Natural Fibre As Soil Stabilizer For Construction

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ABSTRACT

Natural fibres such as jute were the forerunners of the man-made fibres used for centuries for making ropes and for manufacturing burlaps, sacks, hessian and carpet backing. But the use of jute products in civil engineering is relatively widespread for such purposes as sand-bags for concrete curing ,soil enrichment and protection. . Reduction of carbon foot print in constructions is currently attracting global attention warranting innovations in construction technology with stress on eco-congruity. In this context increasing use of eco-concordant materials made of natural fibres to the extent feasible in constructions has assumed significance. 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, California bearing ratio and Permeability Characteristics Etc. The Concept And Principle Of Soil Reinforcement Was First Developed By Vidal (1969), By Which He Demonstrated That The Introduction Of Reinforcing Elements In A Soil Mass Increases The Shear Resistance Of The Mix. Our project is Investigates The Use Of Jute Fibre As Soil Reinforcement Material. Our project mainly comprising the comparison of properties of two different clayey soils is carried out with and without reinforcement. Jute is the natural fibre which is used in our project as soil reinforcement.

Key words: Jute geo-textile, reinforcement, shear strength, dry density, CBR , permeability , settlement.

1.INTRODUCTION

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. The current major use of geotextiles is within the foundation components of load supporting part of a civil engineering structure. Such structure (e.g. building, embankment, dam, canal, road, railway etc.) transfers its load via its own foundation to the soil mass within and below it. The properties of soils under load are crucial to the stability of any civil engineering structure and it is to enhance soil stability for which use of geotextiles gained initial recognition as novel geotechnical materials. More recently, geotextiles have been used to enhance tensile and mechanical properties of civil engineering materials themselves, such as road surfaces and sub-surfaces in both construction of new and renovation of old highways. However, their behaviour in soils and the characteristics of soils enable geotextile functions and applications to be more readily appreciated. Thus, the detailed review reveals that there is a dire need of designing and engineering an innovative jute fabric to suit the requirements of different geotechnical applications.

1.1 Jute Geotextiles

Jute plants are grown mostly in the genetic delta in the eastern part of the Indian subcontinent. People used to consume its leaves as a vegetable and also as a household herbal remedy. Its potential as an important natural fibre-source was a subsequent find. The spurt in use of jute fibres since the middle of the nineteenth century led to improvement of its method of cultivation and extraction of fibres followed by manufacture of fabrics with its yarns. Jute plant has an erect stalk with leaves. It thrives in hot and humid climate, especially in areas where rainfall is in plenty. It grows up to about three meters in height and matures within four to six months. In China, taller Jute plants are being cultivated resulting in higher fibre production. The application area of geotextiles is increasing continuously with the development of modern scientific and technological innovation. Geotextiles particularly, jute geotextiles (JGT) are emerging technical textiles in geotechnical and bio-engineering fields. These are fabricated by both manmade and natural fibres with different designs, shapes, sizes and compositions according to site specific conditions and as well as functional needs. These are a group of commodities, which are used for solving problems related to geotechnical, bio-engineering, agronomic and horticultural requirements by way of consolidation, filtration, separation and management of soil along with agricultural mulching. In respect to their physical, mechanical, hydrological properties, natural geotextiles particularly JGT are getting increasing acceptability due to their environmental complementary support. However, non-environment friendly nature for most of synthetic fibres, particularly polyolefines stand against their continued use. Therefore, the growing consciousness regarding environment preservation has changed the situation in the recent years. Some major plus points regarding jute in this context are include agro-origin, annually renewability, soil friendly organic criteria and complete biodegradable nature, eco-compatibility and improvement of soil fertility and texture, as stated earlier. Therefore, use of JGT, as a geotextile material can be capable for overall survival of old-age jute industry as well as jute cultivators. A vast range of diversified jute products along with JGT can be manufactured through vertical and horizontal modification of existing technology and machineries for the use of different civil engineering applications. Jute Geotextiles is an engineering fabric which, when placed in or on soil, helps to improve its engineering performance against extraneous loads by acting as a change agent or a catalyst. Independent research in the laboratory and field trials has shown jute Geotextile to be technically “fit for purpose”, especially in the fields of soil erosion control and vegetation management.

Interestingly, long before the concept of making fabrics with man-made ingredients took shape, a section of engineers in Scotland and India thought of laying Jute Hessian on roads for strengthening. The trials unfortunately were not monitored and followed up in right earnest and potential of Jute in road construction remained unrealized for long. The trials deserve to be treated as the first use of Jute fabrics as Geotextile. The U.S.A. started using open weave Jute Geotextiles (JGT) under brand names of “Soil Saver”, “Anti-wash” principally for slope erosion control which, till date, remains a major exportable product of India. Concerted efforts to manufacture, use and promote JGT started in early 1990s.Environmentally man-made geotextiles have disadvantages which is why natural Geotextile are gradually being preferred in less critical areas globally. Jute has coarse natural bast fibres lying in the peripheral layer of its stem. It belongs to the genus Corchorus. There are over 30 species of this genus out of which C. Capsularis (known as White Jute) and C. Olitorius (known as Tossa Jute) are utilized for production of fibres. The fibres are extracted from the stem of the plant by a special process known as retting. Retting usually consists of tying the plants in bundles and immersing them in slowly flowing or stagnant water for about 2 to 3 weeks. The process of wetting makes fibre extraction easy from jute stem as it softens and dissolves the sticky substances, especially pectin. Extraction is done manually followed by washing and drying, to make the fibres suitable for commercial use. Jute research outfits are persistently endeavouring to improve retting methods.

2.GEOTEXTILE

2.1 Advantages Of Jute Geotextile

Following Are the Advantages of Jute Geotextile

- Abundant Availability
- Superior Drapability, Jute Geotextile Can Perfectly Shape Itself To Ground Contours.
- High Moisture / Water Absorbing Capacity. Jute Geotextile Can Absorb Moisture / Water Up to About 5 Times Its Dry Weight.
- High Initial Strength.
- Greater Moisture Retention Capacity.
- Lower Costs Compared To Synthetic Geotextiles.
- Ease of Installation. 8. Bio-Degradable Properties. Improves Soil Character E.G., Soil Permeability On Biodegradation.

2.2 Technical Functions

Checks Subsidence of a Pavement by Separating and Preventing Intermixing Of the Soft Subgrade and the Harder Sub-Base.

- 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 enhances CBR value by at least 1.5 times.
- May control reflective cracking of pavements and prolong their fatigue life when used in asphaltic overlays with proper jute geotextile.
- Provides effective drainage system when used as peripheral cover in rubble-filled trench drains, Especially in hilly terrains.
- Enhances strength and stability of high road embankment build with materials of uncertain behaviour like PFA, when interposed at Appropriate Levels. Also Keeps Lateral Dispersion, Subsidence and slides under check. Ertical

jute drains help drain out entrapped water from within an embankment as in case of vertical sand drains, but far more efficiently.
- 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.
- Highly water absorbent; absorbs water about 5 times its dry weight.
- Forms "mulch", retains moisture and builds up a humid surrounding conducive to germination of seeds and growth of plants. Stimulates growth of vegetation.

2.3 Different Types Of Geotextiles

2.3.1 Woven Geotextiles
Woven geotextiles are manufactured from by adopting technique similar to clothing textiles. This type has characteristic appearance of two sets of parallel threads or yarns. They have a surprisingly wide range of applications and they are used in lighter weight form as soil separators, filters and erosion control textiles. In heavy weights, they are used for soil reinforcement in steep embankments and vertical soil walls; the heavier weight products also tend to be used for the support of embankments built over soft soils. The beneficial property of the woven structure in terms of reinforcement, is that stress can be absorbed by the warp and weft yarns and hence by fibres, without much mechanical elongation. This gives them a relatively high modulus or stiffness.

2.3.2 Non-Woven Geotextiles
Non-woven geotextiles can be manufactured from either short staple fibres or continuous filaments. The fibres can be bonded together by adopting thermal, chemical or mechanical techniques or a combination of techniques. The type of fibre (staple or continuous) used has very little effect on the properties of the non – woven geo synthetics. Non-woven geotextiles are manufactured through a process of mechanical interlocking or chemical or thermal bonding of fibres/filaments.

2.3.3 Knitted Geotextiles
Knitted geosynthetics are manufactured using another process which is adopted from clothing textiles industry. In this process, interlocking a series of loops of yarn together is made. The majority of knitted geosynthetics made from polypropylene & polyester fibres. Knitted fabrics, as used in the field of geotextiles, are restricted to warp-knitted textiles, generally specially produced for the purpose. Warp-knitting machines can produce fine filter fabrics, medium meshes and large diameter soil reinforcing grids. However, it is generally found that only the high strength end of the product range is cost effective, usually for soil reinforcement and embankment support functions.

2.4 Geotextile Functions As Reinforcement In Soil
Load on the soil produces expansion. Thus, under load at the interface between the soil and reinforcement (assuming no slippage occurs, i.e. there is sufficient shear strength at the soil/fabric interface). These two materials must experience the same extension, producing a tensile load in each of the reinforcing elements that in turn is redistributed in the soil as an internal confining stress. Thus the reinforcement acts to prevent lateral movement because of the lateral shear stress developed. Hence, there is an inbuilt additional lateral confining stress that prevents displacement. This method of reinforcing the soil can be extended to slopes and embankment stabilisation. Strength created by the introduction of geotextile into the soil & developed primarily through the following three mechanisms-
- Lateral restraint through interfacial friction between Geotextile and soil/aggregate.
- Forcing the potential bearing surface failure plane to develop at alternate higher shear strength surface.
- Membrane type of support of the wheel load.

The structural stability of the soil is greatly improved by the tensile strength of the geosynthetic material. This concept is similar to that of reinforcing steel to the concrete. Since concrete is weak in strength & tension, reinforcing steel is used to strengthen it. Geotextile materials function in a similar manner as the reinforcing steel by providing strength that helps to hold the soil in place. Reinforcement provided by the geotextiles and geogrids allow embankment & roads to be built over very weak soils & allows for steeper embankments to be built.

2.5 Subgrade Stabilization & Base Reinforcement Using Geotextiles In Roads
A large variety of detrimental factors affect the service life of roads and pavements including environmental factors, sub grade conditions, traffic loading, utility cuts, road widening, and aging. The four main applications for geosynthetics in roads are sub grade separation and stabilization, base reinforcement, overlay stress absorption and overlay reinforcement. Sub grade stabilization and base reinforcement involve improving the road structure as it is constructed by inserting an appropriate geosynthetic layer. Sub grade separation and stabilization applies geosynthetics

to both unpaved and paved roads. Base reinforcement is the use of geosynthetics to improve the structure of a paved road.

2.6 Properties Of Jute Geotextile

2.6.1 Physical Properties

- Specific gravity
- Weight
- Thickness
- Stiffness
- Density.

2.6.2 Mechanical Properties

- Tenacity
- Tensile strength
- bursting strength
- Drapability
- Compatibility
- Flexibility
- Tearing strength
- Frictional resistance

2.6.3 Hydraulic Properties

- Porosity
- Permeability
- Permittivity
- Transitivity
- Turbidity /soil retention
- Filtration length etc.

2.6.4 Degradation Properties

- Biodegradation
- Hydrolytic degradation
- Photo degradation
- Chemical degradation
- Mechanical degradation
- Other degradation occurring due to attack of rodent, termite etc.

2.6.5 Endurance Properties

- Elongation
- Abrasion resistance
- Clogging length and flow etc.

3.JUTE GEOTEXTILE

3.1 Specialities Of Jute

Fibres possess good pliancy and render a high degree of flexibility and fineness to fabric construction. High initial modulus, consistency in tenacity (depends on thickness of the filament), high torsional rigidity and low percentage of elongation-at-break make Jute a suitable fibre for geosynthetics. The other remarkable property of Jute is its capacity to absorb water because of its high cellulosic content. Jute fibres/yarns can absorb water up to about 500% of their dry weight. Hygroscopic property of Jute is the highest among all fibres natural & of course man-made. Jute Geotextiles can be manufactured conforming to customized specifications in regard to porometry, tensile strength, permittivity (passage of water across the fabric) & transmissivity (transmission of water along the fabric) which are comparable to man-made geotextiles as shown in table below. Puncture strength and burst strength of Jute Geotextiles are also close to man-made geosynthetics. Besides, JGT has a distinct environmental edge.

3.2 Jute Fibre

Jute, a lingo-cellulosic bast fibre, is grown abundantly in Bengal and adjoining areas of Indian subcontinent. Jute is widely used in production of packaging and wrapping textiles (sacking and hessian) besides its additional uses as carpet backings, decorative / furnishing fabrics, designed carry bag fabrics, geotextile fabrics, as well as for manufacture of high quality paper and composites etc. its main advantages are its renewable agro – origin, bio – degradability, high strength and high moisture regain, medium to good affinity for dyes, good heat and sound insulation properties and ready availability at low cost. Table 1 shows Properties of Geotextile Fabrics . Figure 1 shows Jute Fiber.

Table 1 : Properties of Geotextile Fabrics

Type of jute Geotextile	Mass /unit area(g/m²)	AOS (mm)	Thickness	Tensile strength (KN/m)		Elongation at break (mm)		Puncture test	
				MD	CD	MD	CD	Load	Deformation (mm)
DW TWILL	750	0.10	1.90	32.80	16.75	13.9	10.1	690	10.20
Jute canvas	660	<0.075	1.70	27.20	16.65	16.0	8.0	267	9.00
Russian	420	0.25	1.30	15.65	5.65	15.0	5.68	315	5.40

Figure.1 Jute Fiber (D = 2mm, L = 30 mm)

Being free from toxins and plasticisers it has no pollutants to run-off into ground water or to disturb the ecological system. Its unique mesh construction leaves plenty of rooms for plants to grow and light to enter between the strands and its natural water absorbing capacity helps conserve soil moisture and anchor soil firmly. During water-flow each strand of geojute forms a mini-dam that traps seeds and soil particles and reduces run-off velocity creating a microclimate conducive to germination of seeds and growth of vegetation to conserve soil. Weighing 500 gsm or more, it will not be easily lifted by wind or the flowing water. It is flexible enough to follow any type of surface contour (drapeability). Any variety of grass or ground cover can be selected to fit site and climatic condition for use of this soil saver. Geojute can be used in conjunction with all standard construction and building techniques. Jute geotextiles can be produced by existing jute mills with little or no modifications or additions to machinery and Economical. Huge quantity of these products is very easy to produce by jute mills on bulk scale and can be tailor-made in designing JGT for different purposes. Civil engineering works would gain by improved performance and / or by reduced costs to maintain the techno-economic viability.

3.2.1 Use And Composition Of Jute

Historically, jute has been used in a conventional sense for sacking and wrapping, carpet backing, matting and handicrafts. Jute fabrics used to be the main packaging material for cement and foodgrains but synthetic fibres have taken its place in a big way in modern times. The present day use of jute has been shifted to blended yarns, furnising fabrics, blanket and knitted products, carpets, pulp and paper and geotextiles commonly known as geojute. The main constituents of jute by weight are the following :

Alpha cellulose : 60%
Hemi cellulose : 20%
Lignin : 17% Minerals,
fatty & waxy substances
Nitrogenous matter etc. : 03%

Jute fibres constitute about 7-9% by weight of green plant. It has a multi cellular structure which helps to get mixed with the soil and strengthen it. Jute fibres can be converted into fabrics - for use as geotextiles - by woven and non-woven processes.

3.2.2 Eco-Compatibility Of Jute Geotextiles

Natural fibres are supposed to be eco-compatible by nature from cradle-to-grave. Eco-concordance of retting methods is sometimes questioned. To avoid retting in water as is done in case of Jute, mechanical decertification manually or by simple mechanical appliances without water is being tried by some countries such as China. To establish eco-compatibility of natural fibres, Life Cycle Assessment (LCA) study on Jute and important Jute products entrusted to Price Waterhouse Coopers Ltd by national Jute Board reveals that the most significant impact on the Jute life cycle is carbon sequestration by green Jute plants in the agricultural stage. Approximately 4.88 tons of carbon dioxide get sequestered per ton of raw Jute fibre production. Jute plantation acts as a sink for carbon.

3.3 Characteristics Of Jute Geotextiles (JGT)

Main findings in connection with geotextiles characteristics can be summarized that the woven fabric from heavy and coarse jute yarn and having wide open mesh structure, geojute is the ideal erosion control material for soil slopes under all climatic conditions. Made from a natural fibre, geojute is eco-friendly, biodegradable and decomposing and thereby it adds to the soil rich organic nutrients. Being free from toxins and plasticisers it has no pollutants to run-off into ground water or to disturb the ecological system. Its unique mesh construction leaves plenty of rooms for plants to grow and light to enter between the strands and its natural water absorbing capacity helps conserve soil moisture and anchor soil firmly. During water-flow each strand of geojute forms a mini-dam that traps seeds and soil particles and reduces run-off velocity creating a microclimate conducive to germination of seeds and growth of vegetation to conserve soil. Weighing 500 gsm or more, it will not be easily lifted by wind or the flowing water. It is flexible enough to follow any type of surface contour (drapeability). Any variety of grass or ground cover can be selected to fit site and climatic condition for use of this soil saver. Geojute can be used in conjunction with all standard construction and building techniques. Jute geotextiles can be produced by existing jute mills with little or no modifications or additions to machinery and Economical. Huge quantity of these products is very easy to produce by jute mills on bulk scale and can be tailor-made in designing JGT for different purposes. Civil engineering works would gain by improved performance and / or by reduced costs to maintain the techno-economic viability.

3.3.1 Bio-Degradabilty

Bio-degradability is often considered a disadvantage of jute geotextiles. It is believed that after degradation the strengthening effect of the fabric is lost and the performance of the soil in terms of strength and permeability deteriorates. But jute has been found to be fairly resistant to rapid deterioration when embedded permanently in wet soil below ground water table. In weak subgrade consolidated under the overburden with consequent and gain in strength with time, the performance of the structure becomes less and less dependent on the fabric. So long-term bio-degradability does not necessarily influence bearing capacity significantly.Jute degrades through aerobic processes and produces lignomass with extra nitrogen, phosphorous and potassium. Bio-degradation helps to minimise environmental pollution.

3.3.2 Application Of Jute Geotextiles (JGT)

Jute geotextile is yet to have wide acceptance in civil engineering applications in India.They should give some indication of the potential use of jute geotextile as they often have matching properties for use in place of synthetic fibres and are less expensive.JGT in the form of permeable filter cloth (needle punched jute nonwoven) allows seepage but prevent loss of soil, behind structural defence formed of concrete slabs, stone, gabions, etc. Reinforcement fabrics (jute combination fabrics) protect vegetation to strengthen soil (reinforcement) as well as to strengthen blocks (cables). JGT has a lot of contribution in the protection of slopes in earthen embankments, hill slopes, dumps and heaps of granular materials like fly ash in thermal power plants. Apart from this, JGT has tremendous potential application in stabilization of embankments and control of erosion in banks of rivers, waterways, canals, etc.

3.4 Physical Structure And Properties Of Jute Fibre

Jute fibre extracted by the retting process from the bast of the parent plant comes in the form of long mesh of interconnecting fibres commonly known as jute reed. The jute reed is usually 6-15 feet long. Typical yield of jute fibre based on weight of stem from which it is derived is about 6%. The top of jute reed is thinner than the root. The reeds are then split-opened in carding machine into the component fibres called the spinner□s fibre. Depending upon six fibre quality attributes viz. bundle strength, fibre fineness, reed length and root content, defects, bulk density, colour and lustre, white (W) and tossa (TD) jute are graded into eight varieties viz. W1 or TD1, W2 or TD 2 W3 or TD3 W8 or TD8, in descending order of quality. Multicellular jute fibre, as shown in Fig., consists of 5 to 30 polygonal unit cells (ultimate cell) each having a central lumen, primary/secondary cell walls and middle lamella For the ultimate cells of jute fibre, the length ranges between 0.75 – 6.0 mm and the diameter ranges between 0.0051 – 0.0254 mm. Jute fibres or filaments, as they are often termed, contain a variable number of cells, so the individual values for filament strength, within a sample, vary widely.

4. SOIL STABILIZATION

Site feasibility study for geotechnical projects is of far most beneficial before a project can take off. Site survey usually takes place before the design process begins in order to understand the characteristics of subsoil upon which the decision on location of the project can be made. Soil stabilization aims at improving soil strength and increasing resistance to softening by water through bonding the soil particles together, water proofing the particles or combination of the two Usually, the technology provides an alternative provision structural solution to a practical problem. The simplest stabilization processes are compaction and drainage (if water drains out of wet soil it becomes stronger). The other process is by improving gradation of particle size and further improvement can be achieved by adding binders to the weak soils. Soil stabilization can be accomplished by several methods.

4.1 Mechanical Stabilization

Under this category, soil stabilization can be achieved through physical process by altering the physical nature of native soil particles by either induced vibration or compaction or by incorporating other physical properties such as barriers and nailing. Mechanical stabilization is not the main subject of this review and will not be further discussed.

4.2 Chemical Stabilization

Under this category, soil stabilization depends mainly on chemical reactions between stabilizer (cementitious material) and soil minerals (pozzolanic materials) to achieve the desired effect. A chemical stabilization method is the fundamental of this review and, therefore, throughout the rest of this report, the term soil stabilization will mean chemical stabilization.

4.3 Components Of Stabilization

Soil stabilization involves the use of stabilizing agents (binder materials) in weak soils to improve its geotechnical properties such as compressibility, strength, permeability and durability. The components of stabilization technology include soils and or soil minerals and stabilizing agent or binders (cementitious materials).

4.3.1 Soils

Most of stabilization has to be undertaken in soft soils (silty, clayey peat or organic soils) in order to achieve desirable engineering properties. According to Sherwood (1993) fine-grained granular materials are the easiest to stabilize due to their large surface area in relation to their particle diameter. A clay soil compared to others has a large surface area due to flat and elongated particle shapes. On the other hand, silty materials can be sensitive to small change in moisture and, therefore, may prove difficult during stabilization.

4.3.2 Stabilizing Agents

These are hydraulic (primary binders) or non-hydraulic (secondary binders) materials that when in contact with water or in the presence of pozzolanic minerals reacts with water to form cementitious composite materials. The commonly used binders are:

- Cement
- Lime
- Fly Ash

4.4 Stabilization Methods

Soil stabilization is a method of improving soil properties by blending and mixing other materials.

4.4.1 Soil Cement Stabilization

The soil stabilized with cement is known as soil cement. The cementing action is believed to be the result of chemical reactions of cement with siliceous soil during hydration reaction. The important factors affecting the soil-cement are nature of soil content, conditions of mixing, compaction, curing and admixtures used. The appropriate amounts of cement needed for different types of soils may be as follows:

- Gravels – 5 to 10%
- Sands – 7 to 12%
- Silts – 12 to 15%, and
- Clays – 12 – 20%

4.4.2 Lime Stabilization

Lime stabilization is not effective for sandy soils. However these soils can be stabilized with clay, fly ash etc which serve as hydraulically reactive ingredients. The ratio of fly ash to lime generally varies in between 3 to 5. The fly ash is used is about 10 to 20% of the soil weight.

4.4.3 CHEMICAL STABILIZATION OF SOILS

In chemical stabilization, soil is stabilized by adding different chemicals. The main advantage of chemical stabilization is that setting time and curing time can be controlled. Chemical stabilization is however generally more expensive than other types of stabilization.

4.5 In–Situ Stabilization

The method involves on site soil improvement by applying stabilizing agent without removing the bulk soil. This technology offer benefit of improving soils for deep foundations, shallow foundations and contaminated sites. Planning of the design mix involves the selection and assessment of engineering properties of stabilized soil and improved ground. The purpose is to determine the dimensions of improved ground on the basis of appropriate stability and settlement analyses to satisfy the functional requirements of the supported structure (Keller Inc.). The technology can be accomplished by injection into soils a cementitious material such cement and lime in dry or wet forms. The choice to either use dry or wet deep mixing methods depend among other things; the in-situ soil conditions, in situ moisture contents, effectiveness of binders to be used, and the nature of construction to be founded. Depending on the depth of treatment, the in situ stabilization may be regarded as either deep mixing method or mass stabilization.

4.6 Deep Mixing Method

The deep mixing method involves the stabilization of soils at large depth. It is an in situ ground modification technology in which a wet or dry binder is injected into the ground and blended with in situ soft soils (clay, peat or organic soils) by mechanical or rotary mixing tool. Depending on applications, the following patterns may be produced; single patterns, block patterns, panel pattern or stabilized grid pattern. Note that, the aim is to produce the stabilized soil mass which may interact with natural soil and not, to produce too stiffly stabilized soil mass like a rigid pile which may independently carry out the design load. The increased strength and stiffness of stabilized soil should not, therefore, prevent an effective interaction and load distribution between the stabilized soil and natural soil.Thus the design load should be distributed and carried out partly by natural soil and partly by stabilized soil mass (column).

4.7 Wet Mixing

Applications of wet deep mixing involve binder turned into slurry form, which is then injected into the soil through the nozzles located at the end of the soil auger. The mixing tool comprise of drilling rod, transverse beams and a drill end with head. There are some modifications to suit the need and applications. For instance, the Trench cutting Re-mixing deep method (TRD) developed by circa Japan, in 1993 provides an effective tool for construction of continuous cutoff wall without the need for open trench. The method uses a crawler-mounted, chainsaw-like mixing tool to blend in-situ soil with cementitious binder to create the soil-cement wall. It further consists of a fixed post on which cutting, scratching teeth ride on a rotating chain and injection ports deliver grout into treatment zone. Wall depths up to 45 m having width between 0.5 m and 0.9 m are achievable.

4.8 Dry Mixing

Dry mixing (DM) method is clean, quiet with very low vibration and produces no spoil for disposal (Hayward Baker Inc). It has for many years extensively used in Northern Europe and Japan. The method involves the use of dry binders injected into the soil and thoroughly mixed with moist soil. The soil is premixed using specialized tool during downward penetration, until it reaches the desired depth. During withdrawal of the mixing tool, dry binder are then injected and mixed with premixed soil leaving behind a moist soil mix column.

4.9 Salient Features

It brings stability in reinforced earth structure It creates environment friendly interaction of the soil mass with Jute Geo-textile. The portion of Dhaka Sylhet Highway which needs protection from soil erosion mainly comprises sand-silted soil prone to damage and erosion by floods and other natural processes. Application of Jute Geo-textiles for erosion control and slope protection is likely to offer most appropriate solution.

4.9 Soil Stabilization Using Jute Geofibre

4.9.1 Behaviour Of Expansive Soil Mixed With Lime And Fly Ash

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. Table 2 shows Treated jute materials

Table 2 Treated jute materials

Type of product	Biodegradability		Durability	Moisture holding capacity
	Time in month	Weight Loss(%)	Time in year	(%)
Light weight hession	3	30	0.25-0.80	12
Treatment- I	12	15	0.50-1.25	9-10
Treatment- II	12	10	2.0-5-	6-8
Treatment- III	12	5	>10	5-6
Treatment- IV	12	1-3	>20	3-4

4.9.2 Compressible Clay Soil As Backfill Material - Problem And Remedial Measures

As per 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.

4.10 Experimental Studies

A number of laboratory tests were done for the physical properties as well as the engineering properties of peat and black cotton soil. Properties were compared without reinforcement and after providing the reinforcement. Sp Gravity, Liquid limit, Plastic limit were found out. Soil is classified as per Indian Standard Classification System ISCS (IS 1498-1970).

- California Bearing Ratio Test
- Check For Settlement

4.11 Factors Affecting The Strength Of Stabilized Soil

Presence of organic matters, sulphates, sulphides and carbon dioxide in the stabilized soils may contribute to undesirable strength of stabilized materials.

Organic Matter

- Sulphates
- Sulphides
- Compaction
- Moisture Content
- Temperature
- Freeze-Thaw And Dry-Wet Effect

5.CONCLUSION

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 "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. The following conclusions can be drawn on the basis of present work:

- The cost economy: the unit cost is lowest with jute geotextile and highest with sand stabilization.
- 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%)
- Time economy: time of construction is less in the case with jute geotextile in comparison to sand stabilization.

References

[1] T.Subramani,T, “Application of Eco-Friendly Geotextiles for Landslide Mitigation in a Part of Ooty Hills, TamilNadu”, International Journal of Modern Engineering Research,Vol.2, No.3, pp 579 -585,2012.

[2] T.Subramani, T. “Experimental Investigations on Coir Fibre Reinforced Bituminous Mixes” International Journal of Engineering Research and Applications, Vol.2, Issue.3, pp 1794-1804, 2012.

[3] T.Subramani.T , S.Vishnupriya,, “Finite Element Analysis of a Natural Fiber (Maize) Composite Beam”, International Journal of Modern Engineering Research, Volume. 4, Issue. 6 (Version 1), pp 1 – 7, 2014,

[4] T.Subramani.T, Reni Kuruvilla, J.Jayalakshmi., “Nonlinear Analysis Of Reinforced Concrete Column With Fiber Reinforced Polymer Bars" International Journal of Engineering Research and Applications Volume. 4, Issue. 6 (Version 5), pp 306- 316, 2014.

[5] T.Subramani., S.Sekar., C.Kathirvel., C.T.Sivakumar., ”Identification Of Soil Erosion Prone Zones Using Geomatics Technology In Parts Of North Arcot And Dharmapuri District”, International Journal of Engineering Research and Applications, Vol. 4, Issue 12(Version 3), pp.150-159, 2014.

[6] T.Subramani., S.Sekar., C.Kathirvel., C.T.Sivakumar.,, “Geomatics Based Landslide Vulnerability Zonation Mapping - Parts Of Nilgiri District, Tamil Nadu, India”, International Journal of Engineering Research and Applications, Vol. 4, Issue 12(Version 3), pp.139-149, 2014.

[7] T.Subramani.T, S.Krishnan., S.K.Ganesan., G.Nagarajan. ”Investigation of Mechanical Properties in Polyester and Phenyl-ester Composites Reinforced With Chicken Feather Fiber” International Journal of Engineering Research and Applications Vol. 4, Issue 12(Version 4), pp.93-104, 2014.

[8] T.Subramani, P.Malathi , " Land Slides Hazardous Zones By Using Remote Sensing And GIS" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 211-222 , 2015

[9] T.Subramani, A.Mumtaj , " Experimental Investigation Of Partial Replacement Of Sand With Glass Fibre" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 4, Issue 5, pp. 254-263 , 2015

[10] T.Subramani, A.Kumaravel , " Analysis Of Polymer Fibre Reinforced Concrete Pavements By Using ANSYS" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 132-139 , 2016 .

[11] T.Subramani, P.Ramasamy , " Thermal Conductivity Of Fibre Filled With Ferrocement Sandwich Panels" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 204-215 , 2016 .

[12] T.Subramani, P.Sakthivel , " Experimental Investigation On Flyash Based Geopolymer Bricks" , International Journal of Application or Innovation in Engineering & Management (IJAIEM) , Volume 5, Issue 5, pp. 216-227 , 2016 .

[13] T.Subramani, A.Anbuchezian , " Experimental Test On Bitumen With Addition Of 35% Of Plastic Fibre " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 017-022 , ISSN 2319 - 4847.

[14] T.Subramani, A. Fizoor Rahman , " An Experimental Study On The Properties Of Pet Fibre Reinforced Concrete " , International Journal of Application or Innovation in Engineering & Management (IJAIEM), Volume 6, Issue 3, March 2017 , pp. 058-066 , ISSN 2319 - 4847.

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