Expansive Soils Stabilization By Using Flyash And Murrum

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I. INTRODUCTION

1.1 GENERAL

The road generally consists of subgrade, sub base, base and wearing course, as shown in figure 1.1. 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 ≥ 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.

1.2 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 between 20 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.

1.3 FIBRE REINFORCED SOIL

The subgrade should be prepared strictly in conformity with provisions of Sections for Rural

Roads" – SFRR (August 2004) 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 150mm length.

1.4 CHOICE OF FABRIC (NATURAL FIBRES AS SOIL REINFORCEMENT MATERIAL)

It was demonstrated that a fill can be built on the soft clay by placing a geotextile fabric and a low strength one is adequate. A variety of such geotextiles are manufactured from petro products. However, in certain areas of the world, natural fibres such as jute, coir, sisal, kenaf are being increasingly studied and evaluated for use in various engineering applications. The objective of such efforts is to make use of desirable properties of above fibers, make a wider variety of fabric products available for geotechnical engineers where suitable use can be found and in some instances with cost advantages, provided performance criteria are met. The 5th International conference on geosynthetics held in (September 1994) in Singapore developed a special session to Natural Fibre Fabrics.

Since jute is available in India in abundance, a United Nations Development Programme (UNDP) sponsored project on the 'Development and Promotion of Jute Geotextile' is in progress in India covering the period 1992-1997. The Indian Jute Mills Association (IJMA) is the coordinating agency for the project. Development of jute and jute based geotextiles, their evaluation and characterization and the use of such fabrics in full scale experimental construction form the objectives of the project. Efforts were concentrated on carrying out full scale field experiments to demonstrate and evaluate the capabilities of selected varieties of jute fabrics for use in surface erosion control of slopes, drainage, separation to a limited extent and reinforcing function. The fact that jute is biodegradable, with a limited life and deteriorates in a short period of about two years was always kept in mind in the planning and operation of the project and choice of experimental installations. Full scale field experiments covering these applications have been implemented at different locations in India. Ramaswamy (1994) presents in detail the application of jute geotextiles in erosion control, drainage as well as reinforcement.

It is adequate if the reinforcing function of the fabric is available for a period of seven months. The use of fabric has essentially helped in overcoming problems in the placement of the fill and initial low factor of safety. Thus, fabric with a limited life can be tried in this project and its performance evaluated by the field trial. Accordingly jute geotextile fabric having the basic properties given in **Table 1** was chosen for use in the project Sanyal, T, JMDC (2005).

Sl. No.	Property	Test Value
1.	Thickness	3mm
2.	Weight	750 gsm
3.	Tensile Strength	20 kN/m
4.	Elongation	3%
5.	Puncture Resistance	350 N
6.	Overlap Length	30 cm

II. REVIEW OF LITERATURE

2.1 Standard Technique for Improving Properties of Soil

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 of 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), Sherard et al.(1963) the road research laboratory (1952), Froco and associates (1966), Leonard's (1962), Itsekson (2003) 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

2.2 SOIL IMPROVEMENT: ATTEMPTS MADE AT SORT

There are few techniques developed at SORT for improving the properties of soil by mixing locally available material in the Bhopal region. These were discussed in further sub sections.

2.2.1 Economics Construction of Rural Road

Jain (2002) had done the work for economic construction of rural roads for this he did comparative study of cost of road construction on sub-grades having different CBR values. Three type of typical sub-grade soils namely black cotton soil (CBR value 2%), yellow soil (CBR value 7%) and the soft moorum (CBR value 10%) were selected.

The black soil is identified as highly problematic soil. It is classified as CH i.e. clay of high compressibility and plasticity, its differential free swell value is also very high. For improving the behavior of black cotton soil, lime was added in varying quantity (from 1% to 5%) and various tests were conducted and found these results:

Addition of lime increases plastic limit and decreases liquid limit, thus plasticity index of raw black cotton soil reduces from 26 to 4 when 4% lime were added. The variation in liquid limit, plastic limit, plasticity index changes the classification of black cotton soil, following equations were obtained for predication of liquid limit, plastic limit and plasticity index:

(L.L.) at any lime content = (L.L.) raw soil - 3.7 Lc
(P.L.) at any lime content = (P.L.) raw soil + 2.25 Lc
(P.I.) at any lime content = (P.I.) raw soil – 5.5 Lc
L.L = Liquid Limit
P.L. = Plastic Limit
P.I. = Plasticity Limit
Lc = Lime content in percentage

The addition of lime also influenced the permeability of black cotton soil. Permeability increases with increase in lime content. Differential Free Swell (DFS) also decreases with the increase in lime content. The DFS of raw black cotton soil was found to be 63%, which reduces to 14% by adding 5% lime. The soil, which was highly expansive in nature, has become a soil of law expansive by the addition of lime.

2.2.2 Behavior of Expansive Soil Mixed With Lime and Fly Ash

Singh, K (2003) 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 6020' and 8015' respectively, which are increased 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 Ǿ value of the soil with 5% lime content were obtained nearly same as that obtained with 4% lime and 20% fly ash.

2.4 CASE STUDIES

(I) WIDENING AND STRENGTHENING OF MUNSHIRHAT – RAJPUR ROAD WEST BENGAL TREATMENT WITH JUTE GEOTEXTILE

JGT was laid on the extended portion after compacting the sub – grad with a pawer roller of 8 – 10 tons capacity. A single layer brick flat soling was laid on JGT to protect JGT from the puncturing impact of coarse aggregate. Over the BF soling two layers of jhama metal and stone metal consolidation (WBM) were laid. Finally it was finished with 20 mm thick premixed carpeting followed by 6 mm thick bituminous seal coat. The work was completed in November, 2000.

Post work study was conducted by the Civil Engineering Department, Jadavpur University in November, study 2001. No distress of the existing road was noticeable. The riding surface was perfectly smooth. Excavation was made near the edge of the pavement. Soil sample to was collected from the sub-grade below the JGT layer. Jute geotextile was found to have degraded. Soil below pavement was found to be highly compacted.

The laboratory tests for the post work showed that liquid limit, plastic limit and N.M.C. as 42%, 22% and 75 t/m^2.

(II) JUTE GEOTEXTILE USED AS SEPARATORE AND FILTER AT ANDULIA – BOYRATOLA ROAD, WEST BENGAL

Woven jute Geotextile (JGT) was considered to be laid on the prepared Sub-grade of the road for improving its CBR. Pavement was designed with CBR value enhanced by 150% for JGT as per findings of Prof. S. D. Ramaswamy and Prof. M.A.Aziz (1989) The in situ CBR value of 3.16 has been enhanced by 1.5 times (3.16 X 1.50 = 4.74%, which is rounded off to 4% during designing the pavement.

The volume of traffic on the road as per traffic census with its annual growth rate @ 6% per year, CBR value of 4.0% (B Curve- Number. Of Commercial Vehicle / Day being 15 to 45) and taking annual average rainfall to be 1500 mm, the pavement Thickness is designed as per IRC: SP:20:2002 using CBR value for flexible pavement design.

The Pavement Thickness according to CBR Curve is 350 mm (as per IRC: SP: 20:2002 page 98).

Post work evaluation was conducted by the Civil Engineer Department of Bengal Engineering and Science University, Shibpur 18 months after completion of the work. The CBR value as obtained from the field CBR test under unsoaked condition of the soil at the sub-grade level were 10.47% at 0.25 km & 14.0% at 1.40 km.

2.5 CONCLUDING REMARKS

From the review of literatures and case studies, it can be concluded that use of Jute Geotextile improve the strength of subgrade of the road to be constructed. However, cost analysis seems to be not carried out.

In Madhya Pradesh, few roads using subgrade improvement by Sand (Hoshangabad P.I.U.) and one road using Jute Geotextile being constructed (Bhopal P.I.U.). In the present work, cost analysis of work without any stabilization, and stabilization with jute and sand has been carried out. The post CBR values have obtained at soil laboratory of Civil Engineering Dept. of SORT, Bhopal.

III. PROPERTIES OF JUTE FIBRES AND INSTALLATION PROCEDURE

3.1 TYPICAL PROPERTIES OF JUTE FIBRES:

The jute geotextiles available in market are made from jute fibres. The properties of jute fibers are given in **Table 3.1** on the basis of work carried out by (Lee et. at. 1980

Ramaswamy and Aziz 1982 Ramaswamy and Aziz 1983 Aziz and Ramaswamy 1984)

Table 3.1 Typical Properties of Jute Fibres

Property Range of Value	Property Range of Value
Fibre length, mm 180 – 800 Fibre diameter, mm 0.10 – 0.20 Specific gravity 1.02 – 1.04 Bulk density, kg/m³ 120 – 140 Ultimate tensile Strength, N/mm² 250 – 350 Modulus of elasticity, kN/mm² 26 – 32 Elongation at break, (%) 2 – 3 Water absorption, (%) 25 - 40	Thread diameter, mm 1.75 – 1.85 Mesh size, g/m² 3 x 3 Weight, g/m² 680 – 750 Grab tensile strength (wet), N 800 – 900 Elongation at break (wet), Percent 15 – 20 Trapezoidal tear strength, N 300 – 350 i) under unstressed conditions - - 10^{-2} ii) under all round pressure 10^{-3} – 10^{-4} of 500 kN/m²

3.2 Comparison of Properties of Jute Fabric with Synthetic Geotextiles

In this section, a comparison is made the properties of Jute fabric with synthetic geotextile available in the market. This are given in Table 3.2, Ramaswamy and Aziz (1989).

Table 3.2 Comparison of properties of jute Fabric with synthetic geotextiles

Trade names	Weight (gm/m²) ASTM D-1910-64	Thickness (mm) ASTM D-1777	Grab tensile (N) ASTM D-1682	Elongation At break (%) ASTM D-1682	Trapezoidal Tear strength (N) ASTM D-2263	Permeability (cm/s) Falling Head	Type
Propex4545	153	-	400(minimum)	50 (Minimum)	-	$2x10^{-2}$(min) $3x10^{-2}$ (mix)	Non-woven
Mirafi 600X	-	-	1335	-	534	0.01	Woven
Typar	136	15 mill	580	62	312	0.02	Non-Woven (polypropylene)
Supac 5-P	180	15mill	556-670	80	325	0.05	Non-Woven (Polypropylene)
Petro mat	146	-	512	65	-	-	Non-Woven
Terram (140)	280	1.1	1128	150	343	0.072	Non-Woven 75%Plypr. 25% Nylon
Jute fabric	680-750	1.75-1.85	800-900	15-20	300-350	0.02-0.04	Woven

3.3 INSTALLATION PROCEDURE

3.3.1 Installation Procedure of Jute Geotextile on Subgrade

1. The subgrade should be prepared strictly in conformity with the provisions of section 300 mentioned in “Specifications for Rural Roads” – SFRR (August 2004) 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 and interval of 750mm with overlaps of 150mm cross-wise and 300mm longitudinally if seaming of JGT is not possible at site. If seaming can be done at site, at least 90% seam strength has to be ensured. Staples should be preferably U-shaped nails or round headed country nails of 150mm length.
2. A minimum cushion of 50mm of sand (as per section 802.4.1 of SFRR) shall be spread over the laid JGT to prevent probable puncture/damage to the fabric during rolling of the overlying granular sub-base layer.
3. Aggregates in the base layers (WBM G2 & G3) shall then be spread and rolled strictly in conformity with the relevant guidelines of IRC –SP 20-2002.
4. For application in curves, JGT should be folded or cut and overlapped in the direction of turn. Folds in JGT should be stapled at an interval of 300mm ensuring a minimum overlap of 150mm.

Before covering up the installed JGT, its condition should be assessed for any handling / installation damage and should be replaced full width with already recommended overlapping and stapling.

3.3.2 On Slopes of Road Embankments:

1. Earthen embankments shall be constructed in conformity with the relevant provision of section 301 of Specifications for Rural Road.
2. Installation of Jute Geotextile on the embankment slope of the road shall be carried out as per BIS specification (IS 14986:2001).
3. Seeds of the selected species of grass / appropriate vegetation may be spread prior to laying of open weave Jute Geotextile on the slope.
4. JGT shall be unrolled from top of the slope to the bottom or along the direction of surface run-off.
5. JGT shall be secured by steel staples within two anchoring trenches (250mmx 250mm) excavated at

the two ends of the slope. The fabric must touch the two sides and the bottom of the trench before stapling the fabric. The trenches shall be filled up with earth or locally available fine aggregates after stapling of Jute Geotextile is completed.

6. Care should be taken to ensure drapability of JGT i.e., the fabric must touch the surface of the slope at all points under taut condition.
7. Overlaps should be minimum 100mm at the sides and 150mm at the ends.
8. A second dose of seed broadcasting should be given over the laid Jute Geotextile along with dibbling of locally available grass.
9. Special provisions shall be made for draining out surface run-off in slopes through suitably placed saucer drains constructed on the slope as directed by the Engineer. Jute Geotextiles comes in two varieties -woven and non-woven fabrics.

3.4 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.

3.5 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 transmittivity.
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.

IV. RATE ANALYSIS

4.1 Description of Items with sample rate analysis
For Woven Jute Geotextile

Supply of Woven JGT having Tensile Strength as given below and possessing properties as stated in Annex: 1 of the Special Conditions of contract and installation of the fabric strictly as per clause 7.0 of Special Conditions of Contract including transportation from the selected jute mill at / near Kolkata to the work site, testing the fabric as indicated in Sl. No.s. 3 & 5 to 14 of Annex: 1 of the Special conditions of Contract, including loading, unloading, handling and proper storage at site before installation. The rate is inclusive of all taxes, duties and cess as leviable currently on the material and other essential components including contractor’s overhead @ 10%.

(Payment on the item will be made on the finished area covered by the specified jute Geotextile). The payment shall be made in Sqm.

Sample analysis of rate for the item (taking a road in Bhopal as the reference work site.)

1) Cost of Jute Geotextile
(20 kN/m – 2m wide fabric) = Rs. 28.00

i) Local taxes @ 5%
(Cess @ 1% + s.t. @ 4%) = Rs. 1.40

ii) Extra for lap length @ 5% = Rs. 1.40

iii) Extra for not resisting
Treatment L.S. = Rs. 5.00
Rs. 35.80

2) Carriage of JGT
Carrying capacity of a truck (Punjab Body) – 9 M.T.
For 760 gsm JGT
Therefore 9 M.T. = 1000 x 1000 x 9 / 760 = 11,842 Sqm
Carriage cost per truck from Jute mill
Near Kolkata upto Bhopal = Rs. 19000.00
Therefore, Cost per Sqm. = 19,000/11842

= Rs. 1.60
i) Loading, unloading and carriage by head
Upto 30m lead to Go down / site
Loading L.S. = Rs. 200.00
Unloading L.S. = Rs. 200.00
Head load L.S. = Rs. 100.00

Rs. 500.00
Therefore Cost per Sqm = Rs. 500/11842

= Rs. 0.04
3) Testing Charges of JGT
One set of tests: Rs. 6000.00
Therefore Cost per Sqm = Rs.6000/11842
= Rs. 0.51
4) Sundries (nails, staples etc.) L.S. = Rs. 0.50
5) Labour for laying JGT including preparation of bed.
Rate per % Sqm
Mate 1/8th @ Rs. 115.00/diem = Rs.14.37
Majdoor 1/8th x 4 nos. @ Rs. 80.00/diem = Rs. 40.00

Rs. 54.37
Therefore Cost per Sqm = Rs. 0.54
Total Cost (35.80+1.60+0.04+0.51+0.50+0.54) = Rs. 38.99

6) Contractor's Overhead @ 10% = Rs. 3.86

Rs. 42.85

Say Rs. 42.85 / Sq.m

As for 1 Km stretch of Road, the RW is 8.50 m the total quantity of JGT used is
=1000 x 8.50 = 8500 Sqm
Rate per Sqm is Rs. 42.85
The total amount is 8500 x 42.85 = Rs. 364225.00

V. CASE STUDY

Case – I

A cost comparison is made on the road, constructed in the same area with and without JGT.

Name of Road : Approach Road to Semrakalan
Block : Berasia
District : Bhopal
Length of Road : 5.10 Km
Year of Construction : 2007-08
Client : Jute

Manufactures Development Council, Calcutta under

Pilot Project.
Contractor : M/s A.K.Patel, Ahmedabad
Type of Embankment : Yellow soil
Type of Subgrade : Yellow soil mix with Sand
Crust Details :
Sub Base Course : River Bound Material (150mm)
Base Course :
WBM G-II : Basalt (75mm)
WBM G-III : Basalt (75mm)
Wearing Course : Open Graded Premix Carpet (20mm)
Total Cost Rs. : 107.38 Lacs
Cost/Km Rs. : 21.05 Lacs

Description:

The road is constructed under Pilot Project at Berasia block in the year 2007-08.

A cost comparison is made on the road, constructed in the same area with and without JGT.

Fig. 5.1 Preparation of subgrade for laying of Jute Geotextile

Fig. 5.2 Laying of Jute Geotextile on one side of the prepared subgrade

Fig. 5.3 Overlapping and Nailing of Jute Geotextile on the prepared subgrade on both side

Fig. 5.4 Laying of sand cushion on the Jute Geotextile

Fig. 5.5 Rolled surface of subbase over Jute Geotextile

Fig. 5.6 Checking the condition and position of Jute Geotextile by taking sample

Case – II

Name of Road	:	Approach Road to Semrakalan
Block	:	Berasia
District	:	Bhopal
Length of Road	:	5.10 Km
Year of Construction	:	2015
Client	:	MPRRDA

Contractor : M/S Khurana Associates
Type of Embankment : Moorum
Type of Subgrade : Moorum (Disintegrated Rock)
Crust Details :
Sub Base Course : River Bound Material (150mm)
Base Course :
WBM G-II : Basalt (75mm)
WBM G-III : Basalt (75mm)
Wearing Course : Open Graded Premix Carpet (20mm)
Total Cost Rs. : 117.74 Lacs
Cost/Km Rs. : 23.09 Lacs

Case – III

Name of Road : Approach Road to Semrakalan
Block : Berasia
District : Bhopal
Length of Road : 5.10 Km
Year of Construction : 2014
Client : MPRRDA
Contractor : M/S R.K. Gupta, Bhopal
Type of Embankment : Yellow soil
Type of Subgrade : Yellow soil mix with Sand
Crust Details :
Sub Base Course : River Bound Material (150mm)
Base Course :
WBM G-II : Basalt (75mm)
WBM G-III : Basalt (75mm)
Wearing Course : Open Graded Premix Carpet (20mm)
Total Cost Rs. : 119.51 Lacs
Cost/Km Rs. : 23.43 Lacs

Case – IV

Name of Road : Ameerganj to Chakaldi Road
Block : Nasrullaganj
District : Sehore
Length of Road : 12.150 Km
Year of Construction : 2004
Client : Madhya Pradesh Rural Road Development Authority,
Project Implementation Unit, Bhopal (M.P.)
Contractor : M/s M.S.Khurana, Ahmedabad
Type of Embankment : Moorum
Type of Subgrade : Moorum (Disintegrated Rock)
Crust Details :
Sub Base Course : River Bound Material (150mm)
Base Course :
WBM G-II : Basalt (75mm)
WBM G-III : Basalt (75mm)
Wearing Course : Open Graded Premix Carpet (20mm)
Total Cost Rs. : 279.21 Lacs
Cost/Km Rs. : 22.98 Lacs

Description:

The road is constructed under PMGSY at Nasrullaganj block in the year 2014, at present riding surface is quite good only some raveling and rutting is seen on the road.

Soaked CBR of existing subgrade is given.

VII. CONCLUSIONS

In regions where black cotton soil is encountered construction of buildings and other civil engineering structures is highly risky on geotechnical grounds as the soil is highly compressible posses 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 by reducing road defects with the economy resulting in reduced road thickness design & construction time is an added advantage. The excavated soil for drains should be used and transportation cost of borrow area soil is reduced.

Jute Geotextile (JGT) has many potential applications in civil construction works. 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 its use 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.

Jute Geotextile (JGT) is very effective in weak subgrade soils in reducing their compressibility and increasing their strength.

1. The road constructed by using jute geotextile is economical; it is about 9-10% cheaper than the roads constructed by using transported soil.

1. Approach Road to Semrakalan Cost/Km Rs. 21.05 lacs
2. Ameerganj to Chakaldi Rd. Cost/Km Rs.22.98 lacs
3. Rundhal to Andhiyari Cost/Km Rs. 23.37 lacs

It is obtained that the road constructed with Jute geotextile is economical than the roads constructed by soil improvement with sand and with using borrow area soil. 9 to 10% cost is saved by using Jute Geotextile and time is also saved.

2. From the case study given in literature review on page no. 25 Conclusion for road Munshirhar – penro khila Rajpur Road (6^{th} to 8^{th} Km) constructed by using Jute Geotextile Munshirhar – Penro khila Rajpur Road (6^{th} to 8^{th} km.) Howrah, West Bengal it is found that the CBR value of the subgrade before application of JGT was 3.5%. It is evident from the above findings that the subgrade had strengthened by the application of JGT and reached a CBR value of 6.0% (interpolated Co-hesion value).

REFERENCES

[1] "A Manual on use of Jute Geotextiles in Civil Engineering" published by Jute Manufactures Development Council (JMDC), Kolkata.29. IRC : 56-1974 (reprinted 1991) "Recommeded Practice for Treatment of Embankment Slopes for Erosion Control (The Indian Roads Congress Publication).

[2] D. S. Tolia, O. P. Yadav, Jai Bhagwan, N. K. Sharma, Kanwar Singh, S. R. Rao. "Application of Jute Geotextiles in Highway Engineering".

[3] IS 14324-1995 Geotextiles - Methods of Test - Determination of Water Permeability – Permittivity.

[4] IS-14715:2000 'Woven Jute Geotextiles-Specification' published by Bureau of Indian Standards (BIS) in 2000.

[5] IS-14986:2001 'Guidelines for application of Jute Geotextile for Rain water Erosion Control in Road and Railway Embankments and hill Slopes' published by Bureau of Indian Standards (BIS) in 2001.

[6] Jewell, R. A. (1996): Soil Reinforcement with Geotextiles, 1st ed. Construction Industries Research and Information Association, London.

[7] Khanna S. K. and Justo C. E. G. (1993): 'Highway engineering', Nemchand & Brothers publications, Roorkee, India. 7th edition.

[8] Koerner, Robert M.:(1990) "Designing with geosynthetics" Prentice Hall, New Jersy, Second edition, 1990.

[9] Mandal J. N. and Murti M. V. R. (1989): ' Potential for use of natural fibers in Geotextile engineering', Proceedings of International Workshop on Geotextiles, Bangalore, India. Pp. 251-254.

[10] Mandal J. N. and Viswamohan (1989): ' Performance studies on California bearing ratio values using Geosynthetics', Proceedings of International Workshop on Geotextiles, Bangalore, India. pp. 255¬-258.

[11] Mohiuddin, G. (1994), Jute geotextiles, 2nd International Workshop on Geotextiles, Central Board of Irrigation and Power, 1994, New Delhi.

[12] N. Som (2001): "Jute geotextile in civil engineering applications" Published in National Seminar on Application of Geotextiles in civil engineering. 18th May, 2001, New Delhi, India.

[13] Nagarkar, P. K., Kulkarni, V. T. and Desai, G. V. (1980). Use of Fabrics in Civil Engineering Construction. Proc. Indian Road Congress, New Delhi, PP 5-17.

[14] P. Jagannath Rao, Bindumadhava, N.Venisiri "Construction of highway embankment on soft marine soil using jute geotextiles", National Seminar on 'Application of Jute Geotextile and Innovative Jute Products', New Delhi.

[15] Pandey S. N. and Majumdar A. K. (1989): ' Manufacturing, testing and application of jute as Geotextiles', Proceedings of International Workshop on Geotextiles, Bangalore, India. Pp. 240-246

[16] Punmia B. C. (1994): ' Text book of soil mechanics and foundation Engineering', Lakshmi publications, New Delhi, India, 13th edition.

[17] Ramaswamy (1994) detail applications of Jute Geotextiles in erosion control drainage as well as reinforcement.

[18] Ramaswamy S.D. and Aziz, M. A. (1982). "Jute Fabric in Road Construction" Proc. 2nd International Conference on Geotextiles, Las Vegas.

[19] Ramaswamy, S. D. and Aziz M. A. (1983). An Investigation on Jute fabrics as a Geotextile for Subgrade Stabilization. Proc. 4th Conf. Road Eng. Association Asia and Australasia Jakerta, Vol. 3, pp 145-158.

[20] Rao, P. J. et al (1996), 'Use of Jute geotextile as separator in pavements A case study', Proc. Of National Seminar on Jute Based Geotextiles, November 20, 1996, New Delhi.
[21] S. D. Ramaswamy and M. A. Aziz: (1989) "Jute Geotextile for Roads", Published in International Workshops on Geotextiles, 22-29 November, 1989.Bangalore (India).
[22] S. Palit et al (1988): 'Geotextiles: A special reference to Jute', First Indian Geotextiles Conference on Reinforced Soil and Geotextiles, Vol. 1, pp: G.15-G.23.
[23] Silence, P. (1987). Geotextile's in Road's and Highways: State of the Art. Proc. Asia Pacific Conference on Roads, Highways and Bridges, Jakarta, pp. 22/1-2/11, Indonesia.
[24] Specifications for Rural Road SP:20 (2004) Rural Road Manual Published by Indian Road Congress.
[25] Swami Saran (2006): 'Soil Dynamics and Machine Foundation", Galgotia Publicaitons, New Delhi, India 2nd Edition.
[26] Talukdar et. Al. (1994) has studied the influence of various chemicals of copper napthalate.
[27] Venkatappa Rao et. Al. (1994) has shown on the basis of a careful study that the decrease in the narrow strip tensile strength of soil embedded in the soil.
[28] Venkatappa Rao G. and Abid Ali Khan, M. and Narayana Sarma G. V. (1994) 'Durability of geotextiles. Fifth International conference on Geotextiles, 'Geomembranes and Related Products, Singapore 1994, Vol. 2 pp.