

Jute Geotextiles and its Application in Mitigating Soil Related Problems

A brief presentation by

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What is jute and jute geotextile -

- **JUTE IS A NATURAL ECO-FRIENDLY BAST FIBRE. INDIA PRODUCES ABOUT 1.7 MILLION TON JUTE / YR. AND INVOLVES MORE THAN 40 LAC PEOPLE FOR THEIR LIVILIHOD.**
- **Geotextile is the fabric which enhances the engineering properties of soil when applied in or on soil.**
- **Natural Geotextile like, Jute Geotextile (JGT) deserve separate mention because of its natural resource, annual renewability and unique features.**
- **There is hardly any difference between synthetic geotextiles & JGT **function-wise**. The term *geosynthetics* encompass both man made and natural geotextiles.**

USP OF JUTE

- **High tenacity**—comparable to man-made fibres
- **High initial modulus**—even higher than coir
- **Low elongation at break**—lowest among all natural fibres—can provide good membrane support under load
- **Highly hydrophilic** –highest among all fibres
- **High roughness Co-efficient-** ensures better load transference
- **Excellent spinnability / weavability** due to high cellulose content- enables manufacture of customized geotextile
- **Very high thermal stability**—around 170°C
- **Most drapable** of all fibres- can shape itself to soil contours
- **Eco-concordant**—Renewable resource : helps **reduce carbon foot print in construction**
- **Abundantly available**

- JUTE - PLANT TO FABRIC (GEOTEXTILE)



Plant



Retting



Decortication



Fibre



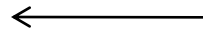
Bundle



Yarn



Fabric



Glimpse of JGTs viz. woven, nonwoven & open weave etc. for use in various civil engineering applications



**WOVEN
JGT**

724 gsm



627 gsm



500 gsm

**NON WOVEN
JGT**



1000 gsm



292 gsm



500 gsm



730 gsm

OPEN WEAVE JGT

Chemical Constituents of jute fibre.

Constituents	%
Cellulose	60 - 62
Hemi Cellulose	22 - 24
Lignin	12 - 14
Others	1 - 2

Properties of Natural Fibres vis-à-vis Synthetic Fibres :

A fibre is suitable to manufacture Geotextiles when it possesses suitable *mechanical and hydraulic properties*

Type of fibre	Tenacity N/tex	Extension at break (%)	Initial modulus N/tex	Volume swelling %	Moisture regain %	Lignin content %
Jute	0.3-0.9	1-1.8	17 - 19	44.3	12-14	12-14
Coir	0.18	41-45	4.22	-	10	30
Sisal	0.37 - 4.7	1.9-4.5	25 - 26	39.5	11-14	9.9
Polyester	0.3-0.8	15 - 55	6 - 12	-	0.4-0.6	Nil
Polypropylene	0.3-0.8	15 - 35	2 - 9	-	<0.1	Nil




Environmental Advantages of JGT :

During 100 days of jute growing period, **1 hectare of jute plant can absorb about 15 MT of CO₂ from atmosphere and liberate about 11 MT of O₂. Studies reveal that CO₂ assimilation rate of jute is higher than trees (Inagaki, 2000; IJSG 2003).**

Specifications of two varieties of woven Jute Geotextiles.

Nomenclature	Woven JGT 25 kN/m	Woven JGT 20 kN/m
Construction	1/1 DW Plain Weave	1/1 DW Plain Weave
Weight (gsm)	724 	627 
Width (cm)	100	100
Ends x Picks / dm	94 x 39	85 x 32
Thickness, (mm at 2 kPa)	1.85	1.7
Tensile Strength (kN/m) MD x CD	25 x 25	20 x 20
Elongation at break (%) MD x CD	10 x 10	8 x 8
Puncture Resistance(kN)	0.500	0.400
Burst Strength (KPa)	3500	3100
Permittivity at 50mm const. head (/sec)	350×10^{-3}	350×10^{-3}
A O S (micron) O₉₅	150 - 400	150 - 400

Specifications of Open Weave Jute Geotextiles

PROPERTIES	TYPE - 1 	TYPE- 2 	TYPE -3 
Weight (g/m ²) at 20% M.R.	730	500	292
Ends x Picks / dm (MD x CD)	7 x 7	6.5 x 4.5	12 x 12
Thickness (mm)	7	5	3
Width (cm)	122	122	122
Aperture size (mm)	12 x 12	13 x 20	8 x 7
Tensile Strength, min. (kN/m) [MD x CD]	12 x 12	10.4 x 7.9	10 x 10
Elongation at break, max.(%) [MD x CD]	10 x 12	11 x 15	12 x 12

Test Methods followed for JGT

Sl. No.	TYPE OF TESTS	UNIT	TEST METHOD (IS / ASTM)
1	WEIGHT	gsm	IS 2387
2	WIDTH	cm	IS 1954
3	ENDS / dm	-	IS 1963
4	PICKS / dm	-	IS 1963
5	THICKNESS (AT 2 KPa)	mm	IS 7702
6	GRAB TENSILE STRENGTH (BOTH WARP & WEFT)	kN	D 4632
7	ELONGATION AT BREAK	%	D 4632
8	BURST STRENGTH	kN	D 3786
9	PUNTURE RESISTANCE	kN	D 4833
10	PERMITIVITY	Per Sec.	D 4491
11	APPARENT OPENING SIZE	mm	D 4751

Standards and Guidelines :

BIS

- ❖ Guidelines for application of Jute Geo-textiles for rain water erosion control in road & railway embankments and hill slopes(IS 14986:2001)
- ❖ Guidelines on rural road construction with JGT (IS 14715 Part I : 2016)
- ❖ Guidelines on river bank protection with JGT (IS 14715 Part II : 2016)
- ❖ Guidelines for jute sapling bag for growth of sapling in nurseries (IS 16089 : 2013
- ❖ Jute Agrotextiles for growth of plants and suppression of weeds (IS 17070 :2018)

RD&SO, Ministry of Railways –

- ❖ Guideline no GE:G1 (July 2003)—
- ❖ Guidelines for earthwork in railway projects, 2007
- ❖ Unified Standard Schedule of Rates by Indian Railways,2011

Indian Roads Congress—

- ❖ Specifications for road & bridge works (2001) & Recommended practice for treatment of embankment slope & erosion control (1991)
- ❖ State-of-the Art Report on JGT prepared jointly by CRRI, IJIRA & NJB has been published by Indian Roads Congress in November 2011
- ❖ Guidelines for the Design and Construction of Low Volume Rural Roads Using Jute Geotextiles, IRC :SP:126-2019

Schedule of Rates –

PWD, WBSRDA & I / W – Govt. of WB, PWD – Govt. of Assam & Meghalaya, BRO and all the 17 Divisions of Indian Railways

IRC Guidelines Released during 80th Session of IRC, Patna, 2019

IRC:SP:126-2019

GUIDELINES FOR THE DESIGN AND CONSTRUCTION OF LOW VOLUME RURAL ROADS USING JUTE GEOTEXTILES



INDIAN ROADS CONGRESS
2019

SOME SALIENT RESEARCH FINDINGS :

- ✓ **Loss of strength of JGT after a year is not a deterrent** as, by that time, **JGT** is seen to have helped in providing **a self sustaining sub-grade for most type of soils** - (Ramaswamy & Aziz, NUS – 1989)
- ✓ **Elongation at break of JGT is significantly lower** than that of synthetic geotextiles (maximum 15% against more than 50 % of SGT) - (Ramaswamy & Aziz, NUS – 1989)
- ✓ **Substantial reduction (more than 50%) in rut depth** under dynamic load tests with JGT- (Ramaswamy & Aziz, NUS – 1989)
- ✓ **Gain in strength of the sub-grade** with time is **compensated** against the **loss of strength of JGT** within the same time frame (ibid & JU 2005)

HENCE, BIO-DEGRADABILITY OF JGT IS NOT A TECHNICAL HINDRANCE

LIST OF JGT USING ORGANIZATIONS

Sl. No.	Govt. of India Organization	Sl. No.	State Govt. Departments
1	Central Soil & Water Conservation Research & Training Institute (CSWCRTI)	1	SRDAs - WB, Assam, Odisha, MP, Chh'garh, Karnataka, Tripura, Monipur, UP, TN
2	Western Coalfields Ltd.	2	P.W.D. – W.B., Assam, Orissa, U.P.
3	Northern Coalfields Ltd.	3	I & W D – W.B. & Agri-Irrg.-WB
4	Border Roads Organization (BRO)	4	Irrigation & Public Health Deptt, Govt. of H.P.
5	Border Road Task Force (BRTF) Port Blair	5	Water Resource Department, Govt. of Orissa
6	National Hydroelectric Power Corporation (NHPC)	6	Sardar Sarobar, Narmada Nigam Ltd., Govt. of Gujrat
7	National Thermal Power Corporation (NTPC)	7	Department of Agriculture, Rajasthan
8	<i>Indian Railways : Northern, Eastern, NF, SE, ECR etc.</i>	8	Forest Deptt., Govt. of H.P.
9	Kolkata Port Trust	9	Horticulture Deptt, Govt. of H.P.
10	Kandla Port Trust	10	Forest Department, Arunachal Pradesh
11	National Highway Authority (NHAI)	11	Forest & Environment, Govt. of Sikkim
12	Central Tobacco Research Institute, Karnataka	12	Delhi Development Authority (DDA)
	Municipality & Other Organizations	13	ICAR, Meghalaya
1	Kankinada Municipality	14	West Bengal Transport Infrastructure Development Corporation (WBTIDC)
2	Tata Nano Plant (Gujrat), TISC (Jharkhand)	15	Forest Department, Govt. of West Bengal
3	Agri-Horticulture, Kolkata	16	Forest Department, Govt. of Haryana
4	Indian Tea Research Association, Assam	17	MGNREGA, West Bengal

THE UNION STATES WHERE JGT HAS BEEN USED WITH SUCCESS -

Andhra Pradesh

Haryana

Bihar

Himachal Pradesh

Assam

Jammu & Kashmir

Punjab

Arunachal Pradesh

Karnataka

Rajasthan

Andaman & Nicobar islands

Maharashtra

Sikkim

Chhattisgarh

Madhya Pradesh

Tripura

Delhi

Manipur

Uttarakhand

Goa

Nagaland

Uttar Pradesh

Gujarat

Odisha

West Bengal

Tamil Nadu

ENCOURAGING RESULTS ACHIEVED FROM EXTENSIVE R & D WORKS FOLLOWED BY FIELD APPLICATIONS HELPED SIGNIFICANT INCREASE IN DEMAND OF JGT.

AS PER AVAILABLE DATA MORE THAN 850 FIELD APPLICATIONS HAVE BEEN UNDERTAKEN SUCCESSFULLY WITH JGT

SUPPORT OF NJB

Provides technical support and guidance to the manufactures for producing standard quality of JGT.

Customization of JGT to address site-specific requirements.

Provides technical support and guidance in selection of right type of JGT & its installation at site apart from other remedial measures.

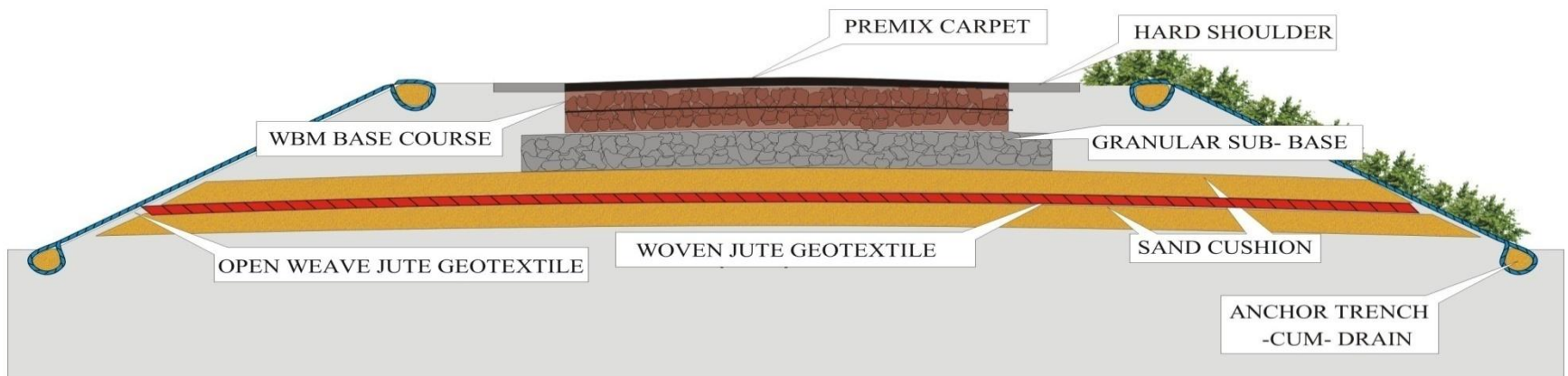
JGT is available from selected jute mills; NJB helps the end-users in procuring the right quality of JGT from the right manufacturers/ suppliers and its testing with certification.

Conducts awareness programme all over the country and also take classes for the trainee engineers at IAHE,IRICEN. CRRI, RCT&RC etc. as guest faculty.

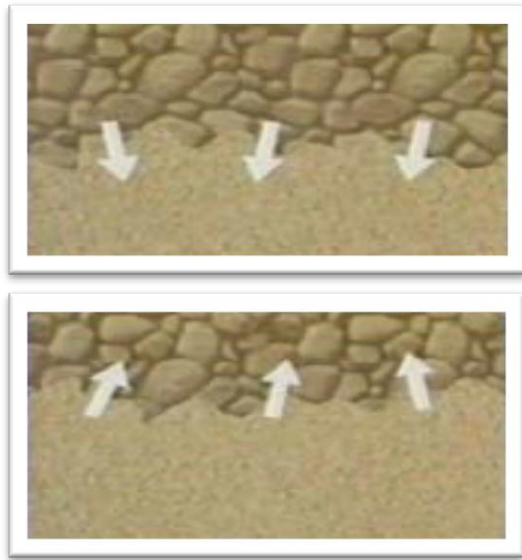
- CASE STUDIES -

APPLICATIONS OF JGT IN THE INTERFACE OF SUB-GRDAE & SUB-BASE OF ROAD

STRENGTHENING OF ROAD WITH JUTE GEOTEXTILE



EFFECT OF SEPERATION IN ROAD SUBGRADE

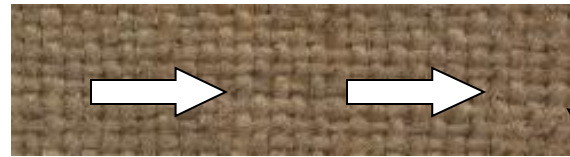


Effect without JGT



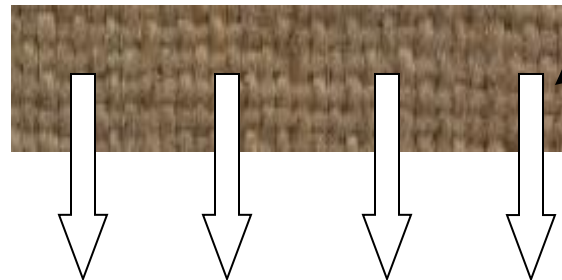
Segregation due to JGT

JGT



Flow along JGT plane

JGT

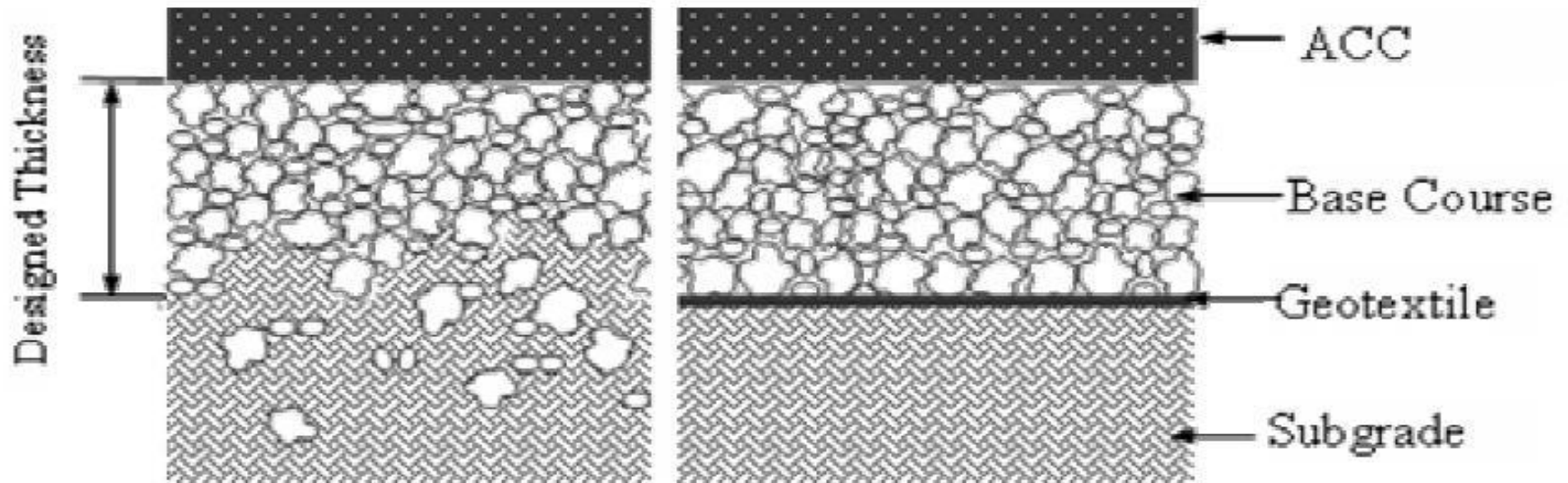


Flow across/ normal to JGT plane

FILTRATION AND DRAINAGE FUNCTION OF JGT

Separation

- Prevent the intermixing of two adjacent soils
- Separating fine subgrade soil from the aggregates of the base course, the geotextile preserves the drainage and the strength characteristics of the aggregate material



Strengthening of road sub-grade, Kanksa to Bati, Murshidabad, WB



**Pre-work
Condition of Road**



**Compaction of sub-
grade with roller**



**Spreading of sand
over sub-grade**



**Laying of JGT with
overlap**



**Sub-base spreading &
roller compaction**



**Condition of road
after two years**

Results

Soil properties -

Properties of sub soil :

Composition : Silty clay

Moisture content : 30 %

Liquid limit : 40 – 45%

Plastic Limit : 28%

OMC & MDD : 15 % & 1.76 g/cc

CBR % (Soaked) : 2.6 (During Construction)

CBR% (Soaked) : 7.42 (After 2.5 Year of application)

**** Depending upon CBR value and calculated traffic volume, thickness of pavement was determined & quality of JGT was ascertained***

Construction of PMGSY Road from Karapadi Mayanam to Pulliampattanumbiur, Erode, TN



Signage & preparation of road Sub-grade



Demo for installation of JGT on sub-grade



Compacted GSB laid over JGT



←
Condi-
-on of
road
after 3
yrs

Construction of PMGSY Road with JGT at Bider, Karnataka



Laying of JGT on Subgrade



Name of work: Improvement And Asphaltting to road from
Hornaddi to Bagdal in Bidas Taluka.
Phase: X (Jute Technology) Package No: KN 06-67



Display of MIB @ CH: 0.0 km



Performance Evaluation of Jute @ CH: 0.60 km

**Avg. soil CBR %
(before laying JGT)**

4.0

**Improved soil CBR %
(after 36 months of laying JGT)**

13.4

PMGSY ROAD WITH JGT IN DARRANG DISTRICT, ASSAM, INDIA



Laying of
JGT &
Rolling



CONDITION OF ROAD AFTER 4 YRS.

Strengthening Sub-Grade : Bankura By-Pass Road from Panchbagha More to NH-60 (Executed by Bankura, PWD)



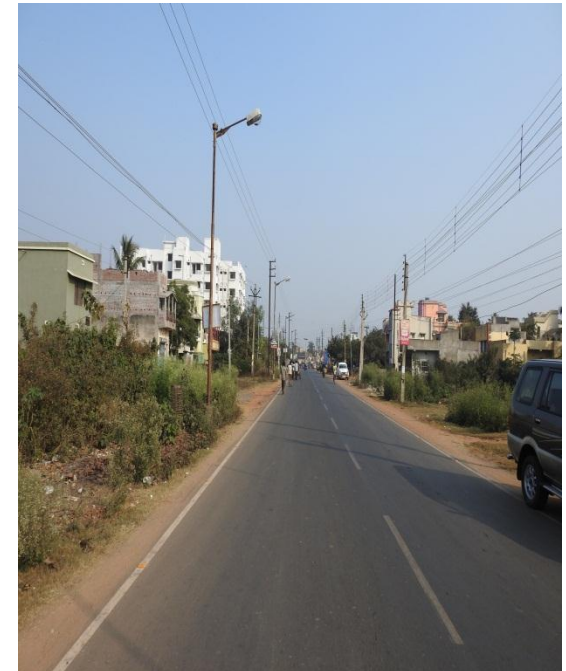
Laying of JGT on compacted sub-grade



Finished Road-open to traffic



Compaction of GSB laid over JGT



Condition of road after 6 years

Improvement of CBR value with the use of JGT in few roads both in India and Bangladesh

India						Bangladesh				
Sl. No.	Name of the Road	Type of Soil (Before Road Construction)	CBR before construction	CBR after construction	Span of time while the CBR increased(months)	Name of the road	Type of Soil	CBR before construction	CBR after construction	Span of time while the CBR increased (Months)
1.	Udal to Chakbrahma, South Dinajpur, West Bengal	Silty Clay (CH- Inorganic clays of high plasticity)	2.8	11.39	47	Turag- Rahitpur Bourvita Road	Silty Sand	3 (With JGT) 3 (Without JGT)	13.57 9.64	50
2.	Nihinagar to Hazratpur, South Dinajpur, West Bengal	Silty Clay (CH- Inorganic clays of high plasticity)	2.2	7.93	47	Circular Road at Savar Cantonment	Medium to High Expansive Silty Clay	3.6 (With JGT) 3.6 (Without JGT)	12.68 7.61	34
3.	Kanksa to Bati, Murshidabad, West Bengal	Clayey Silt (CL-Inorganic clays of low to medium plasticity)	3.8	7.42	33	Bancharampur southpara, Brahmanbaria	Silty Clay	2.3 (With JGT) 2.3 (Without JGT)	13.10 6.50	31
4.	Bagdimarimulo Barada Nagar to Damkal Kheya Ghat, Mathurapur, South 24 Paraganas, West Bengal	Clayey Silt (CL-Inorganic clays of low to medium plasticity)	3.5	11.11	29	Tezkhali- Titas Riverghat Road Brahmanbaria	Clayey Silt	3.3 (With JGT) 3.3 (Without JGT)	8.2 7.7	33
5.	Promod Nagar to Muga Chandra Para, Agartala, Tripura	Data Not available	8	10.86	19	Noabanki Shamnagar Road Sathkira	Silty Clay	1.4 (With JGT) 1.4 (Without JGT)	19.80 5	39
6.	Koracharahatti to T-10 Road, Bidar, Karnataka	CL-Inorganic clays of low to medium plasticity	4	13.4	36					
7.	Devarahospet to Gundur, Davangere, Karnataka	CL-Inorganic clays of low to medium plasticity	2.8	14.6	36					

Control of Potholes & Reflection Crack on Road Surface, Garia Stn Rd, PWD, WB

Objective : Control of potholes & reflection cracks of the riding surface.

Treatment with JGT : The affected stretches of road were leveled up initially with aggregates and rolled. The prepared surface was applied with a tack coat @3 kg/10m². OW JGT was laid and lightly rolled. Another coat of bitumen was applied over JGT @5 kg/10m² followed by a layer of premix of bitumen and stone chips. The average thickness of the overlay was 25 mm.



Potholes on surface



Road Surface after 5 yrs



Roller Compaction of PMC



Applying tack coat on JGT

RESULTS : The treated pavement was inspected by the Civil Engineering Department, Jadavpur University in December, 2002 after it was subjected to two full monsoon season. The following table reveals the conditions prevailing before and after the treatment.

Pre Work Condition	Potholes		Cracks		Depression
	No	%	Area	%	
	770	11	1239 m ²	17.70	5 % (average thickness- 75 mm)
Post Work Condition	84	1.20	257.25 m ²	3.67	Nil

CONCLUSION :

- Evidently the road is in a better shape after the treatment compared to the adjoining stretches where JGT was not applied on the overlay. The trial definitely brought out the fact that JGT helps in reinforcing asphaltic overlay.
- It was observed that the overlay performed satisfactorily where its thickness was in the range of 20 mm to 25 mm.
- There has been reduction in the overall pothole area after the treatment .

Arresting Crack & Potholes of rural road under PMGSY with the use of JGT at Mansorabad, Allahabad, UP



Damaged road



Cleaning & repairing



Spreading Prime & Tack Coat



Road Signage



Laying of JGT



Spreading Prime & Tack Coat on JGT



Pre-mix Carpeting



Seal Coating and Compaction



Condition of Road after 3 years

Prevention of pot holes / reflective cracks : Raiganj to Fatepur (Kaliaganj), SH-10A, PWD, Govt. of WB



Before application



Laying of JGT



Tack coat application



PMC application

Roller compaction



Condition after four season cycles



Strengthening of PWD road sub-grade with JGT from NH34 to Sagardighi, Murshidabad, WB



Condition of road before laying JGT



Laying of JGT on compacted sub-grade

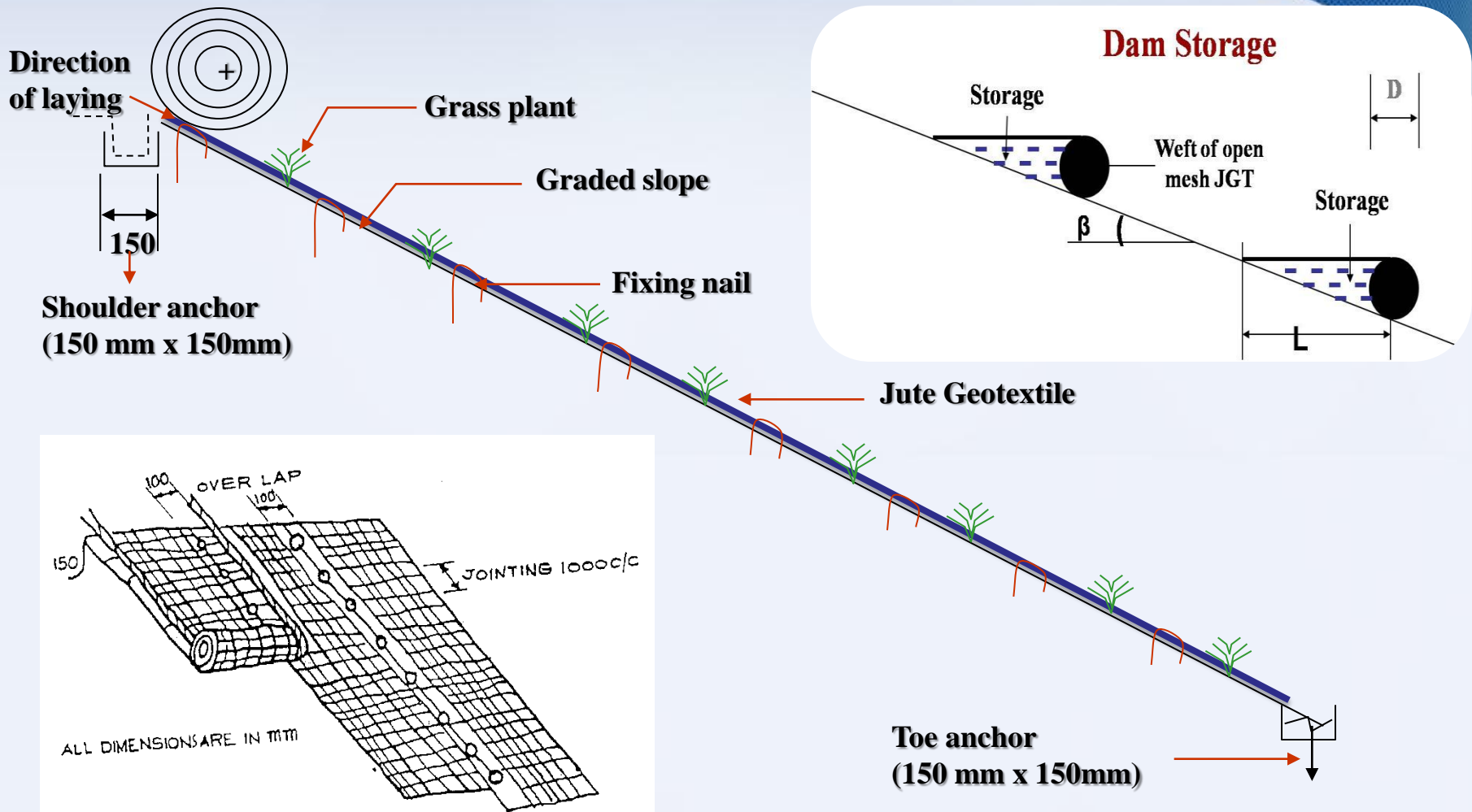


Work in progress

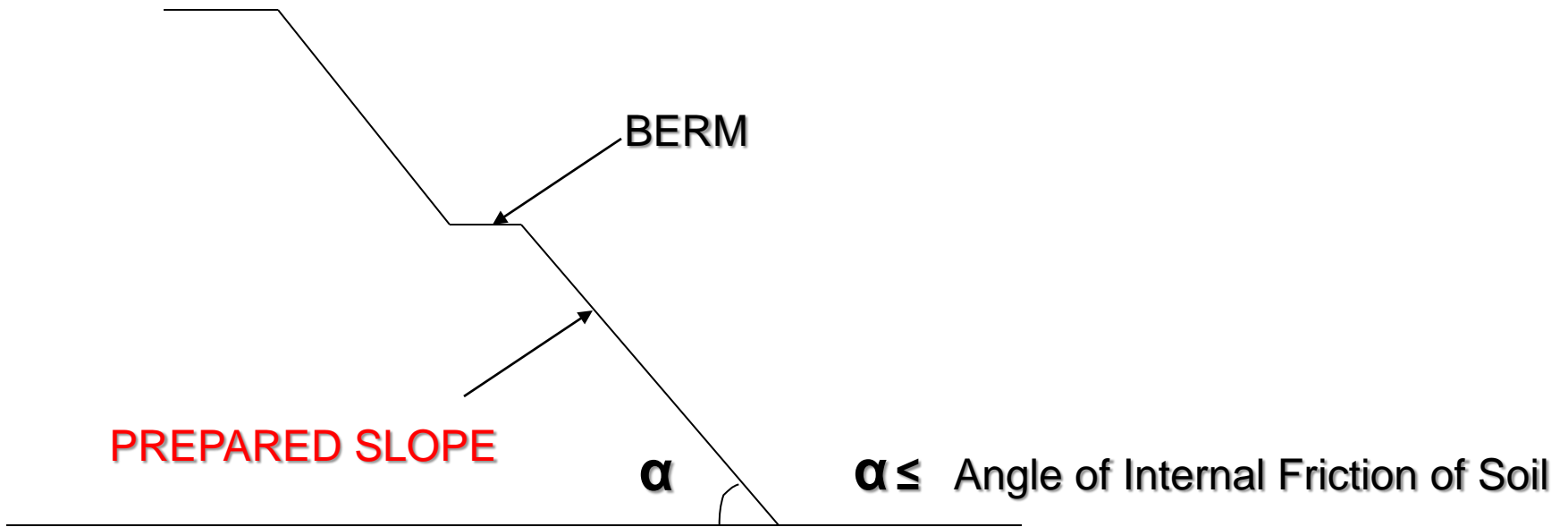


Condition of road after elapse of 3 monsoon

Slope protection – a typical arrangement



Impounded of 2.87 litres of water per sq.m. of 500 gsm open weave JGT on a 1:2 slope

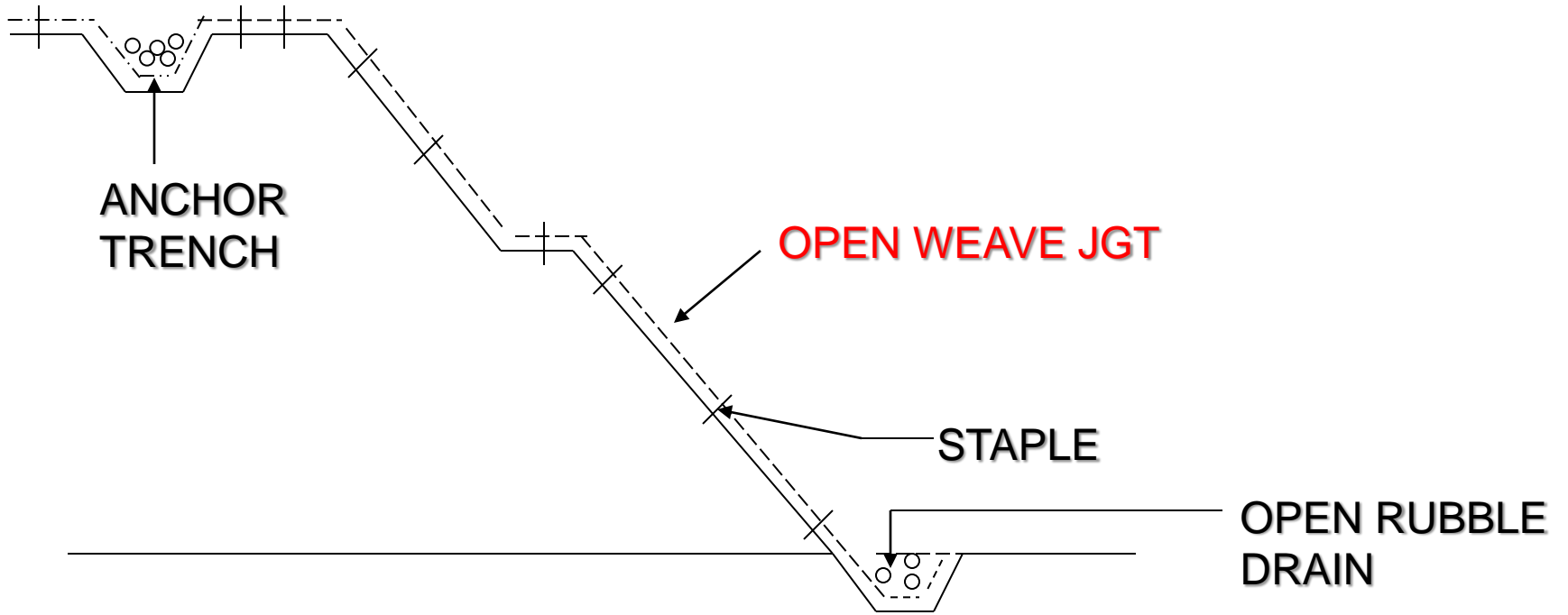


PREPARED SLOPE

α

$\alpha \leq$ Angle of Internal Friction of Soil

SLOPE PROTECTION WITH JGT (OPEN WEAVE)



SLOPE PROTECTION WITH JGT (OPEN WEAVE)

SUSTAINABLE ROAD WITH GREEN TECHNOLOGY THROUGH JGT

Allahabad Bypass Project - 2
Construction of road from km 158+000 to 198+000 (except Ganga Bridge)

HCC
www.hccindia.com

CLIENT: NATIONAL HIGHWAYS AUTHORITY OF INDIA
SUPERVISION CONSULTANT: BCEOM-LASA(JV)
CONTRACTOR: HINDUSTAN CONSTRUCTION COMPANY LTD
DATE OF START: 9TH JUNE 2004
COMPLETION PERIOD: 30 MONTHS
FUNDING AGENCY: WORLD BANK

Corporate Office
Hindustan Construction Co Ltd
Hiranagar Road, Laxi Bahadur Shastri Marg,
Vasant Vihar, Mumbai 400 082 India
Tel + 91 22 2577 9999
Fax + 91 22 2577 7588

Site Office
Hindustan Construction Co Ltd
Allahabad Bypass Project
Village Malabarhi, Post Akarmpur,
Nawabganj, Allahabad
Uttar Pradesh, India
Tel +91 522 227888/89/90



Slope protection of road through bio-engineering technique



Plant growth on road side through JGT

Slope Stabilization of Cuttings, N Rly, Nangal, Panjab



Eroded Slope of Cuttings



Dressing & Installation of JGT



Sprouting of grass seeds through pores of JGT



Slope Stabilized with Vegetative Cover

SLOPE PROTECTION OF BRIDGE APPROACH WITH JGT MUNDESWARI, WB



**LAYING OF JGT ON THE
PREPARED SLOPE**



**STABILIZED SLOPE WITH
VEGETATIVE COVER**

Slope Stabilization with JGT, Jorabani to Imphal Road , Manipur



Destabilized Slope



Laying of JGT



Stabilized slope

Slope Stabilization with JGT, Karimganj - Bangladesh Road, Assam



Eroded slope of road embankment



Dressing of slope for laying JGT



Laying of JGT

**Gayabari Paglajhora land side area on NH 55, Gayabari, Darjeeling, WB
(Executed by PWD Roads, NH Div., Govt. of WB)**



Before application



During application



Progress of vegetation growth after application

Construction completed on Dec. 2011

Hill Slope Site No. 2

**Land slide area at Mid Western Himalayas (Dehradun, Uttarakhand)
(Executed by CSWCRTI, Dehradun)**



Eroded Slope



Installation of JGT

Stabilized Slope

APPLICATION OF JUTE AGROTEXTILE FOR SAND DUNE STABILIZATION IN COLD DESERT, RAJASTHAN



Destabilized Sand Dune – No Growth of Vegetation



Wind Induced Sand Movement Blocks Roads and Canal

SAND DUNE STABILIZATION WITH JUTE AGROTEXTILE



Laying of JAT



Plantation of Local Species



Stabilized Sand Dune with Growth of Vegetation (Forestation)

Hill Slope Stabilization with JGT at Adverse Climatic Zone, Leh



Hill slope stabilization with JGT at Ladakh - A BRO work



Stabilized hill slope and formation of ice on JGT

NB: STUDY CONDUCTED BY 16BRTF, BRO, J&K

SLOPE STABILIZATION OF RAIN WATER HARVESTING TANK WITH JGT



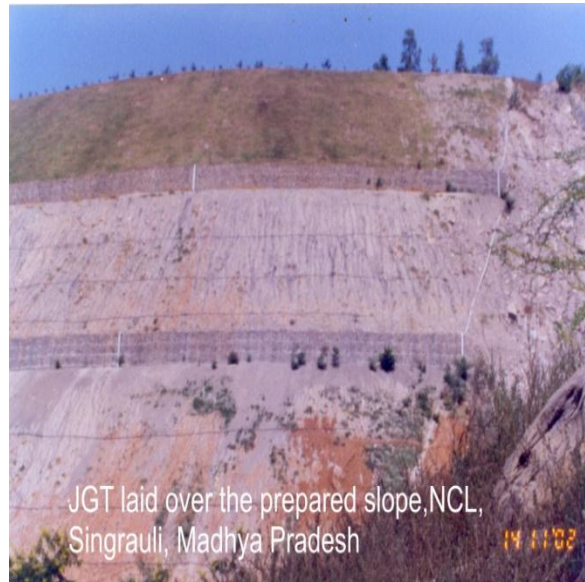
Laying of JGT on
the prepared bank



Stabilization of OB Dump of Mines Spoil with JGT, Singrauli, NCL



**DESTABILIZED SPOIL HEAP,
SINGRAULI, UP**



**LAYING OF JGT ON
PREPARED SLOPE**



**STABILIZED MINE SPOIL
WITH JGT**

JGT for Slime OB Dump Stabilization, TISCO, Noamundi



Destabilized Slope



Gabion at Toe



JGT laid on dressed slope



Spreading of grass seed



Slope Stabilized with vegetative growth

VETIVER GRASS – ITS UNIQUE FEATURES

- **VETIVER IS A RAPIDLY GROWING VARIETY OF GRASS.**
- **IT HAS A LONG FIBROUS ROOT SYSTEM**
- **THE ROOTS PENETRATE VERTICALLY 3.0 M DEEP AND HORIZONTALLY 0.5 M UNDER THE GROUND**



Vetiver Root System

JGT for stabilization of FA OB Dumps, NTPC, Dadri, UP



Rain cut & erosion

COMPACTED SLOPE BEFORE LAYING OF GEO JUTE



Compacted surface



JGT laid on Slope



Vetiver grass Root

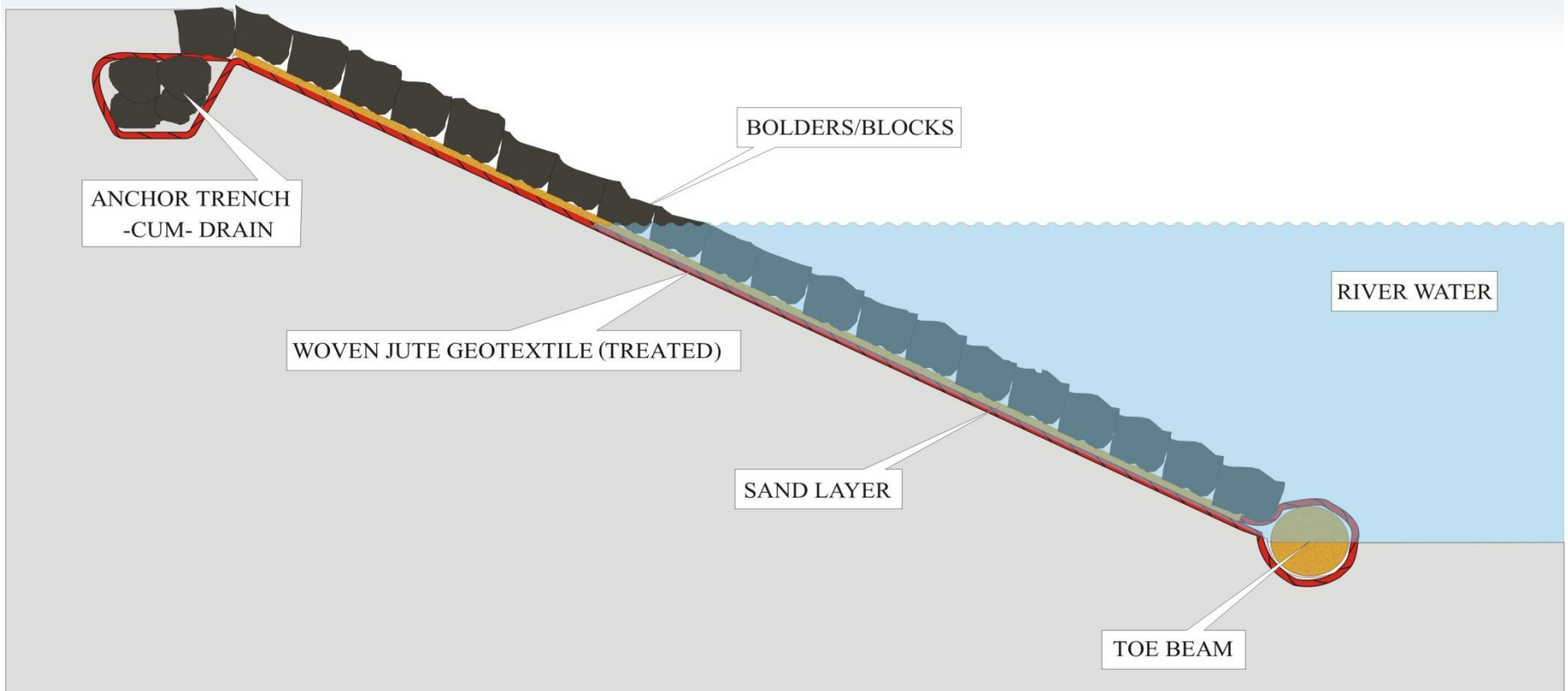


Growth of vetiver grass through JGT



Stabilized FA OB Dump

RIVER BANK PROTECTION WITH JUTE GEOTEXTILE



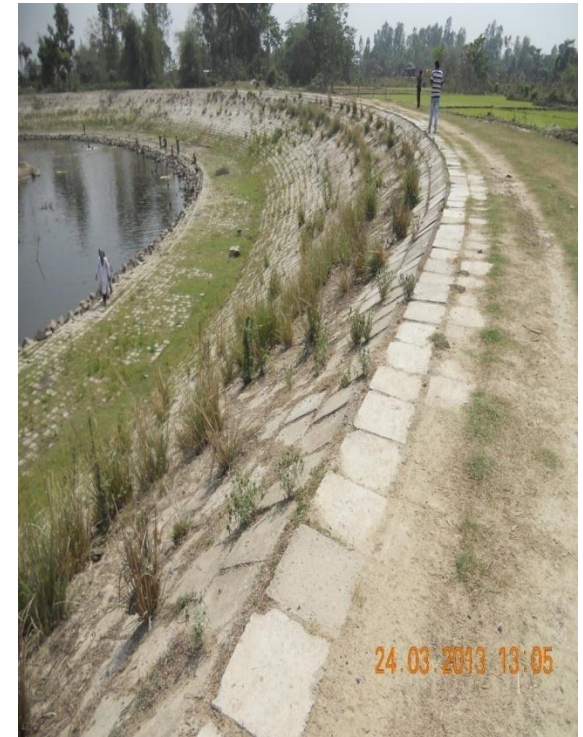
Bank protection work on the right bank of River Punarbhaba at Vill. Battali , Malda (Executed by I & WD, Govt. of WB)



Before application



**Armoring over JGT
laid on bank**



Stabilized bank

Bank protection work at river Dharala (Executed by NB Flood Control Commission, Jalpaiguri)



Eroded bank



**Laying of JGT on
prepared bank**



Stabilized River Bank

Left bank of the river Bhagirathi at Santipur, Dist. Nadia, WB (Executed by Irrigation Department, Nadia)



Nature of erosion



Installation of JGT



Stabilized River Bank



Thank You

For further details pl. contact **National Jute Board**
E mail – jute@njbindia.in, pradip1451@gmail.com,
Website- www.jute.com