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Properties of Sub Grade Soil of Pavement Construction

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ABSTRACT: Design of the various pavement layers is very much dependent on the strength of the sub grade soil over which they are going to be laid. Sub grade strength is also depending on the basic properties of the soil. Subgrade strength is mostly expressed in terms of CBR (California Bearing Ratio). Weaker sub grade essentially requires thicker layers whereas stronger sub grade goes well with thinner pavement layers. The pavement and the sub grade mutually must sustain the traffic volume. The Indian Road Congress (IRC) encodes the exact design strategies of the pavement layers based upon the sub grade strength. The sub grade is always subjected to change in its moisture content due to rainfall, capillary action, overflow or rise of water table. For an engineer, it's important to understand the change of sub grade strength due to variation of moisture content. This project is an attempt to understand the basic properties of sub grade such as moisture content, specific gravity, index properties, particle size distribution, optimum moisture content and maximum dry density.

KEYWORDS: moisture content, specific gravity, Index properties, particle size distribution, MDD & OMC.

I. INTRODUCTION

A pavement is a durable surface having materials laid down on an area subjected to sustain mainly the vehicular traffic, such as a road or highway. A pavement is typically a structure of various layers resting over soil either in embankment or in cutting. In the past, cobblestones and granite sets were extensively used, but these surfaces have mostly been replaced by asphalt or concrete now-a-days. A pavement is classified in general in two categories, i.e. namely a flexible pavement and a rigid pavement. The flexible pavement consists of granular layers of superior quality in upper layers with a preferably bituminous topping, while a concrete pavement consists of a cement concrete slab over occasional granular layers. The design of pavement has seen several modifications over the years. Traditionally the design of either kind of pavement is based on the strength of the compacted soil in the pavement, called sub grade. The design of the pavement layers laid over the sub grade soil starts off with the determination of sub grade strength and the traffic volume which is to be carried. The design of pavement is very much dependent on the sub grade strength of soil. Design criteria mainly needs thickness of layers. Weaker sub grade needs thicker layers whereas stronger sub grade needs thinner pavement layers. The Indian Road Congress (IRC) provides the exact procedures for the pavement layers design which based upon the sub grade strength.

II. EXPERIMENTAL INVESTIGATION

The entire investigations have been conducted on three type of soil, .i.e. 1.Red Soil (from village Shambhupura tehsil nimbaheda and district Chittorgarh.) & 2.Black Cotton Soil (from Nimabaheda tehsil District chittorgarh) & Sandy soil (from chittorgarh district) .

The experimental work comprises in the following parts.

- i. Moisture content by oven drying method.

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- ii. Specific gravity by pycnometer method.
- iii. Determination of index property
 - Liquid limit by liquid limit device
 - Plastic limit
 - Plastic Index
- iv. Particle size distribution
- v. Estimation of maximum dry density and optimum moisture content by modified proctor test

III. ANALYSIS AND DISCUSSION

The main objective of this study is to determine the basic soil properties of sub grade soil of different places such as Chittorgarh, Nimbaheda, Shambhupura.

1sub grade soil of chittorgarh

Table -properties of chittorgarh soil.

Properties of soil	Chittorgarh
Type of soil	Sandy soil
Water content	8.09
Specific gravity	2.28
Liquid limit	18.065
Plastic limit	None
Plastic index	None
Optimum moisture content	10.46
Max. dry density	1.29

In this region of study red sandy soils are soft and can be cut with a chisel when wet. However these harden with time. The plasticity of the red sandy soils decreases with depth as they approach the parent rock. These soils especially those which contain iron oxide have relatively high specific gravity. Maximum dry density of sandy soil is maximum as compare to other soil.

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2 sub grade soil of Nimbaheda.

Table - properties of chittorgarh soil.

Properties of soil	Nimbaheda
Type of soil	Black cotton soil
Water content	9.95
Specific gravity	2.19
Liquid limit	45.69
Plastic limit	40
Plastic index	5.69
Optimum moisture content	13.059
Max. dry density	1.178

In this region soils have high shrinkage and swelling characteristics. The shearing strength of the soils is extremely low. The soils are highly compressible and have very low bearing capacity. It is extremely difficult to work with such soils. Optimum moisture content of these soil is high as compare to other soil but due swelling properties the bearing capacity of this soil is very low. black cotton soil is not suitable for subgrade due to its swelling characteristics and causing number of damages to the structures particularly light buildings and pavements. And this soil is required stabilization to construction of pavement

3 sub grade soil of Shambhupura.

Table - properties of chittorgarh soil

Properties of soil	Shambhupura
Type of soil	Red soil
Water content	13.52
Specific gravity	2.07
Liquid limit	28.93
Plastic limit	17.48
Plastic index	11.45
Optimum moisture content	9.36
Max. dry density	1.267

They are less clayey and sandier and are poor in important minerals like lime, phosphorous and nitrogen. Red soil is

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acidic like that of the Lateritic soil. This soil is mainly cultivated during the monsoon rainy season. OMC of these soil is minimum as compared to black cotton and sandy soil .

IV. COMPARISION

A good pavement is needed for the safe, comfortable and economical movement of traffic. The thickness of road depends on geotechnical properties of subgrade soil and traffic intensity. The soil having more liquid limit (LL), lower Maximum dry density (MDD) and higher Optimum moisture content (OMC) is suitable for subgrade of road.

Table - Comparison of properties of Nimbaheda, Shambhupura Chittorgarh's soil

Properties of soil	Chittorgarh	Nimbaheda	Shambhupura
Type of soil	Sandy soil	Black cotton soil	Red soil
Water content	8.09	9.95	13.52
Specific gravity	2.28	2.19	2.07
Liquid limit	18.065	45.69	28.93
Plastic limit	None	40	17.48
Plastic index	None	5.69	11.45
Optimum moisture content	10.46	13.059	9.36
Max. dry density	1.29	1.178	1.267

According to liquid limit, MDD & OMC the black cotton soil is more suitable for pavement construction but due to swelling characteristics of black cotton soil, these all properties are not sufficient for pavement construction, there is requirement of stabilization. According to the specific gravity , the Specific gravity of sandy soil is more than black cotton soil and red soil so the sandy soil is more suitable soil for pavement construction. According to the liquid limit & MDD Red soil is more suitable as compare to sandy soil for pavement. ButAccording to OMCsandy soil is perfect for pavement construction as compare to the red soil

V. CONCLUSION

Following conclusions are made on the basis of the test results.

1. The basic laboratory test results showed that the soil has low permeability, low strength and high volume change properties. And the water content of Chittorgarh's soil is 8.09% and water content of Nibaheda's soil is 9.95% and water content of Shambhupura's soil is 13.52 %.
2. The specific gravity of sandy soil which is from Chittorgarh is 2.28, the specific gravity of black cotton soil which is from Nimbaheda is 2.19 and the specific gravity of red soil which is from Shambhupura is 2.07 .So sandy soil is more

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- suitable for pavement construction.
3. The liquid limit of sandy soil is 18.065, black cotton soil is 45.69 and red soil is 28.93. so black cotton soil is perfect for pavement but due to swelling characteristics, red soil is more suitable.
 4. The grain size distribution curve of all three type of soil is show s shape curve, so it is well graded soil.
 5. OMC of sandy soil is 10.46 and MDD is 1.29 gm/cm³. OMC of black cotton soil is 13.059 and MDD is 1.178 gm/cm³. OMC of red soil is 9.36 and MDD is 1.267 gm/cm³. So black cotton soil is perfect for pavement but due to swelling characteristics so according to the OMC sandy soil is suitable and according to the MDD red soil is suitable for pavement construction

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