 | 46.80 | 40.88 | 25.79 | 27.87 |
| Wt. of Can+ Dry | 37.74 | 38.86 | 40.87 | 35.39 | 24.28 | 26.22 |
| Wt. of Can (g) = | 23.56 | 23.23 | 23.81 | 19.91 | 18.17 | 19.71 |
| Wt. of Moisture (g) = | 4.68 | 5.24 | 5.92 | 5.49 | 1.52 | 1.65 |
| Wt. of Dry Soil (g) = | 14.19 | 15.63 | 17.06 | 15.49 | 6.10 | 6.52 |
| w (%) = | 33.01 | 33.50 | 34.71 | 35.43 | 24.86 | 25.30 |
| **PI=LL-PL=34-25=9** | | | | | | |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

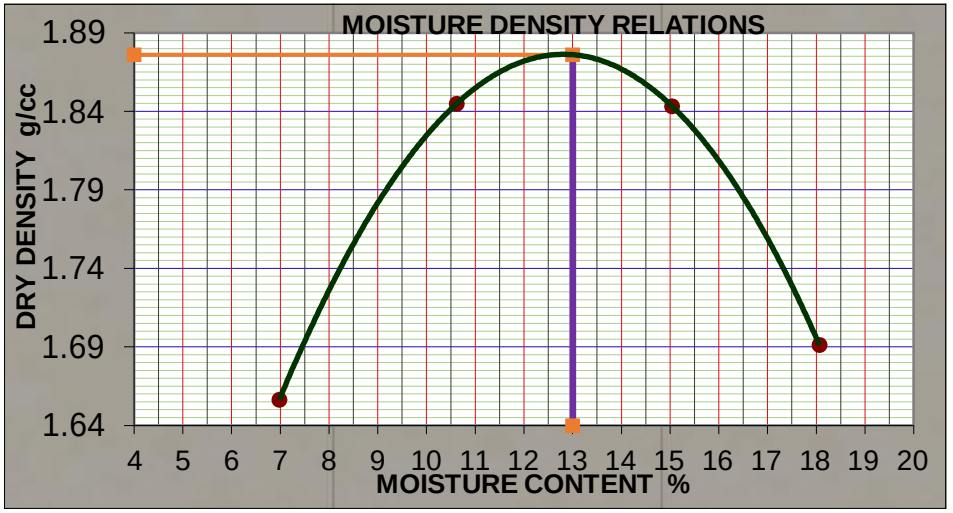
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 11 | 2.20 | 97.80 | | | |
| 0.425 | 175 | 35.00 | 62.80 | | | |
| 0.075 | 135 | 27.00 | 35.80 | | | |
| Total | 500 | | | A-4(0) | **SM** | **S5** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

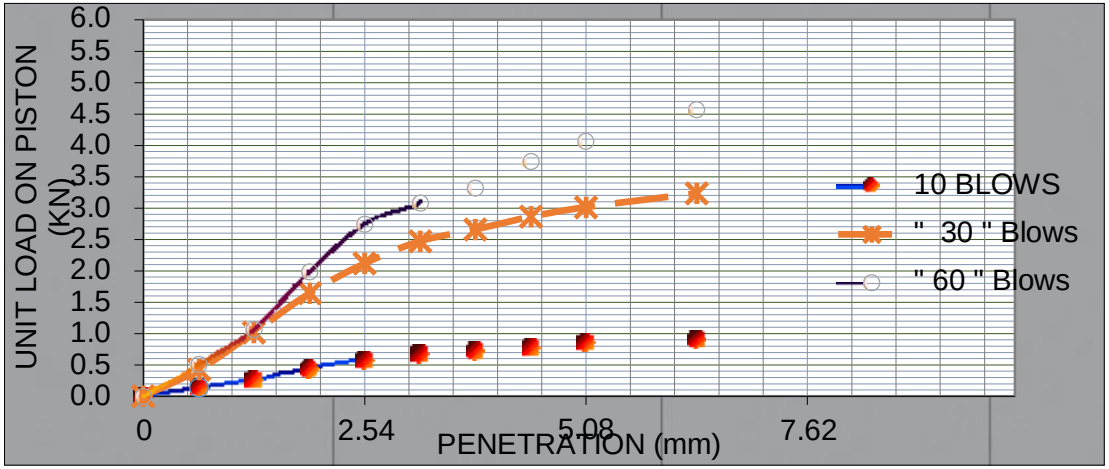
### 1.3.1 Bulk density determination

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL No. | 1 | 2 | 3 | 4 | |
| | Wt. of Soil + Mould (g) $W_1$ | 8719.0 | 9290.0 | 9459.0 | 9696 | |
| | Wt. of Mould (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | Vol. of Mould ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. of Wet Soil (g) $W_3 = W_1-W_2$ | 3,764 | 4,335 | 4,504 | 4,241 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ = | 1.77 | 2.04 | 2.12 | 2.00 | **NMC** |
| | | | | | | |
| MOISTURE | Can No. | 14 | N | 23 | 1 | E |
| | WET SOIL + Can (g) a | 171.2 | 206.6 | 200.1 | 185.0 | 194.5 |
| | DRY SOIL + Can (g) b | 161.9 | 189.4 | 177.6 | 160.9 | 189.5 |
| | Wt. of Can (g) c | 28.7 | 27.5 | 28.0 | 27.5 | 26.8 |
| | Wt. of Water (g) d = a-b | 9.3 | 17.2 | 22.5 | 24.1 | 5.0 |
| | Wt . OF DRY SOIL (g) e =b-c | 133.2 | 161.9 | 149.6 | 133.4 | 162.7 |
| | **w (%) m=** | 6.98 | 10.62 | 15.04 | 18.07 | 3.07 |
| | **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$** | 1.66 | 1.84 | 1.84 | 1.69 | |

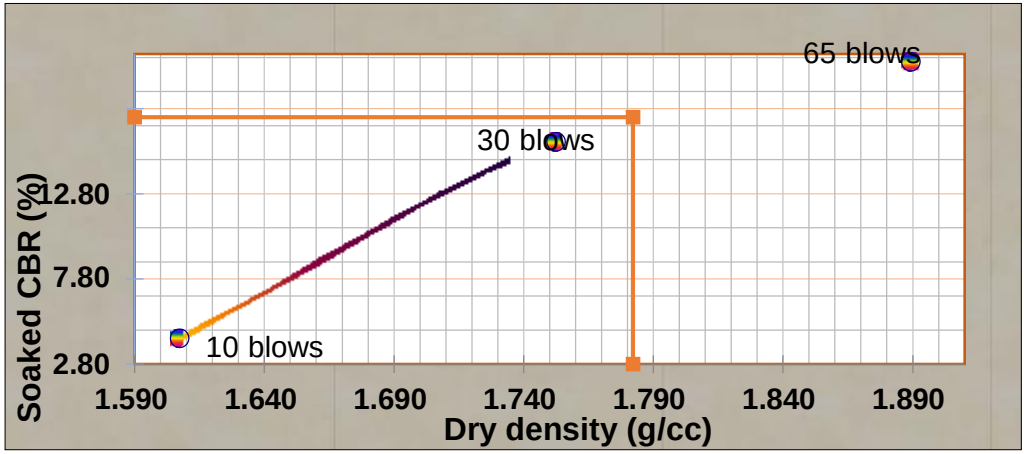



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 8.0 | 0.135 | 25.0 | 0.423 | 30.0 | 0.508 |
| 1.27 | 16.0 | 0.271 | 60.0 | 1.016 | 63.0 | 1.067 |
| 1.91 | 26.0 | 0.440 | 97.0 | 1.642 | 117.0 | 1.981 |
| 2.54 | 34.0 | 0.576 | 125.0 | 2.116 | 162.0 | 2.743 |
| 3.18 | 40.0 | 0.677 | 146.0 | 2.472 | 182.0 | 3.081 |
| 3.81 | 43.0 | 0.728 | 157.0 | 2.658 | 196.0 | 3.318 |
| 4.45 | 46.0 | 0.779 | 169.0 | 2.861 | 221.0 | 3.742 |
| 5.08 | 51.0 | 0.863 | 178.0 | 3.014 | 240.0 | 4.063 |
| 6.35 | 54.0 | 0.914 | 191.0 | 3.234 | 270.0 | 4.571 |



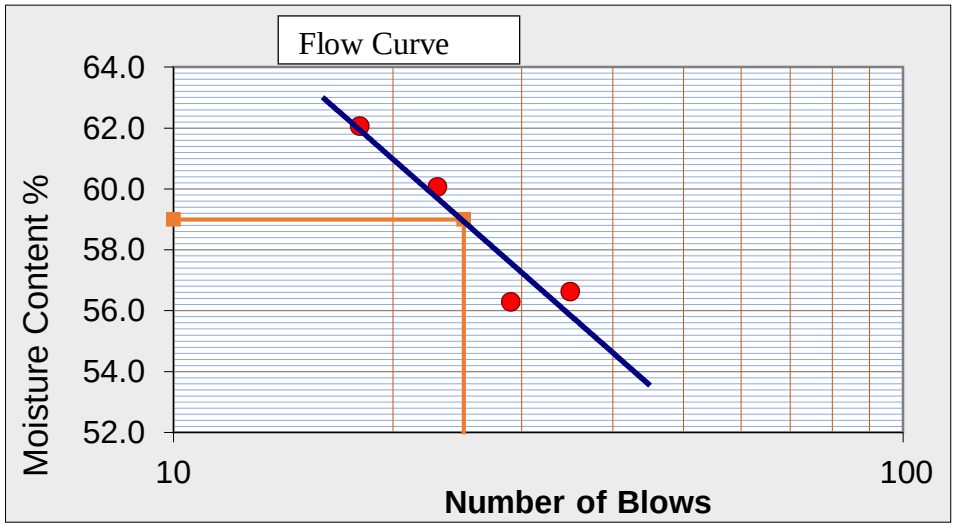
| BLOWS | DD(g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 Mm | |
| **10** | **1.61** | 0.58 | 0.86 | 13.40 | 20.00 | 4.3 | 4.3 | 4.3 |
| **30** | **1.75** | 2.12 | 3.01 | 13.40 | 20.00 | 15.9 | 15.1 | 15.9 |
| **65** | **1.89** | 2.74 | 4.06 | 13.40 | 20.00 | 20.6 | 20.3 | 20.6 |
| Ring Factor =0.01693kN/Div | | | | | | | | |
| **From the compaction curve: MDD = 1.88 g/cm3 and OMC = 13%** | | | | | | | | |
| **From the Density-CBR Curve at 95% MDD (1.786 g/cm3): CBR = 17.3** | | | | | | | | |




## Sample No.: 6 Location of Sample @ Station 7+000Km, Visual Soil Description: brown clayey soil

**1.1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

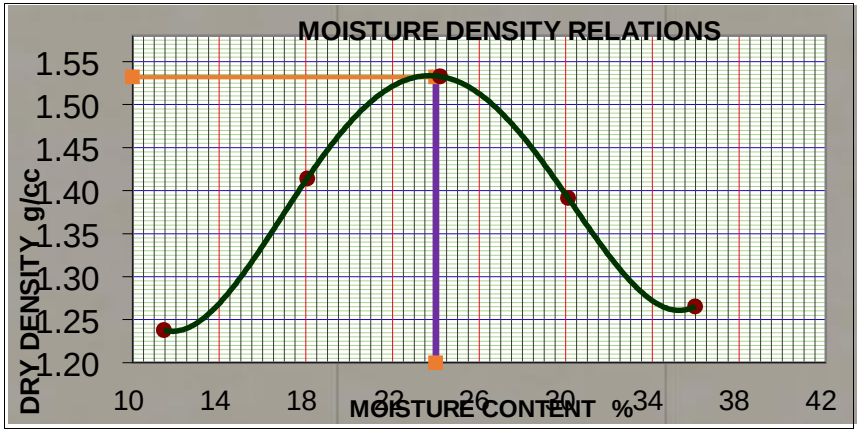
| Description | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 29 | 23 | 18 | | |
| Can No. | 96 | 13 | 17 | 78 | 92 | 1 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 63.20 | 63.90 | 65.20 | 70.50 | 42.30 | 42.30 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 53.33 | 53.96 | 54.28 | 57.25 | 40.73 | 40.76 |
| Weight of Can (g) | 35.90 | 36.30 | 36.10 | 35.90 | 36.40 | 36.50 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 9.87 | 9.94 | 10.92 | 13.25 | 1.57 | 1.54 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 17.43 | 17.66 | 18.18 | 21.35 | 4.33 | 4.26 |
| w (%) | 56.63 | 56.29 | 60.07 | 62.06 | 36.26 | 36.15 |
| **PI=LL-PL=59-36=23** | | | | | | |




| 1.2 Particle size Distribution(TEST METHOD AASHTO T-88) | | | | | | |
|---|---|---|---|---|---|---|
| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
| 2.0 mm | 9.6 | 1.92 | 98.08 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 62.7 | 12.54 | 85.54 | | | |
| 0.075 | 117.9 | 23.58 | 61.96 | | | |
| total | 500 | | | A-7-5(8) | **MH** | **S3** |

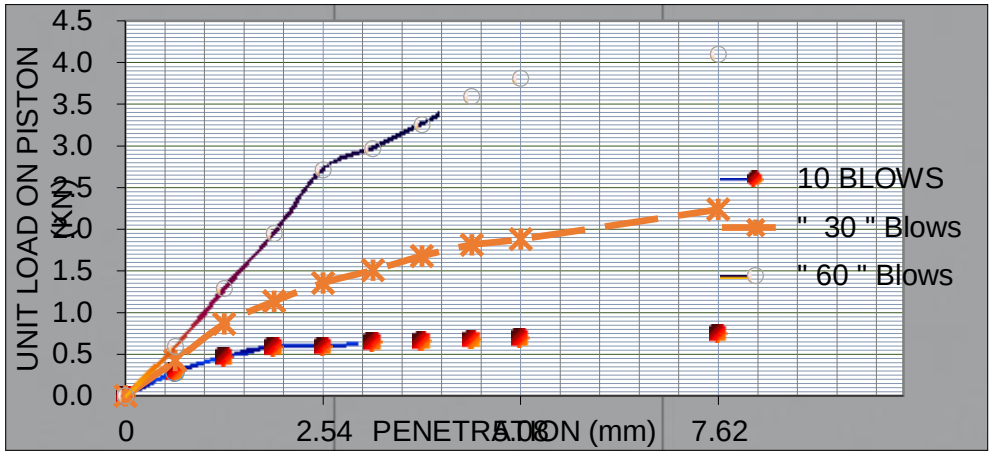
### 1.3.Bulk Density Determination

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | 5 | |
| | Wt of Soil + Mould (g) | 7900.0 | 8516.5 | 9013.2 | 8815.2 | 8625.1 | |
| | Wt. of Mould (g) $W_2$ | 4970 | 4970 | 4970 | 4970 | 4970 | |
| | Vol. of Mould ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | 2124 | |
| | Wt of Wet Soil (g) $W_3$ | 2,930 | 3,547 | 4,043 | 3,845 | 3,655 | |
| | WET DENSITY OF SOIL($g/Cm^3$)$W_d$ | 1.38 | 1.67 | 1.90 | 1.81 | 1.72 | NMC |
| MOISTURE | Can No. | 23 | 1 | 4 | O | T | N |
| | Wet Soil + Can (g) | 252.2 | 254.8 | 196.4 | 203.7 | 210.2 | 264.9 |
| | Dry Soil + Can (g) | 230.5 | 221.7 | 166.2 | 165.4 | 165.4 | 253.2 |
| | Wt. of Can (g) c | 40.9 | 38.5 | 41.4 | 38.2 | 40.9 | 40.6 |
| | Wt of Water (g) d = a-b | 21.7 | 33.1 | 30.2 | 38.3 | 44.8 | 11.7 |
| | Wt. of DRY SOIL (g) e | 189.6 | 183.2 | 124.8 | 127.2 | 124.5 | 212.6 |
| | **W (%)** | 11.45 | 18.07 | 24.20 | 30.11 | 35.98 | 5.50 |
| **DRY DENSITY OF SOIL ( g/Cm3 )** | | 1.24 | 1.41 | 1.53 | 1.39 | 1.27 | |

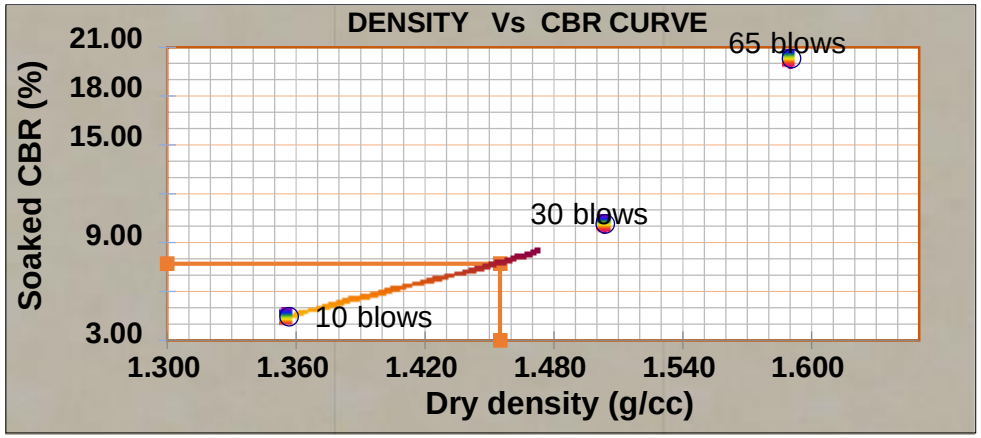



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 17.0 | 0.288 | 25.0 | 0.423 | 35.0 | 0.593 |
| 1.27 | 21.0 | 0.469 | 51.0 | 0.863 | 76.0 | 1.287 |
| 1.91 | 26.0 | 0.581 | 67.0 | 1.134 | 115.0 | 1.947 |
| 2.54 | 35.0 | 0.593 | 80.0 | 1.354 | 160.0 | 2.709 |
| 3.18 | 38.0 | 0.643 | 89.0 | 1.507 | 175.0 | 2.963 |
| 3.81 | 39.0 | 0.660 | 99.0 | 1.676 | 192.0 | 3.251 |
| 4.45 | 40.0 | 0.677 | 107.0 | 1.812 | 212.0 | 3.589 |
| 5.08 | 41.0 | 0.694 | 111.0 | 1.879 | 225.0 | 3.809 |
| 7.62 | 44.0 | 0.745 | 132.0 | 2.235 | | |




| BLOWS | DD(g/Cm3) | LOAD (KN) | | Standard Load | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.36** | 0.59 | 0.69 | 13.40 | 20.00 | 4.4 | 3.5 | 4.4 |
| **30** | **1.50** | 1.35 | 1.88 | 13.40 | 20.00 | 10.2 | 9.4 | 10.2 |
| **65** | **1.59** | 2.71 | 3.81 | 13.40 | 20.00 | 20.3 | 19.0 | 20.3 |

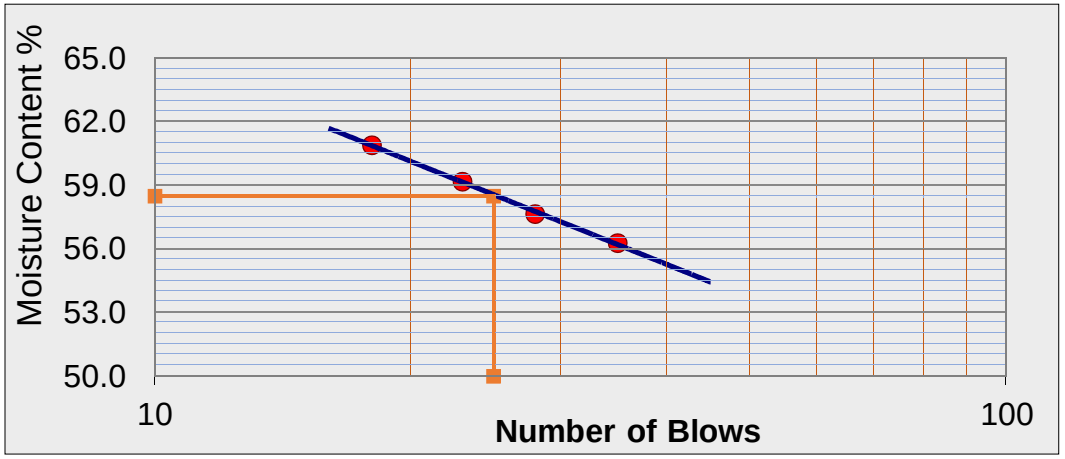



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.53 g/cm3 and OMC = 24%** |
| **From the Density-CBR Curve at 95% MDD (1.453 g/cm3): CBR = 7.7** |

## Sample No.: 7 Location of Sample @ Station 8+000Km, Visual Soil Description: Reddish brown silty soil

**1 SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | 1.1 LL | | | | P L | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 28 | 23 | 18 | | |
| Can No. | 22 | 18 | 16 | 12 | DD | D3 |
| Weight. of Can + Wet Soil (g) = ($W_1$) | 31.56 | 36.33 | 39.85 | 37.80 | 29.51 | 24.21 |
| Weight. of Can + Dry Soil (g) = ($W_2$) | 27.09 | 30.25 | 33.89 | 32.29 | 27.83 | 22.75 |
| Wt. of Can (g)= | 19.14 | 19.72 | 23.82 | 23.24 | 23.97 | 19.36 |
| Wt. Moisture (g) | 4.47 | 6.08 | 5.96 | 5.51 | 1.68 | 1.46 |
| Wt. of Dry Soil (g) | 7.94 | 10.54 | 10.07 | 9.04 | 3.86 | 3.40 |
| W(%) | 56.28 | 57.65 | 59.18 | 60.90 | 43.49 | 42.84 |
| **PI=LL-PL=59-43=15** | | | | | | |

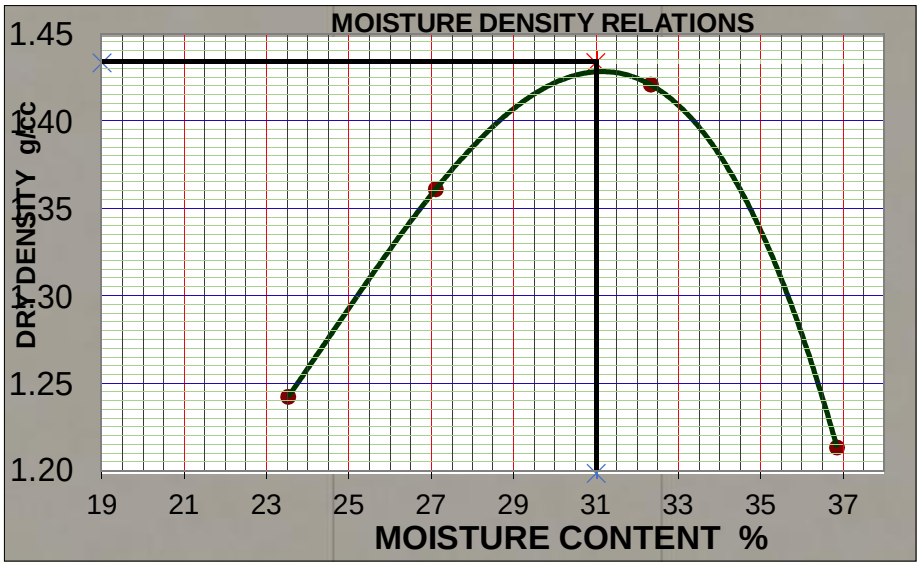



1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 1 | 0.20 | 99.80 | | | |
| 0.425 | 138 | 27.60 | 72.20 | | | |
| 0.075 | 106 | 21.20 | 51.00 | | | |
| total | 500 | | | A-7-5(4) | **MH** | **S4** |

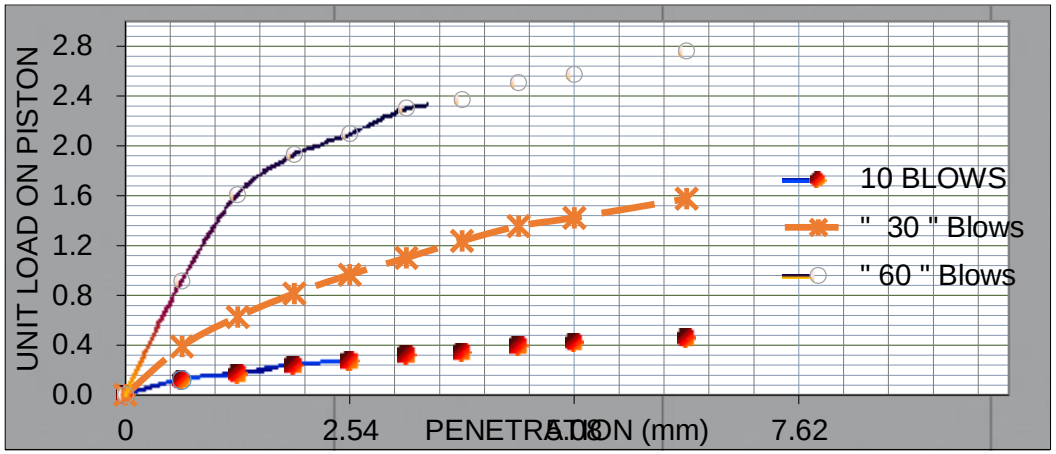
### 1.3.1 Moisture content determination

| | TRIAL NUMBER | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| DENSITY | Wt. of Soil + Mould (g) $W_1$ | 8218.0 | 8634.0 | 8953.0 | 8486.0 | |
| | Wt. of Mould (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | Vol. of Mould ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt . of Wet Soil (g) $W_3$ = | 3,263 | 3,679 | 3,998 | 3,531 | |
| | WET DENSITY OF SOIL( g/$Cm^3$ ) $W_d$ | 1.54 | 1.73 | 1.88 | 1.66 | **NMC** |
| MOISTURE | Can No. | 13 | C | W | 15 | 5 |
| | WET SOIL + Can (g) a | 205.6 | 175.2 | 186.4 | 180.2 | 205.3 |
| | DRY SOIL + Can (g) b | 171.8 | 143.7 | 147.8 | 139.4 | 187.0 |
| | Wt. of Can (g) c | 28.1 | 27.5 | 28.4 | 28.7 | 27.9 |
| | Wt. OF WATER (g) d = a-b | 33.8 | 31.5 | 38.6 | 40.8 | 18.3 |
| | Wt. OF DRY SOIL (g) e | 143.7 | 116.2 | 119.4 | 110.7 | 159.1 |
| | **w (%) m=** | 23.52 | 27.11 | 32.33 | 36.86 | 11.50 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$** | | 1.24 | 1.36 | 1.42 | 1.21 | |

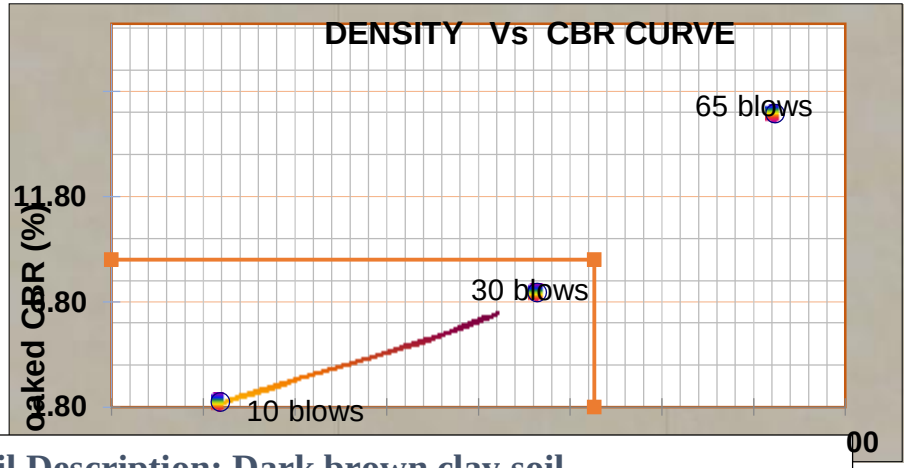


## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| PENETRATION TEST DATA | | | | | | |
|---|---|---|---|---|---|---|
| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 7.0 | 0.119 | 23.0 | 0.389 | 54.0 | 0.914 |
| 1.27 | 10.0 | 0.169 | 37.0 | 0.626 | 95.0 | 1.608 |
| 1.91 | 14.0 | 0.237 | 48.0 | 0.813 | 114.0 | 1.930 |
| 2.54 | 16.0 | 0.271 | 57.0 | 0.965 | 124.0 | 2.099 |
| 3.18 | 19.0 | 0.322 | 65.0 | 1.100 | 136.0 | 2.302 |
| 3.81 | 20.0 | 0.339 | 73.0 | 1.236 | 140.0 | 2.370 |
| 4.45 | 23.0 | 0.389 | 80.0 | 1.354 | 148.0 | 2.506 |
| 5.08 | 25.0 | 0.423 | 84.0 | 1.422 | 152.0 | 2.573 |
| 6.35 | 27.0 | 0.457 | 93.0 | 1.574 | 163.0 | 2.760 |




| BLOWS | DD(g/Cm3) | LOAD (KN) | | Standard Load | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.16** | 0.27 | 0.42 | 13.40 | 20.00 | 2.0 | 2.1 | 2.0 |
| **30** | **1.33** | 0.97 | 1.42 | 13.40 | 20.00 | 7.2 | 7.1 | 7.2 |
| **65** | **1.46** | 2.10 | 2.57 | 13.40 | 20.00 | 15.7 | 12.9 | 15.7 |



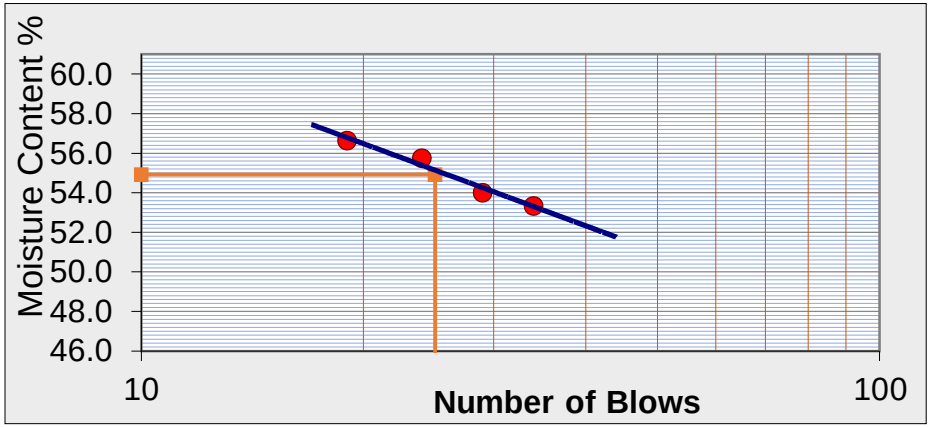

**From the compaction curve: MDD = 1.44 g/cm3 and OMC = 31%**

## Sample No.: 8 Location of Sample @ Station 9+500

**Visual Soil Description: Dark brown clay soil**

**1.1 SOIL CONSISTENCY TEST RESULT (TEST METHOD：AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 24 | 19 | | |
| Can No. | B | F2 | 14 | 35 | A2 | DV |
| Weight. of Can + | 52.88 | 58.34 | 58.11 | 60.64 | 41.83 | 42.01 |
| Weight. of Can + | 43.68 | 49.78 | 49.39 | 51.21 | 40.27 | 40.40 |
| Weight. of Can (g) | 26.43 | 33.93 | 33.75 | 34.56 | 35.06 | 34.98 |
| Wt. of Moisture | 9.20 | 8.56 | 8.72 | 9.43 | 1.56 | 1.61 |
| Wt. of Dry Soil | 17.25 | 15.85 | 15.64 | 16.65 | 5.21 | 5.42 |
| W(%) | 53.33 | 54.01 | 55.75 | 56.64 | 29.94 | 29.70 |
| **PI=LL-PL=55-30=25** | | | | | | |



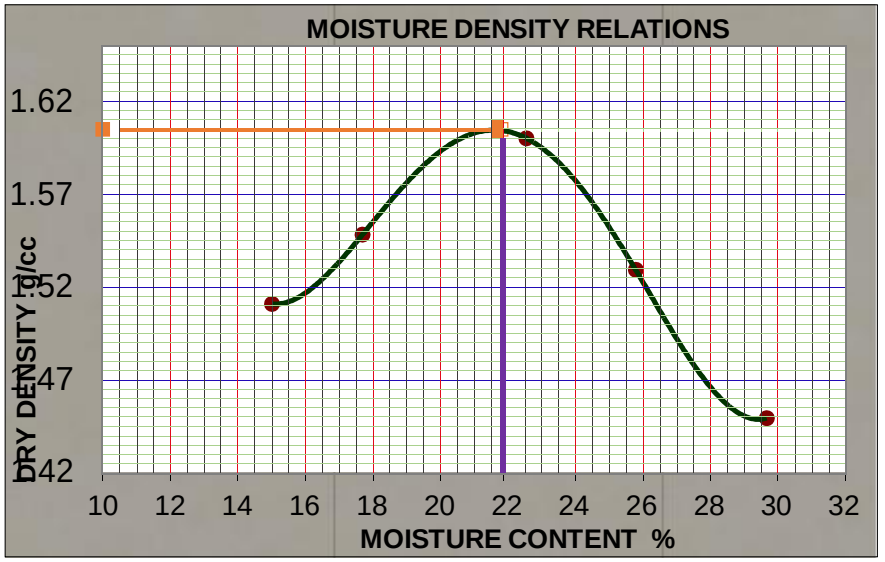
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 10 | 2.00 | 98.00 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 30 | 6.00 | 92.00 | | | |
| 0.075 | 95 | 19.00 | 73.00 | | | |
| total | 500 | | | A-7-5(10) | **CH** | **S4** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

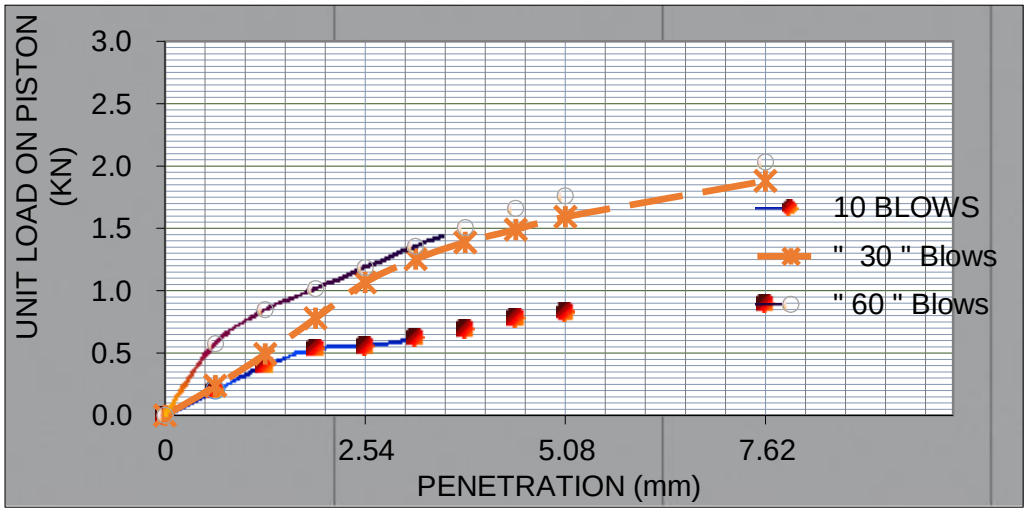
**1.3.1**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | 5 | |
| | Wt. OF SOIL + Mould (g) $W_1$ | 8655 | 8835 | 9130 | 9050 | 8955 | |
| | Wt. OF Mould (g) $W_2$ | 4965 | 4965 | 4965 | 4965 | 4965 | |
| | Vo. OF Mould ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | 2124 | |
| | Wt OF WET SOIL (g) $W_3$ = | 3,690 | 3,870 | 4,165 | 4,085 | 3,990 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ | 1.74 | 1.82 | 1.96 | 1.92 | 1.88 | NMC |
| MOISTURE | Can No. | 35 | 22 | 17 | R | M | E |
| | WET SOIL + CAN (g) a | 257.5 | 251.6 | 243.2 | 238.7 | 217.6 | 235.5 |
| | DRY SOIL + CAN (g) b | 229.2 | 219.5 | 206.0 | 197.6 | 177.2 | 231.3 |
| | Wt. OF CAN (g) c | 40.7 | 38.1 | 41.0 | 38.2 | 41.0 | 41.5 |
| | Wt. OF WATER (g) d = a-b | 28.3 | 32.1 | 37.2 | 41.1 | 40.4 | 4.2 |
| | Wt. OF DRY SOIL (g) e =b-c | 188.5 | 181.4 | 165.0 | 159.4 | 136.2 | 189.8 |
| | **w (%) m=** | 15.01 | 17.70 | 22.55 | 25.78 | 29.66 | 2.21 |
| **DRY DENSITY OF SOIL( g/Cm3 )$D_d$ =** | | 1.51 | 1.55 | 1.60 | 1.53 | 1.45 | |



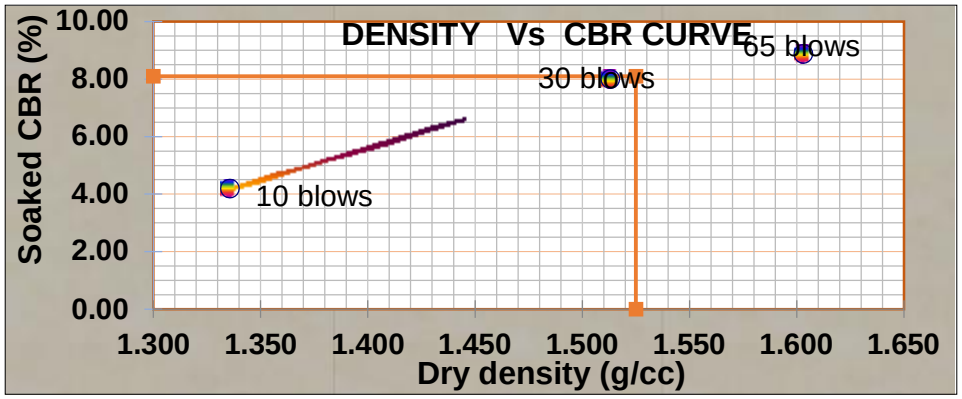

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | 65 Blows | | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 12.0 | 0.203 | 14.0 | 0.237 | 34.0 | 0.576 |
| 1.27 | 18.0 | 0.402 | 29.0 | 0.491 | 50.0 | 0.847 |
| 1.91 | 24.0 | 0.536 | 46.0 | 0.779 | 60.0 | 1.016 |
| 2.54 | 33.0 | 0.559 | 63.0 | 1.067 | 70.0 | 1.185 |
| 3.18 | 37.0 | 0.626 | 74.0 | 1.253 | 80.0 | 1.354 |
| 3.81 | 41.0 | 0.694 | 82.0 | 1.388 | 89.0 | 1.507 |
| 4.45 | 46.0 | 0.779 | 88.0 | 1.490 | 98.0 | 1.659 |
| 5.08 | 49.0 | 0.830 | 94.0 | 1.591 | 104.0 | 1.761 |
| 7.62 | 53.0 | 0.897 | 111.0 | 1.879 | 120.0 | 2.032 |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.34** | 0.56 | 0.83 | 13.40 | 20.00 | 4.2 | 4.1 | 4.2 |
| **30** | **1.51** | 1.07 | 1.59 | 13.40 | 20.00 | 8.0 | 8.0 | 8.0 |
| **65** | **1.60** | 1.19 | 1.76 | 13.40 | 20.00 | 8.9 | 8.8 | 8.9 |

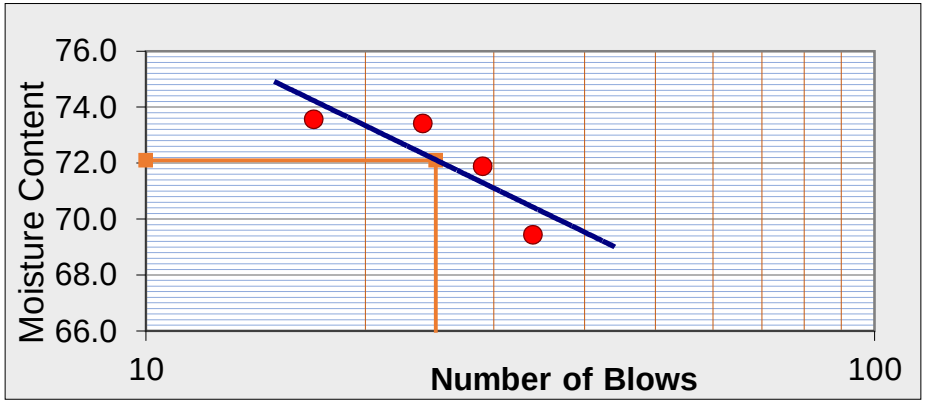



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.61 g/cm3 and OMC = 21.8%** |
| **From the Density-CBR Curve at 95% MDD (1.53 g/cm3): CBR = 8.1** |

## Sample No.: 9 Location of Sample @ Station 10+000Km, Visual Soil Description: Dark brown clay soil

**1. SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 24 | 17 | | |
| Can No. | 2 | 3 | 94 | 98 | 97 | 15 |
| Weight of Can + Wet Soil | 51.88 | 50.45 | 50.06 | 50.43 | 28.16 | 24.66 |
| Weight Can + Dry Soil (g) | 38.57 | 37.80 | 38.86 | 39.40 | 26.87 | 23.07 |
| Weight of Can (g) = ($W_3$) | 19.40 | 20.20 | 23.60 | 24.40 | 23.80 | 19.30 |
| Weight of Moisture (g) =($W_1$ | 13.31 | 12.65 | 11.20 | 11.03 | 1.29 | 1.59 |
| Weight of Dry Soil (g) = ($W_2$- | 19.17 | 17.60 | 15.26 | 15.00 | 3.07 | 3.77 |
| w (%) = (A / | 69.43 | 71.88 | 73.41 | 73.55 | 42.02 | 42.18 |
| **PI=LL-PL=72-42=30** | | | | | | |



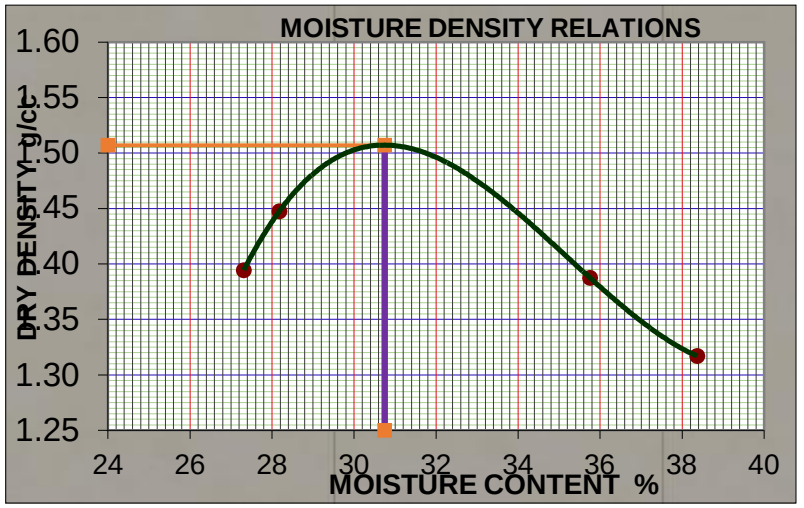

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 10 | 2.00 | 98.00 | | | |
| 0.425 | 32 | 6.40 | 91.60 | | | |
| 0.075 | 90 | 18.00 | 73.60 | | | |
| total | 500 | | | A-7-5 (14) | **MH** | **S2** |

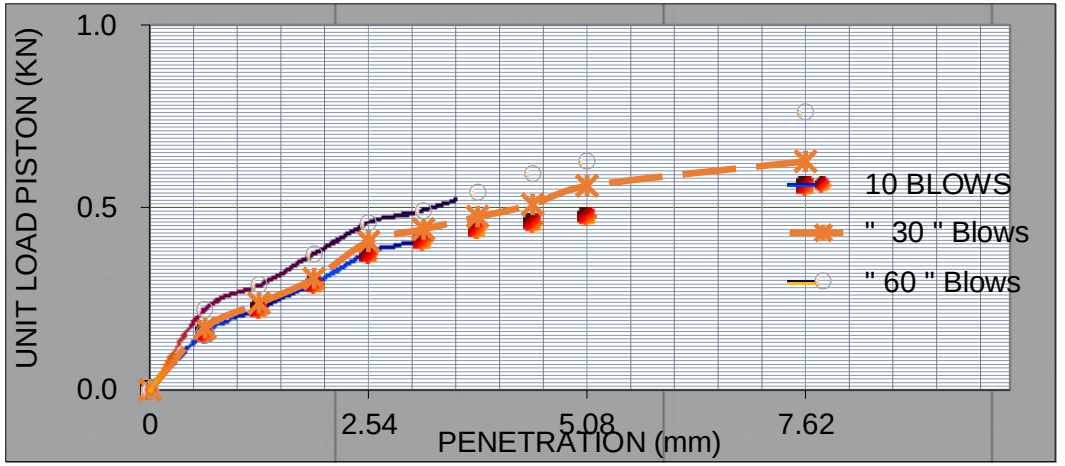
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

### 1.3.1 Bulk Density Determination

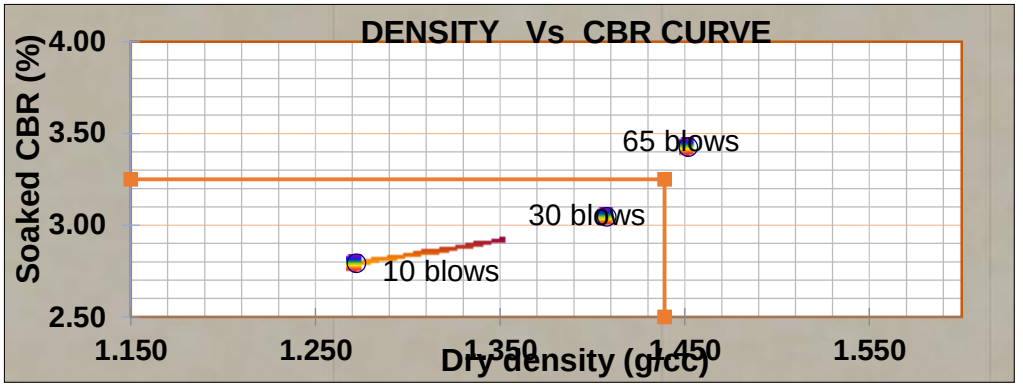
| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8740.0 | 8910.0 | 8970.0 | 8840.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4970 | 4970 | 4970 | 4970 | |
| | Vol. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,770 | 3,940 | 4,000 | 3,870 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d = W_3/V$ | 1.77 | 1.85 | 1.88 | 1.82 | NMC |
| MOISTURE | CAN NO. | 14 | 18 | F | V | 12.000 |
| | WET SOIL + CAN (g) a | 225.6 | 204.8 | 208.6 | 212.6 | 224.5 |
| | DRY SOIL + CAN (g) b | 182.6 | 166.0 | 160.9 | 161.3 | 205.7 |
| | Wt. OF CAN (g) c | 25.2 | 28.3 | 27.5 | 27.6 | 23.7 |
| | WT.OF WATER (g) d = a-b | 43.0 | 38.8 | 47.7 | 51.3 | 18.8 |
| | Wt. OF DRY SOIL (g) e =b-c | 157.4 | 137.7 | 133.4 | 133.7 | 182.0 |
| | **w (%) m= (d/e)*100** | 27.31 | 28.18 | 35.76 | 38.37 | 10.33 |
| **DRY DENSITY OF SOIL( g/Cm3 ) $D_d = W_d/ (100+m)$** | | 1.39 | 1.45 | 1.39 | 1.32 | |




| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 9.0 | 0.152 | 10.0 | 0.169 | 13.0 | 0.220 |
| 1.27 | 13.0 | 0.220 | 14.0 | 0.237 | 17.0 | 0.288 |
| 1.91 | 17.0 | 0.288 | 18.0 | 0.305 | 22.0 | 0.372 |
| 2.54 | 22.0 | 0.372 | 24.0 | 0.406 | 27.0 | 0.457 |
| 3.18 | 24.0 | 0.406 | 26.0 | 0.440 | 29.0 | 0.491 |
| 3.81 | 26.0 | 0.440 | 28.0 | 0.474 | 32.0 | 0.542 |
| 4.45 | 27.0 | 0.457 | 30.0 | 0.508 | 35.0 | 0.593 |
| 5.08 | 28.0 | 0.474 | 33 | 0.559 | 37.0 | 0.626 |
| 7.62 | 33.0 | 0.559 | 37.0 | 0.626 | 45.0 | 0.762 |



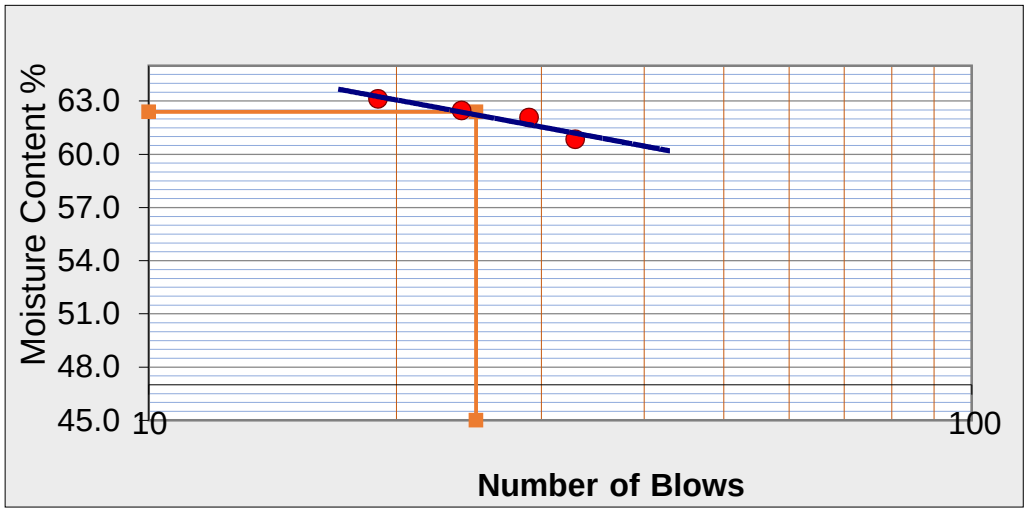

| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 mm | 2.54 | 5.08 | |
| **10** | **1.27** | 0.37 | 0.47 | 13.40 | 20.00 | 2.8 | 2.4 | 2.8 |
| **30** | **1.41** | 0.41 | 0.56 | 13.40 | 20.00 | 3.0 | 2.8 | 3.0 |
| **65** | **1.45** | 0.46 | 0.63 | 13.40 | 20.00 | 3.4 | 3.1 | 3.4 |
| Ring Factor =0.01693kN/Div | | | | | | | | |
| **From the compaction curve: MDD = 1.51 g/cm3 and OMC = 30.7%** | | | | | | | | |
| **From the Density-CBR Curve at 95% MDD (1.434 g/cm3): CBR = 3.25** | | | | | | | | |



## Sample No.: 10 Location of Sample @ Station 11+000Km, Visual Soil Description Reddish clay soil

**1 SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 29 | 24 | 19 | | |
| Can No. | 98 | 15 | 18 | 17 | F2 | 1 |
| Weight of Can + | 45.50 | 47.77 | 43.09 | 46.41 | 25.78 | 25.34 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 35.83 | 38.80 | 34.11 | 37.42 | 24.13 | 23.68 |
| Weight of Can (g) | 19.93 | 24.36 | 19.71 | 23.17 | 19.91 | 19.38 |
| Wt. of Moisture (g) | 9.67 | 8.96 | 8.99 | 8.99 | 1.66 | 1.66 |
| Wt. of Dry Soil (g) | 15.90 | 14.44 | 14.39 | 14.25 | 4.22 | 4.29 |
| w (%) | 60.84 | 62.07 | 62.46 | 63.11 | 39.26 | 38.77 |
| **PI=LL-PL=62-39=23** | | | | AV. P | 39. | |



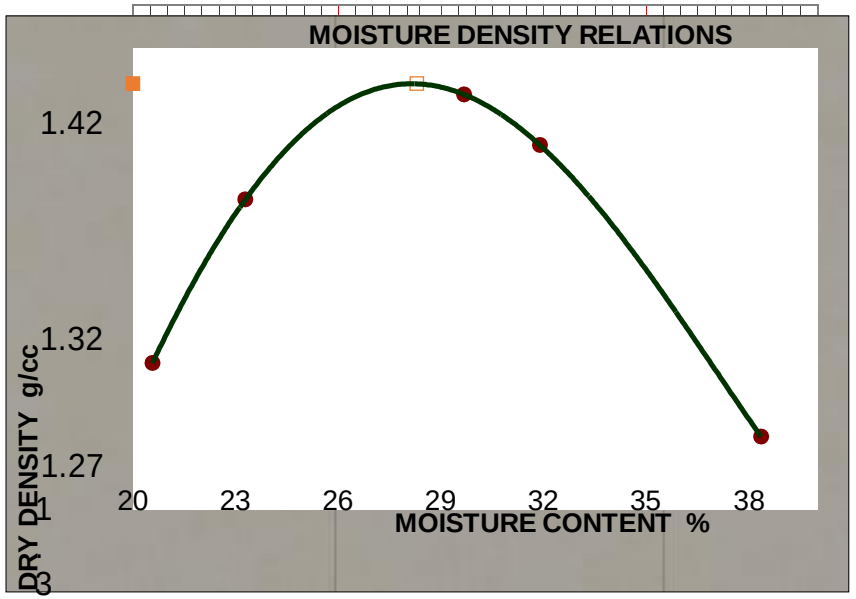

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 0 | 0.00 | 100.00 | | | |
| 0.425 | 35 | 7.00 | 93.00 | | | |
| 0.075 | 248 | 49.60 | 43.40 | | | |
| Total | 500 | | | A-7-5(5) | **SM** | **S2** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

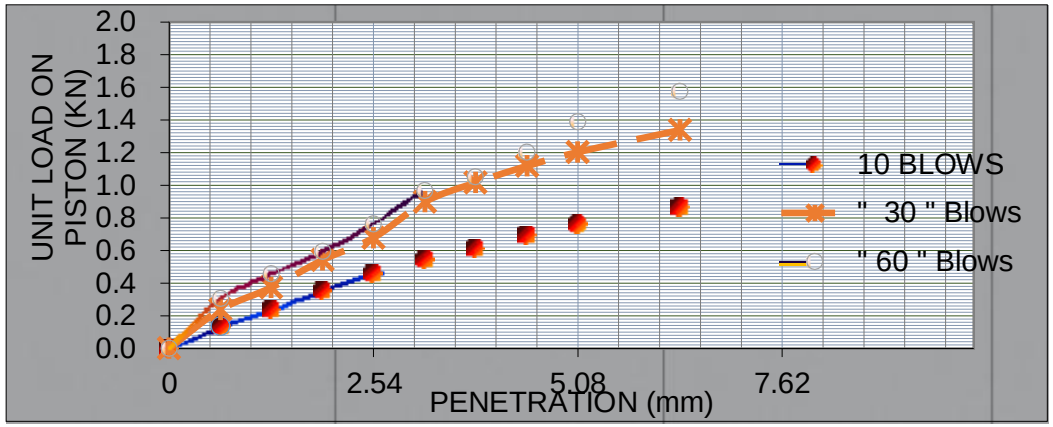
**1.3.1**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | 5 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8354 | 8597 | 8899 | 8911 | 8771 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | 4955 | |
| | Vol. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1$- | 3,399 | 3,642 | 3,944 | 3,956 | 3,816 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ | 1.60 | 1.71 | 1.86 | 1.86 | 1.80 | **NMC** |
| | | | | | | | |
| MOISTURE | CAN NO. | 22 | 12 | O | G | 47 | N |
| | WET SOIL + CAN (g) a | #### | 174.8 | 194.5 | 189.2 | 167.1 | 170.8 |
| | DRY SOIL + CAN (g) b | #### | 147.2 | 156.3 | 149.9 | 128.3 | 156.1 |
| | Wt. OF CAN (g) c | 26.8 | 28.4 | 27.7 | 26.7 | 27.1 | 27.6 |
| | Wt. OF WATER (g) d = a-b | 27.0 | 27.7 | 38.2 | 39.3 | 38.8 | 14.7 |
| | Wt. OF DRY SOIL (g) e =b-c | #### | 118.8 | 128.6 | 123.2 | 101.2 | 128.5 |
| | **w (%) m=** | 20.58 | 23.28 | 29.69 | 31.90 | 38.37 | 11.47 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.33 | 1.39 | 1.43 | 1.41 | 1.30 | |

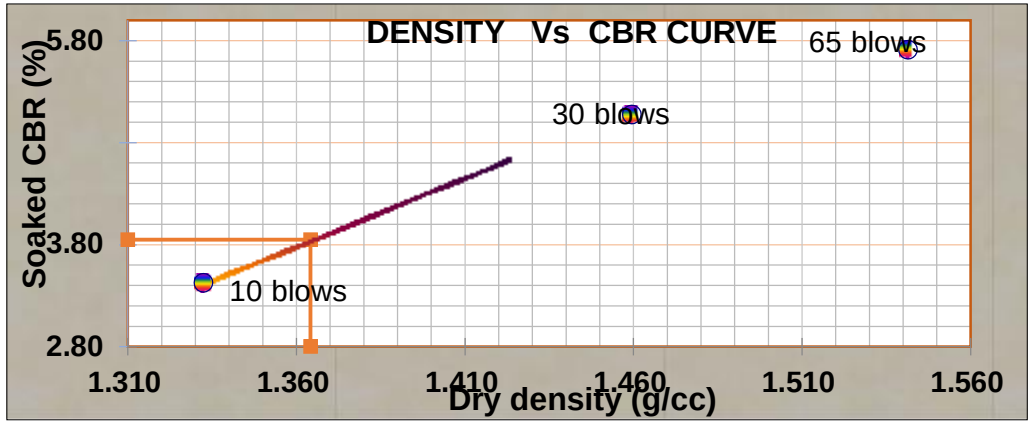


PENETRATION TEST DATA

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL R | LOAD (kn) | DIAL RDG | LOAD (k | DIAL | LOAD |
| 0.64 | 8.0 | 0.135 | 14.0 | 0.237 | 18.0 | 0.305 |
| 1.27 | 14.0 | 0.237 | 22.0 | 0.372 | 27.0 | 0.457 |
| 1.91 | 21.0 | 0.356 | 32.0 | 0.542 | 35.0 | 0.593 |
| 2.54 | 27.0 | 0.457 | 40.0 | 0.677 | 45.0 | 0.762 |
| 3.18 | 32.0 | 0.542 | 53.0 | 0.897 | 57.0 | 0.965 |
| 3.81 | 36.0 | 0.609 | 60.0 | 1.016 | 62.0 | 1.050 |
| 4.45 | 41.0 | 0.694 | 66.0 | 1.117 | 71.0 | 1.202 |
| 5.08 | 45.0 | 0.762 | 71.0 | 1.202 | 82.0 | 1.388 |
| 6.35 | 51.0 | 0.863 | 79.0 | 1.337 | 93.0 | 1.574 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| 10 | 1.33 | 0.46 | 0.76 | 13.40 | 20.00 | 3.4 | 3.8 | 3.4 |
| 30 | 1.46 | 0.68 | 1.20 | 13.40 | 20.00 | 5.1 | 6.0 | 5.1 |
| 65 | 1.54 | 0.76 | 1.39 | 13.40 | 20.00 | 5.7 | 6.9 | 5.7 |

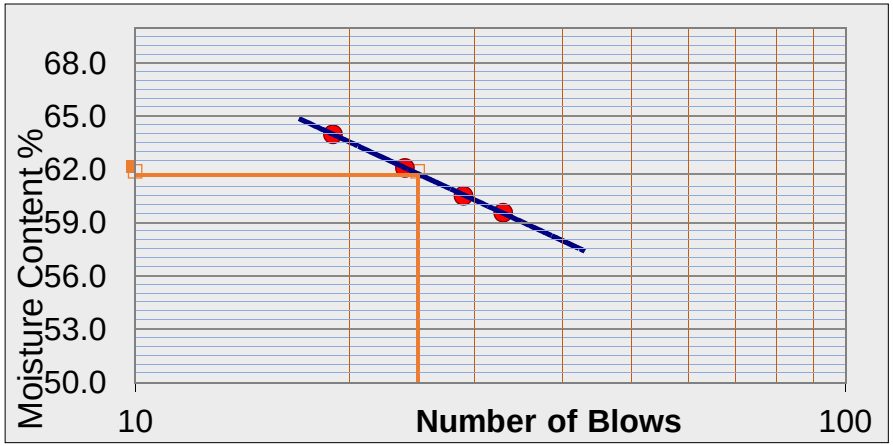



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.44 g/cm3 and OMC = 28.3%** |
| **From the Density-CBR Curve at 95% MDD (1.368 g/cm3): CBR = 3.85** |

**Sample No.: 11 Location of Sample @ Station 12+000Km, Visual Soil Description: Reddish brown clay soil**

**1 SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | Liquid Limit | | | | Plastic Limit | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 29 | 24 | 19 | | |
| Can No. | 16 | 3 | 97 | 2 | 2 | 96 |
| Weight of Can& | 44.72 | 39.32 | 42.67 | 44.40 | 32.00 | 26.30 |
| Weight of Can + | 36.91 | 31.77 | 34.07 | 34.78 | 29.80 | 24.32 |
| Weight of Can (g) | 23.82 | 19.31 | 20.24 | 19.75 | 24.37 | 19.51 |
| Wt. of Moisture | 7.80 | 7.55 | 8.59 | 9.62 | 2.20 | 1.98 |
| Wt. of Dry Soil | 13.10 | 12.47 | 13.84 | 15.03 | 5.43 | 4.81 |
| w (%) = (A / B )x 100 | 59.57 | 60.53 | 62.09 | 63.99 | 40.50 | 41.15 |
| Plastic (PI)=LL-PL=62-41=21 | | | | AV. PL | 41 | |



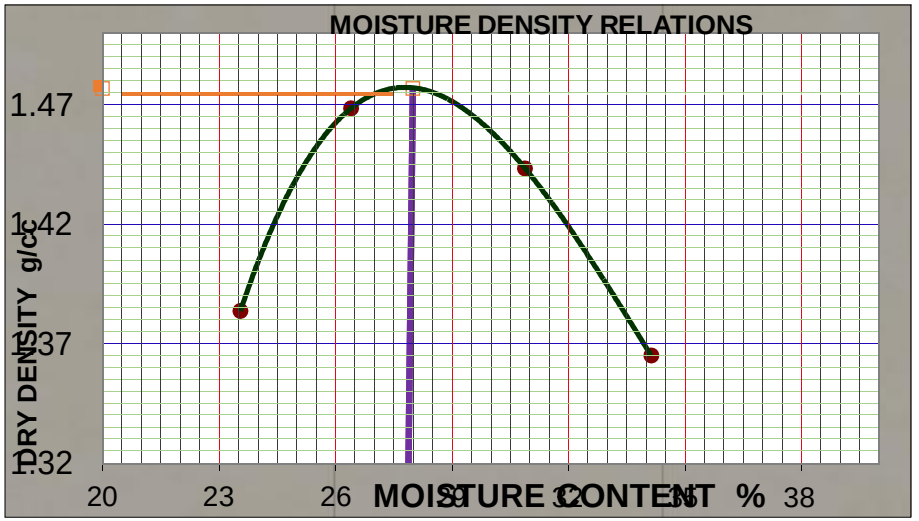
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 0 | 0.00 | 100.00 | | | |
| 0.425 | 125 | 25.00 | 75.00 | | | |
| 0.075 | 227 | 45.40 | 29.60 | | | |
| total | 500 | | | A-2-7(2) | **SM** | **S3** |

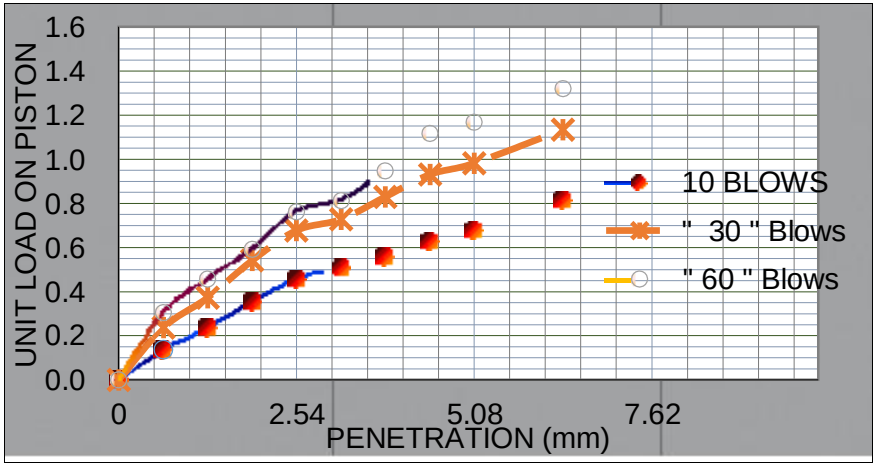
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8586 | 8898 | 8968 | 8844 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,631 | 3,943 | 4,013 | 3,889 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d$ | 1.71 | 1.86 | 1.89 | 1.83 | **NMC** |
| MOISTURE | Can No. | 16 | Q | J | H | N |
| | WET SOIL + Can (g) a | 203.8 | 183.7 | 187.6 | 165.7 | 170.8 |
| | DRY SOIL + Can (g) b | 169.6 | 151.0 | 149.7 | 129.6 | 156.1 |
| | Wt. OF Can (g) c | 24.5 | 27.0 | 26.9 | 23.8 | 27.6 |
| | Wt. OF WATER (g) d = a-b | 34.2 | 32.7 | 37.9 | 36.1 | 14.7 |
| | Wt. OF DRY SOIL (g) e =b-c | 145.1 | 124.0 | 122.8 | 105.8 | 128.5 |
| | **w (%) m=** | 23.55 | 26.40 | 30.88 | 34.13 | 11.47 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$** | | 1.38 | 1.47 | 1.44 | 1.37 | |



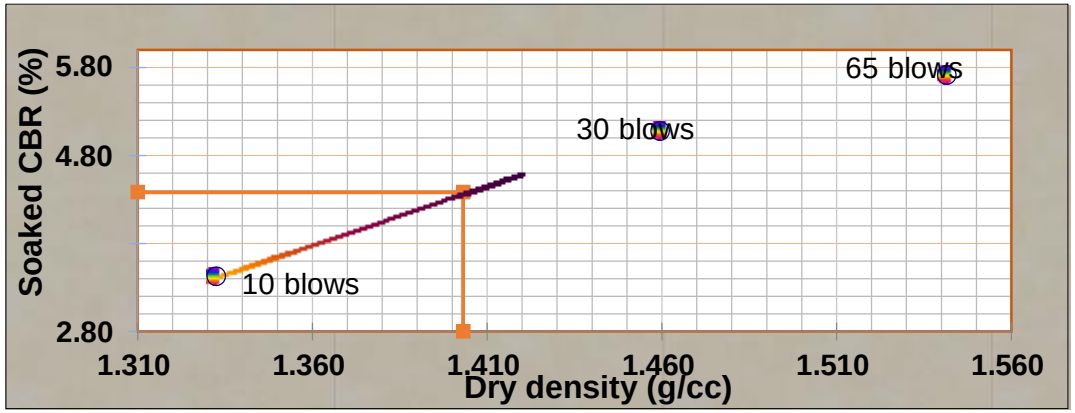

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 8.0 | 0.135 | 14.0 | 0.237 | 18.0 | 0.305 |
| 1.27 | 14.0 | 0.237 | 22.0 | 0.372 | 27.0 | 0.457 |
| 1.91 | 21.0 | 0.356 | 32.0 | 0.542 | 35.0 | 0.593 |
| 2.54 | 27.0 | 0.457 | 40.0 | 0.677 | 45.0 | 0.762 |
| 3.18 | 30.0 | 0.508 | 43.0 | 0.728 | 48.0 | 0.813 |
| 3.81 | 33.0 | 0.559 | 49.0 | 0.830 | 56.0 | 0.948 |
| 4.45 | 37.0 | 0.626 | 55.0 | 0.931 | 66.0 | 1.117 |
| 5.08 | 40.0 | 0.677 | 58.0 | 0.982 | 69.0 | 1.168 |
| 6.35 | 48.0 | 0.813 | 67.0 | 1.134 | 78.0 | 1.321 |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.33** | 0.46 | 0.68 | 13.40 | 20.00 | 3.4 | 3.4 | 3.4 |
| **30** | **1.46** | 0.68 | 0.98 | 13.40 | 20.00 | 5.1 | 4.9 | 5.1 |
| **65** | **1.54** | 0.76 | 1.17 | 13.40 | 20.00 | 5.7 | 5.8 | 5.7 |

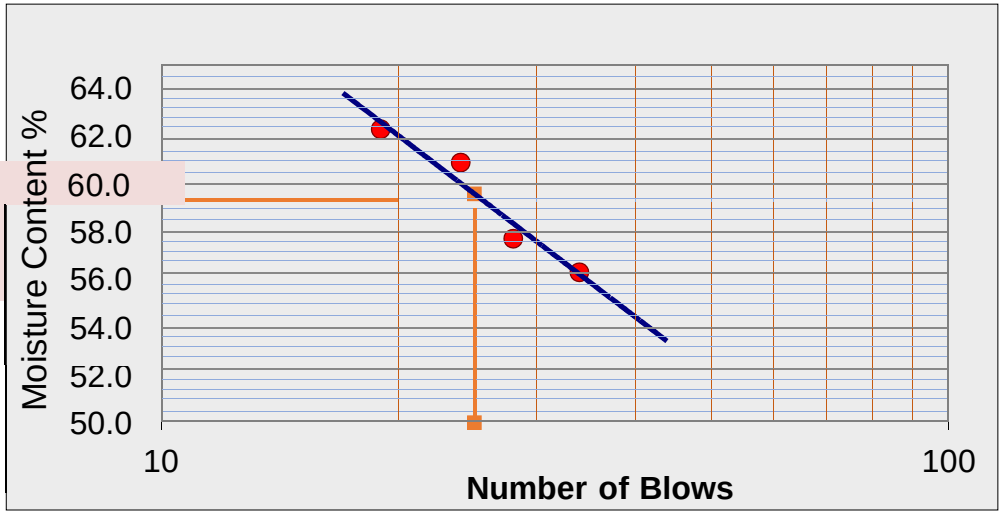



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.48 g/cm3 and OMC = 28%** |
| **From the Density-CBR Curve at 95% MDD (1.406 g/cm3): CBR = 4.52** |

**Sample No.: 12 Location of Sample @ Station 12+500Km, Visual Soil Description: white brown clay soil**

**1 SOIL CONSISTENCY TEST RESULT ( : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 28 | 24 | 19 | | |
| Can No. | F2 | 12 | 14 | 1 | 18 | 3 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 43.90 | 52.84 | 47.12 | 40.28 | 24.88 | 24.80 |
| Wt. of Container + Dry Soil (g) = ($W_2$) | 35.26 | 42.00 | 38.22 | 32.27 | 23.35 | 23.17 |
| Weight of Can (g) | 19.90 | 23.20 | 23.60 | 19.40 | 19.70 | 19.30 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 8.65 | 10.85 | 8.90 | 8.02 | 1.53 | 1.63 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 15.36 | 18.80 | 14.62 | 12.87 | 3.65 | 3.87 |
| w (%) = (A / B )x 100 | 56.30 | 57.72 | 60.91 | 62.30 | 41.88 | 42.23 |
| **PI=LL-PL=60-42=18** | | | A P L | 42 | | |



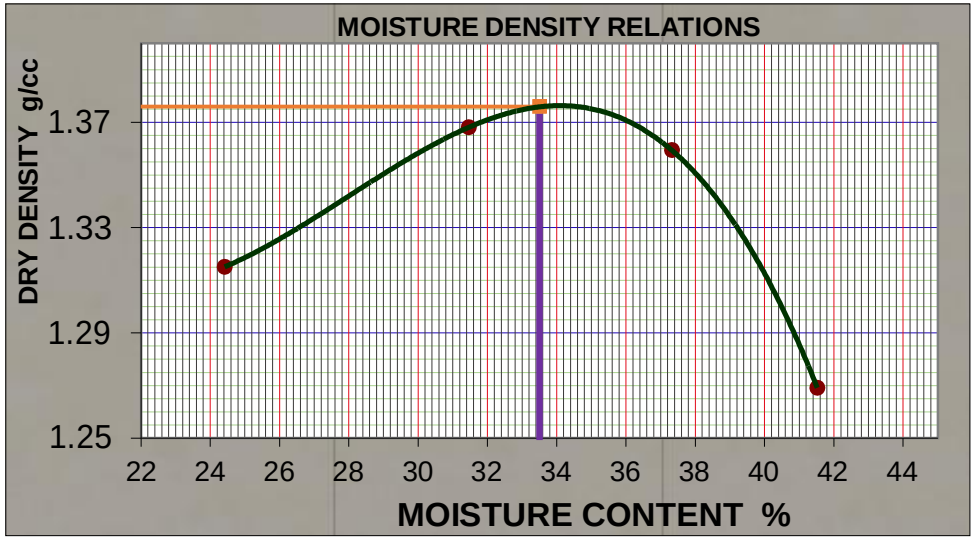

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 35 | 7.00 | 93.00 | | | |
| 0.425 | 85 | 17.00 | 76.00 | | | |
| 0.075 | 270 | 54.00 | 22.00 | | | |
| Total | 500 | | | A-2-7 (1) | **SM** | |

### 1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)

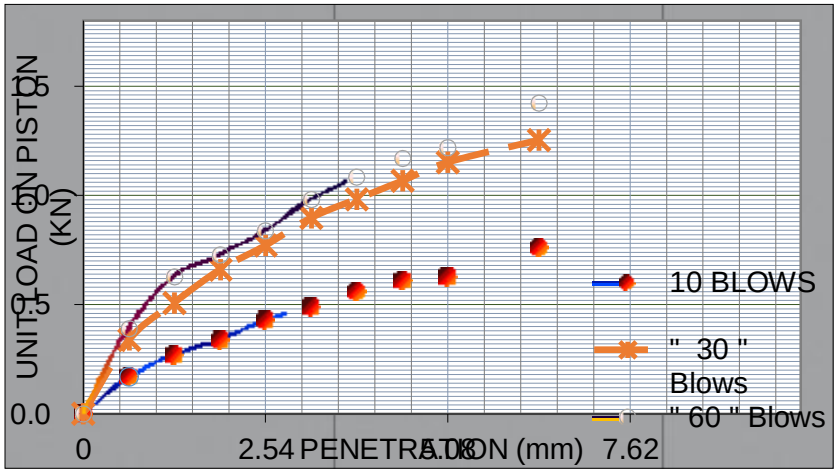
1.31

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL No. | 1 | | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8430.0 | 8775.0 | 8920.0 | 8770.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | Vol. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,475 | 3,820 | 3,965 | 3,815 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d$ | 1.64 | 1.80 | 1.87 | 1.80 | NMC |
| MOISTURE | Can No. | A9 | A6 | 7 | A4 | A8 |
| | WET SOIL + Can (g) a | 222.1 | 214.9 | 212.0 | 199.4 | 223.2 |
| | DRY SOIL + Can (g) b | 183.8 | 170.1 | 161.8 | 149.2 | 193.5 |
| | Wt. OF Can (g) c | 26.9 | 27.7 | 27.3 | 28.3 | 27.1 |
| | Wt. OF WATER (g) d = a-b | 38.3 | 44.8 | 50.2 | 50.2 | 29.7 |
| | Wt. OF DRY SOIL (g) e =b-c | 156.9 | 142.4 | 134.5 | 120.9 | 166.4 |
| | **w (%) m=** | 24.41 | 31.46 | 37.32 | 41.52 | 17.85 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$** | | 1.32 | 1.37 | 1.36 | 1.27 | |




PENETRATION TEST DATA

| PENETRATION | 10 Blows | 30 Blows | 65 Blows | | | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 20.0 | 0.339 | 23.0 | 0.389 |
| 1.27 | 16.0 | 0.271 | 30.0 | 0.508 | 37.0 | 0.626 |
| 1.91 | 20.0 | 0.339 | 39.0 | 0.660 | 43.0 | 0.728 |
| 2.54 | 26 | 0.432 | 46 | 0.770 | 50 | 0.838 |
| 3.18 | 29.0 | 0.491 | 53.0 | 0.897 | 58.0 | 0.982 |
| 3.81 | 33.0 | 0.559 | 58.0 | 0.982 | 64.0 | 1.084 |
| 4.45 | 36.0 | 0.609 | 63.0 | 1.067 | 69.0 | 1.168 |
| 5.08 | 37.0 | 0.626 | 68.0 | 1.151 | 72.0 | 1.219 |
| 6.35 | 45.0 | 0.762 | 74.0 | 1.253 | 84.0 | 1.422 |

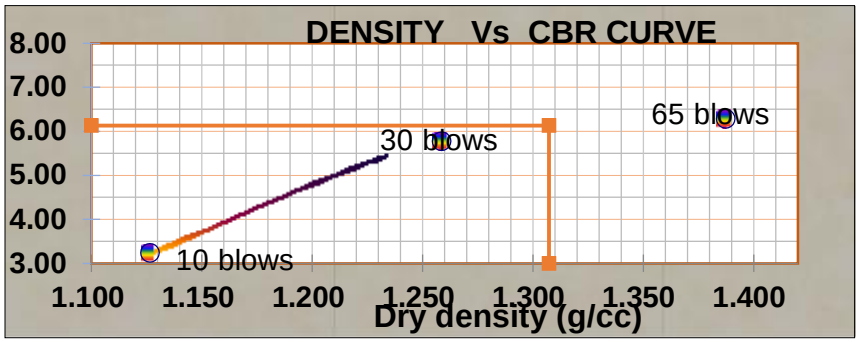



| BLOWS | DD (g/Cm3) | LOAD | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 mm | 5.08 | 2.54 | 5.08 | |
| **10** | **1.13** | 0.43 | 0.63 | 13.40 | 20.00 | 3.2 | 3.1 | 3.2 |
| **30** | **1.26** | 0.77 | 1.15 | 13.40 | 20.00 | 5.8 | 5.8 | 5.8 |
| **65** | **1.39** | 0.84 | 1.22 | 13.40 | 20.00 | 6.3 | 6.1 | 6.3 |

Ring Factor =0.01693kN/Div

**From the compaction curve: MDD = 1.38 g/cm3 and OMC = 33.5%**

**From the Density-CBR Curve at 95% MDD (1.311 g/cm3): CBR = 6.13**



## Sample No.: 13 Location of Sample @ Station13+000Km, Visual Soil Description: Red brown clay soil

**1.1 SOIL CONSISTENCY TEST RESULT (TEST METHOD：AASHTO T89, T90)**

| Description | LL | | | | PL | |
|---|---|---|---|---|---|---|
| **No. of Blows** | **35** | **29** | **24** | **19** | | |
| Can No. | 94 | 91 | B | 2T | Oo | Dv |
| Weight of Can+ Wet Soil (g) = ($W_1$) | 40.72 | 35.80 | 37.98 | 43.99 | 23.27 | 23.01 |
| Weight of Can+ Dry Soil (g) = ($W_2$) | 32.67 | 29.13 | 30.55 | 34.21 | 22.12 | 21.93 |
| Wt. of Can (g) | 19.81 | 19.61 | 20.23 | 21.03 | 19.60 | 19.51 |
| Wt. of Moisture (g) | 8.04 | 6.67 | 7.42 | 9.77 | 1.15 | 1.08 |
| Wt. of Dry Soil (g) | 12.86 | 9.52 | 10.33 | 13.18 | 2.52 | 2.42 |
| w (%) | 62.51 | 70.01 | 71.87 | 74.14 | 45.48 | 44.53 |
| **PI=LL-PL=75-45=25** | | | | A PL | 45.0 | |

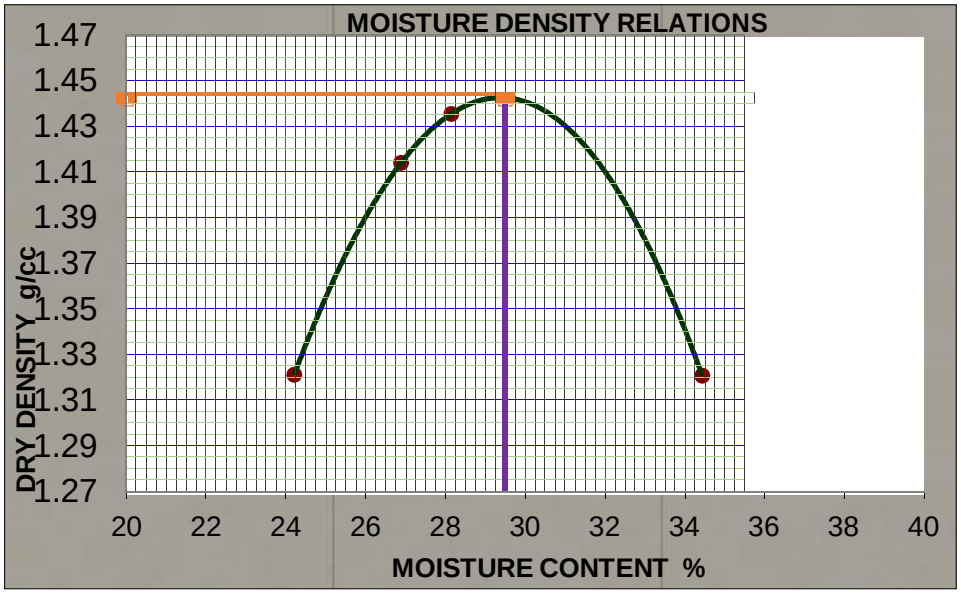

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 4 | 0.80 | 99.20 | **AASHTO** | **USCS** | **ERA Subgrade** |
| 0.425 | 192 | 38.40 | 60.80 | | | |
| 0.075 | 209 | 41.80 | 19.00 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S2** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (: AASHTO T-180 METHOD D)**

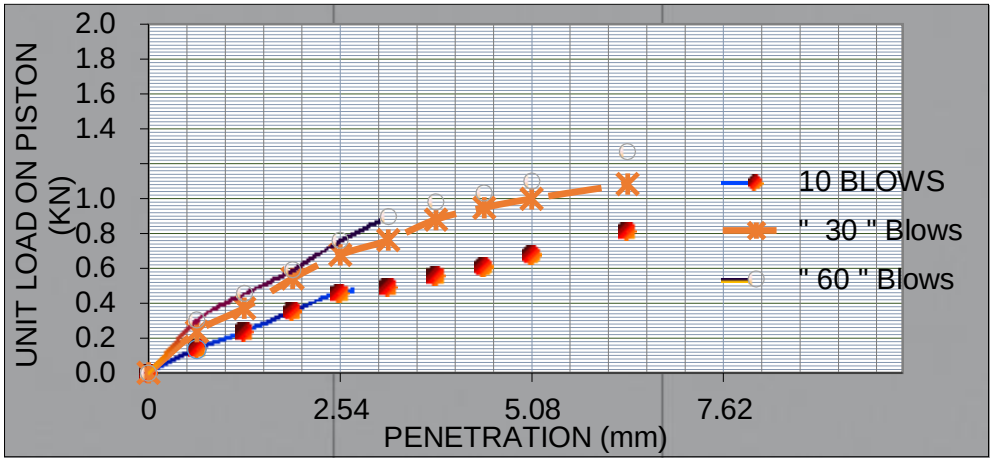
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8444.0 | 8769.0 | 8865.0 | 8730.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1$- | 3,489 | 3,814 | 3,910 | 3,775 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ | 1.64 | 1.80 | 1.84 | 1.78 | **NMC** |
| | | | | | | |
| MOISTURE | Can No. | A | L | S | P | V |
| | WET SOIL + Can (g) a | 192.6 | 209.0 | 193.2 | 150.7 | 180.9 |
| | DRY SOIL + Can (g) b | 160.6 | 170.5 | 156.9 | 119.4 | 166.1 |
| | Wt. OF Can (g) c | 28.3 | 27.3 | 27.9 | 28.5 | 27.2 |
| | Wt. OF WATER (g) d = a-b | 32.0 | 38.5 | 36.3 | 31.3 | 14.8 |
| | Wt. OF DRY SOIL (g) e =b-c | 132.3 | 143.2 | 129.0 | 90.9 | 138.9 |
| | **w (%) m=** | 24.21 | 26.89 | 28.14 | 34.43 | 10.66 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ = $W_d$/(100+m)*100** | | 1.32 | 1.42 | 1.44 | 1.32 | |

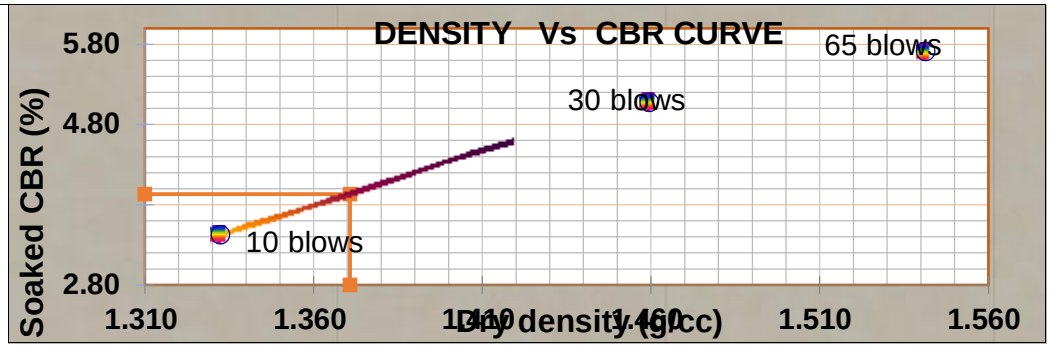


**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| 1.27 | 14.0 | 0.237 | 22.0 | 0.372 | 27.0 | 0.457 |
| 1.91 | 21.0 | 0.356 | 32.0 | 0.542 | 35.0 | 0.593 |
| 2.54 | 27.0 | 0.457 | 40.0 | 0.677 | 45.0 | 0.762 |
| 3.18 | 29.0 | 0.491 | 45.0 | 0.762 | 53.0 | 0.897 |
| 3.81 | 33.0 | 0.559 | 52.0 | 0.880 | 58.0 | 0.982 |
| 4.45 | 36.0 | 0.609 | 56.0 | 0.948 | 61.0 | 1.033 |
| 5.08 | 40.0 | 0.677 | 59.0 | 0.999 | 65.0 | 1.100 |
| 6.35 | 48.0 | 0.813 | 64.0 | 1.084 | 75.0 | 1.270 |



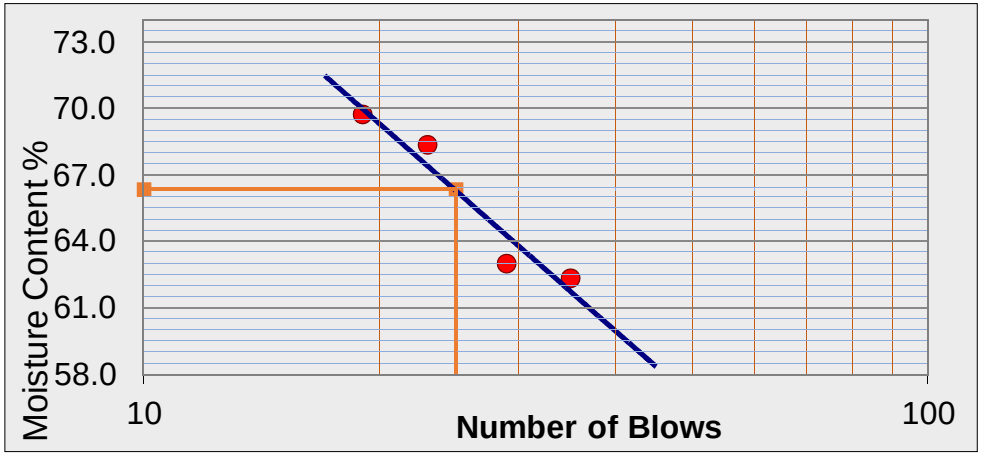

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | (g/Cm3) | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | (%) |
| **10** | **1.33** | 0.46 | 0.68 | 13.40 | 20.00 | 3.4 | 3.4 | 3.4 |
| | | | | | | | | |
| **65** | **1.54** | 0.76 | 1.10 | 13.40 | 20.00 | 5.7 | 5.5 | 5.7 |
| Ring Factor =0.01693kN/Div | | | | | | | | |
| **From the compaction curve: MDD = 1.44 g/cm3 and OMC = 29.5%** | | | | | | | | |
| **From the Density-CBR Curve at 95% MDD (1.368 g/cm3): CBR = 3.93** | | | | | | | | |




**Sample No.: 14 Location of Sample @ Station 14+000Km, Visual Soil Description: Red brown clay soil**

**1.SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| **No. of Blows** | **35** | **29** | **23** | **19** | | |
| Can No. | DD | 35 | 7 | 14 | 22 | 12 |
| Weight of Can + Wet Soil(g) | 48.33 | 41.53 | 47.46 | 51.38 | 23.21 | 26.89 |
| Weight of Can + Dry Soil(g) | 38.91 | 32.94 | 35.57 | 39.95 | 21.86 | 25.68 |
| Weight of Can (g) = ($W_3$) | 23.82 | 19.31 | 18.20 | 23.56 | 19.12 | 23.24 |
| Wt. of Moisture (g) = A | 9.42 | 8.59 | 11.89 | 11.44 | 1.35 | 1.22 |
| Wt. of Dry Soil (g) = B | 15.09 | 13.63 | 17.37 | 16.39 | 2.74 | 2.44 |
| w(%)=(A / B )x100 | 62.39 | 63.05 | 68.43 | 69.81 | 49.38 | 49.75 |
| PI=LL-PL=66-50=17 | | | | AVPL. | 49.6 | |



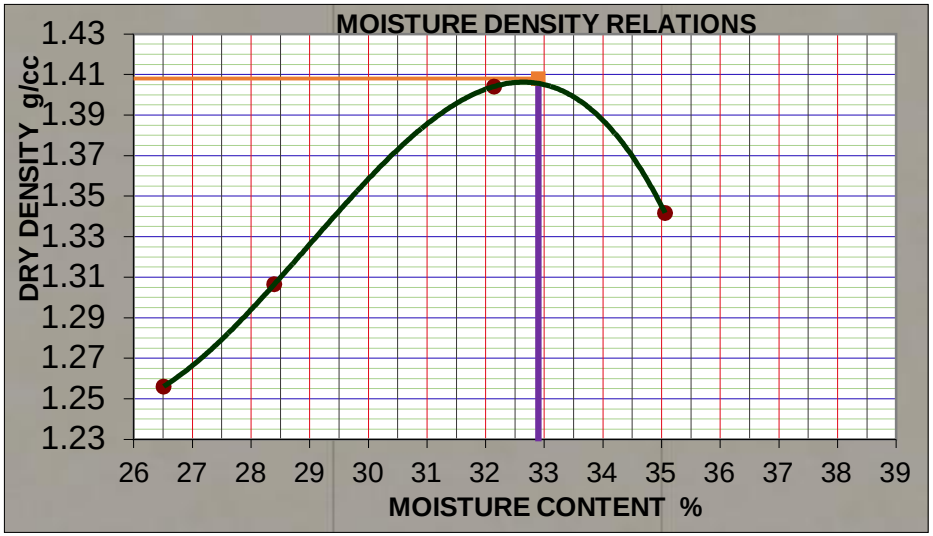
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 6 | 1.20 | 98.80 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 239 | 47.80 | 51.00 | | | |
| 0.075 | 167 | 33.40 | 17.60 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

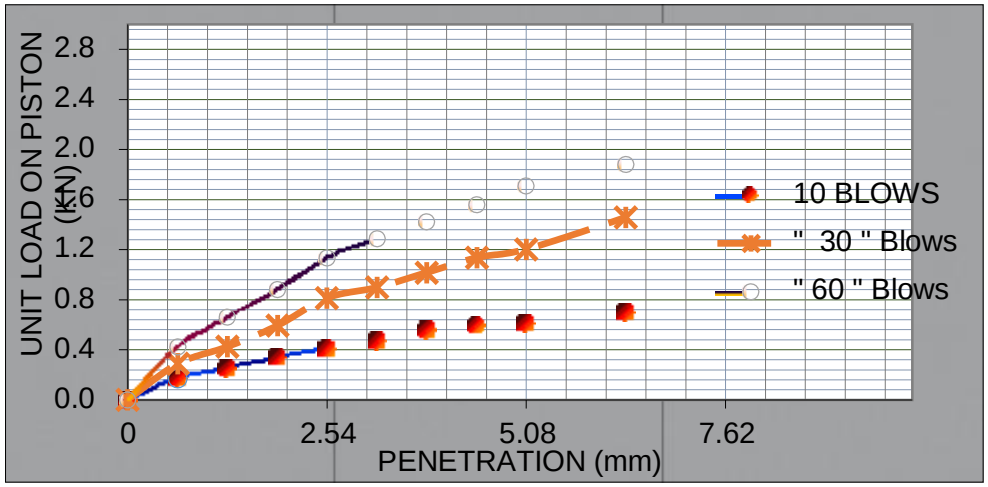
1.31

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8330.0 | 8518.0 | 8896.0 | 8804.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | Vol. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1$ | 3,375 | 3,563 | 3,941 | 3,849 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) | 1.59 | 1.68 | 1.86 | 1.81 | **NMC** |
| MOISTURE | Can No. | 17 | 1 | T | C | 23 |
| | WET SOIL + Can (g) a | 231.5 | 230.5 | 205.7 | 202.4 | 202.9 |
| | DRY SOIL + Can (g) b | 188.9 | 185.6 | 162.4 | 157.0 | 188.3 |
| | WEIGHT OF Can (g) c | 28.2 | 27.5 | 27.7 | 27.5 | 28.0 |
| | Wt. OF WATER (g) d = a-b | 42.6 | 44.9 | 43.3 | 45.4 | 14.6 |
| | Wt. OF DRY SOIL (g) e =b-c | 160.7 | 158.1 | 134.7 | 129.5 | 160.3 |
| | **w (%) m=** | 26.51 | 28.40 | 32.15 | 35.06 | 9.11 |
| **DRY DENSITY OF SOIL ( g/Cm3 )** | | 1.26 | 1.31 | 1.40 | 1.34 | |



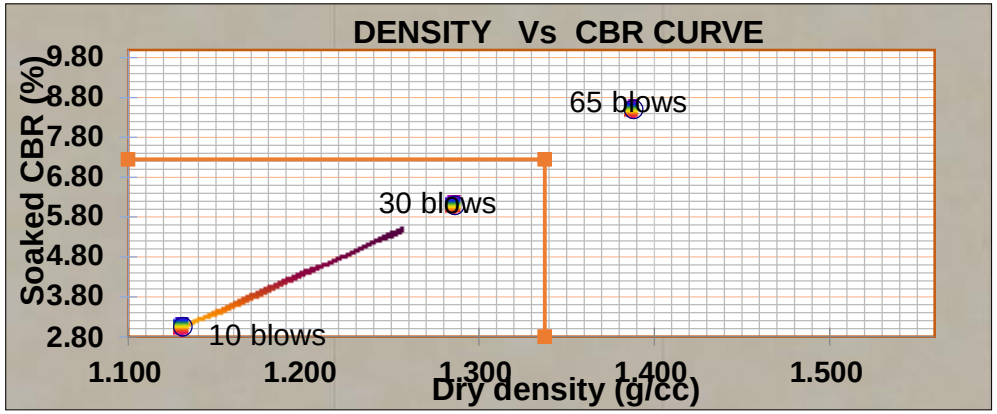

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 17.0 | 0.288 | 25.0 | 0.423 |
| 1.27 | 15.0 | 0.254 | 25.0 | 0.423 | 39.0 | 0.660 |
| 1.91 | 20.0 | 0.339 | 35.0 | 0.593 | 52.0 | 0.880 |
| 2.54 | 24.0 | 0.406 | 48.0 | 0.813 | 67.0 | 1.134 |
| 3.18 | 28.0 | 0.474 | 53.0 | 0.897 | 76.0 | 1.287 |
| 3.81 | 33.0 | 0.559 | 60.0 | 1.016 | 84.0 | 1.422 |
| 4.45 | 35.0 | 0.593 | 67.0 | 1.134 | 92.0 | 1.558 |
| 5.08 | 36.0 | 0.609 | 71.0 | 1.202 | 101.0 | 1.710 |
| 6.35 | 41.0 | 0.694 | 86.0 | 1.456 | 111.0 | 1.879 |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.13** | 0.41 | 0.61 | 13.40 | 20.00 | 3.0 | 3.0 | 3.0 |
| **30** | **1.29** | 0.81 | 1.20 | 13.40 | 20.00 | 6.1 | 6.0 | 6.1 |
| **65** | **1.39** | 1.13 | 1.71 | 13.40 | 20.00 | 8.5 | 8.5 | 8.5 |

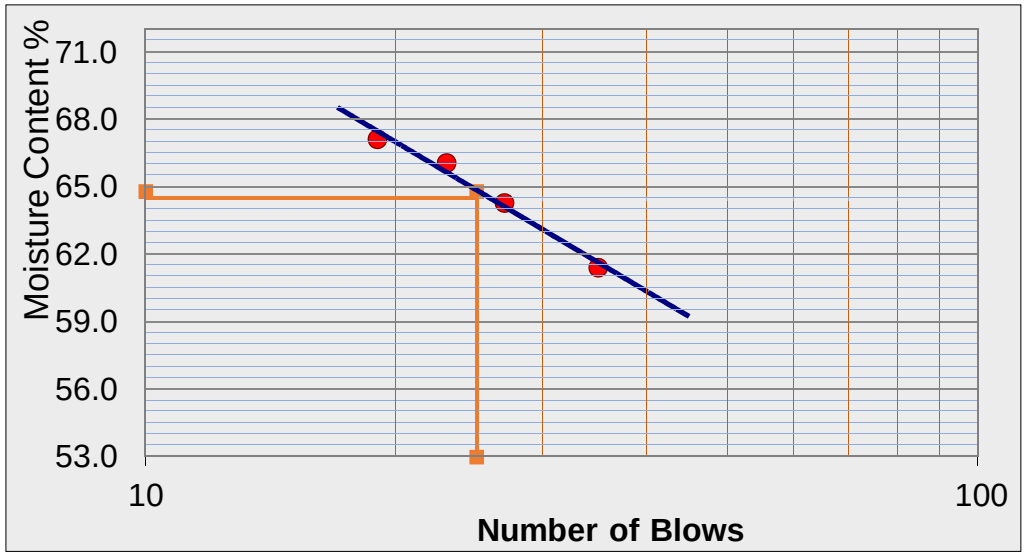



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.41 g/cm3 and OMC = 32.9%** |
| **From the Density-CBR Curve at 95% MDD (1.339 g/cm3): CBR = 7.25** |

**Sample No.: 15 Location of Sample @ Station 14+500Km, Visual Soil Description: Red brown clay soil**

**1.SOIL CONSISTENCY TEST RESULT (TEST METHOD：AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| **No. of Blows** | **35** | **27** | **23** | **19** | | |
| Can No. | B | 98 | 1 | 96 | 2 | F2 |
| Weight Can + Wet Soil (g) =w1 | 47.64 | 42.83 | 48.76 | 43.04 | 23.10 | 23.06 |
| Weight Of Can+ Dry Soil(g) =w2 | 37.22 | 33.88 | 37.08 | 32.96 | 21.86 | 22.07 |
| Weight of Can (g) =w3 | 20.25 | 19.95 | 19.40 | 17.96 | 19.12 | 19.91 |
| Wt. of Moisture (g) = (w1-w3)=A | 10.42 | 8.95 | 11.68 | 10.07 | 1.25 | 0.99 |
| Wt. of Dry Soil (g) = ( w2-w3)= B | 16.97 | 13.93 | 17.68 | 15.01 | 2.74 | 2.16 |
| w (%) = (A / B )x 100 | 61.42 | 64.29 | 66.06 | 67.12 | 45.59 | 45.93 |
| **PI=LL-PL=65-46=19** | | | | AV. P | 45.8 | |



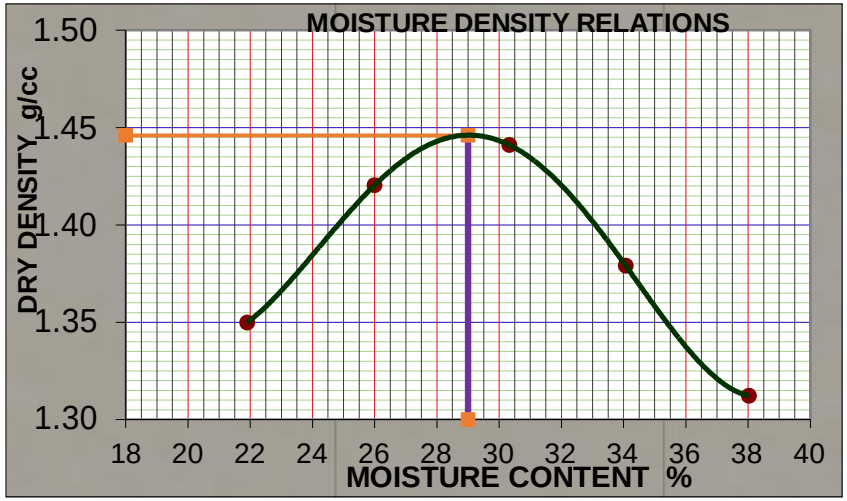

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 11.3 | 2.26 | 97.74 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 116.5 | 23.30 | 74.44 | | | |
| 0.075 | 205.4 | 41.08 | 33.36 | | | |
| total | 500 | | | A-2-7(2) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

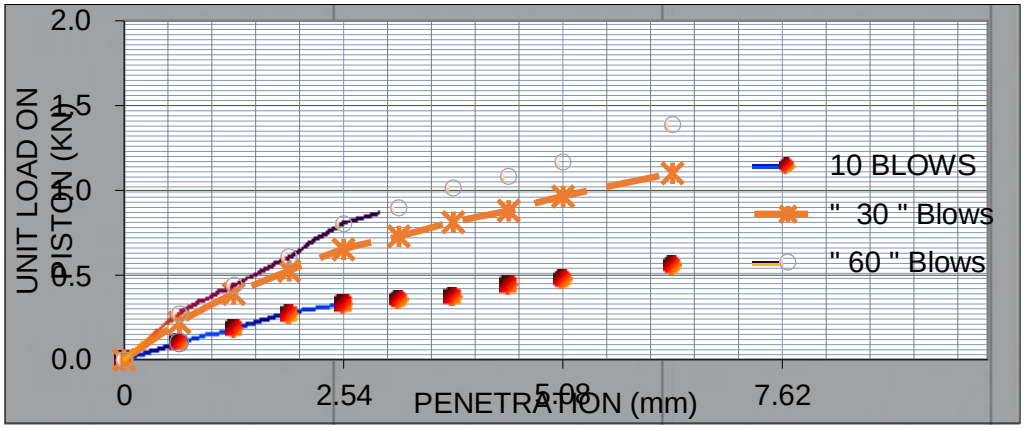
**1.31**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | **1** | **2** | **3** | **4** | 5 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8468.0 | 8774.0 | 8962.0 | 8900.0 | 8820.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4973 | 4973 | 4973 | 4973 | 4973 | |
| | Vol. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | 2124 | |
| | WT. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,495 | 3,801 | 3,989 | 3,927 | 3,847 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d = W_3/V$ | 1.65 | 1.79 | 1.88 | 1.85 | 1.81 | **NMC** |
| MOISTURE | Can No. | **A1** | **A3** | **A4** | **A7** | **25** | **Q** |
| | WET SOIL + Can (g) a | 244.2 | 239.3 | 200.0 | 213.0 | 196.0 | 222.0 |
| | DRY SOIL + Can (g) b | 205.3 | 195.5 | 159.7 | 165.1 | 149.8 | 204.4 |
| | Wt. OF Can (g) c | 27.7 | 27.0 | 26.8 | 24.5 | 28.3 | 26.8 |
| | Wt. OF WATER (g) d = a-b | 38.9 | 43.8 | 40.3 | 47.9 | 46.2 | 17.6 |
| | Wt. OF DRY SOIL (g) e =b-c | 177.6 | 168.5 | 132.9 | 140.6 | 121.5 | 177.6 |
| | **w (%) m= (d/e)*100** | 21.90 | 25.99 | 30.32 | 34.07 | 38.02 | 9.91 |
| **DRY DENSITY OF SOIL $D_d = W_d/(100+m)*100$** | | 1.35 | 1.42 | 1.44 | 1.38 | 1.31 | |

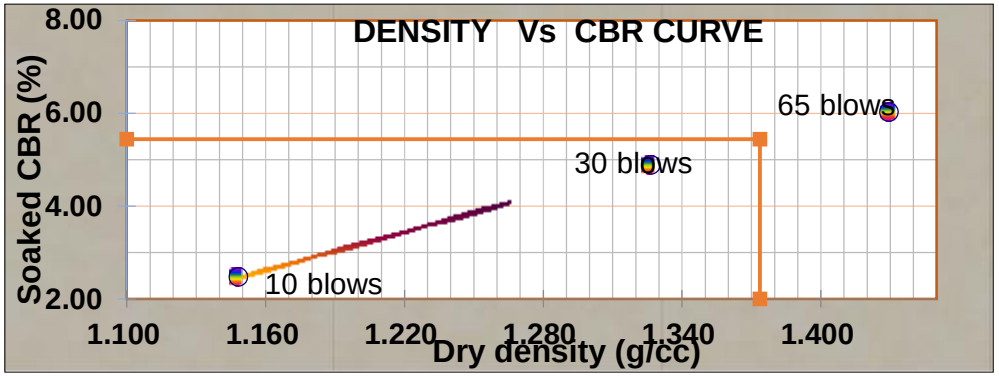



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0.64 | 6.0 | 0.102 | 13.0 | 0.220 | 16.0 | 0.271 |
| 1.27 | 11.0 | 0.186 | 23.0 | 0.389 | 26.0 | 0.440 |
| 1.91 | 16.0 | 0.271 | 31.0 | 0.525 | 36.0 | 0.609 |
| 2.54 | 20 | 0.330 | 39 | 0.652 | 48 | 0.804 |
| 3.18 | 21.0 | 0.356 | 43.0 | 0.728 | 53.0 | 0.897 |
| 3.81 | 22.0 | 0.372 | 48.0 | 0.813 | 60.0 | 1.016 |
| 4.45 | 26.0 | 0.440 | 52.0 | 0.880 | 64.0 | 1.084 |
| 5.08 | 28.0 | 0.474 | 57.0 | 0.965 | 69.0 | 1.168 |
| 6.35 | 33.0 | 0.559 | 65.0 | 1.100 | 82.0 | 1.388 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.15** | 0.33 | 0.47 | 13.40 | 20.00 | 2.5 | 2.4 | 2.5 |
| **30** | **1.33** | 0.65 | 0.97 | 13.40 | 20.00 | 4.9 | 4.8 | 4.9 |
| **65** | **1.43** | 0.80 | 1.17 | 13.40 | 20.00 | 6.0 | 5.8 | 6.0 |



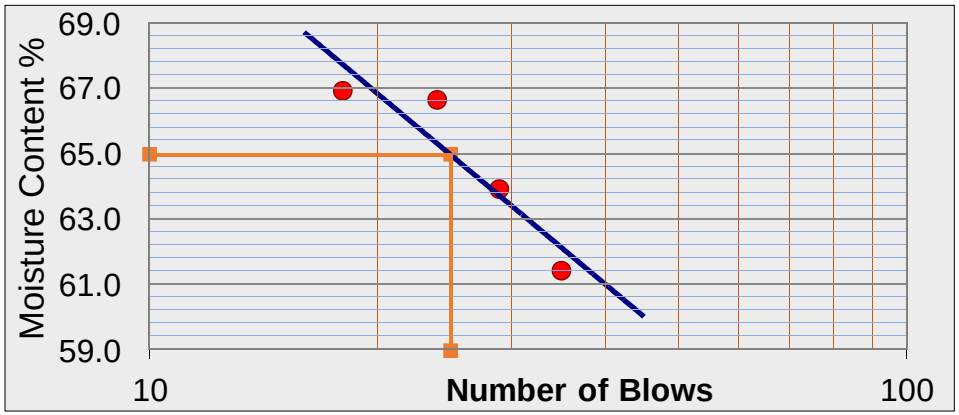

| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.45 g/cm3 and OMC = 29%** |
| **From the Density-CBR Curve at 95% MDD (1.3775 g/cm3): CBR = 5.44** |

## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

## Sample No.: 16 Location of Sample @ Station 15+000Km, Visual Soil Description: Red brown clay soil

**1.SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 29 | 24 | 18 | | |
| Can No. | G1 | 94 | 17 | 96 | 16 | Zt |
| Weight of Can + Wet Soil (g) = | 45.80 | 39.80 | 52.20 | 40.20 | 26.90 | 23.90 |
| Weight of Can + Dry Soil (g) | 35.60 | 32.00 | 40.60 | 31.90 | 26.00 | 23.00 |
| Weight of Can (g) = ($W_3$) | 19.00 | 19.80 | 23.20 | 19.50 | 23.80 | 20.80 |
| Wt. of Moisture (g) = A | 10.20 | 7.80 | 11.60 | 8.30 | 0.90 | 0.90 |
| Wt. of Dry Soil (g) = B | 16.60 | 12.20 | 17.40 | 12.40 | 2.20 | 2.20 |
| w (%) = (A / B )% | 61.45 | 63.93 | 66.67 | 66.94 | 40.91 | 40.91 |
| **PL=LL-PL=65-41=24** | | | | A.PL | 40.9 | |



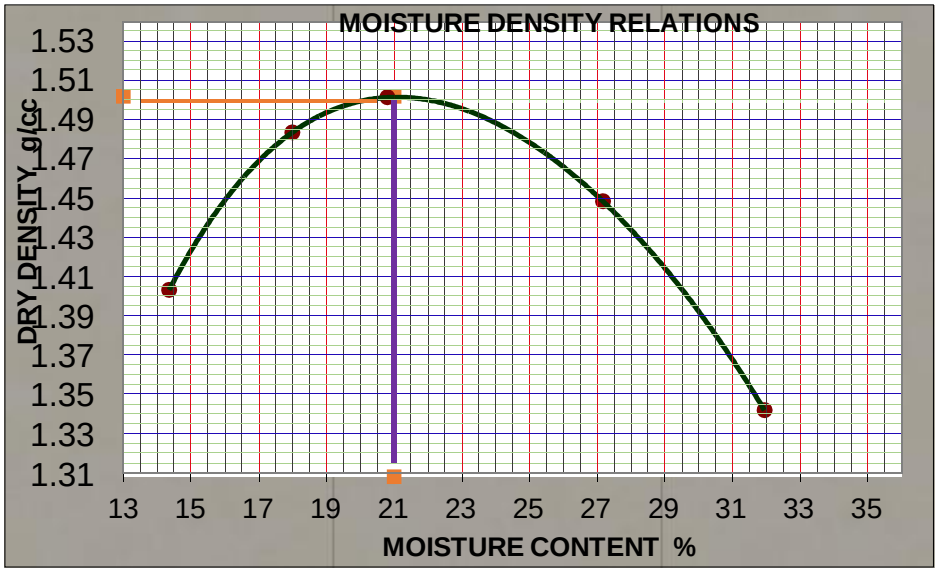

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 30 | 6.00 | 94.00 | | | |
| 0.425 | 105 | 21.00 | 73.00 | | | |
| 0.075 | 104 | 20.80 | 52.20 | | | |
| total | 500 | | | A-7-5-(11) | **MH** | **S2** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

**1.3.1**

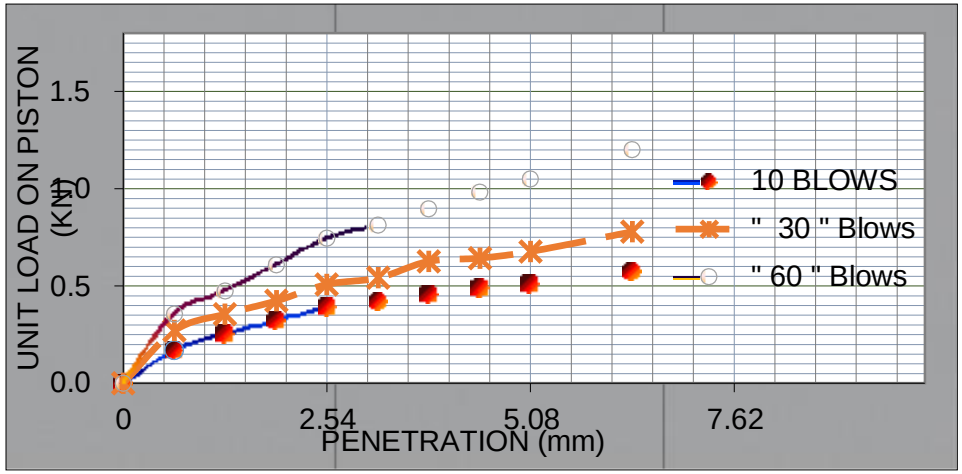
| | TRIAL NUMBER | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|---|
| DENSITY | Wt. OF SOIL + MOULD (g) $W_1$ | 8367 | 8676 | 8810 | 8871 | 8721 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | 4955 | |
| | Vol. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,412 | 3,721 | 3,855 | 3,916 | 3,766 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) | 1.61 | 1.75 | 1.81 | 1.84 | 1.77 | **NMC** |
| | | | | | | | |
| MOISTURE | Can No. | 35 | 2 | 23 | 16 | 22 | F |
| | WET SOIL + Can (g) a | 205.9 | 208.7 | 202.8 | 178.0 | 176.6 | 228.9 |
| | DRY SOIL + Can (g) b | 183.2 | 181.0 | 172.7 | 145.2 | 140.3 | 218.0 |
| | Wt. OF Can (g) c | 25.1 | 27.1 | 28.0 | 24.5 | 26.7 | 27.6 |
| | Wt. OF WATER (g) d = a-b | 22.7 | 27.7 | 30.1 | 32.8 | 36.3 | 10.9 |
| | Wt. OF DRY SOIL (g) e =b-c | 158.1 | 153.9 | 144.7 | 120.7 | 113.6 | 190.4 |
| | **W (%)** | 14.36 | 18.00 | 20.80 | 27.17 | 31.95 | 5.72 |
| **DRY DENSITY ( g/Cm3 ) $D_d$ =** | | 1.40 | 1.48 | 1.50 | 1.45 | 1.34 | |



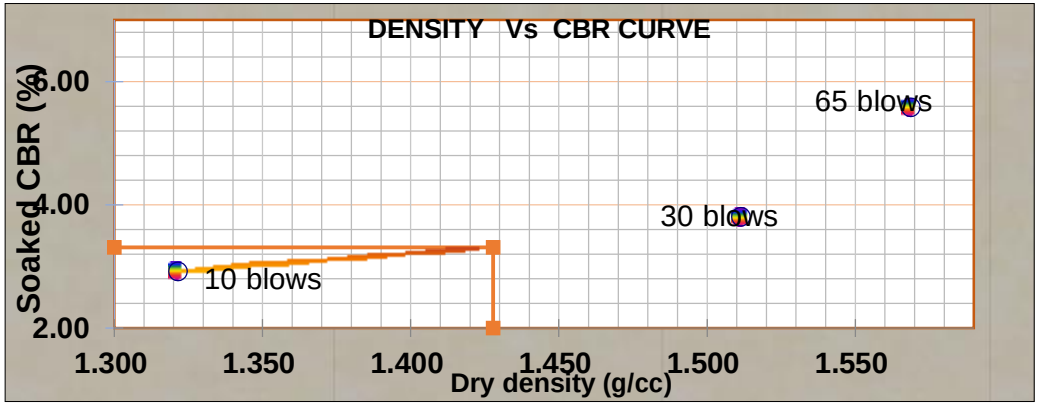
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 16.0 | 0.271 | 21.0 | 0.356 |
| 1.27 | 15.0 | 0.254 | 21.0 | 0.356 | 28.0 | 0.474 |
| 1.91 | 19.0 | 0.322 | 25.0 | 0.423 | 36.0 | 0.609 |
| 2.54 | 23.0 | 0.389 | 30.0 | 0.508 | 44.0 | 0.745 |
| 3.18 | 25.0 | 0.423 | 32.0 | 0.542 | 48.0 | 0.813 |
| 3.81 | 27.0 | 0.457 | 37.0 | 0.626 | 53.0 | 0.897 |
| 4.45 | 29.0 | 0.491 | 38.0 | 0.643 | 58.0 | 0.982 |
| 5.08 | 30.0 | 0.508 | 40.0 | 0.677 | 62.0 | 1.050 |
| 6.35 | 34.0 | 0.576 | 46.0 | 0.779 | 71.0 | 1.202 |




| BLOWS | DD (g/Cm3) | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| **10** | **1.32** | 0.39 | 0.51 | 13.40 | 20.00 | 2.9 | 2.5 | 2.9 |
| **30** | **1.51** | 0.51 | 0.68 | 13.40 | 20.00 | 3.8 | 3.4 | 3.8 |
| | | | | | | | | |

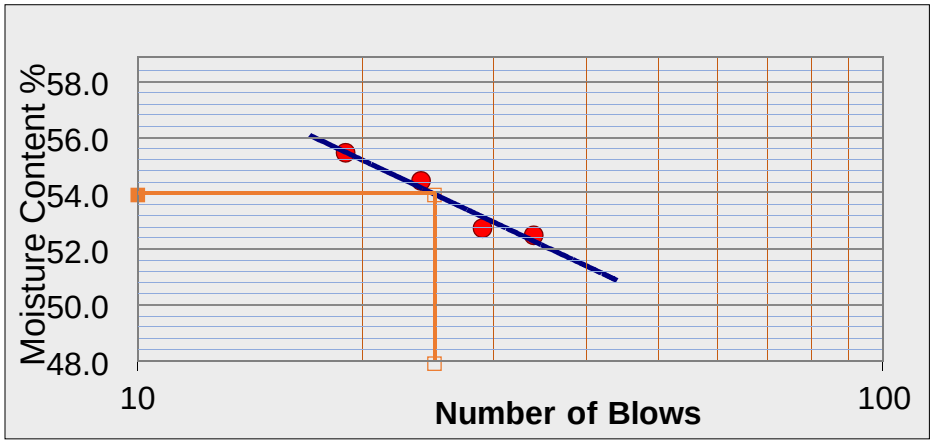



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.5 g/cm3 and OMC = 21%** |
| **From the Density-CBR Curve at 95% MDD (1.425 g/cm3): CBR = 3.31** |

**Sample No.: 17 Location of Sample @ Station 16+000Km, Visual Soil Description: White brown clay soil**

**1 SOIL CONSISTENCY TEST RESULT (TEST METHOD：AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 24 | 19 | | |
| Can No. | 15 | 96 | 18 | 1 | 35 | 91 |
| Weight of Can + Wet Soil (g) | 47.80 | 39.30 | 45.20 | 41.70 | 26.40 | 26.10 |
| Weight of Can + Dry Soil (g) | 39.70 | 31.90 | 36.20 | 33.70 | 24.60 | 24.20 |
| Weight of Can (g) | 24.30 | 17.90 | 19.70 | 19.30 | 19.90 | 19.50 |
| Wt. of Moisture (g) = A | 8.10 | 7.40 | 9.00 | 8.00 | 1.80 | 1.90 |
| Wt. of Dry Soil (g) =B | 15.40 | 14.00 | 16.50 | 14.40 | 4.70 | 4.70 |
| w(%=(A/B)*100 | 52.60 | 52.86 | 54.55 | 55.56 | 38.30 | 40.43 |
| **PI=LL-PL=54-39=15** | | | | AV. PL | 39.4 | |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

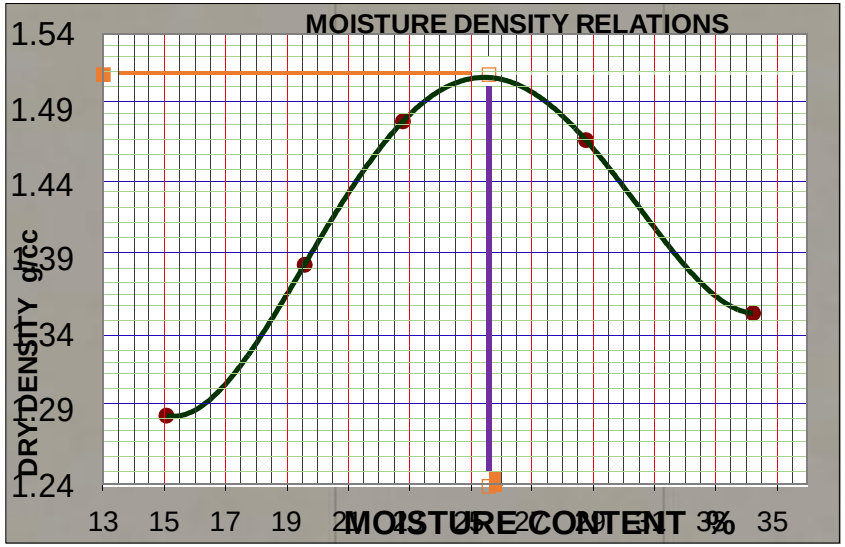
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 26 | 5.20 | 94.80 | | | |
| 0.425 | 89 | 17.80 | 77.00 | | | |
| 0.075 | 141 | 28.20 | 48.80 | | | |
| total | 500 | | | A-7-5(5) | **SM** | **S4** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

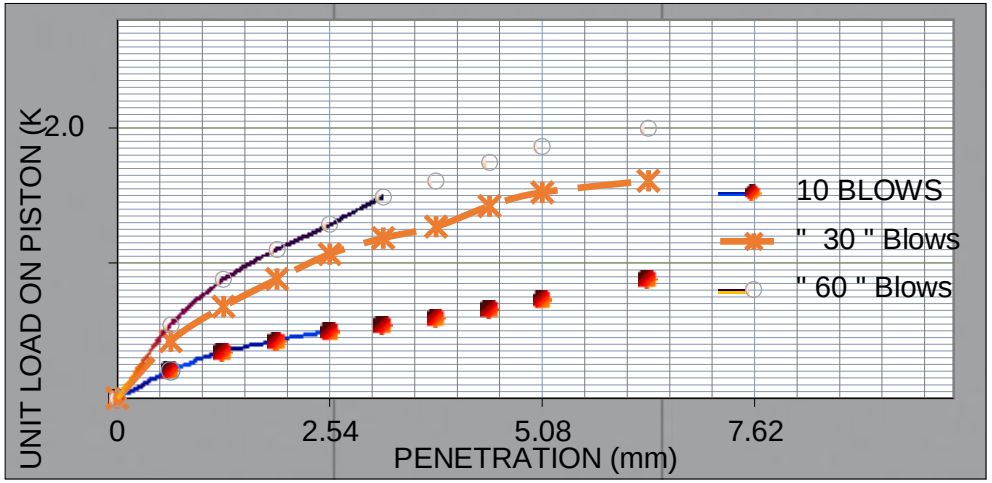
**1.3.1**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | 5 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8100.0 | 8477.0 | 8820.0 | 8974.0 | 8817.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,145 | 3,522 | 3,865 | 4,019 | 3,862 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.48 | 1.66 | 1.82 | 1.89 | 1.82 | **NMC** |
| MOISTURE | Can No. | 47 | N | J | 12 | F | 21 |
| | WET SOIL + Can (g) a | 234.0 | 189.4 | 200.3 | 172.0 | 168.8 | 200.9 |
| | DRY SOIL + Can (g) b | 206.9 | 162.9 | 168.1 | 139.9 | 132.8 | 193.5 |
| | Wt. OF Can (g) c | 27.0 | 27.5 | 26.8 | 28.3 | 27.6 | 27.9 |
| | Wt. OF WATER (g) d = a-b | 27.1 | 26.5 | 32.2 | 32.1 | 36.0 | 7.4 |
| | Wt. OF DRY SOIL (g) e =b-c | 179.9 | 135.4 | 141.3 | 111.6 | 105.2 | 165.6 |
| | **w (%) m= (d/e)*100** | 15.06 | 19.57 | 22.79 | 28.76 | 34.22 | 4.47 |
| **SOIL DRY DENSITY ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.29 | 1.39 | 1.48 | 1.47 | 1.35 | |

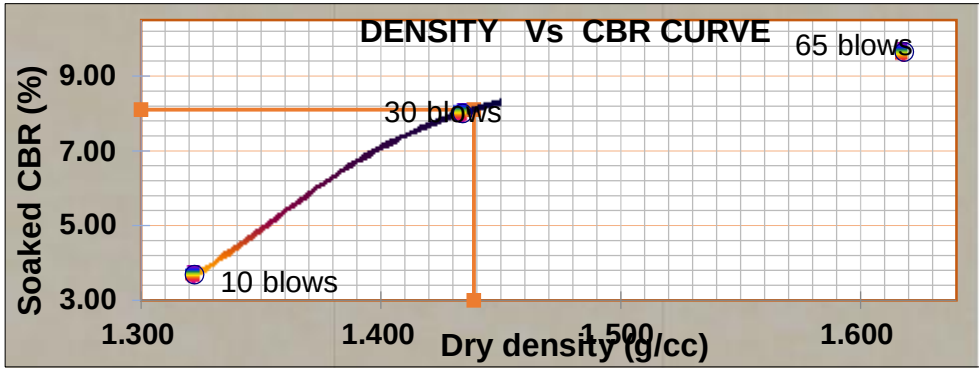



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 12.0 | 0.203 | 25.0 | 0.423 | 32.0 | 0.542 |
| 1.27 | 20.0 | 0.339 | 40.0 | 0.677 | 52.0 | 0.880 |
| 1.91 | 25.0 | 0.423 | 52.0 | 0.880 | 65.0 | 1.100 |
| | | | | | | |
| 3.18 | 32.0 | 0.542 | 70.0 | 1.185 | 88.0 | 1.490 |
| 3.81 | 35.0 | 0.593 | 75.0 | 1.270 | 95.0 | 1.608 |
| | | | | | | |
| 5.08 | 43.0 | 0.728 | 90.0 | 1.524 | 110.0 | 1.862 |
| 6.35 | 52.0 | 0.880 | 95.0 | 1.608 | 118.0 | 1.998 |



| BLOWS | DD (g/Cm3) | LOAD (KN) | | StandardLoad(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.32** | 0.49 | 0.73 | 13.40 | 20.00 | 3.7 | 3.6 | 3.7 |
| **30** | **1.43** | 1.07 | 1.52 | 13.40 | 20.00 | 8.0 | 7.6 | 8.0 |
| **65** | **1.62** | 1.29 | 1.86 | 13.40 | 20.00 | 9.6 | 9.3 | 9.6 |

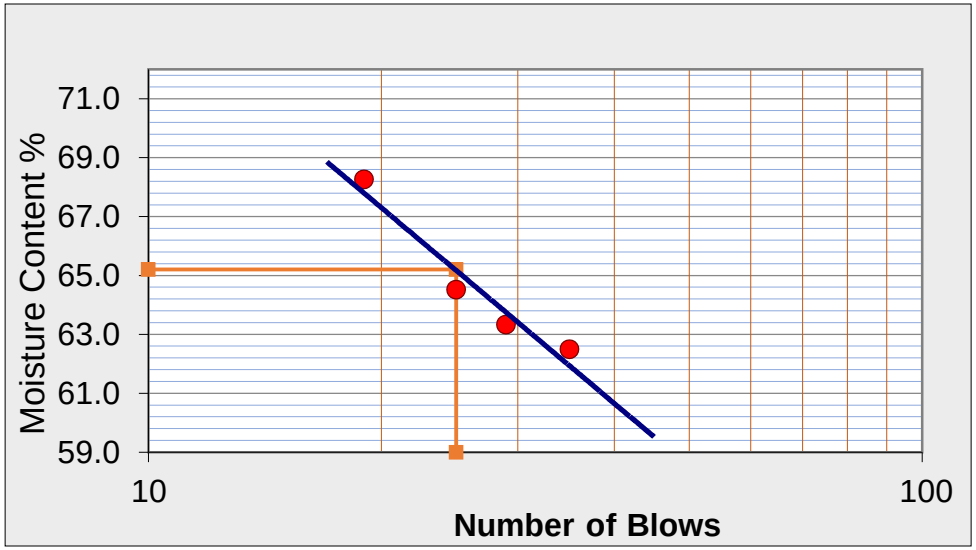



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.52 g/cm3 and OMC = 25.6%** |
| **From the Density-CBR Curve at 95% MDD (1.444 g/cm3): CBR = 8.1** |

## Sample No.: 18 Location of Sample @ Station 17+000Km, Visual Soil Description: brown clay soil

**1. SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 29 | 25 | 19 | | |
| Can No. | 22 | 13 | 94 | 96 | Zt | 98 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 34.70 | 44.10 | 35.10 | 37.00 | 27.50 | 26.00 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 28.70 | 36.50 | 29.10 | 29.90 | 25.40 | 24.00 |
| Weight of Can (g) = ($W_3$) | 19.10 | 24.50 | 19.80 | 19.50 | 21.00 | 19.90 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 6.00 | 7.60 | 6.00 | 7.10 | 2.10 | 2.00 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 9.60 | 12.00 | 9.30 | 10.40 | 4.40 | 4.10 |
| w (%) = (A / B)x 100 | 62.50 | 63.33 | 64.52 | 68.27 | 47.73 | 48.78 |
| PI=LL-PL=65-48=17 | | | | A PL | 48.3 | |



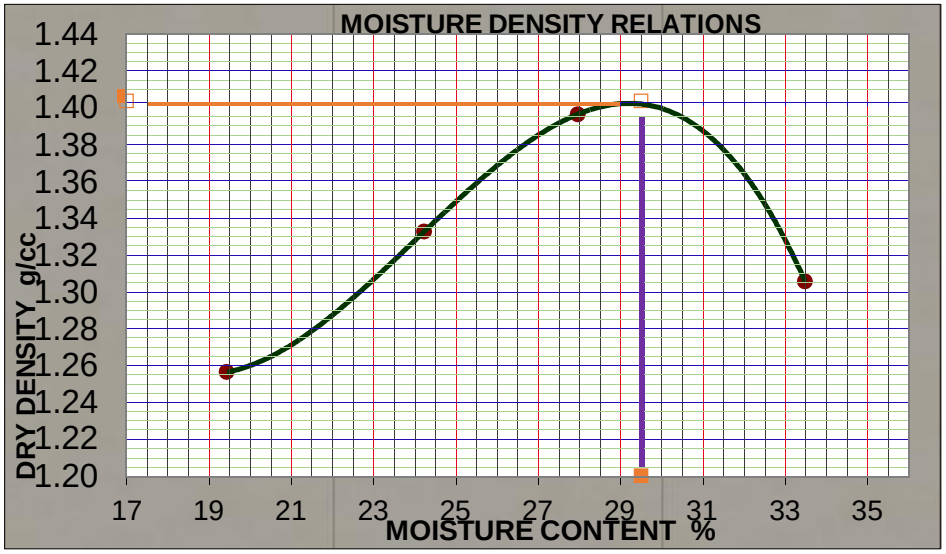

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 7 | 1.40 | 98.60 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 89 | 17.80 | 80.80 | | | |
| 0.075 | 101 | 20.20 | 60.60 | | | |
| total | 500 | | | A-7-5(12) | **MH** | **S2** |

### 1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)

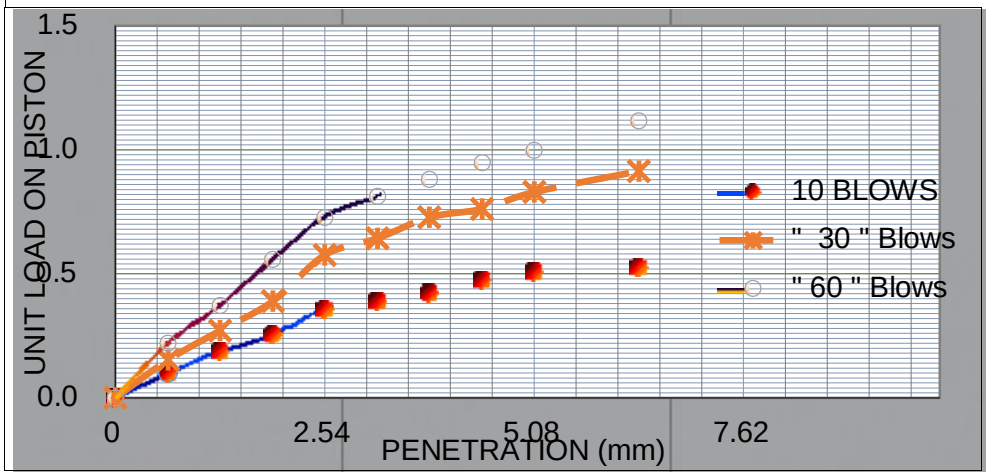
1.3.1

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 2 | 3 | 4 | 5 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8142.0 | 8472.0 | 8751.0 | 8657.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1$- | 3,187 | 3,517 | 3,796 | 3,702 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ | 1.50 | 1.66 | 1.79 | 1.74 | **NMC** |
| MOISTURE | Can No. | 17 | 15 | K | 14 | E |
| | WET SOIL + Can (g) a | 191.7 | 178.4 | 144.7 | 144.7 | 156.9 |
| | DRY SOIL + Can (g) b | 165.1 | 149.2 | 119.2 | 115.6 | 150.5 |
| | Wt. OF Can (g) c | 28.2 | 28.7 | 28.0 | 28.7 | 26.8 |
| | Wt. OF WATER (g) d = a-b | 26.6 | 29.2 | 25.5 | 29.1 | 6.4 |
| | Wt. OF DRY SOIL (g) e =b-c | 136.9 | 120.5 | 91.2 | 86.9 | 123.7 |
| | **w (%) m=** | 19.43 | 24.23 | 27.96 | 33.49 | 5.17 |
| **DRY DENSITY ( g/Cm3 ) $D_d$ = W** | | 1.26 | 1.33 | 1.40 | 1.31 | |

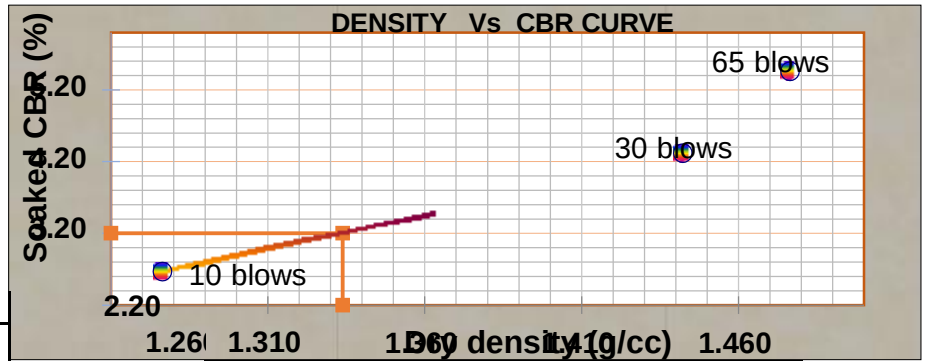



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0.64 | 6.0 | 0.102 | 9.0 | 0.152 | 13.0 | 0.220 |
| 1.27 | 11.0 | 0.186 | 16.0 | 0.271 | 22.0 | 0.372 |
| 1.91 | 15.0 | 0.254 | 23.0 | 0.389 | 33.0 | 0.559 |
| 2.54 | 21.0 | 0.356 | 34.0 | 0.576 | 43.0 | 0.728 |
| 3.18 | 23.0 | 0.389 | 38.0 | 0.643 | 48.0 | 0.813 |
| 3.81 | 25.0 | 0.423 | 43.0 | 0.728 | 52.0 | 0.880 |
| 4.45 | 28.0 | 0.474 | 45.0 | 0.762 | 56.0 | 0.948 |
| 5.08 | 30.0 | 0.508 | 49.0 | 0.830 | 59.0 | 0.999 |
| 6.35 | 31.0 | 0.525 | 54.0 | 0.914 | 66.0 | 1.117 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.28** | 0.36 | 0.51 | 13.40 | 20.00 | 2.7 | 2.5 | 2.7 |
| **30** | **1.44** | 0.58 | 0.83 | 13.40 | 20.00 | 4.3 | 4.1 | 4.3 |
| **65** | **1.48** | 0.73 | 1.00 | 13.40 | 20.00 | 5.5 | 5.0 | 5.5 |




Ring Factor =0.01693kN/Div

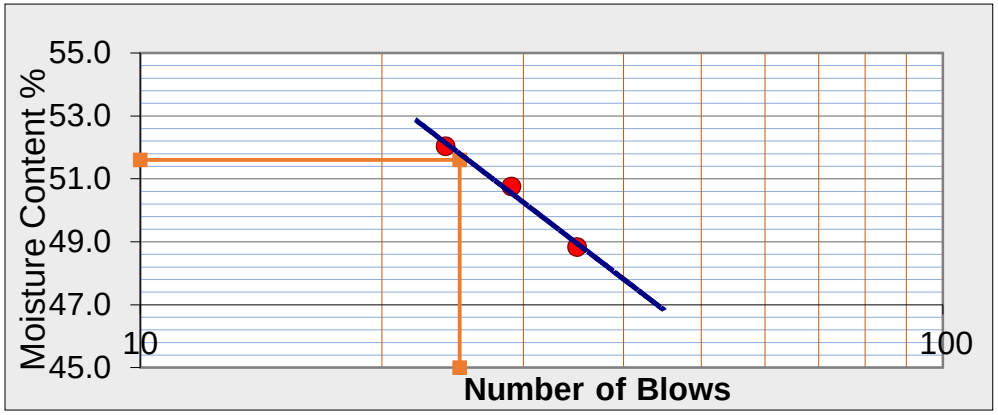
**From the compaction curve: MDD = 1.4 g/cm3 and OMC = 29.5%**

**From the Density-CBR Curve at 95% MDD (1.33 g/cm3): CBR = 3.2**

## Sample No.: 19 Location of Sample @ Station 20+000Km, Visual Soil Description: Reddish brown clay soil

**1. SOIL CONSISTENCY TEST RESULT (TEST : AASHTO T89, T90)**

| | LL | | | PL | |
|---|---|---|---|---|---|
| No. of Blows | 35 | 29 | 24 | | |
| Can No. | 7 | 16 | G | DD | 91 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 34.59 | 33.48 | 33.67 | 23.96 | 23.71 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 30.64 | 28.64 | 28.58 | 22.86 | 22.71 |
| Weight of Can (g) = ($W_3$) | 23.18 | 19.69 | 19.37 | 19.82 | 19.3 |
| Wt. of Moisture (g) = ($W_1 - W_2$) = A | 3.95 | 4.84 | 5.09 | 1.10 | 1.00 |
| Wt. of Dry Soil (g) = ($W_2 - W_3$) = B | 7.47 | 8.95 | 9.21 | 3.04 | 2.78 |
| w (%) = (A / B )x 100 | 52.91 | 54.07 | 55.32 | 36.18 | 35.95 |
| **PI=LL-PL=52-36=19** | | | | 36 | |




1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

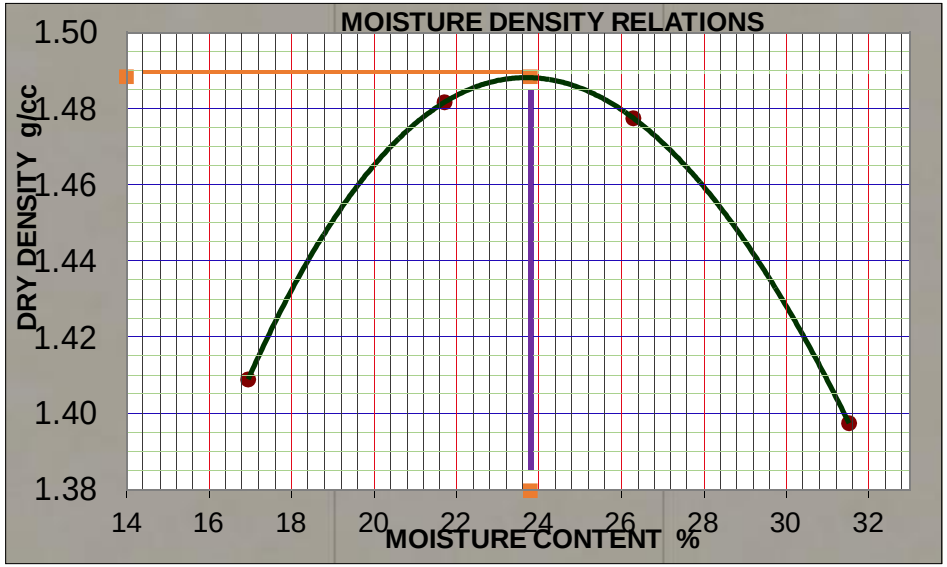
| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 63 | 12.60 | 87.40 | | | |
| 0.425 | 137 | 27.40 | 60.00 | | | |
| 0.075 | 152 | 30.40 | 29.60 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

**1.3.1**

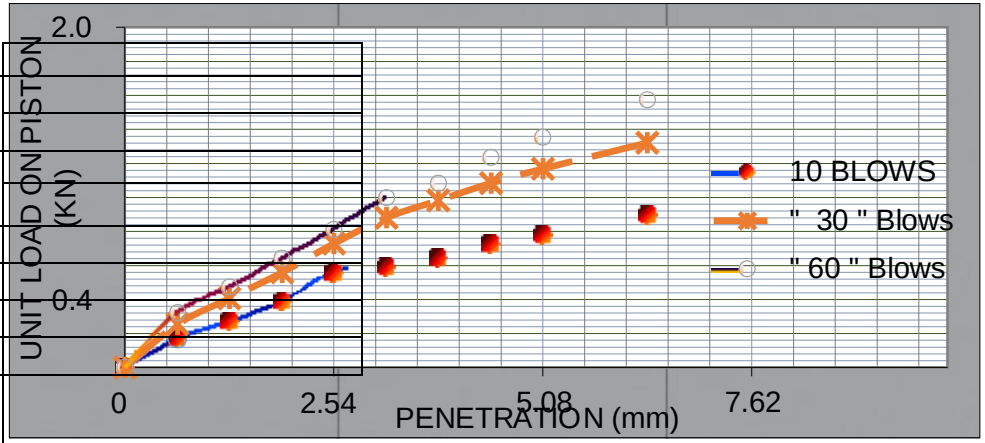
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8456 | 8787 | 8920 | 8860 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1 - W_2$ | 3,501 | 3,832 | 3,965 | 3,905 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.65 | 1.80 | 1.87 | 1.84 | **NMC** |

| | | | | | | |
|---|---|---|---|---|---|---|
| MOISTURE | Can No. | Z | 35 | 1 | S | M |
| | WET SOIL + Can (g) a | 210.4 | 202.4 | 214.6 | 197.5 | 187.6 |
| | DRY SOIL + Can (g) b | 184.0 | 171.3 | 175.6 | 156.7 | 173.8 |
| | Wt. OF Can (g) c | 28.3 | 28.1 | 27.3 | 27.3 | 27.1 |
| | Wt. OF WATER (g) d = a-b | 26.4 | 31.1 | 39.0 | 40.8 | 13.8 |
| | Wt. OF DRY SOIL (g) e =b-c | 155.7 | 143.2 | 148.3 | 129.4 | 146.7 |
| | **w (%) m= (d/e)*100** | 16.96 | 21.72 | 26.30 | 31.53 | 9.41 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.41 | 1.48 | 1.48 | 1.40 | |

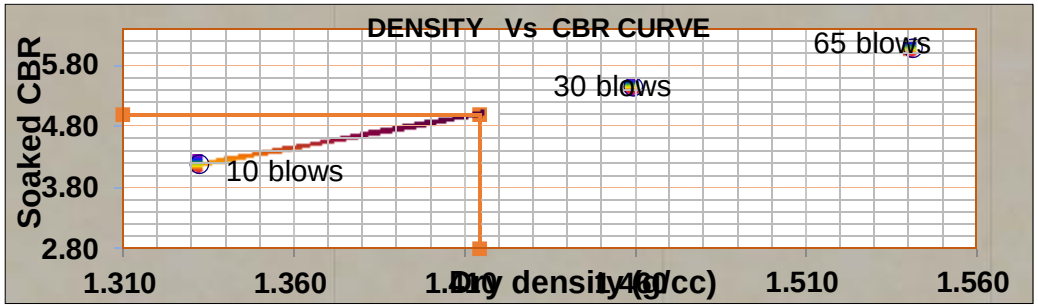


**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 15.0 | 0.254 | 19.0 | 0.322 |
| 1.27 | 16.0 | 0.271 | 24.0 | 0.406 | 28.0 | 0.474 |
| 1.91 | 23.0 | 0.389 | 33.0 | 0.559 | 38.0 | 0.643 |
| 2.54 | 33.0 | 0.559 | 43.0 | 0.728 | 48.0 | 0.813 |
| 3.18 | 35.0 | 0.593 | 52.0 | 0.880 | 59.0 | 0.999 |
| 3.81 | 38.0 | 0.643 | 58.0 | 0.982 | 64.0 | 1.084 |
| 4.45 | 43.0 | 0.728 | 64.0 | 1.084 | 73.0 | 1.236 |
| 5.08 | 46.0 | 0.779 | 69.0 | 1.168 | 80.0 | 1.354 |
| 6.35 | 53.0 | 0.897 | 78.0 | 1.321 | 93.0 | 1.574 |



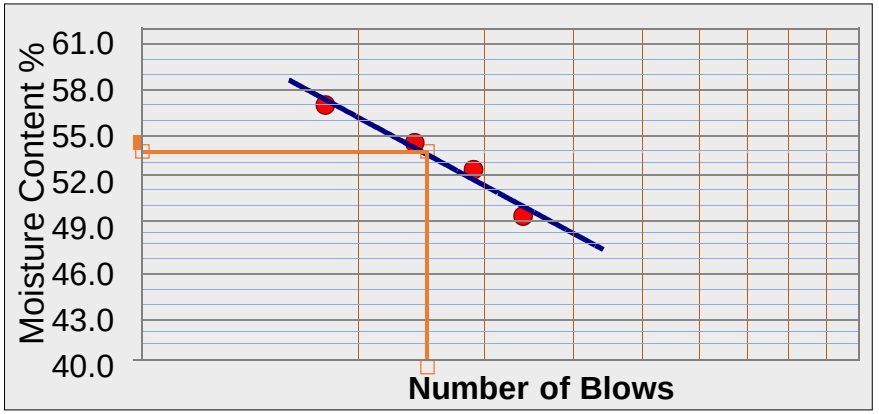

| BLOWS | DD (g/Cm3) | LOAD | | Standard | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.33** | 0.56 | 0.78 | 13.40 | 20.00 | 4.2 | 3.9 | 4.2 |
| **30** | **1.46** | 0.73 | 1.17 | 13.40 | 20.00 | 5.5 | 5.8 | 5.5 |
| **65** | **1.54** | 0.81 | 1.35 | 13.40 | 20.00 | 6.1 | 6.8 | 6.1 |
| Ring Factor =0.01693kN/Div | | | | | | | | |
| **From the compaction curve: MDD = 1.49 g/cm3 and OMC = 23.8%** | | | | | | | | |
| **From the Density-CBR Curve at 95% MDD (1.4155 g/cm3): CBR = 5** | | | | | | | | |




**Sample No.: 20 Location of Sample @ Station 24+000Km, Visual Soil Description: Greyish brown clay soil**

**1.SOIL CONSISTENCY TEST RESULT (TEST METHOD：AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 24 | 18 | | |
| Can No. | 16 | B | 18 | 78 | 97 | 94 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 43.04 | 40.63 | 39.59 | 41.96 | 27.62 | 27.50 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 35.47 | 34.82 | 32.59 | 35.51 | 25.44 | 25.15 |
| Weight. of Can (g) = ($W_3$) | 20.27 | 23.82 | 19.76 | 24.20 | 20.27 | 19.62 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 7.57 | 5.81 | 7.00 | 6.45 | 2.18 | 2.35 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 15.20 | 11.00 | 12.83 | 11.31 | 5.17 | 5.53 |
| w (%) = (A / B )x 100 | 49.80 | 52.82 | 54.56 | 57.03 | 42.17 | 42.50 |
| PI=LL-PL=54-42=12 | | | | AVPL | 42.3 | |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

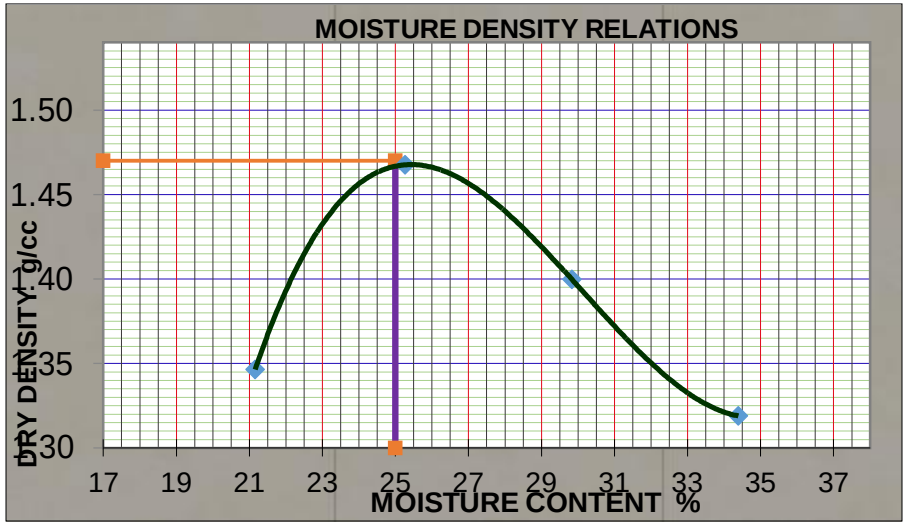
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 60 | 12.00 | 88.00 | | | |
| 0.425 | 139 | 27.80 | 60.20 | | | |
| 0.075 | 200 | 40.00 | 20.20 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

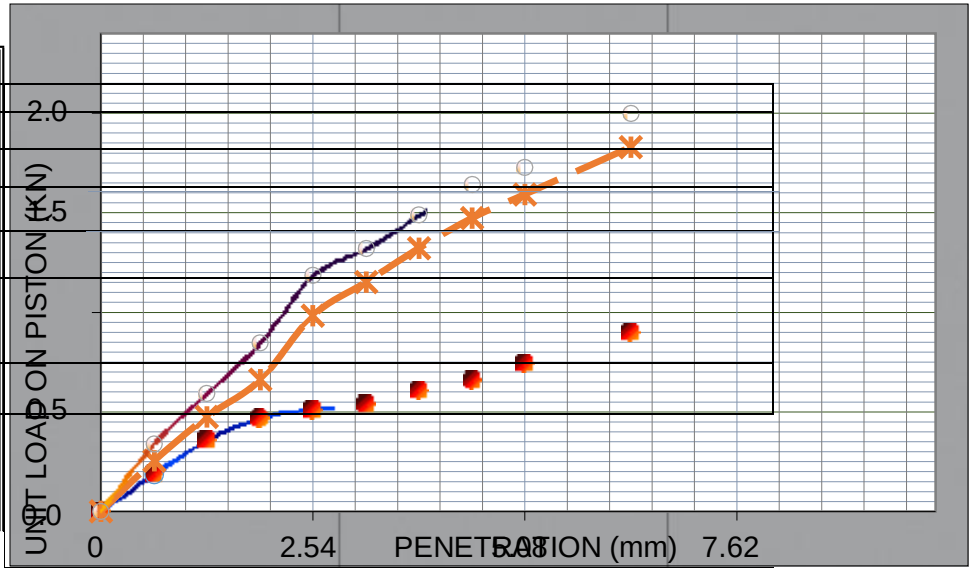
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | **1** | **2** | **3** | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8425.0 | 8865.0 | 8820.0 | 8725.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,465 | 3,905 | 3,860 | 3,765 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ | 1.63 | 1.84 | 1.82 | 1.77 | NMC |
| MOISTURE | Can No. | 11 | M | Z | 26 | 66 |
| | WET SOIL + Can (g) a | 218.5 | 222.0 | 205.3 | 179.6 | 212.4 |
| | DRY SOIL + Can (g) b | 185.3 | 182.7 | 164.4 | 140.6 | 192.8 |
| | Wt. OF Can (g) c | 28.4 | 27.2 | 27.3 | 27.2 | 28.3 |
| | Wt. OF WATER (g) d = a-b | 33.2 | 39.3 | 40.9 | 39.0 | 19.6 |
| | WEIGHT OF DRY SOIL (g) e =b-c | 156.9 | 155.5 | 137.1 | 113.4 | 164.5 |
| | **w (%) m=** | 21.16 | 25.27 | 29.83 | 34.39 | 11.91 |
| **SOIL DRY DENSITY ( g/Cm3 ) $D_d$ = W** | | 1.35 | 1.47 | 1.40 | 1.32 | |



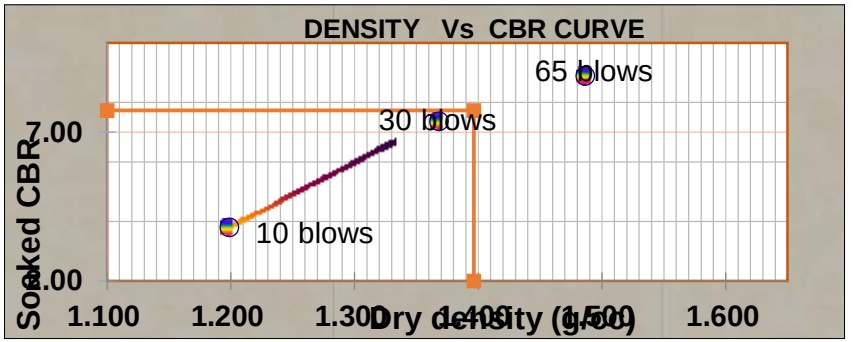

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 11.0 | 0.186 | 15.0 | 0.254 | 20.0 | 0.339 |
| 1.27 | 16.0 | 0.357 | 28.0 | 0.474 | 35.0 | 0.593 |
| 1.91 | 21.0 | 0.469 | 39.0 | 0.660 | 50.0 | 0.847 |
| 2.54 | 30.0 | 0.508 | 58.0 | 0.982 | 70.0 | 1.185 |
| 3.18 | 32.0 | 0.542 | 68.0 | 1.151 | 78.0 | 1.321 |
| 3.81 | 36.0 | 0.609 | 78.0 | 1.321 | 88.0 | 1.490 |
| 4.45 | 39.0 | 0.660 | 87.0 | 1.473 | 97.0 | 1.642 |
| 5.08 | 44.0 | 0.745 | 94.0 | 1.591 | 102.0 | 1.727 |
| 6.35 | 53.0 | 0.897 | 108.0 | 1.828 | 118.0 | 1.998 |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.20** | 0.51 | 0.74 | 13.40 | 20.00 | 3.8 | 3.7 | 3.8 |
| **30** | **1.37** | 0.98 | 1.59 | 13.40 | 20.00 | 7.4 | 8.0 | 7.4 |
| **65** | **1.49** | 1.19 | 1.73 | 13.40 | 20.00 | 8.9 | 8.6 | 8.9 |

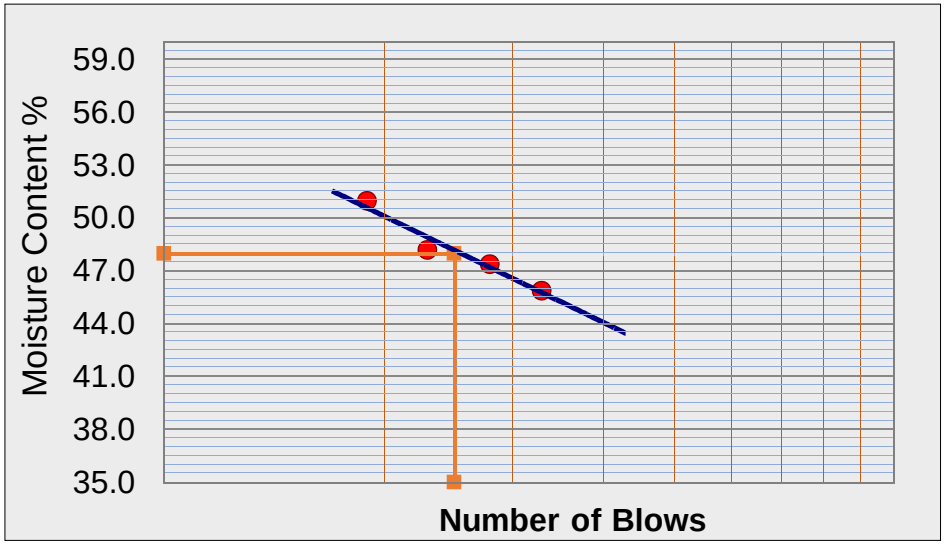



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.47 g/cm3 and OMC = 24.6%** |
| **From the Density-CBR Curve at 95% MDD (1.3965 g/cm3): CBR = 7.73** |

## Sample No.: 21 Location of Sample @ Station 25+000Km, Visual Soil Description: Greyish brown clay soil

**1 SOIL CONSISTENCY TEST RESULT (TEST METHOD：AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 28 | 23 | 19 | | |
| Can No. | 35 | 97 | G1 | 13 | 17 | 94 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 42.20 | 38.00 | 31.10 | 39.50 | 25.76 | 23.08 |
| Weight of Can + Dry Soil(g) = ($W_2$) | 35.20 | 32.30 | 27.20 | 34.40 | 25.10 | 22.30 |
| Weight of Can (g) = ($W_3$) | 19.94 | 20.27 | 19.11 | 24.40 | 23.16 | 19.89 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 7.00 | 5.70 | 3.90 | 5.10 | 0.66 | 0.78 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 15.26 | 12.03 | 8.09 | 10.00 | 1.94 | 2.41 |
| w(%)=(A/B)x100 | 45.87 | 47.37 | 48.20 | 50.98 | 34.04 | 32.32 |
| **PI =LL-PL=48-33=15.** | | | | A PL | 33 | |



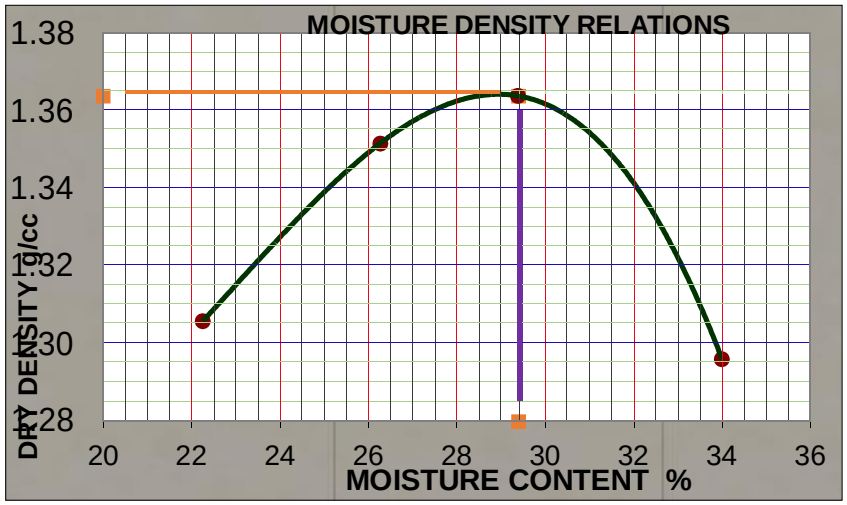

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 39 | 7.80 | 92.20 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 147 | 29.40 | 62.80 | | | |
| 0.075 | 149 | 29.80 | 33.00 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S3** |

### 1.3MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)

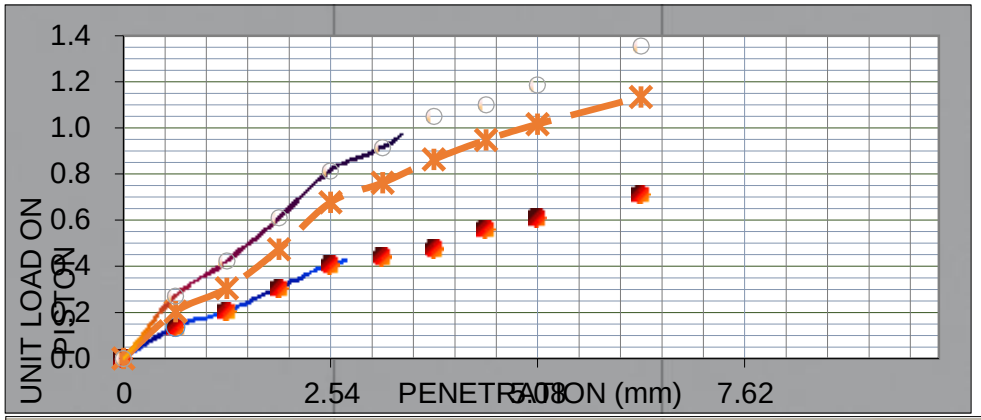
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| Density | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8346.0 | 8580.0 | 8703.0 | 8644.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,391 | 3,625 | 3,748 | 3,689 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.60 | 1.71 | 1.76 | 1.74 | **NMC** |
| MOISTURE | Can No. | 22 | 1 | L | 47 | 13 |
| | WET SOIL + Can (g) a | 182.8 | 162.4 | 206.0 | 207.1 | 184.6 |
| | DRY SOIL + Can (g) b | 154.4 | 134.5 | 124.6 | 161.5 | 167.1 |
| | Wt. OF Can (g) c | 26.8 | 28.3 | 28.3 | 27.4 | 28.2 |
| | Wt. OF WATER (g) d = a-b | 28.4 | 27.9 | 28.3 | 45.6 | 17.5 |
| | Wt. OF DRY SOIL (g) e =b-c | 127.6 | 106.2 | 96.3 | 134.1 | 138.9 |
| | **w (%) m= (d/e)*100** | 22.26 | 26.27 | 29.39 | 34.00 | 12.60 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.31 | 1.35 | 1.36 | 1.30 | |

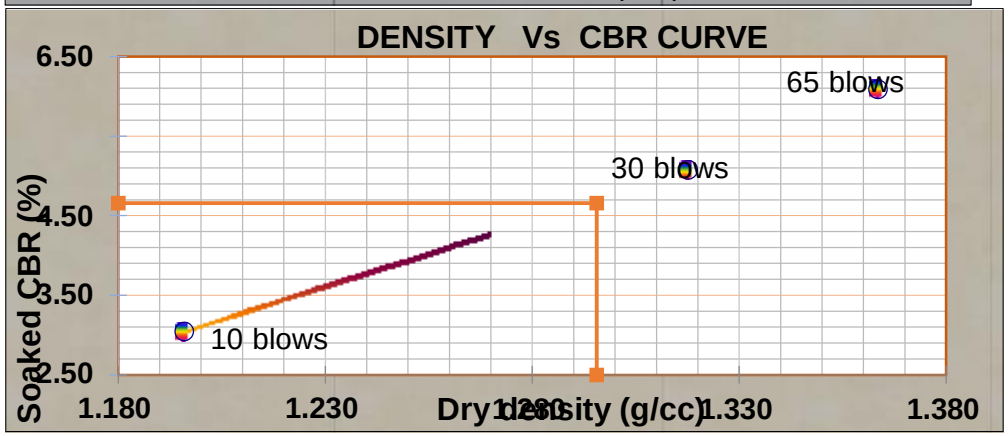



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0.64 | 8.0 | 0.135 | 12.0 | 0.203 | 16.0 | 0.271 |
| 1.27 | 12.0 | 0.203 | 18.0 | 0.305 | 25.0 | 0.423 |
| 1.91 | 18.0 | 0.305 | 28.0 | 0.474 | 36.0 | 0.609 |
| 2.54 | 24.0 | 0.406 | 40.0 | 0.677 | 48.0 | 0.813 |
| 3.18 | 26.0 | 0.440 | 45.0 | 0.762 | 54.0 | 0.914 |
| 3.81 | 28.0 | 0.474 | 51.0 | 0.863 | 62.0 | 1.050 |
| 4.45 | 33.0 | 0.559 | 56.0 | 0.948 | 65.0 | 1.100 |
| 5.08 | 36.0 | 0.609 | 60.0 | 1.016 | 70.0 | 1.185 |
| 6.35 | 42.0 | 0.711 | 67.0 | 1.134 | 80.0 | 1.354 |




| BLOWS | DD | LOAD | | Standard | | CBR (%) | | CBR |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **10** | **1.20** | 0.41 | 0.61 | 13.40 | 20.00 | 3.0 | 3.0 | 3.0 |
| **30** | **1.32** | 0.68 | 1.02 | 13.40 | 20.00 | 5.1 | 5.1 | 5.1 |
| **65** | **1.36** | 0.81 | 1.19 | 13.40 | 20.00 | 6.1 | 5.9 | 6.1 |

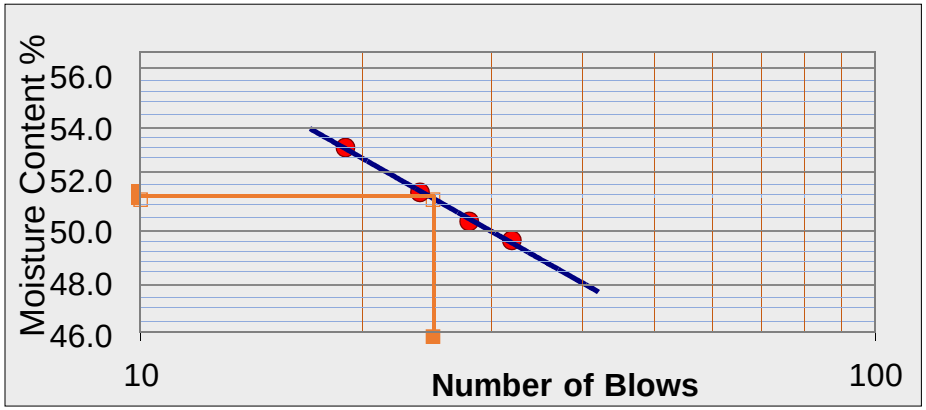



| |
|---|
| **From the compaction curve: MDD = 1.36 g/cm3 and OMC = 29.4%** |
| **From the Density-CBR Curve at 95% MDD (1.292 g/cm3): CBR =4.66** |

## Sample No.: 22 Location of Sample @ Station 25+500Km, Visual Soil Description: Reddish brown clay soil

### 1. SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 32 | 28 | 24 | 19 | | |
| Can No. | 12 | 8 | 17 | 7 | 4 | 5 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 59.10 | 58.36 | 59.26 | 62.46 | 31.80 | 31.76 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 47.25 | 46.60 | 46.94 | 48.88 | 29.57 | 29.53 |
| Weight of Container (g) = ($W_3$) | 23.41 | 23.29 | 23.05 | 23.40 | 23.40 | 23.41 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 11.85 | 11.76 | 12.32 | 13.59 | 2.23 | 2.23 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 23.84 | 23.31 | 23.89 | 25.48 | 6.17 | 6.12 |
| w (%) = (A / B )x 100 | 49.73 | 50.46 | 51.60 | 53.33 | 36.14 | 36.35 |
| **PI=LL-PL=51-36=15** | | | | A PL | 36.2 | |



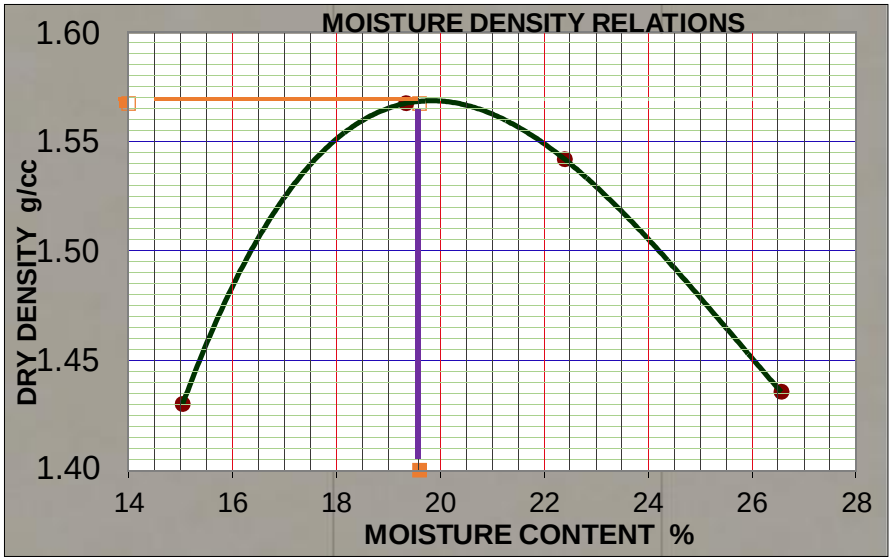

### 1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 58.7 | 11.74 | 88.26 | | | |
| 0.425 | 103.2 | 20.64 | 67.62 | | | |
| 0.075 | 197.1 | 39.42 | 28.20 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S4** |

### 1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)

1.3.1

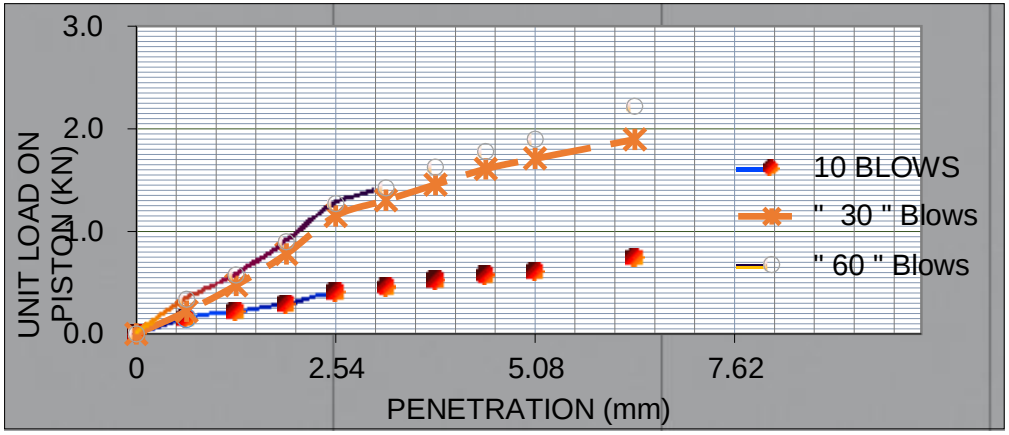
| | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| DENSITY | Wt. OF SOIL + MOULD (g) $W_1$ | 8450.0 | 8930.0 | 8965.0 | 8815.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1$- | 3,495 | 3,975 | 4,010 | 3,860 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ = | 1.65 | 1.87 | 1.89 | 1.82 | **NMC** |
| MOISTURE | Can No. | **D** | **A8** | **A3** | **H** | **A** |
| | WET SOIL + Can (g) a | 247.6 | 243.8 | 239.6 | 242.5 | 240.8 |
| | DRY SOIL + Can (g) b | 218.8 | 208.7 | 200.7 | 196.6 | 228.9 |
| | Wt. OF Can (g) c | 27.3 | 27.2 | 27.0 | 23.8 | 28.3 |
| | Wt. OF WATER (g) d = a-b | 28.8 | 35.1 | 38.9 | 45.9 | 11.9 |
| | Wt. OF DRY SOIL (g) e =b-c | 191.5 | 181.5 | 173.7 | 172.8 | 200.6 |
| | **w (%) m=** | 15.04 | 19.34 | 22.39 | 26.56 | 5.93 |
| **Soil DRY DENSITY ( g/Cm3 ) $D_d$ =** | | 1.43 | 1.57 | 1.54 | 1.44 | |



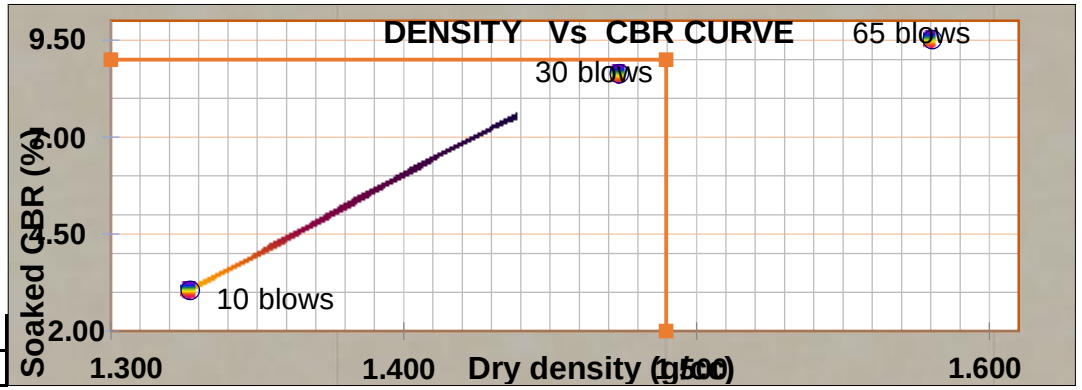
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0.64 | 9.0 | 0.152 | 13.0 | 0.220 | 20.0 | 0.339 |
| 1.27 | 13.0 | 0.220 | 28.0 | 0.474 | 34.0 | 0.576 |
| 1.91 | 17.0 | 0.288 | 46.0 | 0.779 | 53.0 | 0.897 |
| 2.54 | 24.0 | 0.406 | 68.0 | 1.151 | 75.0 | 1.270 |
| 3.18 | 27.0 | 0.457 | 77.0 | 1.304 | 84.0 | 1.422 |
| 3.81 | 31.0 | 0.525 | 86.0 | 1.456 | 96.0 | 1.625 |
| 4.45 | 34.0 | 0.576 | 95.0 | 1.608 | 105.0 | 1.778 |
| 5.08 | 36.0 | 0.609 | 101.0 | 1.710 | 112.0 | 1.896 |
| 6.35 | 44.0 | 0.745 | 112.0 | 1.896 | 131.0 | 2.218 |




| BLOWS | DD (g/Cm3) | LOAD | | Standard | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.33** | 0.41 | 0.61 | 13.40 | 20.00 | 3.0 | 3.0 | 3.0 |
| **30** | **1.47** | 1.15 | 1.71 | 13.40 | 20.00 | 8.6 | 8.5 | 8.6 |
| **65** | **1.58** | 1.27 | 1.90 | 13.40 | 20.00 | 9.5 | 9.5 | 9.5 |

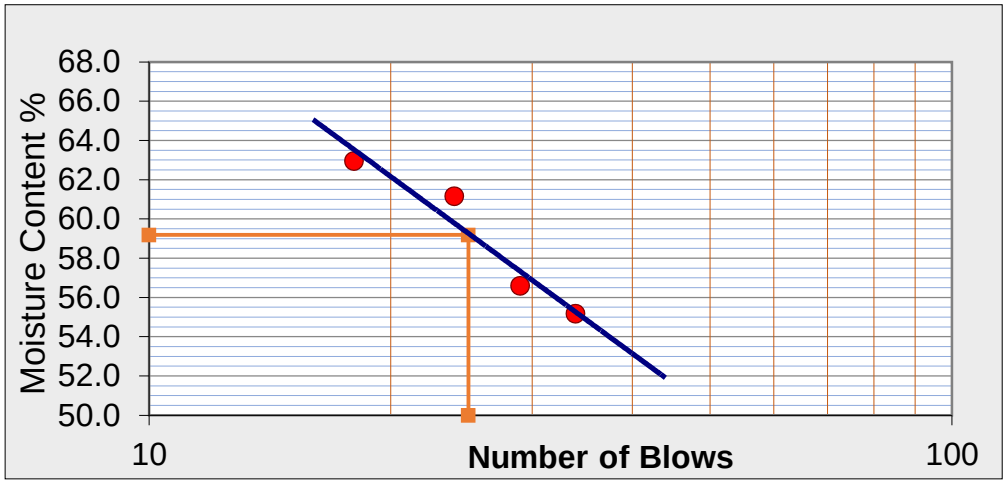



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.57 g/cm3 and OMC = 19.6%** |
| **From the Density-CBR Curve at 95% MDD (1.4915 g/cm3): CBR =9** |

**Sample No.: 23 Location of Sample @ Station 26+000Km, Visual Soil Description: Red brown clay soil**

**1. SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 24 | 18 | | |
| Can No. | 2 | 3 | 13 | 17 | 92 | 96 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 52.49 | 38.80 | 44.16 | 42.79 | 30.34 | 23.92 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 40.85 | 31.75 | 36.66 | 35.21 | 28.71 | 22.31 |
| Weight of Can (g) = | 19.75 | 19.31 | 24.40 | 23.17 | 24.37 | 17.96 |
| Wt. of Moisture (g) = A | 11.64 | 7.04 | 7.50 | 7.58 | 1.63 | 1.61 |
| Wt. of Dry Soil (g) = B | 21.10 | 12.44 | 12.26 | 12.04 | 4.34 | 4.35 |
| w (%) = (A/ B )x 100 | 55.17 | 56.61 | 61.17 | 62.96 | 37.57 | 37.10 |
| **PI=LL-PL=59-37-22** | | | | AVPL | 37.3 | |



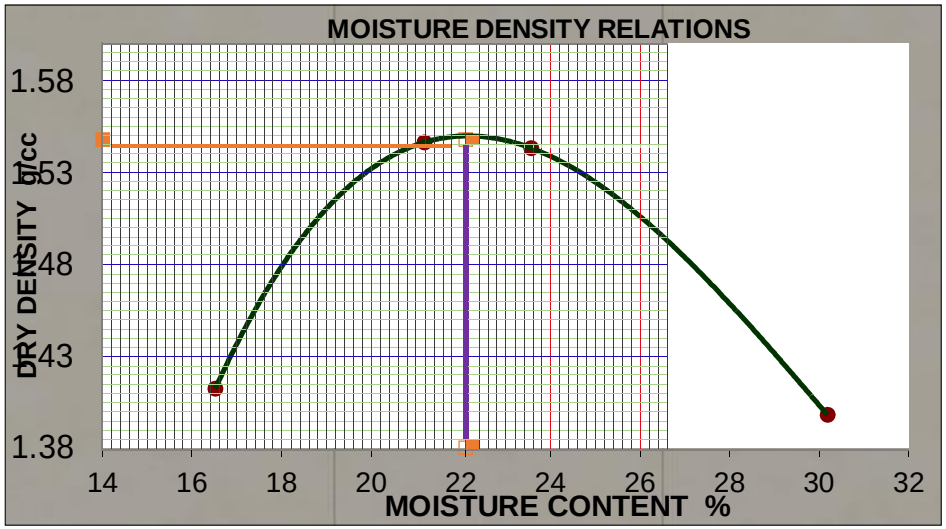
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 21 | 4.20 | 95.80 | | | |
| 0.425 | 45 | 9.00 | 86.80 | | | |
| 0.075 | 156 | 31.20 | 55.60 | | | |
| total | 500 | | | A-7-5 (11) | **MH** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL ( T-180 METHOD D)**

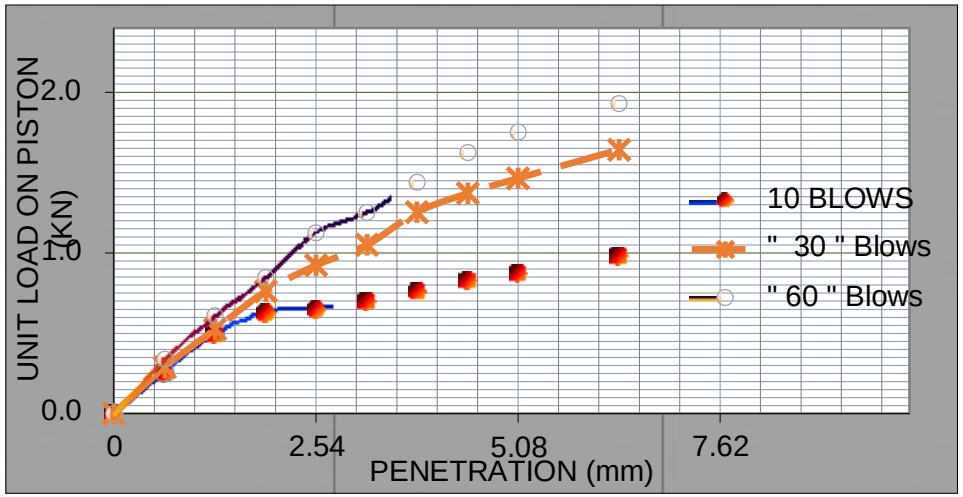
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8450 | 8935 | 9005 | 8820 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,495 | 3,980 | 4,050 | 3,865 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d$ = | 1.65 | 1.87 | 1.91 | 1.82 | NMC |
| MOISTURE | Can No. | **U** | **N** | **R** | **Y** | **E** |
| | WET SOIL + Can (g) a | 240.7 | 241.6 | 240.3 | 233.7 | 204.7 |
| | DRY SOIL + Can (g) b | 210.6 | 204.2 | 199.8 | 185.6 | 190.7 |
| | Wt. OF Can (g) c | 28.3 | 27.6 | 27.9 | 26.2 | 28.0 |
| | Wt. OF WATER (g) d = a-b | 30.1 | 37.4 | 40.5 | 48.1 | 14.0 |
| | Wt. OF DRY SOIL (g) e =b-c | 182.3 | 176.6 | 171.9 | 159.4 | 162.7 |
| | **w (%) m= (d/e)*100** | 16.51 | 21.18 | 23.56 | 30.18 | 8.60 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.41 | 1.55 | 1.54 | 1.40 | |



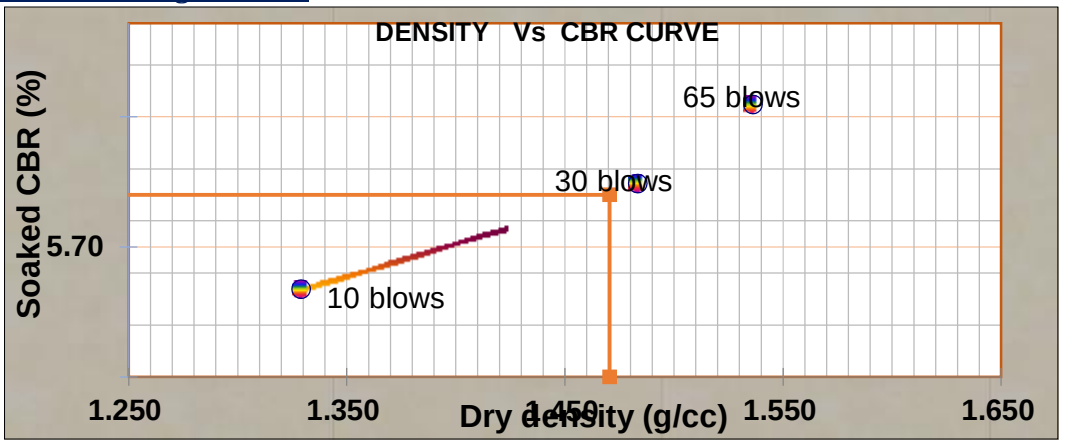

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 15.0 | 0.254 | 17.0 | 0.288 | 20.0 | 0.339 |
| 1.27 | 22.0 | 0.491 | 31.0 | 0.525 | 36.0 | 0.609 |
| 1.91 | 28.0 | 0.625 | 45.0 | 0.762 | 50.0 | 0.847 |
| 2.54 | 39 | 0.652 | 55 | 0.923 | 67 | 1.126 |
| 3.18 | 41.0 | 0.694 | 62.0 | 1.050 | 74.0 | 1.253 |
| 3.81 | 45.0 | 0.762 | 74.0 | 1.253 | 85.0 | 1.439 |
| 4.45 | 49.0 | 0.830 | 81.0 | 1.371 | 96.0 | 1.625 |
| 5.08 | 52 | 0.872 | 87 | 1.464 | 104 | 1.752 |
| 6.35 | 58.0 | 0.982 | 97.0 | 1.642 | 114.0 | 1.930 |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.33** | 0.65 | 0.88 | 13.40 | 20.00 | 4.9 | 4.4 | 4.9 |
| **30** | **1.48** | 0.93 | 1.48 | 13.40 | 20.00 | 7.0 | 7.4 | 7.0 |
| **65** | **1.54** | 1.13 | 1.77 | 13.40 | 20.00 | 8.5 | 8.8 | 8.5 |

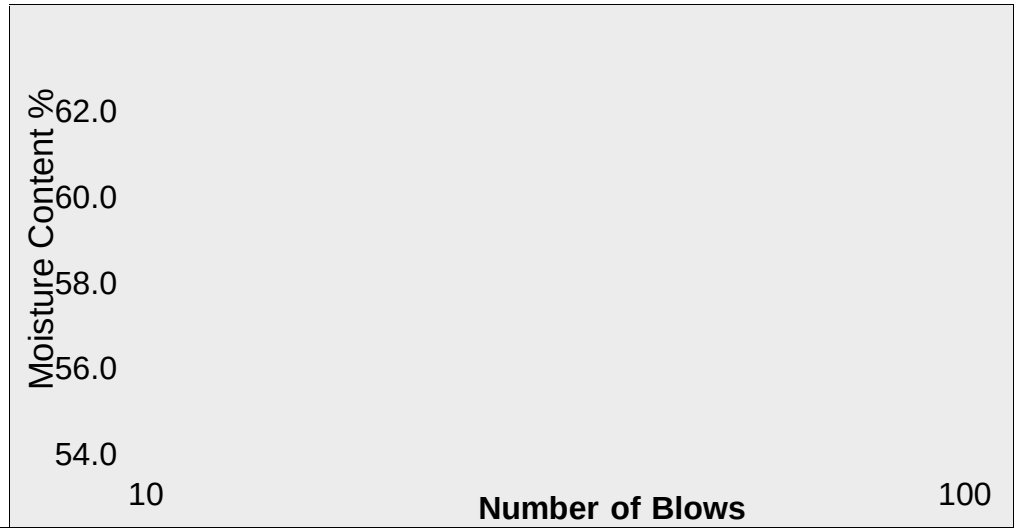



| |
|---|
| **From the compaction curve: MDD = 1.55 g/cm3 and OMC = 22.1%** |
| **From the Density-CBR Curve at 95% MDD (1.4725 g/cm3): CBR =6.7** |

**Sample No.: 24 Location of Sample @ Station 29+000Km, Visual Soil Description: Dark brown silty soil**

**1. SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 23 | 19 | | |
| Can No. | G1 | 92 | 95 | A | 98 | 15 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 42.48 | 52.83 | 47.87 | 53.27 | 26.57 | 32.16 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 33.94 | 42.40 | 36.75 | 40.57 | 24.58 | 29.81 |
| Weight of Can (g)=($W_3$) | 19.06 | 24.38 | 18.20 | 19.79 | 19.97 | 24.35 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 8.54 | 10.43 | 11.12 | 12.71 | 1.99 | 2.35 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 14.88 | 18.02 | 18.55 | 20.77 | 4.61 | 5.47 |
| w (%) = (A / B )x 100 | 57.38 | 57.91 | 59.97 | 61.17 | 43.10 | 42.94 |
| **PI=LL-PL=59-43=16** | | | | AV.PL | 43 | |



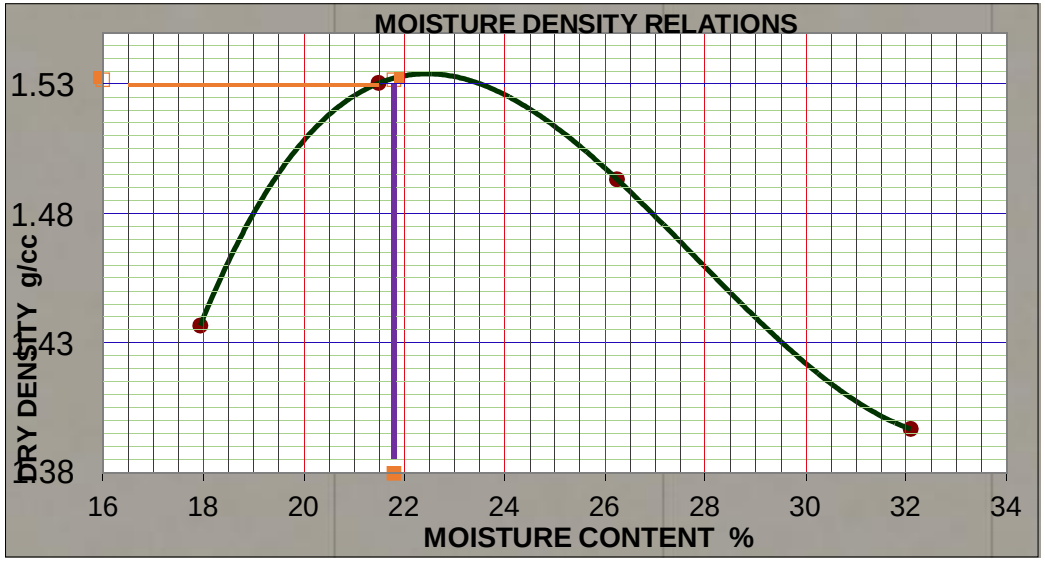

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 45 | 9.00 | 91.00 | | | |
| 0.425 | 125 | 25.00 | 66.00 | | | |
| 0.075 | 210 | 42.00 | 24.00 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

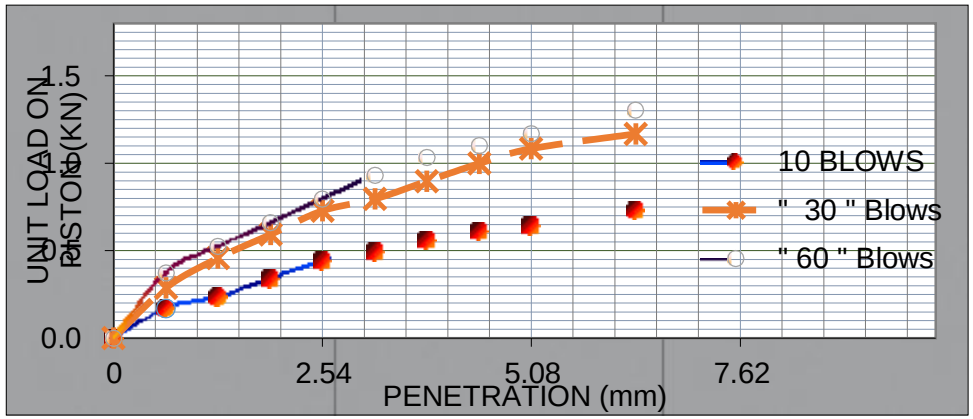
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8560 | 8910 | 8965 | 8880 | |
| | Wt. OF MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,600 | 3,950 | 4,005 | 3,920 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) | 1.69 | 1.86 | 1.89 | 1.85 | **NMC** |
| MOISTURE | Can No. | C | T | J | I | G |
| | WET SOIL + Can (g) a | 217.5 | 216.5 | 214.5 | 206.6 | 209.5 |
| | DRY SOIL + Can (g) b | 188.6 | 183.1 | 175.5 | 163.3 | 196.8 |
| | Wt. OF Can (g) c | 27.5 | 27.7 | 26.9 | 28.4 | 28.4 |
| | Wt. OF WATER (g) d = a-b | 28.9 | 33.4 | 39.0 | 43.3 | 12.7 |
| | Wt. OF DRY SOIL (g) e =b- | 161.1 | 155.4 | 148.6 | 134.9 | 168.4 |
| | **w (%) m=** | 17.94 | 21.49 | 26.24 | 32.10 | 7.54 |
| **SOIL DRY DENSIT ( g/Cm3 ) $D_d$** | | 1.44 | 1.53 | 1.49 | 1.40 | |

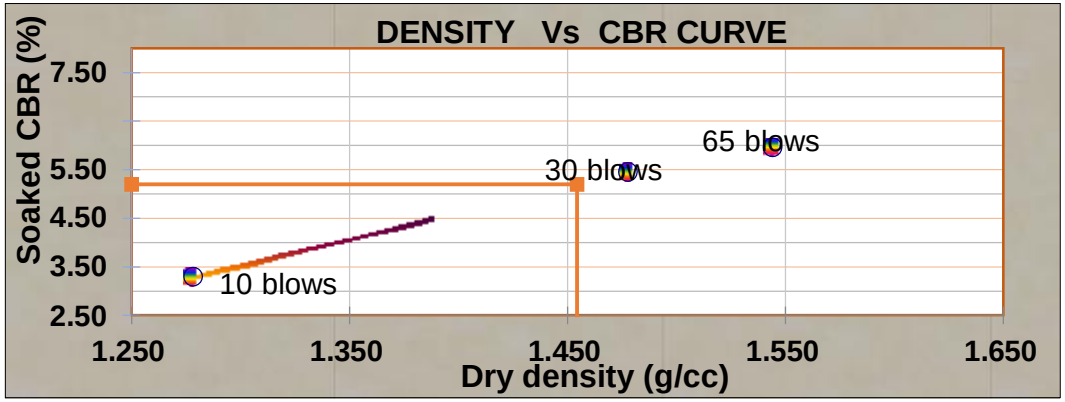



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0.64 | 10.0 | 0.169 | 17.0 | 0.288 | 22.0 | 0.372 |
| 1.27 | 14.0 | 0.237 | 27.0 | 0.457 | 31.0 | 0.525 |
| 1.91 | 20.0 | 0.339 | 35.0 | 0.593 | 39.0 | 0.660 |
| 2.54 | 26.0 | 0.440 | 43.0 | 0.728 | 47.0 | 0.796 |
| 3.18 | 29.0 | 0.491 | 47.0 | 0.796 | 55.0 | 0.931 |
| 3.81 | 33.0 | 0.559 | 53.0 | 0.897 | 61.0 | 1.033 |
| 4.45 | 36.0 | 0.609 | 59.0 | 0.999 | 65.0 | 1.100 |
| 5.08 | 38.0 | 0.643 | 64.0 | 1.084 | 69.0 | 1.168 |
| 6.35 | 43.0 | 0.728 | 69.0 | 1.168 | 77.0 | 1.304 |




| BLOWS | DD | LOAD | | Standard | | CBR (%) | | CBR |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **10** | **1.28** | 0.44 | 0.64 | 13.40 | 20.00 | 3.3 | 3.2 | 3.3 |
| **30** | **1.48** | 0.73 | 1.08 | 13.40 | 20.00 | 5.5 | 5.4 | 5.5 |
| | | | | | | | | |

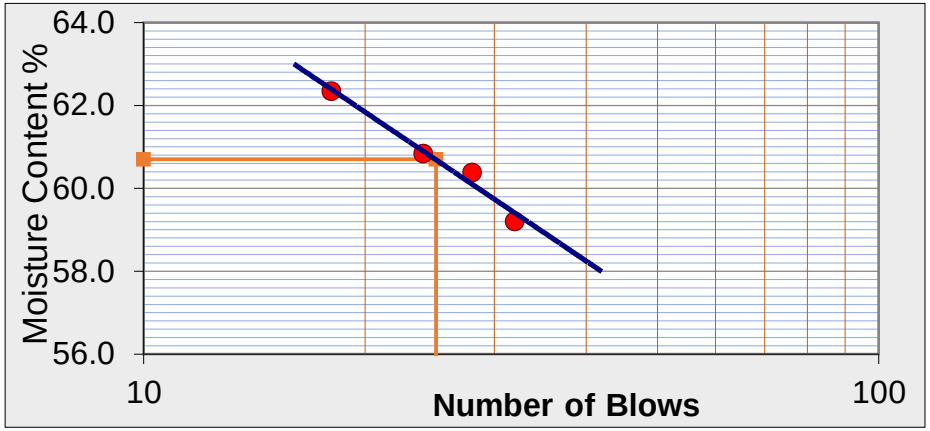



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.53 g/cm3 and OMC = 21.8%** |
| **From the Density-CBR Curve at 95% MDD (1.4535g/cm3): CBR =5.2** |

## Sample No.: 25 Location of Sample @ Station 29+500Km, Visual Soil Description: Dark brown clay soil

**1.SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 32 | 28 | 24 | 18 | | |
| Can No. | B | 18 | 94 | 35 | 13 | 22 |
| Weight of Can + Wet Soil (g) =$W_1$ | 40.75 | 40.61 | 40.97 | 40.22 | 28.85 | 23.66 |
| Weight of Can + Dry Soil g | 33.13 | 32.75 | 32.97 | 32.42 | 27.63 | 22.46 |
| Weight of Can (g) = ($W_3$) | 20.25 | 19.73 | 19.83 | 19.90 | 24.41 | 19.13 |
| Wt. of Moisture (g) = A | 7.63 | 7.86 | 8.00 | 7.80 | 1.22 | 1.21 |
| Wt. of Dry Soil (g) = B | 12.88 | 13.02 | 13.14 | 12.52 | 3.22 | 3.32 |
| w (%) = (A / B )x 100 | 59.21 | 60.39 | 60.84 | 62.35 | 37.88 | 36.26 |
| **PI=LL-PL=61-37=24** | | | | A PL | 37.0 | |



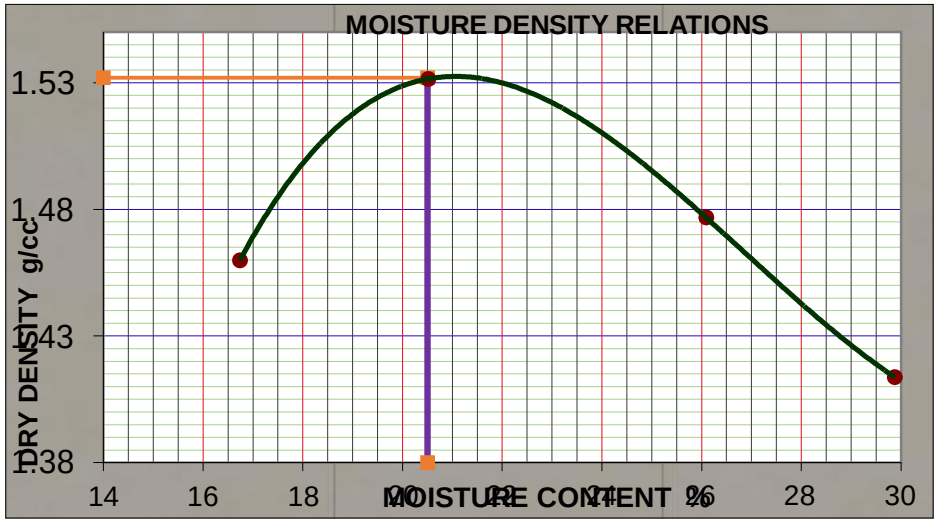

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 35 | 7.00 | 93.00 | | | |
| 0.425 | 140 | 28.00 | 65.00 | | | |
| 0.075 | 220 | 44.00 | 21.00 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

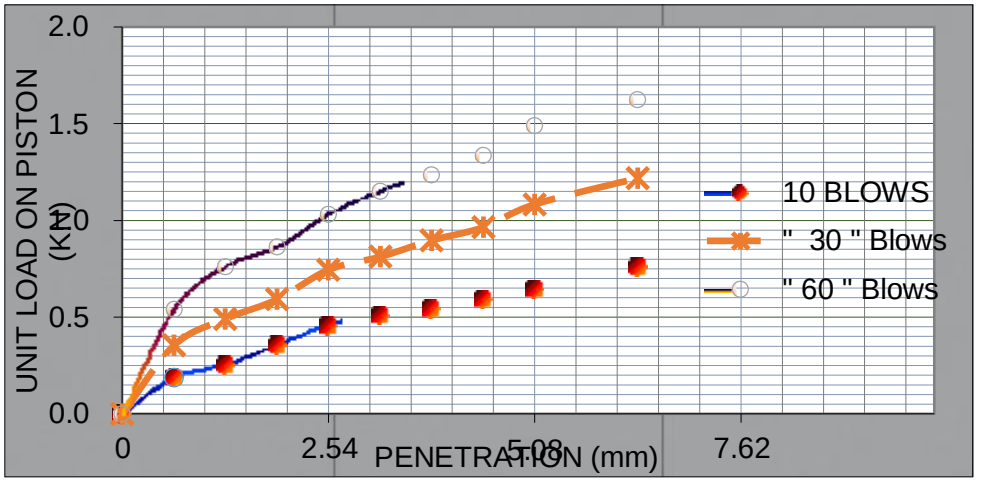
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8580.0 | 8880.0 | 8915.0 | 8860.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,620 | 3,920 | 3,955 | 3,900 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d = W_3/V$ | 1.70 | 1.85 | 1.86 | 1.84 | **NMC** |
| MOISTURE | Can No. | Z | N | B | 35 | 66 |
| | WET SOIL + Can (g) a | 235.0 | 235.0 | 218.6 | 219.1 | 169.0 |
| | DRY SOIL + Can (g) b | 205.2 | 199.7 | 179.1 | 174.5 | 156.3 |
| | Wt. OF Can (g) c | 27.2 | 27.6 | 27.7 | 25.2 | 27.2 |
| | Wt. OF WATER (g) d = a-b | 29.8 | 35.3 | 39.5 | 44.6 | 12.7 |
| | Wt. OF DRY SOIL (g) e =b-c | 178.0 | 172.1 | 151.4 | 149.3 | 129.1 |
| | **w (%) m= (d/e)*100** | 16.74 | 20.51 | 26.09 | 29.87 | 9.84 |
| **SOIL DRY DENSITY ( g/Cm3 ) $D_d = W_d/(100+m)$** | | 1.46 | 1.53 | 1.48 | 1.41 | |

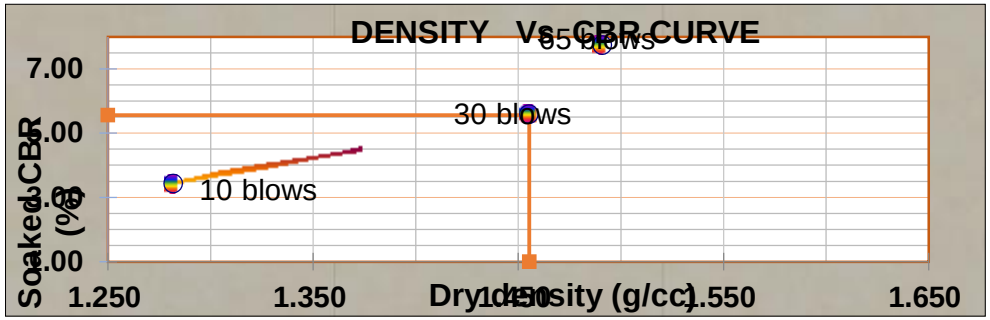


PENETRATION TEST DATA

| PENETRATION (mm) | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 11.0 | 0.186 | 21.0 | 0.356 | 32.0 | 0.542 |
| 1.27 | 15.0 | 0.254 | 29.0 | 0.491 | 45.0 | 0.762 |
| 1.91 | 21.0 | 0.356 | 35.0 | 0.593 | 51.0 | 0.863 |
| 2.54 | 27.0 | 0.457 | 44.0 | 0.745 | 61.0 | 1.033 |
| 3.18 | 30.0 | 0.508 | 48.0 | 0.813 | 68.0 | 1.151 |
| 3.81 | 32.0 | 0.542 | 53.0 | 0.897 | 73.0 | 1.236 |
| 4.45 | 35.0 | 0.593 | 57.0 | 0.965 | 79.0 | 1.337 |
| 5.08 | 38.0 | 0.643 | 64.0 | 1.084 | 88.0 | 1.490 |
| 6.35 | 45.0 | 0.762 | 72.0 | 1.219 | 96.0 | 1.625 |




| BLOWS | DD (g/Cm3) | LOAD | | Standard | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| 10 | 1.28 | 0.46 | 0.64 | 13.40 | 20.00 | 3.4 | 3.2 | 3.4 |
| 30 | 1.46 | 0.74 | 1.08 | 13.40 | 20.00 | 5.6 | 5.4 | 5.6 |
| 65 | 1.49 | 1.03 | 1.49 | 13.40 | 20.00 | 7.7 | 7.4 | 7.7 |

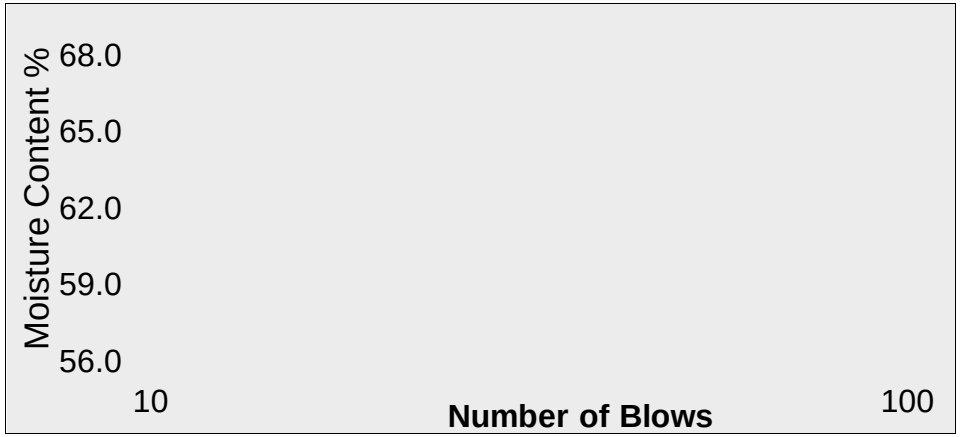



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.53 g/cm3 and OMC = 20.5%** |
| **From the Density-CBR Curve at 95% MDD (1.4535g/cm3): CBR =5.56** |

**Sample No.: 26, Location of Sample @ Station 30+000KM: Visual Soil Description: Dark brown clay soil**

SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 24 | 19 | | |
| Can No. | 98 | 18 | 35 | A | DV | 22 |
| Weight of Can + Wet Soil (g) = | 39.60 | 36.80 | 35.00 | 31.90 | 20.60 | 22.10 |
| Weight of Can + Dry Soil (g) = | 32.20 | 30.30 | 29.10 | 27.10 | 19.80 | 21.20 |
| Weight of Can (g) = ($W_3$) | 19.90 | 19.70 | 19.90 | 19.80 | 17.90 | 19.10 |
| Wt. of Moisture (g) = A | 7.40 | 6.50 | 5.90 | 4.80 | 0.80 | 0.90 |
| Wt. of Dry Soil (g) = B | 12.30 | 10.60 | 9.20 | 7.30 | 1.90 | 2.10 |
| w (%) = (A / B )x 100 | 60.16 | 61.32 | 64.13 | 65.75 | 42.11 | 42.86 |
| PI=LL-PL=63-42=21 | | | | APL. | 42.5 | |



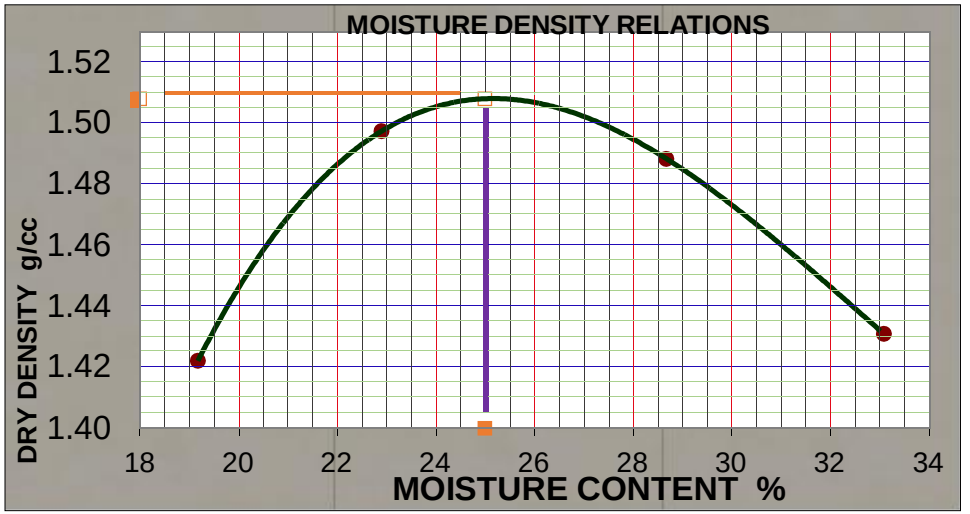
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 32 | 6.40 | 93.60 | | | |
| 0.425 | 175 | 35.00 | 58.60 | | | |
| 0.075 | 165 | 33.00 | 25.60 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S3** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

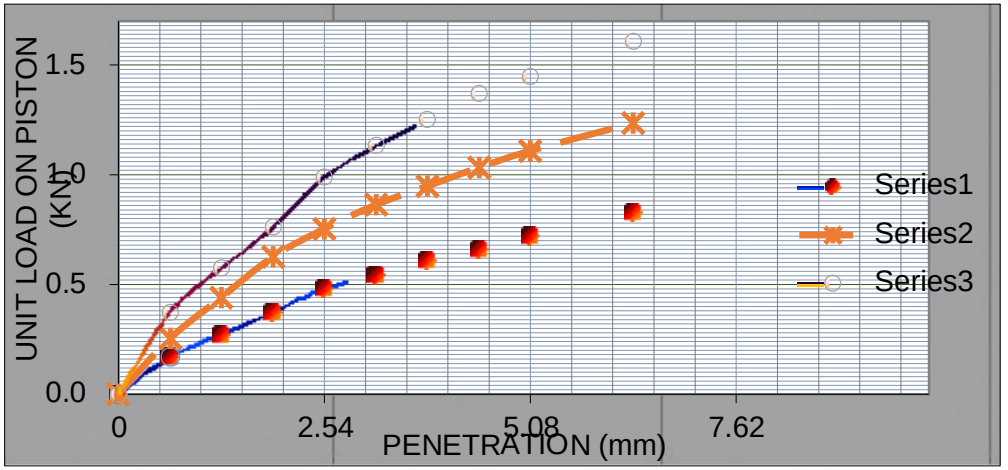
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 1 | 2 | 3 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8555.0 | 8864.0 | 9023.0 | 9000.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,600 | 3,909 | 4,068 | 4,045 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) | 1.69 | 1.84 | 1.92 | 1.90 | **NMC** |
| MOISTURE | Can No. | V | Q | C | V | 35 |
| | WET SOIL + Can (g) a | 250.9 | 226.1 | 190.2 | 193.7 | 242.1 |
| | DRY SOIL + Can (g) b | 214.9 | 188.4 | 153.8 | 152.4 | 214.8 |
| | Wt. OF Can (g) c | 27.2 | 23.8 | 26.9 | 27.6 | 25.2 |
| | Wt. OF WATER (g) d = a-b | 36.0 | 37.7 | 36.4 | 41.3 | 27.3 |
| | Wt. OF DRY SOIL (g) e =b-c | 187.7 | 164.6 | 126.9 | 124.8 | 189.6 |
| | **w (%) m=** | 19.18 | 22.90 | 28.68 | 33.09 | 14.40 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.42 | 1.50 | 1.49 | 1.43 | |

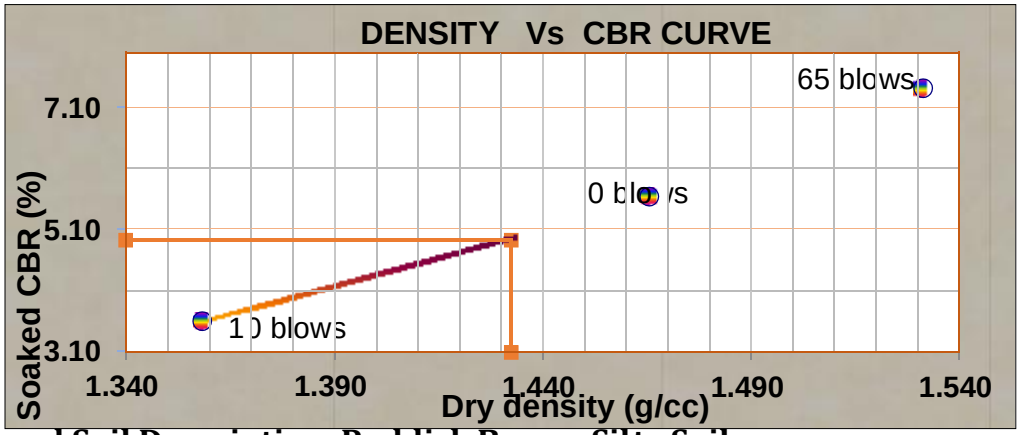



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 15.0 | 0.254 | 22.0 | 0.372 |
| 1.27 | 16.0 | 0.271 | 26.0 | 0.440 | 34.0 | 0.576 |
| 1.91 | 22.0 | 0.372 | 37.0 | 0.626 | 45.0 | 0.762 |
| 2.54 | 29 | 0.483 | 45 | 0.753 | 59 | 0.990 |
| 3.18 | 32.0 | 0.542 | 51.0 | 0.863 | 67.0 | 1.134 |
| 3.81 | 36.0 | 0.609 | 56.0 | 0.948 | 74.0 | 1.253 |
| 4.45 | 39.0 | 0.660 | 61.0 | 1.033 | 81.0 | 1.371 |
| 5.08 | 43 | 0.720 | 66 | 1.109 | 86 | 1.448 |
| 6.35 | 49.0 | 0.830 | 73.0 | 1.236 | 95.0 | 1.608 |



| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.36** | 0.48 | 0.72 | 13.40 | 20.00 | 3.6 | 3.6 | 3.6 |
| **30** | **1.47** | 0.75 | 1.11 | 13.40 | 20.00 | 5.6 | 5.5 | 5.6 |
| **65** | **1.53** | 0.99 | 1.45 | 13.40 | 20.00 | 7.4 | 7.2 | 7.4 |

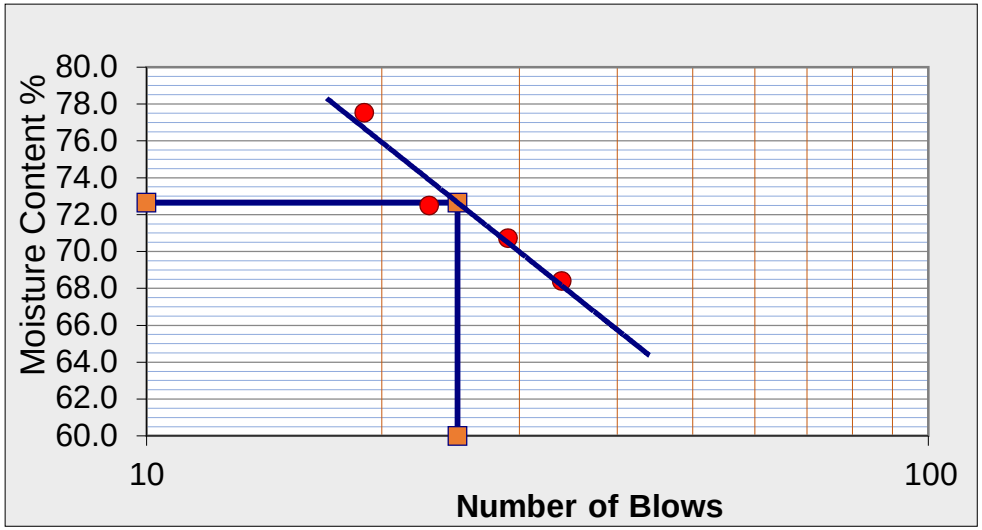



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.51 g/cm3 and OMC = 25%** |
| **From the Density-CBR Curve at 95% MDD (1.4535g/cm3): CBR =4.94** |

**Sample No.: 27, Location of Sample @ Station 30+500KM: Visual Soil Description: Reddish Brown Silty Soil**

**1. SOIL CONSISTENCY TEST RESULT ( : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 4 | 2 | 10 | 8 | | |
| Can No. | 34 | 29 | 23 | 19 | 12 | 7 |
| Weight of Can + Wet Soil(g) | 54.93 | 49.93 | 55.21 | 58.39 | 30.69 | 30.78 |
| Weight of Can + Dry Soil(g) | 42.12 | 38.92 | 41.69 | 43.06 | 28.20 | 28.28 |
| Weight of Can (g) = ($W_3$) | 23.40 | 23.34 | 23.06 | 23.29 | 23.41 | 23.42 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 12.81 | 11.01 | 13.51 | 15.33 | 2.48 | 2.50 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 18.72 | 15.57 | 18.64 | 19.77 | 4.80 | 4.87 |
| w (%) = (A / B)x 100 | 68.40 | 70.73 | 72.50 | 77.53 | 51.78 | 51.35 |
| **PI=LL-PL=73-52=21** | | | | A PL | 51.6 | |




1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

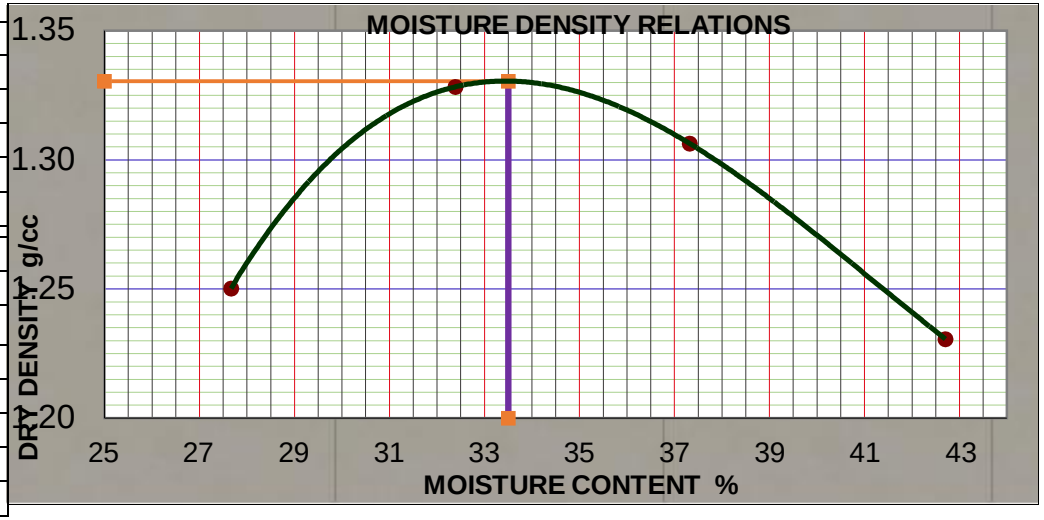
| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 40 | 8.00 | 92.00 | | | |
| 0.425 | 110 | 22.00 | 70.00 | | | |
| 0.075 | 135 | 27.00 | 43.00 | | | |
| total | 500 | | | A-7-5(6) | **SM** | |

## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**MOISTURE DENSITY RELATIONSHIP OF SOIL (: AASHTO T-180 METHOD D)**

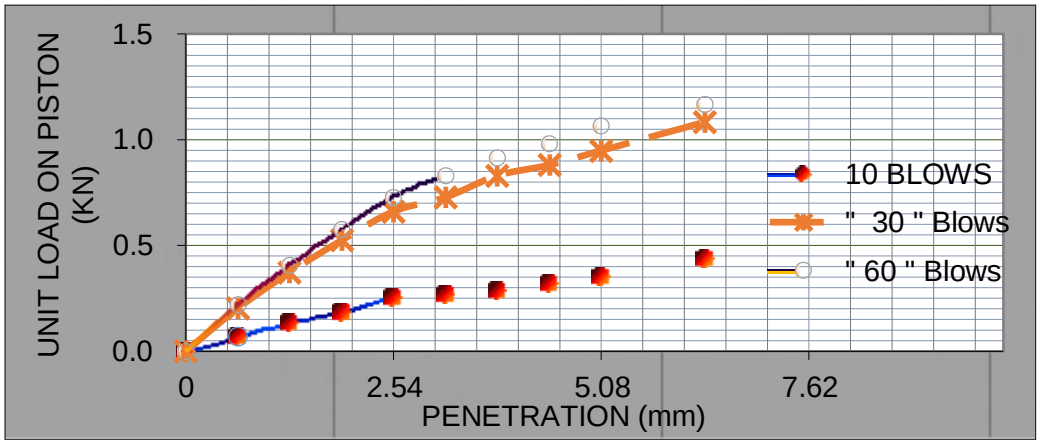
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8350.0 | 8695.0 | 8770.0 | 8690.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,390 | 3,735 | 3,810 | 3,730 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) | 1.60 | 1.76 | 1.79 | 1.76 | **NMC** |
| MOISTURE | Can No. | 22 | A1 | L | U | 47 |
| | WET SOIL + Can (g) a | 222.1 | 214.9 | 212.0 | 199.4 | 223.2 |
| | DRY SOIL + Can (g) b | 179.8 | 169.1 | 161.8 | 148.2 | 191.7 |
| | Wt. OF Can (g) c | 26.9 | 27.7 | 27.3 | 28.3 | 27.1 |
| | Wt. OF WATER (g) d = a-b | 42.3 | 45.8 | 50.2 | 51.2 | 31.5 |
| | Wt. OF DRY SOIL (g) e =b-c | 152.9 | 141.4 | 134.5 | 119.9 | 164.6 |
| | **w (%) m=** | 27.67 | 32.39 | 37.32 | 42.70 | 19.14 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$** | | 1.25 | 1.33 | 1.31 | 1.23 | |

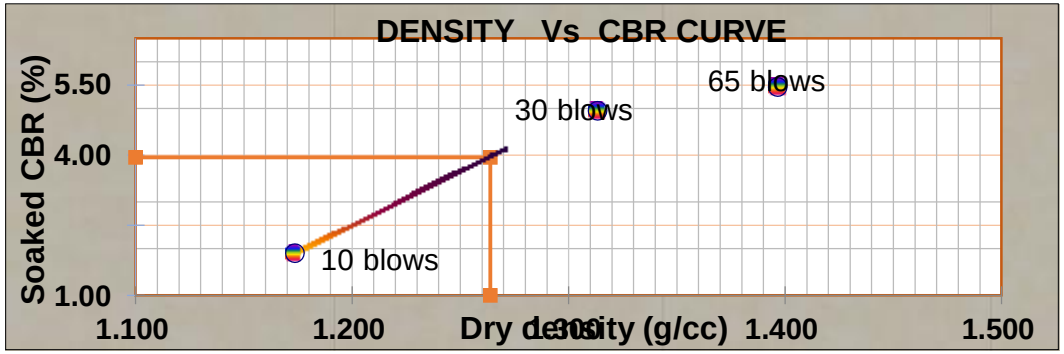



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL R | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0.64 | 4.0 | 0.068 | 12.0 | 0.203 | 13.0 | 0.220 |
| 1.27 | 8.0 | 0.135 | 22.0 | 0.372 | 24.0 | 0.406 |
| 1.91 | 11.0 | 0.186 | 31.0 | 0.525 | 34.0 | 0.576 |
| 2.54 | 15.0 | 0.254 | 39.0 | 0.660 | 43.0 | 0.728 |
| 3.18 | 16.0 | 0.271 | 43.0 | 0.728 | 49.0 | 0.830 |
| 3.81 | 17.0 | 0.288 | 49.0 | 0.830 | 54.0 | 0.914 |
| 4.45 | 19.0 | 0.322 | 52.0 | 0.880 | 58.0 | 0.982 |
| 5.08 | 21.0 | 0.356 | 56.0 | 0.948 | 63.0 | 1.067 |
| 6.35 | 26.0 | 0.440 | 64.0 | 1.084 | 69.0 | 1.168 |




| BLOWS | DD (g/Cm3) | LOAD | | Standard | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.17** | 0.25 | 0.36 | 13.40 | 20.00 | 1.9 | 1.8 | 1.9 |
| **30** | **1.31** | 0.66 | 0.95 | 13.40 | 20.00 | 4.9 | 4.7 | 4.9 |
| | | | | | | | | |
| Ring Factor =0.01693kN/Div | | | | | | | | |
| **From the compaction curve: MDD = 1.33 g/cm3 and OMC = 33.5%** | | | | | | | | |
| **From the Density-CBR Curve at 95% MDD (1.2635g/cm3): CBR =3.95** | | | | | | | | |

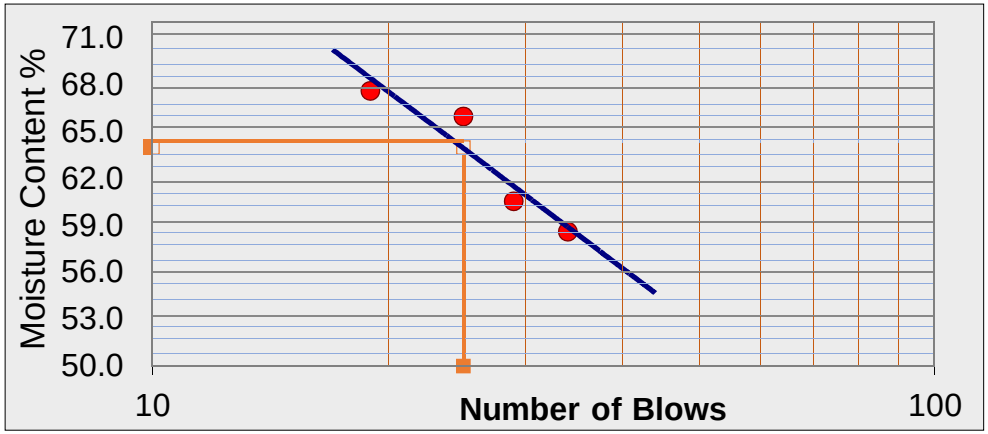


## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**Sample No.: 28, Location of Sample @ Station 31+000KM: Visual Soil Description: Gray Brown Clay Soil**

**1 SOIL CONSISTENCY TEST RESULT (TEST METHOD : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 25 | 19 | | |
| Can No. | 96 | 22 | 17 | 35 | G1 | DV |
| Weight of Can + Wet Soil (g) = ($W_1$) | 33.30 | 30.50 | 39.20 | 37.40 | 24.10 | 23.40 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 28.20 | 26.20 | 32.80 | 30.30 | 22.50 | 21.90 |
| Weight of Can (g) = ($W_3$) | 19.50 | 19.10 | 23.10 | 19.80 | 18.90 | 18.10 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 5.10 | 4.30 | 6.40 | 7.10 | 1.60 | 1.50 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 8.70 | 7.10 | 9.70 | 10.50 | 3.60 | 3.80 |
| w (%) = (A / B )x 100 | 58.62 | 60.56 | 65.98 | 67.62 | 44.44 | 39.47 |
| **PI=LL-PL=64-42=22** | | | | A PL. | 42.0 | |



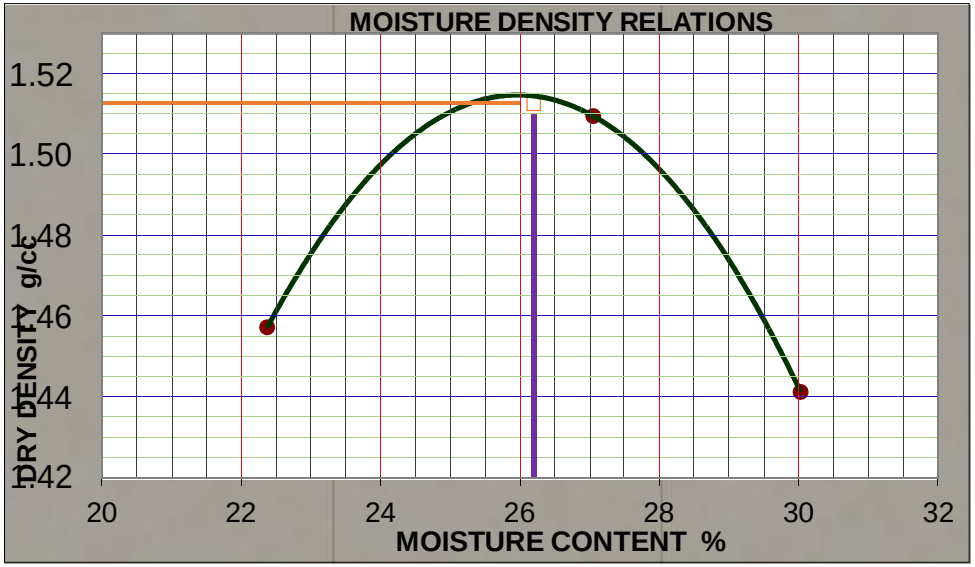

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 9 | 1.80 | 98.20 | | | |
| 0.425 | 191 | 38.20 | 60.00 | | | |
| 0.075 | 231 | 46.20 | 13.80 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S4** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL (: AASHTO T-180 METHOD D)**

**1.3.1**

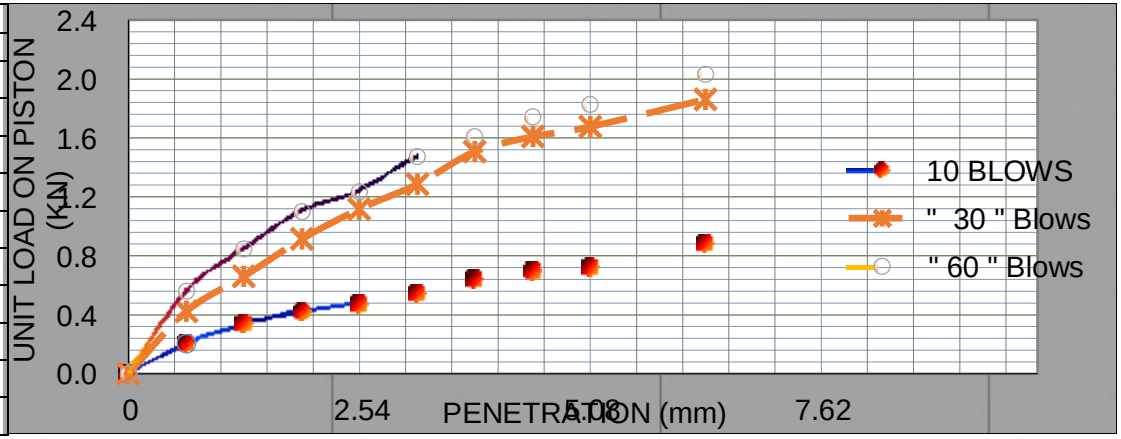
| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8409.0 | 8744.0 | 9030.0 | 8937.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,454 | 3,789 | 4,075 | 3,982 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ | 1.63 | 1.78 | 1.92 | 1.87 | **NMC** |
| MOISTURE | Can No. | K | 23 | S | C | Z |
| | WET SOIL + Can (g) a | 190.0 | 214.0 | 161.0 | 206.0 | 176.0 |
| | DRY SOIL +Can (g) b | 166.6 | 179.9 | 133.0 | 164.7 | 166.2 |
| | Wt. OF Can (g) c | 28.2 | 27.5 | 28.4 | 27.2 | 27.7 |
| | Wt. OF WATER (g) d = a-b | 23.4 | 34.1 | 28.3 | 41.3 | 9.8 |
| | Wt. OF DRY SOIL (g) e =b-c | 138.4 | 152.4 | 104.6 | 137.5 | 138.5 |
| | **w (%) m= (d/e)** | 16.91 | 22.38 | 27.06 | 30.04 | 7.08 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ = $W_d$/(100+m)*100** | | 1.39 | 1.46 | 1.51 | 1.44 | |



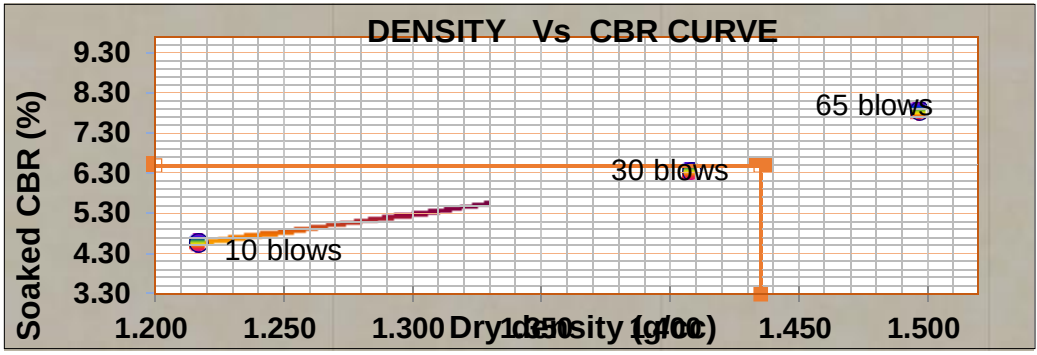
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL | LOAD |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 12.0 | 0.203 | 17.0 | 0.288 | 20.0 | 0.339 |
| 1.27 | 20.0 | 0.339 | 31.0 | 0.525 | 36.0 | 0.609 |
| 1.91 | 25.0 | 0.423 | 42.0 | 0.711 | 50.0 | 0.847 |
| 2.54 | 28.0 | 0.474 | 49 | 0.830 | 61 | 1.033 |
| 3.18 | 32.0 | 0.542 | 58.0 | 0.982 | 70.0 | 1.185 |
| 3.81 | 38.0 | 0.643 | 70.0 | 1.185 | 81.0 | 1.371 |
| 4.45 | 41.0 | 0.694 | 74.0 | 1.253 | 90.0 | 1.524 |
| 5.08 | 43.0 | 0.728 | 81 | 1.371 | 98 | 1.659 |
| 6.35 | 52.0 | 0.880 | 90.0 | 1.524 | 110.0 | 1.862 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.22** | 0.47 | 0.73 | 13.40 | 20.00 | 3.6 | 3.6 | 3.6 |
| **30** | **1.41** | 0.83 | 1.37 | 13.40 | 20.00 | 6.2 | 6.9 | 6.2 |
| **65** | **1.50** | 1.03 | 1.66 | 13.40 | 20.00 | 7.7 | 8.3 | 7.7 |

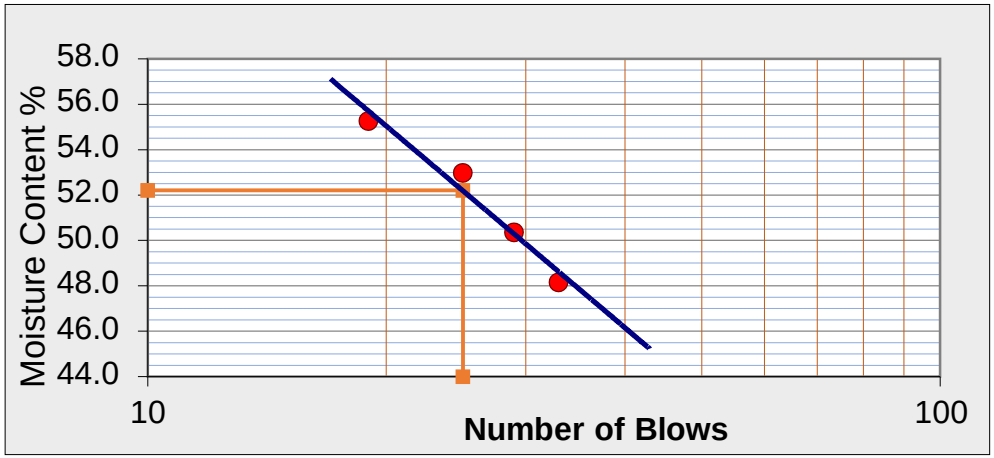



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.51 g/cm3 and OMC =26.6%** |
| **From the Density-CBR Curve at 95% MDD (1.4535g/cm3): CBR =6.5** |

**Sample No.: 29, Location of Sample @ Station 31+500KM: Visual Soil Description: Reddish Brown Silty Soil**

**1. SOIL CONSISTENCY TEST RESULT ( : AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 29 | 25 | 19 | | |
| Can No. | A | 13 | 15 | 22 | 98 | D |
| Weight of Can + Wet Soil (g) | 47.13 | 51.34 | 51.95 | 46.15 | 26.34 | 25.58 |
| Weight of Can + Dry Soil (g) | 39.07 | 43.46 | 43.76 | 37.94 | 24.90 | 24.20 |
| Wt. of Can (g) = ($W_3$) | 18.80 | 24.40 | 24.30 | 19.20 | 20.00 | 19.40 |
| Wt. of Moisture (g) = A | 8.06 | 7.88 | 8.19 | 8.21 | 1.44 | 1.38 |
| Wt. of Dry Soil (g) = ($W_2$-$W_3$) = B | 20.27 | 19.06 | 19.46 | 18.74 | 4.90 | 4.80 |
| w (%)=(A/B )x100 | 39.76 | 41.37 | 42.12 | 43.79 | 29.28 | 28.83 |
| **PI=LL-PL=42-29=13** | | | | AV. PL | 29.3 | |



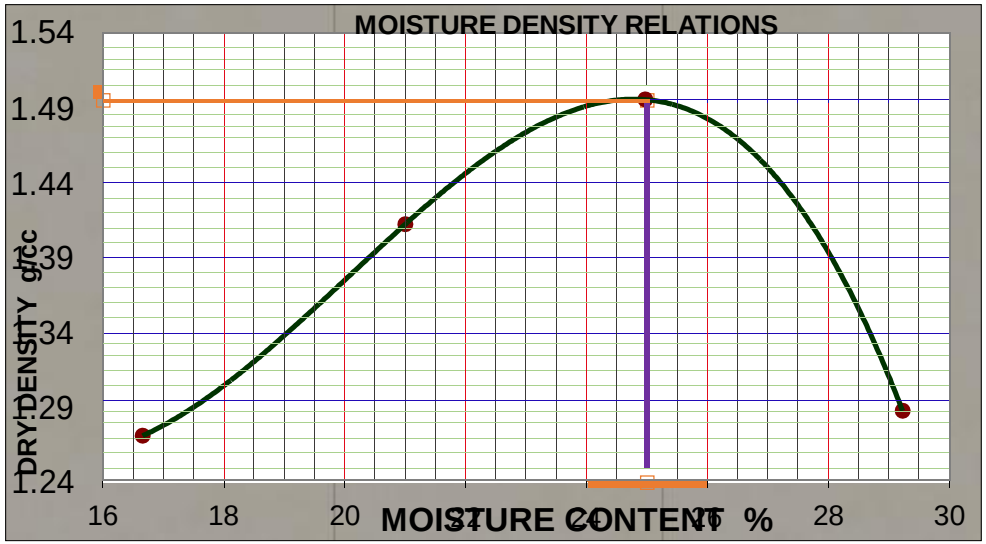
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 40 | 8.00 | 92.00 | | | |
| 0.425 | 135 | 27.00 | 65.00 | | | |
| 0.075 | 245 | 49.00 | 16.00 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S3** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL( AASHTO T-180 METHOD D)**

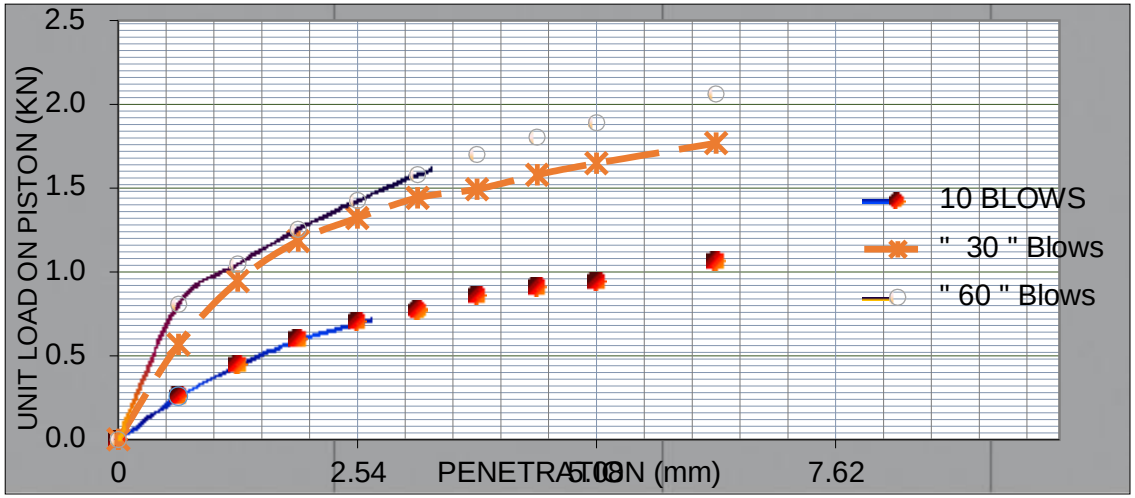
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8110.0 | 8590.0 | 8930.0 | 8495.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | VO. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,150 | 3,630 | 3,970 | 3,535 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d$ | 1.48 | 1.71 | 1.87 | 1.66 | **NMC** |
| MOISTURE | Can No. | **S** | **A7** | **A2** | **25** | **J** |
| | WET SOIL + Can (g) a | 258.4 | 221.0 | 236.7 | 218.0 | 208.7 |
| | DRY SOIL + Can (g) b | 225.5 | 186.9 | 195.0 | 174.8 | 196.2 |
| | Wt. OF Can (g) c | 27.9 | 24.5 | 28.0 | 27.0 | 26.9 |
| | Wt. OF WATER (g) d = a-b | 32.9 | 34.1 | 41.7 | 43.2 | 12.5 |
| | Wt. OF DRY SOIL (g) e =b-c | 197.6 | 162.4 | 167.0 | 147.8 | 169.3 |
| | **w (%) m=** | 16.65 | 21.00 | 24.97 | 29.23 | 7.38 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.27 | 1.41 | 1.50 | 1.29 | |



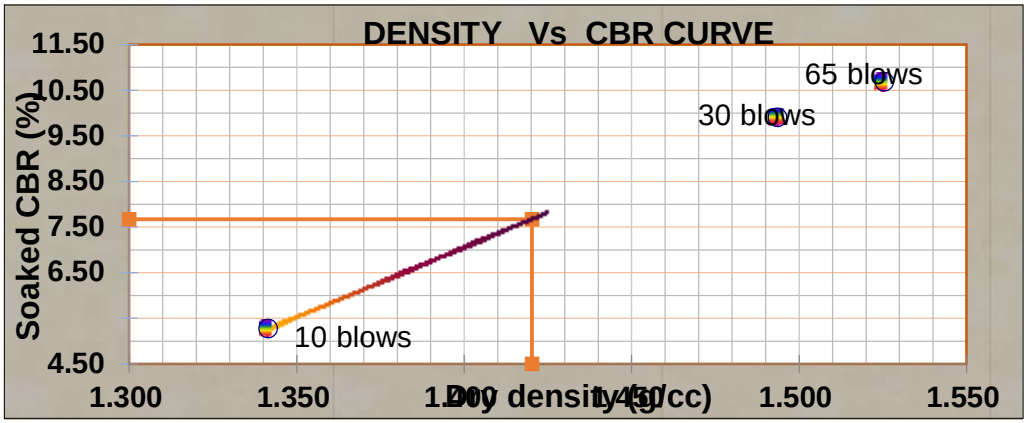

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL | LOAD | DIAL R | LOAD | DIAL | LOAD |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 15.0 | 0.258 | 33.0 | 0.567 | 47.0 | 0.807 |
| 1.27 | 26.0 | 0.446 | 55.0 | 0.944 | 61.0 | 1.047 |
| 1.91 | 35.0 | 0.601 | 69.0 | 1.185 | 73.0 | 1.253 |
| 2.54 | 41.0 | 0.704 | 77.0 | 1.322 | 83.0 | 1.425 |
| 3.18 | 45.0 | 0.773 | 84.0 | 1.442 | 92.0 | 1.580 |
| 3.81 | 50.0 | 0.859 | 87.0 | 1.494 | 99.0 | 1.700 |
| 4.45 | 53.0 | 0.910 | 92.0 | 1.580 | 105.0 | 1.803 |
| 5.08 | 55.0 | 0.944 | 96.0 | 1.648 | 110.0 | 1.889 |
| 6.35 | 62.0 | 1.065 | 103.0 | 1.769 | 120.0 | 2.060 |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.34** | 0.70 | 0.94 | 13.40 | 20.00 | 5.3 | 4.7 | 5.3 |
| **30** | **1.49** | 1.32 | 1.65 | 13.40 | 20.00 | 9.9 | 8.2 | 9.9 |
| **65** | **1.53** | 1.43 | 1.89 | 13.40 | 20.00 | 10.7 | 9.4 | 10.7 |

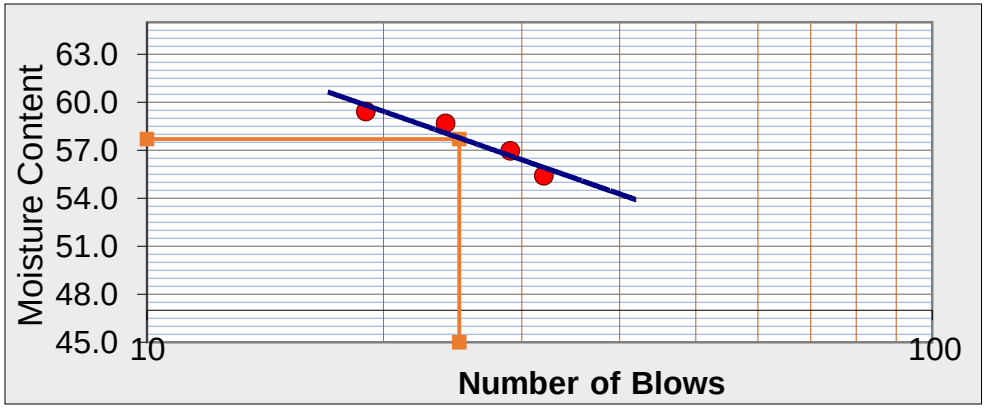



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.5 g/cm3 and OMC = 25%** |
| **From the Density-CBR Curve at 95% MDD (1.425g/cm3): CBR =7.67** |

**Sample No.: 30, Location of Sample @ Station 33+000KM: Visual Soil Description: Dark Brown Silty Soil**

**1. SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 32 | 29 | 24 | 19 | | |
| Can No. | 96 | 94 | 98 | F2 | G1 | 16 |
| Weight of Can + Wet Soil (g) = | 31.00 | 32.30 | 39.10 | 41.90 | 23.80 | 27.70 |
| Weight of Can + Dry Soil (g) = | 26.90 | 27.80 | 32.00 | 33.70 | 22.30 | 26.70 |
| Weight of Can (g) = ($W_3$) | 19.50 | 19.90 | 19.90 | 19.90 | 19.10 | 23.70 |
| Wt. of Moisture (g) = A | 4.10 | 4.50 | 7.10 | 8.20 | 1.50 | 1.00 |
| Wt. of Dry Soil (g) = B | 7.40 | 7.90 | 12.10 | 13.80 | 3.20 | 3.00 |
| w (%) = (A / B)x 100 | 55.41 | 56.96 | 58.68 | 59.42 | 46.88 | 33.33 |
| **PI=LL-PL=58-40=18** | | | | AV. PL | 40.1 | |



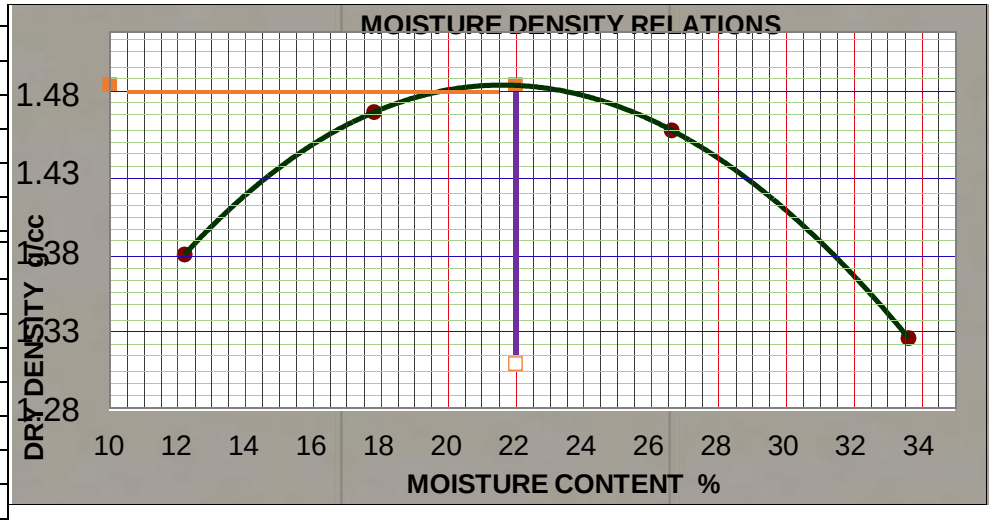

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 44.3 | 8.86 | 91.14 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 245.7 | 49.14 | 42.00 | | | |
| 0.075 | 133.6 | 26.72 | 15.28 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S4** |

### 1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)

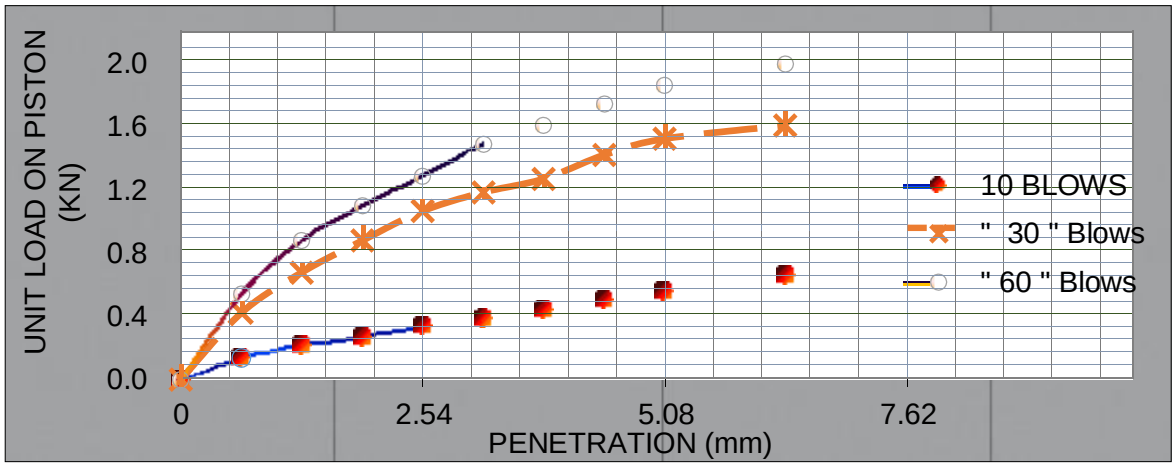
1.3.1

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8242.0 | 8632.0 | 8876.0 | 8719.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,287 | 3,677 | 3,921 | 3,764 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d$ | 1.55 | 1.73 | 1.85 | 1.77 | **NMC** |
| MOISTURE | Can No. | F | N | 18 | T | O |
| | WET SOIL + Can (g) a | 176.6 | 195.5 | 155.8 | 163.1 | 197.1 |
| | DRY SOIL + Can (g) b | 160.4 | 170.1 | 134.6 | 129.0 | 192.9 |
| | WEIGHT OF Can (g) c | 27.7 | 27.5 | 28.3 | 27.6 | 27.7 |
| | Wt. OF WATER (g) d = a-b | 16.2 | 25.4 | 28.3 | 34.1 | 4.2 |
| | Wt. OF DRY SOIL (g) e =b-c | 132.7 | 142.6 | 106.3 | 101.4 | 165.2 |
| | **w (%) m= (d/e)*100** | 12.21 | 17.81 | 26.62 | 33.63 | 2.54 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$** | | 1.38 | 1.47 | 1.46 | 1.33 | |



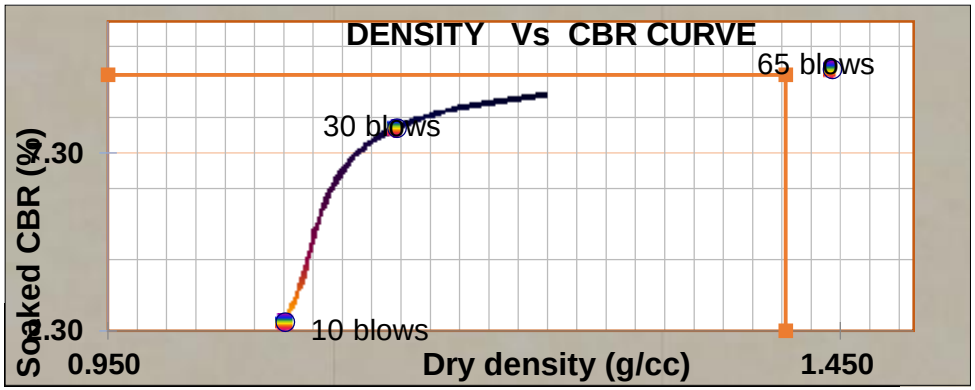

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL | LOAD | DIAL | LOAD | DIAL RDG | LOAD |
| 0.64 | 8.0 | 0.135 | 25.0 | 0.423 | 32.0 | 0.542 |
| 1.27 | 13.0 | 0.220 | 40.0 | 0.677 | 52.0 | 0.880 |
| 1.91 | 16.0 | 0.271 | 52.0 | 0.880 | 65.0 | 1.100 |
| 2.54 | 20.0 | 0.339 | 63.0 | 1.067 | 76.0 | 1.287 |
| 3.18 | 23.0 | 0.389 | 70.0 | 1.185 | 88.0 | 1.490 |
| 3.81 | 26.0 | 0.440 | 75.0 | 1.270 | 95.0 | 1.608 |
| 4.45 | 30.0 | 0.508 | 84.0 | 1.422 | 103.0 | 1.744 |
| 5.08 | 33.0 | 0.559 | 90.0 | 1.524 | 110.0 | 1.862 |
| 6.35 | 39.0 | 0.660 | 95.0 | 1.608 | 118.0 | 1.998 |




| BLOWS | DD (g/Cm3) | Load | Standard Load | | | CBR% | | CBR % |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.07** | 0.34 | 0.56 | 13.40 | 20.00 | 2.5 | 2.8 | 2.5 |
| **30** | **1.15** | 1.07 | 1.52 | 13.40 | 20.00 | 8.0 | 7.6 | 8.0 |
| **65** | **1.44** | 1.29 | 1.86 | 13.40 | 20.00 | 9.6 | 9.3 | 9.6 |

| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.487 g/cm3 and OMC =22%** |
| **From the Density-CBR Curve at 95% MDD (1.4126g/cm3): CBR =9.5** |

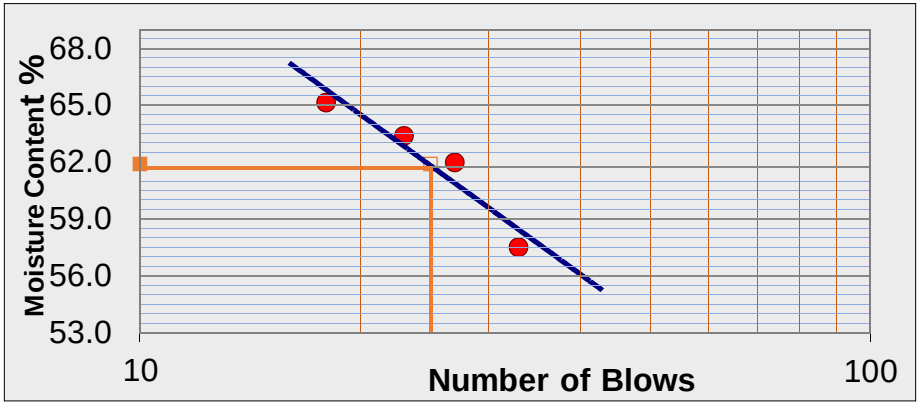


## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

## Sample No.: 31, Location of Sample @ Station 34+000KM: Visual Soil Description Gray Clay Soil

**1. SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 27 | 23 | 18 | | |
| Can No. | Zt | 78 | 17 | 22 | 13 | D3 |
| Weight o Can + Wet Soil (g)= ($W_1$) | 39.90 | 43.90 | 46.30 | 40.90 | 29.60 | 25.30 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 33.00 | 36.40 | 37.30 | 32.30 | 27.80 | 23.30 |
| Weight of Can (g) = ($W_3$) | 21.00 | 24.30 | 23.10 | 19.10 | 24.40 | 19.30 |
| Wt. of Moisture (g) = ($W_1 - W_2$) = A | 6.90 | 7.50 | 9.00 | 8.60 | 1.80 | 2.00 |
| Wt. of Dry Soil (g) = ($W_2 - W_3$) = B | 12.00 | 12.10 | 14.20 | 13.20 | 3.40 | 4.00 |
| w (%) = (A / B )x 100 | 57.50 | 61.98 | 63.38 | 65.15 | 52.94 | 50.00 |
| **PI=LL-PL=62-52=10** | | | | A.PL. | 51.5 | |



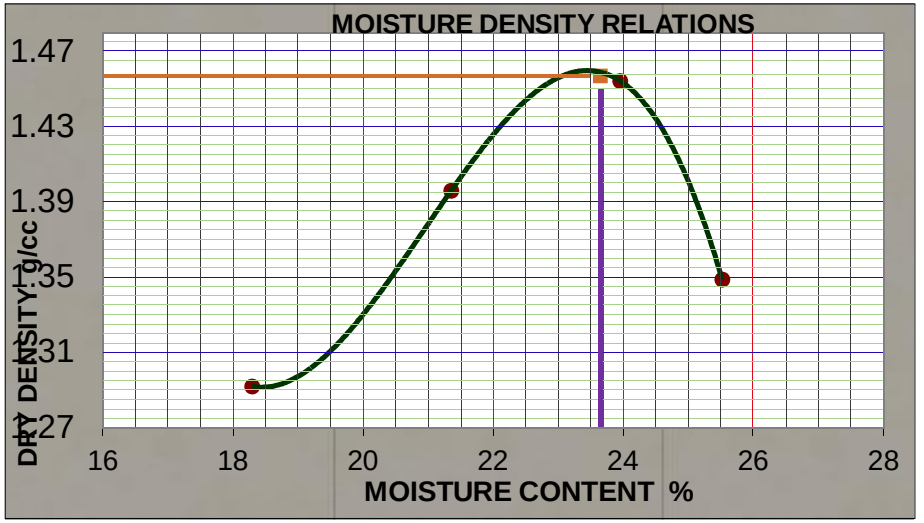

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 10 | 2.00 | 98.00 | | | |
| 0.425 | 13 | 2.60 | 95.40 | | | |
| 0.075 | 191 | 38.20 | 57.20 | | | |
| total | 500 | | | A-7-5(9) | **MH** | **S4** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

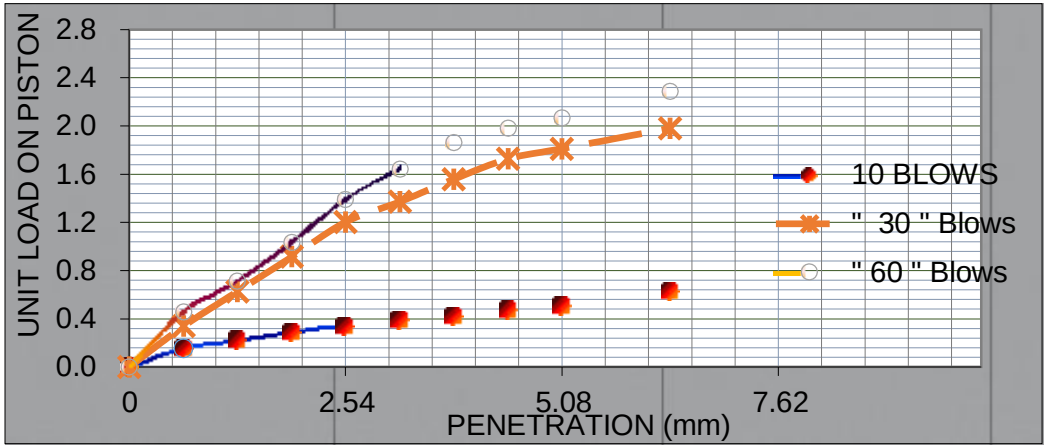
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8200.0 | 8553.0 | 8784.0 | 8550.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VO. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1 - W_2$ | 3,245 | 3,598 | 3,829 | 3,595 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.53 | 1.69 | 1.80 | 1.69 | **NMC** |
| MOISTURE | Can No. | **M** | **A** | **47** | **J** | **66** |
| | WET SOIL + Can (g) a | 206.3 | 198.4 | 169.7 | 170.0 | 139.1 |
| | DRY SOIL + Can (g) b | 178.6 | 160.7 | 142.2 | 141.0 | 138.7 |
| | Wt. OF Can (g) c | 27.2 | 28.2 | 27.4 | 27.4 | 27.1 |
| | Wt. OF WATER (g) d = a-b | 27.7 | 28.3 | 27.5 | 29.0 | 0.4 |
| | Wt. OF DRY SOIL (g) e =b-c | 151.4 | 132.5 | 114.8 | 113.6 | 111.6 |
| | **w (%) m=** | 18.30 | 21.36 | 23.95 | 25.53 | 0.36 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.29 | 1.40 | 1.45 | 1.35 | |

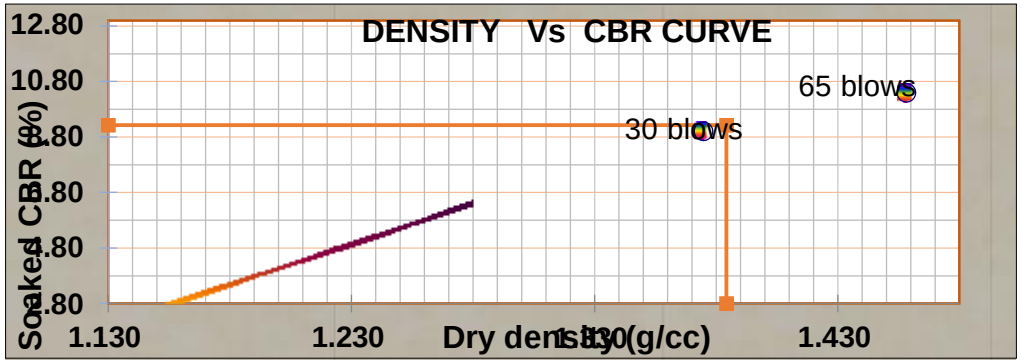


**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIALRDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 9.0 | 0.152 | 20.0 | 0.339 | 27.0 | 0.457 |
| 1.27 | 13.0 | 0.220 | 37.0 | 0.626 | 42.0 | 0.711 |
| 1.91 | 17.0 | 0.288 | 54.0 | 0.914 | 61.0 | 1.033 |
| 2.54 | 20.0 | 0.339 | 71.0 | 1.202 | 82.0 | 1.388 |
| 3.18 | 23.0 | 0.389 | 81.0 | 1.371 | 97.0 | 1.642 |
| 3.81 | 25.0 | 0.423 | 92.0 | 1.558 | 110.0 | 1.862 |
| 4.45 | 28.0 | 0.474 | 102.0 | 1.727 | 117.0 | 1.981 |
| 5.08 | 30.0 | 0.508 | 107.0 | 1.812 | 122.0 | 2.065 |
| 6.35 | 37.0 | 0.626 | 117.0 | 1.981 | 135.0 | 2.286 |




| BLOWS | DD | LOAD (KN) | | Standard | | CBR (%) | | CBR |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **10** | **1.15** | 0.34 | 0.51 | 13.40 | 20.00 | 2.5 | 2.5 | 2.5 |
| **30** | **1.37** | 1.20 | 1.81 | 13.40 | 20.00 | 9.0 | 9.1 | 9.0 |
| **65** | **1.46** | 1.39 | 2.07 | 13.40 | 20.00 | 10.4 | 10.3 | 10.4 |

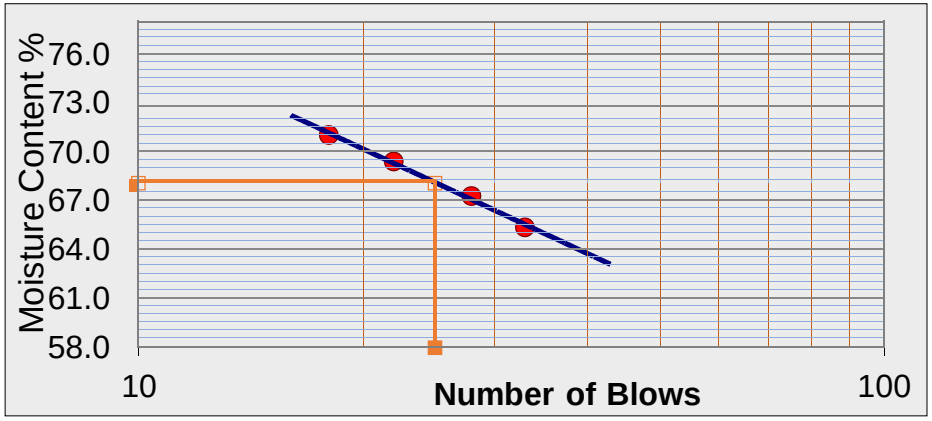



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.457g/cm3 and OMC = 23.7%** |
| **From the Density-CBR Curve at 95% MDD (1.3842g/cm3): CBR =9.23** |

**Sample No.: 32, Location of Sample @ Station 34+500KM: Visual Soil Description Reddish Clay Soil**

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 28 | 22 | 18 | | |
| Can No. | 12 | 8 | 9 | 10 | 12 | 7 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 45.03 | 47.77 | 49.59 | 49.70 | 23.64 | 24.03 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 35.54 | 36.52 | 38.76 | 37.27 | 22.23 | 22.60 |
| Weight of Can (g) = ($W_3$) | 21.03 | 19.80 | 23.16 | 19.76 | 19.58 | 19.92 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 9.49 | 11.25 | 10.83 | 12.44 | 1.42 | 1.43 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 14.51 | 16.72 | 15.60 | 17.50 | 2.65 | 2.68 |
| w (%) = (A / B )x 100 | 65.38 | 67.31 | 69.43 | 71.06 | 53.57 | 53.29 |
| **PI=LL-PL=68-53=15** | | | | A PL. | 53.4 | |



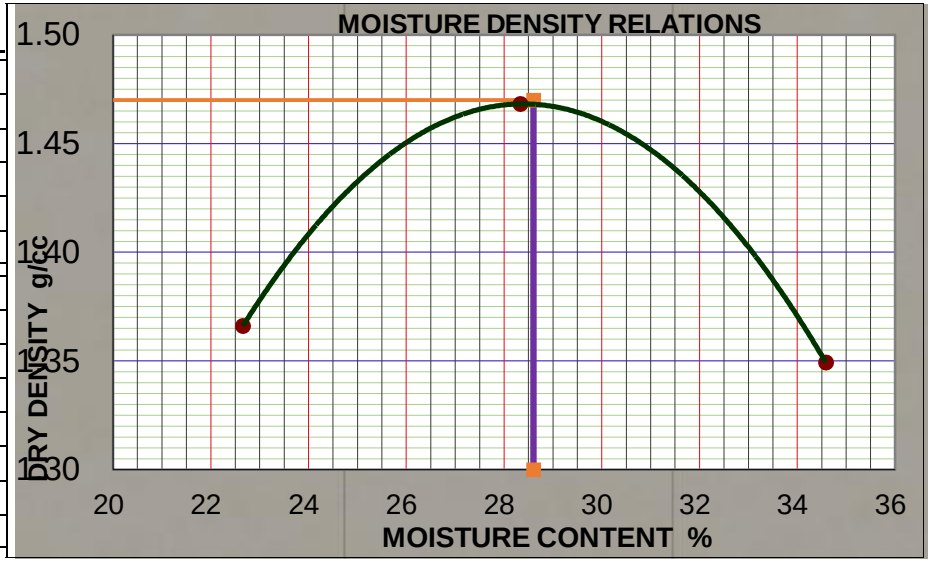
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 27.8 | 5.56 | 94.44 | | | |
| 0.425 | 151.5 | 30.30 | 64.14 | | | |
| 0.075 | 215.7 | 43.14 | 21.00 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

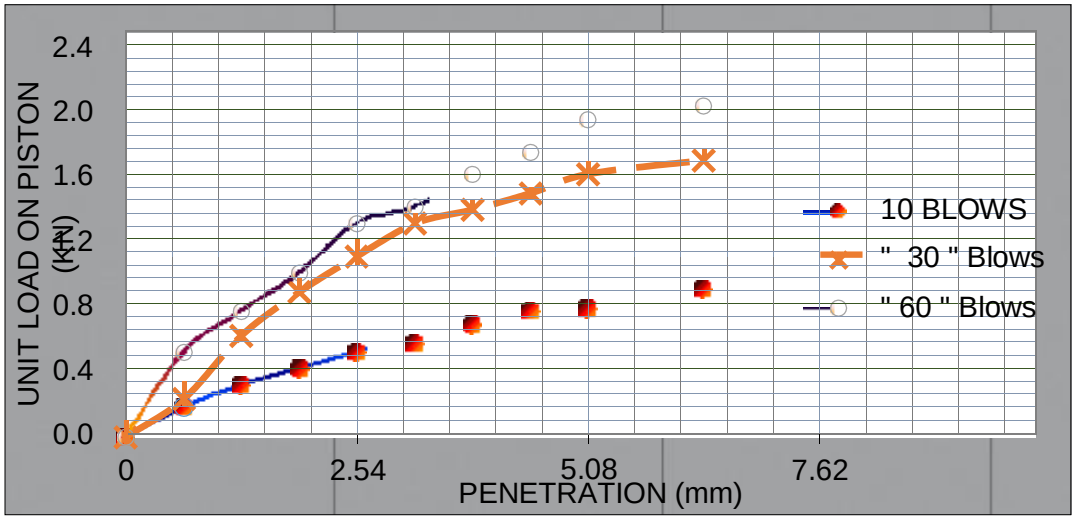
**1.3.1**

| | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| DENSITY | Wt. OF SOIL + MOULD (g) $W_1$ | 8256.0 | 8513.0 | 8956.0 | 8811.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4954 | 4954 | 4954 | 4954 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,302 | 3,559 | 4,002 | 3,857 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.55 | 1.68 | 1.88 | 1.82 | **NMC** |
| MOISTURE | Can no. | **C** | **L** | **H** | **T** | **O** |
| | WET SOIL + Can (g) a | 221.7 | 224.9 | 187.3 | 185.3 | 188.5 |
| | DRY SOIL + Can (g) b | 194.5 | 188.4 | 151.2 | 144.8 | 176.6 |
| | WEIGHT OF Can (g) c | 28.7 | 27.3 | 23.8 | 27.7 | 27.8 |
| | Wt. OF WATER (g) d = a-b | 27.2 | 36.5 | 36.1 | 40.5 | 11.9 |
| | Wt. OF DRY SOIL (g) e =b-c | 165.8 | 161.1 | 127.4 | 117.1 | 148.8 |
| | **w (%) m= (d/e)*100** | 16.41 | 22.66 | 28.34 | 34.59 | 8.00 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.34 | 1.37 | 1.47 | 1.35 | |

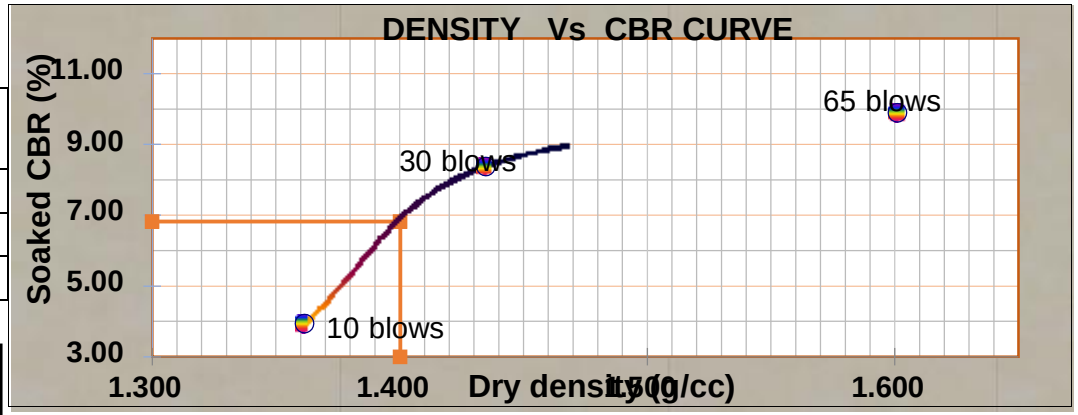



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL | LOAD | DIAL R | LOAD |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 11.0 | 0.186 | 14.0 | 0.237 | 31.0 | 0.525 |
| 1.27 | 19.0 | 0.322 | 37.0 | 0.626 | 46.0 | 0.779 |
| 1.91 | 25.0 | 0.423 | 53.0 | 0.897 | 60.0 | 1.016 |
| 2.54 | 31.0 | 0.525 | 66.0 | 1.117 | 78.0 | 1.321 |
| 3.18 | 34.0 | 0.576 | 78.0 | 1.321 | 84.0 | 1.422 |
| 3.81 | 41.0 | 0.694 | 83.0 | 1.405 | 96.0 | 1.625 |
| 4.45 | 46.0 | 0.779 | 89.0 | 1.507 | 104.0 | 1.761 |
| 5.08 | 47.0 | 0.796 | 96.0 | 1.625 | 116.0 | 1.964 |
| 6.35 | 54.0 | 0.914 | 101.0 | 1.710 | 121.0 | 2.049 |



| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load (KN) | | CBR | CBR | |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.36** | 0.52 | 0.80 | 13.40 | 20.00 | 3.9 | 4.0 | 3.9 |
| **30** | **1.43** | 1.12 | 1.63 | 13.40 | 20.00 | 8.4 | 8.1 | 8.4 |
| **65** | **1.60** | 1.32 | 1.96 | 13.40 | 20.00 | 9.9 | 9.8 | 9.9 |

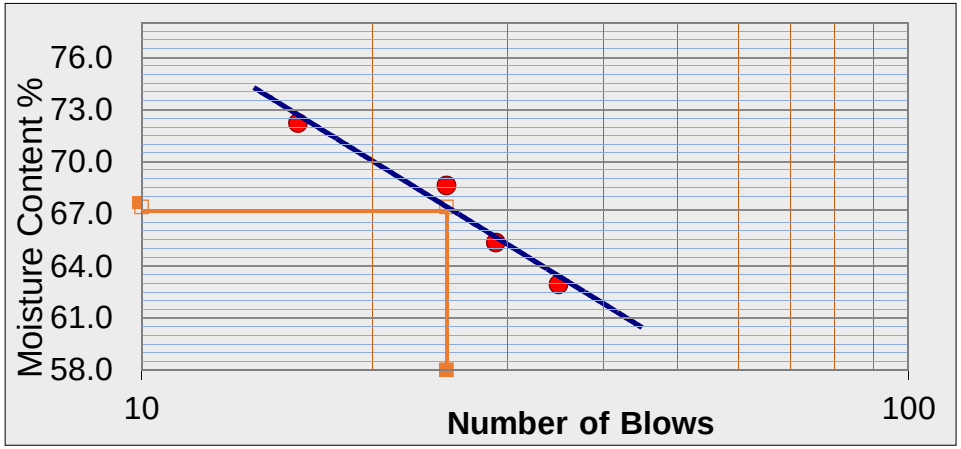



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.47 g/cm3 and OMC =29.6%** |
| **From the Density-CBR Curve at 95% MDD (1.3965g/cm3): CBR =6.82** |

**Sample No.: 33, Location of Sample @ Station 35+000KM: Visual Soil Description Dark Brown Clayey Soil**

**1. SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 29 | 25 | 16 | | |
| Can No. | 1 | 13 | 14 | 1 | 35 | 95 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 44.44 | 49.21 | 51.38 | 44.44 | 25.00 | 25.84 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 35.70 | 40.38 | 41.27 | 35.70 | 23.82 | 24.04 |
| Weight of Can (g) = ($W_3$) | 19.43 | 24.42 | 23.57 | 19.43 | 19.93 | 18.17 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 8.74 | 8.83 | 10.11 | 8.74 | 1.18 | 1.80 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 16.27 | 15.96 | 17.70 | 16.27 | 3.89 | 5.87 |
| w (%) = (A / B )x 100 | 53.72 | 55.33 | 57.12 | 53.72 | 30.33 | 30.66 |
| **PI=LL-PL=57-30=27** | | | | A.PL | 30 | |




1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

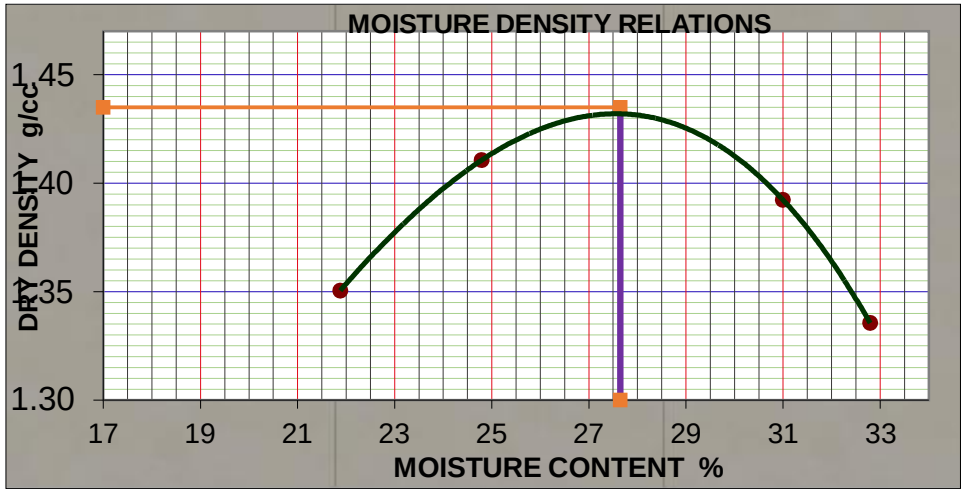
| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 3.4 | 0.68 | 99.32 | | | |
| 0.425 | 50 | 10.00 | 89.32 | | | |
| 0.075 | 302.2 | 60.44 | 28.88 | | | |
| total | 500 | | | A-2-7(3) | **SC** | **S1** |

## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

1.MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)

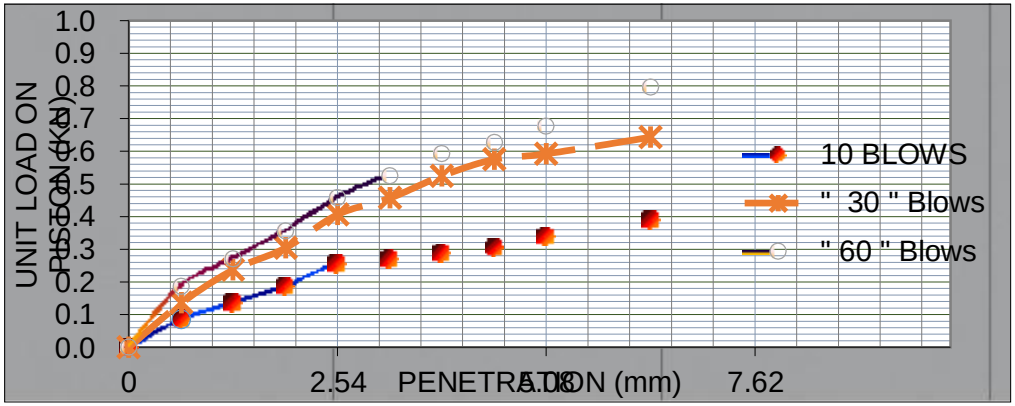
1.3.1

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 2 | 3 | 4 | 5 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8450.0 | 8693.0 | 8828.0 | 8721.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4954 | 4954 | 4954 | 4954 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,496 | 3,739 | 3,874 | 3,767 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.65 | 1.76 | 1.82 | 1.77 | **NMC** |
| MOISTURE | Can No. | **CO** | **W** | **L** | **1** | **M** |
| | WET SOIL + Can (g) a | 221.6 | 210.5 | 202.1 | 200.0 | 210.8 |
| | DRY SOIL + Can (g) b | 186.7 | 174.3 | 161.0 | 157.4 | 193.0 |
| | Wt. OF Can (g) c | 27.2 | 28.3 | 28.4 | 27.5 | 27.3 |
| | Wt. OF WATER (g) d = a-b | 34.9 | 36.2 | 41.1 | 42.6 | 17.8 |
| | Wt. OF DRY SOIL (g) e =b-c | 159.5 | 146.0 | 132.6 | 129.9 | 165.7 |
| | **w (%) m=** | 21.88 | 24.79 | 31.00 | 32.79 | 10.74 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.35 | 1.41 | 1.39 | 1.34 | |

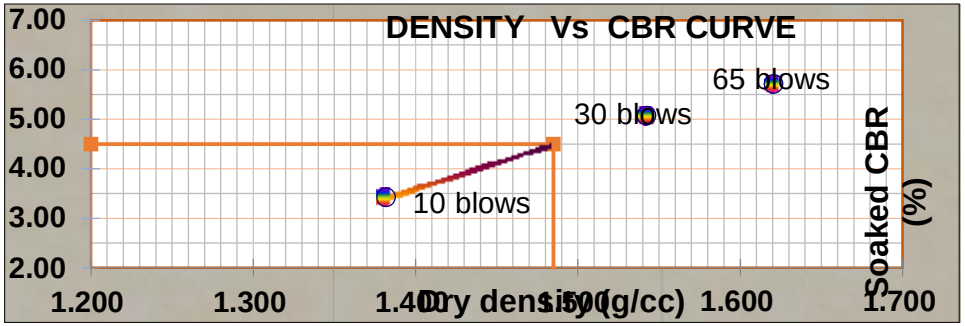



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0.64 | 8.0 | 0.135 | 14.0 | 0.237 | 18.0 | 0.305 |
| 1.27 | 14.0 | 0.237 | 22.0 | 0.372 | 27.0 | 0.457 |
| 1.91 | 21.0 | 0.356 | 32.0 | 0.542 | 35.0 | 0.593 |
| 2.54 | 27.0 | 0.457 | 40.0 | 0.677 | 45.0 | 0.762 |
| 3.18 | 30.0 | 0.508 | 43.0 | 0.728 | 48.0 | 0.813 |
| 3.81 | 33.0 | 0.559 | 49.0 | 0.830 | 56.0 | 0.948 |
| 4.45 | 37.0 | 0.626 | 55.0 | 0.931 | 66.0 | 1.117 |
| 5.08 | 40.0 | 0.677 | 58.0 | 0.982 | 69.0 | 1.168 |
| 6.35 | 48.0 | 0.813 | 67.0 | 1.134 | 78.0 | 1.321 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.38** | 0.46 | 0.68 | 13.40 | 20.00 | 3.4 | 3.4 | 3.4 |
| **30** | **1.54** | 0.68 | 0.98 | 13.40 | 20.00 | 5.1 | 4.9 | 5.1 |
| **65** | **1.62** | 0.76 | 1.17 | 13.40 | 20.00 | 5.7 | 5.8 | 5.7 |

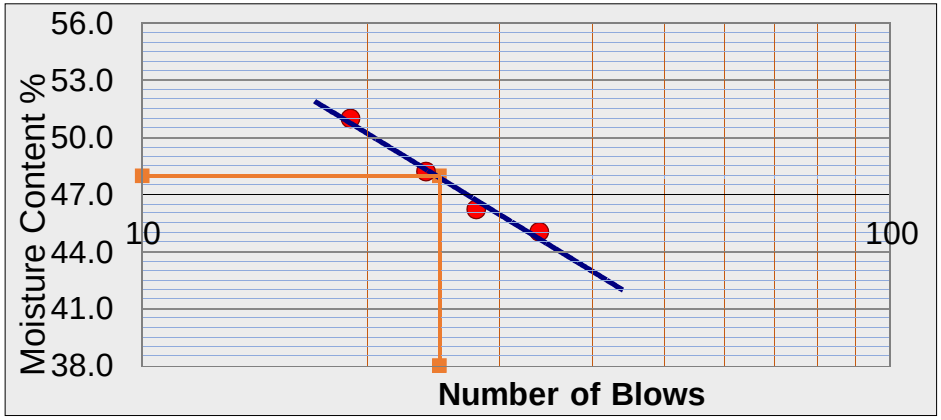



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.44 g/cm3 and OMC =27.7%** |
| **From the Density-CBR Curve at 95% MDD (1.368g/cm3): CBR =4.5** |

## Sample No.: 34, Location of Sample @ Station 35+500KM: Visual Soil Description Dark Brown Clayey Soil

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 28 | 24 | 19 | | |
| Can No. | 1 | 2 | 13 | 14 | G1 | 96 |
| Weight of Can + Wet Soil (g) =($W_1$) | 42.08 | 44.66 | 46.61 | 47.71 | 25.74 | 24.44 |
| Weight of Can + Dry Soil (g) =($W_2$) | 35.04 | 36.79 | 39.39 | 39.55 | 23.88 | 22.65 |
| Weight of Can (g) = ($W_3$) | 19.40 | 19.75 | 24.42 | 23.57 | 19.04 | 17.96 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$)= A | 7.04 | 7.87 | 7.22 | 8.15 | 1.86 | 1.79 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$)= B | 15.64 | 17.03 | 14.97 | 15.99 | 4.84 | 4.69 |
| w (%) = (A / B )x 100 | 45.05 | 46.23 | 48.20 | 51.00 | 38.36 | 38.22 |
| **PI=LL-PL=48-38=10** | | | | AV.PL | 38.3 | |



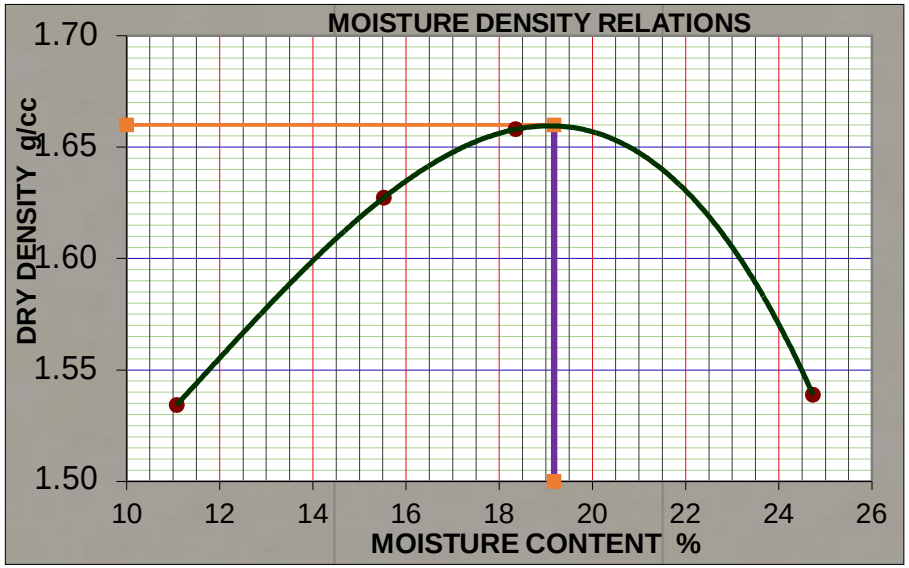

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 2.5 | 0.50 | 99.50 | | | |
| 0.425 | 152.1 | 30.42 | 69.08 | | | |
| 0.075 | 241.1 | 48.22 | 20.86 | | | |
| total | 500 | | | A-2-5(0) | **SM** | **S4** |

**MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

1.3.1

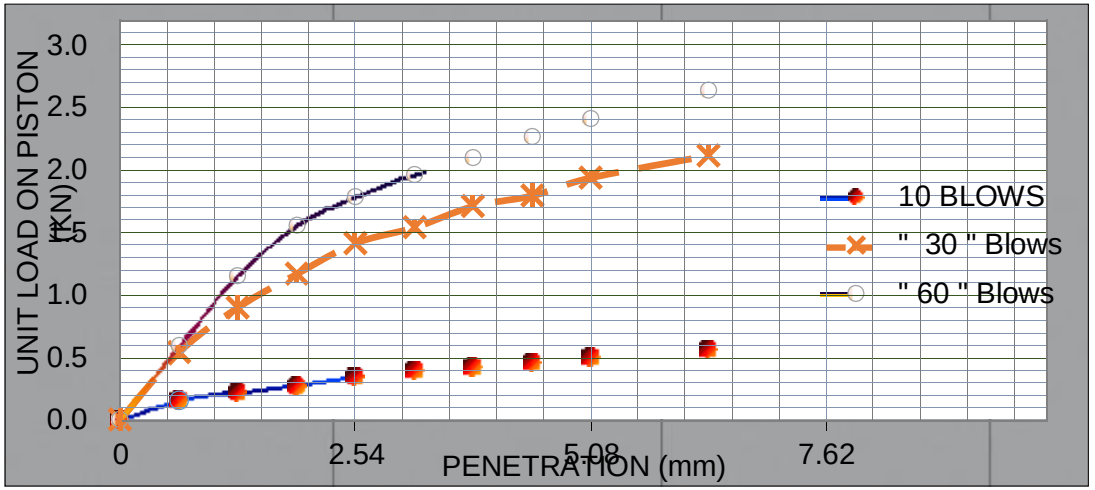
| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8574.0 | 8947.0 | 9122.0 | 9031.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4954 | 4954 | 4954 | 4954 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,620 | 3,993 | 4,168 | 4,077 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.70 | 1.88 | 1.96 | 1.92 | **NMC** |
| MOISTURE | Can No. | U | E | S | C | Z |
| | WET SOIL + Can (g) a | 259.6 | 222.5 | 238.1 | 204.0 | 226.6 |
| | DRY SOIL + Can (g) b | 236.5 | 196.2 | 205.5 | 169.0 | 216.8 |
| | Wt. of Can (g) c | 28.0 | 26.8 | 27.9 | 27.5 | 27.2 |
| | Wt. OF WATER (g) d = a-b | 23.1 | 26.3 | 32.6 | 35.0 | 9.8 |
| | Wt. OF DRY SOIL (g) e =b-c | 208.5 | 169.4 | 177.6 | 141.5 | 189.6 |
| | **w (%) m= (d/e)*100** | 11.08 | 15.53 | 18.36 | 24.73 | 5.17 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ = $W_d/(100+m)*100$** | | 1.53 | 1.63 | 1.66 | 1.54 | |



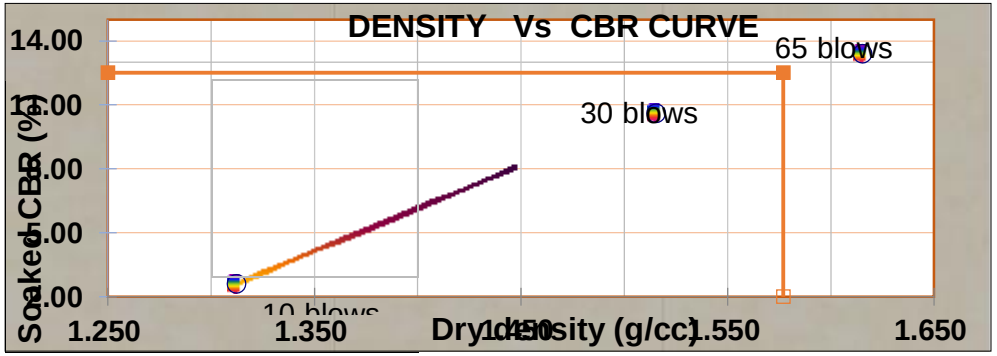
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 9.0 | 0.152 | 32.0 | 0.542 | 35.0 | 0.593 |
| 1.27 | 13.0 | 0.220 | 53.0 | 0.897 | 68.0 | 1.151 |
| 1.91 | 16.0 | 0.271 | 69.0 | 1.168 | 92.0 | 1.558 |
| 2.54 | 21 | 0.347 | 84 | 1.414 | 106 | 1.786 |
| 3.18 | 23.0 | 0.389 | 91.0 | 1.541 | 116.0 | 1.964 |
| 3.81 | 25.0 | 0.423 | 101.0 | 1.710 | 124.0 | 2.099 |
| 4.45 | 27.0 | 0.457 | 106.0 | 1.795 | 134.0 | 2.269 |
| 5.08 | 30 | 0.499 | 115 | 1.938 | 143 | 2.413 |
| 6.35 | 33.0 | 0.559 | 125.0 | 2.116 | 156.0 | 2.641 |




| BLOWS | DD | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR |
|---|---|---|---|---|---|---|---|---|
| | | | | | | | | |
| **10** | **1.31** | 0.35 | 0.50 | 13.40 | 20.00 | 2.6 | 2.5 | 2.6 |
| **30** | **1.52** | 1.41 | 1.94 | 13.40 | 20.00 | 10.6 | 9.7 | 10.6 |
| **65** | **1.62** | 1.79 | 2.41 | 13.40 | 20.00 | 13.4 | 12.1 | 13.4 |

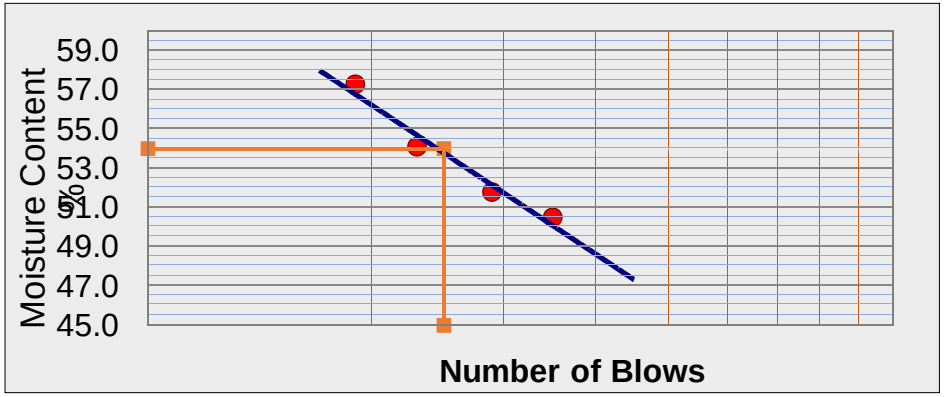



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.66 g/cm3 and OMC = 19.2%** |
| **From the Density-CBR Curve at 95% MDD (1.577g/cm3): CBR =12.5** |

**Sample No.: 35, Location of Sample @ Station 36+000KM: Visual Soil Description Dark Brown Clay Soil**

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 28 | 24 | 17 | | |
| Can No. | 16 | 18 | DD | 96 | 35 | B |
| Weight of Can + Wet Soil (g)= ($W_1$) | 45.85 | 40.45 | 44.02 | 49.71 | 31.06 | 33.50 |
| Weight of Can + Dry Soil (g)= ($W_2$) | 38.46 | 33.38 | 35.46 | 38.72 | 27.93 | 29.78 |
| Weight of Can (g) = ($W_3$) | 23.83 | 19.74 | 19.62 | 19.53 | 19.90 | 20.25 |
| Wt. of Moisture (g) =($W_1$ - $W_2$) = A | 7.39 | 7.07 | 8.57 | 10.99 | 3.13 | 3.72 |
| Wt. of Dry Soil (g) =($W_2$ - $W_3$) = B | 14.63 | 13.65 | 15.83 | 19.20 | 8.02 | 9.54 |
| w (%)=(A / B )x 100 | 50.50 | 51.80 | 54.10 | 57.28 | 39.07 | 39.00 |
| **PI=LL-PL=54-39=15** | | | | A. PL | 39 | |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

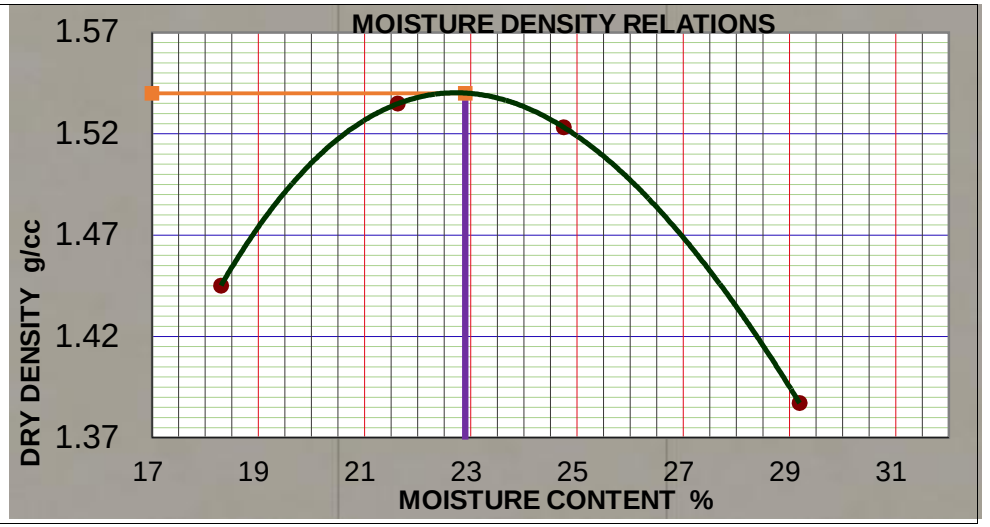
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 40 | 8.00 | 92.00 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 180 | 36.00 | 56.00 | | | |
| 0.075 | 220 | 44.00 | 12.00 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S4** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL AASHTO T-180 METHOD D)**

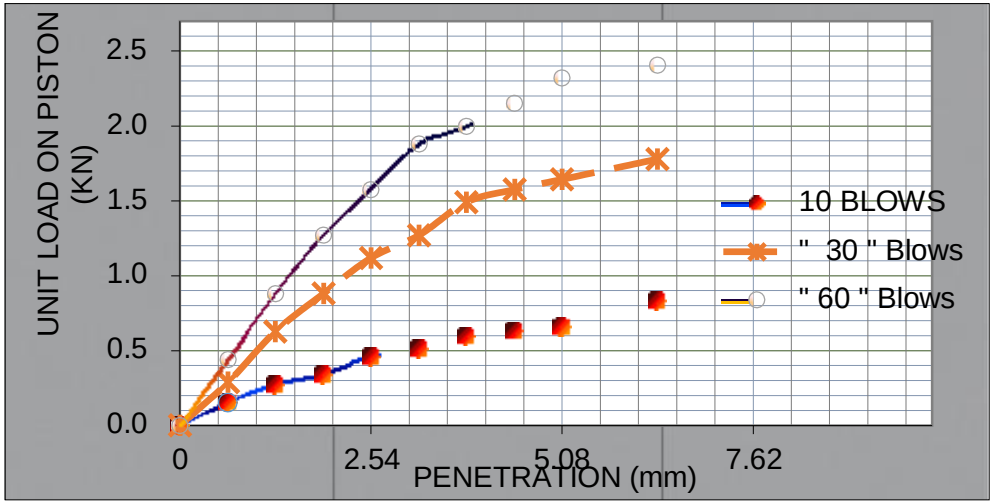
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8585.0 | 8919.0 | 8990.0 | 8760.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4954 | 4954 | 4954 | 4954 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,631 | 3,965 | 4,036 | 3,806 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.71 | 1.87 | 1.90 | 1.79 | **NMC** |
| MOISTURE | Can No. | 11 | 1 | 16 | 22 | 21 |
| | WET SOIL + Can (g) a | 184.5 | 238.4 | 200.9 | 184.8 | 209.8 |
| | DRY SOIL + Can (g) b | 160.4 | 200.9 | 165.9 | 149.1 | 193.2 |
| | WEIGHT OF Can (g) c | 28.7 | 27.5 | 24.5 | 26.8 | 28.0 |
| | Wt. OF WATER (g) d = a-b | 24.1 | 37.5 | 35.0 | 35.7 | 16.6 |
| | Wt. OF DRY SOIL (g) e =b-c | 131.7 | 173.4 | 141.4 | 122.3 | 165.2 |
| | **w (%) m=** | 18.30 | 21.63 | 24.75 | 29.19 | 10.05 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.45 | 1.53 | 1.52 | 1.39 | |




**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | |
| 1.27 | 16.0 | 0.271 | 37.0 | 0.626 | 52.0 | 0.880 |
| 1.91 | 20.0 | 0.339 | 52.0 | 0.880 | 75.0 | 1.270 |
| 2.54 | 27.0 | 0.457 | 66.0 | 1.117 | 93.0 | 1.574 |
| 3.18 | 30.0 | 0.508 | 75.0 | 1.270 | 111.0 | 1.879 |
| 3.81 | 35.0 | 0.593 | 88.0 | 1.490 | 118.0 | 1.998 |
| 4.45 | 37.0 | 0.626 | 93.0 | 1.574 | 127.0 | 2.150 |
| 5.08 | 39.0 | 0.660 | 97.0 | 1.642 | 137.0 | 2.319 |
| 6.35 | 49.0 | 0.830 | 105.0 | 1.778 | 142.0 | 2.404 |



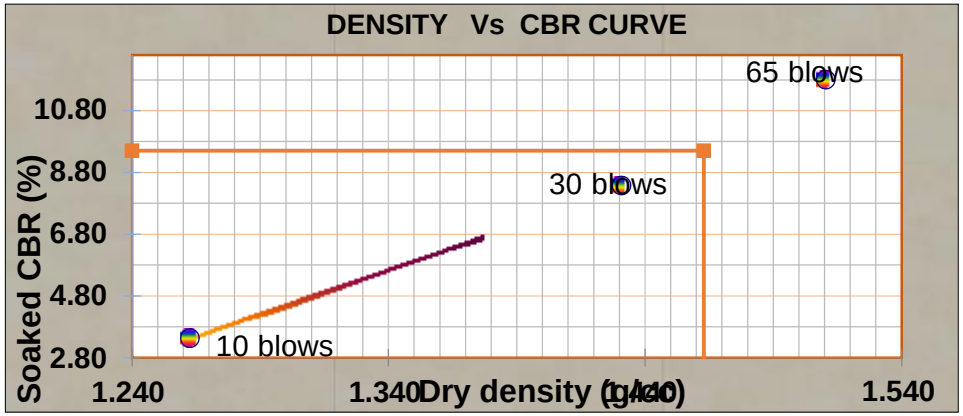
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD (KN) | | St. Load(KN) | | CBR (%) | | CBR % |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| 10 | 1.26 | 0.46 | 0.66 | 13.40 | 20.00 | 3.4 | 3.3 | 3.4 |
| 30 | 1.43 | 1.12 | 1.64 | 13.40 | 20.00 | 8.4 | 8.2 | 8.4 |
| 65 | 1.51 | 1.57 | 2.32 | 13.40 | 20.00 | 11.8 | 11.6 | 11.8 |

Ring Factor =0.01693kN/Div

**From the compaction curve: MDD = 1.54 g/cm3 and OMC = 22.9%**

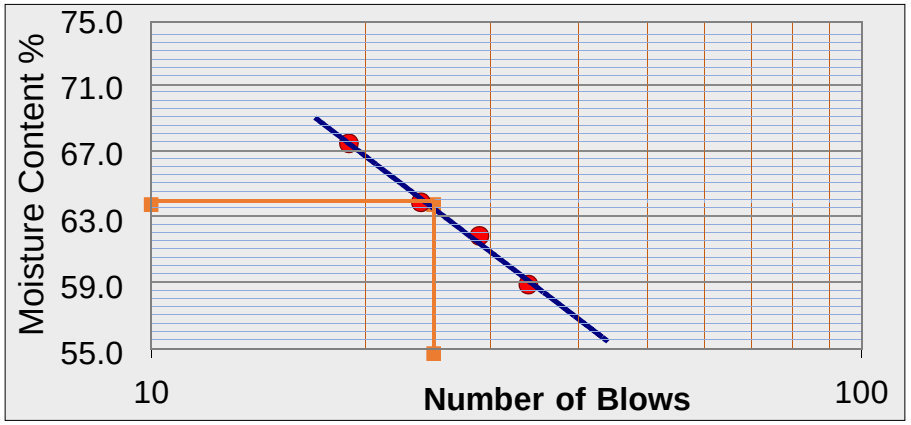
**From the Density-CBR Curve at 95% MDD (1.463g/cm3): CBR =9.5**




**Sample No.: 36, Location of Sample @ Station 37+000KM: Visual Soil Description Dark Brown Clay Soil**

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 24 | 19 | | |
| Can No. | 13 | 22 | D3 | 78 | F2 | DV |
| Weight of Can + Wet Soil (g) = ($W_1$) | 45.38 | 38.82 | 36.01 | 42.30 | 23.61 | 23.12 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 37.59 | 31.28 | 29.51 | 35.00 | 22.54 | 22.07 |
| Eight of Can (g) = ($W_3$) | 24.42 | 19.14 | 19.37 | 24.22 | 19.93 | 19.52 |
| Wt. of Moisture (g) =($W_1$ - $W_2$)=A | 7.79 | 7.54 | 6.50 | 7.30 | 1.07 | 1.05 |
| Wt. of Dry Soil (g) =($W_2$ - $W_3$)=B | 13.17 | 12.14 | 10.14 | 10.79 | 2.61 | 2.55 |
| w (%)=(A / B )x 100 | 59.17 | 62.10 | 64.13 | 67.69 | 40.96 | 41.18 |
| **PI=LL-PL=64-41=23** | | | | APL | 41.0 | |



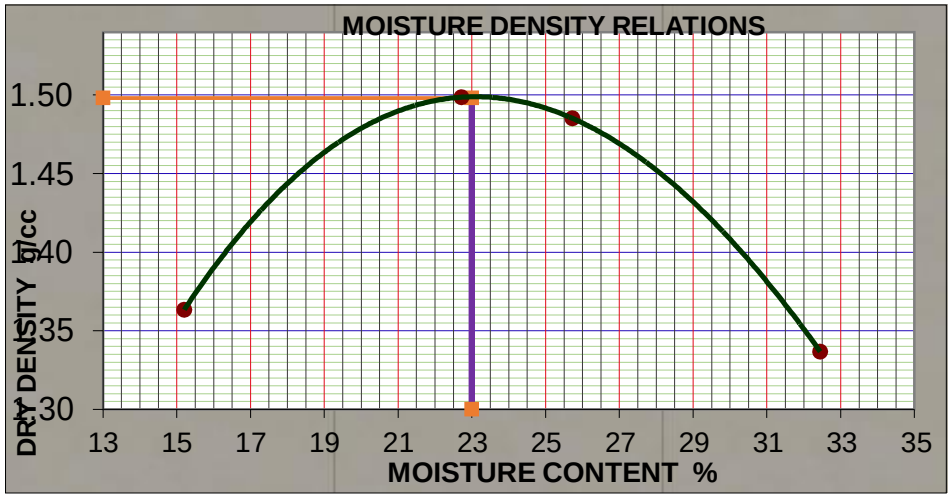

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 48 | 9.60 | 90.40 | | | |
| 0.425 | 198 | 39.60 | 50.80 | | | |
| 0.075 | 148 | 29.60 | 21.20 | | | |
| total | 500 | | | A-2-7(1) | **SM** | **S3** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

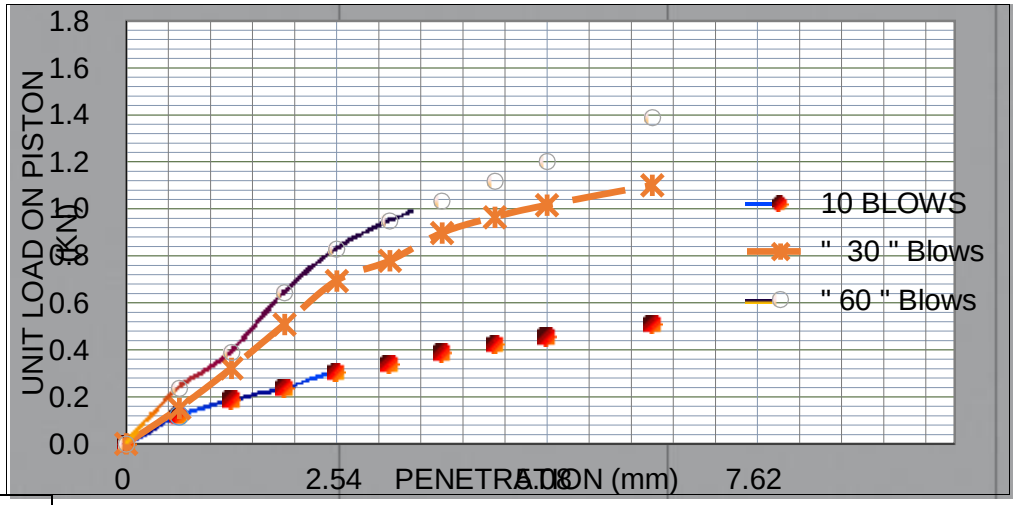
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8290.0 | 8860.0 | 8920.0 | 8714.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4954 | 4954 | 4954 | 4954 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,336 | 3,906 | 3,966 | 3,760 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d = W_3/V$ | 1.57 | 1.84 | 1.87 | 1.77 | **NMC** |
| MOISTURE | Can No. | **13** | **18** | **35** | **47** | **Z** |
| | WET SOIL + Can (g) a | 196.3 | 184.5 | 170.8 | 171.6 | 190.5 |
| | DRY SOIL + Can (g) b | 174.1 | 155.6 | 141.0 | 136.2 | 175.0 |
| | Wt. OF Can (g) c | 28.1 | 28.4 | 25.2 | 27.1 | 27.2 |
| | Wt. OF WATER (g) d = a-b | 22.2 | 28.9 | 29.8 | 35.4 | 15.5 |
| | Wt. OF DRY SOIL (g) e =b-c | 146.0 | 127.2 | 115.8 | 109.1 | 147.8 |
| | **w (%) m= (d/e)*100** | 15.21 | 22.72 | 25.73 | 32.45 | 10.49 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.36 | 1.50 | 1.49 | 1.34 | |

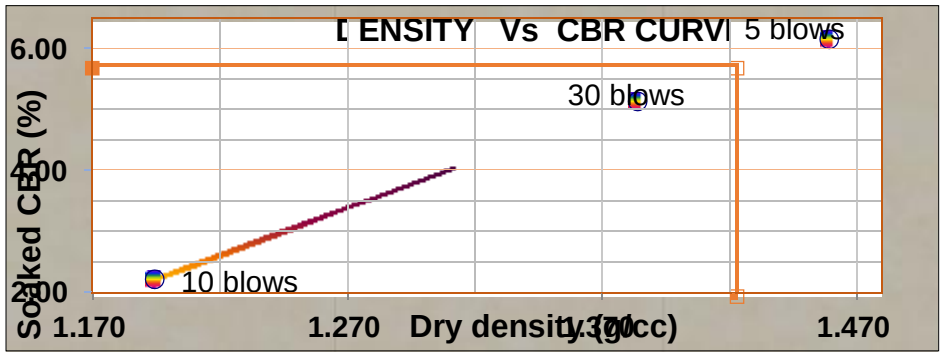



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 7.0 | 0.119 | 9.0 | 0.152 | 14.0 | 0.237 |
| 1.27 | 11.0 | 0.186 | 19.0 | 0.322 | 23.0 | 0.389 |
| 1.91 | 14.0 | 0.237 | 30.0 | 0.508 | 38.0 | 0.643 |
| 2.54 | 18.0 | 0.305 | 41.0 | 0.694 | 49.0 | 0.830 |
| 3.18 | 20.0 | 0.339 | 46.0 | 0.779 | 56.0 | 0.948 |
| 3.81 | 23.0 | 0.389 | 53.0 | 0.897 | 61.0 | 1.033 |
| 4.45 | 25.0 | 0.423 | 57.0 | 0.965 | 66.0 | 1.117 |
| 5.08 | 27.0 | 0.457 | 60.0 | 1.016 | 71.0 | 1.202 |
| 6.35 | 30.0 | 0.508 | 65.0 | 1.100 | 82.0 | 1.388 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.5 | 5.08 | 2.54 | 5.08 mm | 2.54 | 5.08 | |
| **10** | **1.19** | 0.30 | 0.46 | 13.40 | 20.00 | 2.3 | 2.3 | 2.3 |
| **30** | **1.38** | 0.69 | 1.02 | 13.40 | 20.00 | 5.2 | 5.1 | 5.2 |
| **65** | **1.46** | 0.83 | 1.20 | 13.40 | 20.00 | 6.2 | 6.0 | 6.2 |



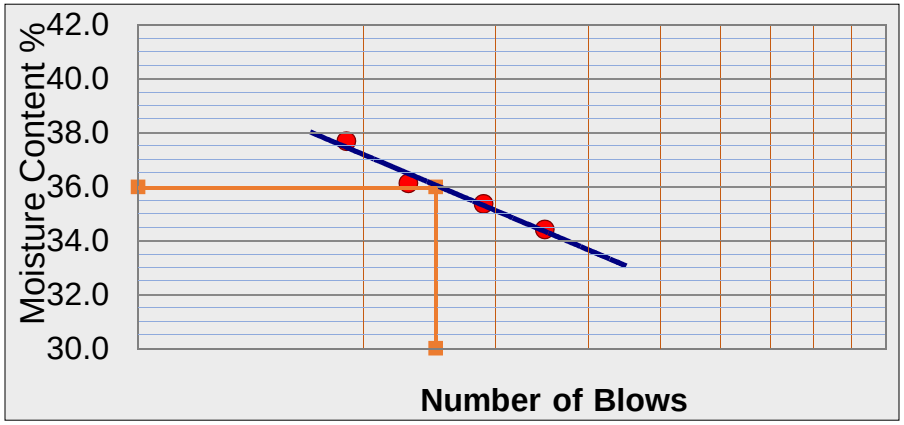

| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.498 g/cm3 and OMC = 23%** |
| **From the Density-CBR Curve at 95% MDD (1.4231g/cm3): CBR =5.75** |

## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

## Sample No.: 37, Location of Sample @ Station 37+500KM: Visual Soil Description Reddish Brown Clay Soil

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 28 | 24 | 19 | | |
| Can No. | 13 | 22 | D3 | 78 | F2 | DV |
| Weight of Can + Wet Soil (g) = ($W_1$) | 46.48 | 39.91 | 37.03 | 43.31 | 24.29 | 23.73 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 38.16 | 31.92 | 30.07 | 35.56 | 22.94 | 22.43 |
| Weight of Can (g) = ($W_3$) | 24.42 | 19.14 | 19.37 | 24.22 | 19.93 | 19.52 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 8.32 | 7.99 | 6.96 | 7.75 | 1.36 | 1.30 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 13.74 | 12.78 | 10.69 | 11.34 | 3.01 | 2.91 |
| w (%) = (A / B )x 100 | 60.55 | 62.53 | 65.11 | 68.33 | 45.05 | 44.74 |
| **PI=LL-PL=64-45=19** | | | | A.PL | 44.9 | |



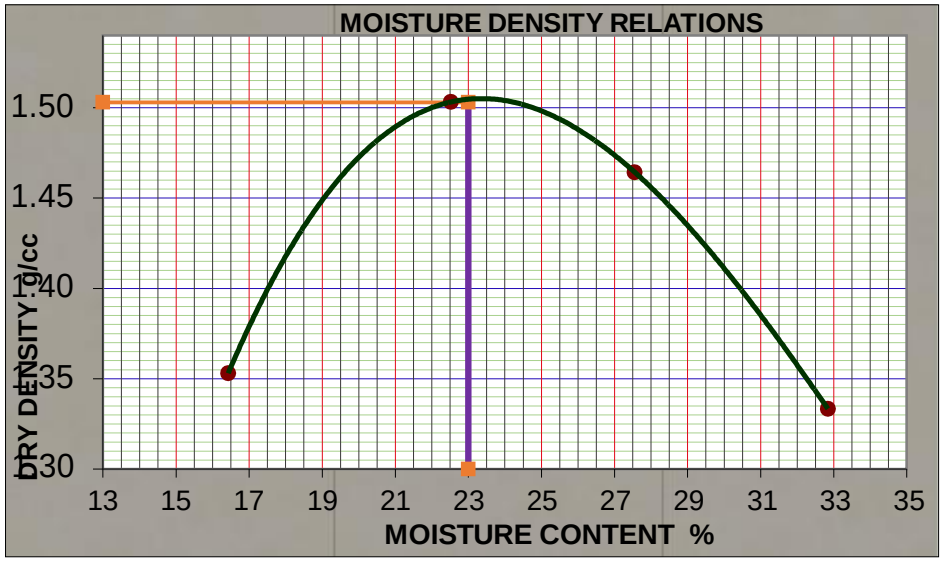

1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 35 | 7.00 | 93.00 | | | |
| 0.425 | 191 | 38.20 | 54.80 | | | |
| 0.075 | 178 | 35.60 | 19.20 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S3** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

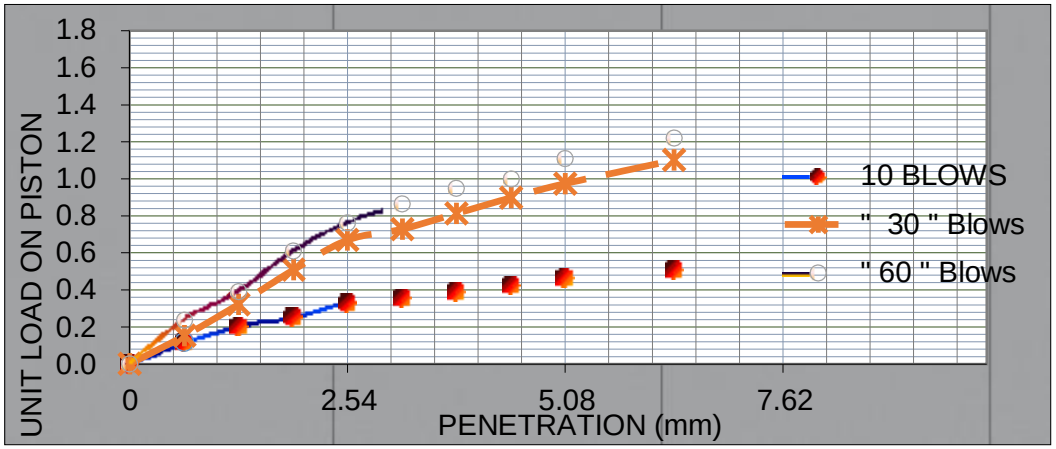
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8300.0 | 8866.0 | 8921.0 | 8716.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4954 | 4954 | 4954 | 4954 | |
| | VOL.OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,346 | 3,912 | 3,967 | 3,762 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.58 | 1.84 | 1.87 | 1.77 | **NMC** |
| MOISTURE | Can no. | **13** | **18** | **35** | **47** | **Z** |
| | WET SOIL + Can (g) a | 198.3 | 184.5 | 173.8 | 170.7 | 190.5 |
| | DRY SOIL + Can (g) b | 174.3 | 155.8 | 141.7 | 135.2 | 175.0 |
| | Wt. OF Can (g) c | 28.2 | 28.4 | 25.2 | 27.1 | 27.2 |
| | Wt. OF WATER (g) d = a-b | 24.0 | 28.7 | 32.1 | 35.5 | 15.5 |
| | Wt. OF DRY SOIL (g) e =b-c | 146.1 | 127.4 | 116.5 | 108.1 | 147.8 |
| | **w (%) m=** | 16.43 | 22.53 | 27.55 | 32.84 | 10.49 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.35 | 1.50 | 1.46 | 1.33 | |

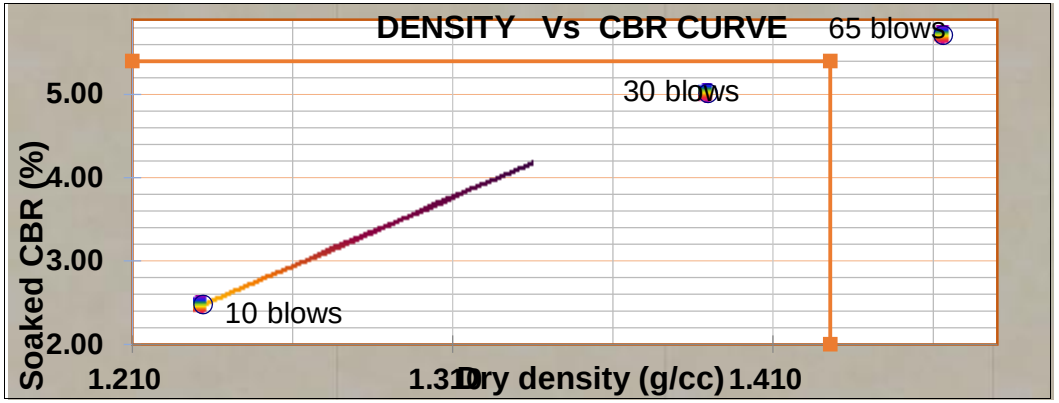


**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 7 | 0.119 | 9 | 0.152 | 14 | 0.237 |
| 1.27 | 12 | 0.203 | 19 | 0.322 | 23 | 0.389 |
| 1.91 | 15 | 0.254 | 30 | 0.508 | 36 | 0.609 |
| 2.54 | 20 | 0.330 | 40 | 0.669 | 45 | 0.762 |
| 3.18 | 21 | 0.356 | 43 | 0.728 | 51 | 0.863 |
| 3.81 | 23 | 0.389 | 48 | 0.813 | 56 | 0.948 |
| 4.45 | 25 | 0.423 | 53 | 0.897 | 59 | 0.999 |
| 5.08 | 28 | 0.466 | 58 | 0.973 | 66 | 1.109 |
| 6.35 | 30.0 | 0.508 | 65 | 1.100 | 72 | 1.219 |




| BLOWS | DD (g/Cm3) | | | | | | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.23** | 0.33 | 0.47 | 13.40 | 20.00 | 2.5 | 2.3 | 2.5 |
| **30** | **1.39** | 0.67 | 0.97 | 13.40 | 20.00 | 5.0 | 4.9 | 5.0 |
| **65** | **1.46** | 0.76 | 1.11 | 13.40 | 20.00 | 5.7 | 5.5 | 5.7 |

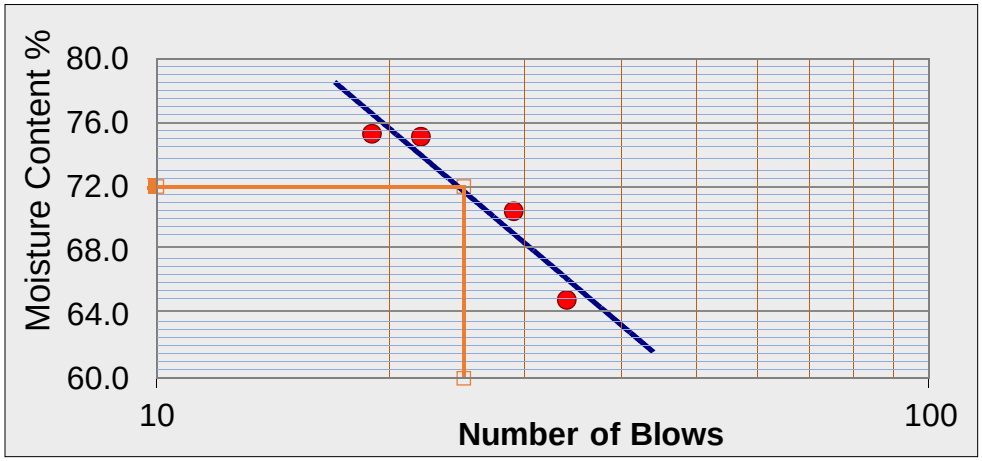



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.503 g/cm3 and OMC = 23%** |
| **From the Density-CBR Curve at 95% MDD (1.4238g/cm3): CBR =5.4** |

**Sample No.: 38 Location of Sample @ Station 39+000KM: Visual Soil Description Dark Brown Clay Soil**

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 34 | 29 | 22 | 19 | | |
| Can No. | D3 | 78 | 98 | 16 | 22 | F2 |
| Weight of Can +Wet Soil (g= ($W_1$) | 44.07 | 50.72 | 52.48 | 55.68 | 26.83 | 31.59 |
| Weight of Can + Dry Soil (g= ($W_2$) | 34.34 | 39.82 | 38.52 | 42.01 | 24.41 | 27.98 |
| Weight of Can (g) = ($W_3$) | 19.35 | 24.35 | 19.94 | 23.86 | 19.03 | 19.91 |
| Wt. of Moisture(g)=($W_1$ - $W_2$) = A | 9.73 | 10.90 | 13.96 | 13.67 | 2.42 | 3.61 |
| Wt. of Dry Soil (g)=($W_2$ - $W_3$) = B | 14.99 | 15.47 | 18.58 | 18.15 | 5.38 | 8.07 |
| w (%) =(A / B )x 100 | 64.91 | 70.46 | 75.13 | 75.32 | 44.98 | 44.73 |
| **PL=LL-PL=72-45=27** | | | | AV.PL | 45 | |



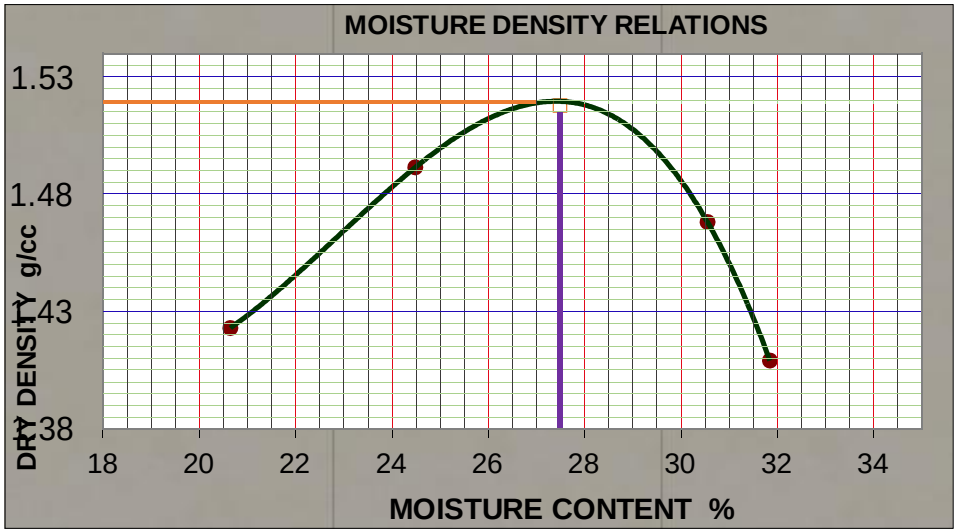
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 27 | 5.40 | 94.60 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 96 | 19.20 | 75.40 | | | |
| 0.075 | 189 | 37.80 | 37.60 | | | |
| total | 500 | | | A-7-5(5) | **SM** | **S1** |

**1.3 MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

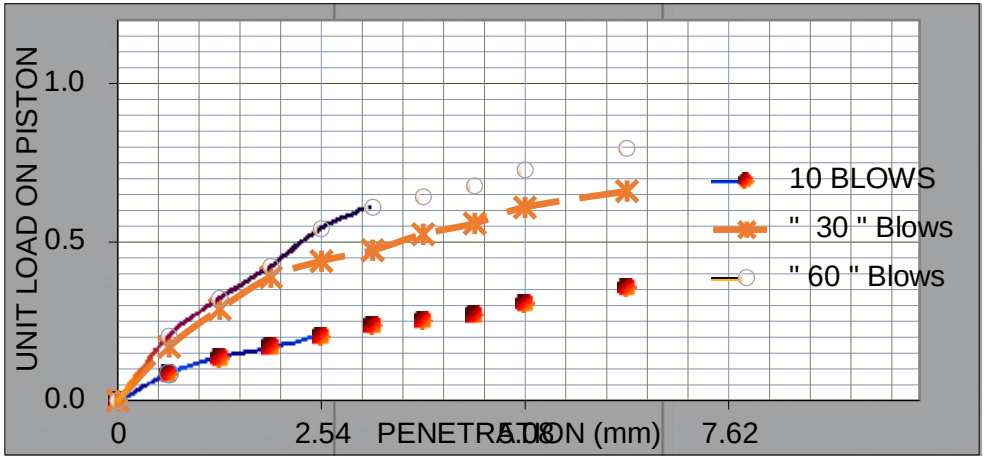
**1.3.1**

| | TRIAL NUMBER | **1** | **2** | **3** | **4** | |
|---|---|---|---|---|---|---|
| DENSITY | Wt. OF SOIL + MOULD (g) $W_1$ | 8600.0 | 8897.0 | 9025.0 | 8900.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4953 | 4953 | 4953 | 4953 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,647 | 3,944 | 4,072 | 3,947 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.72 | 1.86 | 1.92 | 1.86 | **NMC** |
| MOISTURE | Can No. | **21** | **47** | **35** | **T** | **K** |
| | WET SOIL + Can (g) a | 224.6 | 208.7 | 168.6 | 186.1 | 186.4 |
| | DRY SOIL + Can (g) b | 190.9 | 172.6 | 135.5 | 147.9 | 171.9 |
| | Wt. OF Can (g) c | 27.7 | 25.2 | 27.2 | 28.0 | 27.7 |
| | Wt. OF WATER (g) d = a-b | 33.7 | 36.1 | 33.1 | 38.2 | 14.5 |
| | Wt. OF DRY SOIL (g) e =b-c | 163.2 | 147.4 | 108.3 | 119.9 | 144.2 |
| | **w (%) m= (d/e)*100** | 20.65 | 24.49 | 30.56 | 31.86 | 10.06 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.42 | 1.49 | 1.47 | 1.41 | |



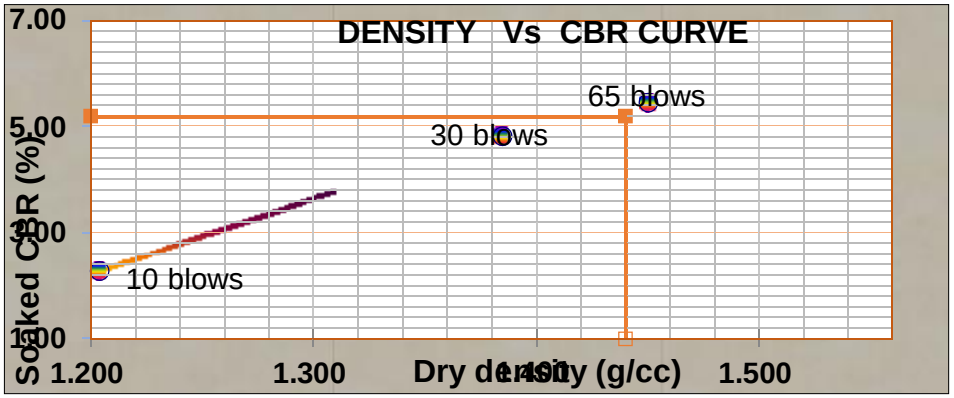

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 5 | 0.085 | 8 | 0.135 | 13 | 0.220 |
| 1.27 | 10 | 0.169 | 18 | 0.305 | 22 | 0.372 |
| | | | | | | |
| 2.54 | 18 | 0.305 | 38 | 0.643 | 43 | 0.728 |
| 3.18 | 20 | 0.339 | 42 | 0.711 | 50 | 0.847 |
| 3.81 | 22 | 0.372 | 47 | 0.796 | 55 | 0.931 |
| 4.45 | 24 | 0.406 | 52 | 0.880 | 58 | 0.982 |
| 5.08 | 25 | 0.423 | 56 | 0.948 | 64 | 1.084 |
| 6.35 | 29.0 | 0.491 | 64 | 1.084 | 71 | 1.202 |



## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.20** | 0.30 | 0.42 | 13.40 | 20.00 | 2.3 | 2.1 | 2.3 |
| **30** | **1.39** | 0.64 | 0.95 | 13.40 | 20.00 | 4.8 | 4.7 | 4.8 |
| **65** | **1.45** | 0.73 | 1.08 | 13.40 | 20.00 | 5.5 | 5.4 | 5.5 |

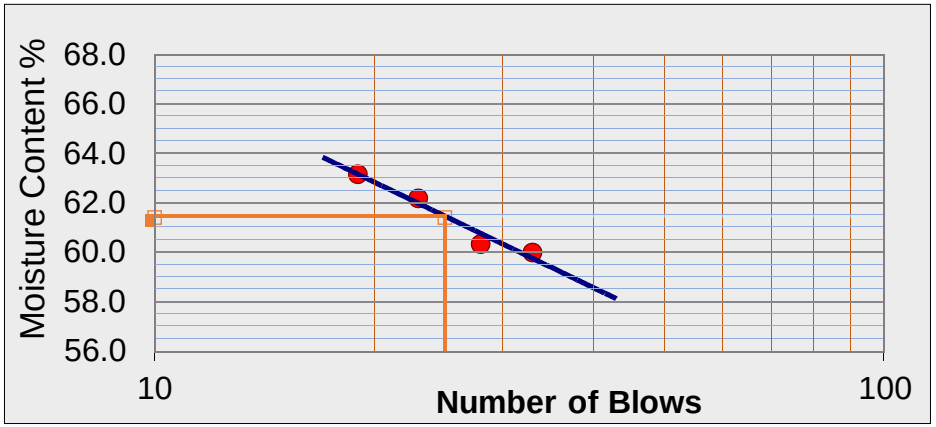



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.516 g/cm3 and OMC = 27.5%** |
| **From the Density-CBR Curve at 95% MDD (1.4402g/cm3): CBR =5.2** |

**Sample No.: 39, Location of Sample @ Station 39+500KM: Visual Soil Description Brown Clay Soil**

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | | PL | |
|---|---|---|---|---|---|---|
| No. of Blows | 33 | 28 | 23 | 19 | | |
| Can No. | 1 | 96 | 12 | B | Zt | 16 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 43.50 | 45.60 | 44.67 | 38.22 | 26.73 | 28.93 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 34.46 | 35.82 | 36.45 | 31.26 | 24.96 | 27.34 |
| Weight of Can (g) = ($W_3$) | 19.38 | 19.61 | 23.24 | 20.23 | 21.03 | 23.81 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 9.04 | 9.78 | 8.22 | 6.96 | 1.78 | 1.58 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 15.08 | 16.21 | 13.22 | 11.03 | 3.93 | 3.53 |
| Moisture Content (%) = (A / B )x 100 | 59.98 | 60.32 | 62.17 | 63.16 | 45.27 | 44.83 |
| **PI=LL-PL=61-45=16** | | | | AVPL. | 45.1 | |




1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

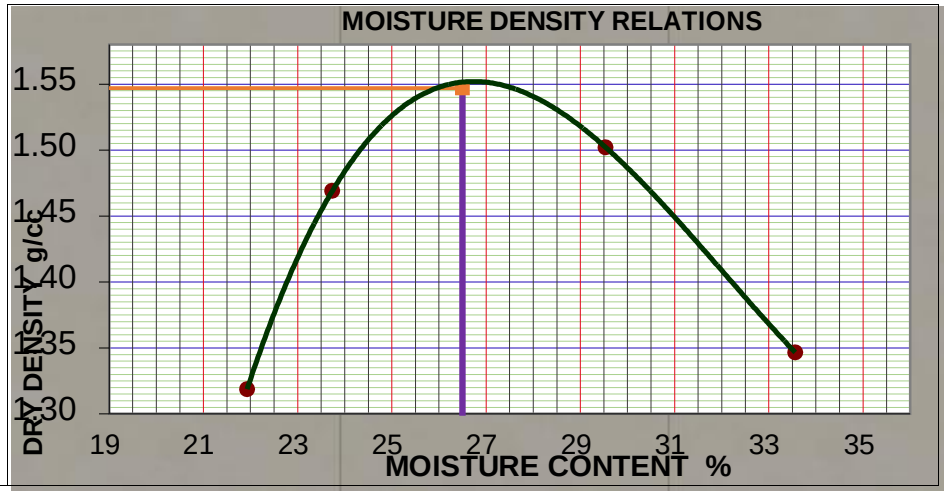
| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 21 | 4.20 | 95.80 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 148 | 29.60 | 66.20 | | | |
| 0.075 | 83 | 16.60 | 49.60 | | | |
| total | 500 | | | A-7-5(7) | **SM** | **S3** |

## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**MOISTURE DENSITY RELATIONSHIP OF SOIL ( AASHTO T-180 METHOD D)**

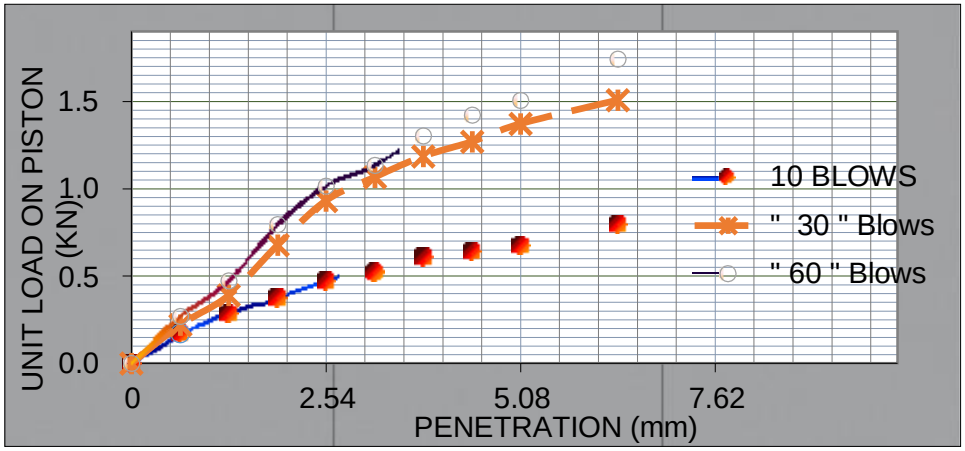
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | **1** | **2** | **3** | **4** | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8375.0 | 8821.0 | 9093.0 | 8780.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,415 | 3,861 | 4,133 | 3,820 | |
| | WET DENSITY OF SOIL ( $g/Cm^3$ ) $W_d = W_3/V$ | 1.61 | 1.82 | 1.95 | 1.80 | **NMC** |
| MOISTURE | Can No. | **1** | **12** | **S** | **J** | **P** |
| | WET SOIL + Can (g) a | 236.0 | 236.9 | 216.5 | 202.8 | 231.9 |
| | DRY SOIL + Can (g) b | 198.5 | 196.9 | 173.5 | 158.6 | 210.6 |
| | Wt. OF Can (g) c | 27.5 | 28.4 | 27.9 | 26.9 | 28.5 |
| | Wt. OF WATER (g) d = a-b | 37.5 | 40.0 | 43.0 | 44.2 | 21.3 |
| | Wt. OF DRY SOIL (g) e =b-c | 171.0 | 168.5 | 145.6 | 131.7 | 182.1 |
| | **w (%) m=** | 21.93 | 23.74 | 29.53 | 33.56 | 11.70 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.32 | 1.47 | 1.50 | 1.35 | |

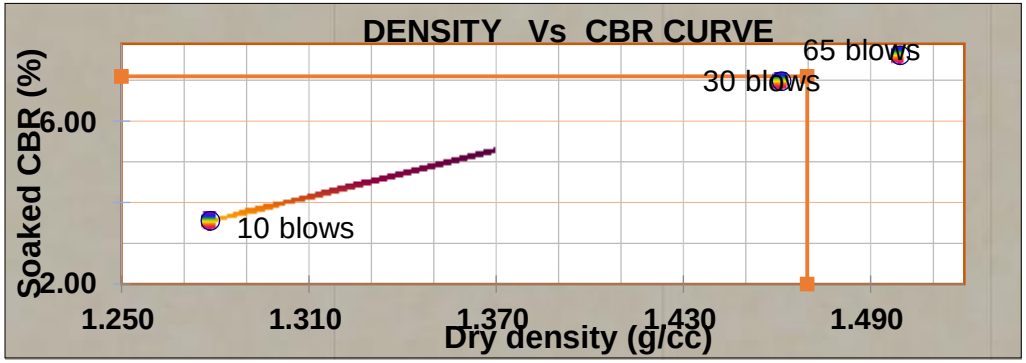



**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 10.0 | 0.169 | 13.0 | 0.220 | 16.0 | 0.271 |
| 1.27 | 17.0 | 0.288 | 23.0 | 0.389 | 28.0 | 0.474 |
| 1.91 | 22.0 | 0.372 | 40.0 | 0.677 | 47.0 | 0.796 |
| 2.54 | 28.0 | 0.474 | 55.0 | 0.931 | 60.0 | 1.016 |
| 3.18 | 31.0 | 0.525 | 63.0 | 1.067 | 67.0 | 1.134 |
| 3.81 | 36.0 | 0.609 | 70.0 | 1.185 | 77.0 | 1.304 |
| 4.45 | 38.0 | 0.643 | 75.0 | 1.270 | 84.0 | 1.422 |
| 5.08 | 40.0 | 0.677 | 81.0 | 1.371 | 89.0 | 1.507 |
| 6.35 | 47.0 | 0.796 | 89.0 | 1.507 | 103.0 | 1.744 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | St. Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 | 2.54 | 5.08 | 2.54 | 5.08 | |
| **10** | **1.28** | 0.47 | 0.68 | 13.40 | 20.00 | 3.6 | 3.4 | 3.6 |
| **30** | **1.46** | 0.93 | 1.37 | 13.40 | 20.00 | 7.0 | 6.9 | 7.0 |
| **65** | **1.50** | 1.02 | 1.51 | 13.40 | 20.00 | 7.6 | 7.5 | 7.6 |



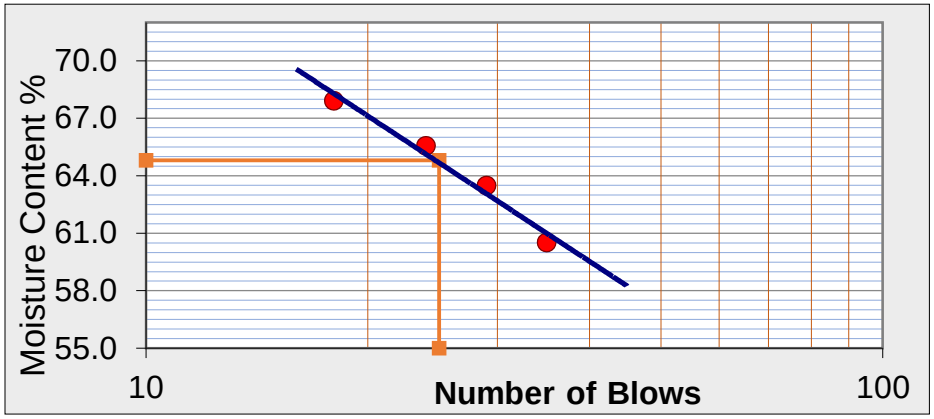

| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.547 g/cm3 and OMC = 26.5%** |
| **From the Density-CBR Curve at 95% MDD (1.4696g/cm3): CBR =7.1** |

## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

## Sample No.: 40, Location of Sample @ Station 40+000KM: Visual Soil Description Red Brown Clay Soil

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | PL | | |
|---|---|---|---|---|---|---|
| No. of Blows | 35 | 29 | 24 | 18 | | |
| Can No. | 78 | 15 | D3 | 17 | 14 | 2 |
| Weight of Can + Wet Soil (g) = ($W_1$) | 50.17 | 45.63 | 39.49 | 41.77 | 28.47 | 24.85 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 40.38 | 37.37 | 31.53 | 34.25 | 26.97 | 23.30 |
| Weight of Can (g) = ($W_3$) | 24.22 | 24.36 | 19.39 | 23.18 | 23.58 | 19.75 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 9.78 | 8.26 | 7.96 | 7.52 | 1.50 | 1.55 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 16.17 | 13.01 | 12.14 | 11.07 | 3.39 | 3.55 |
| w (%) = (A / B )x 100 | 60.51 | 63.48 | 65.55 | 67.92 | 44.24 | 43.68 |
| **PI=LL-PL=65-44=21** | | | | AVPL | 44.0 | |

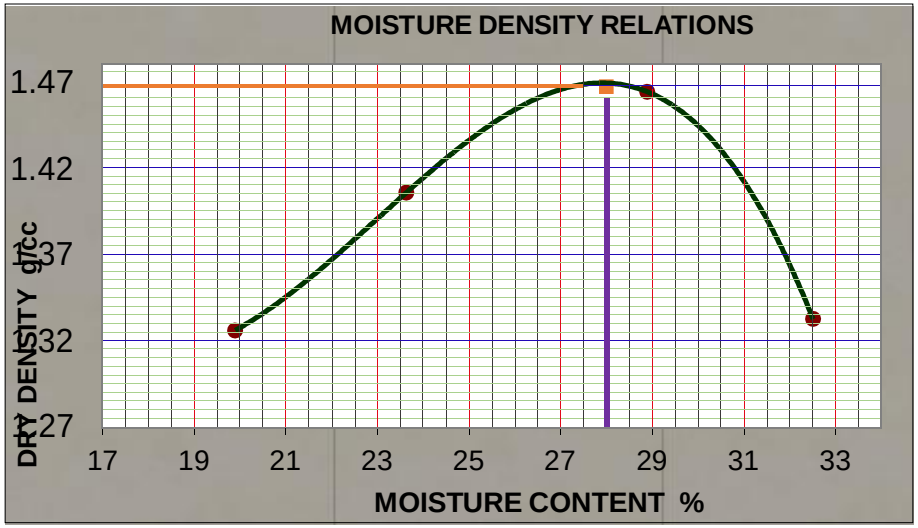



1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| 2.0 mm | 21 | 4.20 | 95.80 | AASHTO | USCS | ERA Subgrade |
| 0.425 | 148 | 29.60 | 66.20 | | | |
| 0.075 | 183 | 36.60 | 29.60 | | | |
| total | 500 | | | A2-7(2) | **SM** | **S3** |

**1.3.1**

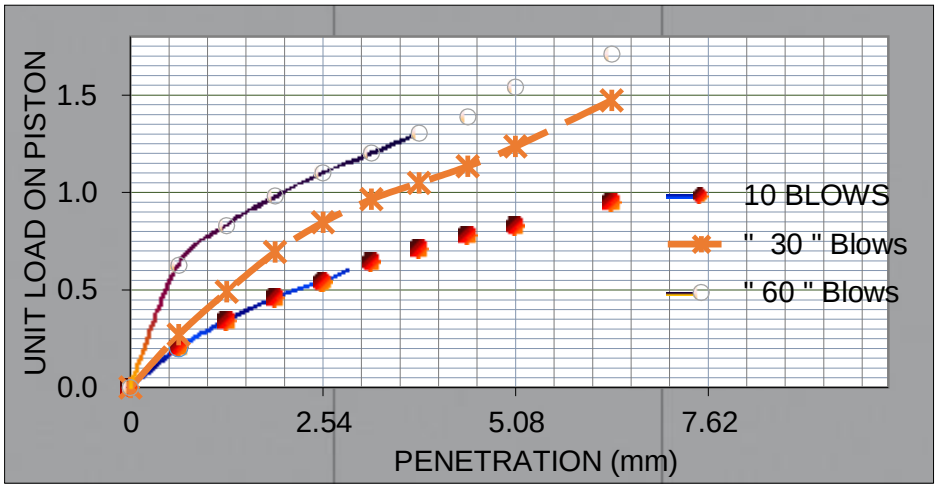
| | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
|---|---|---|---|---|---|---|
| DENSITY | Wt. OF SOIL + MOULD (g) $W_1$ | 8336.0 | 8651.0 | 8968.0 | 8710.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4960 | 4960 | 4960 | 4960 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3 = W_1-W_2$ | 3,376 | 3,691 | 4,008 | 3,750 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) $W_d = W_3/V$ | 1.59 | 1.74 | 1.89 | 1.77 | **NMC** |
| MOISTURE | Can No. | 11 | 15 | 25 | 35 | **47.000** |
| | WET SOIL + Can (g) a | 213.4 | 232.2 | 214.9 | 198.4 | 216.0 |
| | DRY SOIL + Can (g) b | 182.7 | 193.3 | 172.8 | 155.9 | 199.2 |
| | Wt. OF Can (g) c | 28.4 | 28.7 | 27.1 | 25.2 | 27.1 |
| | Wt. OF WATER (g) d = a-b | 30.7 | 38.9 | 42.1 | 42.5 | 16.8 |
| | Wt. OF DRY SOIL (g) e =b-c | 154.3 | 164.6 | 145.7 | 130.7 | 172.1 |
| | **w (%) m= (d/e)*100** | 19.90 | 23.63 | 28.89 | 32.52 | 9.76 |
| **SOIL DRY DENSITY ( g/Cm3 ) $D_d = W_d/(100+m)*100$** | | 1.33 | 1.41 | 1.46 | 1.33 | |



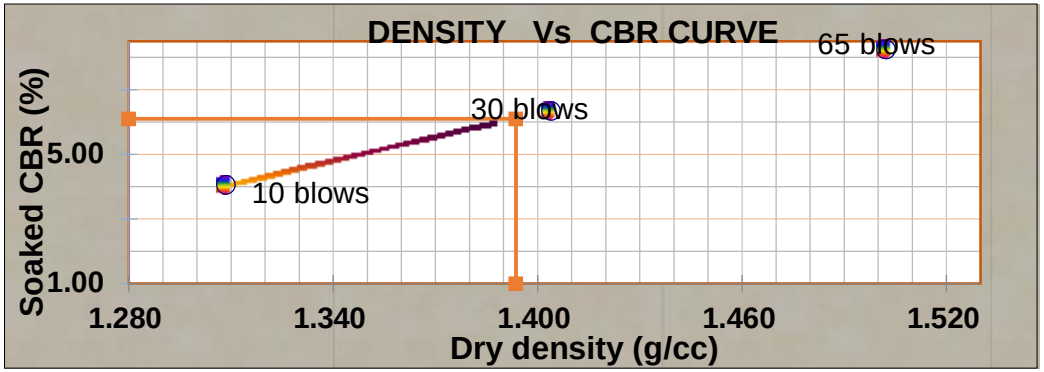
## Prediction of Soaked CBR value From Index Properties and Compaction Characteristic of Subgrade Soils

**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 12.0 | 0.203 | 16.0 | 0.271 | 37.0 | 0.626 |
| 1.27 | 20.0 | 0.339 | 29.0 | 0.491 | 49.0 | 0.830 |
| 1.91 | 27.0 | 0.457 | 41.0 | 0.694 | 58.0 | 0.982 |
| 2.54 | 32.0 | 0.542 | 50.0 | 0.847 | 65.0 | 1.100 |
| 3.18 | 38.0 | 0.643 | 57.0 | 0.965 | 71.0 | 1.202 |
| 3.81 | 42.0 | 0.711 | 62.0 | 1.050 | 77.0 | 1.304 |
| 4.45 | 46.0 | 0.779 | 67.0 | 1.134 | 82.0 | 1.388 |
| 5.08 | 49.0 | 0.830 | 73.0 | 1.236 | 91.0 | 1.541 |
| 6.35 | 56.0 | 0.948 | 87.0 | 1.473 | 101.0 | 1.710 |




| BLOWS | DD (g/Cm3) | LOAD (KN) | | St. Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.31** | 0.54 | 0.83 | 13.40 | 20.00 | 4.1 | 4.1 | 4.1 |
| **30** | **1.40** | 0.85 | 1.24 | 13.40 | 20.00 | 6.3 | 6.2 | 6.3 |
| **65** | **1.50** | 1.10 | 1.54 | 13.40 | 20.00 | 8.2 | 7.7 | 8.2 |

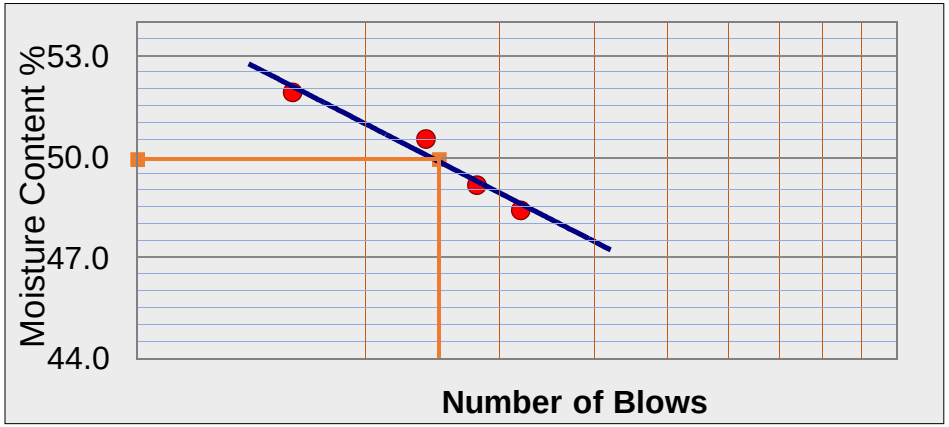



| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.467 g/cm3 and OMC = 28%** |
| **From the Density-CBR Curve at 95% MDD (1.3936g/cm3): CBR =6.1** |

**Sample No.: 41, Location of Sample @ Station 41+000KM: Visual Soil Description Dark Brown Clay Soil**

**1 SOIL CONSISTENCY TEST RESULT (AASHTO T89, T90)**

| | LL | | | PL | | |
|---|---|---|---|---|---|---|
| No. of Blows | 32 | 28 | 24 | 16 | | |
| Can No. | 2 | 94 | 13 | 16 | DV | B8 |
| Weight of Can + Wet Soil (g)= ($W_1$) | 34.80 | 33.80 | 38.90 | 43.10 | 22.76 | 24.04 |
| Weight of Can + Dry Soil (g) = ($W_2$) | 29.89 | 29.19 | 34.03 | 36.51 | 21.50 | 22.82 |
| Weight of Can (g) = ($W_3$) | 19.75 | 19.80 | 24.40 | 23.80 | 18.10 | 19.70 |
| Wt. of Moisture (g) = ($W_1$ - $W_2$) = A | 4.91 | 4.61 | 4.87 | 6.60 | 1.27 | 1.22 |
| Wt. of Dry Soil (g) = ($W_2$ - $W_3$) = B | 10.14 | 9.39 | 9.63 | 12.71 | 3.40 | 3.12 |
| w (%) = (A / B )x 100 | 48.40 | 49.16 | 50.52 | 51.91 | 37.38 | 39.01 |
| **PI=LL-PL=50-38=12** | | | | AV.PL | 38.2 | |



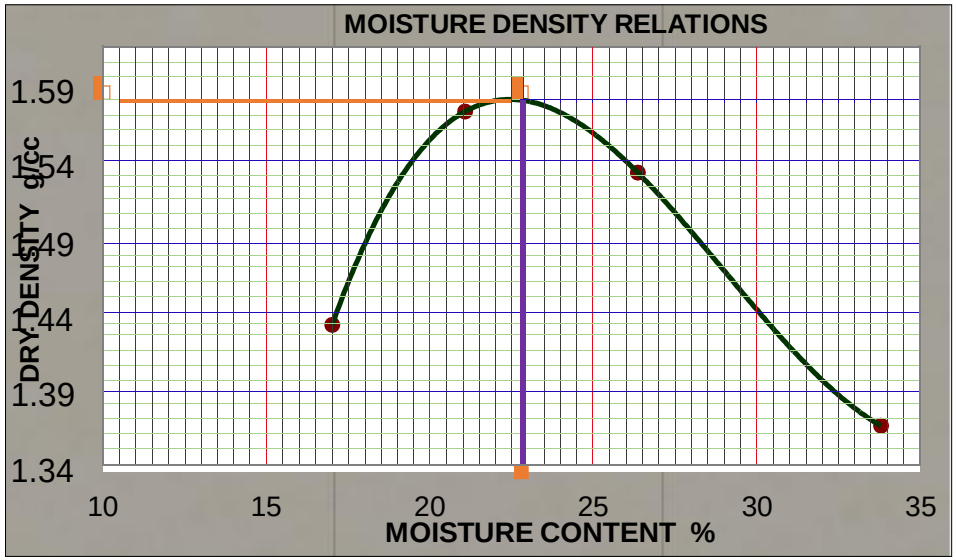
1.2 Particle size Distribution(TEST METHOD AASHTO T-88)

| sieve size(mm) | weight retained | % retained | % pass | Soil Classification | | |
|---|---|---|---|---|---|---|
| | | | | AASHTO | USCS | ERA Subgrade |
| 2.0 mm | 20 | 4.00 | 96.00 | | | |
| 0.425 | 116 | 23.20 | 72.80 | | | |
| 0.075 | 228 | 45.60 | 27.20 | | | |
| total | 500 | | | A-2-7(0) | **SM** | **S4** |

**1.3MOISTURE DENSITY RELATIONSHIP OF SOIL (AASHTO T-180 METHOD D)**

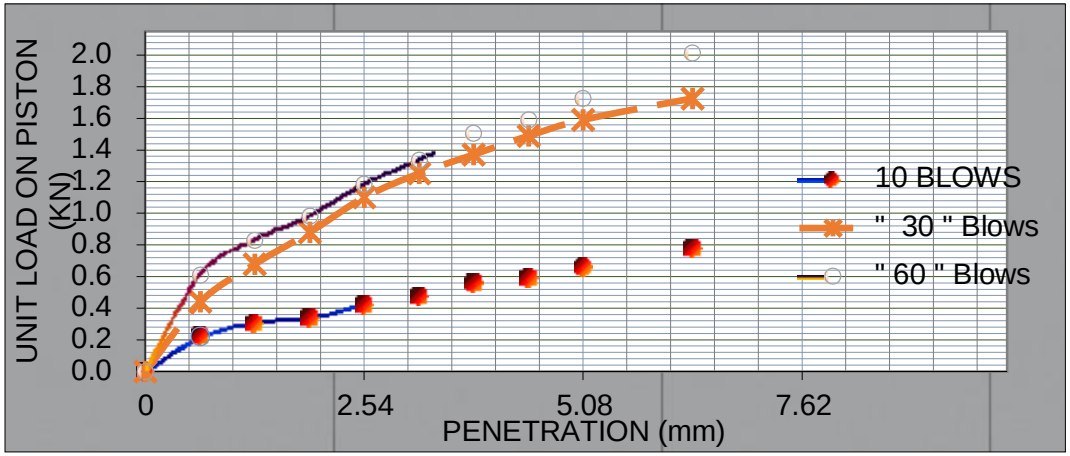
**1.3.1**

| | | | | | | |
|---|---|---|---|---|---|---|
| DENSITY | TRIAL NUMBER | 1 | 2 | 3 | 4 | |
| | Wt. OF SOIL + MOULD (g) $W_1$ | 8526.0 | 9012.0 | 9081.0 | 8850.0 | |
| | Wt. OF MOULD (g) $W_2$ | 4955 | 4955 | 4955 | 4955 | |
| | VOL. OF MOULD ($Cm^3$) V | 2124 | 2124 | 2124 | 2124 | |
| | Wt. OF WET SOIL (g) $W_3$ = | 3,571 | 4,057 | 4,126 | 3,895 | |
| | WET DENSITY OF SOIL ( g/$Cm^3$ ) | 1.68 | 1.91 | 1.94 | 1.83 | **NMC** |
| MOISTURE | Can No. | F | 17 | 1 | w | 47 |
| | WET SOIL + Can (g) a | 226.5 | 194.2 | 214.4 | 185.4 | 204.6 |
| | DRY SOIL + Can (g) b | 197.6 | 165.3 | 175.4 | 145.7 | 199.3 |
| | Wt. of Can (g) c | 27.7 | 28.2 | 27.5 | 28.3 | 27.1 |
| | Wt. OF WATER (g) d = a-b | 28.9 | 28.9 | 39.0 | 39.7 | 5.3 |
| | Wt. OF DRY SOIL (g) e =b-c | 169.9 | 137.1 | 147.9 | 117.4 | 172.2 |
| | **w (%) m=** | 17.01 | 21.08 | 26.37 | 33.82 | 3.08 |
| **DRY DENSITY OF SOIL ( g/Cm3 ) $D_d$ =** | | 1.44 | 1.58 | 1.54 | 1.37 | |




**PENETRATION TEST DATA**

| PENETRATION | 10 Blows | | 30 Blows | | 65 Blows | |
|---|---|---|---|---|---|---|
| (mm) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) | DIAL RDG | LOAD (kn) |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.64 | 13.0 | 0.220 | 26.0 | 0.440 | 36.0 | 0.609 |
| 1.27 | 18.0 | 0.305 | 40.0 | 0.677 | 49.0 | 0.830 |
| 1.91 | 20.0 | 0.339 | 52.0 | 0.880 | 58.0 | 0.982 |
| 2.54 | 25.0 | 0.423 | 65.0 | 1.100 | 70.0 | 1.185 |
| 3.18 | 28.0 | 0.474 | 74.0 | 1.253 | 79.0 | 1.337 |
| 3.81 | 33.0 | 0.559 | 81.0 | 1.371 | 89.0 | 1.507 |
| 4.45 | 35.0 | 0.593 | 88.0 | 1.490 | 94.0 | 1.591 |
| 5.08 | 39.0 | 0.660 | 94.0 | 1.591 | 102.0 | 1.727 |
| 6.35 | 46.0 | 0.779 | 102.0 | 1.727 | 119.0 | 2.015 |



| BLOWS | DD (g/Cm3) | LOAD (KN) | | Standard Load(KN) | | CBR (%) | | CBR (%) |
|---|---|---|---|---|---|---|---|---|
| | | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | 2.54 mm | 5.08 mm | |
| **10** | **1.35** | 0.42 | 0.66 | 13.40 | 20.00 | 3.2 | 3.3 | 3.2 |
| **30** | **1.48** | 1.10 | 1.59 | 13.40 | 20.00 | 8.2 | 8.0 | 8.2 |
| **65** | **1.58** | 1.19 | 1.73 | 13.40 | 20.00 | 8.9 | 8.6 | 8.9 |

| Ring Factor =0.01693kN/Div |
|---|
| **From the compaction curve: MDD = 1.59 g/cm3 and OMC = 22.8%** |
| **From the Density-CBR Curve at 95% MDD (1.5105g/cm3): CBR =8.75** |