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Soil Improvement By Using Jute Geotextile And Sand

A Comparative Study

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ABSTRACT :*The Good Connectivity To Any Part Of The Country In All Seasons Is The First Step To Develop The Infrastructure Of The Nation. The Structure Of Road Consists Of The Formation Or Subgrade And The Pavement. The Structural Element Of The Pavement Is The Foundation (Soiling Or Bottoming) Also Called The Sub-Base Of The Base. The Base May Be Surfaced Either With A Concrete Or A Bituminous Surfacing.Subgrade Is And Integral Part Of Road Pavement Structure As It Provides Support To The Pavement As Its Foundation. The Main Function Of The Subgrade Is To Give Adequate Support To The Pavement And For This The Subgrade Should Possess Sufficient Stability Under Adverse Climatic And Loading Conditions. The Formation Of Waves, Corrugations, Rutting And Shoving In Black Top Pavements Are Generally Attributed To Poor Subgrade Conditions.Geotextile, Both Natural And Synthetic, Are Helpful In Improving The Geotechnical Properties Of Soil. These Fabrics Are Used For Erosion Control, Drainage, Filtration, As Separation Layer, For Vegetation Support Etc. Jute Is Also A Geotextile Which Is More Ecofriendly And Can Be Used In Road Works Cost Effectively.*

KEY WORDS: Sub Soil, B.C. Soil, Volume Change, Moisture Content, Jute, Geotextile, Sand.

INTRODUCTION

The Road Generally Consists Of Subgrade, Sub Base, Base And Wearing Course. The Subgrade, Which Is Made Of Existing Soil, Is An Important Part Of Road Construction. The Economy Of Road Construction Depends On It. However, If The Subgrade Is Made Of Weak Of And Highly Expansive Soil, Such As Black Cotton, It Is Customarily To Replace A Part Or Whole Soil By Select Soil (CBR 2: 7%) To Achieve Economy In Construction. If The Select Soil Is Not Available In The Nearby Areas And Is To Be Transported From Long Distance, Then There Is A Increase In Cost And Time Of Construction. Hence, There Is A Need For Soil Improvement By Using Jute Geotextile, In Which We Can Use Locally Available Weaker Soil.

Geotextile Is A Type Of Technical Textile Which Is Used In Or On Soil To Improve Its Behaviour And Performance. Geotextiles Were First Developed In Developed Countries By Making Use Of Manmade Polymers. At Present, Synthetic Geotextiles Are Extensively Used Throughout The World For Protection Of Banks 'And Beds Of Water Ways, Strengthening Of Roads, Stabilization Of Embankments, Management Of Slopes, Consolidation Of Soft Soil And' Other Soil-Related Engineering Applications. All Geotextiles Essentially Acts As Catalysts.

JUTE GEOTEXTILE (JGT)

Jute Plant Is Woody Type Growing To About 3m High And Under Its Bark Bundles Of Fibres Run Longitudinally Down The Stem (Stem Dia. Varies Between 20 To 30mm) Held Together By Sticky Resin. When Harvested, The Cut Stems Are Tied Into Bundles And Kept Submerged In Water For Between20 To 30 Days. This Process Is Known As Retting. The Tissues Of The Stems Are Then Broken Down Under Bacterial Action. The Resulting Soggy Mass Consists Of Strands Of Overlapping Fibres.

The Fibres Are Then Stripped Off From The Stem Manually, Washed In Water And Dried Under The Sun.

The Earth Reinforcement Is An Ancient Technique And Is Demonstrated Abundantly By The Nature In The Action Of Tree Roots. This Concept Is Used For The Improvement Of Certain Desired Properties Of Soil Like Bearing Capacity, Shear Strength, Permeability Characteristics Etc. The Concept And Principle Of Soil Reinforcement Was First Developed By Vidal (1969)[1], By Which He Demonstrated That The Introduction Of Reinforcing Elements In A Soil Mass Increases The Shear Resistance Of The Mix. This Work Investigates The Use Of Jute Fibre As Soil Reinforcement Material.

FIBRE REINFORCED SOIL

The Subgrade Should Be Prepared Strictly In Conformity With Provisions Of Sections For Rural Roads" - SFRR (August 2004)[2], Published By Indian Road Congress. The Approved JGT Should Be Laid On The Prepared Subgrade By Unrolling, Ensuring Proper Drapability (I.E. JGT, Should Touch The Subgrade Surface At All Points) Under Taut Condition And Stapled At An Interval Of 750mm, With The Soil Overlaps Of 150mm Cross-Wise And 300mm Longitudinally If Seaming Of JGT Is Not Possible At Site. If Seaming Can Be Done At The Site, At Least 90% Seam Strength Has To Be Ensured. Staples Should Be Preferably U-Shaped Mails (11 Gauge) Or Round Headed Country Nails Of 150rnm Length.

The Strength And Condition Of The Jute Fabric Beyond A Period Of One Year After Placement Should Not Be Of Any Concern As By That Time The Fabric Would Have Already Played A Very Important Role In Providing A Self Sustaining Subgrade For Most Types Of Soils.

OBJECTIVES OF THE STUDY

The Prime Aim Of The Present Investigation Is To Assess The Usefulness Of Jute Geotextile As Soil Reinforcement. The

Present Investigation Has Been Limited To The Following. Studies,

1. To Study The Cost Comparison Of Roads Constructed With And Without Jute Geotextiles.
2. To Study The Strengthening Of Soil Of Low Bearing Capacity
3. To Study The Effect Of Subsidence Of A Pavement By Separating And Preventing Intermixing Of The Soft Subgrade And The Harder Sub- Base
4. To Study The Effect Of Geotextile As A Arrests Migrating Of Soil Particle And Allows Water To Permeate Across It.
5. To Study The Influence Of Jute Geotextile On California Bearing Ratio

REVIEW OF LITERATURE

There Are Many Situations Where The Strength And Other Properties Of The Soil Have To Be Improved By Ground Improvement Techniques. Soil Stabilization Is A Technique Aimed At Increasing Or Maintaining The Stability 01 A Soil Mass Or Otherwise Improving Its Engineering Properties. Many Techniques Of Soil Improvement Are Being Discussed In Literature. **In** Past, The Contributions Were Made By Lambe (1962)[10], Sherard Et Al.(L963)[11], The Road Research Laboratory (1952)[12], Froco And Associates (1966)[13], Leonard's (1962)[14], Itsekson (2003)[15] And Latest Being Published In International Journal Of Pavement Engineering, 2006.

Soil Improvement Methods Are Classified As Follows:

1. Mechanical Stabilization
2. Chemical Stabilization
3. Bitumen Stabilization
4. Cement Stabilization
5. Thermal Stabilization
6. Lime Stabilization
7. Electrical Stabilization.
8. Stabilization By Grouting
9. Sand Stabilization

Mechanical Stabilization

Mechanical Stabilization Is Probably The Cheapest And The Simplest Method Of Soil Stabilization. It Is Commonly Used For The Construction Of Sub-Bases, Bases And Surfacing Of Roads And Also For Improving The Subgrade Soils Of Low Bearing Capacity And Highly Expansive Soils. Mechanical Stabilization Is Also Referred To Granular Stabilization' Or Stabilization With Soil-Aggregate Mixtures.

Behavior Of Expansive Soil Mixed With Lime And Fly Ash

Singh, K (2003) [19] Has Been Studied The Properties Of Expansive Soil Mixed With Lime And Varying Percentage Of Fly Ash, He Concluded That When Lime Is Added To The Expansive Soil, It, Reduces Liquid Limit, Increases Plastic Limit And Decreases Plasticity Index Of The Soil. Addition Of Fly Ash With Fixed Percentage Of Lime (I.E. 4% In This Case) Further Decreases Liquid Limit. Determination Of Plastic Limit Becomes Difficult As Fly Ash Content Increases. He Also Noted That Liquid Limit Of The Soils Obtained With 4% Lime And 40% Fly Ash.

CBR Values Of Raw B.C. Soils Were 2% And 2.4% Respectively. These Are Improved To 11.8% And 12%Respectively With A Combination Of 4% Lime And 40% Fly Ash.

Angle Of Shearing Resistance Of Treated Soils Increases With The Increase In Fly Ash Contained. The Angle Of Shearing Resistance Of Raw Soils Were 6°20' And 8°15' Respectively, Which Are Increase To 300 And 330 With 4% Lime And 40% Fly Ash, However Cohesion Value Decreases With Lime And Fly Ash Content.

When The Lime And Fly Ash Were Added To The Expansive Soil, Lime Was The Main Constituent Which Causing Significant Changes In The Cohesion And Angle Of Shearing Resistance Value. C And ϕ Value Of The Soil With 5% Lime Content Were Obtained Nearly Same As That Obtained With 4% Lime And 20% Fly Ash.

Compressible Clay Soil As Backfill Material- Problem And Remedial Measures

As Per Verma, A.K. (2005) [20] Properties Of The Backfill Soil Vary From Site To Site Depending Upon The Material Available From Excavation. Many Times Due To Use Of Poor Soils Or Due To The Loss Of Strength In The Hindrance To The Traffic Crossing The Utility Trenches And May Also Cause' Damage To The Utility. Stabilization Of Yellow Clays Obtained From The Excavation Of The Trench, Having High To Moderate Compressibility, Can Be Done With Locally Available Sand. This May Be One Of The Cost Effective And Quick Methods Of Improving The Properties Of Such Soils.

From The Experimental Results Obtained By The Study, It Has Been Found That The Modified Soil Has Lower Liquid Limit, Low Plasticity Index And Higher, Strength Properties. The Yellow Clay Mixed With25% Sand Has Shown CBR Value 8.63 As Against 2.63 For Raw Soil. The Swelling Test Is Found To Be Decreased To 20% As Against 40% Of The Raw Soil. The Improved Soil Has Higher Dry Density And Bear External Stresses With Less Compressibility.

Engineering Behavior Of Saw Dust Mixed Black Cotton Soil

Soni, Y. (2006)[21], Carried Out The Experiment Work For Improving The Properties Of Black Cotton Soil Mixed With Saw Dust. Saw Dust Were Blended In Different Proportion 5%, 10%, 15% And 20% (By Weight) With Black Cotton Soil And Experiments Were Carried Out To Determine Various Properties

Like Liquid Limit, Plastic Limit, Shrinkage Limit, Sieve Analysis, Maximum Dry Density, Optimum Moisture Content, Differential Free Swell, Permeability, CBR Test And Triaxial Shear Strength Test.

Experiments Carried Out And Following Aspects Were Comes Out:

The Saw Dust Mixed Black Cotton Soil Has Minimum Increase In Liquid Limit At 15% Of Saw Dust Mix, And Has Minimum Value Of Plasticity Index Due To Increase In Plastic Limit. This Makes The Blended Mix Less Plastic In Nature.

Decrease In Plasticity Index And Increase In Shrinkage Limits Clearly Indicates That After Addition Of Saw Dust To Expansive Soil, The Expansive Soil Tends To Become Non-Expansive And Volumetrically Stable In Nature.[1]

Differential Free Swell Also Reduce Considerably. The Index Of Differential Free Swell Has Come Down From The Range Of High To A Range Of Moderate Hence The Ill Effects Due To The Volume' Change Of The Expansive Soil Will Be Less.

Deviator Stress Increased By 42.85% As Compare To The Value Of Raw Soil, (70 Kpa Confining Pressure) When Black Cotton Soil Mixed With 15% Saw Dust.

CBR Value Has Increased Considerably For The 15% Addition Of Saw Dust To Expansive Soil, Soaked CBR Value For 15% Addition Of Saw Dust Increases By 135% Of Raw Soil.

Bricks Made By Mixing Saw Dust With Black Cotton Soil In Certain Proportion Have Shown Satisfactory Result And 1% To 2% Respectively. After Mixing Sand And Nylon Fiber With Black Cotton Soil **In** Various Percentages By Weight Of The Soil, It Was Noted That There Was A Reduction In Swelling Pressure Up To 51%And Increase In CBR Value From 3.49 To 6.98%.

Inclusion Of Sand-Nylon Fiber Increases Strength As Well As Other Engineering Properties Of Black Cotton Soil. As The Nylon Fiber Is Not Bio-Degradable, Therefore The Change In The Behavior Of Reinforced Soil Will Not Vanish.

The Effects Of Fiber Content On Decrease In Swelling Pressure Were More In The Case Of Jute Fiber In Comparison To The Nylon Fiber. The Swelling Pressure Of Soil Mixed With 3%Jute Fiber Reduces By About 45% Whereas Corresponding Decrease In Nylon Fiber Were 40%, The Difference In Reduction Of The Swelling Pressure In Jute And Nylon Fiber May Be Due To Following Reasons, The Aspect Ratio Of Jute Fiber Which Was More.

Jute Fiber Was Rough In Comparison To Nylon Fiber, Because Of This Reason Higher Friction Between The Soil And Jute Fiber Was Expected Than Between The Soil And Nylon Fiber. Ultimate Load As Determined From Double Tangent Method Were More In The Case Of Fiber Reinforced Soil Than Unreinforced Soil.

The Effect Of Jute Fiber On Decreasing Pressure And Increasing The Strength Of Soil Depends On The Life Of Jute Fiber. It May Be Possible That In Due Course Of Time The Behavior Of Reinforced Soil May Vanish Due To Degradation Of Jute Fiber Which May Not Be The Case In Nylon.

Water Content,%		--	20	25	30	35
Unconfirmed Compressive Strength (Kn/M^2)	Without Fabric	--		110	45	36
	With Fabric	--		300	115	65
%Strain At Failure	Without Fabric	--		8	115	22
	With Fabric	--	--	26	30	42
CBR Value (%)	Without Fabric	--	5.0	4.7	3.5	2.6
	With Fabric	--	8.0	6.8	5.2	4.5

Durability Studies Have Confirmed That The Jute Fabric Retains Sufficient Strength For About A Year. Long Term Durability Studies And The Decaying Of Jute Fabric With Time Under Different Environmental Conditions Are Needed For Proper Long Term Assessment. The Strength And Condition Of The Jute Fabric Beyond A Period Of One Year After Placement Should Not Be Of Any Concern As By That Time The Fabric Would Have Already Played A Very Important Role In Providing A Self-Sustaining Subgrade For Most Types Of Soils.

ADVANTAGES OF JUTE GEOTEXTILE

Following Are The Advantages Of Jute Geotextile

1. Abundant Availability

2. Superior Drapability, Jute Geotextile Can Perfectly Shape Itself To Ground Contours.

3. High Moisture / Water Absorbing Capacity. Jute Geotextile Can Absorb Moisture / Water Upto About 5 Times Its Dry Weight.

4. High Initial Strength.

5. Greater Moisture Retention Capacity.

6. Lower Costs Compared To Synthetic Geotextiles.

7. Ease Of Installation.

8. Bio-Degradable Properties. Improves Soil Character E.G., Soil Permeability On Biodegradation.

TECHNICAL FUNCTIONS

1. Checks Subsidence Of A Pavement By Separating And Preventing Intermixing Of The Soft Subgrade And The Harder Sub-Base.

2. Arrests Migration Of Soil Particles And Allows Water To Permeate Across It. Also Acts As A Drainage Layer Along Its Plane. Can Be Tailor-Made To Cater To Requirements Of Porometry, Permittivity And Transitivity.

3. Enhances CBR Value By Atleast 1.5 Times.

4. May Control Reflective Cracking Of Pavements And Prolong Their Fatigue Life When Used In Asphaltic Overlays With Proper Jute Geotextile.

5. Provides Effective Drainage System When Used As Peripheral Cover In Rubble-Filled Trench Drains, Specially In Hilly Terrains.

6. Enhances Strength And Stability Of High Road Embankment Built With Materials Of Uncertain Behaviour Like PFA, When Interposed At Appropriate Levels. Also Keeps Lateral Dispersion, Subsidence And Slides Under Check.

7. Vertical Jute Drains Help Drain Out Entrapped Water From Within An Embankment As In Case Of Vertical Sand-Drains, But Far More Efficiently.

8. Slopes Of Embankments With Problematic Soil May Be Stabilized By Applying Jute Geotextile To Help Grow Vegetation Faster And To Anchor Soil For Permanent Biotechnical Solutions To Problems Of Soil Distress.

9. Highly Water Absorbent; Absorbs Water About 5 Times Its Dry Weight.

10. Forms "Mulch", Retains Moisture And Builds Up A Humid Surrounding Conducive To Germination Of Seeds And Growth Of Plants. Stimulates Growth Of Vegetation.

CONCLUSIONS

In Regions Where Black Cotton Soil Is Encountered, The Construction Of Buildings And Roads Is Highly Risky On Geotechnical Grounds As The Soil Is Highly Compressible, Possessing Low Shear Strength And Is Susceptible For Volumetric Instability. Many Investigators Have Attempted To Improve The Engineering Behaviour Of This Soil By Mixing Non Cohesive Materials, Chemicals, Like Lime And Cement Etc

The Geotextile Is Expected To Contribute Towards Better Road Performance And Achieving Economy. The Reduced Road Thickness & Construction Time Are The Added Advantages. The Engineering Properties Of Jute Fabrics Are Suitable For Separation, Reinforcement, Drainage And Filtration Function And Can Be Suitably Used In Overcoming Geotechnical Problems Of Weak Soil.

After It Is Placed On The Weak Subgrade, The Subgrade Stiffens And Becomes Stronger On Consolidation Within About A Year Or So Under The Action Of Granular Sub-Base Surcharge, Self Weight Of Pavement, Construction Rolling And Traffic Loads. The Jute Geotextile Immensely Helps In This Rapid Subgrade Strengthening Processes In Combination With The Drainage Layer Above It. With Time, The Subgrade Becomes Less And Less Dependent On The Fabric For Its Stability And, Therefore, The Long Term Durability Aspect Of Jute Fabric Should Not Deter "Itsuse As A Geotextile For Various Applications In Road Construction. Jute Geotextile Materials Are Biodegradable And Their Uses In Various Geotechnical Engineering Applications Are Ecologically Safe.

The Following Conclusions Can Be Drawn On The Basis Of Present Work:

1. The Cost Economy :

The Unit Cost Is Lowest With Jute Geotextile And Highest With Sand Stabilization.

2. The CBR:

The CBR Value Is Maximum With Sand Stabilization (Approx. 10% On The Basis Of Test Conducted With 40% Sand Mixing). However, The Road Is Designed With CBR = 7% As The Enhancement Of CBR Values Is Not Uniform At The Site.

In Case Of Jute Geotextile, The Value Of CBR Was Obtained Around 6% (As Per Values Given In Literature).

3. Time Economy:

Time Of Construction Is Less In The Case With Jute Geotextile In Comparison To Sand Stabilization.

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