IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

AN EXPERIMENTAL STUDY ON INFLUENCE OF SOAKING ON CBR VALUE OF SOIL IN DELHI

[1]Akash sharma, [2]Ravindra Kumar

[1]M. Tech scholar, Vivekananda Global University, Jaipur

[2]Assistant Professor, Vivekananda Global University, Jaipur

I Abstract- This engineering study related to pavement materials, specifically focusing on the California Bearing Ratio (CBR) test and the effects of soaking on CBR values. The CBR test is a common method used to evaluate the strength of subgrade soils and their suitability for supporting pavements. Soaking of soil samples before conducting the CBR test can provide insight into how moisture affects the soil's properties and its ability to bear loads.

This experimental study is done in Delhi, India. In this study, I am investigating the impact of soaking on CBR values, considering different durations of soaking and how they relate to changes in moisture content

The California Bearing Ratio (CBR) test is a widely used method to assess the strength of subgrade soils. It helps determine how well the soil can support the load from the pavement structure. The CBR value indicates the ratio of the force needed to penetrate the soil to a specific depth to the force needed to penetrate a standard crushed rock material.

Soaking soil samples before conducting the CBR test simulates the effect of moisture on soil behavior under load. Moisture content is an important factor in determining soil strength and behavior. The study aims to understand how different durations of soaking impact CBR values and the corresponding changes in moisture content.

Understanding the relationship between moisture content, soaking, and CBR values is crucial for highway engineers. It helps them make informed decisions about the suitability of subgrade soils for pavement construction and maintenance. Rapid estimation of CBR values is particularly valuable for quick assessments in the field.

The aim of this study is to shed light on how soaking impacts CBR values and how these changes in soil behaviour can influence the overall performance of pavements. This type of research is important for ensuring the long-term durability and stability of highway infrastructure.

Key Words- California Bearing Ratio, Optimum Moisture Content, Maximum Dry Density

II INTRODUCTION- Aim of this study is to investigate the effects of flood-related submergence on the subgrade strength of soil samples collected from a specific area (Delhi-Jaipur National Highway, Delhi, India). The study conducted CBR (California Bearing Ratio) tests under different conditions of submergence and aimed to determine the relationship between the depth and duration of submergence and the subgrade strength of the soils. The purpose of this study is to investigate the impact of flood-related submergence on road infrastructure, particularly on the subgrade soil. It is also determining how varying depths of submergence and duration of submergence affect the strength of the subgrade soil. The CBR tests, which are a standard method for evaluating the mechanical strength of soils used as subgrade material for roads, are performed to evaluate the suitability of the studied soils as subgrade materials based on index and identification tests, which are commonly used to classify soils and assess their engineering properties.

The study's findings include the three types of soils tested from the Delhi-Jaipur National Highway, Delhi, India were all classified as poor materials for subgrade according to the IS (Indian Standard) soil classification system. It also finds that the submergence conditions (both depth and duration) had a significant impact on the subgrade strength of the soils. The study provided insights into how flood-related submergence can contribute to road damage, particularly in terms of subgrade soil strength.[1]

The design of the various pavement layers is very much influenced by the strength of the subgrade soil over which pavement layers are going to be laid. Subgrade strength is mostly expressed in terms of CBR (California Bearing Ratio) value. The subgrade having low bearing capacity requires thicker layers whereas the subgrade having high bearing capacity requires thinner pavement layers.[2] The pavement and the subgrade both must sustain the traffic volume. The Indian Road Congress (IRC) encodes the exact design strategies of the pavement layers based upon the subgrade strength which is primarily dependant on CBR value for a laboratory or field sample soaked for four days. The subgrade is always subjected to change in its moisture content due to rainfall, capillary action, overflow or rise of water table. For an engineer, it is important to understand the change of subgrade strength due to variation of moisture content. This project is an attempt to understand the influence of soaking on CBR value subjected to different days of soaking and the corresponding variation in moisture content. It is observed that the CBR decreases and the moisture content increases for high degree of soaking.[3]

III ANALYSIS & RESULTS

The soil used in this study was course grained gravel soil obtained from local road routes in Delhi-Jaipur National Highway, Delhi, India. The soil was tested for water content, specific gravity, liquid limit, plastic limit, and grain size distribution as to be well known about physical properties of this soil material. From these experimental results a proper idea about the type of soil has been found.

In this experimental study four soil samples are moulded at its optimum moisture content to its maximum dry density (MDD) was tested for its soaked and unsoaked CBR values.

3.1 EXPERIMENTAL ANALYSIS & RESULT OF SAMPLE NO. 1

Liquid limit plasticity limit test: -
Liquid Limit (WL): 23.51%
Plastic Limit (WP): 16.37%
Plasticity Index (PI): 7.14%

Grain size distribution test: -

Here 3000 gm of coarse-grained soil sample was taken and dried in oven for 24 hours. Mostly used test for grain size distribution analysis is sieve analysis. Twelve sieves were used and the results from sieve analysis test of the soil is plotted on a semi-log graph with particle diameter or the sieve size in X axis and percentage finer in Y axis.

Table 4.1: Observation table of Sieve analysis test of soil sample no. 1

Sieve Size	Mass of Soil Retained in each sieve (gm)	Percent Retained (%)	Cumulative Retained (%)	Percent Finer (%)
80mm	0	0	0	100
40mm	0	0	0	100
20mm	0	0	0	100
12.5mm	0	0	0	100
10mm	0	0	0	100
4.75mm	0	0	0	100
2.36mm	330	11	11	89
1.18mm	510	17	28	72
600micron	890	29.67	57.67	42.33
300micron	473	15.76	73.43	26.57
150micron	357	11.9	85.33	14.67
75micron	398	13.27	98.6	1.4
PAN	42	1.4	-----	-----
Clay/Silt (-75micron)			**14.67%**	
Sand (-4.75mm, +75micron)			**85.33%**	
Gravel (-40, +4.75)			**00%**	

Compaction test

OBSERVATIONS:

Table 4.2: Observation table of standard proctor test of soil sample no. 1

Mould Diameter -10cm, Heigh- 12.73cm, Volume- 1000 cc, Weight- 3568gm						
Determination No.	1	2	3	4	5	6
Weight of mould + compacted soil (gm)	5184	5340	5453	5682	5554	5434
Weight of compacted soil, W (gm)	1616	1772	1885	2114	1986	1867
Average moisture content, w %	4.6%	6.1%	8.2%	11.7%	13.1%	15.3%
Bulk density (gm /cc) = W / (Mould volume)	1.616	1.772	1.885	2.114	1.986	1.867
Dry density (gm/cc) = Bulk density/(1+w)	1.54	1.67	1.79	1.89	1.75	1.61

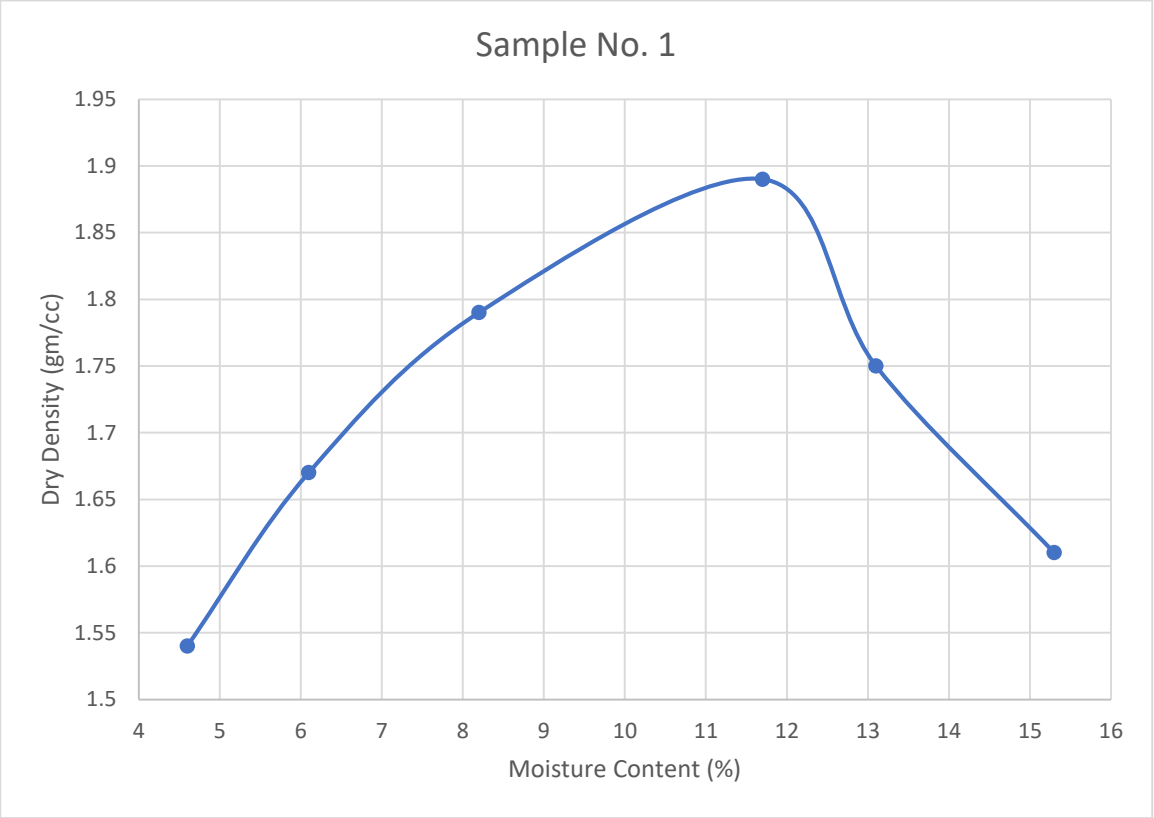

Fig. 4.1 Graph of standard proctor test of soil sample no. 1

CBR test-

Case-A CBR test performed in unsoaked condition

Size of mould= 2250 cc
Standard proctor test results are used
Maximum Dry Density value: 1.89 gm./cc
Optimum Moisture Content: 11.7 %
CBR test is done in three conditions. First one is in unsoaked condition, secondly in 24 hrs. of soaking condition and third in 48 hrs. of soaking condition. CBR value at 2.5mm penetration and 5mm penetration are calculated and the higher value is reported.

OBSERVATIONS

Table 4.3 CBR Values in unsoaked condition sample No. 1

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	80	-----	-----
2	1.0	190	-----	-----
3	1.5	270	-----	-----
4	2.0	350	-----	-----
5	2.5	430	1370	31.38
6	3.0	490	-----	-----
7	3.5	540	-----	-----
8	4.0	580	-----	-----
9	4.5	610	-----	-----
10	5.0	640	2055	31.14
11	5.5	665	-----	-----
12	6.0	690	-----	-----
13	6.5	713	-----	-----

14	7.0	733	-----	-----
15	7.5	751	2630	-----
16	8.0	766	-----	-----
17	8.5	780	-----	-----
18	9.0	792	-----	-----
19	9.5	803	-----	-----
20	10.0	813	3180	-----
21	10.5	823	-----	-----
22	11.0	831	-----	-----
23	11.5	838	-----	-----
24	12.0	844	-----	-----
25	12.5	849	-----	-----
26	13.0	852	-----	-----

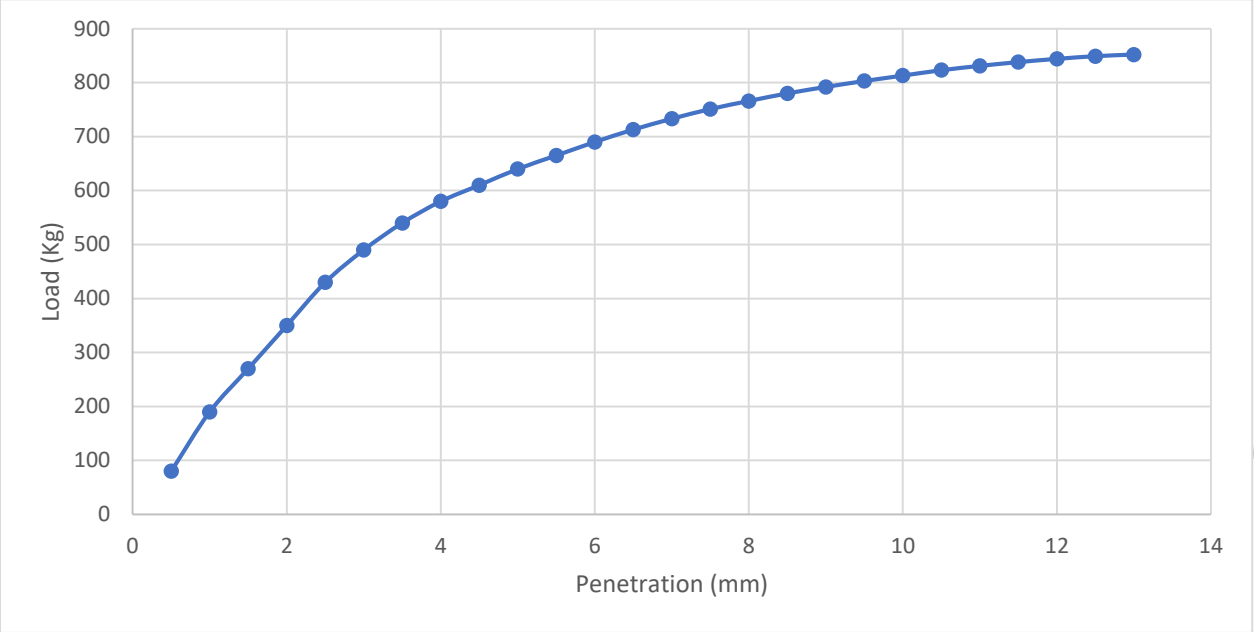

Fig. 4.2 CBR Values in unsoaked condition of sample No. 1

Case B- CBR Test performed with 24hrs soaking-

OBSERVATIONS

Table 4.4 CBR Values with 24 hrs. soaking condition of sample No. 1

S. No.	Penetration depth (mm)	Load (kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	35	-----	-----
2	1.0	75	-----	-----
3	1.5	120	-----	-----
4	2.0	155	-----	-----
5	2.5	205	1370	14.9
6	3.0	230	-----	-----
7	3.5	250	-----	-----
8	4.0	268	-----	-----
9	4.5	285	-----	-----
10	5.0	303	2055	14.74
11	5.5	316	-----	-----

12	6.0	330	-----	-----
13	6.5	343	-----	-----
14	7.0	355	-----	-----
15	7.5	366	2630	-----
16	8.0	377	-----	-----
17	8.5	387	-----	-----
18	9.0	397	-----	-----
19	9.5	406	-----	-----
20	10.0	415	3180	-----
21	10.5	424	-----	-----
22	11.0	432	-----	-----
23	11.5	440	-----	-----
24	12.0	447	-----	-----
25	12.5	454	-----	-----
26	13.0	460	-----	-----

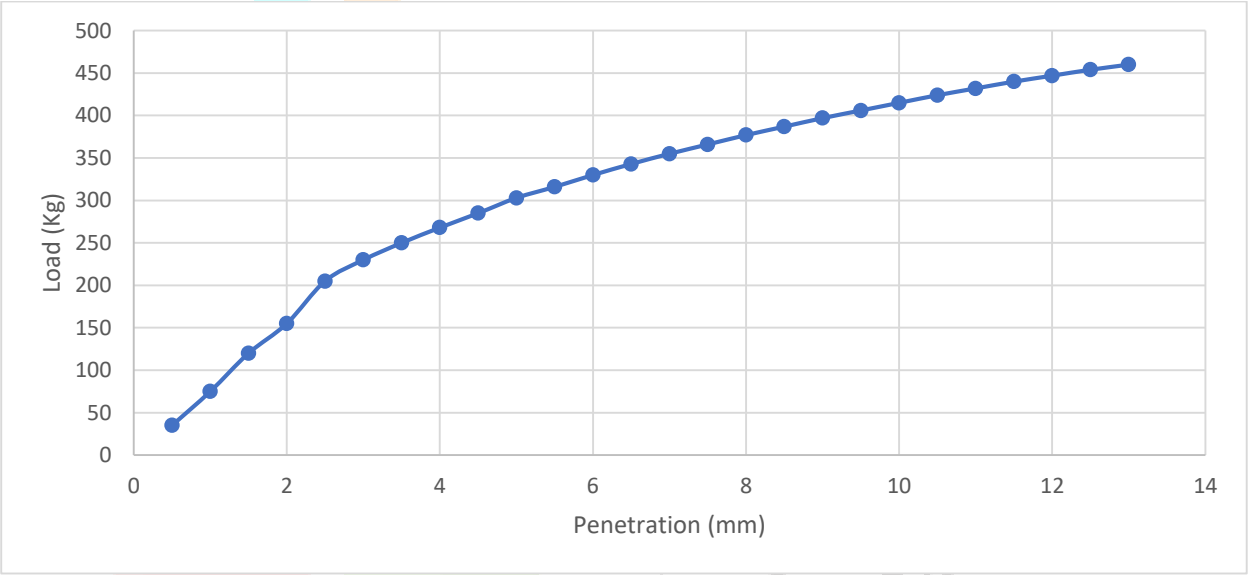

Fig. 4.3 CBR Values with 24 hrs. soaking condition of sample No. 1

Case C- CBR Test performed with 48hrs soaking-

OBSERVATIONS

Table 4.5 CBR Values with 48 hrs. soaking condition of sample No. 1

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	20	-----	-----
2	1.0	55	-----	-----
3	1.5	82	-----	-----
4	2.0	110	-----	-----
5	2.5	137	1370	10.00
6	3.0	152	-----	-----
7	3.5	165	-----	-----
8	4.0	180	-----	-----
9	4.5	190	-----	-----
10	5.0	205	2055	9.97
11	5.5	220	-----	-----

12	6.0	230	-----	-----
13	6.5	239	-----	-----
14	7.0	248	-----	-----
15	7.5	257	2630	-----
16	8.0	265	-----	-----
17	8.5	273	-----	-----
18	9.0	280	-----	-----
19	9.5	286	-----	-----
20	10.0	291	3180	-----
21	10.5	295	-----	-----
22	11.0	298	-----	-----
23	11.5	301	-----	-----
24	12.0	303	-----	-----
25	12.5	304	-----	-----
26	13.0	305	-----	-----

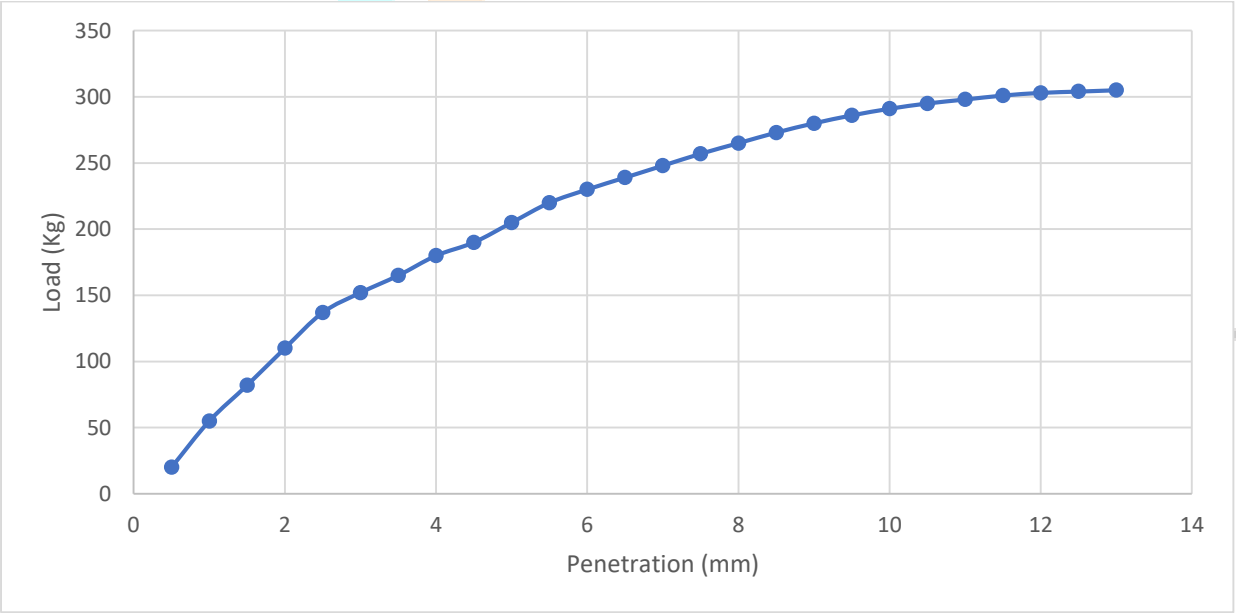

Fig. 4.4 CBR Values with 48 hrs. soaking condition of sample No. 1

Table 4.6 Summary of Experimental results of Sample No. 1

Liquid Limit (LL) %	Plastic Limit (PL) %	Plasticity Index (PI) %	Maximum Dry Density (MDD)	Optimum Moisture Content (OMC) %	CBR Value in Unsoaked Condition (%)	CBR Value with 24 Hrs. Soaking (%)	CBR Value with 48 Hrs. Soaking (%)
23.51	**16.37**	**7.14**	**1.89**	**11.7**	**31.38**	**14.9**	**10**

3.2 EXPERIMENTAL ANALYSIS & RESULT OF SAMPLE NO. 2

Liquid limit plasticity limit test: -

Liquid Limit (WL): 26.34%

Plastic Limit (WP): 17.18%

Plasticity Index (IP):

Grain size distribution test: -

Table 4.7: Observation table of Sieve analysis test of soil sample no. 2

Sieve Size	Mass of Soil Retained in each sieve (gm)	Percent Retained (%)	Cumulative Retained (%)	Percent Finer (%)
80mm	0	0	0	100
40mm	0	0	0	100
20mm	0	0	0	100
12.5mm	0	0	0	100
10mm	0	0	0	100
4.75mm	0	0	0	100
2.36mm	311	10.36	10.36	89.64
1.18mm	450	15	25.36	74.64
600micron	785	26.16	51.52	48.48
300micron	451	15.03	66.55	33.45
150micron	376	12.54	79.09	20.91
75micron	566	18.87	97.96	2.04
PAN	61	2.04	-----	-----
Clay/Silt (-75micron)		**20.91%**		
Sand (-4.75mm, +75micron)		**79.09**		
Gravel (-40, +4.75)		**00%**		

Compaction test

OBSERVATIONS:

Table 4.8: Observation table of standard proctor test of soil sample no. 2

Mould Diameter -10cm, Heigh- 12.73cm, Volume- 1000 cc, Weight- 3568gm						
Determination No.	1	2	3	4	5	6
Weight of mould + compacted soil (gm)	5015	5253	5383	5567	5424	5314
Weight of compacted soil, W (gm)	1447	1685	1817	1999	1856	1746
Average moisture content, w %	4.5%	6.3%	8.4%	11.8%	13.3%	15.1%
Bulk density (gm /cc) = W / (Mould volume)	1.447	1.685	1.817	1.999	1.856	1.746
Dry density (gm/cc) = Bulk density/(1+w)	1.38	1.58	1.67	1.78	1.63	1.51

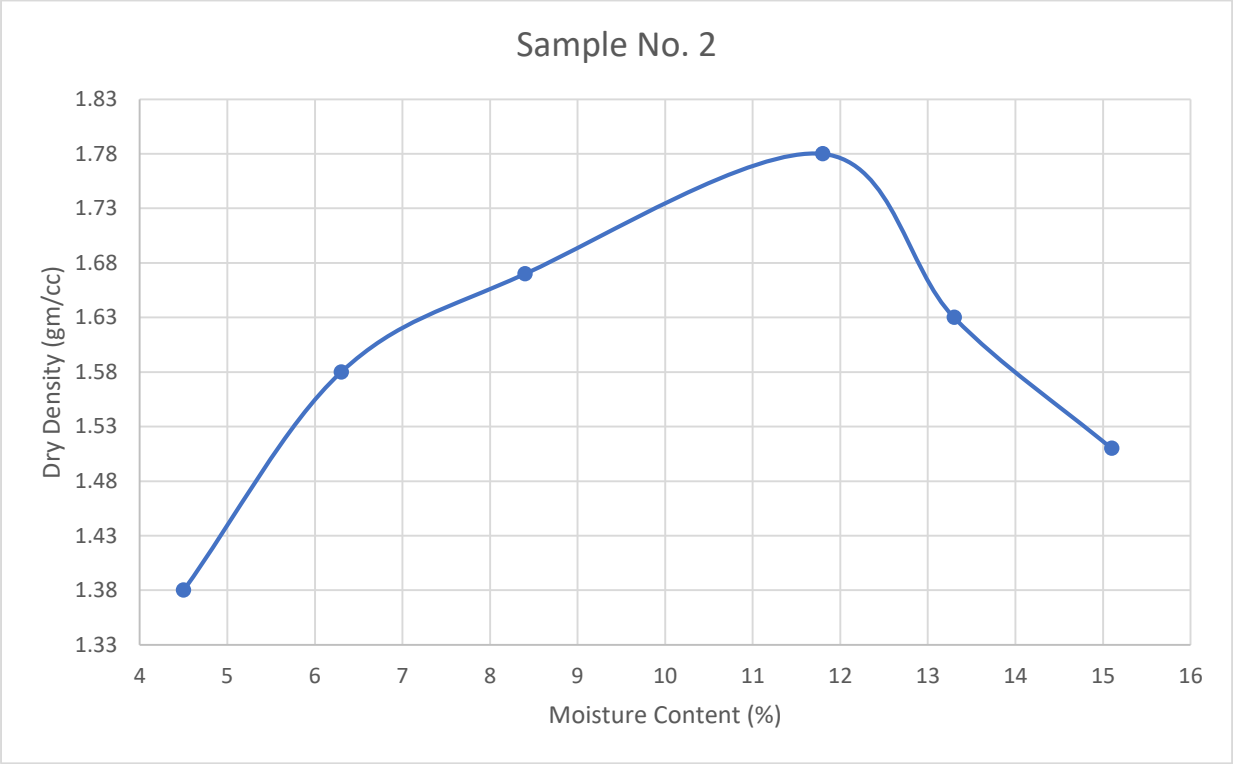

Fig. 4.5 Graph of standard proctor test of soil sample no. 2

CBR test-

Case-A CBR test performed in unsoaked condition

Size of mould= 2250 cc
Standard proctor test results are used
Maximum Dry Density value: 1.78 gm./cc
Optimum Moisture Content: 11.8 %

OBSERVATIONS

Table 4.9 CBR Values in unsoaked condition sample No. 2

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	75	-----	-----
2	1.0	185	-----	-----
3	1.5	260	-----	-----
4	2.0	340	-----	-----
5	2.5	415	1370	30.29
6	3.0	470	-----	-----
7	3.5	520	-----	-----
8	4.0	555	-----	-----
9	4.5	585	-----	-----
10	5.0	610	2055	29.68
11	5.5	635	-----	-----
12	6.0	660	-----	-----
13	6.5	675	-----	-----
14	7.0	693	-----	-----
15	7.5	711	2630	-----
16	8.0	723	-----	-----
17	8.5	735	-----	-----
18	9.0	745	-----	-----

19	9.5	755	-----	-----
20	10.0	763	3180	-----
21	10.5	771	-----	-----
22	11.0	777	-----	-----
23	11.5	783	-----	-----
24	12.0	788	-----	-----
25	12.5	792	-----	-----
26	13.0	795	-----	-----

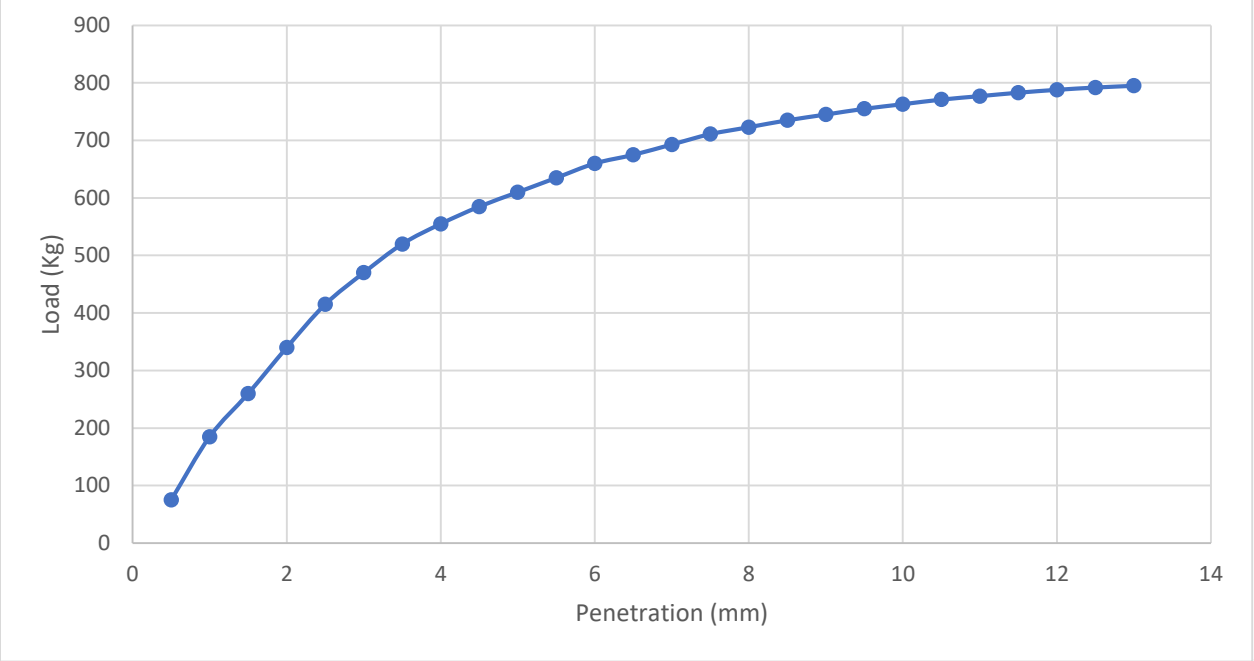

Fig. 4.6 CBR Values in unsoaked condition of sample No. 2

Case B- CBR Test performed with 24hrs soaking-

OBSERVATIONS

Table 4.10 CBR Values with 24 hrs. soaking condition of sample No. 2

S. No.	Penetration depth (mm)	Load (kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	30	-----	-----
2	1.0	70	-----	-----
3	1.5	110	-----	-----
4	2.0	145	-----	-----
5	2.5	190	1370	13.86
6	3.0	215	-----	-----
7	3.5	230	-----	-----
8	4.0	238	-----	-----
9	4.5	246	-----	-----
10	5.0	253	2055	12.31
11	5.5	260	-----	-----
12	6.0	267	-----	-----
13	6.5	273	-----	-----
14	7.0	279	-----	-----
15	7.5	285	2630	-----
16	8.0	291	-----	-----
17	8.5	296	-----	-----

18	9.0	301	-----	-----
19	9.5	305	-----	-----
20	10.0	310	3180	-----
21	10.5	315	-----	-----
22	11.0	319	-----	-----
23	11.5	323	-----	-----
24	12.0	326	-----	-----
25	12.5	328	-----	-----
26	13.0	330	-----	-----

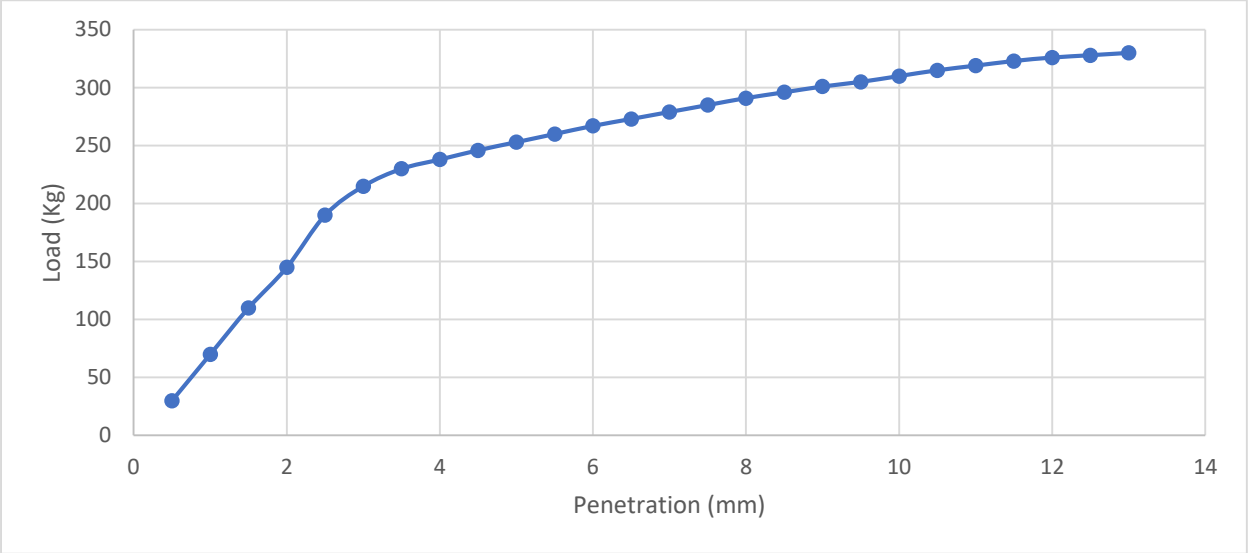

Fig. 4.7 CBR Values with 24 hrs. soaking condition of sample No. 2

Case C- CBR Test performed with 48hrs soaking-

OBSERVATIONS

Table 4.11 CBR Values with 48 hrs. soaking condition of sample No. 2

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	20	-----	-----
2	1.0	55	-----	-----
3	1.5	80	-----	-----
4	2.0	108	-----	-----
5	2.5	133	1370	9.70
6	3.0	145	-----	-----
7	3.5	155	-----	-----
8	4.0	170	-----	-----
9	4.5	178	-----	-----
10	5.0	192	2055	9.34
11	5.5	205	-----	-----
12	6.0	218	-----	-----
13	6.5	230	-----	-----
14	7.0	242	-----	-----
15	7.5	246	2630	-----
16	8.0	256	-----	-----
17	8.5	265	-----	-----

18	9.0	273	-----	-----
19	9.5	281	-----	-----
20	10.0	287	3180	-----
21	10.5	292	-----	-----
22	11.0	296	-----	-----
23	11.5	299	-----	-----
24	12.0	301	-----	-----
25	12.5	303	-----	-----
26	13.0	304	-----	-----

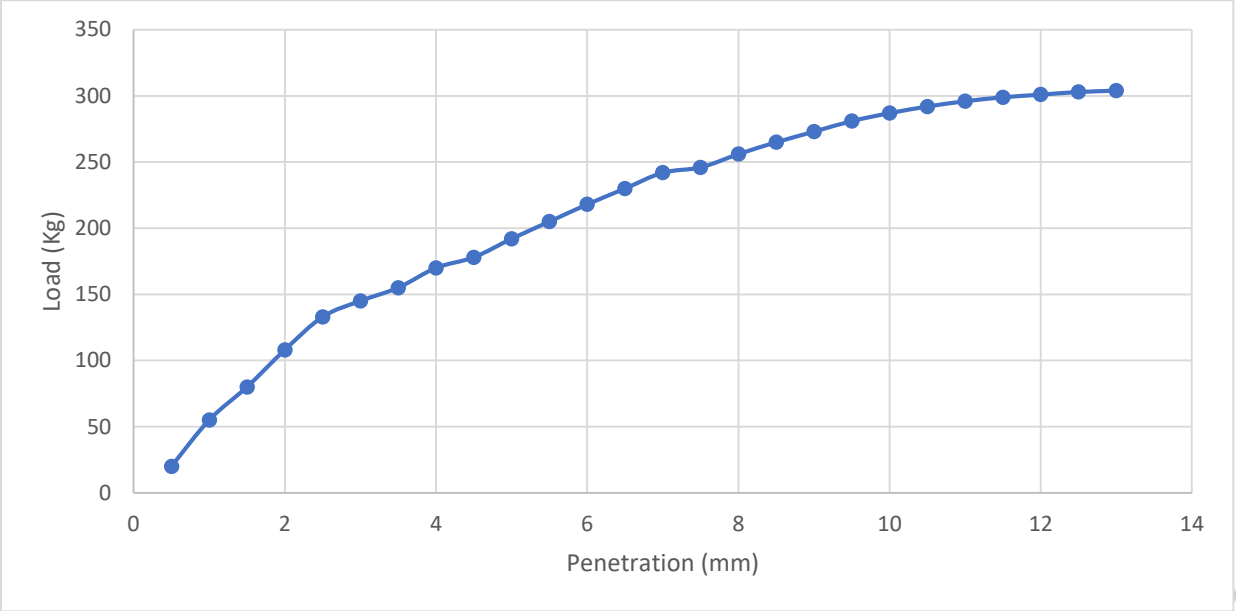

Fig. 4.8 CBR Values with 48 hrs. soaking condition of sample No. 2

Table 4.12 Summary of Experimental results of Sample No. 2

Liquid Limit (LL) %	Plastic Limit (PL) %	Plasticity Index (PI) %	Maximum Dry Density (MDD)	Optimum Moisture Content (OMC) %	CBR Value in Unsoaked Condition (%)	CBR Value with 24 Hrs. Soaking (%)	CBR Value with 48 Hrs. Soaking (%)
23.51	**16.37**	**7.14**	**1.78**	**11.8**	**30.29**	**13.86**	**9.7**

4.3 EXPERIMENTAL ANALYSIS & RESULT OF SAMPLE NO. 3

Liquid limit plasticity limit test: -

Liquid Limit (WL): 23.71%

Plastic Limit (WP): 16.20%

Plasticity Index (IP): 7.51%

Grain size distribution test: -

Table 4.13: Observation table of Sieve analysis test of soil sample no. 3

Sieve Size	Mass of Soil Retained in each sieve (gm)	Percent Retained (%)	Cumulative Retained (%)	Percent Finer (%)
80mm	0	0	0	100
40mm	0	0	0	100
20mm	0	0	0	100
12.5mm	0	0	0	100
10mm	0	0	0	100
4.75mm	0	0	0	100
2.36mm	204	6.8	6.8	93.2
1.18mm	436	14.53	21.33	78.67
600micron	838	27.93	49.26	50.74
300micron	452	15.07	64.33	35.67
150micron	403	13.43	77.76	22.24
75micron	610	20.34	98.1	1.9
PAN	57	1.9	-----	-----
Clay/Silt (-75micron)		**22.24%**		
Sand (-4.75mm, +75micron)		**77.76**		
Gravel (-40, +4.75)		**00%**		

4.2 Compaction test

OBSERVATIONS:

Table 4.14: Observation table of standard proctor test of soil sample no. 3

Mould Diameter -10cm, Heigh- 12.73cm, Volume- 1000 cc, Weight- 3568gm						
Determination No.	1	2	3	4	5	6
Weight of mould + compacted soil (gm)	5165	5321	5423	5641	5522	5413
Weight of compacted soil, W (gm)	1597	1753	1855	2073	1954	1845
Average moisture content, w %	4.6%	6.2%	8.1%	11.7%	13.2%	15.1%
Bulk density (gm /cc) = W / (Mould volume)	1.597	1.753	1.855	2.073	1.954	1.845
Dry density (gm/cc) = Bulk density/(1+w)	1.52	1.65	1.71	1.85	1.71	1.6

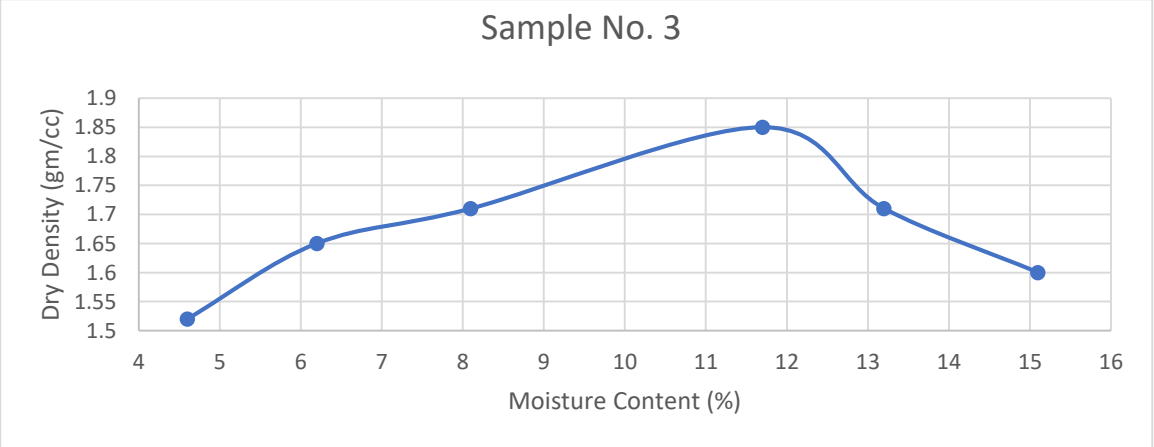

Fig. 4.9 Graph of standard proctor test of soil sample no. 3

CBR test-

Case-A CBR test performed in unsoaked condition

Size of mould= 2250 cc
Standard proctor test results are used
Maximum Dry Density value: 1.85 gm./cc
Optimum Moisture Content: 11.7 %

OBSERVATIONS

Table 4.15 CBR Values in unsoaked condition sample No. 3

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	77	-----	-----
2	1.0	188	-----	-----
3	1.5	264	-----	-----
4	2.0	344	-----	-----
5	2.5	421	1370	30.72
6	3.0	474	-----	-----
7	3.5	525	-----	-----
8	4.0	559	-----	-----
9	4.5	587	-----	-----
10	5.0	614	2055	29.87
11	5.5	639	-----	-----
12	6.0	664	-----	-----
13	6.5	679	-----	-----
14	7.0	695	-----	-----
15	7.5	713	2630	-----
16	8.0	725	-----	-----
17	8.5	737	-----	-----
18	9.0	747	-----	-----
19	9.5	758	-----	-----
20	10.0	765	3180	-----
21	10.5	773	-----	-----
22	11.0	779	-----	-----
23	11.5	785	-----	-----
24	12.0	790	-----	-----
25	12.5	794	-----	-----
26	13.0	797	-----	-----

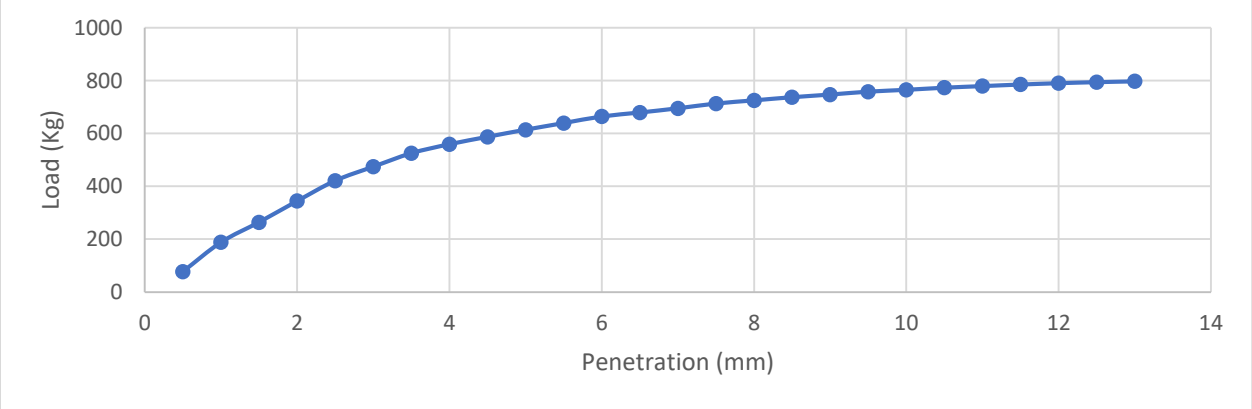

Fig. 4.10 CBR Values in unsoaked condition of sample No. 3

Case B- CBR Test performed with 24hrs soaking-

OBSERVATIONS

Table 4.16 CBR Values with 24 hrs. soaking condition of sample No. 3

S. No.	Penetration depth (mm)	Load (kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	32	-----	-----
2	1.0	72	-----	-----
3	1.5	112	-----	-----
4	2.0	147	-----	-----
5	2.5	192	1370	14.01
6	3.0	217	-----	-----
7	3.5	232	-----	-----
8	4.0	239	-----	-----
9	4.5	248	-----	-----
10	5.0	255	2055	12.4
11	5.5	262	-----	-----
12	6.0	269	-----	-----
13	6.5	275	-----	-----
14	7.0	281	-----	-----
15	7.5	287	2630	-----
16	8.0	293	-----	-----
17	8.5	298	-----	-----
18	9.0	303	-----	-----
19	9.5	307	-----	-----
20	10.0	312	3180	-----
21	10.5	317	-----	-----
22	11.0	320	-----	-----
23	11.5	324	-----	-----
24	12.0	327	-----	-----
25	12.5	329	-----	-----
26	13.0	331	-----	-----

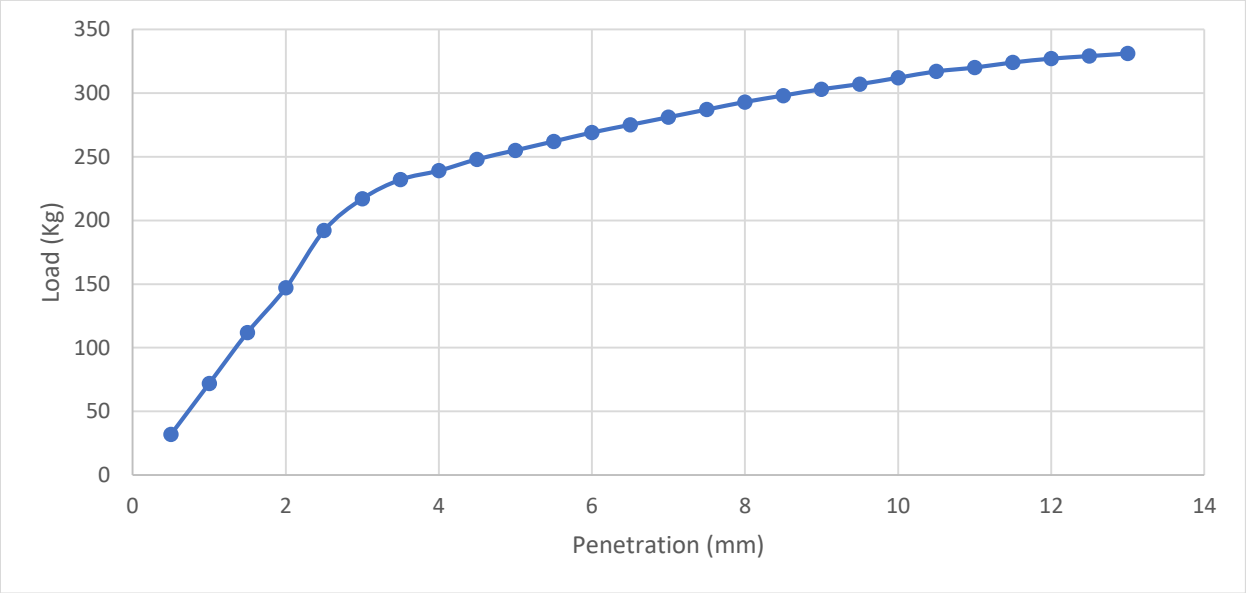

Fig. 4.11 CBR Values with 24 hrs. soaking condition of sample No. 3

Case C- CBR Test performed with 48hrs soaking-

OBSERVATIONS

Table 4.17 CBR Values with 48 hrs. soaking condition of sample No. 3

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	21	-----	-----
2	1.0	56	-----	-----
3	1.5	81	-----	-----
4	2.0	109	-----	-----
5	2.5	134	1370	9.78
6	3.0	146	-----	-----
7	3.5	156	-----	-----
8	4.0	171	-----	-----
9	4.5	179	-----	-----
10	5.0	193	2055	9.39
11	5.5	206	-----	-----
12	6.0	219	-----	-----
13	6.5	231	-----	-----
14	7.0	243	-----	-----
15	7.5	247	2630	-----
16	8.0	257	-----	-----
17	8.5	266	-----	-----
18	9.0	274	-----	-----
19	9.5	282	-----	-----
20	10.0	288	3180	-----
21	10.5	293	-----	-----
22	11.0	297	-----	-----
23	11.5	300	-----	-----
24	12.0	302	-----	-----
25	12.5	304	-----	-----
26	13.0	305	-----	-----

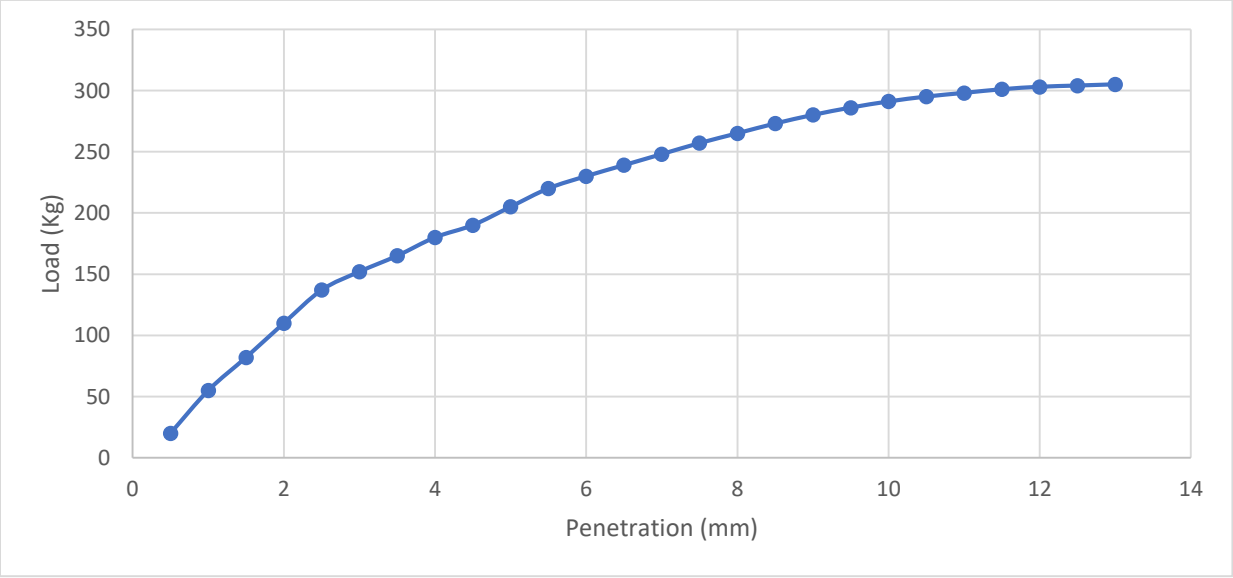

Fig. 4.12 CBR Values with 48 hrs. soaking condition of sample No. 3

Table 4.18 Summary of Experimental results of Sample No. 3

Liquid Limit (LL) %	Plastic Limit (PL) %	Plasticity Index (PI) %	Maximum Dry Density (MDD)	Optimum Moisture Content (OMC) %	CBR Value in Unsoaked Condition (%)	CBR Value with 24 Hrs. Soaking (%)	CBR Value with 48 Hrs. Soaking (%)
23.71	**16.20**	**7.51**	**1.85**	**11.7**	**30.72**	**14.01**	**9.78**

4.4 EXPERIMENTAL ANALYSIS & RESULT OF SAMPLE NO. 4

Liquid limit plasticity limit test: -

Liquid Limit (WL): 24.54%
Plastic Limit (WP): 16.03%
Plasticity Index (IP): 8.51%

Grain size distribution test: -

Table 4.19: Observation table of Sieve analysis test of soil sample no. 4

Sieve Size	Mass of Soil Retained in each sieve (gm)	Percent Retained (%)	Cumulative Retained (%)	Percent Finer (%)
80mm	0	0	0	100
40mm	0	0	0	100
20mm	0	0	0	100
12.5mm	0	0	0	100
10mm	0	0	0	100
4.75mm	0	0	0	100
2.36mm	179	5.96	5.96	94.04
1.18mm	489	16.3	22.26	77.74
600micron	642	21.4	43.66	56.34
300micron	476	15.87	59.53	40.47
150micron	423	14.1	73.63	26.37
75micron	706	23.53	97.16	2.84
PAN	85	2.84	-----	-----
Clay/Silt (-75micron)		**26.37**		
Sand (-4.75mm, +75micron)		**73.63**		
Gravel (-40, +4.75)		**00%**		

Compaction test

OBSERVATIONS:

Table 4.20: Observation table of standard proctor test of soil sample no. 4

Mould Diameter -10cm, Heigh- 12.73cm, Volume- 1000 cc, Weight- 3568gm						
Determination No.	1	2	3	4	5	6
Weight of mould + compacted soil (gm)	5082	5241	5356	5584	5452	5338
Weight of compacted soil, W (gm)	1514	1673	1788	2016	1884	1770
Average moisture content, w %	4.7%	6.5%	8.4%	11.9%	13.4%	15.4%
Bulk density (gm /cc) = W / (Mould volume)	1.514	1.673	1.788	2.016	1.884	1.77
Dry density (gm/cc) = Bulk density/(1+w)	1.44	1.57	1.65	1.8	1.66	1.53

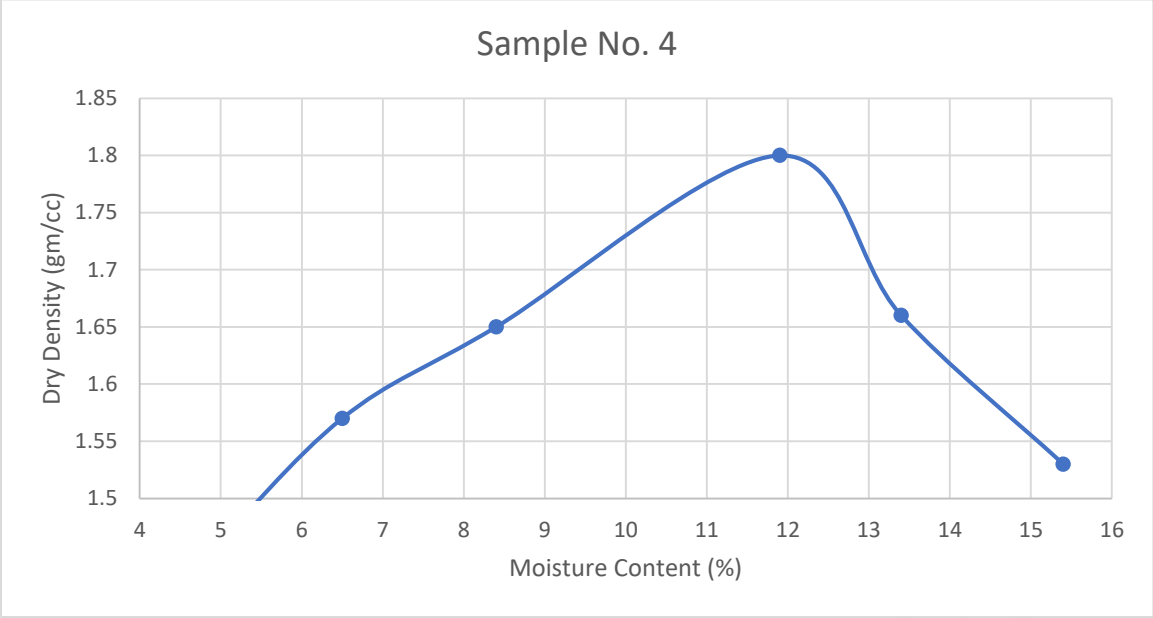

Fig. 4.13 Graph of standard proctor test of soil sample no. 4

CBR test-

Case-A CBR test performed in unsoaked condition

Size of mould= 2250 cc
Standard proctor test results are used
Maximum Dry Density value: 1.8 gm./cc
Optimum Moisture Content: 11.9 %

OBSERVATIONS

Table 4.21 CBR Values in unsoaked condition sample No. 4

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	82	-----	-----
2	1.0	192	-----	-----
3	1.5	273	-----	-----
4	2.0	355	-----	-----
5	2.5	435	1370	31.75
6	3.0	496	-----	-----
7	3.5	546	-----	-----
8	4.0	587	-----	-----
9	4.5	618	-----	-----
10	5.0	648	2055	31.53
11	5.5	674	-----	-----
12	6.0	699	-----	-----
13	6.5	723	-----	-----
14	7.0	743	-----	-----
15	7.5	762	2630	-----
16	8.0	778	-----	-----
17	8.5	793	-----	-----
18	9.0	804	-----	-----
19	9.5	815	-----	-----
20	10.0	825	3180	-----
21	10.5	834	-----	-----
22	11.0	841	-----	-----
23	11.5	850	-----	-----
24	12.0	852	-----	-----
25	12.5	859	-----	-----
26	13.0	865	-----	-----

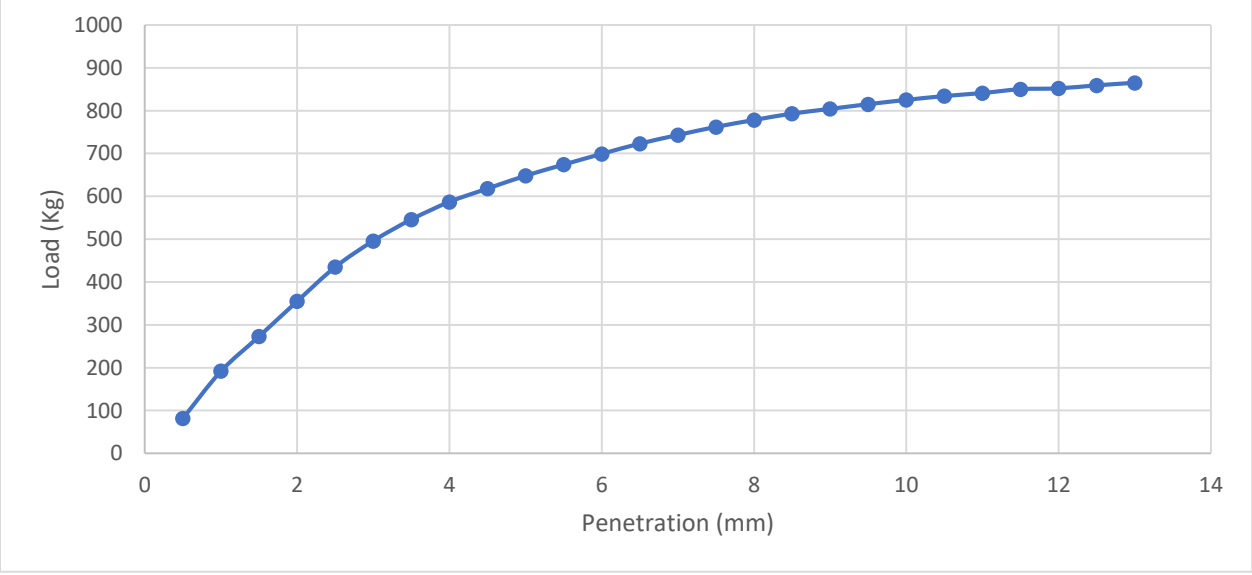

Fig. 4.14 CBR Values in unsoaked condition of sample No. 4

Case B- CBR Test performed with 24hrs soaking-

OBSERVATIONS

Table 4.22 CBR Values with 24 hrs. soaking condition of sample No. 4

S. No.	Penetration depth (mm)	Load (kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	37	-----	-----
2	1.0	77	-----	-----
3	1.5	123	-----	-----
4	2.0	158	-----	-----
5	2.5	209	1370	15.25
6	3.0	237	-----	-----
7	3.5	255	-----	-----
8	4.0	273	-----	-----
9	4.5	291	-----	-----
10	5.0	309	2055	15.03
11	5.5	323	-----	-----
12	6.0	338	-----	-----
13	6.5	352	-----	-----
14	7.0	364	-----	-----
15	7.5	375	2630	-----
16	8.0	387	-----	-----
17	8.5	398	-----	-----
18	9.0	408	-----	-----
19	9.5	418	-----	-----
20	10.0	427	3180	-----
21	10.5	433	-----	-----
22	11.0	439	-----	-----
23	11.5	445	-----	-----
24	12.0	450	-----	-----
25	12.5	454	-----	-----
26	13.0	457	-----	-----

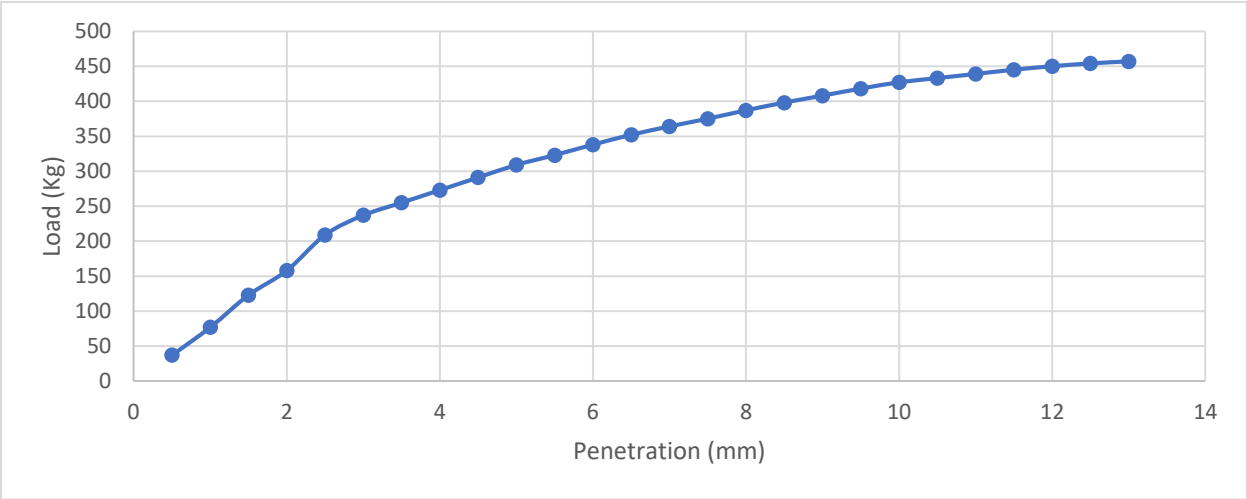

Fig. 4.15 CBR Values with 24 hrs. soaking condition of sample No. 4

Case C- CBR Test performed with 48hrs soaking-

OBSERVATIONS

Table 4.23 CBR Values with 48 hrs. soaking condition of sample No. 4

S. No.	Penetration depth (mm)	Load (Kg)	Standard load (Kg)	CBR Value (%) at 2.5mm and 5.0mm penetration
1	0.5	21	-----	-----
2	1.0	56	-----	-----
3	1.5	84	-----	-----
4	2.0	112	-----	-----
5	2.5	140	1370	10.21
6	3.0	155	-----	-----
7	3.5	169	-----	-----
8	4.0	184	-----	-----
9	4.5	195	-----	-----
10	5.0	210	2055	10.21
11	5.5	226	-----	-----
12	6.0	236	-----	-----
13	6.5	246	-----	-----
14	7.0	255	-----	-----
15	7.5	265	2630	-----
16	8.0	273	-----	-----
17	8.5	282	-----	-----
18	9.0	289	-----	-----
19	9.5	296	-----	-----
20	10.0	301	3180	-----
21	10.5	307	-----	-----
22	11.0	309	-----	-----
23	11.5	313	-----	-----
24	12.0	315	-----	-----
25	12.5	316	-----	-----
26	13.0	317	-----	-----

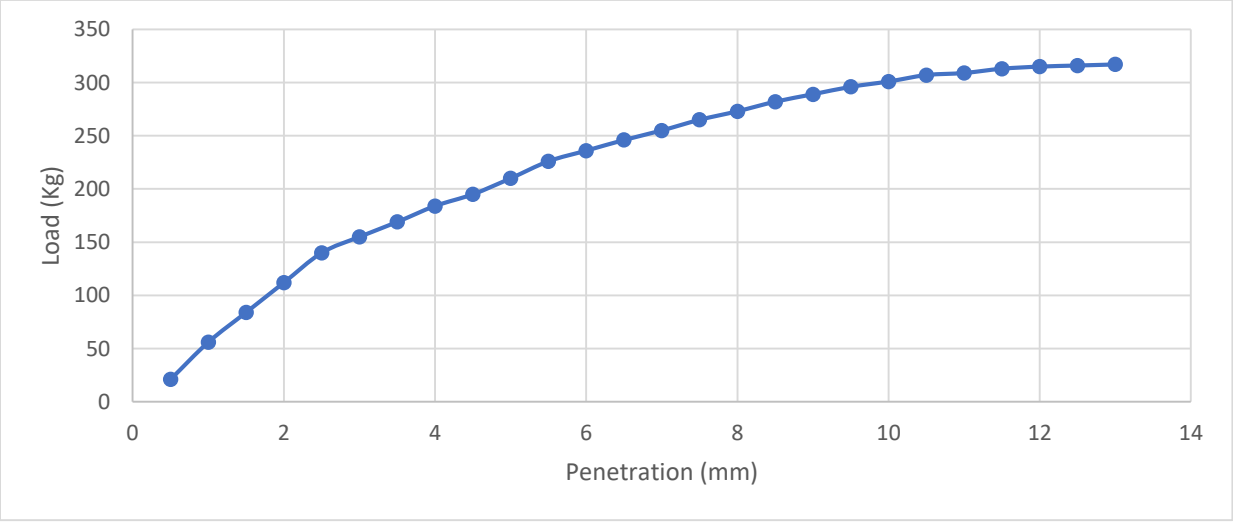

Fig. 4.16 CBR Values with 48 hrs. soaking condition of sample No. 4

Table 4.24 Summary of Experimental results of Sample No. 4

Liquid Limit (LL) %	Plastic Limit (PL) %	Plasticity Index (PI) %	Maximum Dry Density (MDD)	Optimum Moisture Content (OMC) %	CBR Value in Unsoaked Condition (%)	CBR Value with 24 Hrs. Soaking (%)	CBR Value with 48 Hrs. Soaking (%)
24.54	16.03	8.51	1.8	11.9	31.53	15.25	10.21

CONCLUSIONS The study appears to focus on how the CBR value changes over time as the soil samples are soaked, and how this change is related to the moisture content of the soil.

CBR Decrease with increase in Soaking Time**:** The study found that the CBR value of the soil sample decreases rapidly during the initial 24 hours of soaking. This suggests that the mechanical strength of the soil diminishes as it absorbs water. After this initial rapid decrease, the rate of decrease in CBR slows down. This could be due to the fact that the soil has already reached a certain level of saturation or swelling, and further soaking has a diminishing effect on its strength.

Effect of Soaking on Moisture Content**:** As the soil samples are soaked, the study also indicates that their moisture content increases. This is expected, as soaking causes the soil particles to absorb water and become more saturated. The increase in moisture content can contribute to the reduction in mechanical strength, as water weakens the bonds between soil particles.

Variation in CBR Across Sample Points**:** The study also mentions that soil samples were taken from different locations and tested. It is possible that the CBR values and moisture content varied across these different points. This variation is due to differences in soil composition, compaction, or other factors.

REFERENCES

1. Yashas, Shivamurthy Ravindra & Harish, S & Muralidhara, H. (2016). Effect of CBR on soil properties. 5. 28-37.
2. Mayank Korde, Prof. R K Yadav “A Study of Correlation between CBR Value and Physical Properties of Some Soils” International Journal of Emerging Technology and Advanced Engineering, ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 5, Issue 7, July 2015.
3. Eboukou, R. and Manguet, D. (2022) California Bearing Ratio Test on the Bearing Capacity of a Foundation in Unsaturated Soil. Journal of Geoscience and Environment Protection, 10, 12-25.
4. Arora K.R. “A Text book of Soil Mechanics”
5. Bindra S.P. "A Text Book of Highway Engineering" Dhanpat Rai Publications, New Delhi
6. Berry D.S. K.B. and Goetz Woods, W.H. Highway Engineering Hand Book, McGraw Hill Book Co. Inc. India.
7. Khanna S.K. and C.E.G. Justo, Nem Chand & Bros; Roorkee Highway engineering.
8. Mathew V. Tom , (2009), Entitled "Pavement materials: Soil Lecture notes in Transportation Systems Engineering.
9. Punmia B.C., Ashok Kumar Jain & Arun Kumar Jain “A Text Book of Soil Mechanics & Foundations.”
10. Sahoo Biswajeet & Nayak Devadatta, (2009) "A Study of Subgrade Strength Related to moisture"
11. Singhal, R.P. (1967). Soil Mechanics and Foundation Engineering, Singhal Publications, India.
12. Terzaghi, K. (1943). Theoretical soil Mechanics, Chapman and Hall, London and John Wiley & Sons.
13. Terzaghi, K. and Peck, R.B. (1967). Soil Mechanics in engineering practice, Hohn Wiley & Sons.
14. Yoder, E.J., Principles of pavement design, John Wiley and Sons, India.
15. “Guidelines for the Design of Flexible Pavements for low volume of Rural Road” IRC- SP-72,

16. IS 2720 Part-5 “Method of test for Soil-Determination of Liquid limit and Plastic limit”
17. IS 2720 Part –8 “Method of test for Soil-Determination of Water Content, Dry density relation using a heavy Compaction”
18. IS 2720 Part-16 “Methods of test for Soil-Laboratory determination of CBR ”Partha Chakroborty & Animesh Das “Principles of Transportation Engineering” Ministry of Road Transport and Highways Report of the Specifications for Road and Bridge Work in India.
19. IRC-SP 72-2007, "Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads" IRC, New Delhi.
20. Indian Roads Congress, Guidelines for the design of flexible pavements (second revision), IRC: 37-2001.
21. Road Research Laboratory, Soil mechanics for road engineers, DSIR, HMSO publication, India.