Development of New Open Weave Jute Geotextiles to Use for Rain Water Erosion Control in Road, Railway Embankment and Hill Slopes

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ABSTRACT

Soil erosion induced by intense rainfall and surface runoff poses a serious threat to the stability and serviceability of road and railway embankments and hill slopes, particularly in high-rainfall and seismically sensitive regions. Natural fibre–based geotextiles, especially jute geotextiles (JGTs), offer a sustainable and biodegradable alternative to synthetic materials for short- to medium-term erosion control.

This paper presents the design, development, laboratory evaluation, and field implementation of newly standerdised open-weave jute geotextiles of 600 GSM and 1200 GSM, aimed at addressing performance gaps identified in existing Indian specifications. Constructional parameters, mechanical properties, hydraulic characteristics, and field applicability were assessed through mill surveys, laboratory testing, and pilot installations on National Highway hill slopes in Mizoram, India.

The results demonstrate that the newly developed JGTs provide enhanced tensile strength, improved stability on steep slopes, and effective erosion control under varying soil and climatic conditions. The study further highlights the need for harmonization and refinement of existing standards for open-weave jute geotextiles.

Keywords: Jute geotextile, open-weave geotextile, erosion control, hill slope stabilization, sustainable infrastructure, railway embankments.

INTRODUCTION

Rainwater-induced soil erosion significantly affects the stability and longevity of road and railway embankments and hill slopes. Conventional hard engineering measures often entail high costs, environmental degradation, and limited adaptability to complex terrain. In contrast, biodegradable geotextiles made from natural fibres such as jute provide temporary reinforcement, surface protection, and facilitation of vegetation growth, ultimately leading to sustainable slope stabilization.

Open-weave jute geotextiles (JGTs), commonly known as jute soil savers, are particularly effective in reducing runoff velocity, trapping soil particles, and creating favourable micro-environments for vegetation establishment. While several grades of open-weave JGTs are currently in use in India (292, 500 and 730 GSM), field feedback indicates performance limitations under steep slopes, high rainfall intensity, and strong wind conditions. This study addresses these gaps through the development and validation of new 600 GSM and 1200 GSM open-weave JGTs.

REVIEW OF LITERATURE

Extensive research has established the efficacy of jute geotextiles in erosion control and slope stabilization. Sanyal (2011) demonstrated that open-weave JGTs effectively reduce surface runoff and promote vegetation growth, gradually transferring load-bearing functions to root systems as the jute biodegrades. Rao et al. (1996) reported successful use of treated jute geotextiles as temporary reinforcement in highway

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embankments over soft marine clay. Ghosh et al. (2015) highlighted the suitability of open-weave JGTs for high-rainfall regions, emphasizing mesh size and tensile strength as key performance parameters.

Studies on railway embankments and hill slopes have further confirmed the environmental and engineering benefits of jute-based systems. Internationally, the Bangladesh Standard BDS 1909:2019 provides a structured classification of open-weave JGTs for hill slope management, incorporating slope angle and rainfall intensity. In contrast, the Indian Standard IS 14986 combines application guidelines and product specifications, leading to ambiguities in testing and performance requirements. These findings underline the need for improved design and standardization of open-weave JGTs.

METHODOLOGY

Information Collected from Users :

All the information collected from users are given below.

Information Collected from User 1

1. **Type of The Item used-** Jute Soil Saver /Jute Geo Textile 500 GSM

2. **Suggestions -** Modernizing and Upgrading Technology and Enhanced Quality Control and Standardization

3. **Challenges being faced -** Labour issues and Infrastructure Hurdles

Information Collected from User 2

1. **Type of The Item used-** Open weave JGT of 730 GSM**.**

2. **Standards and regulations being followed**- As per technical recommendation

Properties of Jute Geotextiles proposed for Applications are given below:

Table – 1, Open weave Jute Geotextiles (soil saver)	
Parameters	**Standard Values**
Width (cm)	≥ 122 cm
Weight (gsm) at 20% MR	730 (-5%, +10%)
Ends X Picks/dm	≥ 8 X 8
Thickness (mm)	5.50 (± 10%)
Wide width Tensile strength (kN/m) MD X CD	≥ 16.8 X 11.7
Elongation at break (%) MD XCD	≤ 10 X 10
Open Area (%)	40 - 45
Water Holding Capacity (%) on dry weight	400 - 600

1. **Suggestions**- Weight of JGT 730 gsm could not give much stability at area having slope > 50 %. At higher slope percentage area heavier JGT >730 gsm should be used.

2. **Challenges being faced-** Due to undulated topography and high slope percentage it was difficult to lay JGT at site.

Information Collected from User 3

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Type of Item used –

Table – 2, JGT Quality Used by ABCI Infrastructure Pvt. Ltd.

	Vendor Name	Item Description	Quantity	Project Site
1	Reliance Jute Mills (International) Ltd.	Jute Open Weave Soil Saver – width 122 cm, 730 GSM, 7 X 7/ dm, Length of each Roll 68.58 m	12344.41 m, 180 rolls	Dalkhola
2	Reliance Jute Mills (International) Ltd.	Jute Open Weave Soil Saver – width 122 cm, 730 GSM, 7 X 7/ dm,	3291.84 m, No. of Rolls- 48	Cooch Behar
3	Kamarhatty Co. Ltd.	Jute Open Weave Soil Saver – width 122 cm, 500 GSM, (HSN- 6305)	60200 sq. m	Package-4 (GP Project Mizoram)

Challenges Identified During Field Application

Despite the proven effectiveness of open-weave jute geotextiles in erosion control, several practical challenges were identified during field implementation, particularly in hilly terrains:

a. Installation on Steep Hill Slopes:

Installation of JGTs on steep and high hill slopes was found to be difficult due to slope instability, high gradient, and adverse site conditions. Maintaining proper anchorage, alignment, and overlap of the geotextile becomes increasingly challenging as slope angle increases, especially under windy conditions.

b. Inadequate Vegetation Growth Due to Drapability Issues:

In certain locations, inadequate drapability of the geotextile resulted in poor contact between the fabric and the soil surface. This led to the formation of voids beneath the fabric, reducing soil–geotextile interaction and adversely affecting moisture retention and seed germination. Consequently, vegetation growth was slower and less uniform in such areas.

Standardisation of New Open-Weave Jute Geotextiles

During the course of the study, it was observed that a 600 GSM open-weave jute soil saver, which is standardized and widely used in Bangladesh, is not currently included in Indian specifications. Recognizing the suitability of this grade for hill slope applications, a 600 GSM open-weave jute geotextile was newly developed to address moderate slope conditions.

Further field surveys and user feedback revealed that for steeper hill slopes, especially in regions experiencing high wind velocity and intense rainfall, lighter open-weave JGTs are prone to displacement during installation and early service life. To overcome this limitation, a heavier and more stable open-weave jute geotextile of 1200 GSM was designed and manufactured.

Both the 600 GSM and 1200 GSM open-weave jute geotextiles were produced at two different jute mills

following predefined constructional and performance parameters. These newly developed products were intended to improve drapability, enhance stability during installation, and provide superior erosion resistance under varying slope and climatic conditions.

Design of New open weave jute geotextiles:

As per the paper Design and Development of Potentially Important Jute Geotextile, by Pradip Kumar Choudhury,

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- To determine the weight and tensile strength of fabric following formula / empirical relationship were used-

a) Weight of Fabric (gsm) = 1.425 (N1 G1 + N2G2), where, N1 = Ends /inch & N2 = Picks /inch and G1= Warp count in lbs & G2=Weft count in lbs.

b) Warp way (MD)Tensile Strength of Fabric (kgf) = [(Warp count x QR) x Ends /dm x Utilization %] ÷ 2.204

c) Weft way (CD)Tensile Strength of Fabric (kgf) =[(Weft count x QR x Picks /dm x Utilization %)] ÷ 2.204

As discussed with experts, expected strength values are determined as given in table 11 for the new open weave geotextiles.

Proposed Specification of New open weave jute geotextiles:

Table - 3

Sl. No.	**Characteristics**	**Type 4**	**Type 5**	**Test Method**
1	Material	Jute Fibre	Jute Fibre	
2	Construction	Plain Weave	Plain Weave	
3	Mass per unit area at 20 % MR (in gsm)	600	1200	IS 2387: 2024
4	Width (in cm)	122	122	IS 1954 : 2024 (ISO 22198 : 2006)
5	Ends/ dm	9	14	IS 1963: 2025
6	Picks/dm	8	14	
7	Thickness (mm)	5.5	6	IS 13162 Part 3
8	Aperture Size (mm)	12 X 12	6 X 6	IS 2405 Part 1 and 2
9	Breaking Load, Warpway (kN/m)	12	14	IS 16635:2017
10	Breaking Load, Weftway (kN/m)	6	22	
11	Breaking Elongation, Warpway (%)	14	16	
12	Breaking Elongation, Weftway (%)	14	16	
13	Yarn linear density of Warp (grist)	115	122	IS 3442:2023
14	Yarn linear density of Weft (grist)	78	4	

Details of the Industries Manufactured 600 and 1200 GSM Open Weave Jute Geotextiles:

Two Jute mills were involved in manufacturing new 600 and 1200 GSM open weave jute geotextiles. Specification given in Table 11, were supplied to the jute mills.

Figure 1, Rove Spinning **Figure 2, Open Weave Creel Fitted Loom**

Testing of newly developed 600 GSM and 1200 GSM open weave jute geotextiles :

After manufacturing of the samples, Fabrics were collected from mill. A part of samples were transferred to Mizoram for application on hill slopes and a part kept at IJIRA for testing. One part of sample sent to M/S Eskaps India Pvt Ltd for testing and other part kept at IJIRA for testing at IJIRA lab.

Application of newly developed 600 GSM and 1200 GSM open weave jute geotextiles:

Field Implementation of Newly Developed Open-Weave Jute Geotextiles (OPEN WEAVE JGTs) under BIS Project 0273

Under the BIS-sponsored Project (Project Code: 0273), the Indian Jute Industries' Research Association (IJIRA) successfully developed two new varieties of Open-Weave Jute Geotextiles with nominal mass per unit area of 600 GSM and 1200 GSM. These jute-based geotextiles were specifically engineered for rainwater erosion control and slope stabilization, with particular emphasis on application in hilly terrains and high rain fall regions.

To evaluate the field performance of the newly developed geotextiles, an IJIRA representative visited Hnahthial district, Mizoram, and supervised their installation at an ongoing National Highway construction project. The objective of the field implementation was to assess constructability, handling characteristics, and preliminary performance under actual site conditions.

Site Details

The field trial was carried out at the following project location:

- **Project Title:** Widening and Upgradation to 2-Lane with Paved Shoulder from km 166.00 to km 208.00 (Package-4)
- **Section:** Aizawl–Tuipang, NH-54
- **Implementing Agency:** ABCI Infrastructure Pvt. Ltd.
- **Client:** National Highways & Infrastructure Development Corporation Limited (NHIDCL)

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At the project site, the 1200 GSM Open-Weave Jute Geotextile was installed over a slope of approximately 18 m height at Chain age 178+010, while the600 GSM open weave JGT was installed 178+270, covering a slope of approximately 6 m height. At the project site, the 1200 GSM open weave JGT was installed on a hill slope of approximately 18 m height at Chainage 178+010, while the 600 GSM open weave JGT was installed at Chainage 178+270, covering a slope of approximately 6 m height. The two locations were selected to represent distinct slope geometries and soil conditions, enabling comparative performance assessment.

Observations Recorded During and Immediate after Installation

The following observations were recorded during and immediately after installation:

- At the location characterized by a steep slope (~18 m height) with coarse-grained soil composition, the 1200 GSM open-weave JGT was installed. This zone was identified as highly susceptible to surface erosion and soil slippage due to the combined influence of steep gradient and high rainfall intensity. The higher GSM fabric was selected to provide greater tensile strength, improved stability, and enhanced resistance to high-velocity runoff.

- The 600 GSM open-weave JGT was installed on a moderate slope (~6 m height) comprising silty clay to mixed loamy soil, subjected to moderate hydraulic loading and alternating dry–wet cycles. The purpose was to evaluate its effectiveness in erosion control under comparatively less severe slope and hydrological conditions.

- During installation, adequate anchoring, proper overlap, and close surface conformity were ensured to minimize fabric displacement and enhance soil–geotextile interaction.

- Site engineers and project personnel expressed interest in monitoring the performance of the installed geotextiles during subsequent monsoon seasons, particularly with respect to erosion resistance and vegetation establishment.

The field implementation of 1200 GSM and 600 GSM Open-Weave Jute Geotextiles was successfully completed under proper supervision. The site team extended full cooperation throughout the installation process.

It was proposed to conduct periodic performance observations and feedback collection to assess the long-term efficacy and field durability of the developed jute geotextiles in slope stabilization and erosion control under varying soil and climatic conditions.

Glimpses of study area:

Figure 3, Project site- Before JGT application

Figure 4, Laying of 1200gsm Open weave JGT

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Figure 5, Laying of 600 gsm Open weave JGT

The new developed jute open weave samples transferred to " G. P. Projects Ltd.PKG – 4, NH-54, ROAD NHIDCL,Dist.- Hnahthial, Mizoram – 796571" in 1st week of August 2025. It was decided by PMU –Lungai, that these materials (100 m rolls of each qualities of open weave jute geotextiles) will be usedfor field implementation over an area of approximately total 200 sqm on suitable hill-cut slopes within the project stretch of NH-54 (Package-4).

RESULTS AND DISCUSSION:

Test Results of New Developed Open Weave Jute Geo Textiles Samples:

The available and standardized three types open weave soil savers (600 ad 1200 GSM) are collected from mills and samples are delivered to the laboratories for testing . Test results are given below: Type of Sample: - **600 GSM**

Table- 4

Sl. Nos.	Test Parameters		Average Values		Standard Value as per Bangladesh Standard	Standard Followed
			Mill 1	Mill 2		
1	Materials		Jute	Jute	---	
2	Constructions		Plain Weave	Plain Weave	---	
3	Width(cm)		121.08	122.38	122	IS 1954 : 2024 (ISO 22198 : 2006)
4	Ends X Picks/dm		8 X 7	9 X 8	≥8 X ≥7	IS 1963: 2025
5	Aperture Size (mm)		11.8 X 12.1	11.6 X 12.0	---	IS 2405 Part 1 & 2
6	Mass per unit area @ 20% MR (g/m^2)		696.21	669.06	600 ±10 %	IS 2387: 2024
7	Thickness (mm)		5.78	5.59	5.25 ± 10 %	IS 13162 Part 3
8	Wide width Strength (kN/m)	MD	17.50	17.50	≥12	IS 16635:2017
		CD	9.20	9.20	≥6	

9	Elongation (%)	MD	11.75	11.75	≤ 14	
		CD	10.91	10.91	≤ 14	
10	No. of yarn in wide width strip	MD	18	18	---	--
		CD	18	18	---	
11	Strength in kgf (kN/m) (10 X 20) cm	MD	1.9 kN/10 cm or 19.75 kN/m or 201.75 kgf	1.9 kN/10 cm or 19.75 kN/m or 201.75 kgf	---	IS 1969: Part 1 : 2018 (ISO 13934-1 : 2013) (Reaffirme d Year : 2024)
		CD	1.09 kN/10 cm or 10.94 kN/m or 111.53 kgf	1.09 kN/10 cm or 10.94 kN/m or 111.53 kgf	---	
12	Elongation (%)	MD	10.06	10.06	---	
		CD	7.59	7.59	---	
13	No. of yarn in Good Brand strip	MD	9	9	---	--
		CD	8	8	---	
14	Yarn count from fabric @20% MR(lbs/ 14400y)	MD	132.73	132.73	---	IS 3442:2023
		CD	87.66	87.66	---	
15	Yarn strength from fabric (lbs)	MD	61.90	61.90	---	IS 1670:2025
		CD	43.10	43.10	---	
16	Yarn Elongation %	MD	5.72	5.72		
		CD	4.56	4.56		
17	QR % @20% MR	MD	46.65	46.65	---	--
		CD	69.84	69.84	---	

Type of Sample: - **1200 GSM**

Table- 5

Sl. Nos.	**Test Parameters**	**Average Values**		**Standard Value**	**Standard Followed**
		Mill 1	Mill 2		
1	Materials	Jute	Jute	---	
2	Constructions	Plain Weave	Plain Weave	---	
3	Width(cm)	124.25	124.30	---	IS 1954 : 2024 (ISO 22198 : 2006)

4	Ends X Picks/dm		14 X 14	14 X 13	14 X 13	IS 1963: 2025
5	Aperture Size (mm)		6.07 X 6.03	6.2 X 5.63	---	IS 2405 Part 1 & 2
6	Mass per unit area @ 20% MR (g/m^2)		1133.25	1134.53	---	IS 2387: 2024
7	Thickness (mm)		4.97	5.10	---	IS 13162 Part 3
8	Wide width Strength (kN/m)	MD	15.59	15.59	---	IS 16635:2017
		CD	23.43	23.43	---	
9	Elongation (%)	MD	8.46	8.46	---	
		CD	13.74	13.74	---	
10	No. of yarn in wide width strip	MD	28	28	---	--
		CD	28	28	---	
11	Strength in kgf (kN/m) (10 X 20) cm	MD	1.2 kN/10 cm or 12.2 kN/m or 124.35 kgf	1.2 kN/10 cm or 12.2 kN/m or 124.35 kgf	---	IS 1969: Part 1 : 2018 (ISO 13934-1 : 2013) (Reaffirme d Year : 2024)
		CD	1.9 kN/10 cm or 19.63 kN/m or 200.17 kgf	1.9 kN/10 cm or 19.63 kN/m or 200.17 kgf	---	
12	Elongation (%)	MD	8.0	8.0		
		CD	12.68	12.68		
13	No. of yarn in Good Brand strip	MD	14	14	---	--
		CD	14	14	---	
14	Yarn count from fabric @20% MR(lbs/ 14400y)	MD	101.86	101.86	---	IS 3442:2023
		CD	107.23	107.23	---	
15	Yarn strength from fabric (Grist)	MD	25.55	25.55	---	IS 1670:2025
		CD	22.03	22.03	---	

16	Yarn Elongation %	MD	5.70	5.70		
		CD	4.57	4.57		
17	QR % @20% MR	MD	25.16	25.16	---	--
		CD	20.60	20.60	---	

CONCLUSION

The existing specifications for 292, 500, and 730 GSM open weave jute fabrics have been re-evaluated, and the earlier ambiguity regarding the tensile test has been resolved through actual testing. The modified and recommended specifications for these three varieties, along with the newly developed 600 GSM and 1200 GSM open weave soil saver fabrics, are provided below.

Table- 6

Sl. No.	Characteristics	Type 1	Type 3	Test Method
1	Material	Jute Fibre	Jute Fibre	---
2	Construction	Plain Weave	Plain Weave	---
3	Mass per unit area, at 20 % MR (gsm)	1200	600	IS 2387: 2024
4	Maximum Length (m)	68	68	---
5	Width (cm)	122	122	IS 1954 : 2024 (ISO 22198 : 2006)
6	Ends/ dm	14	9	IS 1963: 2025
7	Picks/dm	13	8	
8	Thickness (mm)	6.0	5.5	IS 13162 Part 3
9	Aperture Size (mm)	6 X 6	12 X 12	IS 2405 Part 1 &2
10	Average Breaking Load, Warpway (kN/m)	14	10.0	IS 16635:2017/ ISO 10319: 2015
11	Average Breaking Load, Weftway (kN/m)	22	9.0	
12	Maximum Breaking Elongation, Warpway (%)	15	14	
13	Maximum Breaking Elongation, Weftway (%)	22	14	

The existing standard **IS 14986** has been divided into two parts. **Part 1** provides the installation guidelines for open weave jute geotextiles, while **Part 2** contains the specifications. Both draft standards are attached

separately along with this report. Guidance for use of different types of open weave JGTs are given belowe in Table 7.

Guidance for Use of Different Types of JGT

Table 7

Mass per unit area (gsm)	Recommended Soil Type	Recommended Applications / Site Conditions
600 gsm *(newly developed)*	Silty clay soils or mixed loam with moderate gravel content	Sites with alternating dry and wet cycles; moderate hydraulic load
1200 gsm *(newly developed)*	Boulder, highly erodible zones; steep slope with high runoff	Extreme rainfall or flash flood-prone areas; high kinetic energy of water flow

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REFERENCES

1. Sanyal, T. (2011). Soil bio-engineering with jute geotextiles for slope erosion control. National Jute Board, Ministry of Textiles, Government of India.
2. Rao, P. J., Bindumadhava, N., & Venisiri, N. (1996). Construction of highway embankment on soft marine soil using jute geotextiles. Proceedings of geotechnical applications of natural fibres, National Jute Board, India.
3. Ghosh, S., Choudhury, P. K., & Sanyal, T. (2015). Development and application of open-weave jute geotextiles for erosion control in slopes and embankments. Journal of Natural Fibres, 12(4), 345–356.
4. Sanyal, T., & Choudhury, P. K. (2011). Stabilization of embankment slopes with jute geotextiles: A case study of NH-2 Allahabad bypass. National Jute Board, Government of India.
5. Manivannan, S., Khola, O. P. S., Kannan, K., Thilagam, V. K., & Choudhury, P. K. (2019). Application of jute geotextiles for sustainable management of hill slopes. Acta Scientific Agriculture, 3(9), 145–152.
6. Ingold, T. S., & Thomson, J. C. (1990). A design approach for prefabricated erosion control systems. Proceedings of the 4th International Conference on Geotextiles, Geomembranes and Related Products, The Hague, pp. 375–380.
7. Juyal, G. P., & Dadhwal, K. S. (2011). Geo-jute for erosion control with special reference to mine spoil rehabilitation. National Jute Board, Government of India.
8. Ramaswami, S. D., & Aziz, M. A. (2011). Jute geotextiles for road applications. National Jute Board, Government of India.
9. Som, N. (2011). Jute geotextiles in civil engineering applications. National Jute Board, Government of India.
10. Thomson, J. C. (2011). The role of natural fibres in geotextile engineering. National Jute Board, Government of India.
11. ICAR–Indian Institute of Soil and Water Conservation (2017). Application of potentially important jute geotextiles for erosion control and slope stabilization. Research Report, Udhagamandalam, India.
12. Bureau of Indian Standards (BIS). (2001, Reaffirmed 2018). IS 14986: Guidelines for application of jute geotextiles for rainwater erosion control in road and railway embankments and hill slopes. New Delhi, India.
13. Bureau of Indian Standards (BIS). (2017). IS 16635: Geotextiles—Determination of tensile properties by wide-width strip method. New Delhi, India.

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14. Bureau of Indian Standards (BIS). (2024). IS 2387: Determination of mass per unit area of textiles. New Delhi, India.
15. Research Designs & Standards Organisation (RDSO). (2007). Guidelines for application of jute geotextiles in railway embankments and hill slopes (RDSO/2007/GE:G-0008). Ministry of Railways, Government of India.
16. Indian Roads Congress (IRC). (2019). IRC:SP:126-2019: Guidelines for the design and construction of low-volume rural roads using jute geotextiles. New Delhi, India.
17. Bangladesh Standards and Testing Institution (BSTI). (2019). BDS 1909:2019: Jute geotextiles—Specification for hill slope management. Dhaka, Bangladesh.
18. Ministry of Rural Development, Government of India. (2022). Vision document on new technology initiatives and guidelines. New Delhi, India.