International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 10, October 2016
www.ijates.com
ijates
ISSN 2348 - 7550

DESIGN OF FLEXIBLE PAVEMENT BY USING CBR TEST FOR SOAKED AND UNSOAKED SOILS

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ABSTRACT

This project deals with Design of flexible pavement by exploitation California bearing ratio test take a look at for both soaked (wet soil) and unsoaked (dry soil). California Bearing Ratio (CBR) value is a very important parameter for design of flexible pavements. It may be used for determination of sub grade reaction of soil. It's one in all the foremost necessary engineering properties of soil for design of sub grade of roads. CBR value of soil may depends on many factors like optimum moisture content (OMC), maximum dry density (MDD), plastic limit (PL), liquid limit (LL), plasticity index (PI), permeability of soil, type of soil etc. The CBR value is also affected by unsoaked or soaked condition of soil. These tests are performed in the laboratory. The CBR may be done on the premise of those tests which are less time consuming and low cost, fast to perform, then it will be simple to induce the data concerning the subgrade strength over the length of roads. By considering this a number of engineers with in the past created their report during this field and designed completely different pavements by determinative the CBR value on the premise of results of less time consuming, simple to perform tests and low cost. In this study, the values of CBR of different soil samples and correlate their CBR values for the design purpose of flexible pavement as per guidelines of IRC: SP: 37-2001.

Keywords: Soaked, Unsoaked, Flexible Pavement and California Bearing Ratio.

I. INTRODUCTION

The load bearing capability of the soil supporting highways, facility runways and alternative pavement systems is of vast importance to the integrity of the pavement. This supporting capability, or soil stiffness, changes from time to time and might vary from place to position at intervals a given space. Soil stiffness is that the degree of resistance to deformation upon loading. The extent and time dependence of, and therefore the degree of recovery from, deformation is primarily dependent upon the soil's properties, existing stress conditions, and therefore the stress history. Soil properties successively determined by a range of complicated interconnected factors as well as composition of particle size distribution, weight-volume relationships and unaltered stresses. The steadiness or bearing capability (capability) of the pavement of airfield runways, highways and different pavement systems is set in important half by the bearing capability of the underlying sub pavement) earth or soil, which can deteriorate over time as a result of environmental and stress influences on soil properties. For example, changes in soil bearing conditions as a result of changes in soil wet content and or perennial loading over time area unit well recognized in engineering fields. Additionally, bound pavement systems like runways and highways usually endure perennial severe loadings on a every day. Standard soil-structure modeling is predicated on the results of laboratory checking of individual localized soil samples, as within the case of the well-known California bearing quantitative relation, or CBR, laboratory test. However checks like the CBR are severely under privileged as a result of the test. Conditions and therefore the soil sample (specimen) isn't representative of unchanged conditions. Absent square measure (a) in-situ overburden stress, (b) in-situ soil interactions, and therefore the like. Further, several if not most soil samples are disturbed to a point throughout sampling and handling. A real composite soil stiffness determination will solely be determined using actual stiffness information of unchanged soil conditions at varied depths (varying sub grade conditions). Another notable technique for determinative composite soil stiffness is that the employment of plate bearing tests on the surface of soil layers. As mentioned here in on high of, this most usually used because of ensure soil stiffness is by exploitation the California bearing ratio (CBR) check on soil samples that unit of measurement prepared at intervals the laboratory, the target being to calculate with the stiffness, or resilient modulus of soil, assumed to be 300mm in thickness, merely at a lower place the pavement crust, providing a suitable foundation for the pavement.

The sub grade in mound is compacted in two layers, usually to succeeding normal than the lower a district of the mound. In cuttings, the cut formation, that's the sub grade, is treated equally to provide a suitable foundation for the pavement. Where the present native sub grade soils have poor engineering properties and low strength in terms of CBR, for instance in Black Cotton soil areas, improved sub grades are provided by method of lime/cement treatment or by mechanical stabilization and alternative similar techniques. The sub grade, whether or not in cutting or in embankment, should be compacted to utilize its full strength and to economize on the general pavement thickness. The current MORT&H specifications need that the sub grade should be compacted. Most dry density achieved by the changed proctor take a look at (IS 2720-PART 7).

II. LITERATURE REVIEW

Anitha. K. R Analysis the result of victimization another adjustment factor, Kaolinite, red soil, and Lateritic soil. This study uncovered that each splashed and un-doused CBR extended through and thru with the extension of RB1-81 for red soil, lateritic & mineral soil. Within the interior of this examination the CBR example were ready with completely different rate RBI-81 i.e. (0%, 2%, 4%, 6% and 8%) water substance of 125+ OMC was incorporated for convenience of illustration. CBR check was done at zero, seven and eleven days of set. In the end examination the maker achieved the conclusion that un-drenched CBR didn't vary abundant for red soil

Venu Gopal.N et al. Think about the properties of soil through silicon dioxide rage as stabilizer and standing out constant and value assessment. Within the interior of this trial the soil example was subjected to research laboratory examination to grasp the grain size allocation define and to center fluid utmost, plastic farthest purpose and flexibility list, maximum dry density (MDD), optimum moisture content (OMC) and California bearing ratio (CBR) values.

III. EXPERIMENTAL PROGRAM

For checking the properties of the soil, reportable totally different properties like liquid limit (LL), plastic limit (PL), and plasticity index (PI), optimum moisture content (OMC), maximum dry density (MDD), etc.

3.1 Collection of Materials

The materials were obtained from the nearby borrow areas, where plenty amount of material is available for the construction purpose. The material which is collected for testing is different in quality and property, so that the material was separately tested in the laboratory so as to design the soil sub grade.

IV. TESTS CONDUCTED ON SOIL SAMPLES OF BOTH SOAKED AND UNSOAKED SOILS

4.1 Determination of Moisture Content

(For unsoaked soil and soaked soil) The natural water content likewise called the natural moisture content is the proportion (ratio) of the heaviness (volume) of water to the heaviness (volume of the solids in a given mass of soil. This ratio is generally communicated as rate (%).

4.1.1 Observation

For unsoaked soil (silt soil) and soaked soil (clay soil)

Sl.no	Details	Values	
		Silt soil	Clay soil
1	Weight of empty container + lid (w_1) gms	11	11
2	Weight of container + lid + wet soil(w_2) gms	59	83
3	Weight of container + lid+ dry soil(w_3) gms	50	66
4	Weight of water in sample (w_2-w_3) gms	9	17
5	Weight of dry sample (w_3-w_1) gms	39	55

The moisture content for unsoaked soil = 23.07%

The moisture content for soaked soil = 30.9%

4.2 Determination of Plastic Limit

For unsoaked soil (silt soil) and soaked soil (clay soil)

Sl.no	Details	Trial-1		Trial-2		Trial-3	
		Silt soil	Clay soil	Silt soil	Clay soil	Silt soil	Clay soil
1	Container no	1	1	2	4	6	6
2	Weight of container + lid (w_1) gms	12	11	13	12	12	12
3	Weight of container + lid + wet sample (w_2) gms	46	50	55	60	56	61
4	Weight of container + lid + dry sample (w_3) gms	40	41	49	51	50	52
5	Weight of water in soil (w_2-w_3) gms	6	9	6	9	6	9
6	Weight of dry sample (w_3-w_1) gms	28	30	36	33	28	40

For unsoaked soil: The average plastic limit of unsoaked soil =17.93%.

For soaked soil: The average plastic limit of soaked soil =25.16%.

The average plastic limit of unsoaked soil = 17.93%

The average plastic limit of soaked soil = 25.16%

4.3 Determination of liquid limit

For unsoaked soil (silt soil) and soaked soil (clay soil)

Sl.no	Description	Tiral-1		Trial-2		Trial-3	
		Silt soil	Clay soil	Silt soil	Clay soil	Silt soil	Clay soil
1	Container no	18	1	8	2	19	4
2	Weight of empty container + lid (w_1)	10	12	12	13	12	12
3	Weight of container + lid + wet soil (w_2)	55	107	61	90	62	85
4	Weight of container + lid+ dry soil (w_3)	43	87	50	70	52	62
5	Weight of water in sample (w_2-w_3)	12	20	9	20	10	20
6	Weight of dry sample (w_3-w_1)	33	75	38	57	40	40
7	No. of. Blows	38	28	32	20	22	16

International Journal of Advanced Technology in Engineering and Science
Vol. No.4, Issue No. 10, October 2016
www.ijates.com
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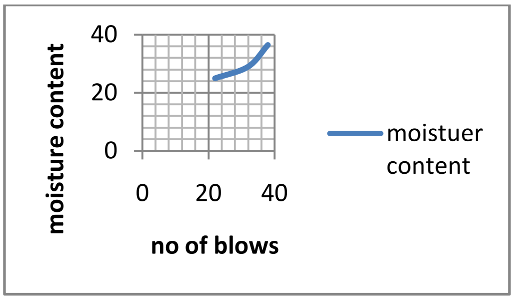
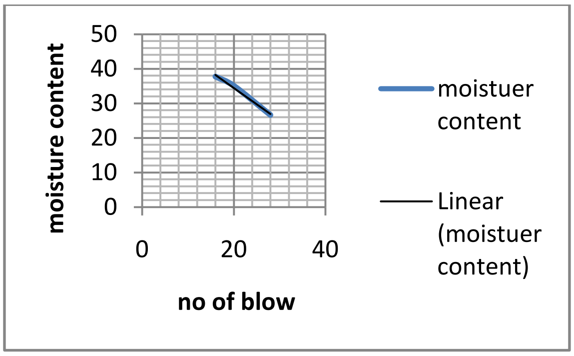
For unsoaked soil: The average liquid limit of unsoaked soil = 30.10%



For soaked soil: The average liquid limit of soaked soil =33.16%



The average liquid limit of unsoaked soil = 30.10%

The average liquid limit of soaked soil = 33.16%

3.4. Determination of Standard Compaction Test: (for unsoaked and soaked soil)

Scope: Determination of the relationship between the moisture content and thickness of soils compacted in a mold of an unsoaked soil and soaked soil.

3.4.1 Observations

Cylinder diameter (d) = 10cm

Height (h) = 12cm

Volume (v) = $(\pi/4) \times d^2 \times h$

$= (\pi/4) \times 10^2 \times 12$

=944cc

Weight of empty cylinder = 2242 gms.

For unsoaked soil (silt soil) and soaked soil (clay soil)

Sl. no	Description	Trial-1		Trial-2		Trial-3		Trial-4	
		Silt soil	Clay soil	Silt soil	Clay soil	Silt soil	Clay soil	Silt soil	Clay soil
1	Water to be added (%)	8%	10%	10%	12%	12%	14%	14%	16%
2	Weight of water to be added	240	300	300	360	360	420	420	480
3	Weight of compacted soil	1706	1706	1936	1936	2055	2055	2044	1650
4	Weight of the cylinder + compacted soil	3948	3948	4178	4178	4297	4297	4286	3892
5	Container no	2	2	4	4	6	6	8	8

6	Weight of empty container + lid (W_1)	39	39	44	44	48	48	36	35
7	Weight of container + lid + wet soil (W_2)	62	62	84	84	92	92	82	62
8	Weight of container + lid + dry soil (W_3)	60	60	79	79	86	86	75	60
9	Water content (%)	9.523	9.523	14.285	14.285	15.78	15.78	17.94	8.00
10	Average moisture content (%)			14.382%	11.647%				
11	Wet density (gm/cc)	1.807	1.807	2.050	2.050	2.176	2.176	2.165	1.747
12	Dry density (gm/cc)	1.649	1.649	1.793	1.793	1.885	1.885	1.835	1.617

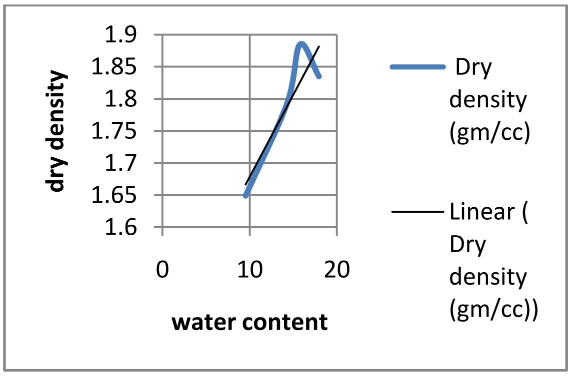
Formulae:

Water content = (W_2-W_3/W_3-W_1) × 100

Wet density = Compacted soil/ volume of mould.

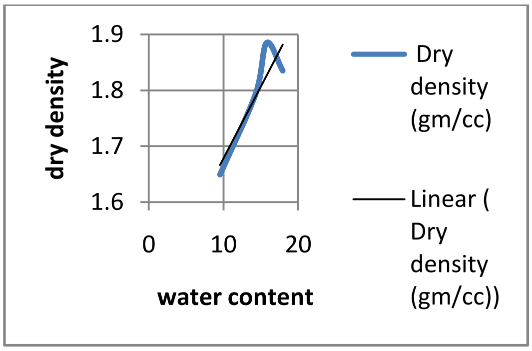
Dry density = Wet density/ 1 + Water content

For unsoaked soil (silt soil**)**



The dry density value of unsoaked soil is 1.835 gm/cc

3.4.2 For soaked soil (clay soil)



The dry density value of soaked soil is 1.617 gm/cc

3.5 Determination of California Bearing Ratio Test: (for unsoaked and soaked soils)

The Golden State bearing penetration take a look at is supposed sure the analysis of sub-grade strength of roads and pavements. The results obtained by this take a look at area unit used with the empirical curves to work out the thickness of pavements and its part layers. This is often the foremost wide used methodology for the planning of versatile pavements.

This instruction sheet covers the laboratory methodology for the determination of California bearing ratio of undisturbed and remolded/ compacted soil specimens, each in soaked also as unsoaked state.

Definition of CBR:-It could be a magnitude relation of force per unit space needed to penetrate a soil mass with customary circular piston at the speed of 1.25mm per minute to it needed for the corresponding penetration of a customary material.

CBR= (test load/standard load) ×100

The following table gives the standard load adopted for different penetrations for the standard material with a CBR value of 100%.

Values of penetration vs standard load

Penetration of plunger(mm)	Standard load(kg)
2.5	1370
5	2055
7.5	2630
10	3180
12.5	3600

3.5.1 Observations

For unsoaked soil (silt soil) and soaked soil (clay soil)

Penetration (mm)		**Moving load**		**Load (kg)**		**Corrected load**	
Silt soil	**Clay soil**	**Silt soil**	**Clay soil**	**Silt soil**	**Clay soil**	**Silt soil**	**Clay soil**
0	0	0	0	0	0		
0.5	0.5	2	2	13.8	4.24		
1	1	3.5	3.5	24.3	10.35		
1.5	1.5	4	4	27.8	25.88		
2	2	5	5	34.7	6.92		
2.5	2.5	6	6	40.7	73.689	**55 kgs**	**100kg**
3	3	6	6	41.7	89.82		
4	4	6.5	6.5	45.1	95		
5	5	8.2	7	48.5	97.51	**67 kgs**	**120kg**
7.5	7.5	8.2	8.2	57	125.62		
10	10	8.9	8.9	61.8	131.06		
12.5	12.5	9.4	9.4	65	132.08		

1 division = 0.01mm

1 division = 6.953 kg

Calculations:

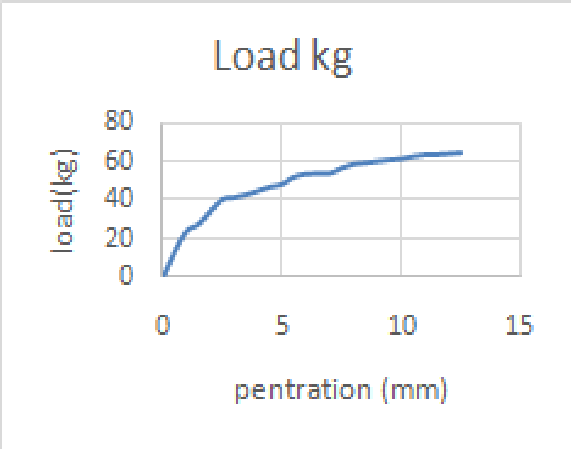
For unsoaked soil

CBR of 2.5mm penetration

CBR= ((7.8×6.953/1370)×100) = 3.95%

CBR of 5mm penetration

CBR = ((8.7×6.953/2055)×100) = 2.94%



The CBR value at 2.5mm penetration is 3.95%

The CBR value at 5mm penetration is 2.94%

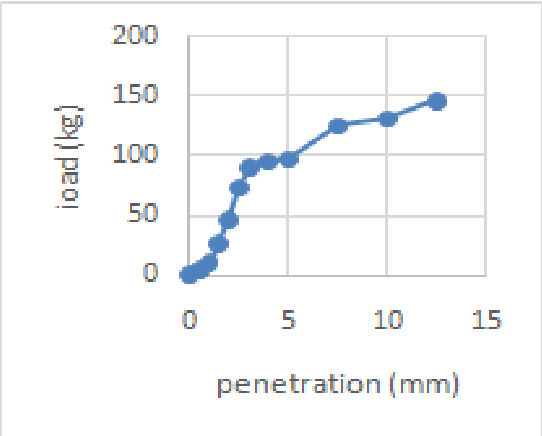
For soaked soil

CBR of 2.5mm penetration

CBR= ((6×6.953/1370) ×100) = 3.04%

CBR of 5mm penetration

CBR = ((8×6.953/2055) ×100) = 2.706%



The CBR value for unsoaked soil at 2.5mm penetration is 3.95%

The CBR value for unsoaked soil at 5mm penetration is 2.94%

The CBR value for soaked soil at 2.5mm penetration is 3.04%

The CBR value for soaked soil at 5mm penetration is 2.706%

IV. RESULTS

4.1 Case I: Unsoaked Soil (Silt Soil)

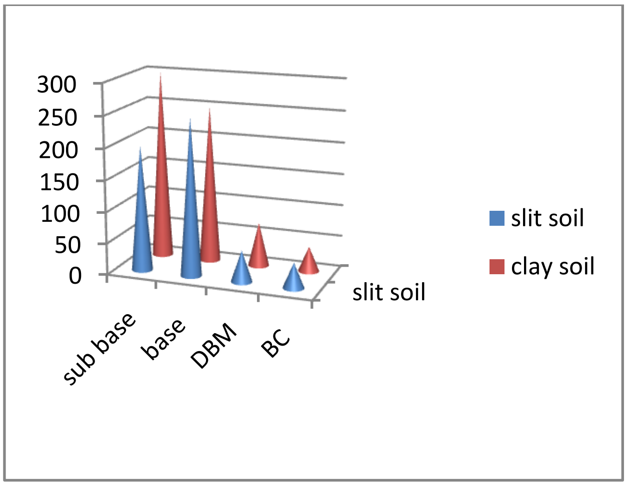
S.no	Description	Layers	Layer thickness (mm)
1	SILT SOIL (UNSOAKED SOIL)	Granular sub base	200
2		Base course	250
3		DBM	50
4		BC	40

Total Thickness of Silt Soil Is 540mm

4.2 Case II: Soaked Soil (Clay Soil)

S.no	Description	Layers	Layer thickness (mm)
1	CLAY SOIL (SOAKED SOIL	Granular sub base	300
2		Base course	250
3		DBM	70
4		BC	40

Total Thickness of Silt Soil is 660mm



Crust thickness with different soil category

V. CONCLUSION

The real conclusions drawn toward the end of this work are as per the following:

The moisture content, plastic limit, liquid limit, compaction test and CBR test are done. But the moisture content, plastic limit, liquid limit values are more in soaked soil compare to unsoaked soil. The compaction test and CBR values are more in unsoaked soil compare to soaked soil.

The thickness of crust layer with the change in the estimation of C.B.R. With higher estimation of C.B.R. the outside layer thickness is less and the other way around. From this lab test it has been watched that the unsoaked soil (silt soil) is reasonable for the development reason for soil sub grade in comparison with the soaked soil (clay soil) on the premise of higher estimations of C.B.R. Because of the sparing in outside layer less amount of material will be relevant so that, huge amount of money can be saved. Because of the higher estimations of C.B.R the silt soil will be stronger in comparison with clay soil.

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