In spite of the domination in the fields of natural fibres and textiles the Indian subcontinent's share in the global geotextiles is a meagre two percent. Even within this miniscule share, man-made geotextiles cater for over ninety percent of the total demand. Hence geotextiles have to be imported in spite of a tremendous capacity of growth within the South Asian countries.

During the Textiles Summit held in New Delhi in September 2007, Dr. Manmohan Singh Hon'ble Prime Minister of India, laid great emphasis on the growth and development of technical textiles. A subsequent study conducted by the Textile Commissioner's office at Mumbari through Pricewaterhouse Cooper revealed that natural geotextiles such as Jute geotextiles (JGT) account for a tiny 1% of the total basket of geotex. Yet, in view of the increasing global concern for environment - friendly biodegradable materials, among the various geotextile materials the JGT has a very high potential because of its various attributes such as spinnability, drapability, hygroscopicity and tensile strength.

The International Jute Study Group (IJSG) had submitted a project proposal on "Development and Application of Potentially important Jute Geotextiles" to the Common Fund for Commodities (CFC) for funding. Before considering the approval of the project it was felt that the feasibility of the project needs to be evaluated through an interactive workshop with all the stakeholders, which would include technical experts, academia, manufacturers, end user agencies, environmentalists, regulatory bodies and the policy makers. It was envisaged that sharing of ideas would ensure the removal of concerns relating to supply chain, technical constraints, quality control, cost benefit and long term sustainability of the use of JGT.

The international workshop at Kolkata on 5 and 6 April 2008 sought to evaluate the potential for the application of JGT specially in the areas of road construction, embankment protection and soil conservation.

The two-day workshop was a resounding success in terms of extensive participation by various stakeholders. It has helped in the formulation of an implementation strategy in India and Bangladesh to begin with. It has also led to an integration of the interests of researchers, manufacturers and end-users. It also brought out the proactive approach of the regulatory bodies and the policy makers in India and Bangladesh, where the pilot projects are to be executed. On the whole, the workshop reconfirmed the validity of the course of actions and the project proposal submitted by IJSG to the CFC for their approval and funding.

IJSG
Dhaka, Bangladesh
May, 2008

Secretary General
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INTERNATIONAL WORKSHOP ON JUTE GEOTEXTILES

Inauguration of the Workshop
Chief Guest Mr. Nirupam Sen is lighting the lamp.
He is flanked by (from left to right) Dr. N. R. Banerjee, the Guest of Honour,
Mr. Sieste van der Werff, Mr. Sudripta Roy & Mr. Atri Bhattacharya

Hon'ble Minister in-charge, Commerce & Industries Department, Govt. of West Bengal &
the Chief Guest, Mr. Nirupam Sen addressing the gathering
Mr. Sudripta Roy, Secretary General IJSG at the Press Meet
Seated (from left to right). Mr. Atri Bhattacharya, Mr. Sietse van der Werff,
Mr. Sudripta Roy, Mr. B. Kispotta & Mr. R. K. Pathak

A section of the participants.
Workshop on Jute Geotextiles
Technical Potential & Commercial Prospects

PROGRAMME

Day 1
(05 April 2008)

10:00 – 10:30 : Registration

10:30 – 11:40 : Inaugural Session

Opening Speech : Mr. Binod Kispotta, Jute Commissioner, Ministry of Textiles, GOI

Special address : Mr. Md. Fazlul Haque, Joint Secretary (Policy), Ministry of Textiles & Jute & Chairman, Committee on Projects (COP) of IJSG, Dhaka, Bangladesh

Remarks of CFC Representative : Mr. Sietse van der Werff, Senior Project Manager CFC

Chairman’s Remarks : Mr. Sudripta Roy, Secretary General, IJSG

Address of the Guest of Honour : Dr. N. R. Banerjee, Vice Chancellor, BESUS

Address of the Chief Guest : Shri Nirupam Sen, Hon’ble Minister-in-Charge Commerce & Industries, West Bengal, India

Vote of Thanks : Mr. Atri Bhattacharya, Secretary, JMDC, Kolkata

11:40 – 12:00 : Tea Break

12:00 – 13:30 : Technical Session - I

Chairman – Prof. Amalendu Ghosh

Case Studies with JGT & Jute-based Technical Textiles

i) Mr. Sudhir Mathur, Head, Geotechnical Engg. Division, Central Road Research Institute (CRRI), India & Dr. P. K. Nanda, Ex-Vice President, Indian Roads Congress, India & Mr. U. K. Guru Vittal, CRRI
ii) Dr. Zahid Hossain Prodhan, Managing Director, Arcadia Property Development, Dhaka 1205

iii) Dr. G. P. Juyal, Central Soil & Water Conservation Research and Training Institute (CSWRTI), Dehra Dun, India

13:30 – 14:15 : Lunch Break


i) Mr. Tapobrata Sanyal, Geotechnical Advisor, JMDC, India

ii) Dr. A B M Abdullah, Executive Director, JDPC, Dhaka

15:15 – 15:30 : Tea Break

15:30 – 17:00 : Technical Session – III Chairman – Dr. Debasish Gupta Quality Control of JGT & Development of Testing Facilities (from mill to site)

i) Prof. Dr. Amalendu Ghosh, Department of Civil Engineering, Bengal Engineering & Science University, Shibpur (BESUS), Kolkata, India

ii) Prof. Abdul Jabbar Khan, Civil Engineering Department, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh

iii) Dr. Prabir Ray, Principal, Institute of Jute Technology, Kolkata, India

Day 2
(06 April 2008)

09:30 – 11:15 : Technical Session – IV Chairman – Mr. Quamrul Islam Siddique, Market & Marketability of JGT vis-à-vis Aspect of Production

i) Mr. Vinay Chand, Vinay Chand Associates, London NW3 6 DJ, UK

ii) Mr. D. C. Baheti, Chairman, Indian Jute Industries’ Research Association (IJIRA), Kolkata, India
iii) Mr. Mahmudul Huq, Deputy Managing Director, Janata Jute Mills Ltd., Dhaka, Bangladesh

iv) Dr. G. Venkatappa Rao, Chief Consultant, Sai Master Geoenvironmental Services Pvt. Ltd., Hyderabad, India

11:15 – 11:30: Tea Break

11:30 – 13:00: Technical Session – V  Chairman – Mr. A. Ghoshal
Standardization of JGT & Its Applications and Related Regulatory Issues

i) Dr. R. Jane Rickson, Chair in Soil Erosion and Conservation, National Soil Resources Institute (NSRI), Cranfield University, UK

ii) Mr. Quamrul Islam Siddique, Former Secretary & Honorary Advisor to LGED, Bangladesh

iii) Dr. Satyendra Mittal, Associate Professor, Indian Institute of Technology (IIT), Roorkee, India

13:00 – 14:00: Lunch Break

14:00 – 17:00: Concluding Session

— Open discussions

— Summing up & recommendations.
INAUGURAL SESSION

The Common Fund for Commodities (CFC) and the International Jute Study Group (IJSG) in collaboration with the Jute Manufactures Development Council (JMDC) organised a two-day Workshop to have thorough discussions among the key stakeholders in the supply chain along with experts of jute geotextiles especially involved in the field of soil management and rural road construction in Bangladesh, India and Europe. The main objective was to identify the actual difficulties /bottlenecks in wider applications of jute geotextiles in the producing countries as well as developed countries. The Workshop held at Hotel Hyatt Regency, Kolkata was inaugurated by H.E. Mr. Nirupam Sen, the Hon’ble Minister-in-Charge, Commerce & Industries, Government of West Bengal, India.

1. At the outset all the Hon’ble Guests on the dais were welcomed, each with a bouquet of jute flowers. A lighting of lamp ceremony was also participated by all honorable guests at the dais.

2. A short promotional audio-visual on jute displaying the use of jute in fashion, everyday life including infrastructure, roads, river banks, mountain slopes, etc. was shown at the beginning of the inaugural session.

3. In the opening speech, Mr. Binod Kispotta, Jute Commissioner of the Govt. of India welcomed all to the Workshop. He hoped the workshop to focus on the perceived and actual potential and technical/ commercial advantages of jute geotextiles, including the aspects of Quality Assurance, Standardization, technical constraints in production etc. that need to be addressed in preparation of a strategic policy with forward and backward linkages on marketing the products. Mr. Kispotta
remarked that jute geotextiles holds the most potential among the natural geotextiles because of its distinctive attributes like spinnability, drapability, hygroscopicity and initial tensile strength. He hoped that this highly participatory/interactive workshop, participated by diverse stakeholders like policy makers, research organizations, R&D institutions, manufacturers/mills/industry, engineers, engineering departments/agencies, private/public users, traders, marketing people, would ascertain the views, reactions of all for ensuring greater acceptance and marketing of jute geotextile in India, Bangladesh & worldwide.

The common platform of this workshop would facilitate meeting of minds in mutually agreed set of objectives to be achieved, he added. He fervently hoped that the 2-day workshop would end on a positive note arriving at an effective set of action plans for the promotion of the JGT products.

4. **Mr. Md. Fazlul Haque**, Joint Secretary (Policy), Ministry of Textiles & Jute, Government of Bangladesh (GOB) and also the Chairman of the Committee on Projects (COP) of IJSG, in his special address spoke on the role of GOB in promoting the jute sector and also Jute Geotextiles through its use/application, production capacity building, market development etc. The emphasis of GOB in diversification of jute uses through establishing Jute Diversification Promotion Centre (JDPC) and supporting establishment of diversified jute product manufacturing units/industry in private sector has been highlighted.

He added that the ‘Road Map’ for jute sector formulated by IJSG that focused jute geotextile as potentially important diversified jute products has also been adopted in Bangladesh Jute Policy. Consequently JDPC
has been appointed as 'Lead Agency' for execution of the proposed IJSG sponsored project on JGT by organizing a national coordinating body with different stakeholders related with production, application and market promotion both in private and public sectors.

Considering present environmental issues along with open market economy, Bangladesh in its policy planning has taken overall decision for maximization of uses of internal resources in development activities and consequently a law has been enacted to ban polyethylene bags and similar products. Moreover in Poverty Reduction Strategy paper (PRSP) and Millennium Development Goal (MDG) maximum importance have been given for activities related with the rural infrastructural development and agro based industrialization.

He thanked IJSG and CFC for identifying jute geotextile project as an important and priority project and involving Bangladesh as one of its partner countries. He specially mentioned the existing capacity of Bangladesh for manufacturing woven & non-woven JGTs both in private and public sector jute mills. Mr. Haque on behalf of the Government of Bangladesh assured to render all support/help in executing the expected IJSG/CFC sponsored JGT project in Bangladesh.

5. Mr. Sietse van der Werff, Senior Project Manager, CFC in his deliberation termed the Workshop as a high level meeting where experts in the field of jute geotextiles have gathered together to shed lights on the potential of jute geotextiles esp. technical and commercial aspects which is very important for the hundreds of thousands of producers & workers in the industry.

He congratulated the organizing teams of both JMDC and IJSG for organising the Workshop in a very efficient manner having such an
expert group together with excellent meeting facilities in a very pleasant environment. He thought it was a very good starting point.

In his brief statement on CFC's programme approach and activities he mentioned that the main focus of CFC activities is 'commodities' as all developing and least developed countries (LDCs) are dependent on commodities which form the backbone of their economies and account for the bulk of the export earning.

He added that the Common Fund works in a novel approach of commodity focus instead of country focus. In the jute portfolio of CFC, 8 projects are completed, 3 are currently on-going and 2 projects are under preparation, one of which is the "Development and Application of Potentially Important Jute Geotextiles". This project and its objectives are central to the expected consultations of the Workshop. At this point he briefly stated the background for CFC's support in organizing the Workshop and the present status of the proposed project.

He hoped that presentations and exchanges among the stakeholders and the participants would lead to identification of all the key issues, e.g. potential demand, problems/bottlenecks in production, application along with regulatory issues with respect to formal approvals for use of JGTs along with suggestive measures to give JGT a proper place in the market. Based on a thorough understanding a common approach could be developed to address the problems identified from this highly interactive and informative workshop, he added.

Finally, he remarked that if this exchanges and insights gained from the workshop results in an improved project proposal with clear prospect of having substantive and sustainable impact, the Common Fund would consider such proposal for financing.
6. **Mr. Sudripta Roy**, Secretary General, IJSG and also the Chairman of the session welcomed and expressed gratitude to the Chief guest, Guest of Honour, all other delegates, experts, participants for making it convenient to participate in the workshop.

He briefly stated the purpose of the workshop and also mentioned how IJSG, as a thinking body, is continuously endeavouring to improve the sector through exploring various opportunities/options to look for new avenues of alternatives/alternative uses especially in today's global concern for environment.

He underscored the importance of jute geotextiles and suggested looking at it as a profitable alternative jute product of the future, instead of too much depending on conventional products like sacking. The Govt. of India may not be able to keep on supporting the jute industry by its mandatory packaging order, so it would be prudent if the industry starts looking into other large scale uses of jute like JGTs as alternative products. The government/policy makers, user agencies/departments both in private and public sector should also look into this technology intently and assess if it can be used in different applications, as presumed/perceived.

This workshop would lead to a project in which suitable JGTs are expected to be developed, evaluated and tried in actual fields not only to arrest soil erosion but also for rural road construction. If cheaper and sustainable alternatives from jute is successfully developed and this project turns up as a successful model JGTs will definitely earn confidence of the users/consumers along with markets, both local and international.

Highlighting a few other potential diverse areas where currently jute is being used, he remarked that opportunity of jute is immense and future
of jute is bright. He again thanked all for assembling here and wished the workshop a great success.

7. **Dr. N. R. Banerjee**, the Vice Chancellor, BESUS in his Special Address expressed happiness for organising such a Workshop at Kolkata.

He mentioned that Govt. of India and particularly the Govt. of West Bengal is encouraging the use of JGTs in soil conservation and rural road construction of the region. He thought it essential to determine the differentials / uniqueness of JGTs as compared to its synthetic counterparts. He also underscored the need for a suitable market strategy / policy for expansion of the JGT market.

He assured that with a dedicated team of scientists/ engineers working with jute geotextiles in BESUS the proposed jute geotextile project where BESUS has been identified as an important partner would be possible to be implemented in the right earnest.

8. **Mr. Nirupam Sen**, Hon'ble Minister in Charge for Commerce and Industry, Govt. of West Bengal welcomed all participants and delegates to this very important workshop. He expressed pleasure in inaugurating the workshop on jute geotextiles as West Bengal is not only the largest jute producing area but also has the largest number of jute industries located here where nearly 40lac farmer families and 2.5lac workers live on this crop.

He remarked that the jute sector is of prime importance for the economy of the state of West Bengal. He further stated that the importance of jute lies not only on the historical perspective but on the interest of the jute farmers and the workers of the jute industry.
He remarked that both the Central and the State governments have a major role to play and see i) if the benefit from the compulsory packaging regulation provided by the GOI as protection of the sector is truly percolated down to the farmers and ii) how the industry can be advanced with adoption of the technologies which are continuously being developed all over the world. He opined that the jute industry should be serious about diversification of jute and take it as a challenge. It is the duty of all stakeholders esp. the private sector to benefit the farmers, labourers, investors and others concerned from any new innovations / technologies, if found suitable.

There are a good number of diversified products possible to be manufactured from jute like carpet, bags, handicrafts etc, but to make it economically viable there has to be bulk use of jute. This is exactly the reason why JGT has its own importance. He remarked that there is serious problem of soil erosion in Bengal. The entire Gangetic belt is facing this problem of erosion, where JGT may be used to arrest this erosion. The road construction is another area of application of JGTs. Public Works and other concerned departments/ agencies may use these JGTs and once these are successfully demonstrated there will be huge market, which will ultimately attract investors in the sector.

Finally, he hoped that various aspects of JGTs will be discussed in the two-day workshop and the workshop would provide a correct solution to the problem of usage of JGTs.

9. Mr. Atri Bhattacharya, Secretary, JMDC, Ministry of Textiles, Govt. of India conveyed thanked all the participants, delegates from all over the world for participating in the workshop.
He offered a very sincere vote of thanks to the Chief guest of the Inaugural Session, Mr. Nirupam Sen, Hon'ble Minister in Charge for Commerce and Industry, Govt. of West Bengal. He thanked the press and media for attending the event and hoped it to be covered with due importance. He thanked all members of the workshop organising bodies i.e. IJSG, JMDC and NCJD. He specifically thanked the Secretary General of IJSG and CFC-representative for their support in organising the Workshop.
SUMMARY OF PRESENTATIONS

Technical Session I

Theme: Case Studies with JGT & Jute-based Technical Textiles

Chairman: Prof. Amalendu Ghosh, Professor & Ex-Head, Deptt. of Civil Engineering, BESUS, Howrah-711 103, India

1. Title of the Paper:
   Jute Geotextiles – Potential and Applications in Rural Road Works

   Presented by:
   Mr. U.K. Guru Vittal, Central Road Research Institute (CRRI), New Delhi, India

   The case studies conducted by CRRI in different states of India with application of JGTs in road construction, soil erosion control, mitigation of land slides & hill slopes, drainage and trench drain etc. were focused in the presentation. Suitability and cost effectiveness of JGT application in road construction along with the properties of a variety of JGT used were highlighted. Some vital issues and questions, that need appropriate solutions and answers emerged from this presentation. Mr. Guruvittal concluded his presentation with the remark that mere usage of geotextiles whether jute based or synthetic based would not ensure good performance of a road; proper selection, correct design, quality assurance of the textiles used along with its installation procedure are most essential.

2. Title of the Paper:
   Eco-rehabilitation of Himalayan hill slopes, affected mine spoils and landslides using Jute Geotextiles – Case Study
In absence of the designated speaker Dr. G. P. Juyal, his paper was presented by Dr. P. K. Bhattacharya, IJIRA.

The presentation highlighted the case studies of bio-engineering techniques for prevention of landslides and stabilization of hill slopes and mine spoils in the sub-Himalayan region. The splash erosion caused by heavy rainfalls has been explained with precise measure of diameter, kinetic energy of rain drops at high rainfall intensity for erosion control simulation. The case studies established the role of open weave JGT called Soil saver in reducing run off velocity and soil erodibility. It also detailed out the steps required for application/installation of JGT in practical fields along with different laying techniques. The community participation in JGT related activities like installation, maintenance and upkeep of vegetation were also highlighted in the paper. That appropriate open weave JGT are suitable for stabilization of steep hilly slopes and mine spoils has been emerged from this paper. The need for creating awareness and training of the user agencies in favour of using JGT have also been highlighted in the paper.

3. Title of the Paper:

Application of Jute Geotextiles in Civil Engineering in India – Some Case Studies

In absence of designated speaker, Dr. Zahid Hossain Prodhan, a paper on “Application of Jute Geotextiles in Civil Engineering in India – Some Case Studies” was presented by Mr. P. K. Chowdhury of IJIRA.

Various case studies on use of JGT in India for a variety of applications were presented in the paper highlighting the effectiveness of JGT in road strengthening, soil erosion control, protection of railway track subsidence, etc. He added that JGT basically acts as a catalyst or a change agent in improving the engineering behaviour of soil and is required for limited period of time, beyond which JGT has a redundant catalytic function.
Discussions:

The discussions were mostly about the technical aspects of JGT e.g. its sampling criteria, specifications like width of JGT, their installation parameters like sand cushion thickness, stapling intervals, direction of laying, filter cake formation, strength requirement, etc. It was apparent that use of specific types of JGTs were found to have effectively controlled soil erosion, mitigated land slides, stabilized mine spoils and successfully improved performance / durability of roads. JGTs are possible to be used in a variety of ways to perform different functions of a road.

A full scale detailed study is felt necessary to obtain important different parameters, answers/solutions to a number of technical questions and determine performance criteria, table/data with use of different JGTs in different specific applications.

Finally it has been confirmed by all that CBR value of soil sub-grade is enhanced by the use of JGT, though a proper explanation of the phenomenon is still awaited from the geotechnical engineers. It has also been agreed upon that proper selection of materials for specific applications is a prerequisite for successful application of JGT. Emphasis has also been made on the selection, specification and quality control of required JGT.
Technical Session II

Theme: Prospective Applications of Jute Geotextiles

Chairman: Prof. Nitin Som, Consultant, Former Dean & Head, Deptt. of Civil Engg., Jadavpur University, Kolkata, India.

4. Title of the Paper:
   Prospective Applications of Jute Geotextiles

   Presented by:
   Mr. Tapobrata Sanyal, Geotech Adviser, Jute Manufactures Development Council (JMDC), Kolkata, India.

   The presentation was based on the prospective applications of JGTs in geo-environmental and geo-technical sector that are expected to have technical and commercial potential. The paper contained the distinctive physical features and characteristics of jute that made JGT unique and placed it among the best geotextiles available. New applications e.g. stabilization of over burden dumps, management of solid municipal waste material; jute reinforced asphaltic overlays/ temporary haul roads, jute reinforced concrete, etc. were identified to have more potential. The presentation also made few suggestions for development of JGT sector through proper exploitation of the functional attributes of jute and JGT.

5. Title of the Paper:
   Prospective Innovative Applications of Jute Geotextiles

   Presented by:
   Dr. A.B.M. Abdullah, Executive Director, Jute Diversification Promotion Centre (JDPC), Dhaka, Bangladesh.

   The presentation reviewed the composition and physical features of jute along with various field applications of jute geotextiles. He mentioned
certain limitations of man-made fibres and the environmental advantage of JGT. Some efforts and programmes taken up by the Government of Bangladesh has also been reported in the paper.

**Discussions:**

A few more prospective new areas of innovative applications of JGT came up from the discussion. It was agreed upon that any new innovative applications must be based on the fundamental properties of the base materials and that the ideas of innovative areas that have been brought forward would require lot more studies, field applications, monitoring and assessment of ultimate benefit to the mankind in general.
Technical Session III

Theme: Quality Control of Jute Geotextiles & Development of Testing Facilities (from mill to site)

Chairman: Dr. Debasish Gupta, IAS, Chief Electoral Officer, Govt. of Jharkhand, Ranchi, India.

6. Title of the Paper:
   Development of Testing Facilities and Specifications for Quality Control of Jute Geotextiles and its Application

   Presented by:
   Prof. Amalendu Ghosh, Prof. & Ex-Head, Deptt. of Civil Engineering, BESUS, India

   The presentation highlighted the need for effective use of JGT, ways of generation of database, various test categories and methods, basic properties/parameters for formulation of specifications and quality control guidelines for specific applications of JGTs. Different steps and measures of quality control have been mentioned in the paper. The need for specifications approved by the appropriate regulatory bodies and development of internationally acceptable standards of JGTs was emphasized upon for increasing confidence of the ultimate users like engineers, contractors/others.

7. Title of the Paper:
   Quality Control of Jute Geotextiles & Development of Testing Facilities

   Presented by:
   Prof. A. Jabbar Khan, Civil Engineering Department, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh
The presentation highlighted various research findings of a study aimed at finding out the technical feasibility of using JGT as an alternative to man-made geotextiles in civil engineering applications. Due to the absence of standard test method or design approach related to JGT, the ASTM and DIN standard test methods were adopted in the study. Based on the test results some design examples as per methodology specified for man-made geotextiles was also highlighted. The presenter was of the view that untreated JGT can be used as separator provided it meets certain property requirement. Treated /designed biodegradable JGT could be an alternative to man-made geotextiles in soil reinforcement applications. Need for development of a common/uniform standard for testing and design methodology specifically for JGT has also been underscored.

8. Title of the Paper:
A Critical Review on Quality Control & Testing of Jute Geotextiles

Presented by:
Dr. Prabir Ray, Principal, Institute of Jute Technology (IJT), Kolkata, India

Different tests, testing methods, different types of treated JGTs for specific uses along with some observations and suggestions were mentioned in the paper. The author presented a comparative analysis of the critical features of JGT found from the tests conducted by IJT based on specifications for man-made geotextile by Indian Road Congress (IRC). The presentation emphasized upon fabric engineering and quality and opined that the width of fabric needs to be more than 2m. He inferred that JGT could match its synthetic counterpart in most of the features at the initial stages. Finally the suitability of JGT for using in construction of connecting and rural roads has also been suggested /recommended in the paper.
Discussions:

Highly interactive discussions on the above presentations revealed the necessity of an interface between the suppliers and the users i.e. agencies, engineers, contractors starting from the design stage to quality and quantum required for enhancing the use of JGTs.

End users' requirement is more important than any number of technical strengths of the products. The industry is capable of supplying quality JGT but there is no systematic demand of the product. Specific information and data of the amount of JGT that is currently being used, and the amount of JGT that has actual potential for being used have come up as major issues. More demonstration projects /works using JGT are needed, which in the long run would convince the users, ultimately increase the demand.

Representatives of Pakistan Jute Mills Association (PJMA) expressed keenness in exploring and convincing the Govt. / related agencies for application of JGT especially in the control of hill slope erosion in different hilly areas of Pakistan and assured of PJMA’s support to the development of JGT sector.
Technical Session IV

Theme: Market and Marketability of Jute Geotextile vis-à-vis Aspect of Production

Chairman: Mr. Quamrul Islam Siddique, President, Water Partnership, LGED-RDEC, former Secretary and Honorary Adviser to LGED, Govt. of Bangladesh.

9. Title of the paper:
Market and Marketability of Jute Geotextile

Presented by:
Mr. Vinay Chand, Vinay Chand Associates, 230 Finchley Road, London, UK

An overview and some statistics of the global market for geotextiles were provided in the presentation. It was mentioned that the rate of growth of JGT has been consistently around 3% per annum. Though there has been sizable increase in the share of natural fibre geotextile from 3-15%, but market of jute geotextiles has not grown as expected. This is mainly due to poor market promotion, lack of product development and more importantly poor distribution mechanism. Development of market oriented JGT product for specific applications where jute may be suitable may advance this sector in the right direction with adequate support by the decision makers. The paper also cited the example of development of coir geotextile market.

10. Title of the paper:
Market and Marketability of Jute Geotextile – Need for Diversifying Production

Presented by:
Mr. D. C. Baheti, Chairman, Indian Jute Industries' Research Association (IJIRA), Kolkata, India
The author assured that the jute industry is capable of producing right types of JGT of any width and length according to demand and required specification. Jute industry is also ready for its expansion and modification, if needed. That market demand of JGT has not expanded as expected due to lack of adequate R&D, technical parameters, market support especially from the developed countries was focused in the presentation. With assured market and the support of the government it is possible to take care of any kind of problem in the supply chain of the product. It is essential to come out quickly with technically compatible JGT products which can be suitably used in specific areas with the help/assistance and support from all stakeholders, national and international agencies.

Industry needs a growing market and believes that JGT has a market poised with tremendous growth potential. The Indian jute industry is looking for new products and do not want to be dependent on traditional products like sacking/packaging but undoubtedly there is still high demand for these products particularly rot-resistant sand bags, which are also used for erosion control esp. in flood situations and help the environment.

11. Title of the paper:
Marketability of Jute Geotextile vis-à-vis Aspects of Production

Presented by:
Mr. Mahmudul Huq, Deputy Managing Director, Janata Jute Mills Ltd, Dhaka, Bangladesh

The experience of manufacturing and marketing of JGT in the international arena and the issues that came up in the process were covered in the paper. All technical issues related to manufacturing could be solved by the industry without difficulty. There lies no technical problem in manufacturing JGT of any width, rather it is a handling
issue. The author assured that production of JGT would pose no problem, but specifications of JGT should be clearly laid down. Quality control and assurance of JGT should be effectively exercised to enhance market and maintain steady demand of JGT.

Discussions:

There is serious concern of river bank erosion both in India and Bangladesh. Discussions revealed huge potential of JGT in controlling the said erosion depending upon how the Geo-technical engineers come up with solutions by appropriate use of right kind of JGT.

As positive indication of cost benefit of using JGT, saving of INR 3-4 lakh per kilometer of 3.75 m wide rural road, calculated by CRRI was mentioned.

Suggestions for conducting a few models /pilot study in different agro-climatic locations with varying soil conditions to demonstrate the performance of JGT were made. Need for designing of application specific JGTs was reiterated.
Technical Session V

Theme: Standardization of Jute Geotextile & Its Applications and Related Regulatory Issues

Chairman: Mr. Amitava Ghosal, Vice-President, Stup Consultants (P) Ltd, Kolkata, India

12. Title of the paper:

Standardisation of Jute Geotextiles: Their Applications and related Regulatory Issues

Presented by:

Prof. Dr. R.J. Rickson, Chair in Soil Erosion and Conservation, National Soil Resources Institute (NSRI), Cranfield University, Bedfordshire, UK

The presentation focused the effectiveness of JGT, issues of standardization, regulatory issues, the compliances required from the industry along with recommendations for ultimate market development and expansion. The author mentioned JGT to be technically suitable especially in the fields of soil erosion control and vegetation management and having high potential in stabilization of rural earth roads. The author specifically focused on different aspects of standardization and referred to various international standards. Some reasons for lack of due market share of JGT despite its all socio-economic advantages were identified in the paper. She said that the specifications of JGT should be application-specific and relevant to the performance/functional requirement. A few reasons for future increase in the use of JGT especially in USA and European countries e.g. legislation for mandatory erosion control plan; heavy rainfall, frequent flood incidences due to climate change; concept of eco-technology like green solution; etc. were indicated in the paper. JGT should be improved to overcome the barriers like irregular supply and pollution related issues.
against its adoption in the global market. Most importantly there should be standards for JGT and proper representation of the natural fibre bodies in setting appropriate standards for JGT to safeguard its interest should be ensured.

13. Title of the paper:

_Application of Jute Fibres in Foundation Beds_

Presented by:

**Dr. Satyendra Mittal**, Associate Professor, Indian Institute of Technology (IIT) Roorkee, India

The presentation was based on an experimental study conducted with the application of jute fibres in improving load bearing capacity of soil. The paper contained experimental details, methodology and results with clear evidence that JGT is capable of increasing the load bearing capacity of soil significantly. The author stated that to exploit the potential of jute fibre optimally in enhancing the bearing capacity of foundation and standardization more in-depth studies with different types of soil and JGT are required. He recommended development of working models, conducting of Awareness Programmes and introduction of “on-line jute helpline” for promotion of JGT.

14. Title of the paper:

_Potential of Jute Geotextiles, its Application and Need for Standards and Regulation_

Presented by:

**Mr. Quamrul Islam Siddique**, President, Water Partnership, Former Secretary and Honorary Adviser to LGED, Dhaka, Bangladesh

The author mentioned briefly some case studies conducted with JGT in India & Bangladesh. In mentioning the huge potential of JGT in the
field of soil erosion control and rural road stabilization in Bangladesh. He referred to the enormous size of rivers, river banks/network and an extensive rural road links of the country. More awareness about the JGT products needs to be created among the people, agencies and organizations responsible for these works especially those in the government. He stressed on formulating specifications, design methodology, standards of JGT for specific applications with the concerted efforts of the concerned people of India and Bangladesh through a suitable project.

Discussions:

From the discussions it emerged that two most important issues that ensure sustainability of any new product are quality control and appropriate standards, without which no new product can earn confidence of the ultimate users.

The reduction of surface runoff velocity that can be achieved by the 3-dimensional character of JGT structure can never be achieved by geosynthetics.

A range of values may be used in determining specifications to reflect the natural inherent variability of the product and has to be addressed by the industry.

Four different types of JGT i.e. 292gsm, 500gsm, 730gsm and 1000gsm are currently available in the market. It would be an additional bonus to be able to promote and market JGT as an organic product.
Chairman: Mr. Sudripta Roy, Secretary General, IJSG

The Chairman opened the concluding session briefly highlighting the key points and issues that came up from the presentations of the two-day workshop. Referring to the success stories of the case studies presented in the workshop he remarked that there are also some failure stories. He touched upon the technical and commercial aspects in respect of the potential and prospect of Jute Geotextiles along with the issues/questions that have been raised.

He mentioned that there are already a lot of information from the earlier studies and projects. This workshop is mainly to see what is still missing in convincing the users for using JGTs particularly in soil erosion control and rural road construction. He referred to the Jute Technology Missions of the Govt. of India as regards increasing productivity through modernization of the industry, regularization of work forces, etc. to achieve the primary objective of cost effectiveness of the product.

With precise summary on each of the presentations the Chairman invited discussion from the floor. A good number of queries mostly on technical aspects and also on regulatory, supply and marketing issues came up from interactive discussions that continued for about 2 hours.

He concluded the workshop by expressing hope that this two-day workshop had been a great learning experience with fruitful interactions/ thought exchanges for all the participants and would definitely benefit the jute sector. The major issues that have arisen from the discussions in the session are as follows:

Issued Discussed:

- Issues of different technical aspects/performances e.g. increased CBR values
• Issue of biodegradability of JGT
• R&D requirement for other uses of JGTs
• Quality control & manufacturing issue
• Guidelines / specifications for rural road construction and erosion control
• Testing methods/ facilities for different variety of JGT for specific applications
• Identifying the bottlenecks of industries
• The nature of technical support needed by the industry for further development.
• Measures to combat competition with other natural products
• Cost effectiveness of JGT
• Availability of raw material
• Change/ modification of existing machinery
• Involving private end user agencies e.g. mining agencies etc. in field testing.
• Involvement of community, Self Help Groups, NGOs, environmental groups/activists
• Preparation of Standards with the involvement of Government bodies
• Present Government policies
• Strategy for marketing of JGT
• Data regarding amount of JGT that is currently being used, and the amount of JGT that has actual potential for being used
• Interaction between regulatory bodies, industry, researchers and end users.
IMPORTANT OBSERVATION AND RECOMMENDATIONS / SUGGESTIONS

The decisions/recommendations emerged from the discussions and interactions among the stakeholders/participants after each of the Technical Sessions and also in the Concluding Session of the workshop are summarized below:

➢ Information on market demand for generation of market database.

➢ Specific types of JGTs were found to have effectively controlled soil erosion, mitigated land slides, stabilized mine spoils and successfully improved performance /durability of roads.

➢ A full scale detailed study is necessary to obtain important different parameters, answers/solutions to a number of technical questions and determine performance criteria of different JGTs in different specific applications.

➢ Identification of potentially effective types of JGT for rural road construction and soil erosion control is essential.

➢ Cost-competitiveness of JGT is important for marketing of JGT.

➢ Cost effectiveness of JGT indicated by CRRI needs to be established with cost-benefit analysis /matrix vis-à-vis other products.

➢ Application-specific and site-specific design JGTs and methodologies should be developed.
Formulation of specifications and technical parameters of JGTs for each specific application.

Need to pursue further technological interventions through appropriate R&D activities for production of a wider variety of new JGT products.

For JGTs – the test methods may be the same as that of geo-synthetics but the interpretation of the results should be different. Consequently separate design methodologies are to be developed for JGT.

Proper selection of jute batch for specific applications is needed.

User friendly manual on JGT may enhance the JGT application.

Awareness programmes should be conducted to improve perception of the possible users.

Comparative Environmental Impact Assessment for constructions with JGT should be carried out.

Regular interaction with the users, suppliers, manufacturers, researchers is essential.

Policy support from the national govts., different govt. bodies and industry.

Problems and obstacles in the supply chain, if any, should be identified and removed.
Guidelines and Specifications required for rural road construction and erosion control considering various field conditions (to be obtained from concerned Government bodies like PWD, Dept. of Soil Conservation, Water Development Board, Irrigation & Flood Control etc.)

Representation from the jute industry/researchers/experts in the different international Standard Committees is vital.

Need for intervention at the design stage of standards in the international standard committees by natural fibre bodies like IJSG in setting standards that do not act as barrier for other viable alternative products like JGTs.

Good practices to be shared among the interested agencies/bodies/govts./countries.

Based on the fundamental properties of jute, new innovative applications of JGT to be explored /identified through more lab studies and field applications.

More projects/models/pilot study in different agro-climatic locations with varying soil conditions are needed to demonstrate the performance of JGT in order to convince the users, thereby increase the demand ultimately.

Quality control and appropriate standards were identified as the two most important elements that ensure sustainability of any new product without which no new product can earn confidence of the ultimate users.
Aggressive marketing effort with appropriate market strategy is required.

Successful use of JGT would assure bulk demand of raw jute and would be helpful for the jute growers.

As the demand driven nature of the future JGT project has been established, the project needs to be pursued and implemented for the benefit of all concerned and growth of the sector.
Jute Geotextiles – Potential and applications In Road Works

Sudhir Mathur* Dr. P. K. Nanda** U. K. Guru Vittal***

ABSTRACT

The performance of Road Pavements is influenced to a large extent by the sub-grade soil strength and its drainage characteristics. Hill roads are further subjected to failure due to instability of slopes adjoining the road or below the road alignment. For improving the performance of sub-grade soil as well as to stabilize the hill slopes, a variety of geosynthetic materials are available. The majority of geosynthetics covering a wide range of woven and non-woven geotextiles, geogrids, etc. are made of polymeric materials derived from petroleum. These materials are not biodegradable and may create environmental problems in the long run. In this regard, as a replacement to synthetic products, geotextiles made from natural product like ‘Jute’ assume significance.

After intensive study and applications, it is now fairly established that the biodegradable nature of jute is an ecofriendly virtue rather than a deficiency for application of jute products in geotechnical engineering. The availability of jute in India in abundant quantity gives the natural jute fibre-based geotextiles an advantage in terms of cost. However, for Jute Geotextiles (JGT) to play an effective role, it is essential to design and develop specific fabric geometry to suit a geotechnical application so that the geotextile can perform particular functions like separation, filtration, drainage and erosion control. Several field application projects involving use of JGT were taken up under CRRI guidance.

This paper brings out salient aspects of field studies conducted by CRRI to promote the use of jute based geotextiles in road works.

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*** Scientist
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INTRODUCTION

The Central Road Research Institute (CRRI) has taken up many R&D projects in the area of geotextiles since early 1980s. Laboratory studies on the physical and engineering properties of different varieties of geotextiles as well as field studies involving use of geotextiles for construction of demonstration road projects have been carried out by the Institute. Jute is a low cost, biodegradable and eco-friendly natural product, which can be used for producing many types of geotextiles. With growing awareness about preserving the environment against ill effects of using synthetic (polymeric) materials, the use of jute-based geotextiles in road works is gaining importance. India is a very large producer of jute; the availability of jute in India in abundant quantity thus gives the jute fibre-based fabrics, an advantage in terms of cost. Jute is a lignocellulosic natural fibre and it is biodegradable. There are various applications where the degradation of fabric does not hinder its usage. The present paper brings out the high lights of the projects conducted to promote the use of jute-based geotextiles in road works. With the growing awareness about ecology around the world, it is worthwhile to develop jute geotextiles for specified end-uses as these products have a large growth potential.

APPLICATIONS OF GEOTEXTILES

The use of geotextiles in various civil engineering works has been increasing worldwide at a rapid rate. The primary function of geotextiles is separation, reinforcement, filtration and drainage. Within these functions, a wide range of applications of geotextiles in geotechnical, highway and environmental activities have arisen and have been experimented in the field, as well as documented in literature. Jute geotextiles also perform similar functions, which a synthetic geotextile does in a road structure.

FIELD DEMONSTRATION OF PROJECTS USING JUTE GEOTEXTILES

To promote use of jute geotextiles in civil engineering applications, a series of field experiments were carried out using jute geotextiles for different
functions. Applications of jute geotextiles for different functions at various locations are described in the following sections.

**Jute Geotextiles as Separator for Improving Pavement Performance at Kandla Port**

In Kandla port area, authorities were facing the problem of road construction on soft soil. The performance of pavements constructed on soft soils can be improved using jute geotextiles. The fabric when used as separator prevents the penetration of subgrade material into voids of granular base course. The permeability characteristics of the fabric also aids in faster dissipation of pore pressures and ensures better drainage which result in long term better performance of the pavement. Provision of fabric reduces rutting and subgrade can develop its full bearing capacity. When the authorities decided to improve the road network in Kandla port trust area, it was proposed to use jute geotextile as a separator between subgrade and sub-base layer. The properties of jute geotextile used at Kandla port road project are given in Table 1.

**Table - 1 Properties of Jute Geotextile used as a separator at Kandla Port**

<table>
<thead>
<tr>
<th>Description of Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Non Woven</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>2.81 kN/m</td>
</tr>
<tr>
<td>Thickness</td>
<td>6.91 mm</td>
</tr>
<tr>
<td>CBR push through load</td>
<td>0.5 kN</td>
</tr>
<tr>
<td>Index puncture resistance</td>
<td>0.077 kN</td>
</tr>
<tr>
<td>Inplane permeability</td>
<td>$9.2 \times 10^4$ m/s</td>
</tr>
<tr>
<td>Falling cone test</td>
<td>No clear hole formed</td>
</tr>
<tr>
<td>Failure strain</td>
<td>30 Per cent</td>
</tr>
</tbody>
</table>
The Table 1 shows that the fabric has low tensile strength but fails at a large strain of the order of 30 per cent. Particularly in falling cone test, no clear depression or punching was observed under the fall of the cone indicating the resistance of fabric for puncturing due to aggregate or the material used in sub-base layers. The jute geotextile provided restraint, acted as reinforcement and prevented localised bearing capacity failures, which resulted from individual stones being forced into the subgrade. Before undertaking laying of jute geotextile, the site was cleaned properly. Subgrade was rolled to achieve specified degree of compaction and its surface was smoothened. Jute geotextile was spread over the compacted subgrade followed by the sub-base course and WBM layers. The engineers of Kandla port trust monitored the completed section for its performance in terms of rut depth and other visible signs of distress. Results of the settlements recorded from February 1997 to May 1997 sent by Kandla Port Trust, shows almost negligible settlements after six months and no signs of distress in the treated test section. This encouraging result prompted Kandla Port Trust to purchase another consignment of jute geotextiles, which were used for road and embankment construction in creek area in Kandla port.

**Jute Geotextiles as Reinforcement at Kakinada Port**

A deep-water port was constructed at Kakinada in Andhra Pradesh and within the port area a road network was developed for transporting cargo from the ships to the storage godowns. The subsoil in these areas was soft silty clay and the water table was at 0.5 m below the ground level. Roads constructed earlier had faced many problems during and after construction such as subsidence of the fill during construction, excessive post-construction settlements and lateral spreading of fill material. On the basis of settlement calculations, it was estimated that as much as 30 per cent of the fill would sink into the soft subsoil during spreading of the fill itself, necessitating additional quantities of costly granular fill material, thereby, pushing up the cost of construction.
In order to mitigate the above problems, various alternatives were examined. The use of geotextiles to improve embankments over soft subsoil is an effective and well-tried method for reinforced soil construction. Geotextiles can be used to improve i) the embankment stability against bearing capacity failure, ii) stability against deep seated slope failure, iii) to allow construction over very soft or difficult foundation soils and ensure uniform settlement of the embankment iv) and also to act as separator between the embankment fill material and soft sub-soil. To some extent they also perform as drainage blanket for draining pore water during consolidation. Reinforcement in an embankment on soft soil is very effective when placed at or close to the foundation surface. It was found that without reinforcement, the factor of safety for the road embankment would be marginally less than unity. By providing jute geotextile of strength 15 kN/m, the factor of safety would increase to about 1.5. Even though jute geotextile is biodegradable, keeping in view, increase in factor of safety of the embankment, as the strength of the foundation sub-soil improves due to consolidation and the foundation soil attains the required strength, the use of jute geotextile was adopted. The reinforcement effect of jute geotextile would be needed only to improve the stability during construction and in the consolidation phase during which the sub-soil attains the required strength. The geotextile along with the sand cushion would also act as a drainage layer for the escape of the pore water during consolidation.

A woven jute geotextile with properties given in Table 2 was used for reinforcement and also as a separator between the embankment and the soft subsoil. From the experiment it was found that the required strength of the subsoil developed within the short life of jute geotextile (about two years after which it biodegrades) and it is economical as well as safe to use geotextile in such projects. Monitoring of completed embankment (both jute geotextile treated and control stretch without jute geotextile) carried out by JNTU College of Engineering; Kakinada showed very good performance of jute treated embankment sections vis-a-vis untreated sections. Photo 1 and 2 shows laying of jute geotextile.
Table - 2 Properties of woven jute geotextiles used at Kakinada Port

<table>
<thead>
<tr>
<th>Property</th>
<th>Test value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness</td>
<td>3 mm</td>
</tr>
<tr>
<td>Weight</td>
<td>750 gsm</td>
</tr>
<tr>
<td>Tensile strength</td>
<td>15 kN/m</td>
</tr>
<tr>
<td>Elongation</td>
<td>10 per cent</td>
</tr>
<tr>
<td>Puncture resistance</td>
<td>350 N</td>
</tr>
<tr>
<td>Overlap length</td>
<td>300 mm</td>
</tr>
</tbody>
</table>

Jute Geotextile as Drainage Filter at Hanuman Setu, New Delhi

In case of reinforced embankments constructed using fly ash as fill material, the drainage aspects of the fill material is of critical importance during construction period because of high permeability of fly ash. Additionally filter criteria for Road Over Bridges like Hanuman Setu becomes critical during the construction, as the water percolation into the back fill is more during construction particularly in monsoon season. After completion of ROB, the percolation of water would be negligible due to impermeable black topping. Thus, the filter requirement was more during construction phase, i.e., for a limited time period. In such cases, jute geotextile as filter can be effectively and economically used along with reduced thickness of conventional filter, which will be sufficient after the construction is over. A non-woven jute geotextile satisfying the filter criteria was used in this project. Before laying
jute geotextile filter, fly ash was compacted in layers of 20 cm thickness up to the edge of the facing panel. Once the height reached up to the next geogrid level, trench of width 0.6 m was excavated in the compacted fly ash. Jute geotextile was cut to the required size and placed vertically in the trench. Sand and coarse aggregates were filled in the trench and compacted. When the construction of reinforced embankment was nearing completion and black topping was yet to be laid, rainfall of moderate intensity occurred at site. From the visual inspection after the rainfall, it was found that jute geotextile retained the fine fly-ash particles effectively and water drained through the jute geotextile.

Jute Geotextile for Drainage and Filtration application on Joshimath- Mallari Road

A stretch of Joshimath-Mallari Road in Uttarakhand state was prone to subsidence and sinking for the last many years. This stretch was located on debris slide area and debris consisted of micaceous sandy silt. During field visit, a number of seepage points were also observed on the uphill as well as downhill slopes. The road was experiencing subsidence during the monsoon every year, leading to damages to the restraining structures and road pavement. Breast walls constructed earlier had got damaged due to slip. During rainy season, the pavement experienced continuous gradual subsidence at many locations in the stretch.

As a measure to arrest the sinking of road pavement, a systematic network of roadside trench drains and cross trench drains were proposed using non-woven jute geotextiles (Photo 3 and 4). Conventional roadside trench drains consists of a shallow trench filled with graded aggregate filter material with or without a perforated pipe. Construction of such drains was difficult due to non availability of suitable filter materials. Such drains even if constructed may loose their efficiency due to clogging, as the fine materials enter the aggregate filter filling the voids. Hence to retain the soil particles, trench drains made of rubbles encapsulated in non woven jute geotextiles were adopted.
For construction of road side and cross trench drains, about 1000 sq
m of non woven jute fabric having 750 gsm was used. This technique was
implemented for about 100 m length of the road in June 1996. The monitoring of
field experiments on this particular stretch of treated road carried out in June
1997 showed encouraging and satisfactory results. There has been no further
sinking and subsidences of the road at this location.

![Photo - 3: Road Side Trench Drain](image)

![Photo - 4: Cross Trench Drain](image)

**Jute Geogrid for Erosion Control of Denuded Slopes**

Field studies by CRRI have shown shallow surficial slides constitute a
significant proportion of landslides in areas with moderate rainfall intensity
and where soil cover is medium cohesive in nature. Most surficial landslides
occur as a result of denudation of vegetation on soil slopes consequent upon
a cut being made for road construction purposes. Denudation of vegetation does
occur due to landslides, both surficial as well as deep-seated. Surficial slides
extend to only a couple of meters below the slope surface and originate as a
result of erosion from flowing water. If erosion is allowed to proceed unchecked,
there is the possibility that the damage may spread laterally or the depth of
erosion may increase, eventually resulting in a much larger damaged slope
area. Vegetative turfing represents one of the most important corrective measures
in either case. In the case of freshly exposed cutting made for road construction,
vegetative turfing is important, even as a preventive measure. Vegetative
turfing has proved to be, by and large, the most economical and simple means
of protecting slopes of hills and embankments against erosion. Based on
several field trials carried out by the Institute (Table 3) a technique has been
developed for treatment of erodible slopes as a part of landslide correction
works.
Table - 3 Field experiments on erosion control using jute geotextiles

<table>
<thead>
<tr>
<th>Project site</th>
<th>Application</th>
<th>Specification of jute geotextile</th>
<th>Quantity used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Satun, Ponta Sahib on SH-1 in Himachal Pradesh</td>
<td>Erosion control by growth of vegetation</td>
<td>Jute netting 2 cm x 2 cm grids</td>
<td>2000 sqm</td>
</tr>
<tr>
<td>Kaliasaur slide near Srinagar, Uttarakhand</td>
<td>Arrest debris flow and growth of vegetation</td>
<td>Jute netting 2 cm x 2 cm grids</td>
<td>1000 sqm</td>
</tr>
</tbody>
</table>

In the field trials, for installing the jute grids, the slopes were initially demarcated, graded and fertilised. The levelling of the area must ensure that when netting is laid, it would cover the entire area flush to the ground permitting water to flow over the jute netting. First a dose of seed broad casting of locally available perennial grasses is done. Thereafter, jute netting of specified 1.25 cm to 2.50 cm openings size and having roll width of 1.0 m to 1.25 m is laid on the prepared slope surface firmly in the direction of water flow. The sides of the netting are secured against displacement by an overlapping of 5 cm to 8 cm and stitched or pegged down with 15 cm long steel nails about 1.0 m apart. The top and bottom ends of the fully stretched jute netting are fixed/anchored in trenches of 30 cm depth. Afterwards, another dose of seed broadcasting and dibbling of locally available grasses 15 to 20 cm apart, row to row is carried out.

The jute net provides innumerable miniature check dams thus absorbing the impact and kinetic energy of the falling rain drops and surface runoff, thereby, reducing its erosion potential. The soil, seed, grass root slips are kept in situ without being dislodged, thereby, getting full benefit of moisture. Jute has maximum absorption capacity of about 400 per cent of its dry weight as compared to about 175 per cent for sisal and 150 per cent for coir. After the first rainy season, vegetation envelops the entire surface thus protecting the slopes permanently. Jute geogrid have been observed to have a life of about 2 to 3 years in the field, which is sufficient for promoting the growth of
vegetative cover over the denuded slope. At the end of jute geogrid’s life, the geogrid decomposes and in the process adds nutrients to the soil. Thus, by providing jute netting, not only the erosion of the slope would be checked due to vegetation growth, but also the possibility of shallow failure averted, due to the strengthening of the top 0.5m of the hill slope.

**Use of Jute Geotextile for PMGSY Road Construction**

This project is presently being implemented by Ministry of Rural Development/NRRDA in association with Jute Manufactures Development Council (JMDC). CRRI has been appointed as Technical Consultant for this project. State Rural Roads Development Agencies in five states - Assam, West Bengal, Orissa, Madhya Pradesh and Chattisgarh have been entrusted the responsibility of constructing these demonstration roads. Under this project 10 roads (two roads in each state) are being constructed using jute geotextile to study its efficacy for drainage, erosion control, capillary cut-off and subgrade improvement. The pavement design incorporating jute geotextiles were earlier carried out by CRRI and ‘Detailed Project Report’ for each of the roads was prepared. Awareness cum Training workshops were held in all the five participating states to impart knowledge about jute geotextiles, their usage, advantages and other related aspects to the engineers from implementing agencies (state rural road construction agencies) jointly by Jute Manufacturers Development Council and CRRI. During construction phase, random quality monitoring of construction work is being carried out by CRRI scientists in these demonstration road projects apart from guiding state engineers on technical aspects. The construction work is nearing completion in some of the roads, after which their performance would be monitored by CRRI for 18 months. Some of the typical proposed pavement cross sections incorporating jute geotextile and photos of construction work are given in Fig 1 and Photos 5 & 6 respectively.
Field experiments carried out at various places in India, have shown that jute geotextiles play an effective role for various applications in highway engineering. Jute geotextiles in their present form are suitable for separation, filtration, drainage and reinforcement functions. The biodegradable nature of
jute netting has a distinct advantage over other synthetic grids used for the control of soil erosion. However, there is need to develop specifications of fabrics to suit geotechnical applications in different areas. Sustained efforts are required for dissemination of technology and also to continue efforts to explore new areas.

ACKNOWLEDGEMENTS

Authors are grateful to colleagues in CRRI for providing details of various demonstration projects carried out in CRRI. The paper is being published with the kind permission of Director, CRRI.
Application of Jute Geotextile on Rural Roads of Bangladesh for Slope Protection

Dr. Zahid Hossain Prodhan

ABSTRACT

The study is about the use of Jute Geotextile in slope protection work on Pakulla-Lauhati Road of Delduar Upazilla, under the District of Tangail about 80 km north of Dhaka, Bangladesh. The project has been designed by the author and implemented by Bangladesh Jute Research Institute (BJRI) and Local Govt. Engineering Department (LGED). The then Ministry of Jute and European Commission (EC) funded the project.

The study highlights the importance and advantage of chemically treated jute making it 'Design-Biodegradable' for use in different development projects. While elaborating different uses of locally available jute the study also indicates various treatment procedures as may be needed in appropriate situations. Embankment designs along with expenditure estimates have also been provided.

Member – IGS, IECA
Managing Director – Arcadia Property Development Ltd. (APDL)
House # 4, Road # 4
Dhanmondi R/A
Dhaka 7205
Significance

Jute Geotextiles provide indigenous, available technologies which have got enough potentiality for improvement of rural roads. This technology has already been scrutinized by a model study implemented by Arcadia Property Development Ltd. (APDL) and Bangladesh Jute Research Institute (BJRI) in BJRI premises. Rural unemployed and unskilled labour can be utilized for application of this technology. Normally Jute fibre gets swelled and degraded within six months in water and is less durable in acidic, alkaline and other solutions. Quick bio-degradability of Jute fibre is the main disadvantage for using Jute as raw material for Jute Geotextile. By different modifications, Jute yarns are converted into specified design-fabric without changing its environment-friendly character.

Objective

The main objectives of the project were –

➢ Optimization of Jute Geotextiles as stabilizer for rural roads.
➢ Technical feasibility study of Jute Geotextiles use in large scale.
➢ Marketing of Jute Geotextiles.
➢ Employment Generation.
➢ Transfer of Technology.

Advantage of Jute Geotextile

Jute Geotextile is much cheaper than synthetic geotextile. It is easy to blend with other fibres. Geotextile is environment-friendly, biodegradable and locally available. Initially it possesses high strength. It is also a renewable source of energy as a natural biomass.
Treatment Procedure

Normally untreated Jute fibre is swelled and degraded within six months in water. So some chemical treatment was necessary to increase its life span upto 5 -10 years.

Rot-proofing Treatment

Sodium Carbonate and Sulphate of Copper is mixed with water and sprayed manually over jute fabrics. The treated fabrics were dried in sun light at NTP.

Treatment with bitumen emulsion of specific density

Carbon black was prepared with required quantity of volatile oil and then bitumen emulsion was added with paste and stirred. After making a homogeneous mix, the emulsion was smeared on the modified hessian cloth by brush manually and dried in sunlight in an open area at NTP.

Treatment with silicate of specific viscosity

Silicate solution was prepared by adding hot water and stirred according to need and then used on the modified bitumen-treated samples manually and dried at NTP.

Treatment with Ca-base grease composite

Ca-base grease was added with required amount of carbon black and a paste prepared by adding volatile oil. The composite paste was then rubbed haphazardly by hand on the modified hessian cloth and completed the rubbing by brush. After rubbing a small amount of carbon black it was sprayed over the located area or the entire sample and then again rubbed by brush.

Preparation of horizontal drain

The whole portion of the drain prepared by hessian cloth was treated with a bitumen emulsion composition. The located area i.e. the middle portion of the sample was smeared with the grease composition and dried in open air at
NTP. Coarse Sand (FM>2.5) was used as the filter material.

**Preparation of vertical drain**

Lightweight Hessian cloth was coated with the grease composition and dried in open air at NTP.

**Placement of Jute Geotextile**

At first existing embankment was cut up to the design level. Levelling, dressing and manual compaction was done up to the specified level. Jute Geotextile was placed layer by layer as per approved design. Depth of each layer was limited to 500 mm. Horizontal and vertical drains were constructed simultaneously.

At our project road, four types of treated Jute Geotextile were used. In the first section we used untreated fabric, in the second section only rot-treated fabric, the third was bituminous emulsion treated while in the last section grease-treated fabric was used.

We will observe that what type of fabrics is the most suitable for such type of project. The project will be monitored up to three years. It seems that Jute Geotextile is very useful in slope protection. In our project Jute fabrics were kept exposed but its durability can be increased by using of CC block or brick block over them.

**CONCLUSIONS**

Using of Jute Geotextile to increase stability of road is a very useful technique. Synthetic Geotextile is very costly and it requires foreign currency to import it. As Bangladesh is a flood-prone region we have to spend a lot to keep our rural roads in working condition. We could use Jute Geotextiles to keep our communication network functional throughout the year.
Annexure - 1

Design of Embankment of Saula Kria Gram Pakulla La unhai Road Using Jute Geotextile At Tangail

Horizontal Drain (Detail -B) — Jute Geotextile

Vertical Drain (Detail -B)

PLAN

Drawing Title
PLAN

Designed By: DR. ZAHID HOSSAIN PROCHOY

Engineer: Md. Mustafizuzzaman

Drawn By: SALMA

CONSULTANT: ARCADIA PROPERTY DEV. LTD.
House # 4, Road # 4, Dhanmondi, Dhaka.

Sheet No.: 01

Annexures

1. Design & Specification Annexure - 1
2. Statement of Expenditure Annexure - 2
Annexure – I (Contd.)

Design of Embankment of Saula Kria Gram
Pakulia Lauhati Road Using Jute Geotextile
At Tangail

SECTION: (A-A)

Designed By: OR. Z M D  H G S
Drawn By: SALMA
CONSULTANT: ARCADIA PROPERTY DEV. LTD.
House #4, Road #4,
Dharmodd, Thaka.

SHEET NO.- 02
Annexure – II

Actual expenditure for chemical treatment of Geo-jute for field testing in Pakulla-Lawhati road under Delduar upazila in Tangail, Bangladesh.

1. Material: Jute geotextile supplied by the ABC unit of Adamjee Jute Mills Ltd.

<table>
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<th>[A]</th>
<th>Chemicals</th>
<th>Unit Price</th>
<th>Amount (Tk/kg)</th>
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<td>i)</td>
<td>Bitumen emulsion</td>
<td>25/-</td>
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<td>20000.00</td>
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<td>Silicate of Specific density</td>
<td>12/-</td>
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<td>iii)</td>
<td>Grease (Na-base)</td>
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<td>v)</td>
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<td>10.00</td>
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<td>vi)</td>
<td>Sulphate of copper</td>
<td>60/-</td>
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<td>vii)</td>
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<td>viii)</td>
<td>Na-Carbonate</td>
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<td>Labour (for Treatment)</td>
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<td>Carrying cost of Jute Geotextile from Adamjee Jute mills to treatment place</td>
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<td>[E]</td>
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<td>Monitoring (on going 3 yrs)</td>
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<td>[H]</td>
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Grand Total One Lac Seventy Two Thousand Eight Hundred Taka Only 172800.00
Eco-Rehabilitation of Himalayan Hill Slopes, Affected Mine Spoils and Landslides Using Jute Geotextile – Case Study

G. P. Jual* & V. N. Sharda**

ABSTRACT

The environmental security of the Himalayan region, already an ecologically fragile system, has been further threatened by large scale road construction, mining and other developmental activities causing massive land degradation, soil erosion, landslides / slips etc. on the hill slopes. Revegetation of such highly degraded slopes by conventional methods is not feasible due to constraints of low fertility status, steep slopes, high rainfall etc. Hence, special bio-engineering techniques are called for to rehabilitate these lands. Jute Geotextile (JGT) along with other requisite soil conservation measures has been used to rehabilitate few degraded sites damaged by mining activity and landslides located in mid-Himalayan region of Uttarkhand and Himachal Pradesh states. The special feature of the programme was that it was implemented in a participatory mode with stakeholders (farmers / mine owners) through their active involvement.

Open Weave JGT (soil saver) of 500 gsm (end x picks = 6.4 x 4.5 dm) was used and planted with useful grasses, hardy soil conservation species and horticultural plants as per site specificities and preferences of farmers. Need-based minor soil conservation measures were also undertaken for moisture conservation and runoff control.

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In the area treated with JGT, there was good establishment of vegetation within a period of about 3 years as compared to control. The soil erosion was checked drastically and moisture conservation through JGT was to the tune of 40%. The cost of application of JGT including minor soil conservation works was Rs.27 per sqm. As an offsite impact, the untreated area below the treated site was also protected (about 2 times the treated one) and farmers utilized this area for cultivation purposes. Considering the fact that an estimated 25000 ha of land is under different mines and nearly 44,000 km of hill roads have been constructed in the Himalayas, JGT has good potential for rehabilitation of landslides and minespoils. The possible users could be PWD, mining companies, watershed development departments, irrigation & power department, farmers etc. However, there is a need for awareness and training of user- agencies for proper application and easy availability of JGT at an affordable price.
Prospective Applications of Jute Geotextiles

Tapobrata Sanyal

ABSTRACT

Versatility and distinctive physical characteristics of jute fibres coupled with its high spinnability, make it an ideal material for new technical applications beyond the existing conventional end-uses. The conventional end-uses of Jute Geotextiles (JGT) in the areas of slope stabilization, surficial soil erosion control, strengthening of road sub-grades and protection of river and canal banks have yielded satisfactory results in quite a few field trials carried out in India. Standardization in use of different varieties of JGT in the aforesaid end-uses is under way.

Application of the appropriate JGT in other geo-environmental and geotechnical end-uses should be concurrently thought of considering the distinctive features of jute fibres to widen its market base.

The author feels that standardization of the prospective applications of JGT will pave the way for larger acceptability of JGT. At the same time there should be no relenting of efforts to continue study and research in the field for improvement of production and ensuring quality of products for a sustainable customer-base.
INTRODUCTION

Versatility and distinctive physical characteristics of jute fibres coupled with its high spinnability make it an ideal material for new technical applications beyond the existing conventional end-uses. Tailor-made technical textiles can be made out of its fibres/yarns a feature that can hardly be matched by any other natural fibre. Principal application of Jute Geotextiles (JGT) is in the sector of erosion control where its efficacy stands established. Biodegradability of jute and, for that matter, of other natural fibres such as coir is a distinct advantage from environmental considerations. But coir is deficient to jute in so far as spinnability is concerned. In view of the renewed global emphasis on adoption of bio-engineering measures especially to address geotechnical problems, jute-made technical textiles have seemingly bright prospects. At the same time there is need to explore avenues for their use in geo-environmental sector. These are areas where man-made geotextiles have inherent limitations.

In this paper, an attempt has been made to present before the readers the prospective applications of JGT other than its conventional uses.

EXISTING APPLICATIONS OF JGT

So long JGT has been used in the following areas with success:

- slope stabilization
- surficial soil erosion control
- strengthening of road sub-grades and drainage
- protection of river & canal banks

Slope stabilization envisages strengthening a soil body threatened with distress. JGT, when inserted within an embankment in appropriate layers, can prevent rotational slides. As a basal reinforcement, JGT curbs the settlement of an embankment or any fill. The principal cause of lateral
dispersion of any fill, besides its low shear strength, is intrusion of water into
the fill-body. Drainage of water can be facilitated by insertion of the right type
of JGT at appropriate levels within the fill.

*Erosion of top soil* either on a flat ground or on a slope can be effectively
prevented by open weave JGT. Three-dimensional construction of open
weave JGT helps reduce the velocity of surface run-off by interposing
successive micro-barriers to the direction of flow and entrap the soil particles
dissociated by the kinetic energy of rain drops. Bio-degradability of JGT
facilitates growth of vegetation because of conditioning of the ambient
temperature and regulation of humidity to a congenial level effected by it. It
has also been reported that JGT may add micronutrients to the soil on which
it is laid and do not draw upon nitrogenous reserves on bio-degradation.
Moreover JGT-residue is beneficial as it helps enhance the hydraulic
conductivity of soil. The efficacy of JGT in control of surficial soil erosion for
all these reasons is now well established.

 Appropriately designed woven JGT when placed on a *road sub-grade*
enhances its bearing capacity (expressed as CBR %). The phenomenon is
the result of the functions of separation and filtration performed by an
appropriately designed woven JGT laid on the sub-grade. Consolidation of
soil is a protracted process. It is for this reason CBR of a sub-grade keeps
on increasing over a period even after degradation of the jute fabric. This is a
pointer to the fact that JGT and, for that matter, all geotextiles act as a change
agent to the soil helping it to consolidate to its maximum. Normally the range
of enhancement of CBR of a sub-grade treated with JGT is 150% to 300% of
the control value.

Bitumen-treated woven JGT has performed satisfactorily in *controlling erosion
of river and canal banks*. Woven JGT can serve as a better and cost-effective
substitute of the conventional granular filter. Availability of granular aggregates
often poses difficulty, apart from the difficulties encountered in exercising
quality control. A layer of woven JGT treated with a suitable water-repellant
additive may replace the layers of granular aggregates. An armour layer over
the fabric is however necessary to prevent the fabric displacement and its
direct exposure to weather.

Bitumen, however, is not the ideal material for coating JGT as bitumen makes
the fabric rigid and less drapable. Search is on for a better additive that can
retard degradation of JGT even after its continuous exposure to water; but
we may have to rely on bitumen as a water-repellant additive till such time a
more suitable alternative is found and successfully tried. Incidentally bitumen
and jute have excellent thermal compatibility. IIT Kharagpur has been entrusted
with this project by JMDC under Jute Technology Mission, India. We may
have to wait for a period of three years for the result.

PROSPECTIVE APPLICATIONS OF JGT

Considering the physical attributes of jute, it is worth trying JGT in some
form or the other in areas other than what was indicated above. Geo-
environmental applications of JGT should demand priority considering its
eco-concordance. In developing countries the progress so far in this area
has been sluggish. Developed countries are likely to encourage use of natural
bio-degradable products that decompose within its short ecological cycle.
Man-made geotextiles have obvious limitations in this respect.

a) Prospective geo-environmental applications

Prospective application of JGT may be categorized into two groups—geo-
environmental and geo-technical. JGT holds commercial promise under the
first group in the following sectors.

• stabilization of mine-spoils and over-burden dumps (OB dumps)
• management of fly ash (PFA) heaps
• management of solid municipal waste (MSW)
• water-shed management.
Open cast mines are saddled with the problem of *over-burden in stability*. Mine safety is jeopardized as a result of unplanned heaping of O B dumps that may rise up to a height of 50 meters and above with apprehension of sliding/slipping. Mine Safety Regulations are often not followed in private open cast mines. Besides, such unplanned heaping contravenes the national mineral policy of the government that emphasizes adherence to mine safety rules and stabilization of vulnerable bare dumps.

Mine spoils usually consist of coarse aggregates varying in size from 0.2 mm to 50 mm. Hydraulic conductivity being very high, water retention on surface can be ensured by use of thick open weave JGT. Entrapment of particles detached as a result of precipitation can also be effectively achieved due to 3-D structure of thick open weave JGT. Conjunctive use of open weave JGT and vegetation is recommended in stabilizing such dumps. The method was successfully tried in O B dumps under Northern Coalfields at Singrauli and Western Coalfields at Nagpur in India with the advice of the World Bank consultants, I.I.T Kanpur.

Thermal power plants face persistent problems with *PFA heaps*. Only about 15% of PFA out of 100 million tonnes generated in thermal power plants in India are used for diverse applications such as land-filling, brick manufacture. Accumulation of PFA in the precincts of thermal power plants not only poses environmental threats (air and sub-surface pollution), but also intrudes upon the essential free space within the plant along with uncertainties on their stability. A few years back a fly ash bund failed at Kolaghat thermal power plant in West Bengal.

PFA is usually alkaline and therefore should not stand in the way of land-filling and brick-making. It has a lower specific gravity than soil (between 2.15 and 2.18). If no other avenues are found, there remains hardly any option but to use the heaps for landscaping at least to prevent pollution. What is needed is proper planning considering the normal life of a thermal power plant to be 30 years. The quantity of PFA likely to be generated during the
period is to be estimated vis-a-vis the extent of its utilization and open area availability for disposal.

Any way, PFA heaps can be similarly treated with open weave JGT and vegetation as in the case of O B dumps. Additionally a cover of non-woven JGT will prevent air pollution. Both O B dumps and PFA heaps can be developed into pleasing greeneries with the support of JGT. It is however needed to be selective about the species of vegetation. Expert advice in the matter should be sought.

Management of solid municipal waste (MSW) is a neglected sector in developing countries. MSW is a veritable source of pollution. It may contaminate ground water, pollute air and spread diseases. In developed countries daily covers are used over MSW. Non-woven JGT can be conveniently used as daily covers to help dissipation of foul gases and entrapped polluted liquids and to keep air pollution on check. Unfortunately the concept of providing daily cover over MSW heaps has not gained ground in developing countries.

Watershed management has not received the importance it deserves in developing countries. Denudation of ground makes it vulnerable to erosive forces of precipitation and overland flow. Detached soil particles are carried away to the nearest waterway with the run-off and either deposited over the bed of the waterway or transported further to a distance by the flowing stream depending on velocity of flow, weight and plasticity of particles. Any way deposition of sediment is instrumental in reduction of cubature of waterways and consequently their capacity to hold water. This is the main reason of occurrence of floods in this part of the globe. If vegetation can be grown on bare ground, the probability of soil erosion will get substantially reduced. Open weave JGT may be especially effective for growth of vegetation in arid and semi-arid regions because of high water absorbing capacity of jute and its mulching properties.
b) Prospective geotechnical applications

Under the geotechnical category, the following prospective applications are worth trying.

➢ turf-reinforced mat (TRM) with JGT- backing
➢ jute-reinforced asphaltic overlays
➢ jute-reinforced temporary haul roads
➢ fabriforms jute fibre-reinforced concrete

Ready-to-use turf mat with JGT backing can be conveniently used on vulnerable slopes and denuded ground. TRMs are in good demand in the overseas. Cost aspects however deserve consideration.

Bitumen-soaked jute-overlays may be used as riding surface of roads. Presently in India mastic asphalt is being extensively used. Jute-based asphaltic overlays will be cheaper though less durable. Jute and hot bitumen have excellent thermal compatibility. Moreover non-woven JGT is a very good receptor of bitumen. A combination of woven and non-woven JGT smeared with bitumen is expected to work as a resilient, water-proof and abrasion-resistant paving sheet on roads. Such sheets will have wide application especially for resurfacing the distressed riding surfaces of flexible pavements. A project to design and develop jute-based asphaltic overlay is included in the on-going Jute Technology Mission in India.

Jute possesses a higher modulus than its competitive man-made counterpart, has lower elongation at break and is proportionately stiffer. For temporary haul roads as in the case of approaches to construction sites, internal roads in mines, woven JGT hold both a technical and commercial advantage over its man-made counterpart. New roads can be built over such temporary roads without the hazard of lifting the used JGT. This is an unexplored area in developing countries though JGT should have a good market in developed countries for such use.
**Fabriform** is a kind of fabric that can hold wet concrete in a desired shape. Once the concrete hardens, the utility of the fabric ceases. It can be used as revetment mattresses, for restoration of concrete elements and as lining and armour. The advantage is its cost and degradability. JGT fabriforms may replace the costly boulders—granite, laterite etc—used conventionally as armour or ballast.

*Concrete reinforced with jute fibres* should be stronger and is expected to be resistant against minor distresses in concrete. Recently man-made fibres have been tried to reinforce concrete with reported success. Jute fibres should add to the both tensile and compressive strength of concrete. A project for this purpose has been included in the ongoing Jute Technology Mission under “Design & Development of JDPs”. Jute fibre-reinforced concrete may also reduce the extent of steel reinforcement in RCC.

**Jute geogrids** may serve as a substitute of polymer-based geogrids if proved cost-effective. Geogrids can be used for control of slips and slides in hilly slopes and to check the sustained migration of debris along the slopes. Such geogrids may be used with advantage in shallow surficial slides in areas with temperate rainfall and moderately cohesive soil cover. Central Road Research Institute (CRRI) used such geogrids in Himachal Pradesh, India. Till date, jute geogrids have been used sparingly.

**Prefabricated Vertical Jute Drains (PVJD)** should have a good market for ground improvement. A wide range of such drains with man-made yarns are being marketed commercially. PVJD are equally effective as substantiated by studies and trials. PVJD has been patented in the U K and Singapore and has also been registered as a utility model in Japan (Ramaswamy 1997). PVJD, according to reports, are being used in south-east Asian countries, especially in Indonesia for hastening consolidation of soft deep-seated clay. I.I.T, Delhi has devised a similar drain with a braided sheath. In India use of PVJD has been insignificant so far. PVJD needs special rigs for insertion into the ground. This could be a reason why the product has not found encouragement from the consultants.
Woven JGT has been experimented successfully as separator and filter in reclamation of land from the sea (Tan et al 1994). But for some reasons use of woven JGT in land reclamation has not gained ground. It is felt that problems of reclamation of water-logged areas can be effectively obviated by use of JGT as separator and filter.

In hill slopes, fall of fine debris, especially during the monsoon, is common. This is precursor to heavier slips and slides. Arresting the detached aggregates within the slope itself is a way that can reduce or delay the chances of heavier damages as a result. Ranklor (1994) suggested erection of silt fences for this purpose. Silt fences can be constructed by erecting locally available timber/ bamboo/ tree branches down the slope at suitable intervals and filling the interspaces between the posts with woven JGT. Understandably woven JGT screens will need replacement when it loses strength or worn out.

Prof Ramaswamy indicated in a paper (1990) that he had developed jute geomembranes while working in a UNDP project at Indian Jute Industries' Research Association, Kolkata. This was a blend of two layers of woven JGT impregnated with bitumen emulsion and a high density HDPE sheet sandwiched in between. It is however felt this exercise will not provide any commercial advantage. Moreover use of HDPE sheet sandwiched between JGT layers is apt to raise questions on the suitability of bitumen-smeared woven JGT as a water-proof barrier.

**CONCLUSIONS**

In order that prospective applications of JGT may find larger acceptability, it is imperative that technical requirements of the end-users should be precisely ascertained and appropriate JGT developed with an eye to the comparative commercial advantage over its man-made counterpart. It is to be accepted that JGT cannot match man-made GT in terms of durability. However in the majority of geotechnical applications, geotextile acts as a
change agent to the soil on and in which it is laid. Durability therefore is a matter of secondary concern in such cases. JGT scores over its man-made counterpart if environmental aspects are considered. Measures to protect environment with eco-friendly materials should fetch a special discount.

Harding (1994) suggested an Erosion Control Benefit Matrix (ECBM) for comparative assessment of environmental management practices. The matrix takes into account six salient characteristics viz acceptance, cost, effectiveness, installation, vegetation establishment and maintenance with several sub-variables under each. JGT has distinct advantages in respect of each variable determinant. What is perhaps needed is to standardize each existing and prospective application of JGT, to exercise quality control over the product to meet the desired specification and to adopt a pro-active marketing strategy by the manufacturers. At the same time there should be no relenting of efforts to improve the products on the basis of scientific studies and research in the field. The deficiencies need be continually addressed through relentless research.

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6. Environmental Applications of Jute Geotextiles:
   Sanyal T
Prospective Innovative Applications of Jute Geotextile

Dr. A. B. M. Abdullah

ABSTRACT

Geotextiles particularly Jute Geotextiles (JGT) are emerging technical textiles in geotechnical and bio-engineering fields. These are fabricated by both man-made and natural fibres with different designs, shapes, sizes and compositions according to 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.

JGT are sometimes used on the surface to prevent surficial soil erosion and sometimes inside a construction under the surface as separator and reinforcer of soil. In fact geotextiles are multi-functional and location-specific in nature. Bioengineering / agro-mulching of natural fibrous materials are most effective due to their biodegradability, eco-compatibility and improvement of soil fertility and texture. In addition to erosion control they also facilitate vegetative growth, de-weeding and canopy of the land.

The application area of geotextiles is increasing continuously with the development of modern scientific and technological innovation. In respect to their physical, mechanical, hydrological properties, natural geotextiles particularly JGT are getting increasing acceptability due to their environmental complementary support.

Moreover, increasing scientific and technological information and knowledge about earth, soil, water, environment and ecological sustainability as a whole, are facilitating emergence / development of new kind of natural geotextiles as per specific location / functional needs. Different kinds of design with biodegradable geotechnical applications are being developed and increasingly used.

Executive Director,
Jute Diversification Promotion Centre
Dhaka, Bangladesh
INTRODUCTION

Jute is a seasonal agricultural crop. Widely grown in this part of the world, particularly Bangladesh, India, Nepal, Myanmar, Thailand and Vietnam. Commercial jute fibers are extracted from two spices Chorchorus Capsularis (white), Chorchorus Olitorious (tossa), through complex microbial process of retting. It is a photo reactive plant, only 120 days are needed for its harvesting. Temperate, wet and humid climate of Bangladesh are very conducive to the growth of jute.

Jute is a ligno-cellulosic, composite natural bast fiber. Cellulose, hemicellulose and lignin are its major constituent components & its three dimensional structure is formed by different inter and intra-molecular forces resulting from various physical, chemical, and hydrogen bonds between them. The commercial fiber consists of hairy strands of cylindrical networks of ultimate jute fiber. Properly retted and washed jute fibers are fairly lustrous with moderate strength but rough to touch. The color of the fiber also varies from creamy white to brown.

Jute is one of the important fiber crops being exceeded in production and use only by cotton. It is a coarse textile fiber being used as a raw material for the production of packaging materials like twines, hessian, carpet backing, gunny back, tarpaulin, woolpack, cotton bagging etc. It is one of the versatile natural fibers. Its intrinsic and extrinsic properties are the accumulated properties of individual component and various groups and bonds attested to them. Jute and jute products are biodegradable, photo-degradable, thermal degradable, nontoxic, non-plastic, acidic, anionic, hydrophilic, drapable, less extensible, with higher moisture and UV absorbing capacity and higher tenacity. Most of the cellulose are present in crystalline part of it. Amorphous parts are mostly non-cellulosic in nature due to the presence of hemicellulose and lignin. It has similarity with soft and hard fiber and cotton and wood simultaneously. A vast range of diversified jute products can be manufactured through vertical and horizontal modification. These are textiles, home textiles, technical textiles, medicare textiles, geotextile, agrotextiles, woven and
nonwoven, composite and non-composite, decorative, toys and handicrafts, pulp/paper and their products and cellulose and cellulose derivates etc, which can be used as a substitute of cotton, wood, synthetic, plastic etc.

There are numbers of traditional products as mentioned above which are manufactured in spinning and composite mills through existing conventional jute spinning and looms. A wide range of fabrics can be produced with the variation of drafts, twists, dollop weight, design such as plain, twill, basket, satin/sateen with closed, dense and open structure with definite strength, tenacity, porosity, permeability according to need. Moreover, nonwoven, knitted and netted jute fabrics can also be manufactured by needle punching, stitching and chemical bonding, with different strength, thickness, porosity and permeability according to need. Furthermore composite types of fabrics can also be manufactured by the combination of knitted, netted jute fabric, with the specific need and functions.

Geotextiles particularly jute geotextiles are emerging technologies in geotechnical and bio-engineering fields. Geotextiles are not a single commodity. These can fabricated by both synthetic and natural fiber with different design, shape, size, composition according to functional needs. These applications are generally categorized as; soil stabilizer, application at the interface of the formation of soil and the track back to minimize pumping of fine soil into granular materials; to lay beneath asphalt surface to delay crack development; consolidation of soil through filtration and drainage by filter cake formation; application as erosion control; reinforcement of civil construction; moisturization, protection from rain, wind, light and cold etc. In fact geotextiles are multi-functional and location-specific in nature. Bioengineering/agro mulching of natural fibrous materials are most effective due to their biodegradability, eco-compatibility and improvement of soil fertility and texture. In addition to erosion control they also facilitate vegetative growth, de weeding and canopy of the land.

Divergent and prospective applications of jute and modified jute products can be used as a solutions of various problems related to geotechnical/erosion
control/mulching/environment related activities are narrated briefly in this paper.

**IMPORTANT CHARACTERISTIC PROPERTIES OF GEOTEXTILES**

These are broadly classified as;

1) **Physical properties**:
   a) specific gravity, b) weight  c) thickness  d) stiffness  e) density etc.

2) **Mechanical properties**:
   a) tenacity b) tensile strength c) busting strength d) drapability e) compatibility f) flexibility g) puncture strength h) tearing strength i) fictional resistance etc.

3) **Hydraulic properties**:
   a) porosity b) permeability c) permittivity d) transmissivity  e) soil retention  f) filtration etc.

4) **Degradation properties**:
   a) biodegradation b) hydrolytic degradation  c) photo degradation d) chemical degradation e) mechanical degradation f) other degradation occurs due to attack of rodent, mite, termite etc.

5) **Endurance properties**:
   a) Crip/ elongation under texture b) abrasion resistance c) clogging length and flow etc.

All jute products as mentioned above can be used as geotextiles. But one of the most important weakness of the jute products is their quick biodegradability. But their life span can be extended even up to 20 years through different treatments and blendings. Thus it is possible to manufacture designed biodegradable jute geotextile, having specific tenacity, porosity, permeability, transmissivity according to need and location specificity soil, its type and
composition, water its quality of flow, landscape etc. Physical situation determines the application and choice of what kind of jute geotextiles, should be used. In contrast to synthetic geotextiles, though jute geotextiles are less durable they also have some advantages in certain areas to be used particularly in agro-mulching and similar areas where quick consolidation are to take place. Again for erosion control and rural roads where soil protection from natural and seasonal degradation caused by rain, water, monsoon, wind and cold weather are required jute geotextiles as separator, reinforcing and drainage activities along with topsoil erosion in shoulder and cracking are used quite satisfactorily. Furthermore after degradation of jute geotextiles lignomass are formed which increases soil organic content, fertility, texture and increases vegetative growth with further consolidation and stability of soil.

In fact in mulching and top soil erosion control, jute geotextiles of open weave construction (300-1000gmsq.m) create micro-climate for easy passage of water, retaining soil particles. Further application of grasses on it helps to harness stabilization and protection.

APPLICATIONS AND USES

Geotextiles are used in wide range of areas. Following are some important application areas where treated-untreated, blended-nonblended, natural and synthetic, geotextiles are used. They may be woven-nonwoven, knitted-netted, corded, composites and sandwiched etc. But application of geotextiles being location-specific, in addition to the characteristics of geotextiles, identification and application of geotextiles depend on soil type, soil composition, moisture content, liquid limits, plasticity index, bulk density, soil pH, iron/calcium content, clay/silt and sand composition, land sloping & hydraulic action etc. Moreover, climatic condition of the application site is also to be considered.
A. As a Separator

These are aggregates used to form some layer which prevent contamination of one kind of material from another kind of material, called separator. They are used in all classes of roads and civil foundation as the base of construction on contaminated layer is the single-most cause of premature failure. The use of separator prevents pumping effect created by dynamic load and also help the passage of water while retaining soil particles. In these types of geotextile, thickness and permeability are most important characteristic properties.

B. Reinforcement of Weak Soil And Other Materials

Reinforcement with geotextiles is intended to reduce the level of stress in the soil. For example it could be used for building of a road/any civil construction over soft soils like marshes, swamps, wetland, peat of similar difficult areas. Similarly stability of dams and embankment can be increased with their property of reinforcement. Strength and durability are the major characteristic properties needed for this type of geotextile. Geotextiles can reduce the thickness of the pavement and increase the life span of the road along with cost reduction.

C. Filtration (Cross-Plane Flow)

In filtration fabrics can be either woven or non-woven, to permit the passage of water while retaining soil particles. Porosity and permeability are the major properties of geotextiles which act in filtration. This applications are also suitable for both horizontal and vertical drains.

D. Drainage (In-Plane Flow)

1. Fiber drains/prefabricated drains:

In foundation engineering, consolidation settlement of clayey, silty and muddy soil create serious problems for construction engineers. The application of
various types of drains is to allow accelerated dissipation of pore water pressure by lateral drainage provided by geotextiles. There are various kinds of drains having their own characteristic properties, these are; sand drain, cardboard drain, wick drain, prefabricated drain and latest innovated banana drain. Ideal drains would have following characteristics:

1) High permeability to enable rapid dissipation. Its permeability must be much higher than that of the ground to be treated.

2) Good flexibility to enable large ground movement and not act as a pile and so prevent consolidation. Similar stiffness to soil mass is preferred.

3) A good hydraulic connection with a natural or placed permeable blanket layer which act as a hydraulic sink and have continuity over its length.

4) Introduction into the soil should be without any harm/disturbance as to modify its beneficial action as drain.

5) Remain useful as a drain over the required period in most cases a few months and rarely over a year for consolidation processes as opposed to permanent drains.

6) It should be preferably biodegradable.

7) The properties should kept over various states of stress usually increasing stress.

8) Porosity/permeability/textures of the drain body should not be clogged by the surroundings fine soils.

9) To reduce consolidation time it is obviously necessary to shorten the length of the flow paths. Installation of vertical drains of high permeability capacity are needed for quick and specific path direction.

Jute Geotextiles can be conveniently used for separation reinforcement, filtration and drainage.

In fact though geotechnical appliances are function-oriented, yet the same contrivance can serve for more than one functions simultaneously.
E. Geotextiles in Rural Road Construction

The use of geotextile products in temporary and rural unpaved road construction is one of their most common uses, and work on them is well established. The basis behind their use is that by placing a geotextile between the weak subgrade soil and the aggregate fill the unpaved road construction get strengthenes.

Considering above factors, treated and untreated, composite and blended, jute geotextiles can be used in stabilizing rural roads and protecting them from natural and seasonal devastation with increasing life span.

F. Erosion Control

Erosion control products are designed to control erosion and cover a diverse range of products which includes; nets, meshes, mats, blankets, both synthetic and natural biodegradable and non-biodegradable are used to mitigate erosion under different conditions for short, medium and long terms.

Jute geotextiles particularly geojute of open, porous and knitted structure (500-1000gm/sqm) are generally used for its effective and advantage over synthetic geotextiles. Such use helps to create microclimate to protect top soil erosion by rain, water, wind flow etc. Recently hessian of 270-300 g/m² have also shown to be effective in erosion control in certain cases.

G. Mulching

In agricultural practices, particularly in agronomic/horticultural activities, various fibrous materials are being used from time immemorial for better and effective benefits in producing better crops. Mulches are used to suppress the growth of certain plant species, whilst enhancing the growth of others. Agro-mulching is a general term applied to mulches used for agricultural applications and includes traditional loose mulches such as straw. Most application require suppression of weed growth to reduce competition with
the selected or designed vegetation for vital resources such as moisture, light and nutrients. End users have included horticultural and land escaping operations. To ensure success, jute geotextiles must have following characteristics.

- suppress weed growth
- enhance growth of the selected vegetation spices by reducing competition and enhancing soil/plant/water relationship.
- protect from heat and cold and from drying & wilting etc.

Jute geotextiles are biodegradable and have only a lifespan of one season. In horticultural applications this may correspond with a crop season, and the products is simply removed and disposed of at harvesting. Where an agro-plant mulch is required for a longer time (as in land escaping applications) then careful selection of site and species is important, or specialized treatments may have to be used to increase the longevity of the mulch product.

These mulches are used in the cropland where conditions are less favorable and there is a need to protect them. A natural mulch is most commonly straw, hay, although nearly any organic materials (leaves, peat, wood chips, barks, banana leaves etc. that are non-toxic can be used ). There are also synthetic mulches such as polypropylene, plastics, bitumins/latexes, treated fibrous material etc. Mulch provides some protection from rainsplash, erosion retards runoff, traps sediment and creates a better environment for plant germination and development.

Some times treated and untreated light jute fabrics in the form of taps are used for covering plants from natural injury from cold and wilting. These are nursery pot, nursery sheet, nursery tapes, nursery fabrics etc.
H. Moisturizers

Moisturizers are generally from natural fibers. They are fabricated and designed so that they have high water holding capacity. High capillaries and hydrogen bonding properties are special properties for this types of geotextile, so that they can provide water to the plants/crops/land/structure when needed.

There are woven, non-woven, composites, treated and untreated fabrics like nursery sheet/pot, nursery tapes etc. Some time with special treatment for higher water absorption capacity, anti-microbial protection etc. Some applications areas are;

1) Seasoning newly constructed RCC/civil structure during building

2) Protect land from desertification by planting specials type of grass/herbs/plants and providing water for initial growth propagation.

3) Protection of forest plant from drought/dehydration by supplying soil moisture and preventing evaporation.

4) Anti-forest fire retardant/stopping fire propagation by the application of specially treated geotextile in forest area.

5) Land reclamation from sea/desert

Jute is a versatile fiber having composite nature of high chelate forming groups along with high water absorbing capacity, can easily form complexes with silts passing through the big rivers and settle down quickly as a sedimentation at the confluence to sea/river. By setting them land reclamation can be undertaken and further with the formation of lignomass quicker vegetative growth occurs.

On the other hand desert area can be transformed into a cropland with the transformation of sand into soil by gradual supply of water and plantation on it.
I. Cropland / Hydroponics / Roof-Top Planting / Orchid Production / Floriculture etc.

These are special type of fabrication made by sandwiching nonwoven with open structure netting where nonwoven part contains seed, fertilizer and soil in specific ratio according to crop need. Water is occasionally sprinkled to the fabrics. Generally these are used as seed beds during emergency and devastating flood. This seed bed can be placed anywhere like roof of the building. Again similar type of fibrous fabrics are also used for hydrophonic agriculture, generally placed on raft made of banana stem or similar structure.

Rooftop planting /orchid production/floriculture became very popular and modern approach of gardening/floriculture in top roof of buildings and similar places. These types of jute geotextiles are similar to that of cropland but they are modified with specific needs in respect of water content, soil content, fertilizer content and canopy needs. These types of geotextiles are getting popular in city and urban areas as these not only harness economic benefits but also protect environment by Carbon dioxide-Oxygen balance in the atmosphere.

J. Irrigation liner

Irrigation liners are non-permeable fabrics, generally synthetics or natural modified with resin/rubber/polymers etc. so that water can not pass through it.

Some times these irrigation liners are made with differently treated jute ribbons.

K. Seismic protection

Jute and other fibrous materials were used as a reinforcing material in the construction of mud houses of this part of the world from time immemorial. Recently jute and other fiber materials have been identified as an effective raw materials for stabilizing various buildings made mud in Asia and African countries from protection of earthquake.
L. As Temporary Irrigation Dam

These are specially treated /modified jute fabrics which are hydrophobic, non-permeable and easily movable so that water can be channelised to a short usable area.

M. Protection of Tea Garden

Jute having high moisture and UV protecting character have a definite capability to protect soft tea leaves giving appropriate moisture and protection from UV radiation reflected from sun by giving canopy.

CONCLUSIONS

There is a wide scope for innovative and prospective uses of jute geotextiles as it is not only environment friendly but application of jute products particularly jute geotextiles are effective for protecting environmental degradation. So application of jute geotextiles can play an important role for sustainable economic development and planning where jute is easily available. Though scientific and technological innovation related to the uses of jute geotextiles are available, yet it could not be popularized for commercial uses due to non-availability of user application parameters needed for putting them in design of working plan.
References


2. Fiber and Yarn Quality in Jute Spinning, H,P Stout The Textile Institute (Manchester)


5. Geotextile and Related Products as Filter and Drain in Dams Construction, Madras, India, 1987


8. Production of Jute/Coir Blended Yarn From Low Grade Jute And Coir Fibers, Abdullah, Kabir, Latifa, Rahman etal BJRI 1987


13. As Referances-4


Some Important Data Information related to Jute and Jute Geotextiles.

**Table No. 1 Major physical properties of jute fiber**

<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jute cell width</td>
<td>15-20 microns</td>
</tr>
<tr>
<td>Jute cell length</td>
<td>1-6 mm</td>
</tr>
<tr>
<td>Jute ultimate fiber length (average)</td>
<td>2.5 mm</td>
</tr>
<tr>
<td>Jute ultimate fiber diameter (average)</td>
<td>0.018 mm</td>
</tr>
<tr>
<td>Tenacity g/tex</td>
<td>2.7-5.3</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>1.48</td>
</tr>
<tr>
<td>Moisture regain at 65RH/22°C</td>
<td>13.8</td>
</tr>
<tr>
<td>Refractive Index (Parallel)</td>
<td>1.577</td>
</tr>
<tr>
<td>Refractive Index (Perpendicular)</td>
<td>1.536</td>
</tr>
<tr>
<td>Florescence with corning filter</td>
<td>Bluish white</td>
</tr>
<tr>
<td>Phosphorescence</td>
<td>Yellow</td>
</tr>
<tr>
<td>Phosphorescence (time)</td>
<td>15 sec</td>
</tr>
<tr>
<td>Swelling in water (diameter)</td>
<td>20-21%</td>
</tr>
<tr>
<td>Swelling in water (area)</td>
<td>40.0%</td>
</tr>
<tr>
<td>Stiffness (Average)</td>
<td>185 g/tex</td>
</tr>
<tr>
<td>Specific heat capacity</td>
<td>0.324</td>
</tr>
</tbody>
</table>

**Table No. 2 Properties of some specific jute fabrics:**

<table>
<thead>
<tr>
<th>Property</th>
<th>Type A</th>
<th>Type B</th>
<th>Type C</th>
<th>Type D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>B-Twill</td>
<td>A-Twill</td>
<td>Heavy Cee</td>
<td>DW plain</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Mass/unit area (g/sqm)</td>
<td>644</td>
<td>756</td>
<td>682</td>
<td>538</td>
</tr>
<tr>
<td>Linear density</td>
<td>0.3721</td>
<td>0.4656</td>
<td>0.3355</td>
<td>0.3416</td>
</tr>
<tr>
<td>No. of yarns per inch (MD)</td>
<td>13</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>No. of yarns per inch (CD)</td>
<td>9</td>
<td>8</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>Narrow strip tensile</td>
<td>21.78</td>
<td>27.50</td>
<td>24.26</td>
<td>20</td>
</tr>
<tr>
<td>Strength (kN)</td>
<td>22.50</td>
<td>27.50</td>
<td>25.00</td>
<td>24.50</td>
</tr>
</tbody>
</table>
Table No. 3 (a) Characteristic Properties of Some Jute Fabrics

<table>
<thead>
<tr>
<th>Jute Fabrics Properties</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Name</td>
<td>Canvas</td>
<td>CBC</td>
<td>Twill</td>
<td>Felt</td>
</tr>
<tr>
<td>Unit weight (gsm)</td>
<td>540</td>
<td>240</td>
<td>610</td>
<td>620</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>1.36</td>
<td>1.13</td>
<td>1.82</td>
<td>4.22</td>
</tr>
<tr>
<td>O₂₅ (mm)</td>
<td>0.06</td>
<td>2.0</td>
<td>0.6</td>
<td>0.3</td>
</tr>
<tr>
<td>Grab tensile strength (N)</td>
<td>840</td>
<td>410</td>
<td>410</td>
<td>240</td>
</tr>
<tr>
<td>Grab tensile Elongation (%)</td>
<td>22</td>
<td>10</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>Burst Strength (k Pa)</td>
<td>2500</td>
<td>1760</td>
<td>1960</td>
<td>1760</td>
</tr>
<tr>
<td>Index Puncture Resistance (N)</td>
<td>600</td>
<td>160</td>
<td>400</td>
<td>250</td>
</tr>
</tbody>
</table>

Table No. 3 (b)

<table>
<thead>
<tr>
<th>Properties</th>
<th>Type - 1</th>
<th>Type - 2</th>
<th>Type - 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g/sqm)</td>
<td>292</td>
<td>500</td>
<td>730</td>
</tr>
<tr>
<td>Threads/dm (MDxCD)</td>
<td>12x12</td>
<td>6.5x4.5</td>
<td>7x7</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>3</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Width (cm)</td>
<td>122</td>
<td>122</td>
<td>122</td>
</tr>
<tr>
<td>Open Area (%)</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Strength (kN/m) (MDxCD)</td>
<td>10x10</td>
<td>10x7.5</td>
<td>12x12</td>
</tr>
<tr>
<td>Waterholding capacity on dry weight (%)</td>
<td>400</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>Durability (max.) years</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Properties</td>
<td>Grey</td>
<td>Rot resistance</td>
<td>Bitumen treated</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------</td>
<td>----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Weight (g/sqm)</td>
<td>760</td>
<td>760</td>
<td>1200</td>
</tr>
<tr>
<td>Threads/dm (MDxCD)</td>
<td>102x39</td>
<td>102x39</td>
<td>102x39</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Width (cm)</td>
<td>76</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Strength (kN/m) (MDxCD)</td>
<td>20x20</td>
<td>20x20</td>
<td>21x21</td>
</tr>
<tr>
<td>Elongation at break (%) (MDxCD)</td>
<td>10x10</td>
<td>10x10</td>
<td>10x10</td>
</tr>
<tr>
<td>AOS O₉₀ (Micron)</td>
<td>300</td>
<td>300</td>
<td>150</td>
</tr>
<tr>
<td>Flow Rate at 10 cm water head (litre/sqm/sec)</td>
<td>50</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td>Puncture Resistance (N/cm²)</td>
<td>380</td>
<td>380</td>
<td>400</td>
</tr>
<tr>
<td>Durability (max.) years</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

**Table No. 3 (d) Non-Woven Jute Geo textiles**

<table>
<thead>
<tr>
<th>Properties</th>
<th>Type-1</th>
<th>Type-2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (g/sqm)</td>
<td>500</td>
<td>1000</td>
</tr>
<tr>
<td>Thickness (mm)</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Width (cm)</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Strength (kN/m) (MDxCD)</td>
<td>4x5</td>
<td>6x7</td>
</tr>
<tr>
<td>Elongation at break (%) (MDxCD)</td>
<td>20x20</td>
<td>25x25</td>
</tr>
<tr>
<td>AOS O₉₀ (Micron)</td>
<td>500</td>
<td>300</td>
</tr>
<tr>
<td>Permittivity Co-eff</td>
<td>3.4X10⁻³</td>
<td>3.4X10⁻⁴</td>
</tr>
<tr>
<td>Durability (max) years</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Table No. 4

<table>
<thead>
<tr>
<th>Type of product</th>
<th>Biodegradability</th>
<th>Durability</th>
<th>Moisture holding capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time in month</td>
<td>Weight loss (%)</td>
<td>Time (year)</td>
</tr>
<tr>
<td>Light Weight hessian</td>
<td>3</td>
<td>30</td>
<td>0.25-0.80</td>
</tr>
<tr>
<td>Treatment 1</td>
<td>12</td>
<td>15</td>
<td>0.50-1.25</td>
</tr>
<tr>
<td>Treatment 2</td>
<td>12</td>
<td>10</td>
<td>2.0-5.0</td>
</tr>
<tr>
<td>Treatment 3</td>
<td>12</td>
<td>5</td>
<td>&gt;10</td>
</tr>
<tr>
<td>Treatment 4</td>
<td>12</td>
<td>1-3</td>
<td>&gt;20</td>
</tr>
</tbody>
</table>

Table No. 5 Some technical specification for geotextiles used in erosion control:

<table>
<thead>
<tr>
<th>Woven Produced</th>
<th>Weight g/m²</th>
<th>Yarns/per/m</th>
<th>Yarn Dia (mm)</th>
<th>Open Area (%)</th>
<th>Mean Area Geo textile (cm²)</th>
<th>Tensile strength kN/m</th>
<th>Water holding capacity % of dry wt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geojute</td>
<td>500</td>
<td>65</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>46</td>
<td>54</td>
</tr>
<tr>
<td>Soil saver</td>
<td>500</td>
<td>65</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>49</td>
<td>51</td>
</tr>
<tr>
<td>Antiwash</td>
<td>500</td>
<td>64</td>
<td>46</td>
<td>5</td>
<td>5</td>
<td>46</td>
<td>54</td>
</tr>
<tr>
<td>Erosmat</td>
<td>500</td>
<td>64</td>
<td>46</td>
<td>5</td>
<td>5</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>IJRAN</td>
<td>500</td>
<td>65</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>47</td>
<td>53</td>
</tr>
<tr>
<td>IJ1RAR</td>
<td>400</td>
<td>34</td>
<td>15</td>
<td>2</td>
<td>3</td>
<td>42</td>
<td>58</td>
</tr>
<tr>
<td>IJIRAP</td>
<td>300</td>
<td>17</td>
<td>45</td>
<td>2</td>
<td>5</td>
<td>53</td>
<td>47</td>
</tr>
<tr>
<td>Hessian</td>
<td>275</td>
<td>46</td>
<td>1.5</td>
<td>1.5</td>
<td>20</td>
<td>80</td>
<td>0.01</td>
</tr>
<tr>
<td>Balfour Mesh</td>
<td>292</td>
<td>10</td>
<td>12</td>
<td>3</td>
<td>3</td>
<td>54</td>
<td>46</td>
</tr>
<tr>
<td>Coir Geomat</td>
<td>700</td>
<td>11</td>
<td>70</td>
<td>4</td>
<td>4</td>
<td>42</td>
<td>58</td>
</tr>
</tbody>
</table>
### Table No. 6 Some properties of jute geotextiles in unpaved earth road stabilization.

<table>
<thead>
<tr>
<th>Product</th>
<th>Material Characteristics</th>
<th>Weight (g/m²)</th>
<th>Ultimate tensile strength (kN/m) weft value</th>
<th>Extension at max. load (%)</th>
<th>Quality Ratio (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Savar</td>
<td>100% jute woven mesh</td>
<td>500</td>
<td>7.5</td>
<td>11</td>
<td>38</td>
</tr>
<tr>
<td>IJIRA SSR</td>
<td>100% jute woven mesh</td>
<td>400</td>
<td>5.7</td>
<td>15.8</td>
<td>17</td>
</tr>
<tr>
<td>Soil Savar</td>
<td>100% jute woven mesh</td>
<td>500</td>
<td>7.5</td>
<td>11</td>
<td>38</td>
</tr>
<tr>
<td>Geomat</td>
<td>100% coir fiber woven mesh</td>
<td>700</td>
<td>11.6</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Grassmat</td>
<td>jute nonwoven + polythene mesh</td>
<td>950</td>
<td>3.1</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Brila 300</td>
<td>100% jute needle pounced non woven</td>
<td>300</td>
<td>2.8</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Birla 750</td>
<td>100% jute needle pounced non woven</td>
<td>500</td>
<td>5.2</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Birla 1000</td>
<td>100% jute needle pounced non woven</td>
<td>1000</td>
<td>7.5</td>
<td>24</td>
<td>38</td>
</tr>
<tr>
<td>Poltefelt TS 420</td>
<td>100% polypropylene needle pounced continuous filament</td>
<td>130</td>
<td>8.1</td>
<td>50-80</td>
<td></td>
</tr>
<tr>
<td>Fortrace</td>
<td>polyester yarns covered with pvc geogrid</td>
<td></td>
<td>35</td>
<td>12.5</td>
<td></td>
</tr>
<tr>
<td>Hessian fabric</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Development of Testing Facilities and Specifications for Quality Control of Jute Geotextiles and its Applications

Dr. Amalendu Ghosh

ABSTRACT

Jute is a natural fibre with unique characteristics having potential of diverse technical end-uses. One of the potential sectors of applications of jute is in the field of Geotechnical Engineering where it can be put to use as geotextiles with advantage. The major areas of application of Jute Geotextiles are in roads, for soil erosion control and stabilisation in allied infrastructures. Attempts are being made by the Government bodies, researchers and professionals to exploit the potential of jute in the field of geotechnical engineering.

It was emphasized in the reports of various studies conducted by ITC and IJO that jute products would have high potentiality in seizing a sizeable share of the geotextiles market in the end use of (1) rural road pavement construction, and (2) soil erosion control. However, there is paucity of data for formulation of specifications and quality control guidelines. To enhance the application of Jute Geotextiles in Civil Engineering constructions, suitable design methodologies, considering geotechnical mechanism, are to be developed. The required properties of JGT, determined on the basis of loading, environmental conditions, requirement of degree / nature of improvement for specific field problems are to be checked through suitable testing methodology. To develop the appropriate specifications for different field applications, simulation studies are essential. The guidelines of quality control of JGT and its applications conforming to the design are to be developed for its acceptance in the global market.

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INTRODUCTION

Jute is a natural fibre with unique characteristics having end use applications. Jute production provides a necessary break between the crops and helps enrich the soil. Jute fibre used to be called the ‘golden fibre’ in Bangladesh and India because of its success in the export market. An overview of supply and demand indicates that jute production is increasingly concentrated in Bangladesh and India. China, Thailand and Nepal contribute a very small share. Land allocation between rice and jute depends on the relative prices. The world production of jute reached the peak of over 6.0 million tons in mid 1980s and went down to 2.7 million tons by 1995/96. This has climbed up to 3.1 million tons in 2002-2003. Food and Agriculture Organisation of the United Nations (FAO) estimates predict that jute production will contract to 2.3 million tons by 2010. FAO also predicts that land for jute is going to be reduced by 3.0% in the year 2010 compared to 1998-2000. This projection takes into account factors like contraction of demand and the subsequent fall in prices. Even with a production of 3.0 million tons, there is over supply resulting in lower prices. A price chart vis-à-vis production of raw jute over a period from 1995-96 to 2004-05 is shown in Table 1. The reduction in demand has arisen out of the expansion of synthetic substitutes in the packaging market. Since the decline of traditional uses for jute fibres and textiles, the jute industry has been searching for innovative uses and novel markets for this environmentally friendly, sustainable natural resource.

To address the problem of reduction in demand for jute products and the consequential reduction in jute prices, the International Jute Study Group (IJSG) has a strategy focused on promotion of productivity, product quality, development of standards and specifications, product development, identification of viable diversified end-uses, promotion of demand and sustainable production. In this overall strategy, the promotion of existing jute products for diversified uses and the development of new diversified products are the key components.
NEW MARKETS FOR JUTE & JUTE GEOTEXTILES

It has been accepted for many years that new markets and alternative uses of jute must be found if the industry was to survive. One relatively novel use of jute fibres and textiles is in the form of "geotextiles", where high volumes of relatively low-grade jute raw materials can be utilised. Previous commercial and technical investigations have shown that the use of jute and jute based products as "geotextiles" has significant potential (Common Fund for Commodities, 1998; Rickson and Loveday, 1996; Cranfield University / Ingold Associates, 1996). The potential of jute geotextiles is complemented by the demand for these products in environmental protection and management.

The Expert Committee on Textile Policy, constituted by Ministry of Textiles, Government of India, has in its report on August, 1999 highlighted the potential of technical textiles in the country and had made strong recommendation for promoting its growth to enable India to create a place for itself in the international technical textiles scenario. The textile policy – 2000 has also enunciated that priority should be accorded for the growth and development of technical textiles in the country. However, the recommendations of the Expert Committee on Textile Policy were not found adequate to formulate an action plan for exploiting the opportunities of technical textiles. Subsequently an Expert Committee on Technical Textiles (ECTT) was constituted by the Government of India to identify the fields of application where the technical textiles can be used successfully.

The ECTT, through interactive sessions with the institutional users, the experts from industry, research associations and technical institutions, observed the following:

Polypropylene and polyester are the two common polymeric materials used in the global geotextiles market. Geotextiles made of jute and some other natural fibres like coir, sisal etc. are also used where bio-degradability is a desired property or the functional requirement is for small duration and a subsequent bio-degradation of the geotextiles do not affect the construction and / or where the project demands the use of ecofriendly material.
The jute-based geotextiles have very large potentials for use in construction of village roads, soil erosion control, slope stabilization, protection of embankments etc.

Further, the Ministry of Rural Development, Government of India is in the opinion of promulgating mandatory regulations for use of jute geotextiles, in the construction of rural roads, where the California Bearing Ratio (CBR) of soil is below certain threshold value.

Jute geotextiles are considered as an important component of the strategy for the following reasons:

a) Ever increasing concerns of environmental protection and conservation of natural resources worldwide will provide new opportunities for use of natural fibre geotextiles, including jute products.

b) Geotextiles are technical textiles sold primarily for their technical and engineering characteristics rather than on aesthetic appeal.

c) Jute geotextiles can be produced by existing jute mills with little or no modifications or additions to machinery.

d) The demand for geotextiles is very large and expanding. Even a small portion of the market would be sufficient to improve the jute economy.

e) The socio-economic condition of jute producers (farmers) will be improved and thus there will be contribution to the development of the society as a whole with a view to alleviating poverty by way of providing employment opportunities in the jute sector, particularly for women.

**POTENTIAL APPLICATIONS OF JGT**

Though synthetic geotextiles led the overall geotextiles use in 1980s it was revealed in various studies conducted by International Jute Organisation (IJO) that jute products would have high potentiality in sharing the geotextiles market in the end use of:
i) **Rural Road Pavement Construction**: The increasing traffic volumes and loadings on rural earth roads may exceed load carrying capacity, resulting in irreversible rut formation and roadside edge fretting. Jute geotextiles can be used in road construction as reinforcement, allowing higher load bearing capacities, thus increasing permissible loading thresholds before damage takes place. In addition to the reinforcement function geotextiles also acts as a separator to prevent coarse grains from being pressed out of the base or sub-base course into the weak or soft sub-grade and also prevents intrusion of fines from the subgrade into the base layer under the influence of traffic loads. Thus geotextiles help in arresting the subsidence of road surfaces. Jute fabrics may also be used for retardation of reflective cracking in bituminous overlay.

ii) **Soil Erosion Control**: Soil erosion takes place mainly due to wave action (both water and wind), current attack and discharge of surface and/or ground water from the land. The run-off of surface water also erodes the protection construction considerably, particularly in areas where little or no land drainage is provided. Soil erosion may cause the failure of slopes. Jute geotextiles can be used to control loss of soil from unprotected, bare soil slopes, such as newly constructed cuttings and embankments. Without such erosion control, it is extremely difficult to establish protective vegetation on such sites. Sediments, generated out of erosion, washed into water courses cause turbidity, poor water quality and detrimental effects on aquatic ecosystems.

**RURAL ROAD PAVEMENT CONSTRUCTION**

A lot of field applications of JGT in rural roads have been carried out in India principally for the purpose of strengthening of sub-grades and roadside drainage (as drain encapsulating rubble with non-woven JGT). These projects were undertaken in consultation with Central Road Research Institute (CRRI), India. Woven JGT with varying porometric features and tensile strength were tried with success. But all such applications were based on available jute
fabric rather than on stiffness of JGT (secant modulus). Giroud and Noiray (1981), it may be mentioned, devised a relation based on axle loads, number of passes, allowable rut depths and undrained shear strength for man-made geotextiles. The elements of stiffness of fabric were also taken into account. For JGT no such study has yet been undertaken.

In a recent pilot project with JGT under "Pradhan Mantri Gram Sadak Yojana (PMGSY)" in India in 10 rural roads in 5 states, CRRI has prepared Detailed Project Reports (DPRs) and has been engaged by JMDC to monitor performance up to 18 months from the dates of their completion. In this project CRRI has chosen 3 varieties of woven JGT (15, 20 and 30 kN/m), 1 variety of non-woven JGT (500 gsm) and 1 variety of open woven JGT presumably with a view to watching the ultimate performance of the JGTs under different soil conditions.

Rao, Venisiri and Rao (1998) reported that JGTs were effective to minimise post construction settlement and reduction of lateral spreading of fill material. Jute geotextiles appears to be very effective even in weak sub-grade soils in reducing their compressibility and increasing their strength as reflected from their good performance even after a lapse of 7 years.

Sukla et al. (2004) also presented a case study along with laboratory tests on the use of jute fabrics for retardation of reflective cracking in bituminous overlay. The asphalt coated jute fabrics were found to be effective in reducing the crack and it was also found economic compared to synthetic geofabric.

**SOIL EROSION CONTROL**

Techno-Economic Manual under the aegis of CFC and IJO presented some examples of previous work on soil erosion control in September, 1996, which included the following: Reynolds (1976) had reported that 400 gsm jute mesh showed lowest soil movement for clayey soil in field plots. Results on erosion control with 500 gsm JGT in the plots with rainfall simulation were reported by Thomson and Ingold (1986, 1988). The slope was limited to 26.5° with rainfall intensity up to 75 mm/hr, with duration up to 60 minutes. Fifield et al.
(1988, 1989) showed that 500 gsm JGT performed satisfactorily in the field plots. Rickson (1988) reported the performance of 500 gsm and 320 gsm JGT through laboratory rainfall simulation study only.

Ranganathan (1994) published a status paper on trends in world jute production and consumption in relation to which market potential of jute geotextiles has been assessed. A number of studies (IJO 1987, 1991, 1993; ITC 1984, 1985) on application and marketing of jute geotextiles were reviewed and referred to in the paper. Since the low cost to the user and the inherent variability of soil application well accommodates a natural fibre product, he concluded that, this fact should be well recognized by jute producers, product suppliers, consultants and traders.

Government of West Bengal, India has used JGT for mine spoil stabilization, hill slope protection, and sand dune stabilization (1987, 1988). It has been observed that JGT performed satisfactorily in controlling soil erosion and helped in growth of vegetation.

Bitumen treated JGT has been used on the bank slope of Nayachar Island, in the river Hooghly, West Bengal, India for erosion control (Sanyal, 1992). The undisturbed bank after 11 years implies that JGT performed its designated functions and helped in natural consolidation of the bank soil. Sanyal (2004) presented application of treated woven jute geotextiles along with appropriate engineering measures for prevention of riverbank erosion in the river Ichamati, West Bengal, India.

In the previous study on Jute Geotextile executed under CFC funding by Silsoe College, UK in 1998, the focus was on soil erosion control and vegetation control. Though mention was made on RECP (rolled erosion control products), ECN (erosion control nets), ECM (erosion control meshes), ECB (erosion control blankets), ECRM (erosion control vegetation mats), TRM (turf reinforcing mats or matrices) for short term and medium term applications, the study was concentrated on open weave JGT having weight of 500 gsm and below. The study intended to show that the percentage cover
provided by a JGT is more critical than its weight. But the report of ITC, UNCTAD/ GATT in 1991 has clearly depicted that the storage provided by a JGT significantly helps curb the process of soil detachment. Open structure of JGT also acts as a series of micro- barriers thus reducing the velocity of overland flow. In areas with high precipitation, weight of JGT or for that matter 3-D construction should definitely help.

Earlier studies on the application of JGTs in the areas of rural road pavement construction and soil erosion control have considered only specific types of JGTs for end-use. The aspect of designing a particular type of JGT taking into consideration the site-specific parameters has not received much attention. To enhance the use of JGT in the field site specific guidelines and standards for JGT are to be developed based on characteristics and performance evaluation of varieties of JGTs under varying loading and environmental conditions.

**TESTING OF JUTE GEOTEXTILES**

Like any other engineering material geotextiles are also subjected to testing for determination of their properties. Depending upon the different levels of interest, categories of testing levels are classified as follows:

- Development Tests,
- Fundamental Tests,
- Suitability Tests, and
- Quality Control Tests.

Development tests are carried out in the laboratories during the stage of development of new products to determine the basic properties with respect to the applicability of the new product.

Fundamental tests aim at a better understanding of the properties and performance of the material. They are subject to scientific research carried
out at institutes / universities which are independent of the manufacturers. Since geotextiles – soils form a composite system having varieties of soils on one hand and varieties of geotextiles on the other hand, provide a wide field of unsolved problems and ample room for scientific research and development.

Suitability tests are carried out to evaluate the suitability of the material for certain technical assignments. These investigations may consist of the tests for physical, mechanical and hydraulic properties of geotextiles or tests on composite system of geotextiles-soils. Suitability tests should be carried out by fabric engineers in coordination with geotechnical engineers. Apart from the routine tests, individual test-set-ups (model tests) or procedures are often needed for the evaluation of the suitability of a new product for design purpose, or also for the evaluation of the suitability of a special design if no positive experience is available. Suitability tests also cover some aspects of quality control as they provide basic data for specifications, which have to be met continuously in manufacturing and construction.

Quality control tests on geotextiles are required for quality assurance. Different tests are carried out, which render information about the properties, relevant to the technical application. Quality control tests must be done quickly, efficiently and regularly during manufacturing and application. These tests, therefore, should be of short duration and simple to set up and have an obvious relationship to the qualification or suitability tests. Quality control tests are an essential part of the application supervision. Jute geotextiles being comparatively new material, people have little knowledge about it and hence experts are usually required for the quality control where jute geotextiles are installed.

As beauty is in the eyes of the beholder so the perceived properties of geotextiles are a function of the test methods and conditions under which the properties were measured. The tests on geotextiles are broadly classified as :

- Index Tests, and
- Performance Tests.
Index tests, sometimes known as identification tests, are generally simple tests, which can be carried out quickly and cheaply. These tests do not take into account the interaction, which may occur between the geotextiles and the soil. In general index tests are said to be carried out in isolation of soil.

Performance testing is the broad classification used for tests, which seek to determine how geotextiles perform in service. A basic objective is to determine the values of geotextiles properties to be used in design. Although not laboratory based, performance testing can be considered to extend to the field monitoring of large scale models, field trials, prototypes and full scale service installations to see how they perform and how well this observed performance is predicted by in service geotextile properties and the analytical models used for design purposes. Effects of important parameters like time and environmental conditions on the performance of JGT are to be studied.

The identification of a geotextile for a particular application is achieved by defining and specifying the required properties of the geotextile. The term 'standards' relates to documents, which prescribe standardized practice or methods of testing, designing or specifying. For geotextiles the majority of standards refer to standard methods of testing and these are adopted at either a national or international level.

The index tests, as has been discussed earlier, are required for identification and characterization purpose; these tests are generally conducted in the laboratory. For specific application, or for the solution of a particular engineering problem, it is the designer to determine what properties are required. The role of a designer is to specify the properties required of a geotextile to solve a specific problem. There are various sub classification of properties. The cardinal properties of geotextiles are classified under the following three major categories:

- Physical Properties,
- Mechanical Properties, and
- Hydraulic properties.
Basic physical properties are the quantities of general descriptive character. For jute geotextiles these are: mass per unit area, drapability, thickness, stiffness, and roll width.

Mechanical properties of geotextiles depend on the mechanical properties of the fibre material and fibre structure, the yarn structure and the structure of the geotextiles. Further, the properties depend also on the direction because of the anisotropy of the structure. The mechanical properties are quantified by applying loads to the geotextiles and measuring response. For the purpose of selecting geotextiles for specific use, knowledge of mechanical properties is very essential.

The major mechanical properties are: tensile strength, and interface friction.

The hydraulic properties of geotextiles influence their ability to function as filters and drains. Two important physical properties of geotextiles, which affect its hydraulic characteristics, are its thickness and openings formed during manufacture.

However, the important hydraulic properties are: wettability, permittivity, transmissivity, porometry, and apparent opening size.

Besides the above three categories, some more properties are to be studied to assess the ability of geotextiles to survive during construction / installation / service period. These are as follows:

Constructability / survivability properties viz., puncture resistance, tear resistance, impact resistance, and bursting resistance.

Durability properties viz., abrasion resistance, biological stability, wetting and drying stability.

Although an International Organisation for standardisation (ISO) exists there are in fact very few ISO standards, which apply to geotextiles. Whilst national
standards for test methods set down unified approach for testing, the way in which the test results are applied to specify a geotextiles for a particular application will vary from country to country and end-user to end-user.

Nowadays a number of testing standards for geotextiles (synthetic) are available in different countries, such as ASTM standards : ASTM D4632, D5493, D1987, D5261 D4751 etc., British standards : BS 6906, Indian standards: IS 1969 for thickness, etc., to determine the above mentioned properties. However, standards for jute geotextiles are very limited. Some Indian Standards such as IS 14986: 2001, and IS : 14715 only are available. It is essential to develop the standards especially for JGT approved by regulatory bodies for conducting such tests in the laboratory.

The database on the properties and performance of JGT that will be generated from the above mentioned tests would help formulate the site-specific specification and standards for design of field problems.

**Guidelines for Quality Control**

Roads constitute the basic infrastructure required for development of any country. In India since independence rural roads have been constructed through different programmes. But the technical aspects of design, construction and quality control did not receive due attention. As a result the roads constructed in the past did not last long in many cases. Besides National Highways, State Highways, Major District Roads, Other District Roads and Village Roads, at present the “Pradhan Mantri Gram Sadak Yojana” (PMGSY) cover the rural roads. In a recent pilot project under PMGSY in India, JGTs are being used in some rural roads with a view to watching the ultimate performance of the JGTs under different soil conditions. The basis of choice of the JGTs has not been indicated.
In engineering and manufacturing, quality control and quality engineering are involved in developing systems to ensure products or services are designed and produced to meet customer requirements. These systems are often developed in conjunction with other engineering disciplines using a cross-functional approach.

CONCLUSIONS

To enhance the use of JGT in the fields of rural road pavement construction and erosion control the standards approved by appropriate bodies are essential. To formulate the standards the specifications of the JGT and performance evaluation studies are to be carried out. Based on the performance of JGT design methodologies and design manuals are to be developed. Quality control guidelines for every stage are to be developed for successful implementation.

Table 1. Prices of Jute at Grower Level vis-a-vis Production of Raw Jute in India and Bangladesh

<table>
<thead>
<tr>
<th>Period (June – July)</th>
<th>India</th>
<th>Bangladesh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production (in '000 tonnes)</td>
<td>Price (US $ / ton)</td>
</tr>
<tr>
<td>1995 – 1996</td>
<td>1250.50</td>
<td>402.75</td>
</tr>
<tr>
<td>1996 – 1997</td>
<td>1625.50</td>
<td>329.23</td>
</tr>
<tr>
<td>1997 – 1998</td>
<td>1765.50</td>
<td>164.15</td>
</tr>
<tr>
<td>1998 – 1999</td>
<td>1309.50</td>
<td>215.03</td>
</tr>
<tr>
<td>1999 – 2000</td>
<td>1205.80</td>
<td>221.1</td>
</tr>
<tr>
<td>2000 – 2001</td>
<td>1422.00</td>
<td>215.36</td>
</tr>
<tr>
<td>2001 – 2002</td>
<td>1686.60</td>
<td>226.16</td>
</tr>
<tr>
<td>2002 – 2003</td>
<td>1858.50</td>
<td>181.41</td>
</tr>
<tr>
<td>2003 – 2004</td>
<td>1778.60</td>
<td>176.97</td>
</tr>
<tr>
<td>2004 – 2005</td>
<td>1193.60</td>
<td>268.02</td>
</tr>
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</table>

Source: Food and Agriculture Organization of the United Nations (FAO)
References


Quality Control of Jute Geotextiles & Development of Testing Facilities

Dr. Abdul Jabbar Khan

ABSTRACT

This study was undertaken to find out the feasibility of using Jute Geotextiles (JGT) as an alternative to man-made geotextiles in civil engineering applications. Four types of untreated JGT samples were selected from Bangladesh Jute Mills Corporation (BJMC) and Bangladesh Jute Research Institute (BJRI). Subsequently these were treated with bitumen. Physical, mechanical, hydraulic, short term and long term tensile tests were performed both on treated and untreated JGT samples. It is appreciated that, neither any standard test method nor any design approach related to JGT are currently available. The ASTM and DIN standard test methods for determining the properties and the design approach commonly employed for geotextiles were adopted.

The application areas for JGT were identified as the filtration in cross plane flow, separation of dissimilar materials, reinforcement of weak soils and in-plane flow. These applications, test methods and design approach have been discussed elaborately. The test procedures and results obtained are presented with graphs and charts. An attempt has been made to compare these test results with available geotextile data. Based on these test results some design examples have been presented using the procedures for geotextiles as outlined by Koerner (1997). An economic aspect related to geotextile and JGT is also presented in this study.

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KEYWORDS

Jute geotextiles; synthetic geotextiles; biodegradability; index, mechanical and hydraulic properties; economic aspects.

INTRODUCTION

Jute geotextiles (JGT) has emerged as a strong alternative to synthetic geotextiles for many civil engineering applications. Synthetic geotextiles being made from non-biodegradable polymer based constituents such as polypropylene, polyester or polyethylene, have inherent advantage over natural fibre based biodegradable JGT for long-term applications. Due to their short life span, JGTs are used as separator, vegetation growing mesh on slopes or as vertical drains. Recently, Bangladesh Jute Research Institute (BJRI) and Bangladesh Jute Mills Corporation (BJMC) have developed some treatment techniques for JGTs which may enhance their life up to or even more than twenty years, Table 1. Development of such durable JGT materials is likely to allow them to be used in short-term to medium-term soil reinforcement applications, e.g. rural roads, construction access roads, flood and road embankments etc.

Besides, development of enhanced durability of JGT, it is equally important to set widely acceptable testing standards for these materials. Currently, in absence of any such recognized testing standard, the ASTM, BS, DIN or ISO methods of testing usually employed for synthetic geotextiles are most commonly adopted for the determination of the properties of JGT. Apparently there seems to be no reason why the standards used for synthetic geotextiles should not be applicable for JGTs. However, as the industry gains further momentum and use of JGT gets wider acceptance, the issue may be settled based on technical and construction experiences.
### Table 1. Summary of jute blended with different materials at BJRI

<table>
<thead>
<tr>
<th>Type</th>
<th>Composition</th>
<th>Possible Durability</th>
<th>Biodegradability</th>
<th>Moisture Content</th>
<th>Wt/Unit area (lb)</th>
<th>Tensile Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woven Jute in different structure</td>
<td>Jute</td>
<td>2-6 month</td>
<td>Quick</td>
<td>12-14%</td>
<td>220-800</td>
<td>120-140</td>
</tr>
<tr>
<td>Woven Jute in different structure</td>
<td>Jute, Coir</td>
<td>5-12 month</td>
<td>Slow</td>
<td>7-10%</td>
<td>220-800</td>
<td>240-660</td>
</tr>
<tr>
<td>Woven Jute but treated composite</td>
<td>Jute, Bitumen</td>
<td>6-48 month</td>
<td>Long run</td>
<td>3-8%</td>
<td>Var. Wt.</td>
<td>140-700</td>
</tr>
<tr>
<td>Non woven</td>
<td>Jute blanket</td>
<td>6-18 month</td>
<td>Slow</td>
<td>8-12%</td>
<td>800</td>
<td>300-800</td>
</tr>
<tr>
<td>Non woven</td>
<td>Jute Blanket + Latex</td>
<td>5-20 year</td>
<td>Long run</td>
<td>5-7%</td>
<td>&gt;800</td>
<td>&gt;800</td>
</tr>
<tr>
<td>Woven with different construction</td>
<td>Jute latex</td>
<td>5-20 year</td>
<td>Long run</td>
<td>5-7%</td>
<td>&gt;800</td>
<td>300-800</td>
</tr>
</tbody>
</table>

Source: Abdullah (1999) "A hand book on geotextiles particularly natural geotextiles from jute and other vegetable fibres".

### TEST RESULTS OF SOME JGT PRODUCED IN BANGLADESH

Untreated samples of Jute was obtained from BJRI and untreated Canvas, DW Twill and Hessian were selected from BJMC for the purpose of this study. It should be appreciated that Jute fabric is generally densely woven in which relatively flat type of yarn is used. It is manufactured in BJRI loom mainly for research purpose. However, if ordered, Jute fabrics can be produced in all the jute mills for commercial purpose as well. Canvas is a very densely woven fabric, woven by round twisted yarns. Canvas was used to be produced mainly in ABC Mill of Adamjee Jute Mills. After the layoff of Adamjee Jute
Mills, all the machines were transferred to Latif Bawany Jute Mills situated at Demra of Dhaka. Canvas is the least porous out of the four and is now produced in Latif Bawany Jute Mills. DW Twill is also woven by using relatively flat type yarns like Jute. It is manufactured in many jute mills of Bangladesh. Hessian is the most porous amongst four and produced in all the jute mills of Bangladesh. Both DW Twill and Hessains are extensively used in the country mainly for packaging purpose.

Amongst the untreated JGT samples, Jute, Canvas and DW Twill samples were treated with bitumen by BJRI. The treatment procedure involved the following steps:

i) preparation of carbon black with required quantity of volatile oil

ii) addition of bitumen emulsion with paste followed by stirring

iii) after mixing homogenously, the emulsion was laminated on the jute fabrics by brush and dried in sunlight or open area at normal temperature and pressure (NTP).

The salient properties of the samples are presented in Table 2:

Table 2. Salient properties of JGT samples

<table>
<thead>
<tr>
<th>Trade Name</th>
<th>Source</th>
<th>Condition</th>
<th>Commercial Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Width (inch)</td>
</tr>
<tr>
<td>Jute</td>
<td>BJRI</td>
<td>Treated &amp; Untreated</td>
<td>40-50</td>
</tr>
<tr>
<td>Canvas</td>
<td>BJMC</td>
<td>Treated &amp; Untreated</td>
<td>36-45</td>
</tr>
<tr>
<td>DW (Double Works) Twill</td>
<td>BJMC</td>
<td>Treated &amp; Untreated</td>
<td>20-30</td>
</tr>
<tr>
<td>Hessian</td>
<td>BJMC</td>
<td>Treated</td>
<td>22-80</td>
</tr>
</tbody>
</table>

Source: Bangladesh Jute Mills Corporation Handout, 2003
The tests were then performed on these treated and untreated JGT samples at the geotechnical laboratory of Bangladesh University of Engineering & Technology (BUET). The list of the tests carried out on these samples and the test methods employed for performing the tests are given in Table 3.

For the purpose of comparison of the test results of these JGT samples with the synthetic geotextiles commonly used in Bangladesh, test results of twenty different varieties of non-woven synthetic geotextiles were also obtained from BUET. The test results of JGT samples and non-woven synthetic geotextiles are summarized in Table 4. Some of the test results of JGT samples and non-woven synthetic geotextiles are also shown graphically in Figure 1 to Figure 5 for the purpose of comparison.

Table 3. Tests Performed on treated and untreated JGT samples

<table>
<thead>
<tr>
<th>SL</th>
<th>ASTM/DIN</th>
<th>ASTM/DIN Test Name</th>
<th>Properties to be determined</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D5261</td>
<td>Standard Test Method for Measuring Mass per Unit Area of Synthetic Geotextiles</td>
<td>Physical</td>
</tr>
<tr>
<td>2</td>
<td>D5199</td>
<td>Standard Test Method for Measuring the Nominal Thickness of Geosynthetics</td>
<td>Physical</td>
</tr>
<tr>
<td>3</td>
<td>D4595</td>
<td>Standard Test Method for Tensile Properties of Synthetic Geotextiles by the Wide-Width Strip Method</td>
<td>Mechanical</td>
</tr>
<tr>
<td>4</td>
<td>D4632</td>
<td>Standard Test Method for Grab Breaking Load and Elongation of Synthetic Geotextiles</td>
<td>Mechanical</td>
</tr>
<tr>
<td>5</td>
<td>DIN 54307</td>
<td>CBR Puncture Resistance</td>
<td>Mechanical</td>
</tr>
<tr>
<td>6</td>
<td>D3786</td>
<td>Standard Test Method for Hydraulic Bursting Strength of Knitted Goods and Nonwoven Fabrics</td>
<td>Mechanical</td>
</tr>
<tr>
<td>7</td>
<td>D4751</td>
<td>Standard Test Method for Determining Apparent Opening Size (AOS) of a Geotextile</td>
<td>Hydraulic Properties</td>
</tr>
<tr>
<td>8</td>
<td>D4491</td>
<td>Standard Test Methods for Water Permeability of Synthetic Geotextiles by Permittivity</td>
<td>Hydraulic</td>
</tr>
</tbody>
</table>
Table 4. Test results of treated JGT, untreated JGT and synthetic geotextiles (Mohy 2005)

<table>
<thead>
<tr>
<th>Product</th>
<th>Condition</th>
<th>Mass per unit area (g/m²)</th>
<th>Thickness (mm)</th>
<th>Wide width tensile strength (kN/m) MD/XMD</th>
<th>Grab tensile strength (N) MD/XMD</th>
<th>CBR puncture resistance (N)</th>
<th>Burst strength (kPa)</th>
<th>Permittivity (S⁻¹)</th>
<th>AOS (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jute</td>
<td>Treated</td>
<td>1600</td>
<td>3.5</td>
<td>15/18</td>
<td>800/700</td>
<td>4000</td>
<td>1500</td>
<td>0.06</td>
<td>0.0 to &lt;0.075</td>
</tr>
<tr>
<td></td>
<td>Untreated</td>
<td>800</td>
<td>2.8</td>
<td>10/12</td>
<td>400/220</td>
<td>1500</td>
<td>1250</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>Canvas</td>
<td>Treated</td>
<td>1200</td>
<td>2.5</td>
<td>27/15</td>
<td>1100/700</td>
<td>1800</td>
<td>1600*</td>
<td>0.0</td>
<td>0.0 to &gt;0.075</td>
</tr>
<tr>
<td></td>
<td>Untreated</td>
<td>500</td>
<td>1.3</td>
<td>23/14</td>
<td>850/400</td>
<td>1700</td>
<td>2400</td>
<td>0.03</td>
<td>0.09</td>
</tr>
<tr>
<td>DW Twill</td>
<td>Treated</td>
<td>1400</td>
<td>3.1</td>
<td>25/32</td>
<td>1000/900</td>
<td>1700*</td>
<td>2600</td>
<td>0.21</td>
<td>&lt;0.075</td>
</tr>
<tr>
<td></td>
<td>Untreated</td>
<td>750</td>
<td>2.4</td>
<td>23/26</td>
<td>900/750</td>
<td>4500</td>
<td>2400</td>
<td>0.25</td>
<td>0.8</td>
</tr>
<tr>
<td>Hessian</td>
<td>Untreated</td>
<td>300</td>
<td>1.5</td>
<td>12/14</td>
<td>210/220</td>
<td>1500</td>
<td>1400</td>
<td>1.19</td>
<td>1.0</td>
</tr>
<tr>
<td>Synthetic</td>
<td>Non-woven geotextiles</td>
<td>240-640</td>
<td>2.0-4.5-[15-31]</td>
<td>[1160-5450] /[780-1900]</td>
<td>2660-3800</td>
<td>4500</td>
<td>0.4-1.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Reduced after treatment
Figure 1. Mass per unit area of synthetic geotextiles, untreated JGT and treated JGT (Mohy, 2005)

Figure 2. Thickness of synthetic geotextiles, untreated JGT and treated JGT (Mohy, 2005)
Figure 3.  Grab tensile strength of synthetic geotextiles, untreated JGT and treated JGT (Mohy, 2005)

Figure 4.  Wide-width tensile strength of synthetic geotextiles, untreated JGT and treated JGT (Mohy, 2005)
It may be noted from these test results that the properties of JGT samples generally improve after treatment. However, AOS and cross-plane permeability of some of the samples (Jute and Canvas) literally reduces to zero due to blocking of the openings by application of bituminous agents for treatment. It should be further appreciated that synthetic geotextiles have better index, mechanical and hydraulic properties compared to JGT materials. This indicates that manufacturers and researchers should put more technical efforts to improve the properties of JGT materials so that they become obvious alternative to synthetic geotextiles.

REDUCTION FACTORS/PARTIAL FACTORS FOR JGT

Reinforced soil walls, embankments, slopes etc. are generally analysed and designed by Limit Equilibrium Method or Limit State Approach. Both of these design methods/approaches apply several reduction factors or partial factors to the ultimate values of synthetic geotextiles in order to obtain an allowable value of the mechanical and hydraulic properties.
Strength-Related Problems

In strength related problems the allowable value for synthetic geotextiles is obtained as:

\[
T_{\text{allow}} = T_{\text{ult}} \left( \frac{1}{RF_{\text{id}} \times RF_{\text{cr}} \times RF_{\text{cd}} \times RF_{\text{bd}}} \right)
\]

Where:

\( T_{\text{allow}} \) = allowable tensile strength of synthetic geotextile

\( T_{\text{ult}} \) = ultimate tensile strength of synthetic geotextile

\( RF_{\text{id}} \) = reduction factor for installation damage

\( RF_{\text{cr}} \) = reduction factor for creep

\( RF_{\text{cd}} \) = reduction factor for chemical degradation

\( RF_{\text{bd}} \) = reduction factor for biological degradation

Typical values for strength reduction factors are given in Table 5. These values are usually tempered by the site-specific considerations.

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Range of Reduction Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Installation Damage</td>
</tr>
<tr>
<td>DegradationSeparation</td>
<td>1.1 to 2.5</td>
</tr>
<tr>
<td>Unpaved roads</td>
<td>1.1 to 2.0</td>
</tr>
<tr>
<td>Walls</td>
<td>1.1 to 2.0</td>
</tr>
<tr>
<td>Embankments</td>
<td>1.1 to 2.0</td>
</tr>
<tr>
<td>Bearing capacity</td>
<td>1.1 to 2.0</td>
</tr>
<tr>
<td>Slope stabilization</td>
<td>1.1 to 1.5</td>
</tr>
<tr>
<td>Pavement overlays</td>
<td>1.1 to 1.5</td>
</tr>
</tbody>
</table>
Flow-Related Problems

For filtration and drainage applications problems dealing with flow through or within a synthetic geotextile, the formulation of the allowable values takes the following form:

\[
Q_{\text{allow}} = Q_{\text{ult}} \left( \frac{1}{RF_{\text{SCB}} \times RF_{\text{CR}} \times RF_{\text{IN}} \times RF_{\text{CC}} \times RF_{\text{BC}}} \right)
\]

Where:

\(Q_{\text{allow}}\) = allowable flow rate of synthetic geotextile

\(Q_{\text{ult}}\) = ultimate flow rate of synthetic geotextile

\(RF_{\text{SCB}}\) = reduction factor for soil clogging and blinding

\(RF_{\text{CR}}\) = reduction factor for creep reduction of void space

\(RF_{\text{IN}}\) = reduction factor for adjacent materials intruding into synthetic geotextile void

\(RF_{\text{CC}}\) = reduction factor for chemical clogging

\(RF_{\text{BC}}\) = reduction factor for biological clogging

Typical values for flow reduction factors are given in Table 6. It may be noted that these values are generally tempered by the site-specific conditions.
Table 6. Recommended reduction factor values for flow-related problems (Koerner 1997)

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Range of Reduction Factors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soil Clogging and Blinding</td>
</tr>
<tr>
<td>Retaining wall filters</td>
<td>2.0 to 4.0</td>
</tr>
<tr>
<td>Underdrain filters</td>
<td>5.0 to 10</td>
</tr>
<tr>
<td>Erosion-control filters</td>
<td>2.0 to 10</td>
</tr>
<tr>
<td>Landfill filters</td>
<td>5.0 to 10</td>
</tr>
<tr>
<td>Gravity drainage</td>
<td>2.0 to 4.0</td>
</tr>
<tr>
<td>Pressure drainage</td>
<td>2.0 to 3.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Creep Reduction of Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retaining wall filters</td>
<td>1.5 to 2.0</td>
</tr>
<tr>
<td>Underdrain filters</td>
<td>1.0 to 1.5</td>
</tr>
<tr>
<td>Erosion-control filters</td>
<td>1.0 to 1.5</td>
</tr>
<tr>
<td>Landfill filters</td>
<td>1.5 to 2.0</td>
</tr>
<tr>
<td>Gravity drainage</td>
<td>2.0 to 3.0</td>
</tr>
<tr>
<td>Pressure drainage</td>
<td>2.0 to 3.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Intrusion into Voids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retaining wall filters</td>
<td>1.0 to 1.2</td>
</tr>
<tr>
<td>Underdrain filters</td>
<td>1.0 to 1.2</td>
</tr>
<tr>
<td>Erosion-control filters</td>
<td>1.0 to 1.2</td>
</tr>
<tr>
<td>Landfill filters</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>Gravity drainage</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>Pressure drainage</td>
<td>1.0 to 1.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Chemical Clogging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retaining wall filters</td>
<td>1.0 to 1.2</td>
</tr>
<tr>
<td>Underdrain filters</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>Erosion-control filters</td>
<td>1.0 to 1.2</td>
</tr>
<tr>
<td>Landfill filters</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>Gravity drainage</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>Pressure drainage</td>
<td>1.1 to 1.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Biological Clogging</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retaining wall filters</td>
<td>1.0 to 1.3</td>
</tr>
<tr>
<td>Underdrain filters</td>
<td>2.0 to 4.0</td>
</tr>
<tr>
<td>Erosion-control filters</td>
<td>2.0 to 4.0</td>
</tr>
<tr>
<td>Landfill filters</td>
<td>5.0 to 10</td>
</tr>
<tr>
<td>Gravity drainage</td>
<td>1.2 to 1.5</td>
</tr>
<tr>
<td>Pressure drainage</td>
<td>1.1 to 1.3</td>
</tr>
</tbody>
</table>

It should be appreciated that, to date, no such reduction factors/partial factors have been identified for JGT materials. This is an area where researchers and industries should pay immediate attention for successful implementation of JGT projects. Meanwhile, the values recommended for synthetic geotextiles may be adopted.

DESIGN EXAMPLES

Analysis and design for separation, filtration, drainage, reinforced wall and reinforced embankment using the properties of JGT samples have been carried out for the design examples given by Koerner (1997) for the purpose of comparison of outcome designs with those of synthetic geotextiles. By way of example, design of a JGT reinforced vertical wall and design of goejute filter behind a retaining wall are presented.
JGT reinforced vertical walls

A 6 m high wrap-around type of JGT wall is to carry a storage area of equivalent dead load of 10 kPa. The wall is to backfilled with a granular soil (SP) having the properties of $\gamma = 18 \text{kN/m}^3$, $\phi = 36^\circ$, and $c_a = 0$. A treated DW Twill with warp (machine) direction ultimate wide-width tensile strength of 25 kN/m (Table 4) and friction angle with granular soil of $\delta = 24^\circ$ (since no test of DW Twill related to $\phi$ is carried out, the usual value applied for synthetic geotextile, i.e. $2/3$ $\phi$ is taken) is intended to be used in its construction. The orientation of the JGT is perpendicular to the wall face and the edges are to be overlapped or sewn to handle the weft (cross machine) direction. A factor of safety of 1.4 is to be used along with site-specific reduction factors. For the design of this JGT wall, the method outlined by Koener (1997) for synthetic geotextile reinforced walls is used. The outcome design is shown in Figure 6.

Figure 6. Outcome design of a 6.0m high wall using treated DW Twill JGT
JGT filter behind a retaining wall

Given a 3.5 m high gabion wall consisting of three 1 x 1 x 3 m long baskets sitting on a 0.5 x 2 x 3 m long mattress as shown below, the backfill soil is a medium-dense silty sand $ofd_{10} = 0.03$ mm, $C_u = 2.5$, $k = 0.0075$ m/s, and $D_R = 70\%$. It is required to check the adequacy of four candidate untreated JGTs whose laboratory test properties are given below. The recommended reduction factors and design method outlined by Koemer (1997) are used.

<table>
<thead>
<tr>
<th>No</th>
<th>JGT Type</th>
<th>Permittivity (s$^{-1}$)</th>
<th>AOS (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jute</td>
<td>0.28</td>
<td>0.28</td>
</tr>
<tr>
<td>2</td>
<td>Canvas</td>
<td>0.03</td>
<td>0.075</td>
</tr>
<tr>
<td>3</td>
<td>DW Twill</td>
<td>0.25</td>
<td>0.8</td>
</tr>
<tr>
<td>4</td>
<td>Hessian</td>
<td>1.19</td>
<td>1.0</td>
</tr>
</tbody>
</table>

Figure 7. Flow net behind the gabion wall (after Koerner, 1997)
The design of filter is intended to ensure:

i) Adequate flow of water across the plane of JGT. This is achieved through a factor of safety of 2.0 against permittivity.

ii) No backfill soil loss through the JGT filter. This is achieved by satisfying the Carroll (1983) criteria $O_{95} < 2.5 \ d_{85}$

On the basis of the above and the procedure outlined by Koerner (1997) the outcome analysis is summarized in Table 7.

### Table 7. Summary of the outcome analysis of the JGT filter design

(Mohy, 2005)

<table>
<thead>
<tr>
<th>Product</th>
<th>FoS against permittivity</th>
<th>FoS against AOS</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Untreated Jute</td>
<td>10.9 &gt; 2.0</td>
<td>1.34 &gt; 1.0</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Untreated Canvas</td>
<td>1.17 &lt; 2.0</td>
<td>5.0 &gt; 1.0</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>Untreated DW Twill</td>
<td>9.94 &gt; 2.0</td>
<td>0.46 &lt; 1.0</td>
<td>Unacceptable</td>
</tr>
<tr>
<td>Untreated Hessian</td>
<td>47.0 &gt; 2.0</td>
<td>0.375 &lt; 1</td>
<td>Unacceptable</td>
</tr>
</tbody>
</table>

Thus, it appears that for the given problem untreated Jute may be considered to be the only competent candidate.

**COMPARATIVE COSTS OF JGT AND SYNTHETIC GEOTEXTILES**

In making a proper economic assessment or evaluation, a number of inputs are required such as material cost, labour cost etc. Again, these inputs vary from place to place. In this study, an attempt has been made to analyse the comparative costs of untreated and treated JGT collected from BJRI, BJMC and local market. The comparative costs of the untreated JGT samples are shown in Figure 8.

A cost comparison between different types of locally available synthetic geotextiles is shown in Table 8. It appears that locally manufactured synthetic geotextiles are cheaper than the imported ones. No woven synthetic
geotextiles are produced locally and prices of imported woven synthetic geotextiles are around 10% more than the nonwoven ones. The comparative costs of treated JGT with synthetic geotextiles are shown in Figure 9.

![Figure 8. Comparative costs of the untreated JGT samples (Mohy, 2005)](image)

**Table 8. Cost of woven and nonwoven synthetic geotextiles (Mohy, 2005)**

<table>
<thead>
<tr>
<th>Thickness (mm)</th>
<th>Nonwoven (locally produced)</th>
<th>Nonwoven (Imported) (including tax)</th>
<th>Woven (Imported) (including tax)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>4.65</td>
<td>5.55</td>
<td>6.11</td>
</tr>
<tr>
<td>2.0</td>
<td>5.11</td>
<td>7.09</td>
<td>7.80</td>
</tr>
<tr>
<td>2.5</td>
<td>5.40</td>
<td>8.31</td>
<td>9.14</td>
</tr>
<tr>
<td>3.0</td>
<td>6.50</td>
<td>11.19</td>
<td>12.30</td>
</tr>
<tr>
<td>3.5</td>
<td>7.43</td>
<td>13.25</td>
<td>14.58</td>
</tr>
<tr>
<td>4.03</td>
<td>8.36</td>
<td>17.36</td>
<td>19.10</td>
</tr>
<tr>
<td>Average</td>
<td>6.25</td>
<td>10.46</td>
<td>11.51</td>
</tr>
</tbody>
</table>
The costing of different jute products developed by BJRI in 1997 by blending jute with hydrophobic fiber like coir or by modification with bitumen, latex and wax resinous materials with the collaboration of BJMC and other governmental and nongovernmental organizations are listed in Table 9.

Table 9: Summary of cost of jute blended with different materials at BJRI

<table>
<thead>
<tr>
<th>Type</th>
<th>Composition</th>
<th>Possible Durability</th>
<th>Wt./Unit area</th>
<th>Cost Tk/yd²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woven Jute in different structure</td>
<td>Jute</td>
<td>2-6 month</td>
<td>220-800</td>
<td>8-18</td>
</tr>
<tr>
<td>Woven Jute in different structure</td>
<td>Jute, Coir</td>
<td>5-12 month</td>
<td>220-800</td>
<td>12-32</td>
</tr>
<tr>
<td>Woven Jute but treated composite</td>
<td>Jute Bitumen Carbon</td>
<td>6-48 Month</td>
<td>Var. Wt.</td>
<td>12-35</td>
</tr>
<tr>
<td>Non woven</td>
<td>Jute blanket</td>
<td>6-18 month</td>
<td>800</td>
<td>65</td>
</tr>
<tr>
<td>Non woven</td>
<td>Jute Blanket + Latex</td>
<td>5-20 year</td>
<td>≥800</td>
<td>80</td>
</tr>
<tr>
<td>Woven with different construction</td>
<td>Jute latex</td>
<td>5-20 year</td>
<td>≥800</td>
<td>20-40</td>
</tr>
</tbody>
</table>

(Source: Directorate of Technology, BJRI)
ECONOMIC BENEFIT OF USING JGT IN DIFFERENT APPLICATIONS

On the basis of the analysis and design with JGT and synthetic geotextiles undertaken in this study for different applications and also on the basis of the costs of these materials mentioned above, it is suggested that by using JGT materials instead of synthetic geotextiles, a cost benefit of 35%-50% may be obtained. However, the technical shortcomings and durability restrictions of JGT materials must be appreciated prior to any application.

CONCLUDING REMARKS

It is appreciated that the inherent drawback of the untreated JGT materials is their short life span due to biodegradability. This restricts JGTs to be used as separator, vegetation-growing mesh on slopes or as vertical drains. Recently, BJRI has been able to develop some treatment techniques by means of which it is possible to ensure 'designed biodegradability' of these materials. Development of such durable JGT materials is likely to allow them to be used in short-term to medium-term soil reinforcement applications, e.g. rural roads, construction access roads, flood and road embankments etc. Although a lot requires to be done regarding determination and improvement of their index properties, mechanical properties, hydraulic properties, interaction behaviour and reduction factors, based on the current methods of designing with synthetic geotextiles, JGT materials seem to be a potential alternative. This is further accentuated by the significant cost benefit that may be accrued from using JGT materials instead of synthetic geotextiles.
REFERENCES


A Critical Review On quality Control And Testing of Jute Geotextiles

Dr. Prabir Ray*, Swapan Kumar Ghosh** and Ashis Mukherjee**

ABSTRACT

Jute Geotextiles (JGT) can be classified into three district types considering the distinct fabric – features and form - Open weave (commonly known as Soil Saver), woven and non-woven Jute Geotextiles.

The first category has been in use for years for surface soil erosion, slope protection and embankment stabilization where as the second type has established its effectiveness in performing functions of separation, filtration, drainage and initial reinforcement. The third type (non-woven JGT), which is low in tensile strength, is principally applied for facilitating drainage and sometimes used in combination with the second type to exploit the dominant physical properties of the two types.

The jute industry usually produces three broad categories of open weave JGT featuring weight per unit area principally (200 gsm, 500 gsm & 750 gsm).

Woven JGT has a large potential though it remains to be fully exploited. Fabrics of varying tensile strength and AOS (Apparent opening size) can be produced to meet site-specific needs.

The present paper contains a detailed study of properties tested and compared with the recommended specifications for high ways recommended by the Indian Road Congress (IRC / SP : 49-2002) to establish the suitability for such applications. The test methodology followed in evaluating those properties have also been described. Abrupt variation in test results due to faults in manufactured are also highlighted.

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INTRODUCTION

Geo-textile may be defined as –

"Any permeable textile used for filtration, drainage, separation, reinforcement and stabilization purposes as an integral part of civil engineering structures of earth, rock or other constructional materials".

**Geo-textiles may be classified as follows:**

1. Geo Synthetics
2. Geo Nets
3. Geo Grids – Geo pipes
4. Geo Composites
5. Geo Membrane

In the International Bodies it is customary to refer Geo-textiles under Geo-synthetics. It is a misnomer that there is no specific effort in the International Bodies to come out with a nomenclature for the natural fibres when it is used as Geo-textiles. As jute is the largely used fibre for natural geo-textiles it should be classified under different nomenclature.

**Broad Areas of Application of Geo-textiles**

- Bank & bed protection
- Soil reinforcement
- Land drainage
- Vertical drainage
- Rail/Road construction
- Barrier construction
Why jute should be used for Geo-textiles

Following are the reasons for use of jute as Geo-textile:

- High strength & modulus with low extensibility
- Durable and good dimensional stability
- Good moisture absorption
- High co-efficient of friction
- Good thermal, sound and electrical insulation properties
- Unique surface morphology
- Fibre available in bulk
- Agro based, eco-friendly, biodegradable fibre
- Cost effective fibre
- Better absorbency & degrade with time
- Vegetation / Afforestation
- Increases Soil Fertility
- Cake formation after biodegradation
- Fabric can be treated with chemicals to improve following endurance properties.
  - Ultraviolet degradation
  - Microbial degradation
  - Chemical resistance

JUTE GEO-TEXTILES – PROPERTIES AND EVALUATION

Types of JGT, their properties and evaluation –

Three basic types of Jute Geo-textiles (JGT) are available viz. woven, open weave mesh and non-woven.
Woven JGT is a fabric which is manufactured by interlacement of warp and weft yarns set at right angle to each other through a machine called loom. Open weave JGT is woven in similar manner but by using a thick yarns with pore size of about 20mm x 25mm.

Non-woven JGT is a randomly placed fibrous web of jute fibre and is bonded mechanically through needle punching machine.

It is worth mentioning that JGT can be tailor-made to meet site-specific requirements.

Initially, woven JGT were available for a width of 76 cm. The width necessitates more overlaps and hence wastage. Wider (2 m woven JGTs of varying tensile strengths ranging from 15 kN/m to 30 kN/m have been put to use in the PMGSY Pilot Project in rural roads. The properties of all the three varieties of JGTs tested at laboratory. The observed values of the parameters of JGT have been compared with the specifications of geo-synthetics (SGT) recommended by the Indian Roads Congress for highways (IRC: SP: 59 – 2002) to establish the suitability of JGT for such applications.

**Parameters to be considered for a Jute Geo-textile** –

- Constituent material and method of manufacture
- Mass per unit area
- Thickness
- Opening size
- Roll width, roll length
- Tensile strength/Elongation
- Seam strength
- Interface friction
- Permittivity (flow normal to the geo-textiles)
- Transmissivity (flow in the plane of the geo-textiles)
- Puncture resistance
- Tear resistance
Types of Tests to be conducted for Geo-textile –

| 01. | Width (cm) |
| 02. | Weight (g/m²) at 20% MR |
| 03. | Ends/dm X Picks/dm |
| 04. | Thickness (mm) |
| 05. | Tensile strength (Grab method) & (Strip method)(kN/m), MD X CD |
| 06. | Elongation at Break (%), MD X CD |
| 07. | Trapezoidal Tear Strength (N) |
| 08. | Bursting strength (kPa), (kg/cm²) |
| 09. | Puncture resistance (kN) |
| 10. | Cone drop Test (mm) |
| 11. | Flow Rate (l/m²/min) at 50 mm Constant Water Head Pressure |
| 12. | Permittivity (s⁻¹) at 50 mm Constant Water Head Pressure |
| 13. | Permeability (cm/s) at 50 mm Constant Water Head Pressure |
| 14. | Apparent Opening Size (micron), O₉₆ |

APPLICATION OF JUTE GEOTEXTILES

The Ministry of Textiles with support from the Ministry of Rural Developments approved use five States have been identified to lay jute geo-textiles initially and to find out the performance of jute geo-textiles and its cost effectiveness.

For the above work five types of jute geo-textiles were chosen. These jute geo-textiles were suggested by CRRI after long research. The specifications of these jute geo-textiles are as follows:
a) Specification of Woven JGT

<table>
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<tr>
<th>Nomenclature Construction</th>
<th>15kN Twill Weave (2/1)</th>
<th>20kN Twill Weave (2/1)</th>
<th>30kN Twill Weave (2/1)</th>
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<td>760</td>
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<tr>
<td>Width (cm)</td>
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<td>76</td>
<td>76</td>
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<tr>
<td>Ends x Picks/dm</td>
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b) Specifications of Open Weave Woven JGT

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12 Mills were chosen to produce type 'a' (woven JGT), 6 mills were chosen to produce type 'b' (open Mesh JGT) and one mill was chosen for Non-woven JGT. All the samples were tested at the testing laboratory of Institute of Jute Technology (IJT). Mills were informed to produce 76 cm of woven cloth as most of the mills were not ready to use broad looms. Soil Saver (type b) has been produced in a standard loom of 1.22 m width loom whereas non-woven samples have been prepared with 1.5 m width. Following tests were carried out -
1. Width (cm)
2. Weight (g/m²) at 20% MR
3. Ends/dm X Picks/dm
4. Thickness (mm)
5. Tensile strength (Strip method) (kN/m), MD X CD
6. Elongation at Break (%), MD X CD
7. Bursting strength (kPa)
8. Puncture resistance (kN)
9. Cone drop Test (mm)
10. Flow Rate (l/m²/s) at 50 mm Constant Water Head Pressure
11. Permittivity (s⁻¹) at 50 mm Constant Water Head Pressure
12. Permeability (cm/s) at 50 mm Constant Water Head Pressure
13. Apparent Opening Size (micron), O₉₅

After conducting the tests results were tabulated in Table I – IV. Test results were discussed with the technical personnel of the mills.

Table – I, II & III shows the results of 15 kN/20 kN/30 kN Jute Geo-textiles Woven fabric produced by 12 different mills.

Table – IV shows the Wide Width Tensile Strength Test for Jute Geo-textiles of all 12 mills. It can be seen that those who supplied 200 cm of fabric initially are lacking in providing the higher tensile strength compared to the mills who have supplied only 76 cm fabric.

Table – V shows the result of Apparent Opening Size (AOS) for different jute geo-textiles. From these results it may be seen that those who produced the 2 m width JGT, could not supply the fabric as far as the fabric opening size and the permittivity are concerned due to manufacturing defects.

Table – VI shows the Permittivity of different types of JGT.
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Table – 1: Test Results for 12 Mills
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Table – III: Test Results for 12 Mills
For 30 kN Jute Geo-textile Woven Fabric

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<td>Elongation at Break (%) (Warp X Weft)</td>
<td>Tensile strength (kN/m) Strip method (Warp X Weft)</td>
<td>Elongation at Break (%) (Warp X Weft)</td>
<td>Tensile strength (kN/m) Strip method (Warp X Weft)</td>
<td>Elongation at Break (%) (Warp X Weft)</td>
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**Table V: Test Results for 12 Mills - Results of Apparent Size (O95) for different Geo-textiles**

### Specification - A (15 kN Woven Jute Geo-textile)

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<td>Apparent Opening Size (micron), O95</td>
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<td>260</td>
<td>920</td>
<td>270</td>
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<td>188</td>
<td>910</td>
<td>186</td>
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<td>270</td>
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### Specification - B (20 kN Woven Jute Geo-textile)

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<th>6.</th>
<th>7.</th>
<th>8.</th>
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<th>10.</th>
<th>11.</th>
<th>12.</th>
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<td></td>
<td>Apparent Opening Size (micron), O95</td>
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<td>55</td>
<td>185</td>
<td>155</td>
<td>150</td>
<td>150</td>
<td>187</td>
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<td>80</td>
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### Specification - C (30 kN Woven Jute Geo-textile)

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<td>115</td>
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<td>8.</td>
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</tr>
<tr>
<td>Flow Rate (l/m²/s)</td>
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<td>182.58</td>
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<td>149.54</td>
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<td>176.56</td>
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<td>119.43</td>
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<td>Permittivity (s⁻¹)</td>
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<td>3.65</td>
<td>2.31</td>
<td>2.99</td>
<td>1.87</td>
<td>3.53</td>
<td>1.84</td>
<td>1.63</td>
<td>2.39</td>
<td>1.97</td>
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<tr>
<td>Permeability (cm/sec)</td>
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<td>0.57</td>
<td>0.764</td>
<td>0.380</td>
<td>0.59</td>
<td>0.331</td>
<td>0.663</td>
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<td>0.243</td>
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<table>
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<td>Mills</td>
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<td>Property</td>
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<tr>
<td>Flow Rate (l/m²/s)</td>
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<tr>
<td>Permittivity (s⁻¹)</td>
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<td>Permeability (cm/sec)</td>
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<table>
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<th>Specification – C (30 kN Woven Jute Geo-textile)</th>
</tr>
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<tr>
<td>Mills</td>
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<tr>
<td>Property</td>
</tr>
<tr>
<td>Flow Rate (l/m²/s)</td>
</tr>
<tr>
<td>Permittivity (s⁻¹)</td>
</tr>
<tr>
<td>Permeability (cm/sec)</td>
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</table>
The above results were jointly discussed by the faculties with Geo-technical Cell of Jute Manufactures Development Council and Central Road Research Institute and considering the industry's capability of producing 2m. width of woven fabric, the criteria for different properties have been fixed. The same has been mentioned in Table – VII, VIII & IX. Similarly, the criteria as fixed have been compared with the specification laid down by IRC (IRC/SP:49-2002) for strength sub-surface drainage and erosion control (shown in Table – X, XI & XII) where the jute geo-textiles were found to be comparable and giving the same values or higher in all the cases. It may be, therefore concluded that Geo-textiles may be used for Class – 2 or Class – 3 highways to fulfill different geo-textiles functions.

Table – VII : For Woven JGT

<table>
<thead>
<tr>
<th>Nomenclature</th>
<th>15 kN/m</th>
<th>20 kN/m</th>
<th>30 kN/m</th>
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<td>Width (cm)</td>
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<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Weight (g/m²)</td>
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<td>760</td>
<td>810</td>
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<tr>
<td>Thickness (mm)</td>
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<tr>
<td>Tensile Strength (kN/m)</td>
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<td>20</td>
<td>30</td>
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<td>Elogation at Break (%)</td>
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<td>8</td>
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<tr>
<td>Bursting Strength (kPa) (MARV)</td>
<td>3100</td>
<td>3500</td>
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<td>Puncture Resistance (kN) (MARV)</td>
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<td>Permittivity at 50 mm constant head (per second) (MARV)</td>
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<td>350 X 10⁻³</td>
<td>350 X 10⁻³</td>
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<td>AOS (micron) – O₉₅ (MARV)</td>
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<td>Ends/dm X Picks/dm</td>
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<td>102 X 38</td>
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Table – VIII : For Open Weave JGT

Nomenculate – 500 gsm
Weight (g/m²) – 500
Thickness (mm) – 4
Width (cm) – 122
Open Area (%) – 50
Tensile Strength (kN/m)
MD – 10
CD – 7.5

Table – IX : For Non-woven JGT

• Nomenclature (type) for 500 gsm
• Weight (g/m²) – 500
• Thickness (mm) – 4
• Width (cm) – 200
• Tensile Strength (kN / m)
• MD – 4
• CD – 4
• AOS (O₉₅) – (micron) – 200
• Cone drop Test (mm) – 10
• Permittivity (per second) – 300 x 10⁻³
### Table – X: Comparative properties of JGT and SGT (IRC: SP: 59-2002)

**For strength properties for Highways requirements**

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Unit</th>
<th>Geo-textile Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Class - 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Strain&lt;50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(JGT)*</td>
</tr>
<tr>
<td>Grab Tensile Strength</td>
<td>ASTM D4632</td>
<td>N</td>
<td>1400</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(1300)</td>
</tr>
<tr>
<td>Tear</td>
<td>ASTM D4533</td>
<td>N</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(500*)</td>
</tr>
<tr>
<td>Puncture strength</td>
<td>ASTM D4833</td>
<td>N</td>
<td>500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(500*)</td>
</tr>
<tr>
<td>Burst strength</td>
<td>ASTM D3786</td>
<td>kPa</td>
<td>3500</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(3500*)</td>
</tr>
</tbody>
</table>

* Figs. for JGT apply to specification of fabric quality of 30kN/m,

### Table – XI: Geo-textile requirement for subsurface drainage

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Unit</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Percent in situ soil passing 0.0075 mm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;50% (JGT)*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Geo-textile class</td>
<td></td>
<td>Class 2</td>
<td></td>
</tr>
<tr>
<td>Permittivity**</td>
<td>ASTM D 4991</td>
<td>1/s</td>
<td>0.5 (0.5*)</td>
</tr>
<tr>
<td>AOS**</td>
<td>ASTM D 4751</td>
<td>mm.</td>
<td>0.43 (300)</td>
</tr>
<tr>
<td>UV Stability (retained strength)</td>
<td>ASTM D 4355</td>
<td>%</td>
<td>50% after 500 hr. of exposure UV stability of any JGT is hardly of any consequence when placed within pavement</td>
</tr>
</tbody>
</table>

Figs. for JGT apply to specification of fabric quality of 30kN/m
Table XII: Geo-textile requirements for permanent Erosion Control

<table>
<thead>
<tr>
<th>Property</th>
<th>Test Method</th>
<th>Unit</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Percent in situ soil passing 0.0075 mm</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>&lt;50%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(JGT)*</td>
</tr>
<tr>
<td>Geo-textile class</td>
<td></td>
<td></td>
<td>Class 2* (JGT)</td>
</tr>
<tr>
<td>Permittivity**</td>
<td>ASTM D 4991</td>
<td>1/s</td>
<td>0.5 (0.5*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.2 (0.3*)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.1 (0.25*)</td>
</tr>
<tr>
<td>Permittivity</td>
<td>ASTM D 4991</td>
<td>1/s</td>
<td>0.7 (0.75+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.2 (0.2+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.1 (0.1+)</td>
</tr>
<tr>
<td>AOS</td>
<td>ASTM D 4751</td>
<td>mm</td>
<td>0.43 (200+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>max. avg. roll value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.25 (180+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>max. avg. roll value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.22# (150+)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>max. avg. roll value</td>
</tr>
<tr>
<td>UV stability (Retained strength)</td>
<td>ASTM D 4355</td>
<td>%</td>
<td>50% after 500 hr. of exposure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>UV stability of any JGT is hardly of any consequence when placed within pavement</td>
</tr>
</tbody>
</table>

Data in the parentheses represent corresponding property parameters (JGT).

During the testing of the fabrics following faults were observed and the industry should in future take care of these faults -

**Some Comments on Testing**

❖ Fabric faults like missing ends, picks, cracks, starting marks, reed marks were seen to be running continuously in fabric causing irregular flow rate in permeability testing and pore size testing.

❖ Irregular thread spacing in warp and weft direction, bow and biased fabric may affect tensile strength etc.

**Suggestion for future work**

➢ Non-woven fabric may be produced at 2 m width or more as market demands.
Soil Saver (open weave JGT) may be produced with 1.22 m width loom (as existing). In case of higher width, pieces may be joined.

Presently the design of the fabric is twill but (1/1) plain weave may be tried.

For attaining the criteria for various test results, the fibre quality, fineness of yarn, thread spacing may be varied. The factor of cost effectiveness should also be considered.

Instead of double warp 6 in a dent twill weave (present JGT), single warp 3 in a dent twill fabric with a high reed porter may be thought of keeping the thread spacing constant.

The loom width must be of 2 m and more. The loom may be shuttle or shuttle-less loom. In case of shuttle loom following points should be considered.

- New 2 m wide loom will be preferable.
- Old broad loom of 2 m width may be used with modifications incorporating supporting brackets for crank shaft and bottom shaft, both side crank wheel and incorporating.
- Temple rollers.
- Smaller width loom should not be converted at all to a higher width loom.

REFERENCE


Market and Marketability of Jute Geotextile

Vinay Chand

ABSTRACT

Erosion control has always been a recurrent problem. It was used to be tackled on an adhoc basis using traditional materials like wood, cement and gabions but also rare use of coir matting and jute Hessian. Geotextiles are an important part of the erosion control materials market. In the 1970s German exporters promoted use of Jute Geotextiles for the emerging erosion control industry but the plastic industry was also looking for end-use applications that they could cater for and targeted sacking, carpet backing and geotextiles. By 1976 some 5,000 tons of jute were being sold as geotextile in the USA and 10,000 tons globally which accounted for 2% of the global market segment.

Today, some 20,000 tons of jute is being used for geotextiles and it accounts for just under 2% of the market segment after the market has doubled since 1980. The growth in use of jute has been significant. It occupies a greater share of the market for natural materials.

Natural materials have gained a great deal during this period as geotextiles. From a paltry 3% in 1980, natural materials today account for 15% of the geotextile market. There is some substitutability between the natural materials with straw and wood fibres far cheaper than either coir or jute. But they also have unique characteristics and there is certainly no competition between jute and coir although palm fibre being developed in Malaysia is able to marginally compete with both jute and coir offering yet another natural material albeit, with little known unique qualities.
The geosynthetic industry is facing a crisis due to the far higher feedstock prices as well as low profitability for the plants in the USA and Europe. In any case, there is a strong and growing preference on the part of many to use natural bio-degradable and sustainable materials. However, distribution of jute and coir is poor when compared to synthetics.

Jute has been marketed and promoted very poorly to the geotextile industry and there has been relatively little product development in the past. There are understandable reasons for this but it is also clear that there is very considerable scope for increasing market penetration and sales for jute provided the jute industry is interested and willing to do so.

Erosion Control

The two most important agents of soil erosion are wind and water. Large tracts of land are made unusable or less productive by these two. Erosion control has always been a problem and most people would accept that the problem grows every year. For a long time, very little was done except when it was a clear case of urgent needs such as flooding or landslides. To a large degree, the problem is still more ignored than acted on. It used to be tackled on an ad hoc basis using whatever was available including traditional materials like wood, rocks, cement, rubber and gabions but also rare use of coir matting and jute hessian.

It is argued by many that the use of erosion control measures and materials is cost affective but no studies have been published that have undertaken a cost benefit analysis. Therefore, the argument on erosion control is still largely an article of faith. There may be studies that have not been published but IECA is trying to undertake the analysis. The argument for erosion control, therefore, largely still rests on public opinion and that of professionals. With the spread of environmental consciousness more people become convinced of the common sense argument for action.
Use of materials is determined, of course, by the nature of the problem and choice of materials divides up into the time period that they are expected to last. Choice of materials depends on what is available and on what people become accustomed to. At one extreme are permanent works made from hard materials and expected to last a long time. Cement and ecment works, rocks, steel cages to hold the rocks, timber, steel nets and even rubber tyres fall into this category.

At the other extreme are Geotextiles which are an important part of the erosion control materials market. They too are divided by the expected longitude of their life as well as other characteristics. Advances in technology and consequently materials development has allowed an increasing rok- for geotextiles with different plastic structures that have been developed using large research and development budgets. But there was also a need for the characteristics of natural materials. In the way of an illustration, blankets can be made of straw, wood, waste fibres and have the advantage of also being cheap. A basic distinction is between wovens and non wovens and standard technology and machinery to produce both.

The use of geotextiles, whether they be synthetic or natural was being developed from the 1960s. The major effort was to come from synthetic fabric manufacturers looking for new market applications for a fast growing production. A number of textile manufacturers in Europe and in USA led the way. In the 1970s German exporters promoted use of geo-jute for the emerging erosion control industry but the plastic industry was also looking for end use applications that they could cater for and targeted sacking, carpet backing and geotextiles.

The plastics industry took action in the above areas where both, natural and synthetic textiles were applicable. The two global geosynthetics industry leaders today are Propex from USA and Tencate from Europe, the product of consolidation in the industry, but there are many others of substantial scale.
Both come from a polymers background. Propex has diversified into carpet backing cloth (CBC), geotextiles and concrete reinforcement. Tencate have diversified into geotextiles, artificial turf, protective clothing and other technical fabrics. The two have a turnover in hundreds of millions of dollars per annum. They both emphasise product development and a balance between volume and product differentiation. Between the two of them, they account for one third of all geosynthetics and 57% of USA and Europe sales of geosynthetics combined.

It is very difficult to quantify the market. All we have to go by is a square metre figure for geotextiles that is quoted without a clearly identified source. It is not clear what it covers and is not based on primary research. From this per square metre figure, which I estimate at 2 million sq m, another set of assumptions have to be made on average weight per square metre and the weighting of such a figure is not known, but I guess estimate as being one million tons.

**Natural Fibres**

Jute geotextiles were initially promoted in Germany and their partners in USA. Again, producers in India and Bangladesh could only look on with envy. Manufacture could be in India but the profits were in marketing. The margins were far higher than for traditional jute products.
The geosynthetic industry often agreed to distribute natural fibres as well to be able to offer a full range of products but their primary interest was and is overwhelmingly in promoting synthetics. Again, it is difficult to quantify but assuming a one million ton geotextiles figure, and similar figures I have estimated in the past, it is possible to try to give some sort of quantitative guidance.

By 1976 some 5,000 tons of jute were being sold as geotextile in the USA and assuming 10,000 tons globally, accounted for 2% of the global market segment. Jute was acting as a trail blazer for natural fibres in the sector.

Today, some 20,000 tons of jute is being used for geotextiles and it accounts for just under 2% of the market segment since the market has doubled since 1980. The growth in use of jute has been significant and is part of a greater share for natural materials. The main driver has been the unique natural characteristics of the fibre.

That would be very impressive were it not for the far more impressive market sales for coir. In contrast to the very limited promotion of jute for geotextiles, there have been a series of efforts to research the market and promote use of coir. It started off with looking at geotextiles as one of the high value export possibilities being looked at for coir. With time it became apparent that it was the most promising area and has taken coir from virually negligible market share (some white coir netting) to around 5.6%, nearly three times the tonnage of jute being used.

Natural materials have gained a great deal during this period as geotextiles. From a paltry 3% in 1980, natural materials today account for 15% of the geotextile market. There is some substitutability between the natural materials with straw and wood fibres far cheaper than either coir or jute. But the materials also have unique characteristics and there is certainly no competition between jute and coir although palm fibre being developed in Malaysia is able to marginally compete with both, jute and coir but offers yet another natural material albeit with little known unique qualities.
Coir promoters have increased the range of product-market applications. White fibre nets that sought to imitate geo-jute have led to cheaper brown fibre nets, matting and logs and pillows. A major contribution was made by the Federal policy in Germany of insulating public buildings that led to stitched blankets of coir seeded with perennial grass. Stitched blankets have proven very popular with geotextile buyers and have accounted for a great deal of the success of coir.

The geosynthetic industry is facing a crisis due to the far higher feedstock prices as well as low profitability for the plants in the USA and Europe. In any case, there is a strong and growing preference on the part of many to use natural bio degradable and sustainable materials. However, distribution of coir is poor when compared to synthetics and that of jute is very bad indeed.

Jute has been marketed and promoted very poorly to the geotextile industry and there has been relatively little product development in the past. There are understandable reasons for this but it is also clear that there is very considerable scope for increasing market penetration and sales for jute provided the jute industry is interested and willing to do so.

**Reasons for poor jute performance**

Geotextiles represent a substantial end use application area of the erosion control market. **Over 2 million square metres** (one million tons valued at S2.25 billion retail) are being used. It is also clear that although the market developed well in industrialised countries of North America, Europe, Far East and Australasia, the market has by no means reached saturation and only stands in the foothills of the potential global development.

The share of natural fibres in the geotextile market has increased dramatically due to considerations of sustainability and biodegradability as much as appreciation of the qualities and applicability of natural fibres for control of soil erosion and landscaping. But within this increased share for natural fibres jute has gained less than proportionately.
The principal reasons for this include:

1. The existence of a lucrative protected and growing Indian market,
2. Preferential treatment accorded to rice in policy in Bangladesh,
3. Virtual collapse of distribution,
4. Lack of market information,
5. Virtually no market development,
6. Very little product development,
7. No promotion after the 1970s.

The main reason is that those who could have acted to market and promote sales had not enough incentive while those who wanted to do so probably did not have the information, or the funds to do so.

The lack of marketing effort is not confined to geotextiles. There appears to be a more general weakness and the 7 points above would apply to most export jute application areas. They sum up the situation for jute.

At the beginning, the growth of domestic usage of jute had been welcomed as a way of minimising the affect of loss of export markets. But today, India is by far the biggest consumer and the local market is so lucrative that there is little incentive to put in the marketing effort to export. In India, critics have argued that it is the protection afforded by regulations on packaging but this would not explain why the same is true of Pakistan. In the case of the latter, there is no protection or subsidy but market demand is sufficient to afford a lucrative sanctuary. Bangladeshi consumption is rising and China, which had phased jute out is importing increasing amounts.

In contrast, with coir we have had:

1. Substantial increased production,
2. Export based development,
3. Distribution initiatives by producers,
4. ITC market studies and market development,
5. Product innovation,
6. Promotion by machinery manufacturers,
7. Local processing in consuming markets.

**Development potential**

The rate of growth of the market is reported by industry sources to have eased in recent years. But the market these sources were referring to is that in Europe and USA. What it did not take into account is the emergence of new markets in South America, Africa and Asia. These new markets, excluding China, India, Korea and Japan, today probably account for over 120,000 tons of geotextiles and without those exceptions, over 330,000 tons. Growth prospects in Asia are going to be an important future factor.

Therefore, the expectation is that current markets will continue to grow as well as new emerging markets that offer long term potential in addition to current markets. Unfortunately, there has been little effort to promote jute in these markets. Again, it applies to other end uses than geotextiles as well. Distribution of traditional jute products is poor to non existent.

Aside from current markets and emerging ones, there is also scope for new products in both these markets. There are good samples of new products that are being developed but the industry needs to increase product market scope that is specifically targeted at market needs. In other words, products must be developed with particular applications in mind.

Assuming that 20,000 tons of jute and over 40,000-50,000 tons of coir are being used in geotextiles, the market potential for jute is estimated at being more than double current use and possibly three times present consumption.
In fact, in all the areas where synthetics were able to take away most of the markets in the 1970s, there is potential for recovery if jute producers were interested. The problem is in supply. Potential market demand may exist for up to 100,000 tons of jute but there is no indication of it being forthcoming.

As for jute for geotextiles in particular, there is scope for use of existing products in road construction, embankments, golf courses and other landscaping. Further scope can be gained through product development which has been taking place in producing countries but is theoretical and not market led.

In the way of an illustration, stitched coir blankets gained popularity mainly because the Federal Government in Germany was persuaded that roof greening would increase insulation and lower energy consumption. It was manufactured using machinery from either of two German suppliers from Twistriggen, just outside Bremen. They saw a wider applicability for the material and production was quickly established in USA as well as in Germany and today has spread to India, Sri Lanka, Philippines and Ghana.

The important factor was that production of stitched blankets took place in consuming countries. There was thus no distribution problem and good contact with buyers. Those producing the blankets generally also sell other natural materials such as wood shaving, rice straw and others.

The coir industry has benefitted a great deal from efforts on their behalf by ITC, FAO and CFC. In particular, ITC undertook a series of projects to promote coir ending up in the CFC financed project that is the subject of a Technical Paper. We first identified potential exporters who were world market standard. Then we identified important end-users willing to evaluate samples, organised the dispatch of the samples and obtained reactions. The idea was to identify gaps in between what was being produced and what was demanded in order to undertake product development that would fill the gap. The markets studied
were extensive and included Australia, New Zealand, Japan, Korea, Saudi Arabia, Europe and USA. Coir producers acted on information, attended trade fairs and benefitted from good organisation of marketing.

**Market Development**

Although the USA remains the most important market for geotextiles, Asia has become comparable, followed by Europe and South America. In all these markets it is important to look at the specifics of demand in particular national markets, barriers and distribution. It is important to undertake detailed market research covering more markets than in the past.

All the materials stand to benefit from growth in the markets for erosion control products. Polypropylene stands to benefit the most and it is likely to be pp from India or China as much as if not more than from USA. Natural materials are increasingly preferred wherever they can meet needs as much as synthetics. Then there is competition between natural materials where they can be substituted for one another and the competition takes the form of price.

Jute, on one level, is in competition with other materials: with synthetics and other natural materials. But on another level depends on its unique characteristics and how far these are translated into products. There is a limited range of existing products that is well known in most markets. However, there are other products, such as the ones which have been sent to participants as samples that have been developed but are not widely known or accepted in markets as yet. Finally, there are other products, to be made of jute or in combination with other fibres that should be developed. The key thing is to make sure that product development work targets objective needs and that the ability of the product to meet those needs is adequately promoted to decision makers.
Detailed market research in national markets would identify development potential for existing jute products and the needs that jute can contribute to meeting. The producers who are interested in exporting these products should then be assisted in meeting required standards. Tests to validate performance should be undertaken in the markets and not in producing countries. The market research will also have identified optimal distribution for the products and a programme to promote them.

The spread of markets to be studied should be wider than in the past and should include North America, Europe, Asia, Australia, and parts of South America and Africa.
Market and Marketability of JGT – Need for Diversifying Production

D. C. Baheti

ABSTRACT

Market dimensions are determined by multidimensional forces of which consistently aggressive market research for possibility of replacement of the existing products with new products of better quality at competitive prices is of basic and paramount importance.

Marketability is again the result of fast paced research with a vision to develop new products of good quality for the market and improve upon the performance of the products already in market. It is the deliverance of the affordable good quality products and services which counts most to the sensitivity of the market.

Areas of application of Jute Geotextiles (JGT) encompass a wide range. There is need for developing high grade JGT with protracted effective life and high tensile strength for application in areas like sea-shore protection.

Jute woven and non-woven fabrics have proven to be excellent geo-textiles for soil erosion control. They can be produced from short fibres generated in processing of jute in every jute mills. A good use of the short fibres could also be made use of in production of non-woven fabrics for use as pre-seeding field cover.

Executive Director, Gloster Jute Mills Ltd., Kolkata & Chairman, Indian Jute Industries' Research Association, Kolkata – 700 088.
E-mail: info@glosterjute.com

Session – IV
Woven JGT smeared with bitumen / rot-resistant additive can be used extensively in construction of rural roads and protection of river banks. Jute hessians & non-wovens can be fruitfully used for management of solid waste generated every day. All these products are very easy to produce by jute mills on bulk scale.

Good biodegradability, hygroscropicity, high strength, good drapability, good response to bitumen coating, easy needle punching, ready availability in bulk, renewability and eco-friendliness properties, combine to offer JGT as an attractive product for soil improvement in general.

The areas of concern are :

a) Low level agricultural research for jute genome mapping – a precondition to genetic modification of jute.

b) No aggressive techno-economic market research.

c) Un-sustainable planning for development.

d) Non-formulation of standards for each item of Jute Geo-textile.

e) Insufficient and improper investment from Govt. agencies to the willing jute mills.

f) Sufficient study, development and standardization of specific end-uses of Jute Geotextile.

Today's one percent market share of JGT world over offers us a huge opportunity to work on our weaknesses to be able to face challenges offered by market comparable to man-made geotextiles in at least some important areas and grow upon our strength to become more competitive in quantity, quality and pricing so that jute as a natural renewable fibre will have its rightful place in geotextiles world over.
Marketability Of JGT Vis-à-vis Aspects of Production

Mahmudul Huq

ABSTRACT

Our experience in manufacturing and marketing Jute Geotextiles since 2001 has been varied. In the last few years of production, we have come across various product deviations from the normal, most of which the Mill has been successful in producing. They include different cut-lengths in bale or roll form, delivery on pallets, etc. The two exceptions which our Mill has been unable to provide to the market are the wide width fabric and also the heavy JGT because of equipment limitations.

The issues faced by our Mill in enhancing the market potential include specification requirements, i.e. technical parameters of the product, dissemination of information about the range of products that can be produced by the existing jute machinery and their applicability in different soil & climatic conditions. If both the problems are adequately addressed and presented to the global erosion control industry, the market size and potential of JGT will increase considerably.

Presently, we are in the process of installing a Jute Felt project for the manufacture of non-woven JGT which is also intended to address the requirements of top-soil erosion control needs.
INTRODUCTION

Janata Jute Mills Ltd. was established in 1968, and it started production as a conventional Hessian & Sacking Mills in 1968. After nationalization in 1972 and denationalization in 1983, the Mill has expanded considerably by setting up 3 (three) Yarn manufacturing units which commenced production in 1985, 1995 & 2000.

The journey of Janata Jute Mill into the production of Jute Geotextile (JGT) is a simple story! In 2001, following the closure of the Adamjee Jute Mills Ltd., which was the only unit manufacturing JGT in Bangladesh, Janata approached the Government with a view to buying the JGT manufacturing unit of the Adamjee Jute Mill. Failing to obtain a positive decision from the Government, Janata brought into function of a Roving Frame positive which was mothballed previously, converted & installed some traditional Shuttle Looms in order to fill in the vacuum in the supply of JGT from Bangladesh. The Looms went into production in 2002 & since then additional Roving frames & Looms have been installed to boost the production of JGT in response to the continued demand on us despite the transfer of the Adamjee Jute Mills JGT equipment in the Bangladesh Jute Mills Corporation’s Latif Bawany Jute Mills.

Production was started armed with the barest of specifications of the traditional JGT: 48" wide, 1.22 oz/yard, 6.5 Porter x 8.5 Shot, packed in 8 cuts of 75 yds = 600 yds/bale. To achieve this fabric specification, a warp count of 160 lbs & a weft count of 60 lbs were used.

This has been the main product that is presently being sold by Janata in the international market. During this time, in the international market, from which our experiences are derived, different JGT products have thrown up different challenges - some easy to solve & some intractable for the Mill. However, the experience gathered during the last 6 years of exporting to various countries of the world, we have come across different issues which we would like to share with the audience. These relate to:
a) Equipment & Production &

b) Quality Control & Specifications

**Equipment & Production Issues**

First, **to manufacture double width fabric of 95\"**.

It has been difficult to identify the Loom capable of making such a wide width product as the traditional shuttle Looms, using cops, is incapable of handling such wide width fabrics. It is simply not economic to do so. In the circumstances, to make this product, we place 2 fabrics side by side & stitch the fabrics at regular intervals! It was the easiest problem to solve! As the stitching has been found to be adequate, quality issues have not arisen when compared to a wide width single fabric that is available from some Indian Mills.

Second, **to increase the fabric length to cuts of 450 yds.**

Instead of 75 yds, the task was also simple - by adjusting the rolling-up mechanism at the Loom. This was required by buyers who ideally want to have the fabrics in roll form instead of in the bale form for ease of laying on the ground as the baled form goods have strong creases at the folds after the baling is done.

Third, **to manufacture fabrics in roll form of 75 yds.**

That is the market trend. We have recently installed a rolling up unit capable of supplying to the Buyers in such form. It needed some investigation & to do it was not rocket science.

Fourth, **to supply fabrics in 75 yds rolls , stacked on pallets.**

This is the user-friendly form that is increasingly being requested by the market. Being an ISPM 15 certified Company, shipment on Heat treated pallets
does not pose any problems. Hence, Janata is capable to matching the market requirement.

Fifth, to manufacture lightweight JGT of circa 250 g or other light weight JGT.

It is not at all a difficult proposition as the existing equipment is capable of manufacturing it.

Sixth, to manufacture heavier JGT of circa 700 g + or heavier.

The limitation of the Mill to produce such fabrics is the use of Shuttle Looms. It is simply not economic to do so. However, identification & investment in Looms capable to do so has not been done as it is a small percentage of the global requirement.

Specification & Quality Issues

During the course of marketing, we have come across various issues relating to specification & quality matters.

Specification of the various fabrics: Presently, specifications in the barest details, supported by the international traders is being accepted in the international market. However, in order to obtain an increased market share of the global geotextile market, a comprehensive technical specification of the various products/versions of JGT, is essential to win over the skeptics of JGT in the global geotextile market. This has to be formulated by international experts in the testing field and accepted as viable by the manufacturing.

Quality issues: Jute Geotextile remains a product made with less than perfect yarns with less than perfect weaving characteristics. This has not necessarily impinged on the marketability of JGT as it is not critical in obtaining the desired results from their application. However, any specifications drawn up by experts must address the quality issues accordingly.
CONCLUSIONS

In conclusion, the author will not address the issues in marketing of JGT in the subcontinent as we have no experience on the subject. However, in the global JGT market, the JGT industry needs to venture beyond the market segment where it is present. In order to do so, JGT industry will have to introduce different versions of the established products with detailed quality specifications which the JGT industry can fulfill. In addition, established research work needs to be provided so that the market can be convinced that new application in the field of geotextiles is available from the JGT industry and as to its viability & desirability of JGT as the appropriate product for the soil and climatic conditions. The world is turning back to eco-solutions for many of the perils that we are currently facing and in the coming to International Year of Natural Fibres in 2009 (IYNF), provides the appropriate opportunity to begin.
Market & Marketability of JGT vis-à-vis Aspects of Production

Prof. G. V. Rao*, Ms. Anuradha Guda**

ABSTRACT

The erstwhile ‘golden fabric’ jute is now reduced in common perception to mere ‘gunny bags’. While the use of jute in packaging, home décor etc. is well known, the use of jute in geotextiles is a largely unexplored area although it can offer vast benefits to the indigenous industry and agri-economy overall.

In previous studies conducted on JGT, the emphasis was frequently on assessing the suitability of a particular type of JGT for a specific application. This paper proposes a shift in approach; from that of a supply chain bringing together all the stakeholders to a demand network using information systems. This will add ‘value’ to JGT and help them move up the value chain thus increasing profitability for all stakeholders and also be socially and environmentally sustainable.

At the demand end of the network the critical aspects are: a) understanding the application-specific potential such as in erosion control, rural roads and road pavement construction and b) use of site-specific parameters to design JGT. The design requirements will determine the characteristics and quality of jute required which will in turn be a factor to determine the manufacturing facilities required and the type of retting methods used to produce the raw fibre.

This is a paradigm shift which will lead to new product development based on Demand. Using the AIETA model to understand the process of consumer adoption, marketers can develop strategies to market these newly developed products.

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INTRODUCTION

Currently the production of the fibre in India is around 100 lakh bales and about 73 jute mills are operating in the country. Besides, there are several small scale industries in the decentralized sector producing handicrafts, decorative, twines, pulp & paper from jute and allied fibers and particle board from jute stick. As per the latest Exim Bank report on the Jute industry, the world market for geotextiles, currently dominated by synthetics is over 40 million sq. m. Immense potential also exists in the USA and Europe.

The report summarizes the present drawbacks of the Indian Jute industry. As availability of raw jute depends on the vagaries of nature, there is instability in the supply and price of jute. A lack of standardization and indifference to specifications has led to stagnation of the market. Greater emphasis on production and lack of professional marketing has caused deeper erosion of markets by synthetics. High labour costs, accounting for nearly 35% of the cost of the production (partly owing to absence of major technological breakthrough), has made jute cultivation energy inefficient and less lucrative compared to other crops. Excessive dependence on packaging industry has made jute synonymous with "gunny bags", thus leading to a perception problem. As a result, Jute is not able to attract new investment and has limited global production base. Apart from this, there is another common perception that the industry provides low financial return. There appears to be deficient attention to consumer preferences has resulted in mismatch between predicting consumer's needs with respect to quality of fabric, bleaching, printing and designs. Jute Geotextiles (JGT) have been identified by the industry and government as a focus area is offering major potential for all the stakeholders. Some promotional activities have been undertaken, however the future of JGT is also affected by the above problems which affect the jute industry as a whole.
For the above drawbacks, this paper proposes some technology based marketing strategies. Using the popular Ansoff's Product/Market Expansion Grid (Fig. 1), as a starting point, one notes that with the currently available JGT products, there are two strategies available –

1) Market penetration strategy, and
2) Market-development strategy.

Figure 1: Ansoff's Product/Market Expansion Grid:

<table>
<thead>
<tr>
<th>Current products</th>
<th>New Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current markets</td>
<td></td>
</tr>
<tr>
<td>1. Market penetration strategy</td>
<td>3. Product development strategy</td>
</tr>
<tr>
<td>New markets</td>
<td></td>
</tr>
<tr>
<td>2. Market-development strategy</td>
<td>(Diversification strategy)</td>
</tr>
</tbody>
</table>

MARKET PENETRATION STRATEGY

There are three major approaches to increasing current products' market share: The producers/production companies can create more awareness about the benefits of JGT and thus encourage users to increase the purchase quantity. For this, the producers also need to educate their marketing personnel about the technical properties and benefits of their products to avoid selling merely on price. Two, they could try to attract competitors' consumers (in this case say, consumers of synthetic geotextiles) by trying to identify weaknesses in the competitor's products. Finally, they could try to convince non-users of JGT.

MARKET DEVELOPMENT STRATEGY

This can again be done in three broad ways. First, new potential user groups can be identified. Second, additional distribution channels may be sought in
While developing new products, it is crucial to take into consideration, the consumer adoption process. Adoption is an individual's decision to become a regular user of a product.

**Stages in the Adoption Process of an Innovation/New Product**

This simple model focuses on the mental process through which an individual passes from first hearing about an innovation to final adoption.

**Awareness – Interest – Evaluation – Trial – Adoption.**

At each step, marketers need to take appropriate measures to ensure the consumers move on to final adoption. E.g free samples or trial periods are introduced to enable the consumer to evaluate and try the products before making a bulk purchase.

**PARADIGM SHIFT**

Taking into consideration that JGT are generic materials, and that based on the application, the technical specifications vary greatly, a paradigm shift from current marketing practices is necessary to leverage the three intensive growth strategies stated above. So far, in the JGT development process and jute industry as a whole, a broad supply chain model is at work.

A supply chain (Figure 2) is the system of organizations, people, technology, activities, information and resources involved in transforming natural resources to develop a product or service and move it from supplier to customer.

The black arrow represents the flow of materials and information and the gray arrow represents the flow of information and backhauls. The elements are (a) the initial supplier, (b) a supplier, (c) a manufacturer, (d) a customer, (e) the final customer.
i.e the producers and manufacturers are “driving products to market.” In order to reduce inventory investments, pressure is being exerted to place orders. In this environment, demand is naturally often be erratic and therefore hard to predict. Further this method is not customer-centric.

In case of agri-businesses as opposed to factory based businesses, production is affected by the vagaries of nature. Transportation and stocking are further issues. In addition to this, the information requirements for supply chain management of differentiated high value products are much more stringent than for traditional agricultural commodities requiring a two-way information flow from the producer to the customer. Therefore, it is necessary for the JGT industry to change direction and move towards a demand driven model (*Demand-Driven Supply Network (DDSN*) which is driven from the front by the end user. Instead products being pushed to market, they are pulled to market by customers. All the entities in the network share information. The aim of this collaboration is to better position everyone with the ability to more closely follow market demand and produce, in tandem, with what the market wants.

While it is well known that DDSNs has found success in various businesses across industries such as P&G, Wal-Mart, Cisco & Dell, it is less known that that demand based information systems have worked well in dairy business, coffee (e.g. in India ITC’s e-choupal initiative for online auctioning wheat, soyabean and coffee ) business and various Asian fruit exports worldwide, which have directly impacted our lives by the creation a ‘global food system’. In setting up efficient and robust systems, latest technology, knowledge and protocols have been use for post-harvest management in areas such as long time storage, packaging concepts, cold chain management, controlled ripening and quality measurement. These innovations lead to opportunities for better quality products, lower energy consumption, lower transportation costs, more flexibility in using transportation modalities etc. New certification systems are being developed to ensure quality attributes throughout the entire chain.
CONCLUSIONS

Translating the above to the JGT industry, a move towards a demand-driven model will mean bringing changes to the production methods and techniques and developing better equipment to do so. The critical aspects are: a) understanding the application-specific potential such as in erosion control, rural roads and road pavement construction and b) use of site-specific parameters to design JGT. The design requirements will determine the characteristics and quality of jute required which will in turn be a factor to determine the manufacturing facilities required and the type of retting methods used to produce the raw fibre.

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Standardisation of Jute Geotextiles:
Their Applications and Related Regulatory Issues.

Professor R. Jane Rickson

ABSTRACT

This paper will present the various types of geotextile currently available, in terms of physical format, composition and end use. There is evidence of increasing market demand for geotextiles (both in the traditional markets and in jute-producing countries) for diverse applications such as ground separation, earth reinforcement, slope stabilization, groundwater filtration, drainage, soil erosion control and vegetation management. Independent research in the laboratory and field has shown jute geotextiles to be technically “fit for purpose”, especially in the fields of soil erosion control and vegetation management. There is also potential use of these products in the stabilization of rural earth roads.

The advantages of jute geotextiles over competitive products include:

- technical performance / effectiveness in the specified end uses
- cost per unit area
- sourcing from renewable raw materials
- utilization of high volumes of relatively low grade materials
- maintenance of rural livelihoods in jute-producing countries
- production based on existing, well-established manufacturing processes

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environmental friendliness (biodegradable, enhancement of natural resources)

• landscaping aesthetics.

However, these technical and socio-economic advantages of Jute Geotextiles are not reflected in the current market share. Reasons for this include:

• end-users’ perceptions (e.g. quality of product and perceived impact this has on technical performance)

• real (and perceived) patterns of supply and demand, including reliability and timeliness of supply

• non-compliance of Jute Geotextile products with technical standards and specifications, such as those set in the US (ASTM, IECA and ECTC) and Europe (CEN).

The aim of this paper is to overcome the barriers to the adoption of Jute Geotextiles in the specified end-uses of erosion control, vegetation management and stabilization of rural earth roads. The paper will consider both traditional markets in developed countries as well as expanding novel markets in jute producing countries.

INTRODUCTION

Geotextiles are “permeable textiles used in conjunction with soil, foundation, rock, earth or any geotechnical engineering related material, as an integral part of a man made project” (John, 1987). The use of textiles in the construction industry is not new: there are examples of linen fabrics being incorporated into artificial slopes in ancient Egypt, and reinforcing cotton fibres have been found in centuries-old Chinese engineered slopes. In modern times, the use of textiles in civil engineering developed during the 1960s as a result of the expanding construction industry in North America and Europe, and the availability of cheap, surplus synthetic fabrics (such as nylon and
polypropylene), in search of novel (i.e. non-clothing) markets. More recently, the emphasis on “environmentally friendly” products and “green” issues (such as the use of sustainable and renewable resources, and supply chains which minimise carbon footprints) has encouraged the expansion of the natural geotextile market, including the use of jute geotextiles. One potential new application of these products is in the construction and functioning of “ecotowns and cities”, where green technologies are increasingly used.

At present there is a huge global demand for suitable textiles to be used in the civil engineering and construction industries. This market has grown from 250 - 400 million metre² per annum in 1996 (CFC/IJO, 1996), to 1,400 million metre² by 2003 (Pant, 2003). The annual growth rate has been estimated to be between 8.5% - 10% (Jagielski, 1990; Pant, 2003 respectively). Despite the significant market size and growth rate, jute geotextiles only comprise a very small fraction of these sales (estimated to be between 1% - 7.5% (Pant, 2003; CFC/IJO, 1996 respectively).

The purpose of this paper is to evaluate the potential use of jute geotextiles, and to understand why this potential has not been fully realised to date. First, the benefits and advantages of jute geotextiles over competing products are highlighted, in terms of technical effectiveness (assessing whether jute geotextiles are “fit for purpose”). Second, the socio-economic and environmental impacts of sourcing jute geotextiles are discussed. Third, the disappointing market share of jute geotextiles is explained by identifying the barriers to the specification and adoption of these products by end users. Finally, the paper suggests ways in which these barriers can be overcome, so that the demand for jute geotextiles will increase, both in the traditional markets in developed countries, and in expanding novel markets in jute producing countries. In turn this will ensure environmental protection where these products are applied, and a sustainable livelihood for the thousands of people employed in the jute and allied industries throughout the world.

**TYPES OF GEOTEXTILE**

Geotextiles are available in the form of mats, sheets, grids and webs made of woven, non-woven, knitted, or extruded fabrics. Geotextiles are made
from natural or synthetic materials, or a combination of both. Synthetic geotextiles include polypropylene, nylon, polyester and polyethylene, which can be manufactured to very exacting technical specifications. Natural products include jute, coir, sisal, wood chips or shavings and paper. Giroud (1990) provides a full classification of geotextile products: the diverse range is highly dynamic, with new products frequently coming on the market.

**APPLICATIONS AND MARKET DEMANDS**

Geotextiles are used in a variety of applications, including ground separation, earth reinforcement, slope stabilisation, groundwater filtration, drainage, soil erosion control and vegetation management. Traditionally geotextiles have been used in developed countries, notably the USA, Japan and Europe. However, recently there has been increased interest in the potential use of these products in new markets, including those in jute-producing countries.

Synthetic geotextiles dominate the applications of filtration, separation, slope stabilisation and drainage. This is because there are strict technical specifications required of these applications, which natural products cannot attain, such as porosity, tensile strength, durability, resistance to both weathering and microbiological attack, and hydraulic conductivity (see section 5 below referring to the constraints to the adoption of jute geotextiles). These are set in countries with high geotextile use, by international bodies such as the British Standards Institute (BSI), the American Society for Testing and Materials (ASTM), Standards Australia (SA), the European Committee for Standardisation (CEN) and the International Standards Organisation (ISO).

However, there are situations where these strict technical specifications may not be essential (and indeed are sometimes irrelevant) for effective product performance. It is in the applications of soil erosion control, vegetation management and stabilisation of rural earth roads, that jute based geotextiles have shown effectiveness in terms of technical performance, as well as accruing socio-economic and environmental benefits.
GEOTEXTILE PERFORMANCE

Technical performance of jute geotextiles

a) Soil erosion control

Whilst there are many case studies around the world where jute geotextiles have been used for soil erosion control (Rickson, 2000), there has been relatively little scientific, objective testing of these products. In 1994, the Common Fund for Commodities (CFC) and the International Jute Organisation (IJO) jointly funded a project entitled "Technical Specification and Market Study of Potentially Important Jute Geotextile Products". This project presented data that compared the effectiveness of various jute geotextile products with other competitor geotextiles available on the market (CFC/IJO, 1996; CFC, 1998), including other natural and synthetic erosion control products. The tests were performed under numerous environmental conditions, with different rainfall intensities and soil types. In a significant majority of the experimental erosion control tests, woven jute products performed best (Figure 1).

Rickson (2000) went on to analyse why the jute products performed so well at controlling soil erosion. She correlated the physical characteristics of the geotextile products with erosion control performance and found that the following properties are extremely important:

a) Area of the geotextile (% cover)
b) Water holding capacity of the geotextile
c) Geotextile induced roughness to the flow
d) Weight of geotextile when wet
e) Depth of flow ponded by the geotextile.

Identifying these "salient" properties is vitally important for end users, manufacturers and specifiers of erosion control geotextiles. End users can apply this knowledge to evaluate both the products they currently use, and any alternative products available on the market. Specifiers and representatives on Standards Committees should ensure that these salient
properties are quoted in any compliance standards used by the erosion control industry. Manufacturers can use the information on salient properties to improve existing products, and to design new, more effective erosion control geotextiles.

b) Vegetation management

The establishment of vegetation following engineering works such as road construction, urban development or creation of new amenities is one of the greatest challenges in landscape management. Geotextiles may help to establish vegetation by creating more stable, non-eroding conditions by controlling erosion processes (see above). This will result in less washout of seeds and seedlings from slopes, and a reduction in damage to new plants through heavy rainfall and runoff. Geotextiles may also alter local microclimate and soil moisture on slopes, so enhancing vegetation establishment and growth (Fifield et al., 1987; Reynolds, 1976; Dudeck et al., 1970).

At present, despite the widespread availability of geotextile products, there is a lack of scientific validation of their effectiveness and efficacy for vegetation establishment and growth. However, as part of the CFC/IJO project detailed above (CFC/IJO, 1996; CFC, 1998), an experiment was devised to test different geotextiles, including jute based products, in aiding vegetation establishment. All geotextile treatments had greater germination rates than the bare soil control plots. The high percentage cover, non-woven products produced the highest rates of seed germination. This is because they retained more soil moisture by restricting evaporation losses. They also insulated against heat losses from the soil trays at night, thereby maintaining optimum temperatures for germination. The jute woven products, with their relatively low percentage cover did not increase the germination rates to such an extent, but did increase rates compared to the control.

After Day 10, the vegetation was assessed visually on a percentage cover basis. The results for the natural geotextile products are shown in Figure 2. The figure shows that all the products had a relatively steady increase in vegetation cover over the course of the trial. All the woven jute products helped promote the growth of the seeded clover, which produced a much denser cover than the dicotyleous species found on the control plots.
Although the Erosion Control Technology Council (ECTC) has drafted a standard relating to the “determination of temporary degradable rolled erosion control products performance in encouraging seed germination and plant growth”, no internationally recognised technical compliance standards exist for geotextiles used in vegetation management. It is important that the properties listed above are included in the criteria used in compliance or standards setting in the future.

Figure 2. Vegetation establishment: Percentage cover for natural, woven geotextile products.
c) Stabilisation of rural earth roads

Geotextiles can be used to enhance the soil's bearing capacity. The geotextile is used to separate the various layers which comprise the structure of the road. The geotextile can prevent intermixing of the relatively stronger aggregate material (sub-base), and the relatively weaker in-situ soil (or sub-grade). Buried geotextiles will also provide local reinforcement and prevent lateral sliding of the aggregate (Figure 3). In this way, geotextiles may allow a reduction in the thickness of the pavement construction. This may represent savings as to the cost of road building.

Figure 3. Geotextile stabilisation of an unpaved road (John, 1987).

Little research or applied work has concentrated on the specific use of jute geotextiles for this end use. Woven jute geotextiles will have limited ability to provide a physical barrier to the intermixing of the aggregate and subgrade soil, but potentially these products could provide local reinforcement, restrain the aggregate sub-base from downward and lateral movement in the rut, restrain the subgrade soil from upward and lateral movement between the ruts, act as a support membrane and provide sufficient friction to limit lateral sliding of the aggregate.

Despite these potential functions, limited work has been carried out to test jute geotextiles in this application. The few studies that have been carried out (e.g. Ramaswamy & Aziz, 1982; 1983; 1991; Rao et al., 1994; CFC/IJO,
1996) have recognised that jute geotextile products are able to impart tensile strength to soil and improve the ground bearing capacity, so improving traffickability of structures such as rural roads, compared to where no product is used at all. Some reduction in rut depths has also been reported. More research is needed in the physical performance of these products, bearing in mind their characteristics such as biodegradation over time. Also, despite the potential effectiveness of jute geotextiles in this application, the physical properties of jute geotextiles often fail to meet the strict technical compliance standards which dictate the specification of such products (Table 1).

Table 1. Compliance with European Standards for tensile strength (CFC/IJO, 1998)

<table>
<thead>
<tr>
<th>Product</th>
<th>Tensile strength (Measured)</th>
<th>Belgium</th>
<th>France</th>
<th>Germany</th>
<th>Sweden</th>
</tr>
</thead>
<tbody>
<tr>
<td>500 g/m² jute woven</td>
<td>3.4 kN/m</td>
<td>≥ 15 kN/m</td>
<td>12 kN/m</td>
<td>35 kN/m</td>
<td>20 kN/m</td>
</tr>
</tbody>
</table>

Socio-economic benefits of jute geotextiles

In addition to the technical advantages of jute geotextiles over competitive products, jute products remain competitively priced in terms of cost per unit area (including material and installation costs). This is partially explained by the utilisation of high volumes of relatively low grade materials in the manufacture of woven jute geotextiles. Also, the production of jute geotextiles does not require new technology or industrial infrastructure. Production of jute geotextiles is based on existing, well-established manufacturing processes. By expanding the markets for jute geotextiles, the income received will help maintain thousands of (mainly rural) livelihoods in jute-producing countries.

Environmental benefits of jute geotextiles

At a time when the sustainability of resources is being scrutinised, jute geotextiles have a significant advantage in that they are sourced from wholly renewable raw materials. They are perceived to be environmentally friendly
as they are made from 100% natural materials, which have little environmental impact as they are completely biodegradable. It is claimed that the organic matter returned to the soil on fibre break down will enhance the soil’s carbon and nutrient content. Finally, jute geotextiles are aesthetically pleasing in the landscape, as opposed to synthetics competing product, even when these are dyed green to “blend” into the surrounding environment.

**CONSTRAINTS TO USE**

The technical, environmental and socio-economic advantages of jute geotextiles as outlined above clearly illustrate the potential of jute based products for use as geotextiles in the fields of soil erosion control, vegetation establishment and stabilisation of earth roads. The greatest market potential lies in the application of erosion control, and yet surprisingly, jute geotextiles only comprise 7.5% of this market. This anomaly between potential and actual use is discussed below.

**End users’ perceptions**

There have been (largely unfounded) concerns about the quality of jute geotextiles from end users. Natural products show a variability in physical properties such as warp and weft density, roughness of the fibres etc. which may be taken as inconsistency of product quality. However, there is no evidence to show that these irregularities affect the overall performance of these products in controlling erosion or aiding the establishment of vegetation.

There have also been concerns about the use of mineral oil in the production of jute woven textiles, and the environmental fate of any residue left on the jute fibres after installation. Whilst studies have been carried out to allay these concerns, some end users are yet to be convinced of the true environmental credentials of jute products. Currently, IJIRA are conducting trials to assess the use of vegetable oils (e.g. rice bran oil) instead of the traditional mineral oil in the manufacture of jute geotextiles.
Real (and perceived) patterns of supply and demand

In the past there has been concern as to the reliability of supply of jute geotextiles. For example, in the UK, end users have been disappointed that they are unable to source adequate quantities of jute erosion control geotextiles. This is because high transport costs from jute producing countries mean it is only economically viable to import high volumes of jute geotextiles. Importers will only purchase high volumes of jute to minimise transport costs and overheads. This means the supply side of the market is not very responsive to demands. End users would rather specify competing products than wait for the next consignment of jute geotextiles to be imported.

Non-compliance of jute geotextile products

In many industrial sectors, quality assurance and compliance standards are given very high priority. The geotextile and geosynthetics industries are no exception, with increasing number of standards, specifications, reference properties and performance targets, ensuring the products are capable of doing the task they are designed to do. Products must comply with these standards, so giving confidence and assurance to potential end users. For geotextiles, most of this work has been undertaken for the end applications of separation, filtration, drainage and slope stabilisation (see for example, British Standards Institute, 1987; 1997a; 1997b; 1997c).

However, for soil erosion control geotextiles, few standards have been formulated or set to date. Committees are being set up within various organisations specifically for this purpose. These include the European Committee for Standardisation (CEN) (Technical Committee 189), the AASHTO-AGC-ARTBA (American Association of State Highway Transportation Officers – American Geotextile Council - American Road and Transportation Builders Association) Joint Committee, the ECTC (Erosion Control Technology Council), the IECA (International Erosion Control Association) and the ASTM (American Society for Testing and Materials). The latter organisation's Subcommittee D18.25 on Sediment and Erosion Control currently has three proposed test methods for erosion control blankets in the ballot process (http://www.ieca.org).
Perversely, standards that do exist already concern geotextile properties that actually have no influence on erosion control performance, such as resistance to weathering and microbiological attack when buried (BSI, 1997b; 1997c). Another compliance standard, tensile strength, is often specified, for example BS 6906 Part 1 (BSI, 1987), with critical thresholds that must be met by products. However, tensile strength has no relation with erosion control effectiveness, as tested with correlation analysis (Rickson, 2000). Correlation of the tensile strengths of the various geotextiles with their ability to control erosion provides a correlation coefficient of \( r = +0.0364 \), which is not significant.

The American Society for Testing and Materials (ASTM) set a number of compliance standards for geotextiles (although no specific end use is quoted) (http://www.astm.org/search/iatoc). These include thickness (ASTM D1777), mass/unit area (ASTM D3776-84) and tensile strength (ASTM D1682). Again, it appears that there is no relationship between these properties and geotextile erosion control performance, although there is a significant correlation (\( p<0.05 \)) between soil loss and mass/unit area.

However, as listed above, other physical characteristics of geotextiles are correlated with erosion control performance, namely:

- percentage cover,
- geotextile induced roughness/Mannings 'n',
- dry geotextile weight,
- wet geotextile weight,
- ability to increase flow depth,
- water holding capacity.

To date, none of these properties has been considered by the compliance and standards committees. It is suggested that the mismatch between compliance criteria and salient properties of geotextiles for erosion control has two explanations. First, the new erosion control standards committees comprise experienced individuals who have sat on similar committees.
concerned with the other end uses of geotextiles (such as filtration, separation and drainage). In these applications, properties such as tensile strength and durability are important. In contrast, the salient properties of geotextiles with respect to erosion control as listed above are largely unknown outside the erosion control industry. The standards committees will only set criteria with which they are familiar, and which have been defined as standards for the other geotextile end uses, inappropriate though these are to erosion control products.

The second explanation for the discrepancy between formulated standards and actual salient properties is of greater concern, especially for the natural fibre manufacturers and distributors. This point is voiced by CFC/IJO (1996): “Specifications and classifications for geotextiles are not formulated from purely altruistic, technical considerations, but contain a substantial commercial interest”. There is concern in some quarters that the synthetics lobby on the Standards Committees is attempting to marginalise natural products, such as jute and coir. This is done by deliberately setting technical specifications that can never be met by the natural products, but that can be met easily by the synthetic products. This is why properties such as yarn thickness, mat density, tensile strength and durability are selected by the committees as the criteria for geotextile specification. The inherent, natural variability of natural products such as jute and coir woven products is one reason why these products can never meet such exacting standards, even though these products are the more effective at erosion control. Thus these geotextiles will never be selected as they consistently fail to attain the standards set by the synthetics-biased Standards Committees.

It is difficult to see how this situation will change, as individuals who are keen to promote the natural products are seriously underrepresented on the standards committees. CFC/IJO (1996) warns “It is unlikely that products which do not comply with future ASTM, IECA or ECTC standards will flourish in the US market”. The commercial implication of this statement is that the natural products will be denied a share of at least 58% of the world consumption of erosion control geotextiles (=101 million m²). Since the raw
materials for natural products are often sourced from lesser developed countries (e.g. jute), this situation has implications for their economies and for world trade.

Thus there are considerable constraints to the use of jute erosion control geotextiles. However, none of these constraints is insurmountable, but overcoming them will depend on better education of the extensive benefits of erosion control geotextiles, better understanding of the salient properties of effective geotextiles and better promotion in all sectors of the erosion control industry of the most cost-effective products.

If compliance standards for erosion control geotextiles are to be used in the future by the industry, it is vital that the natural geotextile manufacturers and distributors are represented on the committees who set these standards. Failure to do this will mean the synthetics lobby will continue to dominate, and for whatever reason, the performance targets favouring synthetic products will be used, rather than instigation of novel criteria, which reflect soil erosion control effectiveness more realistically. There is a real danger that effective products will fail to comply with performance standards, and so will never be specified despite their cost and erosion control advantages.

**CONCLUSIONS**

The aim of this paper was to identify the advantages of jute geotextiles in the specified end uses of erosion control, vegetation establishment and stabilisation of earth roads. There is evidence that jute geotextiles have advantages in terms of technical, socio-economic and environmental aspects over competitive products. However, several barriers exist which have limited the specification and use of jute geotextiles in construction projects, and these have been identified in the paper. Knowing these barriers, and how they might be overcome will assist in the expansion of the jute geotextiles market both in the traditional markets in developed countries and in expanding novel markets in jute producing countries.
REFERENCES


Application Of Jute Fibres In Foundation Beds

Dr. Satyendra Mittal

ABSTRACT

Jute is a coarse natural fibre. Two types of jute are commonly cultivated – Corchorus capsularis (white jute) and Corchorus olitorius (tossa jute). Only a small portion of the plant is utilized for extracting its fibre (approx 4-6%). An experimental investigation was taken up using this fibre in foundation beds. The tests in plane strain condition were performed on sand with randomly mixed jute fibers in different percentages of 0.125% to 1.0% by weight of dry sand with aspect ratios of 10 and 15. It has been observed that the jute fibres can be used to enhance the bearing capacity of soil.

For comparative evaluation of allowable bearing pressure of virgin sand and sand with randomly distributed jute fibers, the experimental work was conducted in laboratory and results were presented in the form of Load Intensity v/s Settlement plot. Total 11 tests were conducted - 5 Nos. on each aspect ratio and one for unreinforced soil.

The results show that with increasing fibre contents for aspect ratios 10 and 15, the bearing pressure increases with increase in jute fibres content. This increase in bearing pressure is more at higher percentage of jute fibres. At aspect ratio 10, the bearing capacity is about five times and at aspect ratio 15, it is about six times that of virgin soil.

In order that the potential of jute fibres in enhancing the bearing capacity of foundation can be optimally exploited and standardized, we need to undertake laboratory studies with different varieties of jute available and under varying soil composition. Standardization of JGT can be made after further laboratory studies and field applications. The paper is a pointer to the fact that jute fibres can play a significant role in enhancing the bearing capacity of soil and can be used with technical and economic advantage in weak soils.

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Physical and mechanical properties of jute fibres used in the study:

The jute fibres used in the study were torn pieces of jute bags and possessed the following properties:

1. Weight (average) - 800 gsm
2. Thickness (average) - 6 mm
3. Tensile strength (ultimate) - 36 kN/m determined at a sample of 200mm X 100mm
4. Puncture strength - 350 N/cm²
5. Density - 1.4 g/cc

EXPERIMENTAL WORK

For comparative evaluation of allowable bearing pressure of virgin sand and sand with randomly distributed jute fibers, the experimental work was conducted in laboratory and results were presented in the form of Load intensity v/s Settlement plot. The Experimental studies have been done for Plane strain tests conditions on soil with randomly mixed jute fibers. The tests were conducted with different percentage of jute fibers and at different aspect ratios.

MATERIAL USED FOR EXPERIMENTAL WORK

Soil: The soil used in this study was locally available fine sand taken from locally available Solani River bed near Roorkee. The properties of soil were as below (Table 1). The soil classification was SM.
<table>
<thead>
<tr>
<th>Property</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry Density (kN/m³)</td>
<td>16.7</td>
</tr>
<tr>
<td>Specific Gravity</td>
<td>2.61</td>
</tr>
<tr>
<td>Uniformity Coefficient, C_u</td>
<td>1.8</td>
</tr>
<tr>
<td>Max. void ratio (e_max)</td>
<td>0.84</td>
</tr>
<tr>
<td>Min. void ratio (e_min)</td>
<td>0.54</td>
</tr>
<tr>
<td>Liquid Limit (%)</td>
<td>Nil</td>
</tr>
<tr>
<td>Plastic Limit (%)</td>
<td>Nil</td>
</tr>
</tbody>
</table>

Table 1: Properties of soil used in study:

Jute: The jute as available locally was used for the study. The lengths of the jute fibres used for study were- 60mm (for aspect ratio =10) and 90mm (for aspect ratio =15)

TEST PROCEDURE

All the tests were conducted in plane strain conditions. The test tank (Fig. 1) was of dimension 800mmx75mmx350mm. Jute fibers were cut in 60mm and 90mm lengths corresponding to aspect ratios (A.R.'s) 10 and 15 respectively to be randomly mixed with soil in various percentages as 0.125%, 0.25%, 0.50% 0.75% 1.0% by weight of soil. The mixed soil was placed in test tank at R.D. =30%. The load was applied gradually through screw jack attached with Proving Ring of 5.0 kN capacity. The footing of size used in the tests was 75mmx75mm which was made of steel channel. The test was conducted like a normal plate load test till the failure occurred. The settlements were measured for each load applied on footing.
RESULTS AND DISCUSSIONS

In total 11 tests were conducted, 5 nos on each aspect ratio and one for unreinforced soil. The test results are reproduced in Table 2. The results for these tests were plotted as Load Intensity v/s Settlement curve as shown in Figures 2 to 6. The Figures 7 and 8 show the results with increasing fibre contents for aspect ratios 10 and 15 respectively. The Fig. 9 shows the load intensity versus jute fibre content curve. It has been observed that bearing pressure increases with increase in jute fibres content (Fig. 9). Upto 0.5% jute fibres, there has not been significant improvement with bearing capacity with aspect ratio as 10, but for jute fibre more than 0.5%, the bearing capacity increases significantly for aspect.
Table 2: Experimental Results

<table>
<thead>
<tr>
<th>Types of soil</th>
<th>Allowable bearing pressure (kN/sqm.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virgin soil</td>
<td>104.50</td>
</tr>
<tr>
<td>Soil with Jute Fibers</td>
<td></td>
</tr>
<tr>
<td>A.R.=10</td>
<td></td>
</tr>
<tr>
<td>Soil+0.125% jute fiber</td>
<td>135.00</td>
</tr>
<tr>
<td>Soil+0.25% jute fiber</td>
<td>190.00</td>
</tr>
<tr>
<td>Soil+0.50% jute fiber</td>
<td>242.00</td>
</tr>
<tr>
<td>Soil+0.75% jute fiber</td>
<td>371.00</td>
</tr>
<tr>
<td>Soil+1.00% jute fiber</td>
<td>533.33</td>
</tr>
<tr>
<td>A.R.=15</td>
<td></td>
</tr>
<tr>
<td>Soil+0.125% jute fiber</td>
<td>142.00</td>
</tr>
<tr>
<td>Soil+0.25% jute fiber</td>
<td>196.00</td>
</tr>
<tr>
<td>Soil+0.50% jute fiber</td>
<td>248.89</td>
</tr>
<tr>
<td>Soil+0.75% jute fiber</td>
<td>444.44</td>
</tr>
<tr>
<td>Soil+1.00% jute fiber</td>
<td>640.00</td>
</tr>
</tbody>
</table>

Ratio 15 than that for aspect ratio 10. This increase in bearing pressure is more at higher percentage of jute fibres. At aspect ratio 10, the bearing capacity is about five times and at aspect ratio 15, it is about six times that of virgin soil.

RECOMMENDATIONS

1. Significant improvement in bearing capacity is observed when sand is reinforced with jute fiber. As the jute fiber has significant life (4 to 5 years after rot resistant treatment) and is available at practically no cost, the jute fiber reinforced sand bed can be a reliable foundation for rural housing on soft soils, foundation for temporary structure for the instrument storage, erection of heavy instrument at construction site, highway sub grade etc.

2. The aspect ratio (AR) as 15 causes more than 6 times increase in bearing capacity, hence can be adopted for sites with confidence. However, the AR as 10 also increases the bearing capacity by 5 times.

3. The jute fibres quantity by 0.5% of weight of dry soil may double the bearing capacity of virgin soil, hence may be adopted for sites.
4. The above findings are for the jute properties as mentioned in Table-1, which are the average properties of medium class jute. For higher class jute, the bearing capacity may still increase. However the laboratory model tests are recommended before suggesting its use.

REGULATORY ISSUES & SUGGESTIVE MEASURES FOR PROMOTION OF JUTE’S USE

It is evident from the above study that jute can be used in foundation beds for improvement of bearing capacity of soils. Following are some points which, if implemented, may promote not only production but also application of jute:

1. By starting degree or diploma courses on jute technology in various technical institutes.
2. By developing working models of jute’s application in Civil engg. projects.
3. By arranging jute application demonstrations for media personalities and technocrats. Short films on jute applications be prepared and distributed. Electronic media be involved in popularizing jute use in engineering sector.
4. By arranging annual conferences on jute application.
5. By instituting national awards on outstanding project with jute’s use.
6. By providing subsidy/soft loans on the projects where jute is proposed to be used.
7. By arranging ‘hands on training’ to masons for jute’s use in engineering applications.
8. By establishing ‘jute helpline’ through internet.
9. Patents be done for jute application technology, particularly for short term applications in ground improvement techniques.
10. Research be done for longer life of jute when used with soil

11. Preparing a data base of successful projects and dissemination of that in technical institutes

12. Preparation of panel of consultants and making it available ‘on line’

13. Allocation of appreciable funds for Research & Development projects in research laboratories and technical institutions.

REFERENCES


Potential of Jute Geotextiles, Its Application and Need for Standards and Regulation

Quamrul Islam Siddique

ABSTRACT

The traditional market of jute is squeezing as a result of entry of synthetic yarns made of polyamides, polypropylene and other derivatives of petroleum chemical in the market. The jute industry can only be revived with its diversified uses. Use of Jute Geotextile can be one of the potential areas to revive jute industry.

Jute Geotextiles are usually of two types 1) woven and 2) non-wovens. Besides these two types, a number of other products like geogrids and geonets are being used. Non-woven geotextiles are widely used for drainage, lining systems and asphalt overlays while wovens are used in stabilization, separation, filtration and reinforcement of soil. Heavy and thick mulch mattings (around 600 gsm) are being developed for the suppression of weeds that hinder tree planting. A product incorporating large apertures is being developed for hill erosion control and rapid establishment of grass. In Bangladesh ‘Banana Drain’ type of geotextiles have been invented and it is being used as soil stabilizer. One market study in Bangladesh carried out by Bangladesh Jute Mills Corporation (BJMC), Bangladesh Water Development Board and BUET shows that use of Jute Geotextiles for surface erosion control was found satisfactory. Geotextiles are being widely used in developed countries like United States of America (USA), United Kingdom, Switzerland, Italy. Jute Geotextiles should have a fair share of total geotextiles market.
The International Jute Study Group (IJSG) indicates that for certain soil types the lighter weight, 300 and 400 gsm woven JGT perform adequately and, at a pro rata price, could prove attractive to the end-users but any limitations on use should be determined and published to ensure end-users’ confidence. Specifications, design methodologies, standards, user-friendly manuals for Jute Geotextiles (JGT) for special applications which are needed to attract end users are not yet addressed adequately. So far only one standard (Guidelines of Application of Jute Geotextiles for Rain water erosion control in road and railway embankments and hill slopes (IS-14986 2001) has been published by the Bureau of Indian Standards (BIS). Study and research have been taken up for Development of Durable Water-repellent Jute Geotextiles (JGT) with Natural Eco-friendly Additive for Application in Erosion Control in River Banks and Other Appropriate End Uses at the initiative of Jute Manufacturers Development Council (JMDC).

Jute Geotextiles being eco-friendly can benefit the environment and by increased production of jute, the livelihood of farmers can be improved and more revenue can be generated contributing to poverty alleviation. Understanding this in 1996, the Prime Minister's Office, Government of the People's Republic of Bangladesh issued order to all development organizations to use JGT and accordingly Local Government Engineering Department (LGED), Roads and Highways Department (RHD), Bangladesh Water Development Board (BWDB) are using JGT for protection of river bank erosion and soil stabilization.
INTRODUCTION

'Geo' means earth and textiles mean fabricated fibrous materials, thus geotextiles are the textile products which are used for the protection of earth. The professional groups are mostly influenced with their effective uses as geo technical engineering appliances for heavy construction, building construction, hydrological, bio-engineering, soil protection, erosion control, agronomic, application as soil saver, irrigation liner, mulching material & moisturizer. These have important and effective properties for being applied as engineering materials. Both natural and synthetic fibrous materials are being used as construction materials in different parts of the world.

The concept of reinforcing soft soil with use of fabrics was attempted in South Carolina highway in 1926. Heavy construction cotton fabrics were treated with asphalt in this application. Application of topsoil erosion control by netted and open constructed fabrics were also very common stabilizing material for rain-wind erosion protection. Geotextile as erosion control alternative to regular soil filters was originated around the late 50's by using it behind pre-cast concrete sea walls. Permeability, soil retention, strength, filtration, along with other properties of geo-textiles were discussed by Mr. Barnett. In the 1960's Rhone-Poulenc of textile research of France has exposed the application of non-woven, needle punched fabric as geo textile material. ICI, Dupont, Polyfleth and other multinationals had enough contribution in the development of appropriate geo-textiles.

The use of geo-textiles started in the 1950s. But in the following decade, the synthetic textile producers in the developed countries found themselves with a declining market trend and explored the market for technical textiles. This opened up a new area for Jute Geo-textiles due to the shortage and high cost of some of the building materials as well as high energy requirements of extracting and transporting conventional building materials. It was observed that "mud houses" that were built in the Indian-subcontinent were reinforced with jute and other fibrous materials. Similarly split log and bamboo mats were used as a stabilizer for roads that can be dated back to 3000 BC.
JUTE GEO-TEXTILES

A newer and nontraditional use of jute has been in geotextiles. This is an engineering product that strengthens the soil on or in which it is placed. It is being increasingly used to protect eroding riverbanks, strengthen poorly built roads and to take care of dangerous slopes. It can stabilize embankments and control soil erosion.

Jute Geo-textile is one such diversified product of jute which has proved to be highly effective in addressing a number of soil-related problems in civil engineering. It was made from jute fibre in 1981. Bangladesh, China, India and Thailand commercially produce and sell jute geo-textiles. It is a coarse mat with an open mesh woven structure and made from 100% jute yarns and is a product of jute industry using traditional jute machinery. It is sold and serviced by established commercial trade channels for traditional jute products which have been in operation for a century. In the USA jute probably was first used as geotextiles for erosion control by soil conservationists. They took a modified jute mesh used to wrap bales of cotton and laid it on slopes to prevent wash-off-from newly seeded ground.

In the developed world, synthetic materials are used to improve load bearing capacities of roads. Such technology is less common in developing countries, especially in rural areas, due to the costs of these products. The potential of affordable locally sourced and easily available jute geo-textiles as a tensile layer at depth has been proved.

Jute Geo-textile are usually of two types 1) woven and 2) non-wovens. Besides these two types, a number of other products like geo-textiles, geo-grids and geo-nets are being used.

Functionally, Jute Geo-textile (JGT) does not have any dissimilarity with man-made Geo-textiles-commonly known as Synthetic Geo-textiles - made of artificial fibres with various petro-chemical derivatives as their source. The functions are - separation, filtration, drainage and initial reinforcement.
Besides, bio-degradability of JGT helps in quick growth of vegetation by coalescing with the soil, increasing its permeability, retaining the appropriate humidity as “mulch” and creating a micro-climate that is conductive to vegetative growth. In fact, JGT is the most acclaimed natural fabric that provides bio-technical solutions to vulnerable exposed soil.

Jute degrades in over 2 to 4 years, but this is usually a sufficiently long period for vegetation growth to become established, and trials have shown that degraded by-products are beneficial plants. Work is progressing to produce treated jute which has a longer life before degradation.

Types of Jute Geotextile

Table 1: OPEN MESH/NON-WOVEN JUTE GEOTEXTILE

<table>
<thead>
<tr>
<th>Type</th>
<th>Weight</th>
<th>Width</th>
<th>Open area</th>
<th>Strength</th>
<th>Water holding capacity(%)</th>
<th>Expected Durability (Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>292</td>
<td>122</td>
<td>60</td>
<td>75x75</td>
<td>400</td>
<td>1</td>
</tr>
<tr>
<td>II</td>
<td>500</td>
<td>122</td>
<td>50</td>
<td>10x10</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>III</td>
<td>730</td>
<td>122</td>
<td>40</td>
<td>12x12</td>
<td>500</td>
<td>1</td>
</tr>
</tbody>
</table>

Application Areas

- Protection of slopes in road and railway embankments, bridge approaches, terraces in hilly terrains.

- Stabilisation of sand dunes, mine spoils, OB dumps in open cast mines, PFA dumps in thermal power plants, slag heaps.

- Promotion of quick vegetation in areas denuded by natural calamities like cyclones, earthquakes, landslides.

- Stabilisation of waste – dumps.

- Prevention of reflection cracks.
Advantages

➢ Price advantage over any type of Geotextile – natural or synthetic

➢ Unquestionable eco compatibility

➢ Easy availability and transportation

➢ Easy installation

WOVEN JUTE GEOTEXTILE

Table - 2 : Varieties available off-the shelves :

<table>
<thead>
<tr>
<th>Type</th>
<th>Weight (gsm)</th>
<th>Width (cm)</th>
<th>Porometry ($O_{50}$ micron)</th>
<th>Strength (MDxCD) kN/m</th>
<th>Permittivity at 10cm water head (1/ m²/sec)</th>
<th>Durability (Yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Grey</td>
<td>760</td>
<td>76</td>
<td>300</td>
<td>20x20</td>
<td>50</td>
<td>1</td>
</tr>
<tr>
<td>(Untreated)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bitumen</td>
<td>1200</td>
<td>76</td>
<td>150</td>
<td>20x20</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>treated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>II Grey</td>
<td>900(+</td>
<td>200</td>
<td>250</td>
<td>40x40</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>(untreated)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Treated</td>
<td>900(+)</td>
<td>200</td>
<td>250</td>
<td>40x40</td>
<td>30</td>
<td>1</td>
</tr>
<tr>
<td>(Rot resistant)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Application Areas

➢ Protection of river bank

➢ Strengthening of road when used as an intervening layer between sub-grade and sub-base

➢ Filtration by retaining soil particles on the one hand and ensuring permeability of water through and along it on the other.
Advantages

- Easy to transport, handle and install
- Easily available with customized specifications
- Economical
- Eco-compatible
- Helps natural protection by fostering vegetation over it

Characteristics of Jute Geotextiles:

The jute geotextiles have following characteristics:

- Woven from heavy and coarse cent percent 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.

- Its natural water absorbing capacity helps conserve soil moisture and anchor soil firmly in place and thus gives succor to soil from eroding.

- During water-flow each strand of Geo-jute forms a mini-dam that traps seeds and soil particles and reduces run-off velocity creating a micro-climate 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, the flowing water or the growing grass.
It is flexible enough to follow any type of surface contour.

Any variety of grass or ground cover can be selected to fit site and climatic condition for use of this soil saver. Geo-jute can be used in conjunction with all standard construction and building techniques.

<table>
<thead>
<tr>
<th>Jute Geo-textiles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Property Advantages</strong></td>
</tr>
<tr>
<td>High strength and modulus, good dimensional stability and ability to withstand initial stresses of road construction, heaviness and appreciable thickness, good draping quality, stiff body preventing differential settlement on soil, high permittivity and transmittivity, irregular surface morphology preventing lateral and rotational slides, high water absorption performing well in filtration and drainage and soil consolidation (caking) functions, soil friendliness and addition of nutrients to the soil after degradation, eco-compatibility, vegetation support, easy availability, low cost and agro-renewability.</td>
</tr>
</tbody>
</table>

**APPLICATION OF JUTE GEOTEXTILES**

Geotextiles are used in various ways:

- Impermeable sheet (synthetic coated non woven) to prevent seepage, behind structural defence formed of concrete slabs, stores, cement mortar etc.
• Permeable filter cloth (Needle punched jute non woven) to permit seepage but prevent loss of soil, behind structural defence formed of concrete slabs, stone, gabions etc.

• Reinforcement (Jute Combination fabrics) to protect vegetation to strengthen soil (reinforcement) to strengthen blocks (cables)

Two identified popular areas of jute geotextile applications are

i) soil erosion control and

ii) rural road & pavement constructions.

Nonwoven geotextiles are widely used for drainage, lining systems and asphalt overlays while wovens are used in stabilisation, separation and reinforcement of soil. The holes made in jute nonwovens during planting allowed more freedom to the growing plants than those made in 100% polypropylene spunbonded mulches. Heavy and thick mulch mattings (around 600 gsm and up to 15 mm) are being developed for the prevention of weed established on shrub and tree planting. A product incorporating large apertures is being developed for hill erosion control and rapid establishment of grass.

The State Governments in India have used JGT for mine spoil stabilisation, hill slope protection and sand dune stabilisation in 1987 and 1988. It has been observed that JGT performed satisfactorily in controlling soil erosion and helped in growth of vegetation. Bitumen treated JGT has been used on the bank slope of Nayachar Island, in the river Hoogly, West Bengal, India for erosion control in 1992. The undisturbed bank after 11 years implies that JGT performed its designed functions and helped in natural consolidation of the bank soil. Application of treated woven jute geotextiles along with appropriate engineering measures was done for prevention of riverbank erosion in the river Ichamati, West Bengal, India.

A lot of field applications of JGT in rural roads have been carried out in India and Bangladesh principally for the purpose of strengthening of subgrades
and roadside drainage. In Bangladesh ‘Banana Drain’ type of geotextiles have been invented and it is being used as soil stabilizer.

The use of fibrous materials as a mulching materials are also common uses observed in agronomic and horticultural activities in the European, America and other cold countries for protection of seed/seedling, from cold/heat/light moisture and wash away of soil-by rain and wind before germination. Again, fibrous materials were also used as bioengineering materials for protection and improvement of wetland and water bodies. These are used to ecological niche for improved habitat of various flora-funa from various degradative impact caused by external agencies. Similarly application for the protection/stabilization of hill slope by reinforcing it/them with geotextiles is a very common phenomenon. It is also suitable to for the protection of river bank, stabilization of road and high ways as filtering, separating, draining, reinforcing, materials. Very recently synthetic and modified jute and natural fibers materials are being tried to be used as irrigation canal liners. Again recently some particular airport runways improvements are also being done by using geo-textiles products, for example in Malaysia & Singapore. Moreover, in these countries land reclamation activities are also using geotextiles in sea-shore areas for getting extension of land from the sea.
Application on JGT on Soft Soil

JGT in Weed Control

JGT in Slope Protection

JGT in Slope Protection

Application of jute geotextiles in drain

JGT in Canal protection

JGT in Protection of Hill Slope

JGT in River Bank Protection
Geotextile used in Meghna Dhonogoda Irrigation Project for Bank Protection

Bank Protection by jute bags (gunny bags) textile under Meghna-Dhonogoda Irrigation Project

Treated JGT transported for its use in the Pakulla-Delduar road construction

Jute geotextile used for mulching

Inspection of laying of JGT in the construction site of Pakulla-Delduar road in Tangail district

Jute Geotextile used by LGED for River Bank Protection in Tangail district in Bangladesh
Potential of Jute Geotextile:

Geotextile has been of potential use in developed countries like United States of America (USA), United Kingdom, Geneva, Italy and Jute Geotextiles should share a certain volume of total geotextiles application in the field of Geotechnical engineering as Jute Geotextiles have already proven its application in many areas and become popular to the end users because of its eco-friendly nature and cost effectiveness.

In the United States and the European Union, which are the largest markets for geotextiles, there are major concerns as to environmental degradation and poor water quality caused by uncontrolled soil erosion. In order of importance these markets are North America, which currently consumes around 50% of global rolled erosion control products, Western Europe, which consumes around 30%, and the rest of the world which consumes the remaining 12% of production. Of course three regions, North America and Western Europe together account for some 88% of world consumption and are therefore the prime target markets. Over the next few years these markets are forecast to expand at around 5% per annum although within Western Europe there are countries where general geotextile consumption is expanding more rapidly.

Geotextiles have seen unrivalled growth with a forecast by the United Nations International Trade Centre (UNITC) of 1,400 million m² produced by the new millennium Europe and north American markets each account for 40% with the remaining 20% attributed to Japan Asia and Australasia. As Jute accounts for such a small proportion of geotextile use in the west there is enormous scope for increased usage. Most land managers in Europe are generally unaware of the relevance of jute products, as they consider textiles as the main output of the industry, jute accounts for less than 1% of total geotextile use, despite the technical advantages and low cost of jute geotextiles, which has been demonstrated by research and the results of full scale use. A promotion programme which aims to provide product information in readily useable form has been initiated by UNITC, UNDP and JMDC. Conservation land managers, landowners and landscape architects who use jute in environment projects will see immediate improvements in the
rate and quality if vegetation growth, as well as greatly reduced material costs. Two seminars in London and Geneva held in 1997 brought together key jute producers with invited researchers, environmental consultants, suppliers, contractors and specifying authorities where specifications were agreed on jute geo-textiles would need to meet to satisfy environmental and geo-technical engineers. The obvious uses in erosion control were generally known, but it was interesting to note that composite products involving jute in combination with synthetics, or jute together with coir, can offer optimum solutions in other areas.

Due to life span and other advantages synthetic geo textiles are used mostly as geo technical appliances. On other hand natural geotextiles are getting importance for their biodegradable and environmental friendliness. Here also some information are given in tabular form.

**Table -3 Non-Producer world consumption of organic Rolled Erosion Control Products (RECP) (1994)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Consumption (Mm²)</th>
<th>Percentages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North America</td>
<td>57</td>
<td>66</td>
</tr>
<tr>
<td>Western Europe</td>
<td>17</td>
<td>20</td>
</tr>
<tr>
<td>World residual</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td><strong>86</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

RECP = Rolled Erosion Control Products

**Table 4 Non-Producer world consumption of organic RECP by material type.**

<table>
<thead>
<tr>
<th>Product type</th>
<th>Percentages (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excelsior/straw</td>
<td>59</td>
</tr>
<tr>
<td>Coir</td>
<td>22</td>
</tr>
<tr>
<td>Jute/kenaf</td>
<td>15</td>
</tr>
<tr>
<td>Others</td>
<td>4</td>
</tr>
</tbody>
</table>
Synthetic geotextiles markets, applications and production are mostly in the developed countries. They have got advantages due to their technology advancement and the cost of raw materials. On the other hand natural fiber like jute, coir, kenaf, mesta etc. are mostly available in the under developed countries, so, technology, production, market promotion are slowly improving.

**Table - 5 : Here the world position of jute, kenaf & allied products are given below for perception (2003-2004)**

<table>
<thead>
<tr>
<th>Country</th>
<th>Production of raw jute (lac MT)</th>
<th>Export of raw jute (lac MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>9.63</td>
<td>3.48</td>
</tr>
<tr>
<td>India</td>
<td>19.77</td>
<td>N/A</td>
</tr>
<tr>
<td>China</td>
<td>1.65</td>
<td>N/A</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.57</td>
<td>N/A</td>
</tr>
<tr>
<td>Myanmar</td>
<td>0.42</td>
<td>0.10</td>
</tr>
<tr>
<td>Nepal</td>
<td>0.18</td>
<td>N/A</td>
</tr>
<tr>
<td>Vietnam</td>
<td>0.13</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>32.92</strong></td>
<td></td>
</tr>
</tbody>
</table>

In the year 2003, world export of produces of jute, kenaf & allied fibres is 7.16 lac MT which marked slight increased from that of previous year. Total world import of raw jute in 2003 was 3.86 lac MT. Bangladesh on an average export 90 thousand MT of raw jute to Pakistan.

In 2004-05 Bangladesh exported raw jute worth musd 96.19 & jute goods worth musd 307.48 as against musd 78.46 (4.03 lac MT) and jute goods musd 294.90 respectively of preceding year. In 2003-04 India exported 1.79 lac MT jute goods worth musd 144.24.
Bangladesh has been producing about 50 lac bales of jute fibres. More than 130 composite and spinning mills produce various jute products like Twine, Hessain, Gunnybag, CBC and various traditional products which are about 6 lacs tones. There are 107255 lac spindles and about 25 thousand looms are presently in operation. Bangladesh has a production capacity for manufacturing 5000 tones/soil saver/antiwash/geo jute, mostly of which are exported.

The overall market demand for jute products appears to be increasing marginally. The efforts for diversification of jute products are showing some positive impact. The share of jute diversified products in the Indian jute export basket appears to be increasing.

As a matter of interest, it may be pointed out that the international market price for traditional jute goods were in June, 04: Hessian $ 474 , yarn $ 455, CBC $ 419-510 per MT. Grower-level price of raw jute was at that time Tk. 345-350 per maunds in Bangladesh ($ 5.8 per 37 kg) and in India it was Re 335 per maunds ($ 8.37 per 37 kg). However, in Bangladesh in the year 2004-05 the price of raw jute increased to at least 30%.

Market exploitation of the potential use of jute geotextile will ultimately increase the consumption of large volume of jute on a sustainable basis and it will surely contribute to the enduring future of jute.

It has been identified that increasing the total market share of jute erosion control, geotextiles alone has great potentiality in terms of jute consumption.

The traditional market of jute is squeezing as a result of entry of synthetic yarns made of polyamides, ploypropylene and other derivatives of petroleum chemical in the market. The jute industry must be revived with its diversified uses. Use of Jute Geotextile can be one of the potential area to revive jute industry.
Standardization of Jute Geotextiles:

Specifications, design methodologies, standards, user friendly manuals for Jute Geotextiles (JGT) for special applications which are needed to attract end users are not yet addressed adequately. So far only one standard (Guidelines of Application of Jute Geotextiles for Rain water erosion control in road and rainway embankments and hill slopes IS-14986 2001) has been published by the Bureau of Indian Standards BIS and many research are ongoing example for by Development of Durable Water-repellent Jute Geotextiles (JGT) with Natural Eco-friendly Additive for Application in Erosion Control in River Banks and Other Appropriate End Uses undertaken by Jute Manufacturers Development Council (JMDC).

Specifications of traditional jute geotextiles (jute net, antiwash, soil saver are jute geotextiles products): Table-6

<table>
<thead>
<tr>
<th>Materials</th>
<th>100% natural fibres</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length</td>
<td>70 m rolls or longer lengths in rolls or bales as required</td>
</tr>
<tr>
<td>Width</td>
<td>1200 mm</td>
</tr>
<tr>
<td>Thickness</td>
<td>5 mm</td>
</tr>
<tr>
<td>Open Area</td>
<td>65% approx</td>
</tr>
<tr>
<td>Construction</td>
<td>Plain open weave, single yarn 6.5 warp threads/100 mm approximately 4.5 weft threads/100 mm approximately</td>
</tr>
<tr>
<td>Weight</td>
<td>500g/sq meter or 600 g/linear meter (also available, heavier variety of weight 800 g/sq meter)</td>
</tr>
<tr>
<td>Fixation</td>
<td>Number 11 gauge wire staples, 150 mm long or as soil conditions require.</td>
</tr>
</tbody>
</table>

Jute geotextiles may be treated for smoulder resistance, depending on the requirements of local regulations at the usage points.

Due to their low strength and degradability, presently available jute geotextiles are not generally accepted to civil engineering applications such as drainage, filtration, separation, or reinforcement. Furthermore, since present jute
geotextile do not comply in this present form with technical specifications in the dominant end user countries they are effectively excluded from these markets. However, there are exceptions. One is the of jute in strip drains. Strip drains also known as wick drains or band drains, are narrow strip of material, including jute, which are used to speed the consolidation of soft cohesive foundation soils for construction purposes, for example in Thailand.

The study carried out by International Jute Organisation (IJO) shows the existing commercially available woven 500 gsm products or a lighter weight mesh should be specified. These both provide very effective levels of erosion control, combined with aiding germination and vegetation growth. For control of erosion the geotextiles should have the following properties:

- Interception air flow, rainfall and runoff
- Reduce rainfall and wind intensity at the ground surface
- Store water
- Reduce raindrop impact
- Reduce wind and runoff velocities
- Encourage infiltration of surface water

Table - 7 : Technical Specification for geotextiles used in erosion control by IJO

<table>
<thead>
<tr>
<th>Woven</th>
<th>Weight (gsm)</th>
<th>Yarns per/m</th>
<th>Yarn Dia (mm)</th>
<th>Open Area (%)</th>
<th>Area of Geotextile</th>
<th>Textile Strength kN/m</th>
<th>Water Holding Capacity (% of dry wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>warp</td>
<td>weft</td>
<td>warp</td>
<td>weft</td>
<td>warp</td>
<td>weft</td>
<td>warp</td>
</tr>
<tr>
<td>Geojute</td>
<td>500</td>
<td>65</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>46</td>
</tr>
<tr>
<td>Soil</td>
<td>500</td>
<td>65</td>
<td>45</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>49</td>
</tr>
<tr>
<td>Saver</td>
<td>500</td>
<td>64</td>
<td>46</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>46</td>
</tr>
<tr>
<td>Antiwash</td>
<td>275</td>
<td>460</td>
<td>460</td>
<td>1.5</td>
<td>1.5</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Hessian</td>
<td>275</td>
<td>460</td>
<td>460</td>
<td>1.5</td>
<td>1.5</td>
<td>20</td>
<td>80</td>
</tr>
<tr>
<td>Coir</td>
<td>700</td>
<td>110</td>
<td>70</td>
<td>4</td>
<td>4</td>
<td>42</td>
<td>58</td>
</tr>
</tbody>
</table>
The existing 500 gsm JGT product commonly marketed under a variety of trade names by various companies as Geojute, Soil Saver, Anti-Wash etc., was found effective and price competitive compared with other erosion control geotextiles, although the supply was limited due to lack of suitable machinery facility in jute mills. It has been identified that a lighter weight, woven jute material (around 300 gsm) which has been found to have the same techno-economic capability and most jute mills in the jute producing countries are capable of manufacturing it in larger volumes. However, this lighter weight product would require some more work and trials for assessment of its appropriateness and suitability. The technical study indicated that for certain soil types the lighter weight 300 and 400 gsm woven JGTs perform adequately and, at a pro rata price, could prove attractive to the end-user but any limitation on use should be determined and published to ensure end-users confidence.

Although there is ample scope and high potentiality as mentioned earlier there may arise the question as to:

*Why do these products comprise only 15% of the global market for natural fibre erosion control products (and only 7.5% of the total global market for erosion control products), given the proven outstanding technical performance of jute geotextiles in controlling soil erosion?*
*Is the current production capacity of jute woven and non-woven geotextiles limited in any way either by the production process, jute producers or product manufactures, by poor product promotion, by failure to provide adequate technical data to end users, by neglect of end user requirements or any combination of these?

These questions must be addressed before the jute geotextile market can realise its undoubted potential.

Agro-mulching of textiles materials seems to be most effective with the use of natural fibers, due to their biodegradability, echo-compatibility and improvement of soil fertility and texture. The properties of natural geo-textiles are not popularized and well known to the users, particularly to civil engineers and bio engineers.

**Some Projects taken up by JMDC and IJSG:**

JMDC has taken a project on ‘Development of Durable Water-repellent Jute Geotextiles (JGT) with Natural Eco-friendly Additive for Application in Erosion Control in River Banks and Other Appropriate End Uses’.

IJSG has taken up a Project on ‘Development and Application of Potentially Important Jute Geptextiles’.

**Governments’ initiatives in promotion of use of jute geotextiles.**

Both Bangladesh and Indian Government have taken good initiatives to promote jute geotextiles. Two research projects were carried out by the Civil Engineering Department of Bengal Engineering and Science University, Shibpur on “Development and Applications of Jute Geotextiles” and “Engineering Properties of Geojute and Applications in Civil Engineering” funded by UNDP through IJIRA (Indian Jute Industries Research Association) during 1996-98 and sponsored by the Government of India during 1997-2000 respectively.
The results of the efforts could not however be disseminated effectively among end users, the way it have been, but nevertheless the initiative was certainly pioneering, technical awareness were conducted in twelve states in India. Presentations on JGT have been given before a Cabinet group comprising nine senior cabinet ministers of the State, before the Chief Secretary and the Advisory Group of the Department of Science and Technology. These efforts ensured inclusion of one item on JGT in the schedule of PWD (Roads). Meetings were also held with the concerned secretaries in other states and it’s a continuous process in India. Besides, Indian Geo-technical Conference, Indian Roads Congress, Indian Permanent Way Engineers’ Association, Institution of Engineers (India), IITS in Roorkee, Indian Institution of Science, Bengal Engineering and Science University, Shibpur have taken actions for promotion of JGT. A Pilot project on rural roads with Jute Geotextiies – “Pradhan Mantri Gram Sadak Yojana” in 5 states of India has been under way. The project will cover 47.84 km. Besides the end using departments in public sector are showing greater interest in using JGT for its eco-compatibility and competitive price. These are pioneers to the increasing acceptability of JGT in the Indian market. The Jute Manufactures Development Council (JMDC), a statutory body under the Union ministry of textile, Government of India has recently come out with a jute-based geotextile substitute for road construction. The JMDC has already approached the Central Road Research Institute (CRRI) for the use of the same. The CRRI has used the special chemical-treated jute geotextile in a pilot project, identified as eight road projects in the four states of West Bengal, Orissa, Madhya Pradesh and Chattisgarh under the Pradhan Mantri Gramin Sadak Yojana (PMGSY).

In 1996, the Prime Minister Office, Government of the People’s Republic of Bangladesh issued order to all development organisations to use jute geotextiles and accordingly Local Government Engineering Department (LGED), Roads and Highways Department (RHD), Bangladesh Development Board (BWDB) are using Jute Geotextiles for protection of river bank erosion and soil stabilisation. Research and development activities
on jute geotextiles were initiated in Bangladesh by BJRI in 1986. They have worked in collaboration with Civil Engineers/Scientists/Technologists/Designers of BJMC/BUET/PWD/SRDI/LGED and IJO along with different private jute mills.

In Bangladesh there have been a good number of works in field application for soil erosion control and rural road construction example for 1) Pilot Scale Study on use of jute geotextiles for erosion control in Bandarban, a hill district, in collaboration with SRDI/PWD/BJRI and ii) Pilot Study on use of jute geotextiles as rural road stabiliser (Pakulla –Delduar Road) in the district of Tangail in 1999-2001 in cooperation with Ministry of Textiles and Jute (MOTJ)/LGED/BJMC/Adamjee Jute Mills/BJRI.

One market study in Bangladesh carried out by Bangladesh Jute Manufacture Corporation (BJMC), Bangladesh Water Development Board and BUET shows that use of jute geotextiles for surface erosion control was found as satisfactory. Bangladesh water Development Board has used jute geotextiles in Meghna-Dhonogoda Irrigation Project.

Research and development activities were undertaken on crop land types of jute geotextiles and Jute Reinforced Irrigation Canal Development in cooperation with BARI/MAWTS/BJRI and PANASI Project.

RECOMMENDATIONS

To promote use of jute geotextiles following are needed to take care of.

- Need for development testing and promotion of new woven JGT products for field trial applications in different agro-climatic conditions.

- No study has yet been analysed the interactions between 3 critical aspects of JGT production and application. The study is essential as at present 500 gsm jute woven erosion control geotextile contribute only 7.5% of total geotextiles world market although it is technically competent & commercially competitive.
• Increase in consumption of jute through greater sales of JGT globally will increase jute desired revenues to producing countries and improving environmental protection through the use of JGT in consuming countries.

• Whilst the cost of geotextiles (selling in Europe for £ 0.40 to £ 0.80 per m²) is lower than synthetic geotextiles (£ 1.10 to £ 1.35 per m² approx) and other natural fibre geotextiles (£ 0.75 to £ 2.00 per m²) their usage is very low. Thus jute has competitive price, and the technical characteristics are superior to other materials in particular applications.

• One relatively novel use of jute fibres and textiles is in the form of "geotextiles", where high volumes of relatively low-grade, jute raw materials can be utilized. Previous commercial and technical investigations have shown that the use of jute and jute based products as "geotextiles" has significant potential.

  a) Ever increasing concerns of environmental protection and conservation will provide new opportunities for use of natural fibre geotextiles, including jute products.

  b) Geotextiles are technical textiles sold primarily for their technical and engineering characteristics rather than on aesthetic appeal.

  c) Jute geotextiles can be produced by existing jute mills with little or no modifications or additions to machinery.

  d) The demand for geotextiles is very large and expanding. Even a small portion of the market would be sufficient to improve the jute economy.

Whilst synthetic products dominate the overall geo-textile market, previous studies commissioned by the ITC and IJO in the early 1980’s showed that jute products might be able to compete commercially with synthetics in the end uses of: (a) Soil Erosion Control & (b) Rural Road Pavement Construction.
If jute geotextiles are to contribute to this objective, the markets, manufacturing and performance of these products must be fully understood. To date, there have been very few studies investigating these aspects, and no study has analyzed the interactions and synergies between these 3 critical aspects of jute geo-textile production and application.

The jute mills are waiting for the engineers to tell them what to do, whilst the engineers are waiting for the jute mills to show them what is available. Several institutes in jute producing countries as well as in Europe have carried out much research. Interesting results were seen but wider use did not materialise. It will be important to address this issue and to use past experiences as stepping stone for future work. There is currently a very wide gap. Erosion control, foundations, sound barriers, filters, and reinforcement and drainage are suggested as the most appropriate target uses of jute geo-textiles.

By far the most marketable jute geo-textiles are those used for erosion control and these products should be regarded as the main stay of the jute geo-textile industry. At present there are no major specification requirements to be met and the market has been partly developed. In theory, and in fact, the greatest potential for jute erosion control products is in those regions which have the largest and most buoyant erosion control products markets.

As regards marketing, it is for the jute geo-textile manufacturers to decide on the most acceptable approach. On the one hand, there is the option of using independent importer and distributors as at present. This has the advantages of being a known quality which works moderately well in promoting jute erosion control products.

The disadvantage of this present marketing system is that the importing agents and distributors between them take a larger proportion of the gross profit than the manufacturers.

Another option is for the jute geo-textiles manufacturer to employ their own importing agents and to appoint distributors of their choice.
Jute geo-textiles is a new area for jute uses as discussed earlier and can be seen as a dimension of its application both as geo-textiles appliances and bio engineering and agro-mulching. There is a possibility of new application of jute both in developed and developing countries. Many studies and reports show that there exists enough potential market for jute geo-textiles both in developed and developing countries. The major constraint is popularization of uses and marketing of jute geo-textiles as textiles products both woven, non-woven, netted, corded, sandwich and composite type. These products can easily be manufactured in the existing jute mills with minor modification. Bangladesh has enough excess production capacity, which can be utilized for the production of jute geo-textiles.

Again a new areas for using jute geo-textiles has developed in the construction of rural road and erosion control which not only will increase the applications and also help in poverty reduction in rural areas. Moreover, applications of jute geo-textiles will help enormously to protect environment as a whole from degradation.

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# LIST OF PARTICIPANTS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Particulars</th>
<th>Position / Status</th>
</tr>
</thead>
<tbody>
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<td>3</td>
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<tr>
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</table>
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<table>
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<tr>
<td>12</td>
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<td>14</td>
<td><strong>Dr. Debasish Gupta, IAS</strong>&lt;br&gt;Chief Electoral Officer Govt. of Jharkhand Sector II, Dhubra, Ranchi, India 834004</td>
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<td>15</td>
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<td>Chairman, Session - IV &amp; Resource person</td>
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<td><strong>Mr. Amitava Ghosal</strong>&lt;br&gt;Vice President, Stup Consultants (P) Ltd Kolkata, India</td>
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<td>17</td>
<td><strong>Prof. Dr. R.J. Rickson</strong> MSc, BSc, AKC, MIAgrE, CEnv&lt;br&gt;Chair in Soil Erosion and Conservation National Soil Resources Institute (NSRI) Cranfield University, Bedfordshire, UK&lt;br&gt;Tel : +44 1234 750111 ext 2705</td>
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| 18     | **Mr. Vinay Chand**  
Vinay Chand Associates  
230 Finchley Road  
London NW3 6DJ, UK  
Tel: +44 2077945977 | Resource Person |
| 19     | **Mr. U.K. Guru Vittal**  
Geotechnical Engineering Division  
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Cell: +91 9868858380 | Resource Person |
| 17     | **Dr. Pranab Kumar Bhattacharya**  
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17, Taratola Road, Kolkata  
India | Resource Person |
| 20     | **Dr. P. K. Chowdhury**  
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Cell: +91 9830982277 | Resource Person |
| 20     | **Mr. Tapobrata Sanyal**  
Geotech Adviser  
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Tel: +91 33 22172107/2540 | Resource Person |
| 21     | **Dr. A.B.M. Abdullah**  
Executive Director  
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Dhaka 1000, Bangladesh  
Tel: +8802 914 5511, 9125581-5 Ext. 120 | Resource Person |
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| 22     | **Prof. Abdul Jabbar Khan**  
Civil Engineering Department  
Bangladesh University of Engineering & Technology (BUET)  
Dhaka 1000, Bangladesh  
Tel: +8802 8613046, Cell: 01726685407 | Resource Person           |
| 23     | **Mr. Mahmudul Huq**  
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Tel: +8802 9888698 | Resource Person           |
| 24     | **Dr. Prabir Ray**  
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Tel: +91 33 24615621/5444 | Resource Person           |
| 25     | **Mr. D. C. Baheti**  
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Tel: +91 33 22303809 | Resource Person           |
| 26     | **Dr. Satyendra Mittal**  
Associate Professor  
Indian Institute of Technology (IIT)  
Roorkee, India | Resource Person           |
| 27     | **Mr. Mir Jamal Uddin**  
Director  
Faridpur Jute Fibres Ltd.  
Dhaka, Bangladesh  
Tel: | BJSA  
Representative |
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<td>Mr. Farian Yusuf&lt;br&gt;Faridpur Jute Fibres Ltd.&lt;br&gt;Dhaka, Bangladesh&lt;br&gt;Tel:</td>
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<td>29</td>
<td>Mr. Humayun Mazhar&lt;br&gt;Vice-Chairman&lt;br&gt;Pakistan Jute Mills Association (PJMA)&lt;br&gt;Lahore, Pakistan&lt;br&gt;Tel: +92 42 5715447</td>
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<td>30</td>
<td>Mr. Zaheer Abbas Fida&lt;br&gt;Head of Technical&lt;br&gt;Pakistan Jute Mills Association (PJMA)&lt;br&gt;Lahore, Pakistan&lt;br&gt;Tel: +92 42 5715447</td>
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<td>31</td>
<td>Mr. N. R. Shaha&lt;br&gt;SAVYOG International&lt;br&gt;Local agent of&lt;br&gt;Wilhelm G. Clasen in India&lt;br&gt;Kolkata, India&lt;br&gt;Cell: +91 9836621136</td>
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<td>Mr. A. Mitra&lt;br&gt;Consultant&lt;br&gt;Jute Manufactures Development Council (JMDC)&lt;br&gt;Ministry of Textiles, Govt. of India&lt;br&gt;3A Park Plaza, 71 Park Street, Kolkata 700 016, India&lt;br&gt;Cell: +91 9830348782</td>
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<td>Mr. D. Banerjee&lt;br&gt;Consultant, JMDC&lt;br&gt;3A Park Plaza, 71 Park Street, Kolkata 700 016, India&lt;br&gt;Cell: +91 9830348782</td>
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<td>Dr. R. C. Tiwari</td>
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<td><strong>Dr. Asoke Majumdar</strong>&lt;br&gt;National Institute of Research on Jute and Allied Fibre Technology (NIRJAFT)&lt;br&gt;Kolkata, India&lt;br&gt;Cell: +91 9831854340</td>
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<td><strong>Dr. Gautam Bose</strong>&lt;br&gt;National Institute of Research on Jute and Allied Fibre Technology (NIRJAFT)&lt;br&gt;Kolkata, India&lt;br&gt;Cell: +91 9433003241</td>
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<td><strong>Dr. Debashis Roy</strong>&lt;br&gt;Dept. of Civil Engineering&lt;br&gt;Indian Institute of Technology (IIT)&lt;br&gt;Kharagpur, India&lt;br&gt;Cell: +91 9333451843</td>
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<td><strong>Dr. Goutam Bhattacharya</strong>&lt;br&gt;Head, Civil Engineering Deptt.&lt;br&gt;Bengal Engineering &amp; Science University, Shibpur (BESUS) Shibpur, Howrah 711 103&lt;br&gt;West Bengal, Kolkata, India&lt;br&gt;Cell: +91 9433656572</td>
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<td><strong>Prof. Ambarish Ghosh</strong>&lt;br&gt;Civil Engineering Deptt.&lt;br&gt;Bengal Engineering &amp; Science University, Shibpur (BESUS) Shibpur, Howrah 711 103&lt;br&gt;West Bengal, Kolkata, India&lt;br&gt;Cell: +91 9431938544</td>
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<td><strong>Dr. Sudip Roy</strong>&lt;br&gt;Civil Engineering Deptt.&lt;br&gt;BESUS, Shipur, Howrah 711 103&lt;br&gt;West Bengal, Kolkata, India&lt;br&gt;Cell: +91 9830233172</td>
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<td><strong>Dr. Ashis Bera</strong>&lt;br&gt;Civil Engineering Deptt.&lt;br&gt;BESUS, Shipur, Howrah 711 103&lt;br&gt;West Bengal, Kolkata, India&lt;br&gt;Cell: +91 9433928492</td>
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<td><strong>Mr. S. K. Bhattacharya</strong>&lt;br&gt;Executive Vice-Chairman&lt;br&gt;Indian Jute Mills Association (IJMA)&lt;br&gt;Royal Exchange, 6 Netaji Subhas Road&lt;br&gt;Kolkata 700 001, India&lt;br&gt;Cell: +91 9830264158</td>
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<td><strong>Mr. N. Pujara</strong>&lt;br&gt;Chairman&lt;br&gt;Calcutta Jute Fabrics Shippers Association&lt;br&gt;Kolkata, India</td>
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<td><strong>Mr. P. K. Katare</strong>&lt;br&gt;Director&lt;br&gt;National Rural Roads Development Agency (NRRDA)&lt;br&gt;New Delhi, India</td>
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<td><strong>Dr. Debanjan Sur</strong>&lt;br&gt;Ex. Senior Deputy Director, IJIRA&lt;br&gt;IA-297/3 Salt Lake, Sector - 3&lt;br&gt;Kolkata 700 097, India&lt;br&gt;Cell: +91 9830289754</td>
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<td><strong>Mr. U. Sen</strong>&lt;br&gt;Assistant Director, Jute Commissioner's office&lt;br&gt;3rd MSO Building, E&amp;F Wing, CGO Complex&lt;br&gt;DF Block, Salt Lake City, Sector-1,&lt;br&gt;Kolkata 700 064, India&lt;br&gt;Cell: +91 9830081017</td>
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<td><strong>Mr. S Datta</strong></td>
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<td><strong>Mr. Mihir Kumar Samanta</strong>&lt;br&gt;CE-II&lt;br&gt;Irrigation &amp; Waterways Directorate&lt;br&gt;Govt. of West Bengal, Kolkata</td>
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<td><strong>Mr. S. P. Dutta</strong>&lt;br&gt;Ex-Secretary&lt;br&gt;Irrigation &amp; Waterways Directorate&lt;br&gt;Govt. of West Bengal, Kolkata, India&lt;br&gt;Cell: +919433148973</td>
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<td><strong>Mr. Besisajit Ray</strong>&lt;br&gt;Public Works (Roads) Deptt.&lt;br&gt;West Bengal, Kolkata, India&lt;br&gt;Cell: +91 9830257858</td>
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<td><strong>Mr. Arabinda Ghosh</strong>&lt;br&gt;Public Works (Roads) Deptt.&lt;br&gt;West Bengal, Kolkata, India&lt;br&gt;Cell: +91 9830139643</td>
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<td><strong>Mr. B.C. Ghosh</strong>&lt;br&gt;Public Works (Roads) Directorate&lt;br&gt;Kolkata, India&lt;br&gt;Cell: +91 9433094784</td>
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<td><strong>Mr. Piyush Kumar Bose</strong>&lt;br&gt;Former Secretary&lt;br&gt;Irrigation &amp; Waterways Directorate&lt;br&gt;Govt. of West Bengal, Kolkata&lt;br&gt;Cell: +91 9830111891</td>
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<td><strong>Mr. Amitabha Datta</strong>&lt;br&gt;STUP Consultant P. Ltd.&lt;br&gt;Kolkata, India&lt;br&gt;Cell: +91 9830279446</td>
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<td><strong>Mr. I. Cuxton</strong>&lt;br&gt;A I. Champdany Co. Ltd.&lt;br&gt;West Bengal Consultant Organisation Ltd (WEBCON)&lt;br&gt;Shilpa Bhavan, 3rd Floor, 31 Block Burn Lane,&lt;br&gt;Kolkata 700 012, India&lt;br&gt;Tel: +91 33 22489868</td>
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<td><strong>Mr. S. R. Dhua</strong>&lt;br&gt;West Bengal Consultant Organisation Ltd (WEBCON)&lt;br&gt;Shilpa Bhavan, 3rd Floor, 31 Block Burn Lane,&lt;br&gt;Kolkata 700 012, India&lt;br&gt;Tel: +91 33 22266278/6527</td>
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<td><strong>Mr. D. K. Dutta</strong>&lt;br&gt;Chief Consultant&lt;br&gt;West Bengal Consultant Organisation Ltd (WEBCON)&lt;br&gt;Shilpa Bhavan, 3rd Floor, 31 Block Burn Lane,&lt;br&gt;Kolkata 700 012, India&lt;br&gt;Cell: +91 9433012031</td>
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<td><strong>Mr. Dipankar Das</strong>&lt;br&gt;Sr. Scientist&lt;br&gt;DST. Govt. of West Bengal.&lt;br&gt;India&lt;br&gt;Cell: +91 9433133167</td>
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<td>78</td>
<td><strong>Mr. Sujoy Basu</strong>&lt;br&gt;86/B, Monohar Pookur Road&lt;br&gt;Kolkata, India</td>
<td>Participant</td>
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<td><strong>Jute Mills Representatives</strong></td>
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<td><strong>Mr. V. K. Churiwal</strong>&lt;br&gt;Brishti Vinimoy Pvt. Ltd&lt;br&gt;Unit : Premchand Jute Mills,&lt;br&gt;Kolkata, India</td>
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| 80     | **Mr. D. K. Bubna**  
Executive Director cum Company Secretary  
Ludlow Jute Mills (Prop. Aekta Ltd.)  
6, Little Russell Street  
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| 81     | **Mr. B. M. Thakkar**  
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Cell: +91 9831013550 | Participant |
| 82     | **Mr. Sanjay Hada**  
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VNSS Business Centre  
Ideal Plaza, South Block, 4th floor  
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Kolkata 700 020, India | Participant |
| 83     | **Mr. L. R. Lodha**  
President (W)  
Hastings Jute Mills  
Kolkata, India | Participant |
| 84     | **Mr. U. Dutta**  
Hastings Jute Mills  
Kolkata, India | Participant |
| 85     | **Mr. S. K. Chanda**  
Chief Executive  
Hooghly Jute Mills Co. Ltd  
Unit : Hukumchand Jute Mills,  
Kolkata, India | Participant |
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| 86     | **Mr. S. K. Ghosh**  
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Cell : +91 9831256163 | Participant |
| 87     | **Mr. A. K. Kankaria**  
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| 89     | **Mr. P. Chatterjee**  
Joint President  
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Tel : 00 91 33 2213 1680/0380 | Participant |
| 90     | **Mr. D. C. Pattan**  
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Cell : +91 9433308014 | Participant |
| 91     | **Mr. Hemant Bangur**  
Director  
Golster Jute Mills Ltd.  
Kolkata, India | Participant |
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| 92     | Mr. H. N. Ghosh  
The Ganges Manufacturing Co. Ltd.  
Kolkata, India  
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| 93     | Mr. Pradip Ghosh  
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Cell: +91 9830734809 | Participant |
| 94     | Mr. Md. Nurul Amin  
Operations Assistant, IJSG | Participant |
SOME PRESS CLIPPINGS
Jute geo-textiles meet opens in city

Our Correspondent

AN INTERNATIONAL workshop on jute geo-textiles (JGT) opened on Saturday to discuss the potential and prospects of jute geo-textiles and to explore possibilities of changing face of jute through product diversification. The workshop, attended by delegates from India, Bangladesh and other countries, was organised in Kolkata by International Jute Study Group (IJSG), Dhaka, in association with Jute Manufactures Development Council (JMDC).

It was hoped that the two-day workshop is able to sum up various opinions and suggestions of a wide range of experts, technologists, jute researchers and stakeholders so as to draw up a final blueprint of a viable project on JGT.

In fact, Common Fund for Commodities (CFC) — an international financing body for commodity development — and governments of India have contributed $2.5 million and $1.5 million respectively for success of this geo-textiles project with a time limit of three years, the organisers told reporters.

Addressing the seminar, West Bengal industry and commerce minister Nitupam Sen called upon jute technologists and scientists to accept the challenges and opportunities offered by diversification of the golden fibre for placing jute on a sound footing. According to Mr Sen, many things could be made out of jute which would find profitable markets within and outside the country.

"It would be better for all involved in jute growing and end-product manufacturing to look for a change in leadership in the global jute market where geo-textiles could find a prominent place," he said. In this context, the minister referred to the Pradhan Mantri Gram Sadak Yojana (PMGSY) in five states on geo-textiles.

He said geo-textiles could be used in controlling soil erosion, soft soil consolidation and construction of roads. Mr Sen also mentioned that a Canadian firm had put a proposal before him seeking land for starting a paper project where jute and jute-stick could be used as raw materials.

Other speakers who addressed the media conference included CFC senior project manager Sietske van der Werff, IJSG secretary general Sudipta Roy, jute commissioner Binod Kispotta and JMDC secretary Atul Bhattacharya.

Asked about the projects in hand, Mr Roy said IJSG had six projects in present and geo-textiles project was one of them.

IJSG proposed 'development and application of potentially important jute geo-textiles' with financial support from CFC. The project would design particular types of JGT in line with the site parameters as well as marketability, quality assurance, production and standardisation.

He admitted that there existed some lack of coordination among implementing agencies and end-users at the start of PMGSY pilot project.

But this has been solved to a great extent and he claimed that about 80% of the project had been completed.

The pilot project aims at building a 10 km road in each of the five states — Assam, Chhattisgarh, Madhya Pradesh, Orissa and West Bengal.

In fact, the FWDs in many state governments and Central Road Research Organisation were gradually convinced about success of using jute geo-textiles not only in constructing new roads and highways, but also repairing existing roads. It is believed that application of jute soil saving in FWD seems alone could open up a new vista of marketing compared to ill-marketed jute products.

Other areas where geo-textiles can be effectively used include management of eroding slopes in road and railway embankments and mild landslides, prevention of railway track settlement, river embankment, stabilisation of overburdened dumps in mines and management of solid waste.
Cash prop for jute geotextiles

A STAFF REPORTER

KOLKATA, April 5: A domestic company has proposed to set up a plant which would manufacture paper from jute fibres, and sticks using Canadian technology, said Mr Nirupam Sen, West Bengal industry and commerce minister here today. Speaking at an international workshop on Jute Geo-textiles (JGT), Mr Sen said that the industry should look forward to diversify into new areas.

Mr Sudipta Roy, secretary, general of International Jute Study Group, a Dhaka-based inter-governmental organisation, said that the workshop was organised by Dhaka-based International Jute Study Group (IJSG) and the Jute Manufacturers Development Council.

The Indian government will invest another $1.5 million to start a project for the development and application of geotextiles.

A diversified jute product, jute geotextile is effective in addressing soil-related problems in civil engineering.

The global initiative to find an alternative use of jute was announced by CFC's senior project manager, Sieste van der Werff at a workshop here today. The workshop was organised by Dhaka-based International Jute Study Group (IJSG) and the Jute Manufacturers Development Council.

Inaugurating the workshop, Bengal commerce minister Nirupam Sen said a Canadian company had initiated a dialogue with the state government to set up a paper plant using jute fibres.

Sudipta Roy secretary-general of IJSG said, "A project in Bangladesh to make paper from jute produced the finest quality paper. But it was not economically viable." However, further research may make paper manufacturing from jute an economically successful proposition," he added.

Jute units must diversify to survive

Statesman News Service

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