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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,thesuitabilityofasoilforaparticularuseshouldbedeterminedbasedonitsengineeringcharacteristics.Inmost cases,soilsneedtobe'improved'inordertomeetthegeotechnicalcharacteristics/propertiesrequiredforaspecificprojec t.Soilimprovementcouldbeeitherbymechanicalstabilizationorchemicalstabilization,orevenboth.

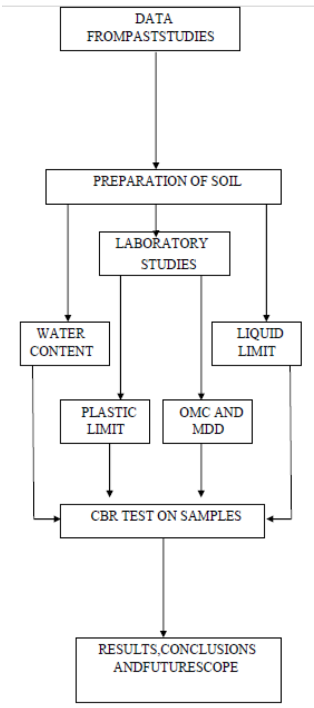
Generally, chemical stabilization is the addition of a stabilizer (rice husk and sawdustin this study)to a soil in order to change its index properties, while mechanical stabilization involves the treatmentof soils to enable their strength and durability to be improved such that they become totally suitablefor construction. Considerable amountof research concerningstabilization of soil with additivessuch as cement, lime, bitumen and polymers has already been extensively carried out and is availableinliterature . However,in recentyears, the use of various waste products in civil engineeringconstruction has gained considerable attention in view of shortage and high cost of conventionalconstruction 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 wasteproducts thathavebeenmentionedwithpotential tobeusedforstabilizationof soilforroadconstruction.The wastematerialsusedinthisstudyare sawdustandricehusk

Huge quantity of sawdust is being generated worldwide due to the rapid urbanization. Thedisposal of sawdust in open areas or landfills is not an environment friendly solution. Utilization ofsawdust in geotechnical applications likely provides a better solution. Anextensive experimentalstudy was carried out to demonstrate the soil improvement prospective of sawdust by performingCalifornia bearing ratio (CBR). That experimental study revealed that the addition of sawdust resultsa significantincrease in CBR. Furthermore the values of CBR obtainedwere within the limitsrecommended by the Asphalt Institute for Highway sub-base and sub-grade. This study helped us inconcluding thatsawdust, an industrial waste, is a cheap satisfactory stabilizing agent for sub-base and base course inclayeyfills.Suchproductsincivilengineeringconstructionhavegainedconsiderable 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 thewasteproductsthathavebeenmentionedwithpotentialtobeusedforstabilizationofsoilforroad Construction.Basedontheinformationcollectedfrompreviousresearches,astudy of thesoilmixedwithsawdustandrice huskata fixedproportionwas carriedout.

1.2 OBJECTIVEOFTHESTUDY

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

II. METHODOLOGYANDRESULTS



2 Materials

2.1 Soil

The soil used in the present investigation wasobtained from asite in PatoliBrahmana, Jammu areaat about 1.25 m to 1.5 m depth from ground level by making an open drench.These soil sampleswere then shifted to laboratory where they were air dried at room temperature and thereafter soillumps were powdered. The sample was then sieved through 425micron sieve before being used forlaboratory purpose.

Fig.1 Soil sample

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

Table 1 Properties of soil used

Soilproperties	**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 dustcollected was obtained from sawing of deodar and kale wood. Saw dust is actually by-products ofsawmills generated by sawing timber. It is the loose particles or wood chippings obtained by sawingwoodintouseablesizes.Aftercollection,cleansawdustnothavingmuchbarkandsonotmuch organic content was air dried at the room temperature. The sawdust was then sieved through 600micron sieves to remove the lumps, gravels and other materials which are deleterious to soil. Thesawdustpassingthrough600micronsieve wasusedforexperimentwork.

2.2.1 2.3 Ricehusk(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 abyproduct 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 ofnatural sand. The high angularity and friction angle of rice husk contributes to excellent stability andload bearing capacity. With specific gravities ranging from 2.8 to 3.8, rice husk aggregates areheavier than conventional granularmaterial. Rice husk aggregate tends to free drying and are notfrostsusceptible.

Fig.2 Ricehusk

3 LABORATORYTEST

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

Determinationofwatercontent

Determinationofplasticlimit

Determinationofliquidlimit

Determinationofplasticityindex

Determinationofoptimummoisture contentandmaximumdrydensity

DeterminationofCBRvalues

Incaseofamixtureofsoil,thesoilismixedwith(4%+2%)and(8%+4%)sawdustandricehusk respectivelybyweightandthesimilarprocedureiscarried outonthemixture aswell.

3.1 TODETERMINETHEWATER CONTENT

Apparatus

- Athermostaticallycontrolledoven,capableofmaintainingatemperaturebetween105°Cand110°C.
- Abalancereadableandaccuratetto0.01 g.

- Numberedaluminumweighingtinswithclosefittingnumberedlids.Asuitablesizeis75mmdiameterand25mmdeep.

- Adessicatorcontaininganhydrousself-indicatingsilicagel.Asuitablesizeis250mmdiameter.

Calculations

Calculatethemoisturecontentofthesoilasapercentage ofthedrysoilweight

MC(%)=(M_2–M_3)(M_3–M_1)×10

Table2Tableformoisturecontent

S. No.	Observationsan dCalculations	DeterminationNo.		
		1	2	3
Observations				
1	Container No.	1	2	3
2	Massofemptycontainer(gm).M_1	19	18	21
3	Massofcontainer+wetsoil(gm).M_2	62.76	57.13	66
4	Massofcontainer+ drysoil(gm).M_3	59	53	60
Calculations				
5	Massofwater(gm).M_w =M_2– M_3	3.76	4.13	6
6	Massofsolids(gm).M_s =M_3–M_1	40	35	39
7	Moisturecontent(%)=(5)/(6)x100	9.4	11.8	15.4

Results:

Watercontentofsample = 12.2%

3.2 TODETERMINETHEPLASTICLIMIT

Apparatus

- Porcelainevaporatingdishabout 12cmindiameter.
- Flatglassplate10mmthickandabout45cmsquareorlonger.
- Groundglassplate20x15cm.
- Airtightcontainers.
- Balanceofcapacity500gramsand sensitivity0.01gram.
- Thermostaticallycontrolledovenwithcapacityupto250°C.
- Rod3mmindiameter and about 10cmlong.

Calculations

Table3Tableforplasticlimit

Sampleno.	1	2	3
Weightofcontainer	18	19	21
Weightofcontainer+wetsoil	22.495	23.17	25.692
Weightofcontainer+drysoil	21.9	22.435	25.03
Weightofwater	0.595	0.735	0.662
Weightofdrysoil	3.9	3.21	4.03
Moisturecontent	15.26%	22.91%	16.43%

Results

Plasticlimit = 18.2%

Fig.3Plasticlimit testing

3.3 TODETERMINETHELIQUIDLIMIT

Objective
Fordeterminationoftheliquidlimitofsoilusing Casagrandeapparatus.
Equipment&Apparatus

- Oven
- Balance(0.01gaccuracy)
- Sieve[425micron]
- Casagrandeapparatus

Fig.4CasagrandeApparatus

Table4Tableforliquidlimit

Determination no.	1	2	3	4
Containerno.	1	2	3	4
Weightofcontainer	14.02	18	19	21
Weightofcontainer+wetsoil	32.52	31.5	33	35
Weightofcontainer+dry soil	28.5	28	30	33
Weightofwater	4.02	3.418	4.187	2.957
Weightofdry soil	10.5	10	11	12
Moisturecontent	38.31	34.18	38.07	24.64
No.ofblows	33	27	23	30

Result: Liquid limit = 33.8%

3.4

Sampleproportion	Moisturecontent(%)	Plasticlimit(%)	Liquid limit(%)	Plasticity index(%)
Soilonly	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%S	6.972	18.05	24.7	6.65

TODETERMINETHEPLASTICITYINDEX

Definition

Theplasticityindexofasoilisthenumericaldifferencebetweenits liquidlimitanditsplasticlimit,andisadimensionlessnumber.Boththeliquid andplasticlimitsaremoisturecontents.

Calculations

Plastic Index= Liquid Limit-Plastic Limit

PI=LL-PL

Table5ConsistencylimitsandPlasticindex

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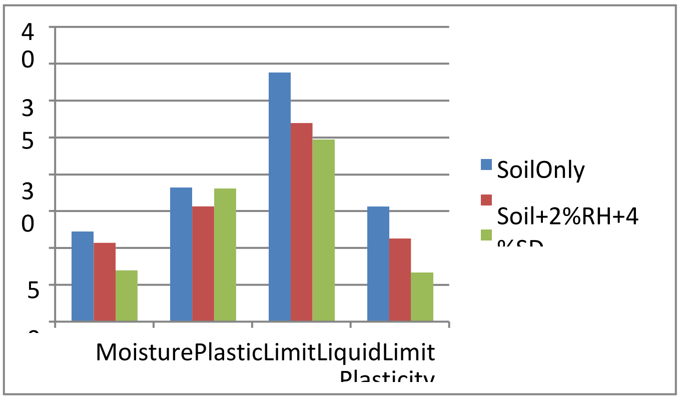


GraphNo.1ConsistencyLimitsandPlasticlimits

3.5 TODETERMINETHEMAXIMUMDRYDENSITYANDOPTIMUMMOISTURE

Standard proctorcompaction test

Objective

To determine the required amount of water to be used when compacting the soil in the fieldand the resulting degree of denseness, which can be expected from compaction at optimum moisturecontent.

Apparatus

- Cylindricalmetalmouldshallbeof100mmdiameterand1000cm3volumeandshallconfirmtoIS:10074–1982.
- Balanceofcapacity500gramsand sensitivity0.01gram.
- Balanceofcapacity15Kg and sensitivityonegram.
- Thermostaticallycontrolledovenwithcapacityupto250°C.
- Airtightcontainers.
- Steelstraightedgeabout 30cmin lengthandhavingonebeveled edge.
- 4.75mm,19mmand 37.5mmIS sievesconfirming toIS460(Part1).
- Mixingtoolssuchastrayorpan,spoon,trowelandspatulaorsuitablemechanicaldevicefor thoroughlymixingthesampleofsoilwithadditions ofwater.

CONTENT

Heavycompactionrammer ofmass2.6 kg having afreefallof310 mm

Calculations

Calculatethebulk density'w'ing / cm3 ofeachcompacted specimen fromtheequation,
$w= (M_2–M_1)/V_m$

where,
M_1=Weightofmouldwithbaseplate.
M_2=Weightofmouldwithcompactedsoil
V_m=Volumeofmouldincm
Calculatethe drydensity'd'ing/cm3fromthe equation,d=w/(1+W/100)
where,

w=Bulk density

W=%ofmoisturecontent

Report

Plotthevaluesobtainedforeachdeterminationonagraphrepresentingmoisturecontentonx-axisanddrydensityony-axis.
Drawasmoothcurvethroughtheresultingpointsanddeterminethepositionofthemaximumdrydensityinthecurve.
Report the drydensitycorrespondingtothemaximumpointtothe nearest0.01.

Precaution

With clays of high plasticity or where hand mixing is employed,itmay be difficulttodistribute themoistureuniformly throughouttheairdriedsoilby mixingalone,soitmaybenecessary topreserve the mixed samplein a sealed container for a minimum period of about 16hoursbeforeconductingthetest.

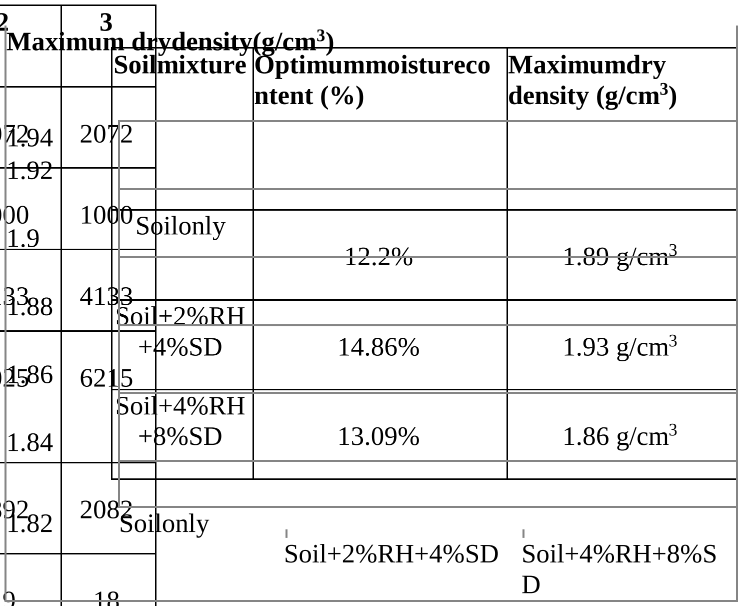
Table6 TableforStandardproctortest

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

Table7 TableforMaximumdrydensityandOptimummoisturecontent

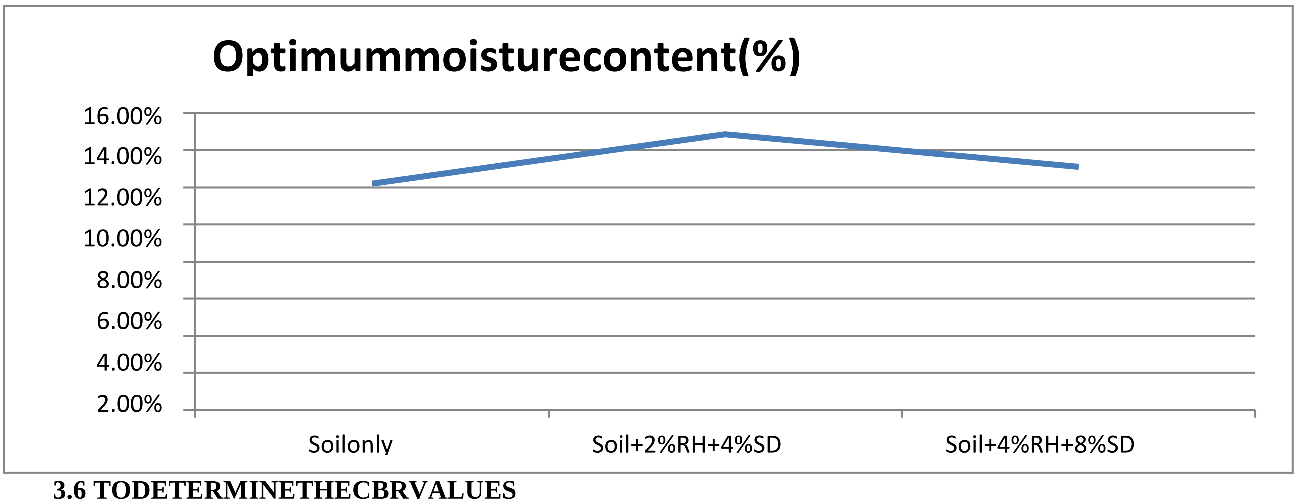
Observations	**1**	**2**	**3**
Weightofemptymould	2072	2072	2072
Volumeofmould(V)	1000	1000	1000
Weight ofmould+baseplate(W_m)	4133	4133	4133
Weight ofmould +baseplate+compactedsoil(W_c)	5938	6025	6215
Weightofcompactedsoil(W) $W=W_c–W_m$	1805	1892	2082
Weightofcontainer	17	19	18
Weightofcontainer+wetsoil	50.5	62.77	53.13
Weightofcontainer+dry soil	47	58	50
Weight ofdry soil	30	39	32
Weightofwater	3.5	4.77	3.13
Moisturecontent(w)	11.7	12.2	9.78
Drydensity	1.66	1.89	1.69

Soilmixture	**Optimummoisturecontent (%)**	**Maximumdry density (g/cm^3)**
Soilonly	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



GraphNo. 2Maximumdrydensity

GraphNo.3 OptimumMoistureContent



3.6 TODETERMINETHECBRVALUES

Theory: California Bearing Ratio (CBR) is defined as the ratio expressed in percentage of force perunitarearequiredforpenetratingasoilmasswithacircularplungerof50mmdiameterattherateof 1.25mm/mintothatrequiredforcorrespondingpenetrationinastandardmaterial.Testsareperformed out on natural or compacted soils in water soaked conditions and the results so obtainedare comparedwiththecurves ofstandardtest.

ApparatusRequired:

- CBRmouldwithdetachableperforatedbaseplate
- Spacerdiscwitharemovablehandle(tobeplacedinsidethemould)
- Collarof50mmhigh
- Penetrationplungerof50mmdiameter
- Oneannular andafewslottedsurchargemasses2.5kgeach
- Rammer(2.6kgwith 310mmdropforstandardproctorresults)and(4.89kgwith 450mmdropformodifiedproctorresults)
- Straightcuttingedge
- Loadingmachineof 50KNcapacityfittedwithacalibratedprovingringtowhichplungerhastobeattached
- Penetrationmeasuringdialgauge of 0.01accuracy

- Soakingtank
- Swelling gaugeconsisting ofperforatedplatewithadjustableextensionstem

Mouldspecification:
Diameter of the mould = 150mm
Heightofthemould =175mm
HeightoftheCBRsoilspecimen=125mm

Soilspecification:

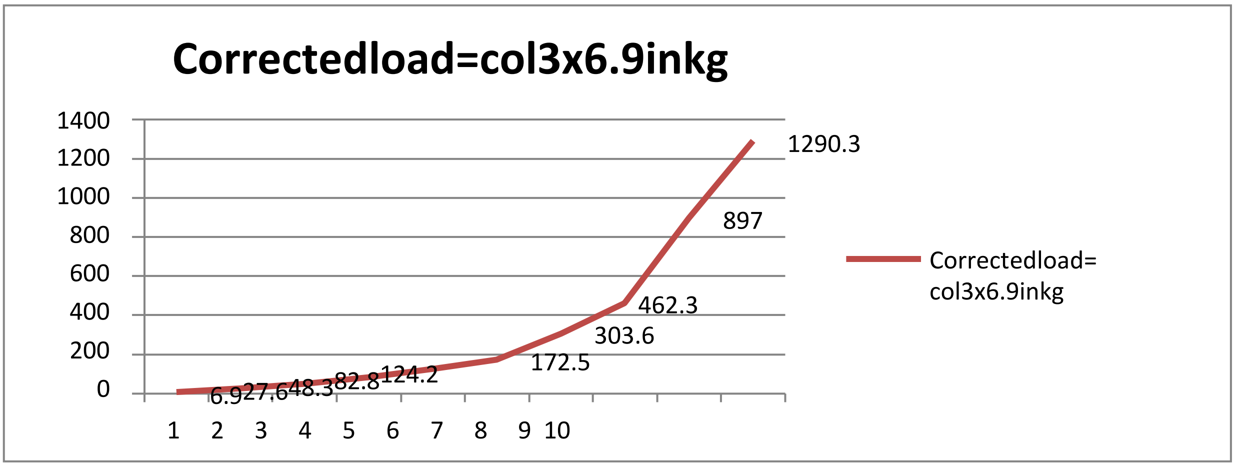
Particle size = should pass through 19mm sieve . Soil particles of size greater than 19mm should bereplacedbyparticles ofsizebetween4.75mmand19mm

FIG.5CBRTestingMachin

LoadinKg	Penetration Inmm	Loadkg/ 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

TableNo.8SAMPLEA(4%SawDustand 2&Rice Husk)

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



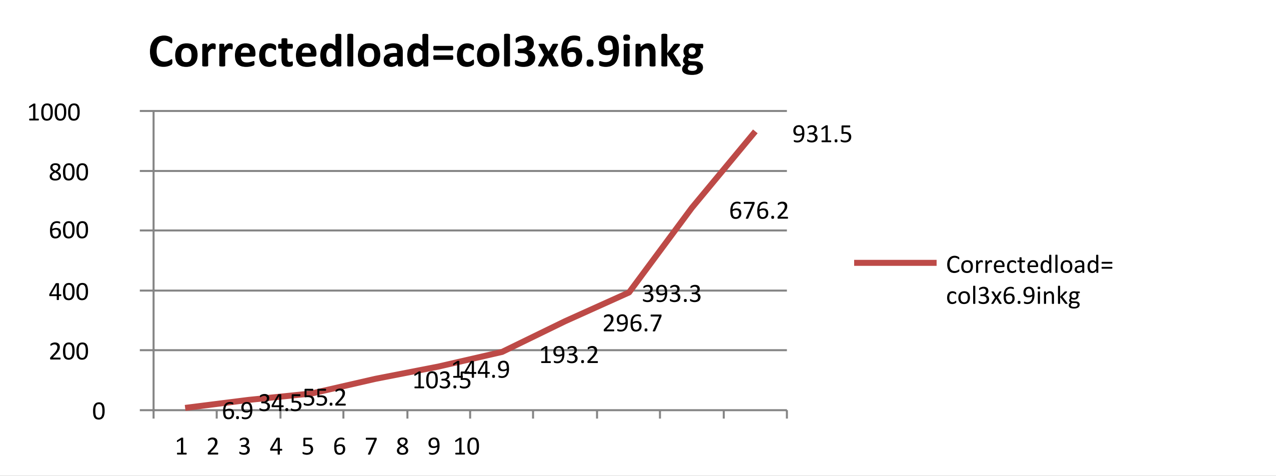
GraphNo. 4Correctedload(a)

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

TableNo.9SAMPLEB(8%Saw Dust&4%RiceHusk)

LoadinKg	Penetration inmm	Loadkg/ 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%

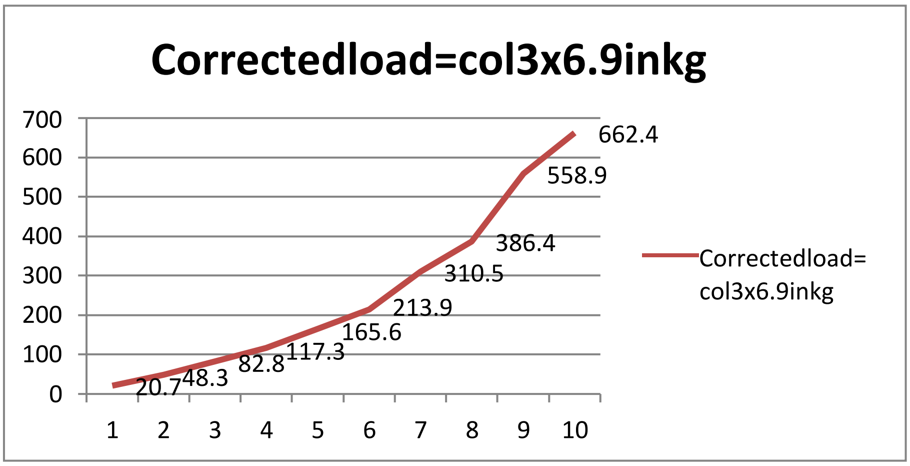


GraphNo. 5Correctedload(b)

TableNo.10SAMPLEC(Soil)

LoadinKg	Penetration inmm	Loadkg/ 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



GraphNo. 6Correctedload (c)

Generally the values at 2.5 mm penetration are greater than the values at 5mm penetration as werepeat 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.

Table11 TableforCBRvaluesat 5mmpenetration

SampleNo	Soil:Sawdust:RiceHusk	CBRSoaked
1	100:0:0	18.80
2	94:4:2	22.50
3	88:8:4	19.14

4. RESULTS

The poorly graded soil is not good for construction and that is why it needed some admixturetochange the propertiesofsoilwhichgivesitgoodstrengthtobearthe heavyloads.

StandardProctorTestResults

After checking the results for different percentages of mixture of sawdust and rice husklike(0%+0%), (4%+2%) and (8%+4%) the better results of proctor test where maximum value of MDDisshownat(4%+2%)ofsawdustandricehuskwhenwemixthemwithsoil.

CBRTestResults

By adding the admixturelike sawdustand rice husk the strength of the soil increases asshown in the above results, the CBR values increases when we add sawdust and rice husk with soilfrom the CBR values increase from 18.80 to 22.50 when 4% of sawdust and 2% of rice husk isaddedtosoil.Andfrom 18.82 to 19.14 when8%ofsawdustand 4%ricehuskisadded tothesoil.

CONCLUSION

It clearly shows that by adding sawdust with rice husk in soil the results are good and we can useit in the sub-grade layer in future for the constructionof roads at places where the soil is poorlygradedanddefinitelystrength willimprove.

4.1 FUTURESCOPE

As per this research the results are good, by this we can improve the sub-grade of road butfor future we can use it in the above layers i.e. sub base and base course. We can also use the othermaterials with these two (i.e. sawdust and rice husk) or individually and it will definitely increasestrength of the soil. By improving strength of the soil itdirectly decrease the thickness of thepavement, when thickness reduces the cost will also reduce. Thus, this study shows that abovementioned admixtures can help us in decreasing the costs as well as increasing the strength of sub-gradesoil.Moreover,better management ofwasteproductscanbe achieved throughthisstudy.

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