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AN EXPERIMENTAL STUDY ON SUBGRADE STABILIZATION WITH LIME AND STONE POWDER IN FLEXIBLE PAVEMENT

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***Abstract**:*Theperformanceofflexiblepavementisdeterminedbythefunctionsofthecomponentlayers,particularly the subgrade. Subgrade is the compacted layer of soil provide the lateral supporttothe pavement.Ourapproachistoimprovethe propertiesofsoiliswithadditionofadmixtures like lime and stone dust with soil. Soil stabilization is one of the most suitablealternativeswhicharewidelyusedinpavementconstruction.Soilstabilizationandsoiltreatmentgivesaninnovativesolutiontoimprovetheengineeringpropertiesofsoilbyimprovingthebearingcapacity,durabilityofweaksoilandothercharacteristicsasper requirement. In this study lime and stone powder has been selected as a stabilizer. The soil istested in the laboratory by reinforcing it with different percentages of lime and stone dust,namely5%,10%,15%,20%,25%, 30%.Atterberglimitand compactiontestwerecarriedouton both unmodified and modified soil. California bearing ratio (CBR) test was performed todeterminethe strength properties of the soil, lime, stone powder mixtures.

Key words: Flexible Pavement, Subgrade Soil, Stabilization, Lime, Stone dust, CBR, BearingStrength.

I. INTRODUCTION

Pavement:

The pavement is the part of the road that carries the traffic, and has a set of layers or materialplaced over the natural ground. The pavement layers spread the load of the vehicles so that itdoesnot exceed the strength capacity of thesubgrade.

TypesofPavements:

Therearetwo typesof pavementsbased ondesignconsiderations.Theyare,

1. RigidPavement,
2. FlexiblePavement.

. **RigidPavement:**

1. Arigidpavementisconstructedfromcementconcreteorreinforcedconcreteslabs.Groutedconcreteroadsarein thecategory ofsemi-rigid pavements.
2. Thedesignofrigidpavementisbasedonprovidingastructuralcementconcreteslabofsufficientstrength to resiststheloads fromtraffic.

3. Therigidpavementhasrigidityandhighmodulusofelasticitytodistributetheloadsoverarelatively wideareaofsoil.

StructureofRigidPavement:

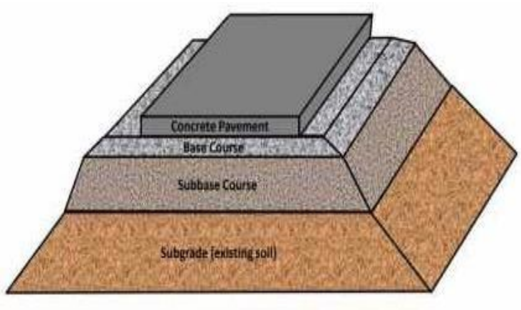


FIG.1.1.ComponentsofRigidPavement

FlexiblePavement:

1. Flexible pavement can be defined as the one consisting of a mixture of asphaltic orbituminous material and aggregates placed on a bed of compacted granular material ofappropriatequality in layers over thesubgrade.
2. Water bound macadam roads and stabilized soil roads with or without asphaltic toppingsareexamplesof flexiblepavements.
3. Thedesignofflexiblepavementisbasedontheprinciplethatforaloadofanymagnitude,theintensityofaloaddimin ishesastheloadistransmitteddownwardsfromthesurfacebyvirtuespreadingoveranincreasinglylargerarea,byc arryingitdeepenoughintothegroundthroughsuccessivelayersof granularmaterial.

. **StructureofFlexiblePavement:**

Surface Course

BinderCourse

Base Course

SubbaseCourse

Subgrade

FIG.1.2.ComponentsofFlexiblePavement

II. LITERATURE REVIEW

1.M.A.PETER(2023).

The paper "effects of stone dust on lime stabilized granular soil" focuses on the variationof CBR value of stabilized granular soil on addition with lime and stone dust. The CBRvalue is important factor which determines the strength of the pavement. The lateral loadson the pavement distributed to the subgrade soil. So, subgrade soil should have highstrength.

2.DOMMARAJUSOMESH etall.(2020).

The purpose of the paper "techno-economical design of flexible pavement based on thestabilizationofsoilusingstonedustasadditive"istodeterminethepropertiesofexpansivesoildevelopedbymixingstonedusttoe xpansivesoilindifferentproportionsandobservingthe improvement in properties.

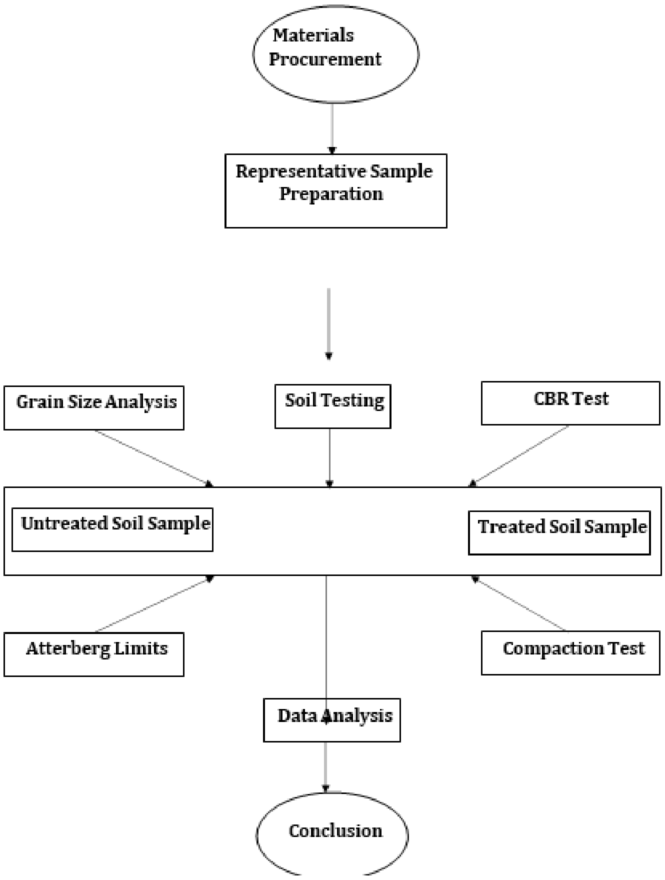
3. ANTENEHGEREMEWetall.(2019).

The paper"performance studies on subgrade formation using lime and cement in roadprojects" determines the how CBR Values effects the pavement thickness of FlexiblePavement. CBR value is inversely proportional to pavement thickness. The CBR valuegives the total thickness requirement of the pavement above a subgrade and this thicknessvalue would remain the same irrespective of the quality of materials used in componentlayers.

4. AMERENDRAKUMAR,DR.RAVIKUMAR SHARMA(2013).

The paper " compaction and subgrade characteristics of clayey soil mixed with foundrysand and fly ash" determines the The maximum dry density of clay-foundry sand mixdecreased with additionof fly ash.

III. METHODOLOGY



StudyArea

Thered soil used in this study was collected from west Ibrahimpatnam,AndhraPradesh, India

. StudyArea

MixingProportions

Themixing proportions of soil,limeand stone powder areasfollows:

SOIL (%)	LIME (%)	STONEPOWDER(%)
100	0	0
90	5	5
80	10	10
70	15	15
60	20	20
50	25	25
40	30	30

IV. TESTS CONDUCTED

GRAINSIZEANALYSIS–MECHANICALMETHOD:

Aim: Todeterminethegrainsizedistributionofthegivencoarse-grainedsoilbysieving.

Apparatus: Thermostaticallycontrolledoven, Sieves and Wire brush,Mechanical Sieve shaker,Rubber Pedestal & Mortar.

Theory:

Thegrainsizedistributionisuniversallyusedinengineeringclassificationofthesoils.Inaddition, the suitability criteria of soil used for road and airfield construction, dam and otherembankmentconstructionandthedesignoffiltersforearthdamsarebasedpartlyontheresultsof grain sizeanalysis.

Thegrainsizeanalysisismeanttodeterminetherelativeproportionsofthedifferentgrainsizes that constitute a given soil mass. This is accomplished by obtaining the quantity ofmaterialpassingthrough theaperturesof agiven sizedsieve butretainedonasieveofsmallersized apertures. The weight of the quantity of soil retained any particular sieve with referenceto the overall weight of the soil sample taken for the analysis, expressed as a percentage, istermedasthepercentageweightofthesoilretained.Thepercentageofsoilthatpassesthroughthe sieve is termed as the percentage finer. For the purpose of determining the proportion ofsoil retained on or passing through the sieves of different apertures the sieve analysis, the soilretained on 75micron sieve is used. The analysis performed on this soil is called the coarseanalysis.

Procedure:

1. Keepthegivenrepresentativesampleofsoilintheovenfor24hours.
2. Pulverizetheovendriedsamplebyusingthemortarandpedestalandsieveitonthe4.75mmdrive.
3. Takeabout1kgofthefractionofthesoilpassing4.75mmsieveandretainedon75mmsieveforthesieveanalysis.

Take the following setof sieves and stack them one over the other in the order ofarrangement shown (i.e the sieve with the largest aperture at the top

Lid
4.75mmsieve
2.00mmsieve
1.00mm sieve
600-micron
300-micron
150-micron
75-micron
Pan

4. Placethesoilinthetop sieve,closethelid,transferthesetofsieveswiththereceiverpanatthebottomto amechanical sieveandfitthem. Sievethe soilforaperiod of10 minutes.
5. Removethestackofsievesfromtheshakerandobtaintheweightofthematerialretainedoneach sieve.
6. Computethepercentageretainedoneachsievebydividingtheweightretainedoneachsieveby theoriginal weight ofthesoilsampletaken fortheanalysis.
7. Computethepercentagefinerbystartingwith100%andsubtractingthepercentretainedoneach sieveasaccumulativeprocedure.
8. Drawagraphbetweenthepercentagefiner,drawntonaturalscaleonthe Y-axisandtheparticlesizedrawto logarithmic scale on theX-axis.

Onthegraph,thegrainsizescorrespondingtothedifferentcoloursofsoilsareshownontheX-axis (drawnto alog scale) asshown:

GRAVEL	**SAND**			**SILT**	**CLAY**
	COARSE	**MEDIUM**	**FINE**		
Grain sizerangein mm	4.75 – 2.00	2.00 – 0.425	0.425 – 0.075	0.075 – 0.002	<0.002

Comments:

FromthegivensizedistributioncurvegrainsizessuchasD_{10},D_{30},andD_{60}maybeobtained.Dreferstothegrainsizewhilethesubscript(10,30,60)denotesthepercentagefiner.ThusD_{10} =0.10mmindicatesthediameteroftheparticlecorrespondingto1percentfiner.Or,inotherwords, 10% of thesample has grains smallerthan0.10mm.

Fortheabovevalues,twoquantities,namelythecoefficientofuniformity,C_U,andthecoefficient of curvature,$C_C$may becomputed by using the following formulae.

$$C_U=D_{60}/ D_{10}.$$

$$C_C=(D_{30})^2 /(D_{60}*D_{10}).$$

These quantities enable to know whether the soils are well graded (W) i.e, it has a goodrepresentationofallparticlesizes,orpoorlygraded(P)i.e,agoodrepresentationofallparticlessizesdoes not exist.

For a well graded soil,C_U> 4 forgravels

C_U> 6 forsandsand

$C_C$mustbe between 1 and 3 for both.

Ifthe criteriaarenot met,the soil may betermed a poorly graded(P).

Formulae:

$$C_U=D_{60}/D_{10}.$$

$$C_C=(D_{30})^2 /(D_{60}*D_{10}).$$

Where,

C_U = Coefficient of uniformity,C_C=Coefficientof curvature,

D_{10},D_{30},D_{60}=Grainsizeat10%,30%,60%finer.

SI.No	ISSieve	ParticleSize, D(mm)	WeightRetained(gm)	%Retained	Cumulative %Retained	Cumulative %Finer
1.	4.75	4.75	68	6.80	6.80	93.2
2.	2.00	2.00	84	8.40	15.2	84.8
3.	1.00	1.00	92	9.20	24.4	75.6
4.	600	0.60	161	16.1	40.5	59.5
5.	300	0.30	262	26.2	66.7	33.3
6.	150	0.15	193	19.3	86.0	14.0
7.	75	0.075	97	9.70	95.7	4.30
8.	Pan	-	43	4.30	100	0
		TotalWeight	1000 gm			

Result:

AsperIS:1498-1970classificationandidentificationofsoilsforgeneralengineeringpurposes.C_C*rangesfrom 1 to 3 for well graded soil,*

C_U>4forgravels,C_U

> 6 forsands.

For thecollectedsoil sample, C_U= 5.143C_C= 1.032.Hence,

the soil is well graded soil.

PLASTICLIMITTEST:

NeedandScope*:*

Soil is used for making bricks, tiles and soil cement blocks in addition to its use as foundationforstructures.

ApparatusRequired:

1. Porcelaindish,
2. Glassplateforrollingthespecimen,
3. AirtightContainers,
4. WeighingBalance,
5. ThermostaticallycontrolledOven.

Theory:

The plastic limit of a soil is the moisture content at which soil begins to behave as a plasticmaterial. At this water content (plastic limit), the soil will crumble when rolled into threads of3.2mm in diameter.

Procedure:

1. Takeabout20gmofthoroughlymixedportionofthematerial passingthrough425micron

   I.S Sieveobtained in accordance withIS: 2720 (Part 1).

2. Mixitthoroughlywithdistilledwaterintheevaporatingdishtillsoilmassbecomesplasticenoughto be easily moulded withfingers.
3. Allow it to season for sufficient time (for 24 hours) to allow water to permeate throughoutthesoil mass.
4. Takeabout190gmsofthisplasticsoilmassandrollitbetweenfingersandglassplatewithjust sufficient pressure to roll the mass into a threaded of uniform diameter throughout itslengththe rateof rolling shallbebetween 60and90 strokesper minute.
5. Continuerollingtillyougetathreadedof3mmdiameter.
6. Kneedthesoiltogetherto auniformmass andre-roll.
7. Continuetheprocessuntilthethread crumbles whenthediameteris 3mm.
8. Collectthepiecesofthecrumbledthreadinairtightcontainerformoisturecontentdetermination.
9. Repeatthetesttoatleast3timesandtake theaverage ofresults.Calculatedtothenearestwholenumber.
10. Comparethediameterofthreadatintervalswiththerod.

Formulae:

Plasticity Index, I_P = W_L– W_P.Where,W_L=LiquidLimit,

W_P=Plastic Limit.

ObservationsandCalculations:

1. 100%Soil+5%Lime+5%StonePowder.

Soil(%)+ Lime(%)+StonePowder(%)	PlasticLimit,W_P(%)	PlasticityIndex,I_P(%)
100 +0 +0	25.00	15.25
90 +5 +5	24.08	13.32
80 +10 +10	22.85	13.47
70 +15 +15	20.70	12.56
60 +20 +20	18.54	12.27
50 +25 +25	16.40	11.16
40 +30 +30	14.28	10.15

V. CONCLUSION

1. As per IS: 1498-1970 classification and identification of soils for general engineeringpurposes, $C_C$ranges from 1 to 3 for well graded soil, C_U > 4 for gravels, C_U > 6 for sands.Forthecollectedsoilsample,C_U=5.143C_C=1.032.Hence,thesoiliswellgradedsoil.
2. The collected soil sample has 44.689 % of sand and 55.311 % of silt. Hence the soil iscombinationofsilt and sand.
3. LiquidLimit,W_L=40.25333%,PlasticityIndex,I_P=14.785%.FromtheA-Linechart,theSoilis Intermediate Compressible Silt.
4. Liquid Limit, $W_L$is gradually decreases on increasing with the addition of differentpercentages of Lime and Stone Powder to the Soil. liquid Limit, W_L between 35% to 50%normally indicates an intermediate compressibility and intermediate shrinkage/ swellingpotential.
5. Plastic Limit, $W_P$is gradually decreases on increasing with the addition of differentpercentagesof limeandStone Powder to theSoil.
6. Plasticity Index, I_P is initially increases and then decreases with the addition of differentpercentages of Lime and Stone Powder to the Soil. The decreasing in Plasticity Index, $I_P$generallyresultsin high shear strength.
7. Theoptimummoisturecontent,OMC(%)ofsoilinitiallydecreaseswiththeadditionof20

   % lime and 20% stone powder to the soil, and then the maximum dry density graduallyincreaseswithincreasing percentagesof lime andstonepowder.
8. The CBR value of Soil initially increases with the addition of 20 % Lime and 20 % StonePowdertotheSoil,andthentheCBRvaluegraduallydecreaseswithincreasingpercentagesof LimeandStone Powder.

9. The optimum percentage of lime and stone powder added to increase the strength ofsubgradesubgradesoilis20% lime and20%stonepowder.

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