Standards For Application Of Jute Geotextile In Control Of Bank Erosion In Rivers & Waterways

1.0 SCOPE

1.1 The Standard provides guidelines for application of Jute Geotextile (JGT) in control of erosion in rivers and waterways including its specifications and installation methods.

2.0 REFERENCES

2.1 The guidelines have been prepared on the basis of performance of JGT in controlling erosion of banks of rivers and waterways in several field applications mentioned in the anthology of case studies entitled **"Performance Evaluation of Jute Geotextile**" published by Jute Manufacturers Development Council (JMDC), Ministry of Textiles, Govt. of India (2003).

3.0 TERMINOLOGY

3.1 For the purpose of these guidelines, the following definitions shall apply.

3.1.1 Woven Geotextile –

Interlacement of warp and weft yarns to form a fabric , conforming to the specified weight, tensile strength, porometry, transmittivity and permittivity.

3.1.2 Non-woven Geotextile –

Mechanically bonded fabric formed by entangling fibres to ensure comparatively loose bonds where fibres cross over.

3.1.3 Open Weave Jute Geotextile –

Open structured Jute Geotextile in which yarns of a specified diameter are laid in specified numbers /length in both warp and weft directions.

3.1.4 Ends

The number of warp threads of a JGT.

3.1.5 Picks

The number of weft threads of a JGT.

3.1.6. Moisture Regain

Weight of moisture regain in a JGT (or any jute product) expressed as percentage of its oven dry weight (105°C + 3°C mixed with air under standard atmospheric conditions).

3.1.7 Permittivity of JGT (ψ)

Flow capacity across a JGT under a given hydraulic gradient and flow area.

$\Psi = K_g./t_g$; where K_g is the coefficient of permeability of JGT (m/s.) and t_g is the thickness of the same JGT (m)
Ψ is expressed in reciprocal of time (sec^{-1})

3.1.8 Transmittivity of JGT

Flow or draining capacity of a JGT along its plane under a given hydraulic gradient and flow area.

3.1.9 Porometry of JGT

Pore size of a woven JGT. A finer pore size reduces OAR (Open Area Ratio), thus reducing its permittivity. Also called A.O.S. (Apparent Opening Size).

Symbol – O_n

3.1.10 Open Area Ratio (OAR)

Ratio between total area of openings in a JGT and total area covered by the JGT expressed as percentage.

3.1.11 CBR (California Bearing Ratio)

Measure of the bearing capacity of a road sub-grade. Ratio of the resistance of a sub-grade /soil to a standard plunger up to a pre-stated thickness (2.5 cm or 5 cm) to the corresponding resistance through a crushed rock. Expressed as percentage (%)

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3.1.12 Consolidation of Soil

Process of gradual expulsion of water from voids of a soil due to imposition of loads.

3.1.13 Drapability of JGT

Measure of a JGT to shape itself to the contours of any surface. It is a measure of JGT's "flex-stiffness" i.e., bending of JGT under its own weight between two points on a surface.

3.1.14 Puncture Strength of JGT

Measure of resistance of a JGT against puncturing under imposed loads.

3.1.15 Tensile Strength of JGT

The stretching load at which a JGT sample breaks. The JGT is stretched by gripping it at two ends till its failure or break. Expressed in kN/metre.

3.1.16 Elongation–at- break of JGT

Measure of extension of a JGT- specimen at failure (break) over its initial length. Expressed in percentage (%).

3.1.17 Grain Size Distribution of soil

Represented by a semi-logarithmic curve that plots logarithm of the grain size in the abscissa against percentage of grains by weight smaller than the size denoted in the abscissa, in the ordinate. The more uniform is the grain size, the steeper is the curve.

3.1.18 Retention of fines or Soil tightness

A part of filtration function, implying restriction of top soil migration without impairing permittivity and transmittivity.

3.1.19 Uniformity Co-efficient (C_u) of Soil

Ratio between the grain diameter corresponding to 60% by weight of the finer particles in a soil sample to that corresponding to 10% by weight of finer particles ($C_u = d_{60}/d_{10}$).

4.0 SPECIFIC REQUIREMENTS

4.1 The main causes of bank erosion are

-- Weak bank soil which is easily erodable

--Strong current and eddies near the bank.

--Waves induced by wind and moving vessels

--Large fluctuation of water-level &

--Uplift pressures due to alternating hydraulic gradients

4.1 Mechanism of Control

Bank erosion may be controlled effectively either by repulsion of flow away from the affected banks say, by construction of spurs or by providing a durable protection to the affected banks or by a combination of both these measures.

Repulsion of flow is a task of the concerned engineers and can be effected by construction of suitable regulatory measures at appropriate locations. Protection to the banks should be done as already indicated by a combination of conventional granular filter / armour and JGT.

The top of the bank protection work should have a cover of vegetation (e.g., quick–growing local grass, 'vetivar' grass, mangroves in saline inter-tidal zones).

4.2 Approach to Control Bank Erosion

The approach to control bank erosion is to ensure 'sand tightness' and permittivity to prevent differential over pressure developing across the fabric. At the same time, it requires to be ensured that JGT should possesses sufficient strength to withstand installation stresses (Survivability of JGT) and retain the design strength up to at least 4 years for tidal rivers with two-way flows and 2 years for one-way rivers.

Use of woven JGT in controlling riverbank erosion is recommended as an eco-friendly substitute of the conventional granular filter comprising graded boulders & ballasts of stone, laterite or similar materials of the desired specific gravity. JGT, while ensuring sand tightness under different types of extraneous hydraulic and mechanical loads, facilitates dissipation of the over pressure created as a result of intrusion of water into the bank soil due to rise of water level usually during the high tides in a tidal river and in unidirectional rivers during the rains. This is essentially a function of filtration ("sand tightness"). Lateral dispersion of water is also facilitated by JGT (drainage). Erosion is controlled as migration of the bank soil is substantively prevented and the entrained water within it is effectively release.

JGT laid over the prepared bank soil requires to be ballasted by a layer of armour stones to prevent its direct exposure to weather.

It is strongly advised that seeds of local deep-rooted vegetation/grass should be spread after laying of the fabric. On degradation of JGT vegetation will take over, cling to the bank soil, dissipate energy of current and waves to a good extent.

This is a bio-engineering approach that is being increasingly favoured in developed countries. JGT on its degradation will nourish the bank soil and improve its hydraulic conductivity, fostering quick growth of vegetation under normal situation.

It is recommended that JGT to be used should be coated with a suitable natural additive to delay its time of degradation. As a substitute bitumen emulsion may also be used as an additive. Care is to be taken to ensure that porometric features and tensile strength of the fabric are not adversely affected.

4.3 SPECIFICATIONS OF JGT

Usually, woven JGT possessing tensile strength of 20 kN/m should serve the purpose. The fabric has to be smeared with bitumen preferably polymer-modified bitumen/ bitumen emulsion, in absence of a suitable natural additive, to add to its desired durability against its constant contact with water.

Porometry should be decided on the basis of grain size distribution of the bank soil. PIANC (1987) recommends the porometry for man-made geotextiles as indicated hereunder---

Case - I

When d_{40} is less than 0.60 mm

O_{90} shall be at least 300 microns up to 1500 microns maximum & thickness of JGT shall be at least 5 mm (up to 15 mm) maximum.

Case –II

When d_{40} exceeds 0.60 mm

O_{90} shall be al least 500 microns up to 2000 microns maximum. JGT shall have minimum thickness of 5 mm (up to 20 mm maximum).

The range of pore size is wide. It is advisable to adopt the lower value under normal geotechnical features of the bank soil.

In all bank erosion-control works it is imperative that the longevity of JGT should be at least 4 to 5 years. The purpose is two-fold. First, to allow sufficient time for stable formation of filter cake and secondly, to ensure growth of a dense vegetative cover for holding the base soil naturally. The selected JGT should therefore be smeared with suitable rot-resistant chemicals or bitumen of suitable grade and type. Care may be taken to ensure that such application of rot-resistant chemical/bitumen does not affect the porometry of JGT beyond a tolerance limit of 25%.

Considering that there may be reduction in Open Area ratio (OAR) as a result of application of rot-resistant chemical/bitumen, it is recommended that pore-size of any selected untreated JGT should be decided keeping in view the possible reduction in OAR after treatment (usually 100% in case of treatment with bitumen).

5.0 INSTALLATION METHOD

5.1 The following sequence in installation JGT shall be followed

-the bank should first be cut to a stable slope preferably at the angle of internal friction of the bank soil.

-the surface should be leveled and made free from angular projections, undulation, soil –slurry or mud.

-anchoring trench (usually rectangular) should be excavated at the top of the slope. Recommended dimensions of the trench – 500 mm deep and at least 250 mm wide at the bottom. The trench should be free from foreign materials, mud etc.

-JGT should then be unrolled across the trench and along with slope from top down to the lowest water-level.

-JGT should be stapled with U-shaped nails (usually 11 gauge) within the anchoring trench both at the sides and bottom at an interval of 150 mm along the length of the trench. There should be at least 2 staples both depth-wise and width wise in each cross–section.

-JGT should be laid with the overlapping in the direction of water-flow.

-care should always be taken to ensure that JGT does not suffer damage due to puncture, tear and similar operational stresses.

-the recommended overlap is 150 mm (minimum). The overlapped portion should be stapled at an interval of 75 mm.

-the anchoring trench should then be filled with stones/boulders for securing and protecting the JGT.

-care should be taken to ensure that JGT touches the bank slope at all points (proper drapability of JGT).

-armour overlay of stone/boulder should then be placed on the JGT carefully. It should be ensured that armour stones/boulders are not dropped on the JGT, but are carefully placed and properly arranged. A thin layer of sand as a cushion on top of the JGT is recommended to avoid puncture of the fabric by granular over-lay.

-similar care in laying should be taken when a combination of granular filter and JGT is used under reversing flow-condition.

-there must be a beam at the toe of slope. This can be done by folding the JGT as per dimensions (usually 500 mm. dia) with sand fill ad duly stapled on the other side preferably at an interval of 75 mm.

-alternatively, an angular trench may be dug at the toe and the JGT placed on it ensuring full contact with the soil, duly stapled at a spacing of 75 mm and ballasted.

- care should be taken to see that the overlapping layer is not displaced during installation.

- suitable grass-seeds should then be spread on the treated bank. Alternatively, saplings of suitable plants may be planted at close intervals through the interstices of the overlay, taking care to place them into the bank-soil.

(N.B. The weight and specific gravity of each boulder shall be at least 25 kg – 30 kg with sp. gr. of 2.8)

6.0 TRANSPORTATION, STORAGE & HANDLING

6.1 JGT can easily be handled and transported. Jute yarns are basically robust. But care is to be taken to keep a free from moisture (being hygroscopic) and fire. JGT can be shipped in rolls or bales. A bale weighs around 340 kg. (680m2) and may consist of a number of lengths (8 t0 10) depending on the required individual roll length.

6.2 Storage

Prolonged storage of JGT in warehouse is discouraged as JGT is susceptible to microbial action and consequent loss of strength. JGT should be provided with a water-proof cover for protection against rains and moisture. Its direct contact with soil during storage should also be avoided.

6.2.1 Humidity, temperature variation, lack of air-circulation and abnormal moisture absorption affect the quality of JGT therefore calls for attention. The main thrust should be on safe transportation and storage of JGT at site without damaging and unduly exposing the material of adverse climatic conditions.

6.2.2 Site unloading

A fork lift or front-end loader fitted with a long tapered pole (carpet pole/stinger) is recommended for unloading JGT rolls. The carpet pole is inserted into the core of the JGT roll which is then unloaded from the truck. Nylon straps/ropes/roll pullers may also be used. Not more than three JGT rolls should be lifted / unloaded at a time. Use of chains & cables for unloading purposes is discouraged. A tarpaulin, a sheet of plastic or the like should be placed on ground for initial storage of JGT.

6.2.3 Site Handling

As already stated, JGT rolls should be provided with a protective wrapping. It should be kept above the ground and should be covered with a tarpaulin or a thick plastic sheet.

6.2.4 Exposure of JGT to moisture/water may pose handling problems. As JGT can absorb water up to 5 times of its own dry weight, handling wet JGT becomes more difficult than handling a moisture-free JGT. The cores of JGT-rolls usually made of laminated paper are susceptible to damages on being exposed to moisture / water and should be kept dry.

6.2.5 JGT should not normally be stored for a long period. Protracted storage of JGT may impair its strength to some extent.

7.0 MONITORING

The treated bank should be kept under watch for at least one full season-cycle. Frequent visits to sites during and after the rains or any natural calamity are necessary. Siltation is expected to take place after about a month which should cover up the granular overlay gradually. Maintenance involves, besides monitoring re-arrangement of the overlay, if displaced, in position. No part of JGT should be allowed atmospheric exposure due to displacement of the overlay. The JGT strength may be ascertained after one season – cycle and the overall performance analysed.

8.0 MARKING

8.1 Unless otherwise agreed to between the buyer and the seller, the roll shall be stenciled with an indelible ink of any suitable colour with the following :

a) Roll Number
b) Specification including quality and construction
c) Length of cloth rolled in metres or yards or both as specified by the buyer.
d) The legend “MADE IN INDIA” with the name of the manufacturing mill.
e) Port/Place of entry, and
f) Other declarations required as per law in force.

Table - I : Typical Specifications of Bitumen- treated Woven JGT

Nomenclature	Woven 20 KN/ m bitumenised
Construction	Twill Weave (2/1)
Corrected mass (gsm)	1200 (+7%) (-5%)
Width (cm) min	200 +5%
Ends x Picks/dm	102 +4, - 2 x 39+2, -1
Thickness, (mm) at 2 kPa	2.0 +10%
Tensile Strength(kN/m) MD x CD	21 X 21
Elongation at break (%) MDxCD	8 x
Puncture Resistance (kN) min	0.500
Burst Strength (kPa) min	3500
Permittivity at 50mm constant head (per sec)	350×10^{-5}
A O S (micron) O_{95}	300

Table-II Test Methods of Jute Geotextile

Sl. No.	JGT - P r o p e r t i e s	ASTM Test Method
1	Weight/Unit area	D-5261-92 (1966)
2	Thickness	D-5199-01
3	Tensile Strength and Elongation test- Strip tensile test method	D-4595-86 & D 4885
4	Tensile strength and Elongation test- Grab tensile test method	D-4632
5	Impact Tear strength Test etc.	D-5884
6	Cone plunger test / cone drop test	D-5617-99
7	Trapezoidal Tear test	D-4533
8	Pore size determination - dry	D-4751—99a
9	Water flow test – Normal	D-5493-93 (1998)
10	Water permeability test	D-4491
11	Planar Water flow test	D-4716-01
12	Abrasion resistance test and Fatigue resistance test	D-4886 & 6243
13	Bursting Strength test	IS : 1966 -1975

JGT IN BANK-PROTECTION TYPICAL ARRANGEMENT