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A Study on "Soil Stabilization by Using Saw Dust and Rice Husk"

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ABSTRACT
Soil is one of the most abundant naturally occurring construction and foundation material. Generally, chemical stabilization is the addition of a stabilizer (rice husk and sawdust in this study)) to a soil in order to change its index properties, while mechanical stabilization involves the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction. Considerable amount of research concerning stabilization of soil with additives such as cement, lime, bitumen and polymers has already been extensively carried out and is available in literature. Fly ash, molasses, rice husk, egg shells, human hairs, waste rubber, sawdust etc. are some of those waste products have been mentioned with potential to be used for stabilization of soil for road construction. The waste materials used in this study are sawdust and rice husk.
Keywords: *SAW DUST , RICE HUSK*

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I. INTRODUCTION

1.1 GENERAL

Soil is one of the most abundant naturally occurring construction and foundation material. Generally, the suitability of a soil for a particular use should be determined based on its engineering characteristics. In most cases, soils need to be'improved' in order to meet the geotechnical characteristics/properties required for a specific project. Soil improvement could be either by mechanical stabilization or chemical stabilization, or even both.

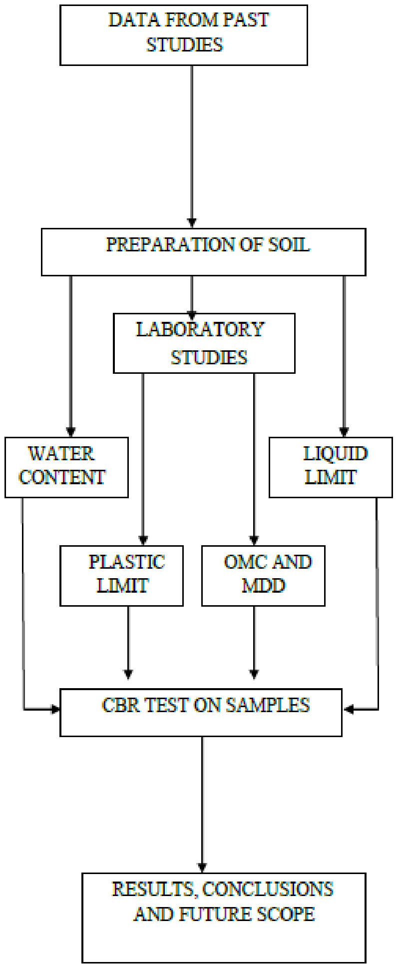
Generally, chemical stabilization is the addition of a stabilizer (rice husk and sawdust in this study) to a soil in order to change its index properties, while mechanical stabilization involves the treatment of soils to enable their strength and durability to be improved such that they become totally suitable for construction. Considerable amount of research concerning stabilization of soil with additives such as cement, lime, bitumen and polymers has already been extensively carried out and is available in literature . However, in recent years, the use of various waste products in civil engineering construction has gained considerable attention in view of shortage and high cost of conventional construction materials, increasing cost of waste dispose land environmental constraints. Fly ash, molasses, rice husk, egg shells, human hairs, waste rubber, sawdust etc. are some of those waste products that have been mentioned with potential to be used for stabilization of soil for road construction. The waste materials used in this study are sawdust and rice husk

Huge quantity of sawdust is being generated worldwide due to the rapid urbanization. The disposal of sawdust in open areas or landfills is not an environment friendly solution. Utilization of sawdust in geotechnical applications likely provides a better solution. An extensive experimental study was carried out to demonstrate the soil improvement prospective of sawdust by performing California bearing ratio (CBR). That experimental study revealed that the addition of sawdust results a significant increase in CBR. Furthermore the values of CBR obtained were within the limits recommended by the Asphalt Institute for Highway sub-base and sub-grade. This study helped us in concluding that sawdust, an industrial waste, is a cheap satisfactory stabilizing agent for sub-base and base course in clayey fills. Such products in civil engineering construction have gained considerable attention in view of shortage and high cost of conventional construction materials, increasing cost of waste disposal, and environmental constraints. Similarly rice husk is one of the waste products that have been mentioned with potential to be used for stabilization of soil for road Construction. Based on the information collected from previous researches, a study of the soil mixedwith sawdust and rice husk at a fixed proportion was carried out.

1.2 OBJECTIVE OF THE STUDY

The primary objective of this study is to compare the effect of addition of rice husk and sawdust to soil. An analysis of the results has been made. Rice husk is non-plastic in nature and sawdust is a great environmental threat causing damage to the land and the surrounding area in which it is dumped. Lots of ways are being thought of for disposing them by making commercial use of these. This study is performed to study the properties of soil mixed with a proportion of sawdust and rice husk.

II. METHODOLOGY AND RESULTS



2 Materials

2.1 Soil

The soil used in the present investigation was obtained from a site in Patoli Brahmana, Jammu area at about 1.25 m to 1.5 m depth from ground level by making an open drench. These soil samples were then shifted to laboratory where they were air dried at room temperature and thereafter soil lumps were powdered. The sample was then sieved through 425micron sieve before being used for laboratory purpose.

Fig.1 Soil sample

The properties of the soil used in these experiments are detailed in the table below.

Table 1 Properties of soil used

Soil properties	Value
Liquid limit LL%	33.8
Plstic limit PL%	18.2
Plasticity index PI%	15.6
Max.dry density gm/cc	1.89
Optimum moisture content %	12.2
CBR value %	6.1

2.2 Sawdust (SD)

The saw dust was collected from local saw mill, Domana, J&K @Rs 5 per kg. The saw dust collected was obtained from sawing of deodar and kale wood. Saw dust is actually by-products of sawmills generated by sawing timber. It is the loose particles or wood chippings obtained by sawing wood into useable sizes. After collection, clean saw dust not having much bark and so not much organic content was air dried at the room temperature. The sawdust was then sieved through 600 micron sieves to remove the lumps, gravels and other materials which are deleterious to soil. The sawdust passing through 600 micron sieve was used for experiment work.

2.2.1 2.3 Rice husk (RH)

The rice husk was collected from Mulkh Raj Rice & General Mill at Barnai, Akhnoor Road, Jammu. The rice husk was grounded and then sieved through 600micron sieve. The rice husk is a byproduct material produced from the process of manufacturing of rice. Annually 60,000 tons of ricehusks are produced in India. It is chemically stable and its physical properties are similar to that of natural sand. The high angularity and friction angle of rice husk contributes to excellent stability and load bearing capacity. With specific gravities ranging from 2.8 to 3.8, rice husk aggregates are heavier than conventional granular material. Rice husk aggregate tends to free drying and are not frost susceptible.

Fig.2 Rice husk

III. LABORATORY TEST

The laboratory studies were carried out to determine the properties of spoil as well as the properties of soil mixed with sawdust and rice husk. Following tests were carried out to determine the properties of soil and soil mixed with sawdust and rice husk:

Determination of water content

Determination of plastic limit

Determination of liquid limit

Determination of plasticity index

Determination of optimum moisture content and maximum dry density

Determination of CBR values

In case of a mixture of soil, the soil is mixed with (4%+2%) and (8%+4%) sawdust and ricehusk respectively by weight and the similar procedure is carried out on the mixture as well.

3.1 TO DETERMINE THE WATER CONTENT

Apparatus

- A thermostatically controlled oven, capable of maintaining a temperature between 105 °C and 110 °C.
- A balance readable and accurate to 0.01 g.
- Numbered aluminum weighing tins with close fitting numbered lids. A suitable size is 75mm diameter and 25 mm deep.
- A dessicator containing anhydrous self-indicating silica gel. A suitable size is 250 mmdiameter.

Calculations

Calculate the moisture content of the soil as a percentage of the dry soil weight

$MC(\%) = (M_2 - M_3)(M_3 - M_1) \times 10$

Results:

Water content of sample = 12.2%

3.2 TO DETERMINE THE PLASTIC LIMIT

Apparatus

- Porcelain evaporating dish about 12cm in diameter.
- Flat glass plate 10mm thick and about 45cm square or longer.
- Ground glass plate 20 x 15 cm.
- Airtight containers.
- Balance of capacity 500grams and sensitivity 0. 01gram.

Table 2 Table for moisture content

S. No.	Observations and Calculations	Determination No.		
		1	**2**	**3**
Observations				
1	Container No.	1	2	3
2	Mass of empty container(gm),M_1	19	18	21
3	Mass of container + wet soil(gm),M_2	62.76	57.13	66
4	Mass of container + dry soil(gm),M_3	59	53	60
Calculations				
5	Mass of water(gm), M_W= $M_2 - M_3$	3.76	4.13	6
6	Mass of solids(gm), M_S= $M_3 - M_1$	40	35	39
7	Moisture content(%)= (5)/(6)x100	9.4	11.8	15.4

- Thermostatically controlled oven with capacity up to 250°C.
- Rod 3mm in diameter and about 10cm long.

Calculations

Table 3 Table for plastic limit

Sample no.	1	2	3
Weight of container	18	19	21
Weight of container + wet soil	22.495	23.17	25.692
Weight of container + dry soil	21.9	22.435	25.03
Weight of water	0.595	0.735	0.662
Weight of dry soil	3.9	3.21	4.03
Moisture content	15.26%	22.91%	16.43%

Results
Plastic limit = 18.2%

Fig.3 Plastic limit testing

3.3 TO DETERMINE THE LIQUID LIMIT
Objective
For determination of the liquid limit of soil using Casagrande apparatus.

Equipment & Apparatus

- Oven
- Balance (0.01g accuracy)
- Sieve [425 micron]
- Casagrande apparatus

Fig.4 Casagrande Apparatus

Table 4 Table for liquid limit

Determination no.	**1**	**2**	**3**	**4**
Container no.	1	2	3	4
Weight of container	14.02	18	19	21
Weight of container + wet soil	32.52	31.5	33	35
Weight of container + dry soil	28.5	28	30	33
Weight of water	4.02	3.418	4.187	2.957
Weight of dry soil	10.5	10	11	12
Moisture content	38.31	34.18	38.07	24.64
No. of blows	33	27	23	30

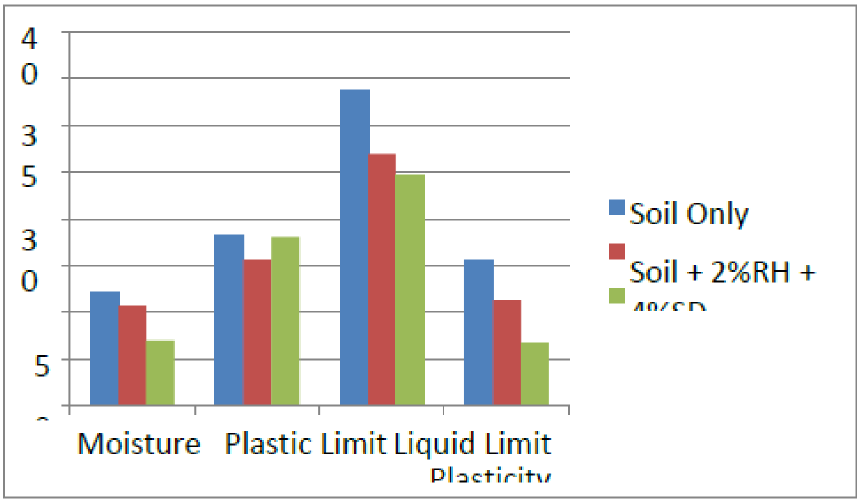
Result: Liquid limit = 33.8%

3.4 TO DETERMINE THE PLASTICITY INDEX

Definition
The plasticity index of a soil is the numerical difference between its liquid limit and its plastic limit, and is a dimensionless number. Both the liquid and plastic limits are moisture contents.
Calculations
Plastic Index= Liquid Limit-Plastic Limit
PI=LL-PL

Table 5 Consistency limits and Plastic index

Sample proportion	**Moisture content (%)**	**Plastic limit (%)**	**Liquid limit (%)**	**Plasticity index(%)**
Soil only	12.2	18.2	33.8	15.6
Soil+2%RH+4% SD	10.69	15.67	26.98	11.31
Soil+4%RH+8% SD	6.972	18.05	24.7	6.65



Graph No. 1 Consistency Limits and Plastic limits

3.5 TO DETERMINE THE MAXIMUM DRY DENSITY AND OPTIMUM MOISTURE

Standard proctor compaction test
Objective
To determine the required amount of water to be used when compacting the soil in the field and the resulting degree of denseness, which can be expected from compaction at optimum moisture content.
Apparatus

- Cylindrical metal mould shall be of 100mm diameter and 1000cm3 volume and shall confirmto IS: 10074 – 1982.
- Balance of capacity 500grams and sensitivity 0.01gram.
- Balance of capacity 15Kg and sensitivity one gram.
- Thermostatically controlled oven with capacity up to 250°C.
- Airtight containers.
- Steel straight edge about 30cm in length and having one beveled edge.
- 4.75mm, 19mm and 37.5mm IS sieves confirming to IS 460 (Part 1).
- Mixing tools such as tray or pan, spoon, trowel and spatula or suitable mechanical device for thoroughly mixing the sample of soil with additions of water.

CONTENT
Heavy compaction rammer of mass 2.6 kg having a free fall of 310 mm

Calculations

Calculate the bulk density 'w' in g / cm3 of each compacted specimen from the equation,
$w = (M_2 - M_1) / V_m$

where,
M_1 = Weight of mould with base plate.
M_2 = Weight of mould with compacted soil
V_m = Volume of mould in cm
Calculate the dry density 'd' in g/cm3 from the equation, $d = w / (1+W/100)$
where,

w = Bulk density

W = % of moisture content

Report

Plot the values obtained for each determination on a graph representing moisture content on x-axis and dry density on y-axis.
Draw a smooth curve through the resulting points and determine the position of the maximum dry density in the curve.
Report the dry density corresponding to the maximum point to the nearest 0.01.

Precaution
With clays of high plasticity or where hand mixing is employed, it may be difficult to distribute the moisture uniformly throughout the air dried soil by mixing alone, so it may be necessary to preserve the mixed sample in a sealed container for a minimum period of about 16 hours before conducting the test.

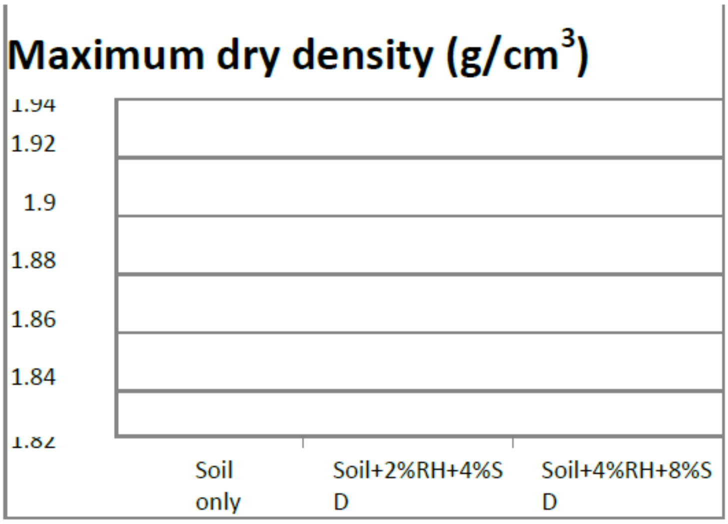
Table 6 Table for Standard proctor test

Observations	1	2	3
Weight of empty mould	2072	2072	2072
Volume of mould (V)	1000	1000	1000
Weight of mould +base plate (W_m)	4133	4133	4133
Weight of mould + base plate + compacted soil (W_c)	5938	6025	6215
Weight of compacted soil (W) $W = W_c - W_m$	1805	1892	2082
Weight of container	17	19	18
Weight of container + wet soil	50.5	62.77	53.13
Weight of container + dry soil	47	58	50
Weight of dry soil	30	39	32
Weight of water	3.5	4.77	3.13
Moisture content(w)	11.7	12.2	9.78
Dry density	1.66	1.89	1.69

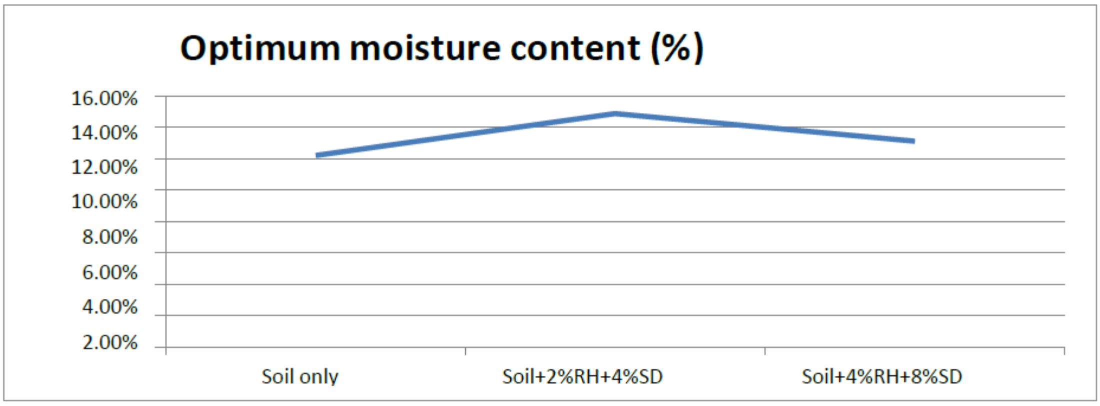
Optimum moisture content = 12.2%
Maximum dry density= 1.89 g/cm^3

Table 7 Table for Maximum dry density and Optimum moisture content

Soil mixture	Optimum moisture content (%)	Maximum dry density (g/cm^3)
Soil only	12.2%	1.89 g/cm^3
Soil+2%RH+4 %SD	14.86%	1.93 g/cm^3
Soil+4%RH+8 %SD	13.09%	1.86 g/cm^3



Graph No. 2 Maximum dry density



Graph No. 3 Optimum Moisture Content

3.6 TO DETERMINE THE CBR VALUES

Theory: California Bearing Ratio (CBR) is defined as the ratio expressed in percentage of force per unit area required for penetrating a soil mass with a circular plunger of 50 mm diameter at the rate of 1.25 mm/min to that required for corresponding penetration in a standard material. Tests are performed out on natural or compacted soils in water soaked conditions and the results so obtained are compared with the curves of standard test.

Apparatus Required:

- CBR mould with detachable perforated base plate
- Spacer disc with a removable handle (to be placed inside the mould)
- Collar of 50mm high
- Penetration plunger of 50 mm diameter
- One annular and a few slotted surcharge masses 2.5 kg each
- Rammer (2.6 kg with 310mm drop for standard proctor results) and (4.89 kg with 450mm dropfor modified proctor results)
- Straight cutting edge

- Loading machine of 50 KNcapacity fitted with a calibrated proving ring to which plunger hasto be attached

- Penetration measuring dial gauge of 0.01 accuracy
- Soaking tank
- Swelling gauge consisting of perforated plate with adjustable extension stem

Mould specification:
Diameter of the mould = 150mm
Height of the mould = 175mm
Height of the CBR soil specimen = 125mm

Soil specification:

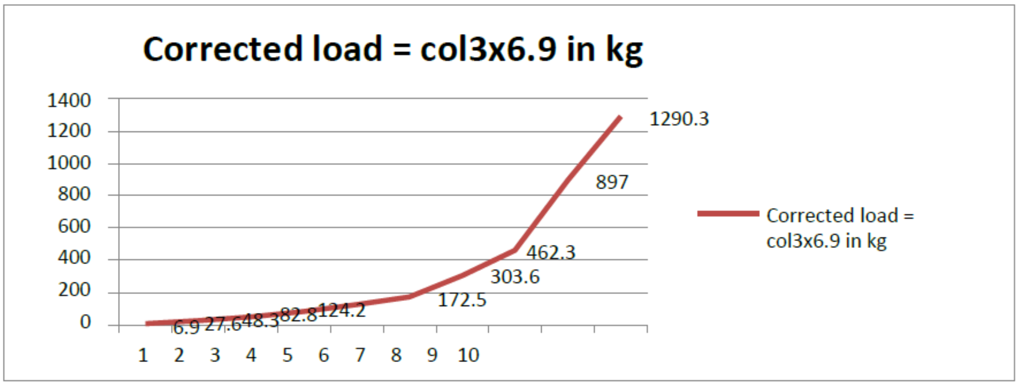
Particle size = should pass through 19mm sieve . Soil particles of size greater than 19mm should bereplaced by particles of size between 4.75mm and 19mm

FIG.5 CBR Testing Machin

Table No. 8 SAMPLE A(4% Saw Dust and 2 & Rice Husk)

Load in Kg	Penetration In mm	Load kg/ sq.cm
0.0	0	0.00
6.9	0.5	0.35
27.6	1	1.41
48.3	1.5	2.46
82.8	2	4.22
124.2	2.5	6.32
172.5	3	8.78
303.6	4	15.46
462.3	5	23.54
897.0	7.5	45.67
1290.3	10	65.70

At 2.5mm= 6.32x19.64/1370 = 9.06%



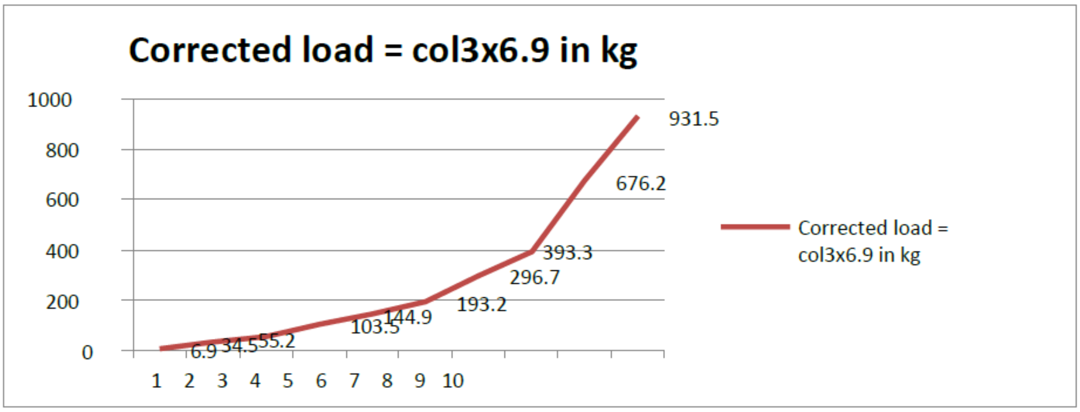
Graph No. 4 Corrected load (a)

At 5mm = 23.54x19.64/20.55=22.50%

Table No. 9 SAMPLE B (8% Saw Dust & 4% Rice Husk)

Load in Kg	Penetration in mm	Load kg/ sq.cm
0.0	0	0.00
6.9	0.5	0.35
34.5	1	1.76
55.2	1.5	2.81
103.5	2	5.27
144.9	2.5	7.38
193.2	3	9.84
296.7	4	15.11
393.3	5	20.03
676.2	7.5	34.43
931.5	10	47.43

At 2.5 mm = 7.38x19.64/1370 = 10.56%
At 5 mm = 20.03x19.64/2055= 19.14%

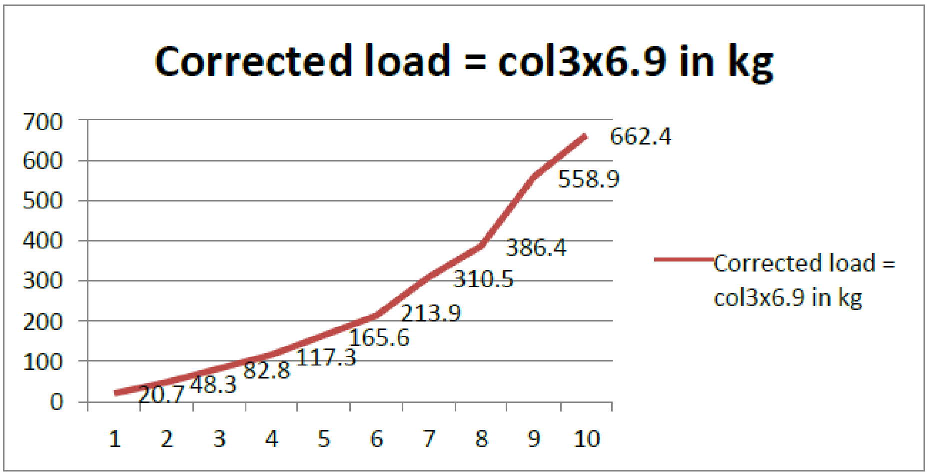


Graph No. 5 Corrected load (b)

Table No. 10 SAMPLE C (Soil)

Load in Kg	Penetration in mm	Load kg/ sq.cm
0.0	0	0.00
20.7	0.5	1.05
48.3	1	2.46
82.8	1.5	4.22
117.3	2	5.97
165.6	2.5	8.43
213.9	3	10.89
310.5	4	15.81
386.4	5	19.67
558.9	7.5	28.46
662.4	10	33.73

At 2.5 mm = 8.43x19.64/1370=12.08%
At 5mm=19.67x19.64/2055=18.80



Graph No. 6 Corrected load (c)

Generally the values at 2.5 mm penetration are greater than the values at 5mm penetration as we repeat the same test the value are same as previous test performed. So we take the values at 5mm penetration for the design as per the IS: 2720 [Part 16]:1987 page no. 4.2.2 California bearing ratio (CBR) .For 5mm Penetration.

Table 11 Table for CBR values at 5mm penetration

Sample No	Soil: Sawdust: Rice Husk	CBR Soaked
1	100:0:0	18.80
2	94:4:2	22.50
3	88:8:4	19.14

IV. RESULTS

The poorly graded soil is not good for construction and that is why it needed some admixture to change the properties of soil which gives it good strength to bear the heavy loads.

Standard Proctor Test Results

After checking the results for different percentages of mixture of sawdust and rice husk like (0%+0%), (4%+2%) and (8%+4%) the better results of proctor test where maximum value of MDD is shown at (4%+2%) of sawdust and rice husk when we mix them with soil.

CBR Test Results

By adding the admixture like sawdust and rice husk the strength of the soil increases as shown in the above results, the CBR values increases when we add sawdust and rice husk with soil from the CBR values increase from 18.80 to 22.50 when 4% of sawdust and 2% of rice husk is added to soil. And from 18.82 to 19.14 when 8% of sawdust and 4% rice husk is added to the soil.

V. CONCLUSION

It clearly shows that by adding sawdust with rice husk in soil the results are good and we can use it in the sub-grade layer in future for the construction of roads at places where the soil is poorly graded and definitely strength will improve.

FUTURE SCOPE

As per this research the results are good, by this we can improve the sub-grade of road but for future we can use it in the above layers i.e. sub base and base course. We can also use the other materials with these two (i.e. sawdust and rice husk) or individually and it will definitely increase strength of the soil. By improving strength of the soil it directly decrease the thickness of the pavement, when thickness reduces the cost will also reduce. Thus, this study shows that above mentioned admixtures can help us in decreasing the costs as well as increasing the strength of sub- grade soil. Moreover, better management of waste products can be achieved through this study.

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