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COMPARATIVE STUDIES OF CBR VALUE OF SOIL SAMPLE USING VARIOUS GROUND IMPROVEMENT MATERIALS

Rabi Das[1], Raja Saha[2], Minhaj Aktar Mollah[3], Abhirup Sadhukhan[4], Jhilik Das[5], Shayantani Dutta[6]

[12]*Lecturer, Department of Civil Engineering, Technique Polytechnic Institute, Hooghly, India*
[3456] *Student, Department of Civil Engineering, Technique Polytechnic Institute, Hooghly, India*

Abstract - *California Bearing Ratio (CBR) value of sub grade is used for design of flexible pavements. It can also be used for determination of reaction of subgrade of soil by using correlation. It is one of the most important engineering properties of soil for design of sub grade of roads. California Bearing Ratio (CBR) value is an important soil parameter for design of flexible pavements and runway of air fields. By means of CBR value one can understand the strength of soil. In this study we attempt to improve the strength of soil by adding different types ground improvement materials. And lastly we compare which material is best as per our experiments for strengthening the soil as per the guidelines of IRC 37-2001*

Key Words: California Bearing Ratio, Soaked, Flexible Pavement, Bitumen etc.

1. INTRODUCTION

CBR is the **ratio of force per unit area** required to penetrate a soil mass with standard circular piston at the rate of 1.25 mm/min. to that required for the **corresponding penetration** of a standard material. The California Bearing Ratio Test (CBR Test) is a penetration test developed by ***California State Highway Department (U.S.A.)*** for evaluating the bearing capacity of subgrade soil for design of flexible pavement.

Tests are carried out on natural or compacted soils in water soaked or un-soaked conditions and the results so obtained are compared with the curves of standard test to have an idea of the soil strength of the subgrade soil.

The **california bearing ratio test** is penetration **test** meant for the evaluation of subgrade strength of roads and pavements. The results obtained by these **tests** are used with the empirical curves to determine the thickness of pavement and its component layers.

CBR test can be done in soaked and unsoaked condition. Here we are performing soaked CBR test of soil sample using different types of ground improvement materials & unknown materials. For calculating CBR value we need to know various standard loads for various penetration values given by IRC-37. The standard loads are as per table given below-

Table-1: Different types of standard loads

Penetration of plunger (mm)	Standard load (kg)
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

There are various penetration values , but as per IRC guidline we will use 2.5 mm & 5 mm penetration only

1.1 Procedure

- Normally 3 specimens each of about 7 kg must be compacted so that their compacted densities range from 95% to 100% generally with 10, 30 and 65 blows.
- Weigh of empty mould
- Add water to the first specimen (compact it in five layer by giving 10 blows per layer)
- After compaction, remove the collar and level the surface.
- Take sample for determination of moisture content.
- Weight of mould + compacted specimen.
- Place the mold in the soaking tank for four days (ignore this step in case of unsoaked **CBR**.
- Take other samples and apply different blows and repeat the whole process.
- After four days, measure the swell reading and find %age swell.
- Remove the mould from the tank and allow water to drain.
- Then place the specimen under the penetration piston and place surcharge load of 10lb.
- Apply the load and note the penetration load values.
- Draw the graphs between the penetration (in) and penetration load (in) and find the value of **CBR**.
- Draw the graph between the %age **CBR** and Dry Density, and find **CBR** at required degree of compaction.

1.2 Uses and Significance

- The **CBR test** is one of the most commonly used methods to evaluate the strength of a sub grade soil, sub base, and base course material for **design of thickness for highways** and **airfield pavement.**
- The California bearing ratio test is penetration test meant for the **evaluation of subgrade strength** of roads and pavements. The results obtained by these tests are used with the empirical curves to determine the thickness of pavement and its component layers as per IRC-37. This is the most widely used method for the design of flexible pavement.
- This instruction sheet covers the laboratory method for the determination of **C.B.R**. of undisturbed and remolded /compacted soil specimens, both in soaked as well as unsoaked state.

2. SOIL SAMPLE & MTERIALS USED FOR IMPROVEMENT OF CBR VALUE

As this paper was made with the students , so there was no scope for the soil sample from outside. So, the entire experiment was done by taking Institute's soil sample which the students belong to.
There are various types of ground improving materais but we conducted the experiments by taking some known and some unknown materials just to see whether the unknown materials are effective or not. The materials are:

- 2 % Bitumen by weight of total sample
- 2 % Rice husk by weight of total sample
- 2 % Nacl by weight of total sample
- 2 % Coal ash by weight of total sample

Note: The percentage is taken arbitrary as this a research work. This may give the value of CBR greater than the maximum specified value given by IRC (i.e 10 % CBR)

3. OBSERVATIONS AND CORRELATIONS

Following observations were made and respective CBR graphs were made.

Table-2: Normal Soil sample

SAMPLE DESCRIPTION: COLLAGE SOIL SAMPLE
DATE OF CASTING: 08/04/17
DIA OF PLUNGER: 50 mm²
AREA OF PLUNGER=1963.49 mm² = 19.63 cm²
LEAST COUNT: 1 division of proving ring = 6.23 kg

SL NO	PENETRATION VALUE (mm)	LOAD DIVISIONS	LOAD VALUE= LOAD DIVISION X LEAST COUNT (Kg)	PRESSURE SUSTAINED (Kg/cm²)
1	0.5	2	12.2	0.62
2	1.0	4	24.4	1.24
3	1.5	5	30.5	1.55
4	2.0	6	36.6	1.86
5	2.5	8	48.8	2.46
6	4.0	15	91.5	4.66
7	5.0	20	122.0	6.21
8	7.5	41	250.1	12.74
9	10.0	65	396.5	20.20
10	12.5	87	530.7	27.04

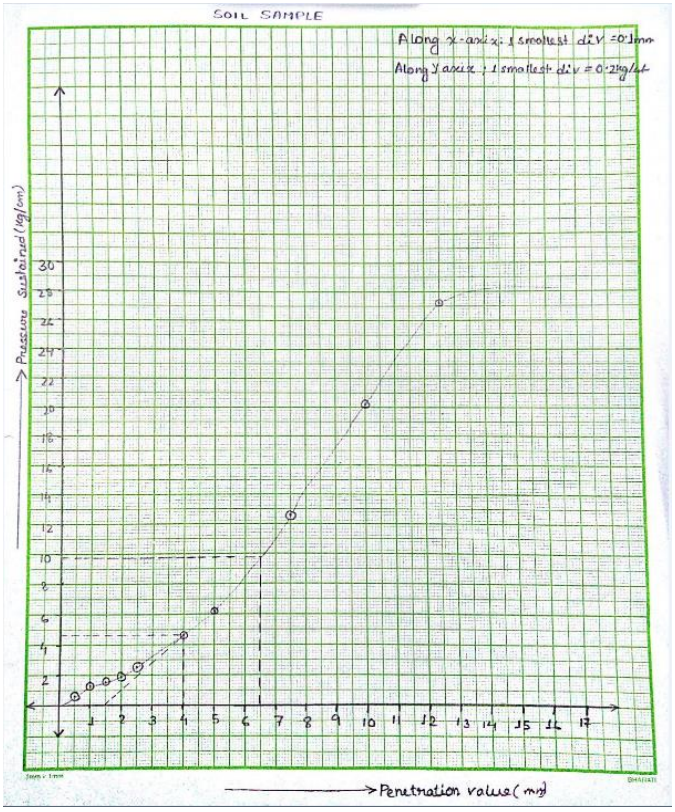

Chart -1: CBR Graph for Normal Soil sample

Table-3: Soil sample with 2 % bitumen

SAMPLE DESCRIPTION: COLLAGE SOIL SAMPLE WITH 2% BITUMEN

DATE OF CASTING: 8/04/17

DIA OF PLUNGER: 50 mm²

AREA OF PLUNGER=1963.49 mm² = 19.63 cm²

LEAST COUNT: 1 division of proving ring = 6.23 kg

SL NO	PENETRATION VALUE (mm)	LOAD DIVISIONS	LOAD VALUE= LOAD DIVISION X LEAST COUNT (Kg)	PRESSURE SUSTAINED (Kg/cm²)
1	0.5	2	12.46	0.63
2	1.0	4	24.92	1.27
3	1.5	6	37.38	1.90
4	2.0	11	68.53	3.49
5	2.5	17	105.91	5.39
6	4.0	33	205.59	10.47
7	5.0	47	292.81	14.91
8	7.5	71	442.33	22.53
9	10.0	86	535.76	27.29
10	12.5	89	554.47	28.24

Table-4: Soil sample with 2 % Nacl

SAMPLE DESCRIPTION: COLLAGE SOIL SAMPLE WITH 2% Nacl

DATE OF CASTING: 13/04/17

DIA OF PLUNGER: 50 mm

AREA OF PLUNGER=1963.49 mm² = 19.63 cm²

LEAST COUNT: 1 div of proving ring = 6.23 kg

SL NO	PENETRATION VALUE (mm)	LOAD DIVISIONS	LOAD VALUE= LOAD DIVISION X LEAST COUNT (Kg)	PRESSURE SUSTAINED (Kg/cm²)
1	0.5	8	49.84	2.53
2	1.0	13	80.99	4.12
3	1.5	19	118.37	6.02
4	2.0	27	168.21	8.56
5	2.5	35	218.05	11.10
6	4.0	57	355.11	18.08
7	5.0	70	436.1	22.21
8	7.5	107	666.61	33.95
9	10.0	137	853.51	43.46
10	12.5	162	1009.26	51.40

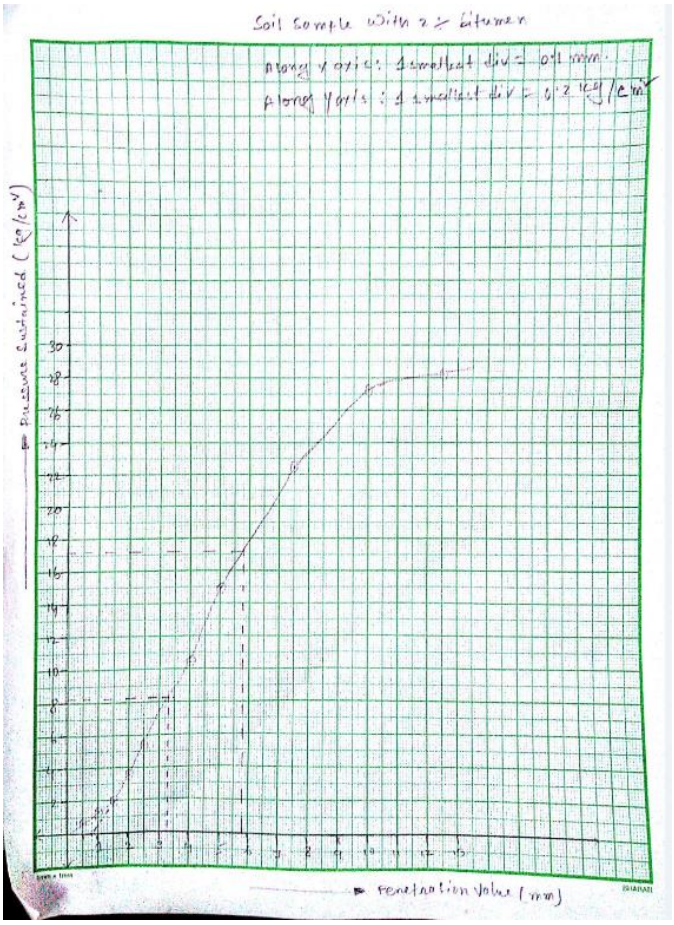

Chart -2: CBR Graph for Soil sample with 2 % bitumen

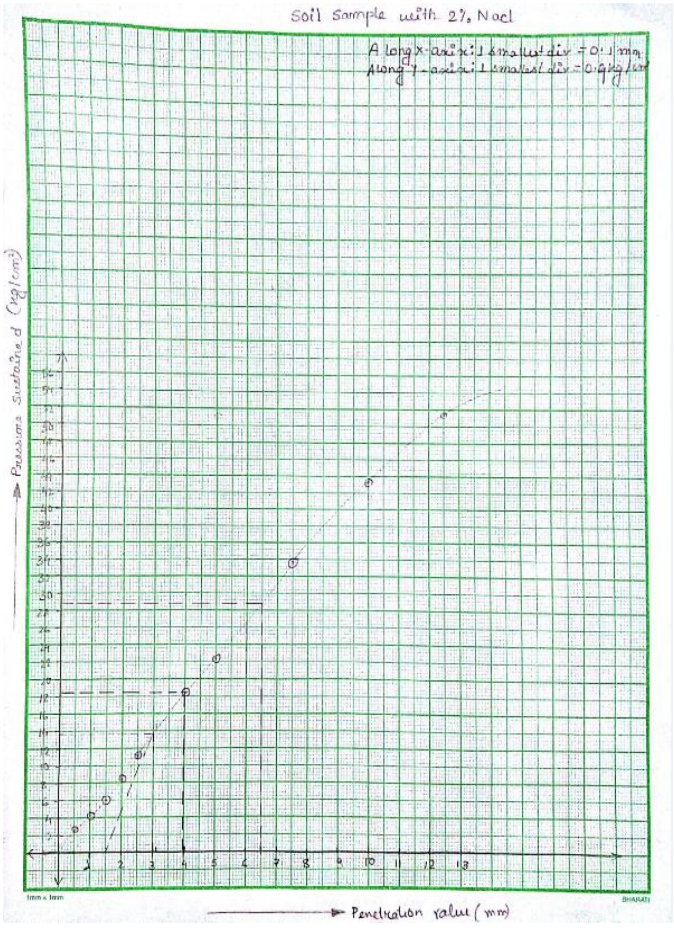

Chart -3: CBR Graph for Soil sample with 2 % Nacl

Table-5: Soil sample with 2 % Coal ash

SAMPLE DESCRIPTION: COLLAGE SOIL SAMPLE WITH 5% COAL DUST

DATE OF CASTING : 8/04/17

DIA OF PLUNGER: 50 mm

AREA OF PLUNGER=1963.49 mm^2= 19.63 cm^2

LEAST COUNT: 1 division of proving ring = 6.23 kg

SL NO	PENETRATION VALUE (mm)	LOAD DIVISIONS	LOAD VALUE= LOAD DIVISION X LEAST COUNT (Kg)	PRESSURE SUSTAINED (Kg/cm^2)
1	0.5	6	37.38	1.90
2	1.0	13	80.99	4.12
3	1.5	22	137.06	6.98
4	2.0	30	186.9	9.51
5	2.5	41	255.43	13.01
6	4.0	75	467.25	23.80
7	5.0	85	529.55	26.97
8	7.5	105	654.15	33.32
9	10.0	128	797.44	40.61
10	12.5	151	940.73	47.91

Table-6: Soil sample with 2 % Rice husk

SAMPLE DESCRIPTION: COLLEGE SOIL SAMPLE WITH 2% RICE HUSK

DATE OF CASTING: 13/04/17

DIA OF PLUNGER: 50mm

AREA OF PLUNGER=1963.49 mm^2 = 19.63 cm^2

LEAST COUNT: 1 division of proving ring = 6.23 kg

SL NO	PENETRATION VALUE (mm)	LOAD DIVISIONS	LOAD VALUE= LOAD DIVISION X LEAST COUNT (Kg)	PRESSURE SUSTAINED (Kg/cm^2)
1	0.5	5	31.15	1.59
2	1.0	11	68.53	3.49
3	1.5	18	112.14	5.71
4	2.0	24	149.52	7.61
5	2.5	35	218.05	11.10
6	4.0	69	429.87	21.89
7	5.0	85	529.55	26.97
8	7.5	135	841.05	42.84
9	10.0	167	1040.41	53.00
10	12.5	188	1171.24	59.65

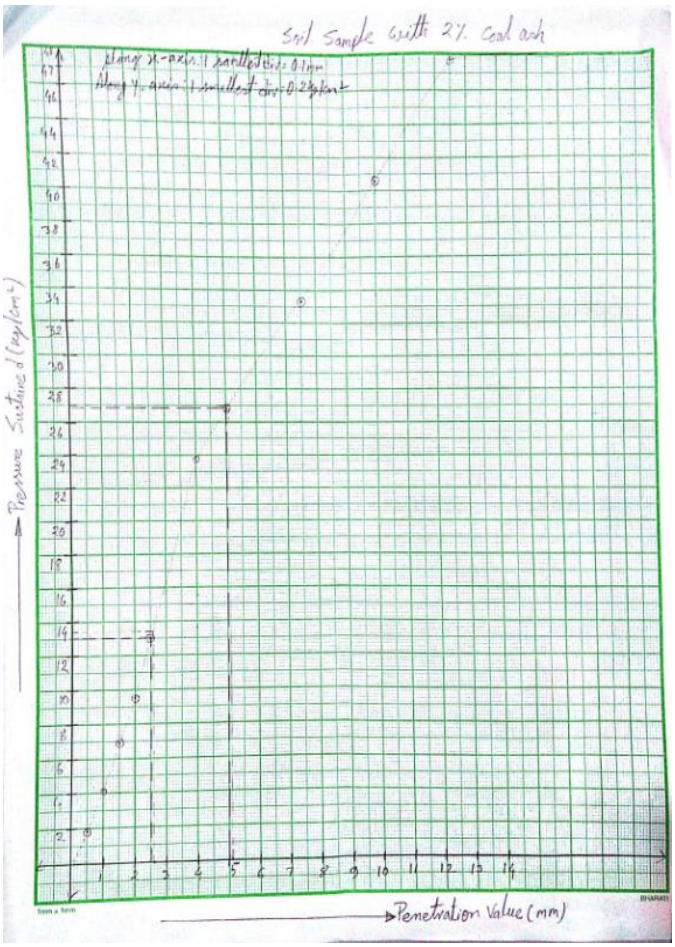

Chart -4: CBR Graph for Soil sample with 2 % Coal ash

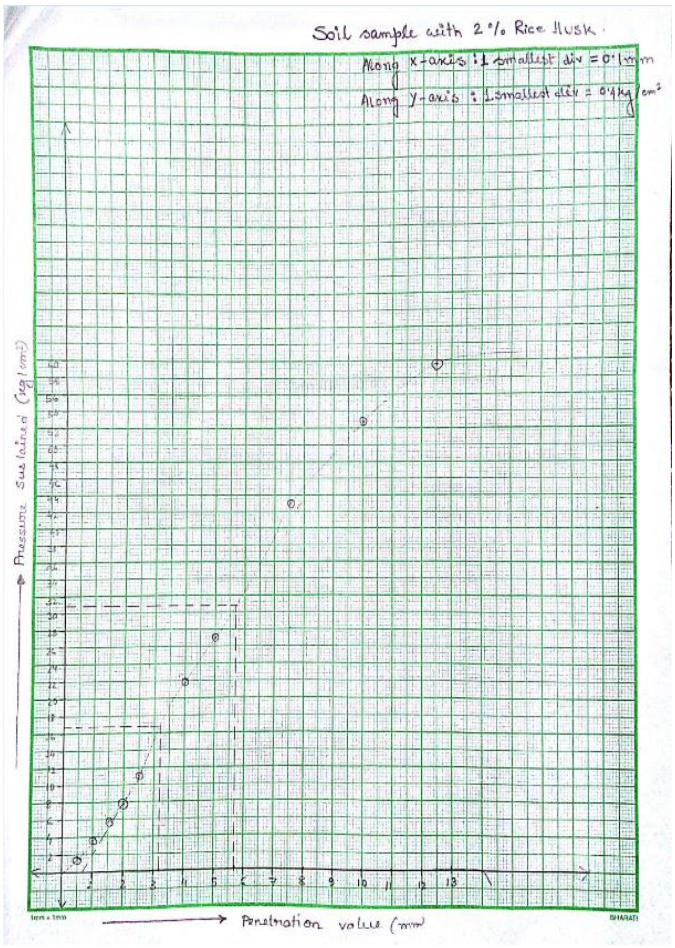

Chart -5: CBR Graph for Soil sample with 2 % Rice husk

3.1. CALCULATED CBR VALUES

(i) For Normal Soil sample

CBR = 8.1 %

(ii) For Soil sample with 2 % bitumen

CBR = 16.38 %

(iii) For Soil sample with 2 % Nacl

CBR = 26.86 %

(iv) For Soil sample with 2 % Coal ash

CBR = 25.52 %

(v) For Soil sample with 2 % Rice husk

CBR = 29.33 %

4. CONCLUSIONS

After going through all the datas and calculation it is seen that CBR values with different materials are greater than nthat of normal soil sample. But all the value are greater than 10 % . But as per IRC guidelines, the maximum CBR value for design of flexible pavement is 10 %. As we add 2 % material which improve the strength of soil in a huge manner. So we have to reduce the the percentage. But if we consider the actual value obtained from the experiment , we can see that soil sample with rice husk gives more CBR value than rest of the materials. Hence we can conclude that Rice Husk is more effective ground improvement material than others.

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BIOGRAPHIES

Live in Kolkata, west Bengal. Passed B. Tech in Civil Engineering in the year of 2015 from Narula Institute Of Technology. Presently associated with Technique Polytechnic Institute (Hooghly) as a Lecturer in Civil Engineering Department.

Live in Kolkata, west Bengal. Passed B. Tech in Civil Engineering in the year of 2012 from Camellia School Of Engineering & Technology . Presently associated with Technique Polytechnic Institute (Hooghly) as a Lecturer in Civil Engineering Department.

Live in Hooghly, west Bengal. Pursuing diploma in Civil Engineering from Technique Polytechnic Institute. Year of passing 2017.

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