STUDY ON THE IMPACT OF MOISTURE CONTENT ON SUBGRADE STRENGTH

Isma Lebbe Mohamed Sabri
National Water Supply and Drainage Board, Monaragala, Sri Lanka
msabrila@gmail.com

ABSTRACT: This study presents the relationship between subgrade strength and moisture content. Major function of subgrade is to provide support to pavement. Subgrade soil type, compacted density and moisture significantly affect pavement design. Surface and subsurface drainage of pavement and from adjoining land also affect subgrade strength significantly. Subgrade strength is mostly expressed in terms of California Bearing Ratio. The subgrade strength owing to its inconsistency or variable nature poses a challenge for the engineer to come up with a perfect design pavement. For example, the subgrade is always subjected to change in its moisture content due to precipitation, capillary action, and flood or subside of water table. Change in moisture content causes change in subgrade strength. It becomes quite essential for an engineer to understand the exact nature of dependence of subgrade strength on moisture content. In this study variation of subgrade strength with moisture content was studied considering, the variation of subgrade strength with days soaking and to analyse the relationship between subgrade strength, moisture and days soaking by used statistical software Mnitab16. Thus the different soil samples were tested for their proctor density, optimum moisture content, California Bearing Ratio after being soaked in water for 1 day, 2 days, 3 days and 4 days and Un-soaked for each sample. Study shows that a strong curvilinear correlation between subgrade strength and moisture content. On increasing number of days of soaking, subgrade strength decreases due to increases of moisture content. The rate of change in subgrade strength per percentage change in moisture content during un-soaked from the optimum moisture content was one to seven times larger than during soaking for four days from optimum moisture content with the average of about five times. So it will help design a good road pavement because subgrade is the foundation of road pavement.

Keywords: Subgrade Strength,Moisture Content,California Bearing Ratio

1. INTRODUCTION

This study presents the relationship between subgrade strength and moisture content. Major function of subgrade is to provide support to pavement. Subgrade soil type, compacted density and moisture significantly affect pavement design. Surface and subsurface drainage of pavement and from adjoining land also affect subgrade strength significantly.Subgrade strength is mostly expressed in terms of California Bearing Ratio (CBR). The subgrade strength owing to its inconsistency or variable nature poses a challenge for the engineer to come up with a perfect design pavement. It becomes quite essential for an engineer to understand the exact nature of dependence of subgrade strength on moisture content.

2. METHODOLOGY

2.1 Experiment

The subgrade soil samples viz.1, 2, 3,4,5,6,7,8,9 and 10 moulded at its optimum moisture content to its proctor density was tested for its California Bearing Ratio (CBR) strength. Thus the process comprises as estimation of proctor density and optimum moisture content for each soil samples also determination of CBR strength of the respective soil samples in moulds using the CBR instrument. Each soil sample is tested for its CBR strength after being soaked in water for 1 day, 2 days, 3 days and 4 days. Un-soaked CBR is also determined for each sample.

2.2 Sampling and Testing

The subgrade soil samples that are used in this study were collected from the road sites in Sammanthurai, Ampara district. The laboratory tests carried out on the subgrade soil compaction and CBR were in accordance with British Standard Institute (1975) and ASTM (1962)

2.3 Analysis

Statistical package Minitab-16used to analyse the tested results and to fit the statistical models for subgrade strength. To find the best model for subgrade strength tested the factors of the fitted models areR^2 value, S, SSE, Model significant and individual parameter test. By used these all factors an approximately best model was selected.

3. RESULTS AND DISCUSSION

3.1 Estimation of maximum dry density (MDD) and Optimum moisture content (OMC) of subgrade soils

Its shows that there was a slightly increase in the Maximum Dry Density (MDD) with decreasing Optimum Moisture Content (OMC) of subgrade soil in the Figure 1 ,it represents compaction characteristics of subgrade soil peak value of MDD recorded 2.35 g/cm3 on the sample number 2 and minimum value recorded 1.87 g/cm3 on the sample number 8. The maximum of OMC recorded 13.3% on the sample 8 and minimum value recorded 6.7% on the sample number 5 respectively.

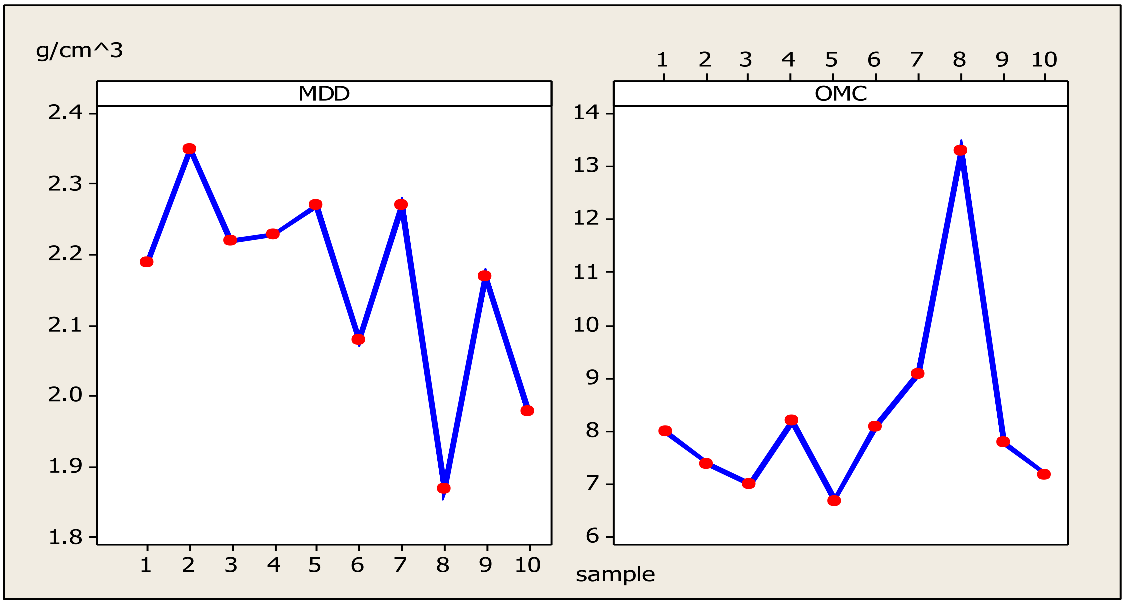

Figure: 1 Plot of MDD and OMC of various subgrade soil samples

3.2 Estimation of moisture content and subgrade strength of various subgrade samples with different days of soaked and un-soaked

It shows that the CBR values of un-soaked subgrade soil higher than soaked subgrade soil and dramatic loss of strength is observed when un-soaked soil is soaked for one day under water. On further increasing the number of days of soaking up to four days, gradual and not dramatic loss of subgrade strength is observed. Hence Figure2 for California bearing ratio of various subgrade soil samples with different days of soaked and un-soaked commences with a steep fall and then goes on with feeble falls.It shows that un-soaked subgrade moisture content were the optimum moisture contents of the sample which were collected. The increase in moisture content is observed when un-soaked soil is soaked for one day under water. On further increasing the number of days of soaking up to four days it observed that the moisture content also increased. Figure 3 clearly shows that how the moisture contents of subgrade soil samples increased with the days of soaked under water respectively. And also its shows that the gradient of increased subgrade moisture contents.

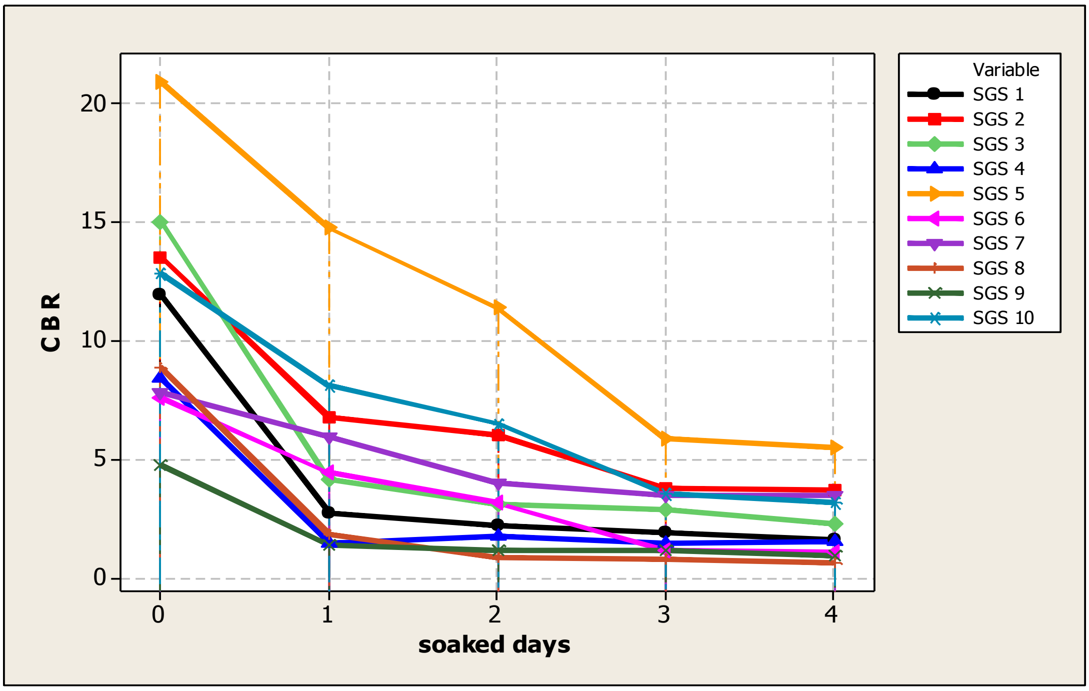

Figure: 2 Plot for California bearing ratio of various subgrade soil samples with different days of soaked and un-soaked

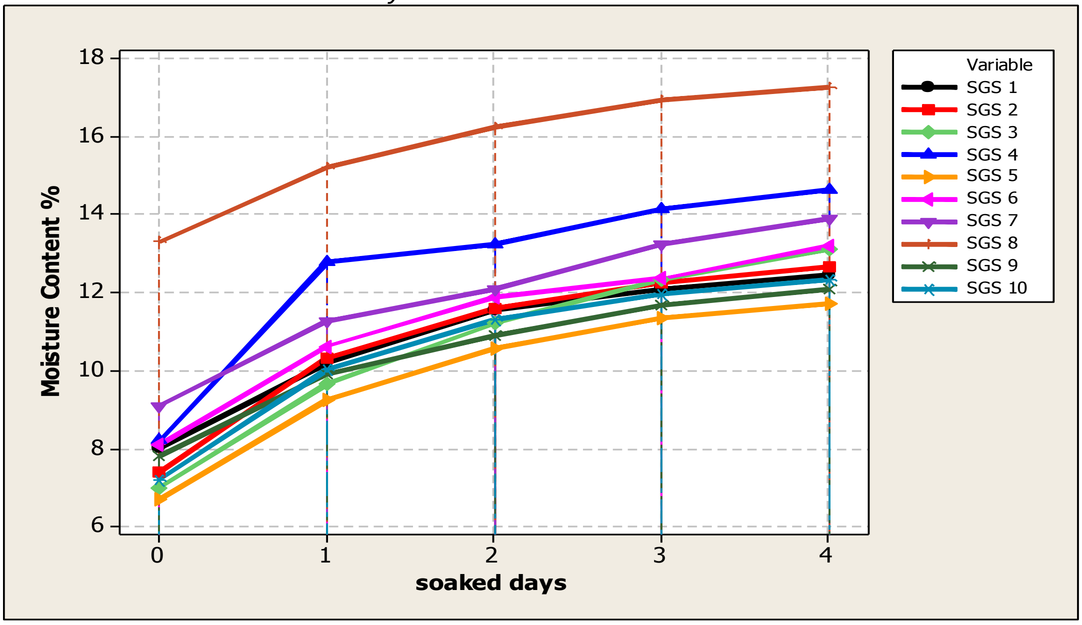

Figure: 3 Plot for Moisture content of various subgrade soil samples with different days of soaked and un-soaked

3.3 Statistical model for subgrade strength (CBR) verses Moisture content

If its consider that both linear and curvilinear regression models for subgrade strength (CBR) with its Moisture content it can be summarized in the Table 1 of statistical analyses for statistical model for subgrade strength (CBR) with Moisture content.Among those five statistical models which were statistically analysed all five statistical models are statistically significant at 5% of significant level but higher R square value which is 65.0% and low standard error which is 2.72961 for the statistical model shows in equation 1 that is the model for subgrade strength shows in the equation 2.So it can used to predict subgrade strength by used only moisture content. Figure 4 shows that envelop for subgrade strength verses moisture content. It can be used to predict subgrade strength if its moisture content known. It's very simple to get the subgrade strength from its moisture content via projecting line as shown in figure 4 respectively but the envelop shows that the increment of subgrade strength (CBR) with the moisture content after 15.75% moisture content its normally not happened . So that it can used to predict CBR only up to 15% of moisture content.

$$Y = a + bX + cX^2 \quad \text{- Equation 1}$$

$$CBR = 43.4 - 5.46(moisture) + .177(moisture)^2 \quad \text{– Equation 2}$$

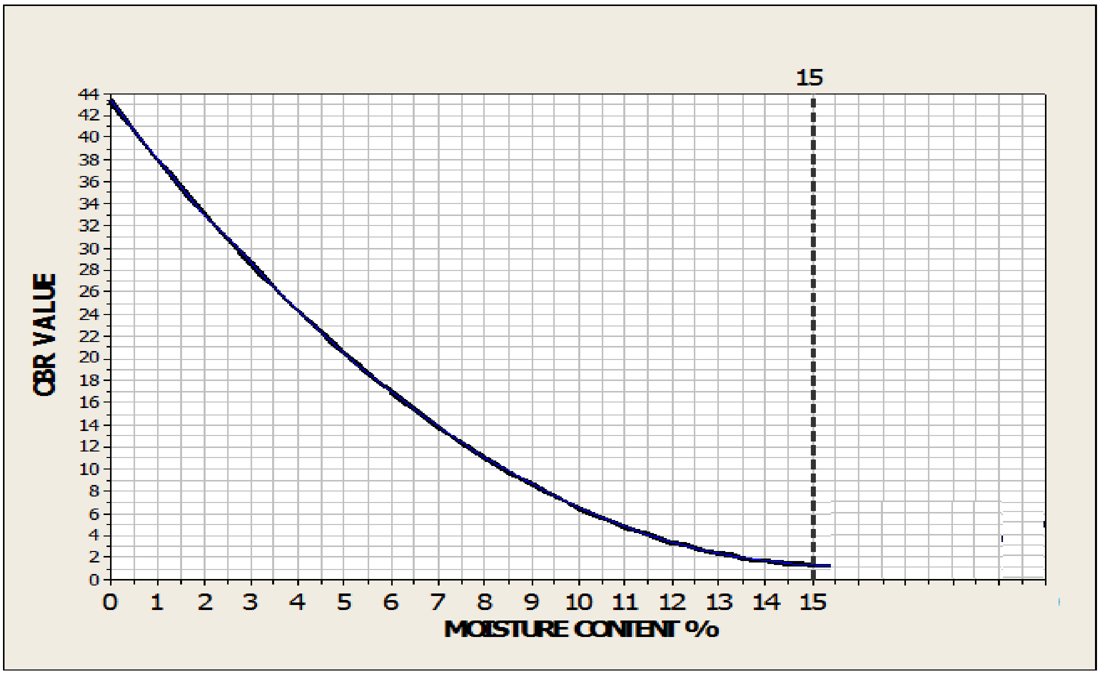

Figure: 4 Envelope for subgrade strength verses moisture content

Table: 1 Statistical analyses for statistical model for subgrade strength (CBR) with Moisture content

Model		$Y= \beta_0 + \beta_1 X$	$Y= \beta_0 + \beta_1 X^2$	$Y= \beta_0 + \beta_1 X^3$	$Y= \beta_0 + \beta_1 X + \beta_2 X^2$	$Y= \beta_0 + \beta_1 X + \beta_2 X^3$
R^2 value		54.4%	46.6%	38.6%	65.0%	64.3%
Adjusted R^2 value		53.5%	45.5%	37.3%	63.5%	62.8%
S		3.08314	3.33617	3.57865	2.72961	2.75818
SSE		1000.97	1000.97	1000.97	1000.97	1000.97
Model significance		P value= 0	P value=0	P value=0	P value=0	P value=0
		Model is statistically significant at 5% of significant level	Model is statistically significant at 5% of significant level	Model is statistically significant at 5% of significant level	Model is statistically significant at 5% of significant level	Model is statistically significant at 5% of significant level
Importance of Slope (β_0) and coefficients (β_1 and β_2)	**β_0**	P value=0	P value=0	P value=0	P value=0	P value=0
		β_0 is Important to the model at 5% of significant level	β_0 is Important to the model at 5% of significant level	β_0 is Important to the model at 5% of significant level	β_0 is Important to the model at 5% of significant level	β_0 is Important to the model at 5% of significant level
	β_1	P value=0	P value=0	P value=0	P value=0	P value=0
		β_1 is Important to the model at 5% of significant level	β_1 is Important to the model at 5% of significant level	β_1 is Important to the model at 5% of significant level	β_1 is Important to the model at 5% of significant level	β_1 is Important to the model at 5% of significant level
	β_2				P value=0	P value=0.001
					β_2 is Important to the model at 5% of significant level	β_2 is Important to the model at 5% of significant level
Significant model		CBR = 20.7 – 1.36 (moisture)	CBR = 12.5 –0.0537 (moisture)^2	CBR= 9.58- 0.00262 (moisture)^3	CBR = 43.4 - 5.46 moisture +0.177(moisture)^2	CBR = 35.4 - 3.35 moisture +0.00476 (moisture)^3

4. CONCLUSIONS

Study shows that a strong curvilinear correlation between subgrade strength and moisture content. On increasing number of days of soaking, subgrade strength decreases due to increases of moisture content. The rate of change in subgrade strength per percentage change in moisture content during un-soaked from the optimum moisture content was one to seven times larger than during soaking for four days from optimum moisture content with the average of about five times based on the laboratory results and analysis of this study, which are applicable to the materials used and the test conditions adopted.

5. REFERENCES

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