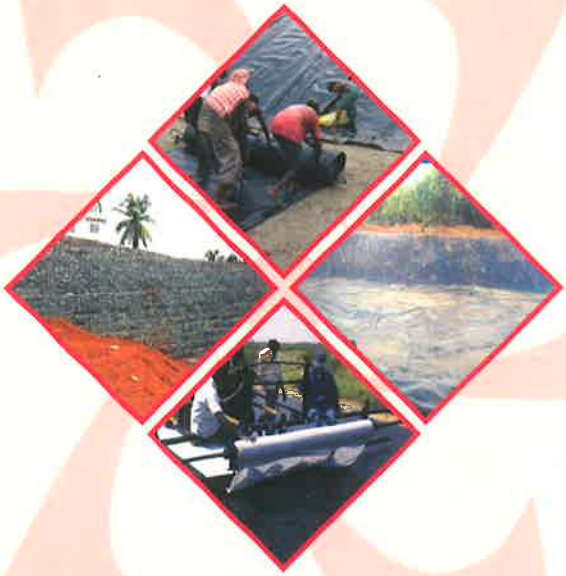
Handbook on
"Geosynthetics case studies of ITTA Members"



INDIAN TECHNICAL TEXTILE ASSOCIATION

'A' Block, The Bombay Textile Research Association(BTRA),
Near R-City Mall, L. B. S. Marg, Ghatkopar(W), Mumbai 400086
Tel. :022-25003098 Email : ed@ittaindia.org / info@ittaindia.org
Website : www.ittaindia.org

Handbook on
"Geosynthetic case studies of ITTA Members"

INDIAN TECHNICAL TEXTILE ASSOCIATION

'A' Block, The Bombay Textile Research Association(BTRA),
Near R-City Mall, L. B. S. Marg, Ghatkopar(W), Mumbai 400086
Tel. :022-25003098 Email : ed@ittaindia.org / info@ittaindia.org
Website : www.ittaindia.org

Published by

INDIAN TECHNICAL TEXTILE ASSOCIATION

'A' Block, The Bombay Textile Research Association(BTRA),
Near R-City Mall, L. B. S. Marg, Ghatkopar(W), Mumbai 400086
Tel. :022-25003098 Email : ed@ittaindia.org / info@ittaindia.org
Website : www.ittaindia.org

PREFACE

India has one of the largest road network of 41.09 lakh kilometers, comprising of National Highways / Expressways (71,772 km), State Highways (1,54,522 km), major District Roads (2,66,058 km) and other District Roads and Rural Roads (36,17,240 km). Roads carry about 63 percent of freight and 87 percent of passenger traffic. Although National Highways constitute only 1.7 percent of the road network, it carries 40 percent of the total road traffic. Indian Road Network, however, has certain limitations which has a bearing on the growth of the Indian economy.

2. A view is gaining ground that growth of Indian economy cannot be sustained without a world class infrastructure. The rapid growth of China is fueled by the development of robust infrastructure. Similarly, quality infrastructure is the backbone of western developed economies. To accelerate the growth of Indian economy, India also needs support of world class road infrastructure.

3. Globally, geosynthetics has been a important component of road infrastructure. However, in India the usage of geosynthetics is limited. Reasons for limited usage of geosynthetics interalia include lack of awareness of the technical advantages and economic benefits of usage of geosynthetics. The geosynthetics are also perceived to be costlier vis-à-vis conventional method. In some quarters there is also a question mark over indigenous availability of range of geosynthetic products.

4. Indian Technical Textile Association (ITTA) is an exclusive association of technical textile value chain and has major manufacturers of geosynthetics as its member. To present the technical advantages of usage of geosynthetics in infrastructure ITTA has made an attempt to compile the details of the successful case studies of all types / fibre base of geosynthetics in the country. A compilation of selective case studies is provided in this handbook. The case studies have been classified under five categories (i.e., soil stabilization-pavement and embankment; RSW with block, panel, gabion and wire cage facing; river bank –shore protection and erosion control; canal lining and hydraulic control; landfill) for the easy reference and use of the agencies involved in infrastructure development. It is, however, equally important to point out that mere usage of geosynthetics will not ensure good performance. Proper selection of geosynthetics, correct design and quality assurance are essential for building up quality infrastructure.

5. A chapter on cost benefits of geosynthetics is also included in the hand book. There are many studies which reinforces the view that geosynthetics provide cost effective solutions for building up infrastructure. The corporate profiles of the major indigenous manufacturers is also provided in the handbook to showcase the indigenous availability of range of geosynthetics products in the country. The capacity installed (coupled with capacity in pipeline) and technological competence of indigenous manufacturers supports the view that indigenous availability is adequate to meet the increased consumption of geosynthetics in the country.

6. The vision of ITTA is to increase significantly the consumption of geosynthetics for development of world class infrastructure in the country. This hand book is being circulated to facilitate journey towards this goal.

Mrs. Shashi Singh
Executive Director
Indian Technical Textile Association

Place: Mumbai
Date: 5th February 2013

Content

Content

Content

Content

COST BENEFITS OF GEOSYNTHETICS

1. Huge infrastructure development undoubtedly requires routing through marsh-lands, along unstable hill slopes, through cuttings, river crossings, etc. The demand has also increased for the natural resources like sands, gravel, and clay. This in turn has encouraged various activities like quarry ing,sand mining etc which is creating an imbalance in the ecosystem and environmental damage. Increased depletion of natural resources has forced the engineers to seek better alternatives.
2. With advancement of technology in the field of construction, 'Geosynthetics' have become successful replacements to various conventional solutions respecting the safety, technical and functional requirements of structure. In general, Geosynthetics can be used in roads for various applications like: separation, filtration, reinforcement, drainage, and erosion control.
3. For construction of retaining walls, a drainage bay may be required behind the wall. For this, it is necessary to provide graded material to ensure adequate relief of porewater pressures / hydostatic pressures, and at the same time ensure that there is no piping of backfill. Grading can be avoided by providing an appropriate nonwoven geotextile separating the basic gravel drainage from the backfill soil, thereby not only reducing the thickness of the drainage bay but also providing ease of construction. Cost saving with this replacement is certain and the saving would vary depending on the location.
4. Retaining structures are essential elements of infrastructure development especially in highway design. Retaining structures are used not only for bridge abutments and wing walls, but also for landslide mitigation, slope stabilization, and embankment retentionand support. Retaining structures also used essentially to minimize right-of-way of high level carriageways. For many years, retaining structures were almost exclusively made of reinforced concrete and were designed as gravity or cantilever wa lls. Reinforced Soil (RS) Walls and Reinforced Soil Slopes (RSSs) are cost effective soil -retaining structures. RS walls offer significant technical and cost advantages over conventional reinforced concrete retainin g structures.At sites with poor foundation conditions,the elimination of costs for foundation improvements such as piles and pile caps that may be required for support of conventional structures, have result ed in cost savings of greater than 50 percent on completed projects (Ref. FHWA NHI -10-024 MSE Walls and RSS-Vol 1). The exact cost savings may vary from site to site. In general, RS walls of height more than 3m are cheaper than conventional retaining structures.
5. For drainage of subsurfacein pavements, a properly designed aggregate filter is required. In fine soils, a multi-layered filter is required which generally consists of fine aggregate which retain natural soil particles at their original positions. These aggregate filters can be minimised by using non woven geotextiles (Ref. IRC 34). Also, edge drains can be provided using geosynthetic material 'drainage composite'. These alternatives are not only cost effective where natural resources like aggregates are costl y, but also easy to install. Being factory made material, consistency in quality is assured.
6. Various Geosynthetic products are used in pavement layers all over the world. The use of Geosyntheti c products in pavement is cost effective solution compared to conventional solution. A study by Central Road Research Institute (CRRI) on use of geotextiles in roads on soft soil was conducted on ten roads in Gujarat and Maharashtra, each about 4-6 kms. The study clearly showed that geotextiles are an effective substitute for conventional blanket course. The study has also shown that use of geotextiles is cost effective when good quality sub-base materials are not available within economic leads and the CBR of sub-grade is low i.e, less than 3. A study was also carried out by Prof.B.V.S.Viswanadha n of IIT, Powai with

polypropylene woven textiles in Maharashtra. This study has evaluated the net cost savings (NCS) of using geosynthetics, considering the difference between the cost of un-reinforced road and the cost of a reinforced road. According to the study, the NCS for a life period of 15 years was estimated at USD 14,500 per km.

7. Prices for geosynthetic products and their installation vary significantly depending upon the location of the construction project (and thus the haul distances involved), the size of the project, and contractor experience (level of confidence or sense of risk). Furthermore, the cost of polymer (from which Geosynthetic products are made) and, of course aggregates, good quality fill material, tack coats, relate closely to the petroleum industry, which has been varying drastically during the past several years. Therefore, the exact cost savings figure may vary.
8. The methodology for assessing the savings in initial construction cost and life cycle cost is given in Geosynthetic Materials Association (GMA) White Paper II (June 27, 2000) on Geosynthetics reinforcement of the aggregate base / subbase courses of pavement structures. The relevant extract of aforesaid white paper is reproduced below.

"6.2 INITIAL CONSTRUCTION COST

Initial construction cost savings are usually realized when constructing over a low subgrade. The amount of calculated savings may vary with the method and/or geosynthetic used in design. However, the approach to quantifying the cost savings is independent of the design method and geosynthetic. A step-by-step procedure for computing an initial construction cost savings follows.

This procedure assumes that the preferred design procedure has already been selected.

STEP 1. Quantify costs.

A. Base course material in-place ($BC), $/mm/sq. m (dollars/millimeter thickness/square meter of pavement)

B. Over-excavation removal and disposal ($OE), $/mm/sq. m

C. Geosynthetic in-place ($G), $/sq. m

STEP 2. Quantify base course and over-excavation thickness reductions with geosynthetic.

Thickness reduction, Δtr, from the selected design procedure.

STEP 3. Compute initial construction cost savings (or increase).

A. Compute construction cost savings ($CCS) per square meter of pavement area.

Δtr ($BC + $OE) - $G = $CCS $/sq. m

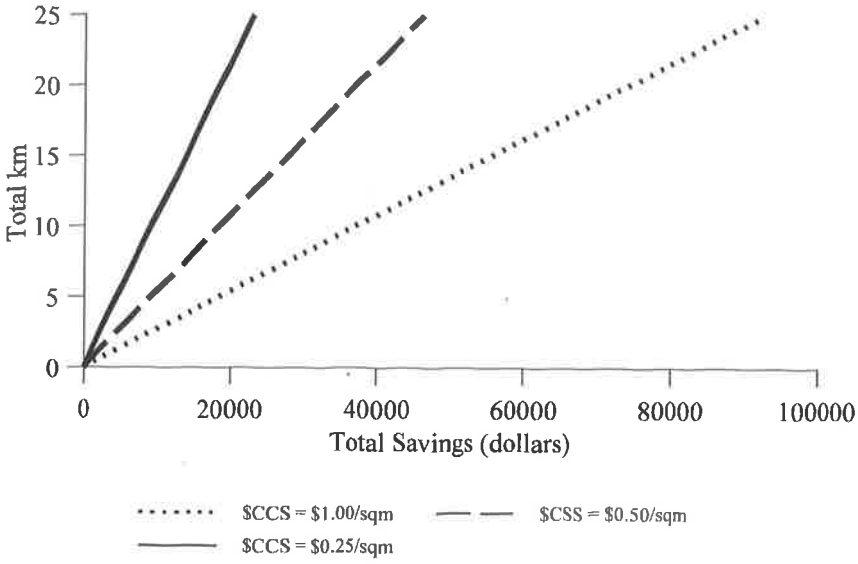


Figure 6-1. Initial construction cost savings.

B. Compute cost savings on a lane-kilometer basis. Use Figure 6-1 or the following equation.

$CCS $/sq m [(1000 m) (3.7 m lane width)] = $CCS $/lane-km

STEP 4. Evaluate whether a more detailed analysis is justified.

A. If initial construction costs are lower with geosynthetic, use of a geosynthetic is justified. Perform a life-cycle cost analysis if cost savings over the life of the project must be quantified.

B. If initial construction costs are greater with the geosynthetic, cost benefits may be realized over the life of the project. Therefore, perform life -cycle cost analysis (see Section 6.4).

6.4 LIFE-CYCLE COSTS

There are many costs and additional factors to be considered in a life-cycle cost analysis. The majorinitial and recurring costs that should be considered in the economic evaluation of alternativepavement strategies [e.g., whether to reinforce with a geosynthetic] include the following(AASHTO, 1993):

(1) Agency costs:

a. Initial construction costs
b. Future construction or rehabilitation costs (overlays, seal coats, reconstruction, etc.)
c. Maintenance costs, recurring throughout the design period
d. Salvage return or residual value at the end of the design period (may be a "negative cost")
e. Engineering and administration costs

f. Traffic control costs, if any are involved

(2) Use costs:

a. Travel time
b. Vehicle operation
c. Accidents
d. Discomfort
e. Time delay and extra vehicle operating costs during resurfacing or major maintenance

Factors that must be defined for a life-cycle analysis include the following: analysis period; performance period; equivalent single axle loads (ESALs) over initial performance period; initialand terminal serviceability values; discount rate; pavement component thicknesses; pavementcomponents structural coefficients; subgrade resilient modulus; annual maintenance costs; initialconstruction costs; and rehabilitation construction costs. Pavement management systems can greatly assist in evaluating the cost of alternatives and can be used to estimate the cost of extending servicelife through use of geosynt hetic reinforcement. Such a large number of variables precludedevelopment of general graphs for computing cost savings (see, Figure 6-1). Clearly, life-cycle cost analyses must be performed on an individual agency basis and/or project basis.

Several alternatives should be analyzed with life-cycle costs. Example options that may beevaluated are listed in Table 6-2. The thickness of the pavement materials may vary with theoptions. Other options may be developed by varying (i) the type or strength of reinforcement;

Table 6-2. Design Options to Compare with Life-Cycle Cost Analysis

Design Option	Unreinforced	Reduced Base Course Thickness	Performance Period Extension	Combination
Pavement Option				
ACC Surface	__ mm	__ mm	__ mm	__ mm
ACC Binder	__ mm	__ mm	__ mm	__ mm
Base Course	__ mm	__ mm	__ mm	__ mm
Subbase Course	__ mm	__ mm	__ mm	__ mm
Reduced Over-Excavation[a]	none	__ mm	__ mm	__ mm
Geosynthetic Reinforcement	none	YES	YES	YES
Analysis Period (yrs)				
Performance Period (yrs)				
Initial Construction Cost ($/lane-km)				
Total Life-Cycle[b] Cost ($/lane-km)				
Percent Savings from Unreinforced Design	N/A			

Note: a. Note any undercut reduction due to geosynthetic.
b. In today's dollars.

(ii) the reinforcement design procedure used; or (iii) the base course material (strength and draina ge characteristics). The analysis period will likely be the same for all options, but the performanceperiod may vary. Initial construction and life-cycle costs will vary for the options examined. Lifecycle

cost savings, or additional cost, of the reinforcement design options to the unreinforced optioncan be compared.

6.6 ADDITIONAL BENEFITS OF GEOSYNTHETIC REINFORCEMENT

Geosynthetics are factory manufactured and have well-defined reliable material properties.Incorporation of geosynthetic reinforcement into a pavement adds a degree of redundancy in thestructure. Thus, geosynthetic reinforcement of the base course of a flexible pavement, properlydesigned and installed, increases the reliability of a pavement and the likelihood of satisfactoryperformance of the pavemen t structure over the performance period.

Traffic volume (i.e., ESALs) is a significant input parameter for pavement designs, and can bediffic ult to accurately predict. Geosynthetic base course reinforcement, originally designed toextend the performance periods and decrease life-cycle costs, likely will ensure that at least the unreinforced pavement performance period is reached in roadways, with actual ESALs much greaterthan design ESALs. Geosynthetic reinforcement can provide similar performance on roadways, orsections of roadways, with subgrade strengths significantly lower than design subgrade strength."

****

Case Studies:

1. Case Studies on Soil Stabilisation - Pavement and Embankment:

Sr No.	Case study	Company
1	Pavement strengthening at Kakinada Port, Andhra Pradesh	National Jute Board
2	Pavement strengthening of road to Jorabari (Assam)	National Jute Board
3	Pavement Strengthening of Chatumary to MDR 14 road,Odisha	National Jute Board
4	Widening and Strengthening of Munshirat-Rajpur road,West Bengal	National Jute Board
5	Pavement Strengthening at Andula - Boyratolia,West Bengal	National Jute Board
6	Road reinforcement in Pune, Maharashtra	Reliance Industries Ltd
7	Reinforcement under runway extension of Kolkata Airport	Fibertex Nonwovens
8	Asphalt overlays in Chakdah Bongaon Highway	Fibertex Nonwovens
9	Pavement rehabilitation works at Madhurai(NH-7),Tamilnadu	TenCate Geosynthetics Asia SDN BHD.
10	Basal Reinforcement for ground improvement of embankment on Soft soil coastal road Navi Mumbai, Maharashtra, India.	TenCate Geosynthetics Asia SDN BHD.
11	Reinforcement of loose sand to load bearing application	Strata Geosystems (India) Pvt. Ltd.
12	Rehabilitation of road, Karnataka	Strata Geosystems (India) Pvt. Ltd.
13	Improvement in subgrade strength of roads in Mumbai	Strata Geosystems (India) Pvt. Ltd.
14	Construction of unpaved Road,Haldia,West Bengal	Maccaferri Environmental Solutions Pvt. Ltd.
15	Pavement strengthening at Nadia-Kapadwanj,Gujarat	Maccaferri Environmental Solutions Pvt. Ltd.
16	Ground improvement for road over bridge, Assam	Maccaferri Environmental Solutions Pvt. Ltd.
17	Reinforcement and Separation between Granular subbase and subgrade, Andhra Pradesh	Techfab (India) Industries Ltd
18	Subgrade Stabilisation ,Latur , Maharashtra	Techfab (India) Industries Ltd
19	Subgrade stabilization,Pune-Maharashtra	Techfab (India) Industries Ltd
20	Road embankment ,Calicut Byepass	Techfab (India) Industries Ltd
21	Reinforcement of road-Dahanu,Thane	Techfab (India) Industries Ltd
22	Track bed stabilization ,Assam	Techfab (India) Industries Ltd
23	Construction of embankment at IT Corridor in Chennai	Techfab (India) Industries Ltd
24	Construction of embankment for approaches of Rajiv Gandhi Setu Bridge ,Daman	Techfab (India) Industries Ltd
25	Reinforcement of rural Unpaved road , Ichalkaranji	Kusumgar Corporates Pvt Ltd.
26	Roads reinforcement at Kunde Bhangarwadi , Kalyan.	Kusumgar Corporates Pvt Ltd
27	Reinforced Embankment for Height raising of Jarosite Pond at Zinc Smelter, Daberi, Udaipur.	Garware Wall Ropes Ltd.
28	Erosion Control System for the Kundli-Manesar Highway Project	Garware Wall Ropes Ltd.
29	Hill-road rehabilitation in Gangtok ,Sikkim	Flexituff International Ltd.

PAVEMENT STRENGTHENING AT KAKINADA PORT (ANDHRA PRADESH)

LOCATION :
Kakinada Port area, Andhra Pradesh

INTRODUCTION:
At the proposed area, subsoil is soft clay upto 4m depth and water table is about 0.5m below G.L. The area gets submerged during high tide.

SOLUTION:
To mitigate the mentioned problem, Jute Geotextile was used to improve the performance of embankments over soft soil

CLIENT NAME:
CRRI and Kakinada Municipality

YEAR OF APPLICATION:
1996

PROPERTIES OF SUBGRADE SOIL:

Plasticity Index:	32
CBR of Unsoaked specimen:	2.1%
CBR of Soaked specimen:	1.61%
Soil type:	**CH**

PROPERTIES OF JUTE GEOTEXTILE USED:

Weight :	760 gsm
Tensile Strength :	20 kN/m
Pore Size (O_{90}) :	300micron
Type of JGT :	Woven (Rot-proof)

CONCLUSION:

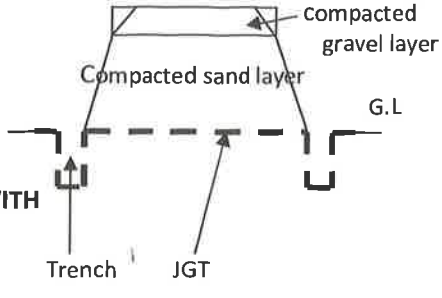
- Jute Geotextile proved very effective in weak sub-grade soils even after reduction in their strength after a lapse of 7 years as reflected from the performance and increase in CBR.

PICTORIAL REPRESENTATION:

Photo 1. Levelling of Damaged

Photo 2. Laying of Jute Geotextile over Sand

Photo3. Finished Road after 7 years of construction



CROSS-SECTIONAL DETAILS OF PAVEMENT WITH JUTE GEOTEXTILE

PAVEMENT STRENGTHENING OF UT ROAD TO JORABARI (ASSAM)

LOCATION :
The road (UT Road to Jorabari) is located at Udalguri in Darrang district, Assam

INTRODUCTION:
This was an earthen road under PMGSY Pilot project. Flash flooding of the area does occur occasionally. Deep ruts had formed at some locations. Average annual rainfall is 1600 1700 mm. The water table is 3 to 4 m below G.L during summer and 1.5 to 2 m during monsoon.

SOLUTION:
To mitigate the problems, Jute Geotextile was used on sub-grade.

ROAD LENGTH:
4.6 Km

CLIENT NAME:
Chief Engineer PWD, Rural Road Works
Assam

YEAR OF APPLICATION:
2007

PROPERTIES OF SUBGRADE SOIL:

Liquid Limit:	24%
Plastic Limit:	Non-plastic
CBR of Soaked specimen:	4%
Soil type:	ML

PRE-WORK TRAFFIC STATUS:

- CVPD was *on an average* 7 with laden weight of 3T or more
- CPVD was projected at 20 after construction of the road
- CVPD for the purpose of pavement design was based on an assumed growth rate of 6% annually at the end of the design life of 10 years which worked out to $20(1+6/100)^{10} = 36$ conforming to the curve 'B' as per the IRC:SP:20:2002

PROPERTIES OF JUTE GEOTEXTILE USED:

Weight :	643/760/810 gsm
Tensile Strength :	15/20/30 kN/m
Pore Size (O_{90}) :	150 – 200 micron
Type of JGT :	Woven (Rot-proof)

CONCLUSION:

- The CBR values had increased more than 1.5 times with decrease in moisture content.
- The blacktop pavement surface was distress-free in all the sub-sections during the entire period of performance monitoring
- Shoulders as well as side slope condition was good without any rain-cuts or settlement and were grassy and green

PICTORIAL REPRESENTATION:

Photo 1. Earthen Track before construction

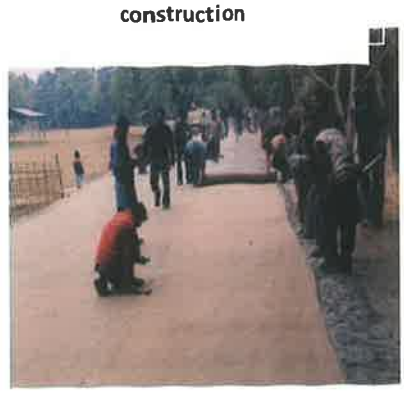
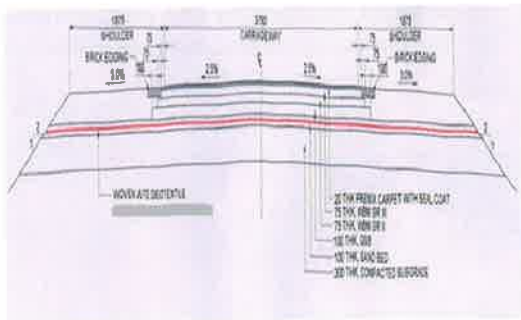


Photo 2. Laying of Jute Geotextile

Photo3. Finished Road



CROSS-SECTIONAL DETAILS OF PAVEMENT WITH JUTE GEOTEXTILE

PAVEMENT STRENGTHENING OF CHATUMARY TO MDR 14 ROAD (ODISHA)

LOCATION :
The road (Chatumari to MDR 14) is located under Tehsil – Bari in Jajpur district, Odisha.

INTRODUCTION:
This was an earthen road under PMGSY Pilot project. Deep ruts had formed at some locations. Average annual rainfall is 1400 mm. The water table is at a depth of 1.5 to 3 m.

SOLUTION:
To mitigate the problems, Jute Geotextile was used on sub-grade.

ROAD LENGTH:
2.67 Km

CLIENT NAME:
Chief Engineer PWD
Rural Works – II
Orissa

YEAR OF APPLICATION:
2007

PROPERTIES OF SUBGRADE SOIL:

Liquid Limit:	27%
Plastic Limit:	Non-plastic
CBR of Soaked specimen:	3%
Soil type:	**ML**

PRE-WORK TRAFFIC STATUS:

- CVPD was *on an average* 7 with laden weight of 3T or more
- CPVD was projected at 44 after construction of the road
- CVPD for the purpose of pavement design was based on an assumed growth rate of 6% annually at the end of the design life of 10 years which worked out to $44(1+6/100)^{10} = 79$ conforming to the curve 'C' as per the IRC:SP:20:2002

PROPERTIES OF JUTE GEOTEXTILE USED:

Weight :	643/760/810 gsm
Tensile Strength :	15/20/30 kN/m
Pore Size (O_{90}) :	150 – 200 micron
Type of JGT :	Woven (Rot-proof)

CONCLUSION:

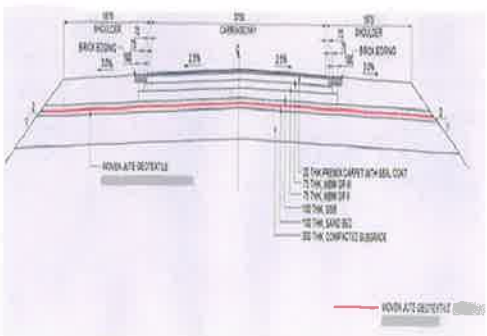
- The CBR values had increased more than 1.5 times with decrease in moisture content.
- The blacktop pavement surface was distress-free in all the sub-sections during the entire period of performance monitoring
- Shoulders as well as side slope condition was good without any rain-cuts or settlement and were grassy and green .

PICTORIAL REPRESENTATION:

Photo 1. Damaged road

Photo 2. Stapling of Laid Jute Geotextile over Subgrade

Photo 3. Finished Road after 2 years



CROSS-SECTIONAL DETAILS OF PAVEMENT WITH JUTE GEOTEXTILE

WIDENING AND STRENGTHENING OF MUNSHIRHAT-RAJPUR ROAD (WEST BENGAL)

LOCATION :
Munshirhat to Penro Khila Rajpur Road, Howrah, West Bengal.

INTRODUCTION:
It is a rural road which was to be widened to carry the increased traffic.

SOLUTION :
Jute Geotextile was laid on the extended portion

ROAD LENGTH:
2 Km

CLIENT NAME:
Howrah Highway Division
PW (Roads) Deptt.
Government of West Bengal

YEAR OF APPLICATION:
2000

PROPERTIES OF SUBGRADE SOIL:

O.M.C	: 19%
Plasticity Index	: 19%
CBR of Soaked specimen	: 3.5%
Soil type	: **OL**

PROPERTIES OF JUTE GEOTEXTILE USED:

Weight :	760 gsm
Tensile Strength :	20 kN/m
Pore Size (O_{90}) :	300micron
Type of JGT :	Woven (Rot-proof)

CONCLUSION:
The subgrade CBR had strengthened by the application of JGT and reached a CBR value of 6% from 3.5% with decrese in liquid and plastic limits considerably. No distress of the road is noticeable and the riding surface of the pavement is perfectly smooth.

PICTORIAL REPRESENTATION:

Photo 1. JGT laid over subgrade

Photo 2. Brick metal laid over JGT

Photo 3. Finished Road

PAVEMENT STRENGTHENING AT ANDULIA – BOYRATOLA ROAD (WEST BENGAL)

LOCATION :
Andulia (Kalupukur More) to Boyratala in Haroa Block, District North 24-Paraganas, West Bengal.

INTRODUCTION:
It is a rural road under PMGSY with a problem of overall decrease in pavement thickness than the designed one because the subgrade consists of soft soil.
Average rainfall of the area is 1500mm

SOLUTION:
To prevent the problem of interpenetration of sub-base and subgrade soft soil, Jute Geotextile is laid over subgrade.

ROAD LENGTH:
3.3 Km

CLIENT NAME:
North 24-Paraganas Zilla Parishad
West Bengal

YEAR OF APPLICATION:
2005

PROPERTIES OF SUBGRADE SOIL:

Optimum Moisture Content:	23.5%
Plasticity Index:	18.10
Soaked CBR at 2.5mm penetration:	3.22%
Soaked CBR at 5.0mm penetration:	3.16%
Soil type:	**OL**

PRE-WORK TRAFFIC STATUS:
Volume of traffic of road as per traffic census with annual growth rate @ 6% per year is **B Curve** – Number of vehicle / day is 15-45.

PROPERTIES OF JUTE GEOTEXTILE USED:

Weight :	810 gsm
Tensile Strength :	30 kN/m
Pore Size (O_{90}) :	150micron
Type of JGT :	Woven JGT

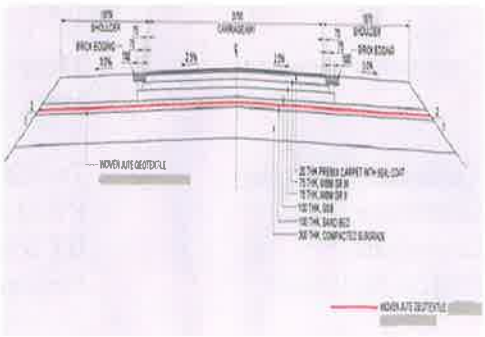
CONCLUSION:
The study substantiates the proven concept that limited durability of JGT is not a technical deterrent as soil gets consolidated to its maximum within a year or so. Consolidation is affected due to arrest ot movement of soil particles on one hand and concurrent release of pore water due to imposition of loads on the other. Separation of sub-base and sub-grade contribute to gradual and natural consolidation of sub-grade. In this case CBR value has got enhanced to more than 3times despite of loss in strength of JGT.

PICTORIAL REPRESENTATION:

ANDULIA-BOY RATA LA ROAD BE FOR E LA YING JGT

JGT LAID ON THE SUB GRADE

Finished Road

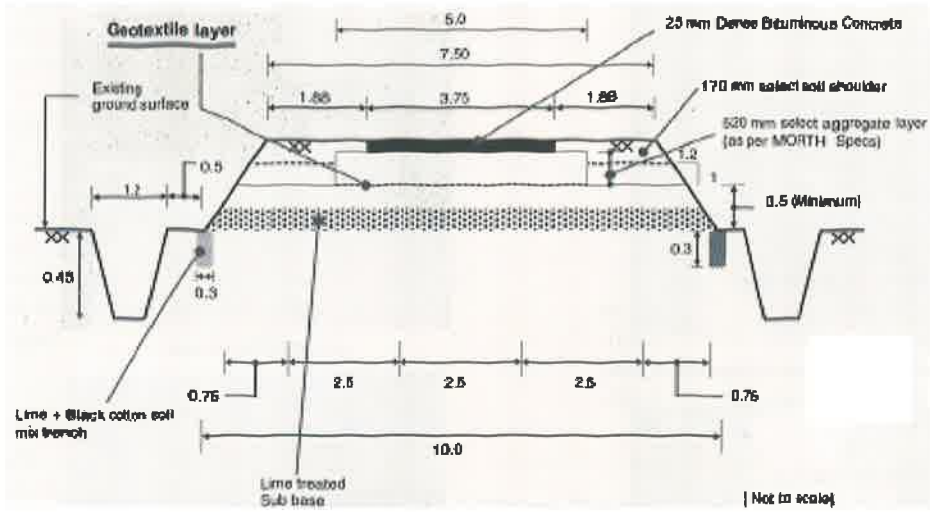


CROSS-SECTIONAL DETAILS OF PAVEMENT WITH JUTE GEOTEXTILE

Reliance
Industries Limited
Growth is Life

Road Reinforcement in Pune , Maharashtra

Name of Project	: Road Reinforcement in MDR 82
Place	: Near Pune (Daund – Gar Tapodi)
Year	: April, 2004
Nature of the work	: Subsoil reinforcement.
Why Geotextile	: Black cotton soil having CBR<3. . Earlier need to relay The road every year due to severe rut formation.
Construction Details	:



Types of Geotextiles	:270 gsm PP slit tape Woven geotextile UV stabilized
Sq metres usge	: 16000 - 2 KM road of 2 lane
No of years passed	: 8 years
Performance as of Jan 2013	: Excellent . No rut formation Vs controlled road.
Cost value analysis	: More than 7 cr saving. No relaying in the past 5 years VS every year .Only Bitumen top coat was given after 6 years.
Geotextile supplier	: Techfab India , Mumbai
Contractor	: PWD contractor
Consultant	: IIT Mumbai
Project facilitator	: Reliance Industries Limited

Reliance
Industries Limited
Growth is Life

Road Reinforcement in Pune , Maharashtra

Images Before laying(2004)

After 4 years of laying (2008)

Images after 8 years of laying

Reliance
Industries Limited
Growth is Life

Certificate received from PWD department after 8 years:

Name of Work: Construction of Daund – Gar Dapodi Road (Pune District) Km 14/500 to 16/500 with the use of Woven Slit film tape Polypropylene Geotextile fabric as a reinforcing layer at the interface of existing subgrade and granular base along with the involvement of Reliance Industries Ltd. Mumbai, IITB Bombay, MERI Nasik and Techfab India.

Sub: Report on Performance of PP Woven slit film tape Geotextile Fabric – Eight years after laying of Fabric (April 2004 to May 2012)

Road Condition and problems before laying of PP Geotextile Fabric: The road passes through Sugarcane area having Black Cotton soil as a natural subgrade and has inadequate drainage. The root cause of road failure was attributed to CH type of soil, with low cohesion under saturated and undrained conditions, reasonably heavy traffic and high axle loads and inadequate drainage arrangement.

Role of PP woven Geotextile in Road Construction: The trial study was executed to arrive at a construction methodology through a_demonstration project involving the use of a_PP Woven Geotextile as a separator cum reinforcement. The project was undertaken to evaluate and compare the performance of a Geotextile reinforced stretch of the road with adjoining stretch of the road constructed_with conventional design under identical conditions. A 2 km long stretch of road along MDR 82 in Daund region of Pune District was selected for this purpose.

Status of Work: An indigenously designed Woven slit film Geotextile, manufactured by TechFab India was laid in the first week of April 2004. The Geotextile has identical load elongation characteristics in the machine and cross-machine directions. Design calculations showed that with Geotextile reinforcement, a 30% reduction in the granular base thickness was possible. Construction of the Geotextile reinforced road was completed and opened to traffic in April 2004. However in this study it was decided to introduce PP Geotextile layer along the interface between existing subgrade and granular base by following the conventional method of Construction._This was carried-out to enable to compare the performance of reinforced stretch with an un-reinforced stretches in adjoining areas.

Observations, Monitoring and Inferences – Eight years after laying of PP Geotextile fabric with **Black top completed**:

1. In the Geotextile reinforced section of the road after Black Top : there are no visible signs of distress even after a period of eight years; whereas the earlier experience showed that the road constructed without any Geotextile layer or strengthening measure was observed to deteriorate within six months. This shows a significant influence of the Geotextile layer on the performance of the road.
2. Further, the significant influence of Geotextile layer in improving the performance of the Road stretch along MDR 82 is adequately demonstrated.

3. After a period of eight years, geotextile sample retrieved from its embedded location was found to be intact and in good condition without any punctures.

4. This implies that strengthening of existing roads on Black Cotton Soil/ Soft soil subgrade by using PP woven slit film Geotextile appears to be a viable and economical alternative.

    1. PP Geotextile has been successfully used in the construction of Lingale Boribel Road (ODR 123) - 1 Km during the FY 2010-11 which is approach road to Daund Sugar Mill subjected to heavy trafficload of sugarcane trucks,tractors and bullock carts.
    2. We have recommended this fabric to our Engineers & Contractors to use in similar soil condition cases for enhancing life of the road.
    3. We have included Polypropylene Woven and Nonwoven Geotextile fabric and PP gabions in District Schedule of Rates (SOR) which serves as a Guideline for our Contracters and engineers and all concerned fraternities
    4. We have recommended above mentioned fabric for the following :
        a. Supa-Chaufula Road
        b. Kurkumbh - Baramati Road
        c. Sonwadi - Gar - Dapodi Road
        d. Daund - Siddhatek Road

Executive Engineer,
Public Works Division(East)
Pune-411 001

No /PB/ Daund/06.06.2012
Office of the Executive Engineer
P.W. Division (East), Pune
Dated: 06.06.2012

Executive Engineer
P.W. Division (East)
Pune

Cc: SE PW circle Pune
Cc: CE PW region Pune for information and n.a.
Cc: Maharashtra Engg. Research Institute, Nashik
Cc: PWD Ministry, Govt. of Maharashtra
Cc : Mr.Satyajeet Bhonsle, Reliance Industries Ltd
Cc: Dr. B.V.S. Visvanadham, Associate Professor, Dept. Of Civil Engineering, IIT Bombay, Mumbai
Cc: Mr. Anant Kanoi,Director, TechFab India, Mumbai

Fibertex NONWOVENS

Reinforcement under runway extension of Kolkata Airport

Owner: Airport Authority of India
Consultant: Construction Engg. Dept., Jadavpur University
Contractor: TRGConstruction Pvt. Ltd.
Land Area: 7000 sqm.
Location: Kolkata N.S.C. BoseAirport

The project was done in Kolkata N.S.C. BoseInternational Airport. The airport runway was extended over a marshy land (soft soil). So, there was a requirement of base reinforcement for the base soft soil.

Solution :
The solution was to provide a separation layer between the existing surface & granular backfill material and a reinforcement layer with granular backfill material.

Materials used:

Fibertex F-600M as separation layer
Secugrid 40/40 Q1 as reinforcement layer

Brickbats and gravels as granular backfill materials

Installing F-600m over fill soil

Installation of Secugrid 40/40 Q1

Gravel on secugrid 40/40Q1

Compaction of gravel on secugrid 40/40

Asphalt Overlays in Chakdah Bongaon Highway

Owner: National Highway Authority of India
Main Contractor: ALS-MBL (JV)
Sub contractor: Coal Mines Associate Traders .
Area: 2,05,000 sqm.
Location: Chakdah-Bongaon Highway, Nadia, WestBengal

Fibertex AM2 has been used in an ADB funded project in Chakdah – Bongaon Road, in West Bengal. 30 km road pavement with a width of 10m is finished with Fibertex AM2 and asphalt overlay. Now the road is working under heavy traffic.

Spraying Tack Coat

Fibertex AM2 is in accordanceto AASHTOM-288, made from polypropylene fibres, is a flexible needlepunched nonwoven fabric added thermal bonding on one side only. The main function of Fibertex AM2 is to avoid reflective cracking of new asphalt and protect the subsoil from water intrusion and thereby loss of bearing capacity. The waterproofing function prevents surface water from entering the bearing courses. Therefore, this method increases the overlay and roadway life, increases pavement serviceability, decreasesroadway maintenance cost. Fibertex AM2 can be used in new road construction as well as in existing road maintenance.

Manual unrolling of AM2

In the above case, Fibertex AM2 was used in new road construction. A bituminous tack coat was provided over the asphalt base course. Then the paving fabric (Fibertex AM2) was laid over the tack coat. Finally 50 mm thick asphalt overlay was provided over the paving fabric.

The asphalt base course is cleaned thoroughly to remove dirt, oil, water and other impurities. Hot melted bitumen is sprayed over the base course by a tanker. Penetration grade of the bitumen is about 80 (as the temperature is around 30°C). The applied quantity of bitumen is 1200 g/m2. The temperature of the tack coat is about 140°C. Any spillage or excess tack coat should either be removed or sand be sprayed over it.

The paving fabric (Fibertex AM2) is unrolled over the tack coat. The unrolling was done manually. But it can be done mechanically also. The paving fabric is placed with heat treated side facing up. The unrolling is done carefully to minimize wrinkles. At the curvature of road, the fabric is laid carefully to avoid wrinkles. Once the fabric gets

attached to the bituminous tack-coat, then it is not possible to separate the fabric from tack-coat. Wrinkles or folds in excess of 25 mm shall be slit and laid flat. Brooming is required to maximise paving fabric contact with the pavement surface. The overlapping is provided 10 cm in longitudinal direction and 20 cm in transverse direction. Overlaps are added extra tack-coat in between the layers. No traffic except necessary construction equipment is allowed to drive on the paving fabric. All areas in which paving fabric has been placed will be paved the same day.

Asphalt overlay (50 mm thick) on the paving fabric is done immediately after the installation of the paving fabric. The retention heat of the hot asphalt material paved on top of the paving fabric must be sufficient to soften the underlying bitumen to ensure maximum saturation of the fabric. Standard hot mixed asphalt materials have plant temperatures varying between 140 -170°C, which are suitable temperatures for paving fabrics made from polypropylene. If the temperature of the asphalt material exceeds 170°C, a small quantity of the asphalt material should be spread manually before paving to protect the paving fabric. If crawlers or vehicle tyres stick to the paving fabric they may damage the fabric. To avoid this, some asphalt material has to be spread in the wheel tracks. When backfilling asphalt material in front of the asphalt paver, the truck driver must not use the brakes and must avoid any unnecessary driving at longitudinal overlaps and in spots with plenty of bitumen.

Paving with asphalt concrete

road view after 6 months

TENCATE
materials that make a difference

CASE HISTORY

Polyfelt PGM-G Asphalt reinforcement fabric
Pavement rehabilitation works at Madhurai(NH -7), Tamilnadu,India.

Project: Pavement rehabilitation in NH 7 from Kovilpatti to Kayathar, Madhurai ,Tamilnadu,India
Project owner: NHAI
Project contractor: IVRCL
Product Installed: PGM-G 50/50
Quantity: 200000sqm

Overview:

This project consists of strengthening the existing pavement structure of 9m width to 12 m width to allow excess traffic flow, decrease the maintenance cost for 20 km stretch. This highway carries heavy traffic loads from Tuticorin Port towards Kanyakumari and Kerala in South India. Cracks were reflected from the pavement surface through the asphalt overlays.

Tack Coat application on the existing pavement surface

Proposed Solution:

It is proposed to use a Geosynthetics layer to strengthen the pavement structure vis-à-vis conventional methods such as rehabilitating the DBM layer and increasing the thickness of the overlay etc. as reinforcing the pavement overlay using Geosynthetics offers an economical option and can be installed in quicker time and allow traffic flow after overlay. It is proposed to use this Geosynthetics layer having sufficient tensile strength with very lower strain between the existing pavement and the wearing course.

Paving Fabric rolled over using Mechanical rig

Product:

The project engineer has chosen to use Polyfelt PGMG 50/50 over other available options in the market such as glass grids as this product has the ability to provide sealing as well as reinforcement functions.

Polyfelt PGM-G is a paving composite which comprises of fiberglass reinforcement yarns bonded to a non-woven fabric. PGMG 50/50 will provide strength of 50kN/m in both longitudinal as well as transverse directions within 3% strain relieving the asphalt overlay from straining due to excessive stresses generated during any settlement process. The non-woven fabric will act as a sealing function which will deny ingress of water into the base and sub-base.

Asphaltic overlay installed on the Paving fabric

The sealing function is very important as it essentially stops the infiltration of water from the pavement surface in to the pavement structure and this will result in maintaining the integrity of the pavement structure. While the reinforcement functions of the glass filaments will be able to absorb the overlay stresses due to cyclic loading from the traffic.
The fabric is saturated and bonded to the old pavement surface by spraying a tack coat over which the fabric is installed.

During Installation and compaction of the new asphalt overlay the paving fabric absorbs the bitumen tack coat and forms a stress relieving interlayer (SAMI) between old and new layers.

Installation:
The resurfacing works are carried out first by cleaning the surface area from dirt and vegetation, cracks (>4mm) are filled with suitable tack coat.
It is then followed by spraying Tack coat (PMB) at the rate of 1.1kg/m^2 on the existing pavement. This rate is required for optimum absorption of the bitumen into the geotextile and achieves sufficient bonding of the paving fabric and old pavement.
A mechanical rig was used for installation of the paving fabric PGM-G to allow the tensioning to be applied to the geotextile and brushed into place over the bitumen to avoid wrinkles developed in the paving fabric position.
Once the whole pavement was treated, an asphalt overlay was installed on the paving fabric.

Completed roadway open for traffic

TENCATE
materials that make a difference

BASAL REINFORCEMENT FOR GROUND IMPROVEMENT OF EMBANKMENT ON SOFT SOILS, COASTAL ROAD, NAVI MUMBAI, MAHARASHTRA, INDIA

Mirafi PET : High Strength Polyester Woven Geotextile as basal reinforcement

Client : City & Industrial Development Corporation of Maharashtra Ltd. (CIDCO)
Contractor: M/s. J.M.Mhatre Infrastructure Pvt.Ltd.
Consultant: IIT, Mumbai
Product : TenCate Mirafi PET 800/50
Project Completion: Dec'2011

Project Overview:

Dronagiri Node is planned and developed to support the various economic activities related to Jawaharlal Nehru Port including a Special economic zone. In order to provide speedy and smooth movements of vehicles for direct connectivity with JNPT, Navi Mumbai Special Economic Zone and Nodal areas, it was proposed to provide 6 lane wide coastal road from NH4B near Navghar to sector-63 at Dronagiri, Navi Mumbai.

The coastal road comprises of 8.3KM, 6- laned highway. The land acquisition for 5.4KM is done initially and construction work has started to build the road having an embankment of around 4.5m height and 52m right of way.

The road alignment passes through very soft soils which exhibit poor bearing capacity and very high compressible. Some problems associated with the construction of 4.5m high embankment over the very soft foundation include large settlements during post construction stage of the embankment and instability of the embankment slope.

Solution:

The proposed road alignment passes through very soft to soft clays subsoil layers with maximum depth up to 9m. The estimated total settlement of 1.7m is anticipated with 90% consolidation to occur in about 20 years.

To accelerate the consolidation process to within 9 months period, prefabricated vertical drain (PVD) ground improvement method with surcharging method was adopted. The PVD was driven up to depth of the soft soil with spacing of 1m in triangular pattern to discharge the pore water from the sub-soil layer through the vertical drainage core of PVD. 300mm thick drainage blanket was applied on the PVD to discharge the water away from the roadway.

The project authorities have proposed to use Geosynthetics ground improvement techniques which include Prefabricated Vertical Drain (PVD) & High-strength woven geotextile.

Photo 1. Existing Site Condition of Very Soft Soils

Photo 2. Installation of PVD with drainage blanket on top.

Photo 3. Placement of Basal Reinforcement over Drainage Layer in progress.

"The use of basal Reinforcement has become critical to support the pre-loaded embankment against rotational failure during the consolidation process. The design required to use high strength polyester woven geotextile having a tensile strength of 400kN/m at 5% strain to meet the serviceability requirements as per recommended in BS8006:1995 design code.

Installation:

The project required using locally available granular soil to be overlain over the existing sub-grade to gain access for the equipment and workers.

Once the access is made, workers & machines can be mobilized to the site to drive in PVD to the design depth and followed by the installation of basal reinforcement layer (Mirafi PET80050). The geotextile need to be overlap at every 5m width along the length of the road alignment and each panel of PET800-50 are stitched together using portable stitching machine with special seam and suitable thread. Embankment back filling process was carried out in stages over the basal reinforcement till the desired embankment height is reached.

Performance : The settlement of the embankment was achieved within the estimated time frame. The use of basal reinforcement increased the stability of the embankment against rotational and sliding failure during the construction stage while waiting for the soft soil to gain strength through the consolidation process. The road embankment was completed on time without any sign of failure and the settlement of the embankment was within the predicted magnitude.

Photo 4. Laying of Basal Reinforcement over Drainage Layer with 1st Preloading to accelerate consolidation process.

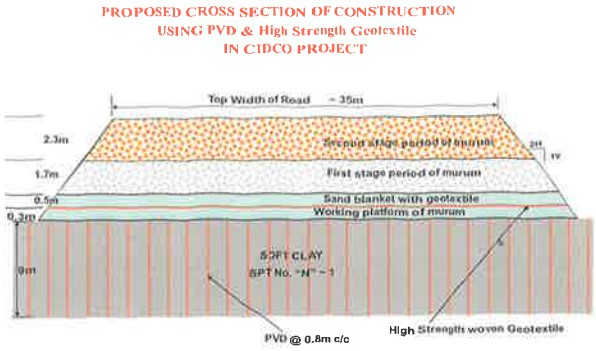


Diagram.1 Cross Section details of embankment.

Reinforcement of loose sand to load bearing application

PROJECT BRIEF:

1 Armoured Engineering Regiment, Suratgarh, Rajasthan, had a critical problem of running its heavy armoured tanks on loose,fine, sand, resulting in delays in its drills. The area is low lying with boggy soil with constant seepage from the surrounding canals. The weight of the various categories of tanksto ply over the terrain ranged from 14 tonnes to 50 tonnes.

> **Main Client:** 1 Armoured Engineering Regiment, Suratgarh, Rajasthan

> **Material Used:** StrataWeb geocells, Style SW35; 150mm

> **Application:** Load bearing application; facility for heavy tank movement over loose sand with high ground water.

> **Project Period:** March 2012.

OBJECTIVE AND DESIGN SOLUTION:

The soil is loose fine sand resulting in problems to movement of heavy weight tanks. Considering the time factor, economic and technical issues, StrataWeb, Style SW35 and of 150mm depth were recommended, with the local sand infill. Importing good quality material in place of local sand would have increased the cost heavily and was also not a feasible solution. Besides, in case of emergency vehicle movement, only the local soil can be used. Each StrataWeb panel was interconnected with high strength cable ties.

CONSTRUCTION OVERVIEW:

StrataWeb panels used were of size 5m X 4m. The 2.6m direction was placed along the width of traffic movement while the 5.6m was placed along the length. The cells were filled with local sand using a JCB and manually by the army jawans, (i.e. The army jawans only). The tanks were immediately run over the StrataWeb stretch as well the unconfined portion beyond.

Movement over the portion over which the StrataWeb was laid was smooth with minimal sand dispersion & increased speeds, utilising locally available material. However severe rutting and dust was observed when the tanks continued over portions where the StrataWeb was not laid.

CONCLUSION:

StrataWeb provide a quick and successful solution for heavy vehicular movement in loose soils even when the water table is almost up to ground level.

STRATA
Geosystems (India) Pvt Ltd

Head Office: 317, Tantia Jogani Industrial Premises, J. R. Boricha Marg,
Lower Parel (East), Mumbai – 400 011, India.

Sales Offices: Delhi, Hyderabad, Bengaluru | Tel : +91 22 4063 5100 | Fax: +91 22 4063 5199 | Email: info@strataindia.com

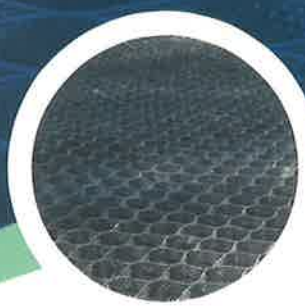
CASE STUDY

PROJECT BRIEF:

Monsoons in North Karnataka are notorious for damage to roads. An example of this can be seen on the two way paved road in the town centre of Hangal in Karnataka.

This stretch was plagued with problems like reflectve cracks, potholes,undulatng surfaces etc., resultng in slow-downs in traffic movement.

- **Project Title:** Rehabilitaton of Road
- **Owner:** PWD Karnataka
- **Locaton:** North Karnataka
- **System Offered:** StrataWeb Geocells of size 150mm depth x L x B
- **Completon Year:** 2010



CHALLENGE:

This stretch had to be rehabilitated tme and again over the past few years,apparently without any long term soluton. Since the area is a major commercial hub, it was not possible to completely close off any secton for a long tme.

STRATA SOLUTION:

Conventonal methods of road-making were previously tried and monitored. With limited optons lef, Strata Geosystems' suggeston of using StrataWeb geocells to strengthen the base course of the road was given due consideratonand selected for the rehabilitaton.

The StrataWeb geocell is essentally a HDPE cellular confinement system andis a proven soluton for load support, earth retenton, slope protecton, and channel applicatons. The expandable, honeycomb-like cellular structure is light andcan be collapsed for easy transportaton even to remote areas. StrataWeb sectons are inert against naturally found chemicals. The cells of the StrataWeb System provide a permanent flexible form adjustng to the shape and grade of the soil. When filled with cohesionless material, StrataWeb form rigid mats capable of distributng imposed loads.

THE PROCEDURE:

The surface was dressed and compacted. StrataWeb geocells were spread over the dressed surface by manual labour. Adjoining sectons of StrataWeb geocells were connected using pneumatc staplers or tes. The geocells were spread open and anchored into positon using metal anchors or wooden stakes. The geocells were then in-filled with granular material using a loader, topping over by 50mm. The only compacton to the filled material and topping was by the loader movement.Before topping off with surface layers, the system was observed for its performance which proved successful. The geocells were later topped off with surface courses as per designs.

BENEFITS TO CLIENT:

Conventonal method of road constructon would restrict traffic movement before the final paving of the road whereas StrataWeb allows immediate plying of vehicles on the road on laying. Savings in natural resources and tme resulted in substantal savings for the Client.

ABOUT US:

Strata Geosystems (India) Pvt. Ltd., established in 2004, is a JV with Strata Systems Inc., USA (part of the Glen Raven Group of Companies) with an ISO certfied manufacturing plant at Daman. Strata provides end-to-end technical solutons, from design to executon for geotechnical applicatons such as reinforced soil walls, slope protecton and stabilizaton, erosion control, foundaton improvement for structures and embankments, steep slope embankments, strengthening of paved and unpaved roads, storage yards and industrial flooring. We are renowned for our quality, durability and cost effectveness and manufacture conforming to strict internatonal quality standards. Our commited team of experienced design engineers and project implementaton specialists ensure tmely and accurate installaton.

STRATA
Geosystems (India) Pvt Ltd

Head Office: 317, Tanta Jogani Industrial Premises, J. R. Boricha Marg, Lower Parel (East), Mumbai – 400 011, India.

Sales Offices: Delhi, Hyderabad, Bengaluru | Tel.: +91 22 4063 5100 | Fax: +91 22 4063 5199 | Email: info@strataindia.com

Improvement in subgrade strength of roads in Mumbai

PROJECT BRIEF:

Since the total area of roads were falling on the filled up soil (filled with debris on the existing creeks), the contractor envisaged that there may be substantial settlement once the road is constructed. Hence, StrataWeb geocells were laid on the subgrade, i.e. just above the filled up soil layer, in order to increase the subgrade strength of the proposed road. This section of road chosen was on completely filled up soil and the traffic movement was very heavy as these are all construction vehicles being used for the construction of the ITSEZ.

- **Project Title:** StrataWeb used to improve subgrade strength of roads
- **Owner:** M/s Hubtown Ltd (erstwhile M/s Ackruti City Ltd.)
- **Contractor / BOT Operator Name:** M/s Sunstream City Ltd., Mumbai
- **Project Size:** 1,000 sqm (10m width X 100m length)
- **Project Type:** Improving Unpaved Roads using StrataWeb
- **Location:** Mulund ITSEZ, Mumbai, India
- **System Offered:** StrataWeb
- **Completion Year:** 2011

CHALLENGES:

The filled up soil freshly laid on the creek areas were a concern for settlement of the subgrade as this subgrade was to be used for laying the subsequent layers (like GSB, WMM, etc) on top for making the permanent paved roads. The high water table, just 1m below the subgrade, was also a concern and moreover the water table was rising as the creek was being filled up with debris & wastes. Matters were envisaged to be much worse during the next monsoon.

STRATA SOLUTION:

StrataWeb geocell – a cellular confinement system was chosen for the job. Geocells are a proven solution for road subgrade improvement on weak subgrade locations. The product is light and easily transported to remote areas. This expandable, honeycomb-like cellular structure can be collapsed and easily transported. StrataWeb remains flexible during installation and also is inert against naturally found chemicals. Another cost saving factor was that the amount of infill needed at the site could be estimated due to the system's uniform depth, and that no training or special tools were required for installation. The cells of the Geocell System provide a permanent flexible form while acting as a series of expansion joints adjusting to the shape and grade of the soil. The sections were transported in folded forms by trucks and placed in designated areas. The installation was complete in 3 days time.

BENEFITS TO CLIENT:

Savings in natural resources, time & money: In normal construction method, to stabilize the soil and to sustain heavy vehicular traffic, at least 800mm to 1m murrum infill would have been required, but by using geocells the client managed to save precious natural resources & also lower the carbon footprint. Geocells being a fast and all-weather installation solution, very little time was taken for installation & infilling. Both the savings in natural resources and time resulted in substantial savings for the client.

STRATA
Geosystems (India) Pvt Ltd

Head Office: 317, Tantia Jogani Industrial Premises, J. R. Boricha Marg,
Lower Parel (East), Mumbai – 400 011, India.

Sales Offices: Delhi, Hyderabad, Bengaluru | Tel.: +91 22 4063 5100 | Fax: +91 22 4063 5199 | Email: info@strataindia.com

MACCAFERRI

CASE HISTORY
CONSTRUCTION OF UNPAVED ROAD
Haldia,West Bengal,India

Product: MacGrid WG4S & Terram 2000


Photo 1 In situ Soil

Problem:

CESC are constructing a 2 X 300 MW Haldia Thermal Power Plant. To cater for the construction traffic which mainly consist of heavy trucks they had to construct a temporary unpaved road with a design life of 2 years. This unpaved road will be converted to a permanent paved road once the construction of the plant is completed.

The foundation soil mainly consists of soft silty clay soil up to a depth of 9 m and hence it was decided to provide a suitable reinforcement for strengthening of the unpaved road. The total proposed length of road was 1.7 km.

Solution:

The solution by CESC was to construct an embankment (with the existing local soil) 1.5 m high having a top width of 11m. The middle 7 m width (road width) of the embankment was constructed up to 1.0 m height to allow for 250 mm each of silver sand and brick bats (Jhama Khoa)

One layer of Terram 2000 was laid over this followed by a 250 mm thick properly compacted silver sand. Over this another layer of Terram 2000 was placed followed by one layer of MacGrid WG4S. A 250 mm thick layer of properly compacted brick bats (Jhama—Khoa) was placed over this to arrive at the road surface.


Photo 2. Site before Construction

Client Name:

HALDIA ENERGY LTD. / CESC

Contractor name:

HEL

Consultant name:

La Mayer

Products used:

Terram 2000 - 31050 MacGrid WG4S - 14625

Construction info:

Construction Start:	April - 2010
Construction End:	June - 2010

Photo 3 Embankment ready for laying Terram 2000

Photo 4 Unrolling Geotextile

Photo 5 Sand Filling on Geotextile

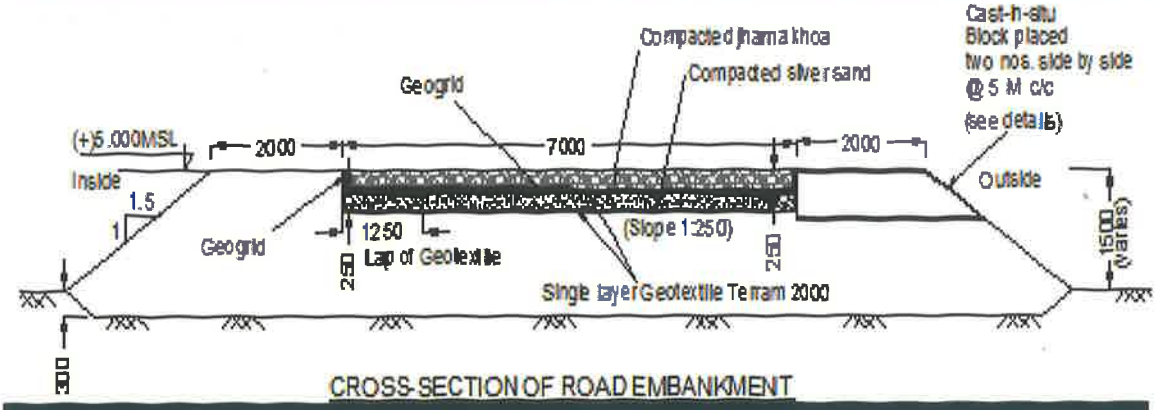


Diagram 1 Cross Section Details

Photo 6 Laying Jhama Khoa

Photo 7 Completed Road after One year

Present Status: Project is completed successfully

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot no. 4, Jasola District Center, New Delhi – 110 044
Tel: +91- 11- 4379 8404, 4379 8400, Fax: +91- 11- 4654 6330
E-mail: technical@maccaferri-india.com - Web site: www.maccaferri-india.com

PAVEMENT STRENGTHENING AT NADIA - KAPADWANJ

Modasa Road Gujarat, India

Road Pavement/Pavement Strengthening

Product: Macgrid AR

Problem:

Nadia-Kapadwanj- Modasa road stretch was subjected to severe problem of series of interconnected cracks. Due to the increased traffic, the existing pavement section was not able to survive for its initial design life. It was observed from the site that the existing pavement had cracks developed on the surface which had deteriorated further into large potholes.

Considering the pavement situations and heavy traffic loading it was required to re-strengthen the pavement by providing an overlay of suitable thickness.

Photo 1 Before Construction—cracking on the surface

Solution:

Current pavement was needed to be repaired by placing an asphalt layer to increase the load carrying capacity of the pavement section. However the ability of asphalt to withstand tensile stress is limited. So there were chances of fatigue and reflective cracking in the surface course. To avoid this type of cracking, Geosynthetic reinforcements are introduced between new overlay and the existing pavement.

For reinforcing the pavement, Geogrid made of fiber glass yarns called as MacGrid AR V5 was suggested to be provided at the interface of the BUSG and BM layer. For ensuring proper adhesion of the MacGrid to the surface, tack coat is applied over the BUSG layer before laying the MacGrid.

Photo 2 Laying of MacGrid over BUSG layer

MacGrid AR V is a reinforcing material specially developed for pavements. It consists of glass fibre strands arranged in a grid structure and covered with a polymer coating.

Photo 3 During construction

Client Name:

Road & Bridge Department, Gujarat

Main contractor name:

Sai Inspiration Pvt. Ltd.

Products used:

MacGrid AR V 5 - 71000 Sq.m

Construction info:

Construction Start:	May-2010
Construction End:	June-2010

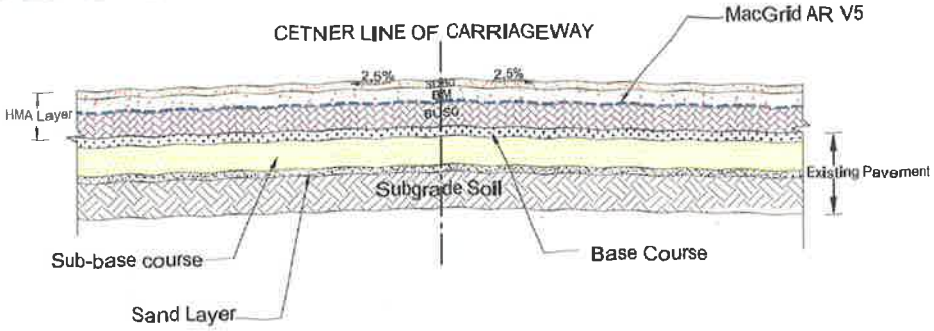


Diagram 1 Cross sectional details of reinforced soil wall

Advantages of MacGrid AR V

High Tensile Strength - Fiber glass exhibits a tremendous strength to weight ratio. MacGrid AR V clearly provides the stiffness required to redirect crack energy.

Low Elongation - MacGrid AR V is very stiff and resists deformation. It exhibits less than 5% elongation at break.

No Long Term Creep - Many reinforcement materials that appear to be initially stable, exhibit creep deformation due to constant loading over long periods of time. Fiber glass exhibits no creep. This assures long term performance.

Thermal Stability - The melting point of fiber glass is 1000°C. This ensures stability when subjected to the excessive heat of a paving operation.

Asphalt Compatibity - The specially formulated polymer coating was designed to deliver high asphalt compatibility. Each fiber is completely coated to ensure no slippage within the composite asphalt.

Durability - The specially coated MacGrid AR V is resistant to biological attack, UV light, and weather. It is designed to provide protection against a wide range of chemical attack.

Easy Installation - MacGrid AR V with its unique adhesive allows quick and easy installation. The product can be rolled out mechanically with special placement tractor or manually.

Photo 4 Laying of 20mm thick SDBC layer

Photo 5 Completion of Construction

Present Status of the Project

The road is completed in the month of June'10. The traffic on the constructed pavement is running smoothly.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot no. 4, Jasola District Center, New Delhi – 110 044
Tel: +91- 11- 4379 8404, 4379 8400, Fax: +91- 11- 4654 6330
E-mail: technical@maccaferri-india.com - Web site: www.maccaferri-india.com

MACCAFERRI

CASE HISTORY

GROUND IMPROVEMENT FOR ROAD OVER BRIDGE

Dibrugarh, Assam, India

GROUND IMPROVEMENT

Technique: Basal Reinforcement with ParaGrid®

Problem:

A Road Over Bridge (ROB) was to be constructed in Dibrugarh district, Assam by NORTHEAST FRONTIER RAILWAY. The region is known to receive very heavy rainfall during monsoon each year. The approach ramps for ROB would be constructed using the Reinforced Soil wall concept. The foundation soil was found to have inadequate bearing capacity to bear the load of the RS walls. Soil investigation reports revealed that the sub-soil at the site was cohesive (CI) for the top 3m, followed by loose to medium dense fine silty sand occurring at lower depths.

Considering the above mentioned properties of soil present at the site, ground improvement was proposed in the approaches of ROB to improve the bearing capacity of soil. Global stability was also a matter of concern.

Solution:

In order to avoid deep excavation and replacing the soil, Ground Improvement with Basal Reinforcement was proposed. Basal reinforcement provided for construction of embankments on soft soils, is a very efficient technique to improve the bearing capacity and global stability of the foundation as all the stresses on the foundation is taken care of by the reinforcement that is provided. Basal reinforcement prevents the collapse and limits the vertical movement of the embankment surface following the formation of a void in the foundation.

Ground improvement was done for heights ranging from 6m to 5m and 5m to 1m for Seismic and Static conditions present at the site. During excavation, water encountered was dewatered. ParaGrid® reinforcement having tensile strength of 50kN/m was used for ground improvement. MXL 30 was laid below the ParaGrid. Then, the Reinforced Soil wall was constructed at the approaches with pre-cast concrete panels as facia and ParaWeb as soil reinforcement which were attached back to back from one wall to the other as shown in Fig.1. Sand from Brahmaputra River was used as backfill. The entire design report was vetted by IIT Guwahati.

Client Name:

NORTHEAST FRONTIER RAILWAY

Main contractor name:

M/s Raitani Engineering Works Pvt. Ltd.

Products used:

PARAWEB AND PARAGRID

Photo 1 Before Laying of Geotextile

Photo 2. Geotextile placed in position on leveled and compacted ground (Ground Improvement)

Photo 3 Spreading of dumped backfill material on geotextile.

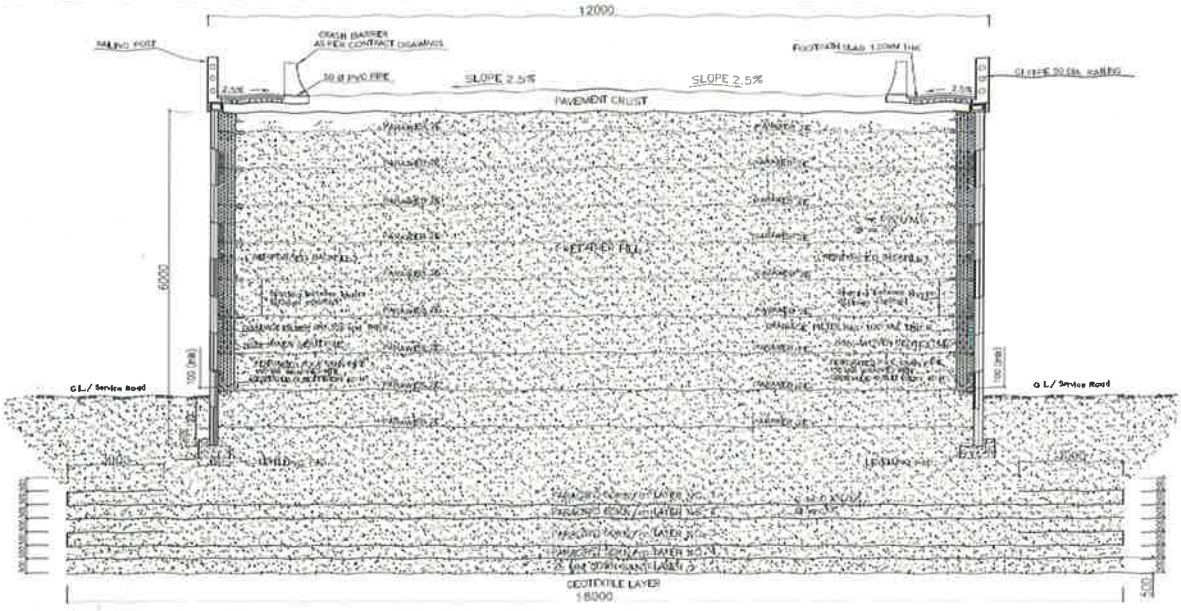


Figure 1 Cross-Section of Reinforced Soil wall for 6 m height near abutment

Photo 4 ParaGrid installed as Basal reinforcement

Photo 5 R S wall facia panels erected

Present Status of the Project
The project has been completed successfully.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot no. 4, Jasola District Center, New Delhi – 110 044
Tel: +91- 11- 4379 8404, 4379 8400, Fax: +91- 11- 4654 6330
E-mail: technical@maccaferri-india.com - Web site: www.maccaferri-india.com

Case Study on Use of Tape Woven Slit Film Geotextiles used as Reinforcement and Separator between Granular Subbase and Subgrade

Client: M/s Reliance Industries Ltd. (RIL)

Consultant: M/s L&T Ramboll

Site Location: Village Gadimoga located about 25 km from Kakinada in Andhra Pradesh.

Completion Date: April 2007

Products Used: TFI 5200 Tape Woven Slit Film Geotextile

Reliance Industries Ltd (RIL) is developing Onshore Terminal for KG D6 field development near the village Gadimoga located about 25 km from Kakinada in the state of Andhra Pradesh.

As a part of the development for KG D6, RIL has constructed internal haul roads on the existing ground conditions having soil with very low CBR value.

RIL and Consultant L&T Ramboll had proposed to use Tape woven geotextile and approved Techfab India Polypropylene Tape Woven Slit Film Geotextile TFI 5200 for the application of reinforcement and separator between granular sub-base and sub-grade. The total quantity of the Tape woven geotextile TFI 5200 was used for the project was 212,660 sq. mtrs.

TFI 5200 Polypropylene Tape Woven Slit Film Geotextile is the warp and fibrillated tape yarns in the weft direction. These engineered geotextiles are stabilized to resist degradation due to ultraviolet exposure and are resistant to commonly encountered soil chemicals, mildew and insects, and are non-biodegradable.

TFI 5200 Tape Woven Slit Film Geotextile is designed to comply with the requirements of AASHTO M 288 Class 2 and IRC: SP: 59-2002 Type 2.

A Schematic sketch of the roads using the Tape woven geotextile TFI 5200 is given below:

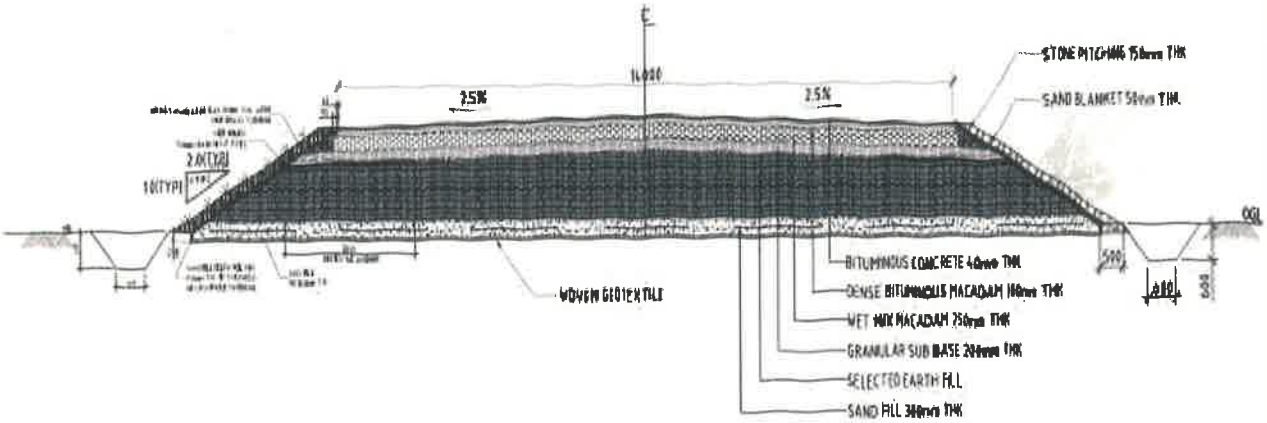
Contact:

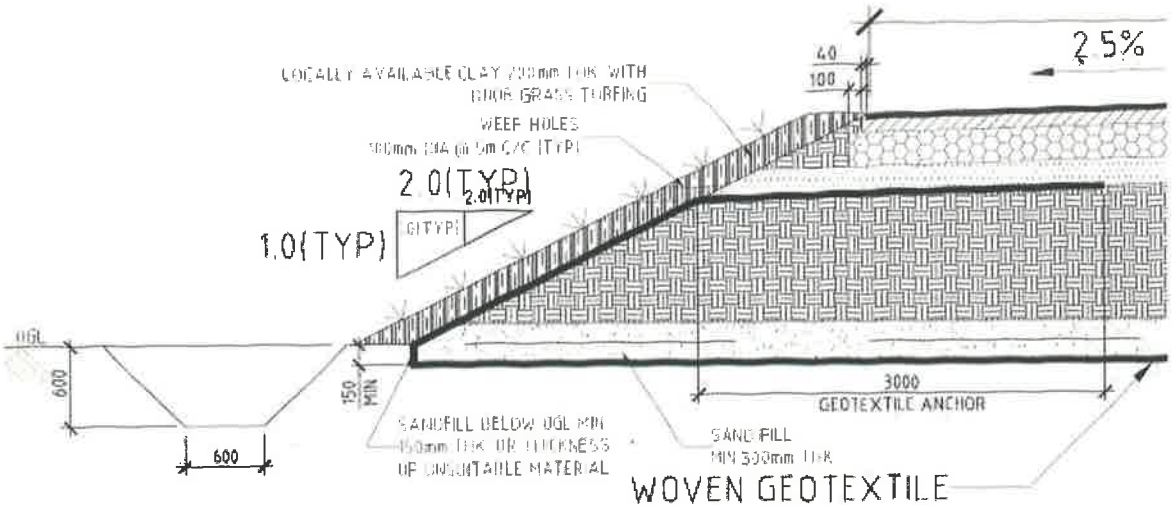
TechFab India, 712 Embassy Centre, Nariman Point,
Mumbai 400021, India

Fax : +91-22-2287 6218

Email : tfi@vsnl.net / anant@techfabindia.com

Web : www.techfabindia.com





Contact:

TechFab India, 712 Embassy Centre, Nariman Point,
Mumbai 400021, India

Fax : +91-22-2287 6218

Email : tfi@vsnl.net / anant@techfabindia.com

Web : www.techfabindia.com

CASE HISTORY

TECHFAB INDIA

TECHGRID BIAXIAL GEOGRID TGB40

FOR

SUBGRADE STABILISATION

Project Description

Project : Improvement to Gharni-Nitur-Nilanga Road SH-167, Taluka-Nilanga, District-Latur, Maharashtra.
Stretch 1:- Km 30/000 to 31/000
Stretch 2:- Km 31/000 to 32/000
Stretch 3:- Km 32/000 to 33/000
Stretch 4:- Km 33/500 to 35/000

Owner : PWD Region Aurangabad/ PWD Circle Osmanabad/ PWD Division Nilanga, District-Latur.

Contractor : *Stretch 1:-* Chairman Wagheshwar Majur Sahkari Sanstha Maryadit, Shiradhon
Stretch 2:- Chairman Azad Magaswargiya Majur Sahkari Sanstha Maryadit, Latur
Stretch 3:- Chairman Azad Magaswargiya Majur Sahkari Sanstha Maryadit, Latur
Stretch 4:- Chairman, Majur Sahkari Sanstha Maryadit, Nadi Hatarga, Latur

Product : TechGrid Biaxial Geogrid TGB40

(Knitted & Polymer Coated Polyester Geogrid with CE Mark)

Manufacturer: TechFab (India) Industries Ltd.

Existing Distressed Pavement,Nilanga, Latur

Existing Distressed Pavement,Nilanga, Latur

CASE HISTORY

TECHFAB INDIA

Salient Features of the Project

TechGrid Quantity: 6676.00 Sqm

Length of Stretch: 1300.0 m

Width of Stretch: 5.5 m (Carriageway)

Site Condition: Stretch passes through rich black cotton soil area

Heavy vehicular traffic & water logging

The Challenge

Gharni-Nitur-Nilanga Road on State Highway SH-167 of Taluka-Nilanga, District-Latur passes through rich black cotton soil having a very low CBR value of 2.9. The road was subjected to heavy vehicular traffic intensity of 2640 Commercial Vehicles per Day and was also surrounded by the irrigable land on both sides. With the onset of monsoon the road got heavily water logged and due to the existence of the black cotton soil and heavy vehicular traffic certain stretches of road got heavily distressed with significant settlement, unevenness & fatigue cracks.

Black cotton soil contains montmorillonite mineral, because of which the soil becomes very slushy when in contact with water and gets brittle on drying. These alternate cycles of wetting and drying makes the highly unsuitable for any type of construction. Flexible pavement designed over this type of soil requires very high crust thickness, which makes it uneconomical.

Public Works Department P.W.D, Nilanga thereby awarded the Improvement of four stretches i.e. a) Km 30/0000 to Km 31/000 b) Km 31/000 to 32/000 c) Km 32/000 to Km 33/000 d) Km 33/500 to Km 35/000 of Gharni-Nitur-Nilanga Road on SH-167, Taluka-Nilanga, District-Latur to M/s a) Wagheshwar Majur Sahkari Sanstha Maryadit, Shiradhon b) Azad Magaswargiya Majur Sahkari Sanstha Maryadit, Latur c) Azad Magaswargiya Majur Sahkari Sanstha Maryadit, Latur d) Majur Sahkari Sanstha Maryadit, Nadi Hatarga, Latur respectively.

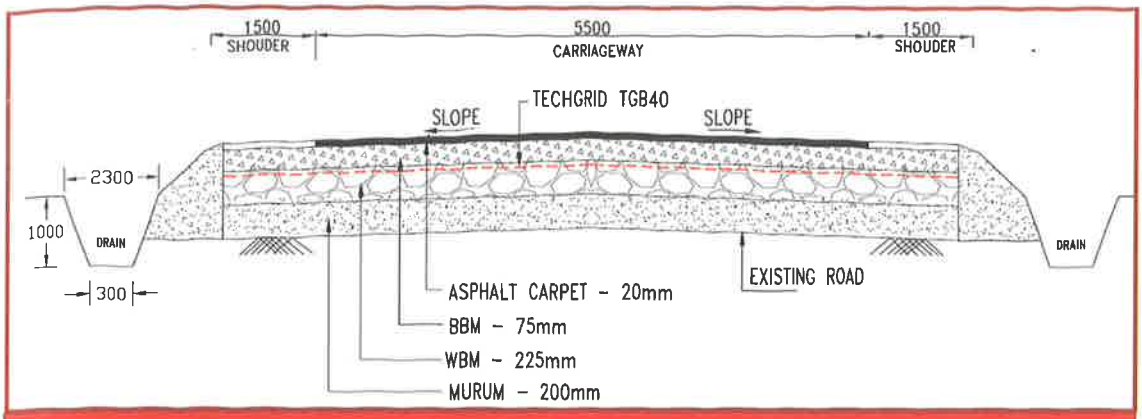
Conventional solutions for road repair, would have led to economic losses (inform of frequent repairs) and discomfort to the travelers using the same.

The Solution

TechFab (India) Industries Ltd suggested the use of TechGrid Biaxial Geogrid TGB40 for the sub grade stabilization / basal reinforcement of the existing road stretches comprising of black cotton soil, heavy vehicular load & heavy water logging.

CASE HISTORY

TechGrid Geogrid TGB Series are manufactured from superior grades of polyester filament yarn with high tenacity, high tensile modulus, low creep and low shrinkage. Yarns with high molecular weight (> 25,000) and low carboxyl end groups (< 30) are used to ensure durability of the Geogrids used in permanent structures.



Cross Section of Pavement with TechGrid TGB40

The grid structure is formed from the yarns using an advanced weft insertion; warp knitting technology employing state-of-the-art warping and knitting machines. This advanced technology ensures a product with uniform structure and consistent properties.

The knitted grid is then given high quality polymeric coating using a specially formulated PVC compound. The coating completely saturates and envelopes the polyester yarn bundles forming a protective cover enhancing - dimensional stability of the Geogrid, resistance to installation damage and protection from the environment.

The design and the use of TechFab India Industries Ltd TechGrid Biaxial Geogrid TGB40 for Reinforcement / Sub grade stabilization were approved in principle by the Superintending Engineer (S.E), P.W.D Circle Osmanabad & Executive Engineer (E.E) of P.W.D, Nilanga.

Laying of TechGrid TGB40

75 mm thk BBM over TechGrid TGB40

Execution

The existing road at the said stretches was first dressed to get the required cross slope, over which 200mm of murrum layer was laid. Water Bound Macadam (WBM) consisting of 40/60 metal was laid in two layers for a total of 225mm thickness. TechGrid Biaxial Geogrid TGB-40 was then laid over the prepared surface in a tight condition, so that it can develop the required tension. Burnt Bitumen Macadam (BBM) of 75mm thick and asphalt carpet 20mm thick was laid over the same.

BBM Completed

Road Condition after 1 Monsoon Period

Applications:

- Reinforcement of granular road base and sub base
- Area Stabilization
- Rail Track bed Stabilization
- Load Transfer Platforms

Benefits:

- Improved lateral confinement of aggregates
- Distributes load over a larger area
- Increase in bearing capacity & shear strength of sub grade
- Reduction in sub base thickness
- Increase in life of pavement

The project was successfully completed in March 2011.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

WOVEN GEOTEXTILE TFI 5300 FOR SUBGRADE STABILISATION

Project Description

Project : Improvement to Jejuri-Morgon Road MDR-65 Km 6/100 to 6/500 & 8/065 to 8/475, Taluka-Purandhar, District-Pune, Maharashtra.

Owner : Public Works Department Pune/ Integrated Public Works Division, Pune.

Contractor : M/s H.J.Tekawade, Taluka-Purandhar, District-Pune.

Product : Woven Geotextile TFI-5300

(Meets requirement of Type -I of IRC SP 59-2002 & Class 1 of AASHTO M288)

Manufacturer: TechFab (India) Industries Ltd.

Distressed Pavement with Cracks

Black Cotton Soil & Sugarcane Field in Vicinity

Distressed Pavement with Cracks

Black Cotton Soil Slightly Removed at Site

CASE HISTORY

TECHFAB INDIA

Salient Features of the Project

Geotextile Quantity: 12150.00 Sqm

Length of Stretch: 810.0 m

Width of Stretch: 15.0 m

Site Cond ition: Black Cotton Soil, Heavy water logging, Heavy Traffic Intensity

The Challenge

Public Works Department P.W.D, Pune had awarded the Improvement of Jejuri-Morgon Road MDR-65 in Km 6/100 to 6/500 & 8/065 to 8/475 in Purandhar Taluka of Pune District to M/s H.J.Tekawade, Taluka Purandhar; District Pune. The given stretch of road was passing through rich black cotton soil area having a very low CBR value of 0.67. Also the pavement was surrounded by sugarcane fields on both sides, which was causing heavy water logging in the area. The same stretch was also an approach to Someshwar Sahakari Sugar Factory Ltd and Indian Seamless (ISMT), which led to a heavy traffic intensity of a maximum vehicular load of 80 MT.

As clear from the photographs, the existing pavement was seriously damaged due to existence of black cotton soil, water logging, heavy vehicular load & presence of sugarcane fields. Fatigue cracks (both crocodile & block types in longitudinal & traverse directions), raveling, rutting, stripping, pot-holes, settlement, shoulder drop-off are amongst the few failure types that were observed.

The Solution

TechFab (India) Industries Ltd suggested the use of Woven Geotextile TFI-5300 for the Subgrade stabilization at the given site comprising of black cotton soil, water logging & heavy vehicular traffic loading.

The design and the use of TechFab India Industries Ltd Woven Geotextile for Subgrade stabilization was approved by the Executive Engineer and the Superintending Engineer of P.W.D, Pune.

Laying of TFI-5300 at Subgrade

Site Visit by Mr. Khaire, Executive Engineer

Woven Geotextile TFI 5300 is Polypropylene Woven Geotextile with slit-film (tape) yarns in the warp and fibrillated tape yarns in the weft direction. These engineered geotextiles are stabilized to resist degradation due to U V exposure and are resistant to commonly encountered soil chemicals, mildew and insects, and are non-biodegradable. Polypropylene is stable within a pH range of 2 to 13, making it one of the most stable polymers available for geotextiles today.

TFI 5300 meets the requirements for AASHTO M288 Class 1 / IRC SP 59-2002 Type -I

Execution

Black cotton soil was slightly removed from the site; surface was prepared with appropriate camber and longitudinal slope achieved. Thereafter, TFI-5300 was laid over the prepared surface with no wrinkles to generate the required tension in the woven geotextile. The designed thickness of various courses for a pavement i.e. sub-base, base course, wearing course etc were then laid and properly compacted. The design of the pavement courses were done based on IRC: SP: 37. Due to high traffic intensity, execution was carried out in three 5m wide stages in two stretches of 410m and 400 m.

Sprinkling of Water & Compaction of Pavement

Unrolling TFI-5300 in 5m Widths

Heavy Vehicular Trafrfic at the Site

Prepared Surface

Woven Geotextile TFI 5300 deployed at the interface between granular sub-base/ base course and the sub-grade can improve the pavement performance by a combination of the following:

- Separation
- Reinforcement
- Filtration
- Drainage

Benefits

- Prevents contamination of granular sub base/ base and prevents loss of aggregate to the sub-grade during placing and compaction.
- Sub-grade stabilization.
- Increases the structural strength of the pavement by means of the tensile strength and shear interaction of the geotextile.
- Minimizes rutting and disturbance of the sub-grade during compaction.

The project was successfully completed in May 2011.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

CASE STUDY

TECHFAB INDIA

Owner: National Highways Authority of India

Contractor: Bharat Geosystems, Chennai

Site Location: Calicut Bye pass phase III, NH – 17, Kerala

Completion date: October 2003

Product used: Polypropylene Tape x Tape Woven Geotextile (Techfab TPP 250 equivalent to TFI 5300) in 5 mtr width manufactured by TechFab India

Description of the Project

As a part of the Calicut Byepass Phase III project, funded by the Ministry of Road Transport & Highways and executed by Public Works Department (National Highways), Kerala, it was required to construct a three km. long road embankment with heights of up to 5 m, on very soft ground comprising old paddy fields and marshy land. Techfab Woven Geotextile was used to solve difficult problems associated with construction of embankments on soft sub- grades.

The Problem

The thickness of the soft clays at the site varied from 3 m to 8 m. Hence issues of embankment stability and post-construction settlements need to be carefully considered. Also, the upper most clay layer was extremely soft with very high water content. Therefore, it was not possible to carryout normal construction operations on this stratum. However, removal of this layer was not a viable option because of uncertainty in thickness of layer, cost and time involved in excavation and removal and environmental objections to disposal of the excavated material. Hence innovative techniques were considered to find a satisfactory and cost-effective solution to these problems

Installation of Techfab TPP 250 Woven Geotextile – Calicut Byepass , Kerala

The Solution

Pre-fabricated Vertical Drains were installed to accelerate the consolidation of the soft clays. As the clay consolidated, there was a corresponding increase in the shear strength, thereby ensuring adequate stability of the embankment. It also ensured that most of the settlements occurred prior to construction of the pavement.

As an alternative to excavation and removal of the top layer of extremely soft clay, it was decided to use a woven Geotextile to stabilize the sub-grade. After a careful evaluation of the required Geotextile functions and properties, Techfab TPP 250, a woven polypropylene tape Geotextile manufactured by Techfab India was selected for this purpose. The Geotextile had a combination of mechanical and hydraulic characteristics making it suitable to function as a separator and reinforcement. In addition, it had a width of 5 m to minimize overlaps.

Techfab TPP 250 Woven Geotextile installed at the surface of the sub-grade functioned as a separator between the very soft clay and the better quality fill material allowing placement of fill material without mixing and excessive rutting. It also acted as a reinforcement supporting the loads imposed by the initial lifts of embankment fill and construction traffic without inducing shear failure of the clay foundation. The restraint offered by the Geotextile, enabled the proper compaction of the initial lifts of embankment fill.

The use of Techfab TPP 250 Woven Geotextile resulted in an environment-friendly solution and enabled the successful completion of the project with appreciable savings in cost and time.

712 Embassy Centre, Nariman Point, Mumbai 400021
Tel: 022 22876224 Fax: 022 22876218
Email: office@techfabindia.com

CASE STUDY FOR TECHGLASS - OVER LAY REINFORCEMENT APPLICATION

Strengthening & Black Topping for SH-30 to Sarawali - Naikepada - Patilpada Road, Tal - Dahanu

Client: Pradhan Mantri Gram Sadak Yojana (PMGSY), by Maharashtra Rural Roads Development Association (MRRDA), under Konkan Region, Thane, Maharashtra
Contractor: M/s Kapil S. Thakur, Dahanu, Dist-Thane.
Location: SH–30 to Sarawali – Naikepada – Patilpada Road, Taluka Dahanu.
Geosynthetic Product: TechGlass 50

Manufacturer: Techfab (India) Industries Ltd, Mumbai.

THE PROBLEM

The road located from State Highway SH-30 to Sarawali – Naikepada – Patilpada, Taluka Dahanu, was 5 years old & was constructed under the government scheme "Pradhan Mantri Gram Sadak Yojana". The existing bituminous surface had undergone wear & tear due to temperature variations, traffic loads, age hardening, braking & turning of vehicles etc. over it. The client thereby wanted an innovative method to increase the life of the overlay and reduce the overall maintenance cost of the same.

THE SOLUTION

Techfab (India) Industries Ltd suggested the use of TechGlass 50 for the reinforcement of the existing bituminous surface. TechGlass 50 provided manifold advantages such as prevent propagation of reflective cracking, prevent wear & tear; increase overall life, high tensile strength, low elongation, good compatibility with asphalt etc.

The existing bituminous surface was cleaned & made free from dust, debris & any obstacles. Tack coat of 60/70 type was sprayed over the cleaned surface. TechGlass 50 was unrolled manually over the sprayed tack coat with no wrinkles over the surface. Wearing course of 20mm thick carpet was laid over the TechGlass 50, to achieve the final prepared surface. Last photograph shows the road condition after 12 months (including monsoon), which shows road in good condition. Looking at satisfactory performance, TechGlass is now incorporated in PMGSY, Schedule of Rates for renewal of roads and asphalt overlay reinforcement.

Contact:
TechFab India, 712 Embassy Centre, Nariman Point, Mumbai 400021, India
Fax : +91-22-2287 6218
Email : tfi@vsnl.net / anant@techfabindia.com
Web : www.techfabindia.com


Unrolling of TechGlass 50 at the site


Laying of TechGlass 50


Over lay being laid over the TechGlass


Compaction of Over Lay


Road Condition after 12 Months (Including Monsoon)

TRACKBED STABILIZATION USING TECHGRID BIAXIAL GEOGRID AND NONWOVEN GEOTEXTILE

Client : M/s Northeast Frontier Railway

Site address : Km 323/0 to 323/2, Between Jamguri & Oating stations, Golaghat District, Assam.

Completion Date : August 2006

Products Used : Techgrid TGB-40 Knitted & PVC coated polyester Geogrid and Nonwoven Geotextile

BACKGROUND

Ballast sinking is a commonly occurring problem in railway track structures founded on wet fine-grained soils like clays and silts, especially where an adequate and functioning blanket layer is absent. This necessitates frequent and costly maintenance resulting in sub-optimal utilization of track capacity. Large stretches of the tracks of Northeast Frontier Railways are prone to this problem. When Techfab India Industries Ltd put forward a proposal for trackbed stabilization using gesynthetics as a lasting solution to this problem, NF Railways agreed to go for a trial installation on an experimental basis to evaluate the efficacy of this technology. Techfab India Industries Ltd. was assigned the task of assessing the site conditions, designing an appropriate solution, and executing the work

THE SITE

A 100 m long stretch between km 323/0 to 323/2 between Jamguri and Oating stations, in Golaghat District of Assam, experiencing a severe and recurring ballast sinking problem was selected for the trial. Here the track alignment crosses paddy fields and the track structure is founded on embankment of approximately 3 m height constructed largely of silty clays (Photo 1). Because of very high ballast sinking rate, tamping and packing operations had to be undertaken very frequently.

THE PROBLEM

A combination of reasons could have contributed to the severe and recurring ballast sinking problem at this location – subgrade comprising fine-grained plastic soils (photo 2); excessive moisture content of the subgrade due to heavy rainfall in the area, ponding of water on the formation because of lack of proper grading and cross-fall of formation and capillary rise due to standing water in the paddy fields; and absence of a properly functioning blanket course. Because of the above three factors ballast sinking could have taken place both through lateral displacements due to the poor restraint offered by the soft and saturated subgrade and penetration of the ballast particles into the subgrade (photo 3). Packing of additional ballast provides relief only for a short time since none of the above factors are addressed and hence sinking would continue with time.

THE SOLUTION

The solution proposed comprised the following measures:

1. Building up / dressing the embankment to the correct level at the required locations and dressing the formation with a cross-fall of 1 in 30 to facilitate drainage.
2. Providing a nonwoven geotextile as a separator and filter between the subgrade and the ballast:

   The geotextile acts as a separator preventing the penetration of the ballast particles into the fine-grained subgrade. The geotextile also acts as a filter which prevents the pumping of subgrade fines into the ballast. A needle-punched nonwoven geotextile with a mass per unit area of 250 g/m2 was used for this purpose. To protect the geotextile from puncture and abrasion by the ballast particles it was decided to sandwich the geotextile between two layers of sand, each 50 mm thick.


1 Site before rehabilitation


2 Subgrade comprising fine grained soil


3 Ballast penetration into the subgrade


4 Removal of existing ballast from the trackbed


5 A thin layer compacted sand on the subgrade


6 Laying of non-woven geotextile

World-class Geosynthetics Manufactured in India by Techfab India Industries Ltd.					
TFI Woven Geotextiles			Techgrid Geogrids	TGC Reinforced Nonwoven Composites	Techdrain PVDs
Polypropylene Tape	Polypropylene Multifilament	Polyester Multifilament			

3. Providing a biaxial geogrid reinforcement (5 m width) below the ballast:

   Techgrid TGB-40, a knitted and PVC coated biaxial geogrid with a tensile strength of 40 kN/m in both machine and cross-machine directions, aperture dimensions of 25 x 25 mm and roll width of 5 m, manufactured by Techfab India at its state-of-the-art plant in Silvassa, Union Territory of Dadra & Nagar Haveli was proposed for this purpose. The geogrid is manufactured from superior grades of high tenacity, high molecular weight and low carboxyl end group polyester yarns which are formed into a grid structure using a highly sophisticated warp-knitting process and is then precision coated with a specially formulated PVC plastisol to produce a strong, flexible, tough, dimensionally stable and durable geogrid.

   A layer of Techgrid biaxial geogrids installed below the ballast constraints and confines the ballast particles reducing the lateral and vertical movement of ballast and enhances the strength and stiffness of the ballast. Reinforcement of the ballast results in a marked improvement of the track performance through several mechanisms:

   - Substantial reduction in the lateral spreading of ballast and penetration of the ballast into the subgrade and associated track settlements.
   - Reduction in subgrade attrition and wear and tear of ballast
   - Reduction in vertical stresses on the subgrade because of better load distribution by the reinforced ballast with enhanced strength and stiffness.
   - Lower shear stresses on the subgrade with consequent increase in bearing capacity.

4. Placing cleaned ballast over the geogrid and restore the track to the desired geometry.


7 Spreading sand above geotextile


8 Laying TechGrid TGB-40 Knitted Polyester Biaxial Geogrid


9 Placing ballast over the geogrid


10 Train running over the rehabilitated track


11 Condition of the track two years after rehabilitation (as on June 2008)

EXECUTION

The work was executed by Techfab India under the overall supervision of the Permanent Way Inspector. Because of the remoteness of the location and the small quantum of work, the work was carried out manually. The blocks allocated allowed completion of about 10 to 12 m of track each day. The rehabilitation work involved the following steps:

- Removal of the ballast and preparation of the exposed subgrade by dressing to ensure a cross-fall of 1 in 30 and ramming with wooden tampers (photo 4).
- Spreading of a thin layer of sand (about 50 mm thick) on the prepared subgrade to cover any ballast particle projecting from the subgrade (photo 5).
- Laying of the geotextile over the sand layer without any folds or wrinkles (photo 6).
- Spreading of a thin layer of sand (approximately 50 mm thick) over the geotextile (photo 7).
- Installing the geogrid over the second layer of sand (photo 8).
- Placing and compacting cleaned ballast over the geogrid (photo 9).

PERFORMANCE

Approximately two years has passed since the completion of the rehabilitation. As per the feed back from NF Railways, any significant ballast sinking problem has not been observed in the location treated with geogrids and geotextiles and there is an appreciable improvement in the track performance. Taking note of the success of this trail, NF Railways rehabilitated another stretch using the same materials and technique with satisfactory results. An inspection of the site in the first week of June 2008 showed that the condition of the treated portion of the track is quite satisfactory.

For further details contact:

TechFab India Industries Ltd
712, Embassy Centre, Nariman Point, Mumbai-400 021, India

Tel : +91 22 2287 6224 / 6225
Fax : +91-22-2287 6218
Email : tfi@vsnl.net / anant@techfabindia.com
Web : www.techfabindia.com

CASE STUDY OF IT-CORRIDOR IN CHENNAI

Construction of Embankment using TFI 5200 Tape Woven Geotextile & TGU 40 TechGrid Geogrids at IT CORRIDOR in Chennai.

Client: Tamilnadu Road Development Corporation (TNRDC), Chennai, India

Consultant: M/S Wilber Smith Associates, India

Site Location: Information Technology (IT) Corridor Chennai-Chennai Old Mahabalipuram Road

Completion Date: Jan-2007

Product Used: TFI 5200 Tape Woven Geotextile and Uniaxial Knitted-PVC Coated-Polyester Geogrid TGU-40

As a part of improvement and widening of the IT corridor in Chennai, low embankments (Height varies from 0.75m to a maximum 1.50m) were to be constructed on ground underlain by weak soil deposits in the stretches of the Km 1/490 to 1/670 and 2/100 to 2/800. Consultant for the project Wilbur Smith Associates Pvt. Ltd., asked Techfab India Mumbai to evaluate the ground and loading conditions and suitable stabilization measures.

Problem:

In view of low shear strength and high compressibility of the poor soil strata there was concern regarding shear failure and excessive settlement.

The soil profile at the site was follows (Starting from ground level):

- Filled up ground consisting of the loose uncontrolled fill mixed with garbage with thickness of 1.50m to 1.70 m.
- Black clay+Clayey sand/ Silty sand with thickness of 1.30 to 1.50. The blck clay is stiff clay with N values in the range 13 to 22. Silty fine sand is loose with N values of 3.
- Very soft clay with thickness of approx 5.0 m. N values for this layer is typically Nil. Only in one case N value 4 is obtained. Undrained cohesion values obtained from direct shear/ UCC tests are in the range of 4.0 to 5.0 kPa.

Contact:

TechFab India, 712 Embassy Centre, Nariman Point, Mumbai 400021, India

Fax : +91-22-2287 6218

Email : tfi@vsnl.net / anant@techfabindia.com

Web : www.techfabindia.com

Solution:

Since the upper most layers consist of loose fill and soil mixed with garbage, it was decided to excavate and remove this layer completely and replaced with compacted quarry dust.

The major problems to be solved were:

- Stability of the embankment because of the very low shear strength of the very soft clay layer
- Placement and compaction of fill (to replace the layer of filled-up ground) was very difficult because of the soft clay and high water table conditions.

After analyzing the ground conditions, Techfab India proposed the following economical solution that saved time and money both by not having to import the fill or use heavy equipment for installation. The use of woven geotextile TFI5200 and TechGrid TGU 40 uniaxial geogrid allows the construction companies to work economically, quickly, safely:

- Where the embankment height was very low (≤0.75m) there was no problem with regard to stability. However placement and proper compaction of fill was difficult. Here it was proposed to lay a geotextile (TFI 5200 Tape Woven Geotextile) on top of the excavated surface to act as a separator cum reinforcement. Above this a 200mm thick layer of quarry dust was to be placed, spread and leveled. After this construction equipment could move on the fill and compact it. The geotextile would work as a tensioned membrane supporting the weight of construction equipment and facilitating satisfactory compaction.
- Where the embankment height was more than 0.75m, stability calculations showed that factor of safety against rotational failure was not adequate. Hence it was decided to go for basal reinforcement using Techgrid knitted and PVC coated polyester geogrids as shown in Figures In view of the urgency of clients to complete the work, TechGrid TGU 40, a uniaxial geogrids with a tensile strength of 40 kN/m in the machine direction, which was readily available in stock was selected. Stability calculations showed that for embankment heights of 0.75m to 1.50m, one layer of TechGrid TGU 40 was adequate. For embankment heights of 1.5 to 2.0 m, two layers of TechGrid TGU 40 were provided.

Laying of Techgrid U-40 as a basal reinforcement

Laying down fill over Techgrid U-40 for Embankment

Laying down fill over Techgrid U-40 for Embankment

Contact:

TechFab India, 712 Embassy Centre, Nariman Point, Mumbai 400021, India

Fax : +91-22-2287 6218

Email : tfi@vsnl.net / anant@techfabindia.com

Web : www.techfabindia.com

Case Study of use of High Strength Polyester woven geotextile TFI 3200 in Rajiv Gandhi Setu Bridge in UT of Daman

Project : Construction of Embankment using High Strength Polyester woven geotextile TFI 3200 for approaches of Rajiv Gandhi Setu Bridge connecting Nani Daman & Moti Daman in UT of Daman .

Owner : M/s Government of Gujarat (Road & Buildings Department.)

Contractor : M/s Vijay M Mistry Construction Pvt Ltd

Consultant : M/s Sheladia Associates & Consultants (India) Pvt Ltd

Completion Date : Feb 3,2009

Product used : High Strength Polyester woven geotextile TFI 3200 of strength 200 KN/m in the principal direction.

Quantity : 82000 sqm

Problem : The approaches of the embankment to be constructed on soft soils having CBR value less than 2 . The maximum height of the embankment to be constructed on the soft foundation soil is 11m with a heavy traffic live load .

Solution to the problem :
The project consultant proposed 2 layers of high strength polyester woven geotextile of strength 200 KN/m in the principal direction & a granular fill of 900mm thickness at the base. The geotextile proposed acts as a basal reinforcement for the embankment and also as a separation layer to separate the granular fill of 900mm thick and the proposed fill .Techfab India Industries Ltd herein referred as TFI supplied 82000 sqm of high strength polyester woven geotextile TFI 3200 of strength 200 KN/m in the principal direction, meeting all the technical specifications as proposed by the consultant for the project.


Existing Area Being Prepared


Laying of High Strength Geotextile TFI 3200


Murum Layer Being placed over Geotextile


Embankment work in progress & partially completed


Rajiv Gandhi Setu Bridge completed & open for Traffic

KUSUMGAR CORPORATES PVT. LTD.
101/102, Manjushree, N.S. Road No. 5,
V.M. Road, Vile Parle (West)Mumbai 400 056
Tel:022-26184341/26184350 Fax : 022-2611 5651
info@kusumgar.com, www.kusumgar.com

APPLICATION OF GEOTEXTILES IN RURAL UNPAVED ROAD AT ICHALKARANJI

Product : Non Woven Needle Punched Fabrics

Problem :

A project sponsored by Department of Sc. & Tech., Government of India was untaken by VJTI, Mumbai. In April 1993 , the field trial was conducted at Ichalkaranji, South Maharashtra on an access road to a sugar factory. Trucks are loaded with sugarcanes (15 to 20 tones) ply on this road. Since the area in mainly used for agricultural purpose. During the dry season, the condition of the road is good, but during rainy season, the condition of road deteriorates to form ruts of 10 cm and is not accessible. In this area 95% of annual rain fall occurs during monsoon and is of high intensity and long duration. Sometimes excessive rainfall for a longer duration causes flooding of this road. Moreover, due to lack of proper drainage provisions by the side of the road compound the inaccessibility due to heavy rutting.

Rut on Road Without Geotextile

Solutions :

Needle punched Non Woven Geotextile of 225 gsm placed at the interface between the aggregate base course and subgrade acts as a separator to prevent subgrade soil and aggregate from intermixing. In addition, geotextile acts as a filter to prevent fine soil from migrating up into the aggregate due to the high pore pressure induced by dynamic wheel loads. It also acts as a drain, allowing the excess pore pressure to dissipate through the geotextile and sub grade soil to gain strength through consolidation and improve with time. Geotextile also provide reinforcement. It is found that the portion of the road constructed with a geotextile is in very good condition.

Laying of Geotextile

Department Name:

VJTI Mumbai under guidance of Dr M K Talukdar

Contractor Name :

Ichalkaranji Municipality

Product Used

225 gsm Needle Punched Nonwoven Geotextile

Construction info :

Construction Start :	**April 1993**
Construction end :	**May 1993**

Road after Laying of Geotextile

Particulars	Before Burial	10 years a+-fter Burial
Mass per unit area, gsm	225	440
Thickness, mm	2.38	1.20
Bk.Strength kN/m, MD CD	4.12 14.88	4.94 7.74

Geotextile excavated after 10 Years

KUSUMGAR CORPORATES PVT. LTD.
101/102, Manjushree, N.S. Road No. 5,
V.M. Road, Vile Parle (West)Mumbai 400 056
Tel:022-26184341/26184350 Fax : 022-2611 5651
info@kusumgar.com, www.kusumgar.com

USE OF GEO STRIPS IN PMGSY AT KUNDE BHANGARWADI IN MURBAD NEAR KALYAN

Problem :

With PMGSY roads the people of Kunde Bhangarwadi started dreaming many things. They are looking forward to use the state transport bus at their door step by which they can directly sell their vegetables to customers. Their children can go to school not walking for miles. Their elders can get medical help from big hospitals. About 200m of PMGSY is concretized. Concrete blocks are cut using a diamond tool in a control manner, which allows for movement cause by temperature change and dry shrinkage. This avoids the cracking of the concrete. But cutting of concrete creates noise & air pollution which is harmful to localities.

Concrete is Poured in Road site

Solution :

PVC coated geostrips are stitched in the form of rectangles of size 1.0 m x 1.0 m. and placed on the road where concretization has to be done. Thereafter premix concrete is laid in the open spaces of the rectangles and allowed to cure. The geostrips take the expansion and contraction of concrete and thus avoids cutting of concrete so as to prevent noise and air pollution. Thereafter, the surfacing of the road is done.

Geostrips used in joint cutting avoided

The Premix Concrete is being Laid

Department Name:

Use of Geostrips in PMGSY

Contractor Name :

PMGSY Amravati

Product Used

PVC Coated Geostrips

Construction info :

Construction Start :	March 2011
Construction end :	June 2011

Road after Completion

GARWARE - WALL ROPES LTD. (Geosynthetics Division)

Reinforced Embankment for Height Raising of Jarosite Pond at Zinc Smelter, Debari, Udaipur

Product: Woven geotextile, HDPE geomembrane

Problem:

To increase the capacity of the Jarosite pond, client has planned to raise the height of the existing embankment. Based on the site topography and to achieve the capacity, total embankment height of 6.0 m to 14.0 m is required. Construction of high height embankment with stable slope requires larger foot print area along the existing embankment. Considering 1500 m embankment length, limited available base width, huge earthwork quantity and construction time, suitable option to reduce the embankment footprint is required.

Photo1. Typical cross-section of proposed geotextile reinforce embankment

Solution:

To minimize the foot print area of the embankment and the quantity of the embankment fill, reinforced embankment slope was suggested by using polyester woven geotextile as reinforcement. Use of woven geotextile to reinforce the steep embankment slopes was found to be a technically viable and economical option.

Photo2. Spreading of geotextile reinforcement in progress

Client:

Hindustan Zinc Smelter, Debari, Udaipur

Contractor:

Garware-Wall Ropes Ltd.

Products used:

Woven Polyester Geotextile	: 1,14,000 Sq.M
HDPE Geomembrane	: 19,000 Sq.M

Construction info:

Year - 2010 to 2011

Photo3. Earthwork operations in progress over the geotextile reinforcement

Photo4.Geotextile reinforced embankment, 14 m high after construction

Photo5. Geotextile reinforced embankment after construction

Advantages:

1. Construction of embankment within the limited base width
2. Reduction in earthwork quantity – conservation of natural resources
3. Speed and high rate of embankment construction
4. Cost effective solution

Present Status:

The Jarosite pond is in operation and the performance of geotextile reinforced embankment is satisfactory.

GARWARE – WALL ROPES LTD. (Geosynthetics Division)

Erosion Control System for the Kundli-Manesar Highway Project

Product: Garmat® - erosion control geomat

Problem:

The embankment slope portion of Kundli to Manesar highway in Haryana is experiencing severe soil erosion along with formation of rills and rain cuts due to lack of proper vegetation on slopes. The height of the embankment was varying from 0 m to 9.0 m and the slopes of embankments are 1V:2H. To avoid soil erosion on slopes, it is required to adopt suitable methods to establish vegetation on slopes.

Photo1. Soil erosion on slope – before installation of Garmat®

Solution:

Establishing vegetation on slopes will develop an effective network of root system penetrating the soil surface and there by render its resistance to erosion. However, in many situations natural turfing does not provide the required superior performance. The product outlined below was suggested to promote for establishing an effective and rapid growth of vegetation.

Garmat® is a high performance product specially engineered as surface protection treatment for slopes that are subjected to erosion forces. Garmat® is a composite geomat comprising a layer of bio-degradable mulching material sandwiched between two layers of polymer netting.

Photo2. Rain cuts on slope – before installation of Garmat®

Client:

D S C Ltd.

Contractor:

Garware - Wall Ropes Ltd.

Products used:

Garmat® : 26,00,000 Sq.M

Construction info:

Year - Ongoing

Photo3. Surface preparation in progress for installation of Garmat®

Photo4. Installation of Garmat® and soil placement in progress

Photo5. After vegetation growth on embankment slope

Advantages:

1. Root system intertwined with the net binds and confines the soil, resulting in a structure that is highly resistant to erosion.
2. Results in higher density of grass cover compared to ordinary turfing.
3. Mulch in the Garmat® also acts as a porous filter, to allow water while retaining the soil. When the mulch biodegrades, it serves as manure for the vegetation.
4. Installation is simple and easier.

Present Status:

The installation of Garmat® is in progress and the performance of the product is satisfactory at the completed stretches.

Case Study : HILL-ROAD REHABILITATION WITH GEOSYNTHETICS

Site: Palace Gate, Gangtok, Sikkim
Govt department: UDH&D, Govt of Sikkim
Length of road stretch: 170m
Project start date: 19/02/2010
Project completion date: 28/04/2010
Latest visuals of rehabilitated road on: 22/11/2012
Agencies involved: Tejase Overseas (material supplier), designed and supervised jointly by: Flexituff International Ltd & Geofabrics India.

AN OVERVIEW OF THE SITE:

Palace Gate in Gangtok, a heritage site, is one of the major tourist attractions of Sikkim. The road along this famous site used to suffer major settlements (see pic) year after year. The observed settlements were as high as 50cm on the valley side at some stretches and approximately 40cm on the hill side of the road at some other stretches. There were instances of subsidence and severe fractures (deep crevices) in the middle and side of the road adjoining the toe-drain which were almost non-existent. At some stretches, the entire pavement had moved away from the toe-drain by almost half a meter (see pic). Soil sustaining the road was nondescript and had least or no cohesion, and angle of repose was very low and that too appeared fictitious. Absence of eyebrow/catch drains along slope down-hill aggravated slope erosion during rains.

Settlement of 50cm on Valley-Side Pavement

Separated by 1m from the Toe-Drain (Hill side)

TECHNICAL ANALYSIS OF THE SITE:

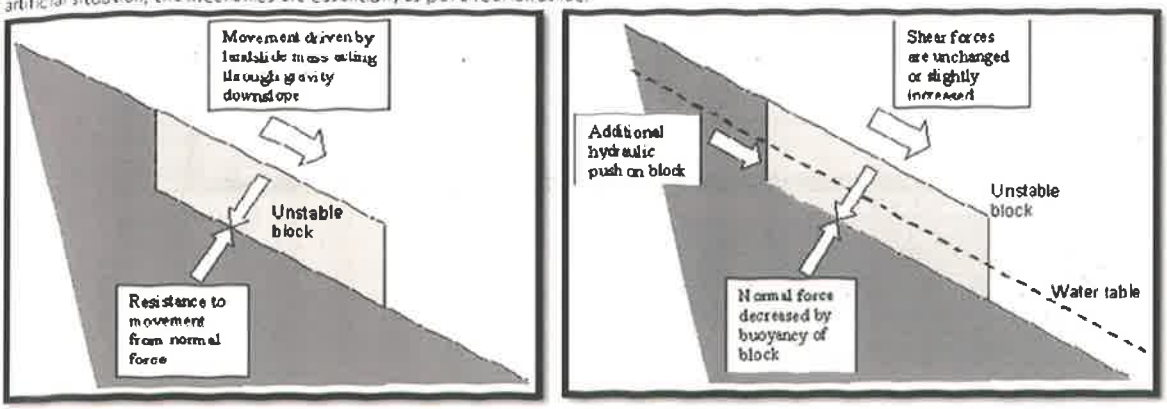
In the absence of real data and on the mere basis of above-described observations, a detailed analysis was undertaken which concluded that absence of information about sub-surface drainage, landslide details (area falls in z-v), and inadequate data about the soil mass atop the hill portion holding the road were the major stumbling blocks in designing a reliable solution to the problem. In summary, the major problem was 'subsidence' which appeared to actually trigger other consequential problems like cracks in the road surface, lateral displacement of the road cross-section, etc.

Our team opted for a detailed site investigation (a massive challenge!) covering various aspects of the geology, topography, rainfall, and the seismic movements in the surrounding areas as well. However, given the expediency and the empirical need of the situation especially in view of the fast approaching next spell of monsoon, only some properties could be studied in detail and rest were derived out of the available and observed values. Our analysis finally led to two important factors that ultimately governed the entire design and execution philosophy there onwards: (a) To provide most effective and possible means of drainage over & inside the road surface and in the areas directly impacting the road performance, & (b) reinforcing the existing soil mass and the road overlays to make them more self-sufficient in bearing the stresses they were subjected to by movement of traffic and the adjoining land masses (to some extent).

IDENTIFIED CAUSES OF FAILURE:

In the ultimate analysis, it was concluded that the failures could be attributable to a combination of factors including but not limited to geological, morphological, physical & human too! The most conclusive factor that was sifted out of series of discussions with the local road users and the government officials was that all the prominently visible and sudden disturbances in that road occurred mostly after a prolonged rainfall. Generally this takes the form of either an exceptional short lived event, such as the passage of a tropical cyclone or even the rainfall associated with a particularly intense thunderstorm or of a long duration rainfall event with lower intensity such as the cumulative effect of monsoon. In the former case it is usually necessary to have very high rainfall intensities, whereas in the latter the intensity of rainfall may be only moderate - it is the duration and existing pore water pressure conditions that are to watch. The importance of rainfall as a trigger for landslides/subsidence of soil masses cannot be under-estimated. A global survey of subsidence and landslide occurrence in the last seven years revealed that over 90% were triggered by heavy rainfall. One rainfall event for example in Sri Lanka in May 2003 triggered

hundreds of landslides, killing 266 people and rendering over 300,000 people temporarily homeless. In July 2003 an intense rain band associated with the annual Asian monsoon tracked across central Nepal, triggering 14 fatal landslides that killed 85 people.
Principally this is because the rainfall drives an increase in pore water pressure within the soil. The figure A illustrates the forces acting on an unstable block on a slope. Movement is driven by shear stress, which is generated by the mass of the block acting under gravity down the slope. Resistance to movement is the result of the normal load. When the slope fills with water, the fluid pressure provides the block with buoyancy, reducing the resistance to movement. In addition, in some cases fluid pressures can act down the slope as a result of groundwater flow to provide a hydraulic push to the landslide that further decreases the stability. Whilst the example given in Figures A and B is clearly an artificial situation, the mechanics are essentially as per a real landslide.



A: Diagram illustrating the resistance to, and causes of, movement in a slope system consisting of an unstable block
B: Diagram illustrating the resistance to, and causes of, movement in a slope system consisting of an unstable block

In some situations, the presence of high levels of fluid may destabilise the slope through other mechanisms, such as: Fluidization of debris from earlier events to form debris flows, Loss of suction forces in silty materials, leading to generally shallow failures (this may be an important mechanism in residual soils in tropical areas following deforestation), & Undercutting of the toe of the slope through river erosion.

OVERWHELMING BENEFITS OFFERED BY GEOSYNTHETICS:

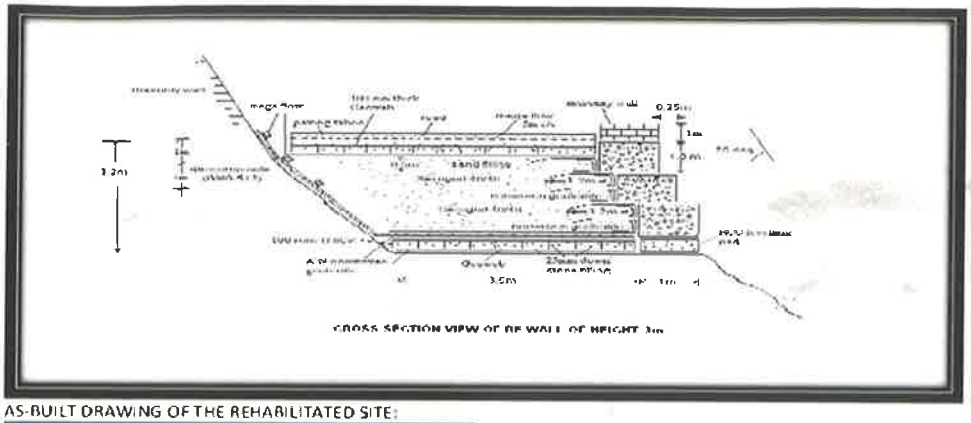
In view of the above-described site conditions, urgent need for completing the work very fast, and all this to be achieved under the ever-desirable need for keeping the costs down (preferably lower than the existing cost estimates), we're faced with a real tricky situation which was further compounded by the fear of the monsoon season that was looming large - fast approaching in that heavy rainfall area (here, rains start as early as Feb-Mar and continue up to Nov-Dec). Geosynthetic application in roads, in its infancy as it is in India, works out a costlier affair if one compares its initial cost against the conventional cost.

But given its indisputable benefits, it was decided to adopt this method to the exclusion of earlier conventional methods by allowing scope for not compromising on the safety and stability aspects of the road users. The benefits thus offered were enormous viz [a] using geotextiles and geogrids to disallow intermixing of layers of road crust, [b] preventing lateral movement of subgrade with the use of 3D-confinement cells, [c] controlling and guiding the entire pore pressure build-up inside the road crust (literally making it a free-draining road) with the help of Megaflo, [d] precluding (or restricting to a great extent) differential settlement of the road (by distributing the load uniformly across the road-width through grids and geocells), [e] using the local factor endowments (soil) having low angle of repose and unskilled labour (providing local employment and skills to the ultimate beneficiaries of the geosynthetic products), [f] lending a direct control over the design factors that to a large extent account for many unseen future adversities like traffic density in excess of the designed values and the unruly behaviour of the traffic (a common phenomenon on Indian roads – enough proof that we live in a truly free & democratic country!!), [g] no-weather-constrained work execution (most of the geosynthetic materials can be used in all weather conditions with slight care and precaution), and most of all [h] a very speedier method of construction to allow the road to be opened to traffic at the shortest possible time period!

RECOMMENDED METHOD/DESIGN WITH GEOSYNTHETICS:

We finally concluded with the following recommendations:
Reconstructing the entire road crust with Reinforced Earth Wall concept with the help of geogrids and non woven geotextiles with a 3D confined (geocell) leveling pad at the subgrade and at base. Erosion control mats to be laid on the valley side. Megaflo (flat panel drainage system – see pic) to be installed along the entire hill side and inside of the road crust including as cross drainage for having very high compressive strength (up to 200 KPa). Eyebrow ditches to be constructed on the valley side slope. Toe drain to be completely eliminated & the entire drainage including on the hill slope side was to be laid inside the construction.

Flexituff International



AS-BUILT DRAWING OF THE REHABILITATED SITE:

MEGAFLO (flat-panel drainage system)

Performance observed after two earthquakes (18/09/2011 and 18/09/2012) and three monsoons:

By: Rajeeva Upadhyay, Country Head (Geosynthetics), Flexituff International Ltd.

Case studies on RSW with Block, Panel, Gabion and Wire cage Facing

Sr No.	Case study	Company
30	Reinforced soil walls with welded wire mesh facing, Wardha,Maharashtra	Techfab (India) Industries Ltd.
31	Reinforced soil walls with warp-around and vegetated facia,J &K	Techfab (India) Industries Ltd.
32	Reinforced soil walls with segmental panel facia-Nagpur-Hyderabad section of NH 7	Techfab (India) Industries Ltd.
33	Reinforced soil walls with discrete panel facing, Lucknow-Muzaffarpur section of NH-28	Techfab (India) Industries Ltd.
34	Reinforced soil walls with discrete panel facing, Surat	Techfab (India) Industries Ltd.
35	Reinforced soil walls with segmental panel facia -Andhra Pradesh	Techfab (India) Industries Ltd.
36	Reinforced soil walls with segmental panel facia -Swaroopgunj Package on NH 14	Techfab (India) Industries Ltd.
37	Reinforced soil walls with discrete panel facia for flyovers and ROB of NH-76,Udaipur,Rajasthan	Techfab (India) Industries Ltd.
38	Reinforced soil walls with segmental panel facia-Vadodara-Bharuch section of NH-8	Techfab (India) Industries Ltd.
39	Earth retention and protection work, Hazaribagh-Ranchi section of NH-33	Techfab (India) Industries Ltd.
40	Reinforced soil walls with segmental panel facia-Section of NH 58-Uttar pradesh	Techfab (India) Industries Ltd.
41	Reinforced soil wall for monsoon palace, Aamby Valley	Techfab (India) Industries Ltd.
42	Reinforced soil walls with modular block facia, Andhra Pradesh	Techfab (India) Industries Ltd.
43	Reinforced soil walls with welded wire mesh facing to retain approaches to a flyover, Mayur Vihar Link road	Techfab (India) Industries Ltd.
44	Construction of Retaining Wall on SH-55 ,Shirur,Pune	Techfab (India) Industries Ltd.
45	Reinforced soil wall ,section of NH-8 between Dahisar and Surat	Strata Geosystems (India) Pvt. Ltd.
46	Reinforced soil wall approaches to the VUPs on the Meerut-Muzaffarnagar Stretch	Strata Geosystems (India) Pvt. Ltd.
47	Reinforced soil wall-Section of NH 8 connecting Surat and Bharuch.	Strata Geosystems (India) Pvt. Ltd.
48	ROB for connectivity between Mundra and NH8, Gujarat	Maccaferri Environmental Solutions Pvt. Ltd.
49	Retention works for Hajj House, Calicut,Kerala, India	Meccaferri Environmental Solutions Pvt. Ltd.
50	Reinforced soil retaining structure for widening of Temple Approach Road,Vijayawada, Andhra Pradesh	TenCate Geosynthetics Asia SDN BHD.
51	Slope Protection by Gravity Retaining Wall, Lanjigarh,Orissa	Garware Wall Ropes Ltd.

TECHGRID GEOGRID REINFORCED SOIL WALLS WITH WELDED WIRE MESH FACING

Project Description

Project : Construction of Approaches for coal handling area and hopper pit and tunnel for the power plant for Lloyd Steel Industries Ltd at Wardha, Maharashtra

Owner : Lloyds Steel Industries Ltd

Contractor : Indrajeet Infrastructure Ltd

Consultant : Fichtner Consulting Engineers

Wall Under Construction

Wall Under Construction

Wall Under Construction

Completed Wall

Salient Features of the Reinforced Soil Walls

Wall Facing Area: 800 Sqm

Wall Height: 10 m

Soil Reinforc ement: TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength Of 40 to 200 KN/m

Facing: Geogrid Wrapped face supported by galvanized welded wire mesh panels filled with locally available slag with batter of 5°

Design Methodology: FHWA-NHI-00-043 Seismic Zone II

TFIIL's scope of work: Detailed engineering design and drawings, supply of geogrids, welded wire mesh panels and geotextile, supervision of construction

The Project

Lloyds Steel Industries Ltd is constructing a captive power plant for its existing steel plant at Wardha near Nagpur. The construction involves a approach ramp to be made to the coal handling area and hopper pit and tunnel.

Lloyds Steel Industries Ltd wanted a solution from TechFab India Industries Ltd to construct the approach ramp that is fast economical, use of local slag material as fill for the approached (they had the problem of dumping the slag) and the structure should be long lasting with proven performance. Lloyds Steel Industries Ltd decided to use Reinforced soil technology for the construction of retaining walls in view of their proven performance and cost economy.

The design of the walls involved several technical difficulties and the construction had to be completed within a short time. After a rigorous evaluation of various aspects, Lloyds Steel Industries Ltd accepted the geogrid reinforced soil wall with a welded wire mesh facing proposed by TechFab India Industries Ltd as best suited to the project and site requirements and awarded the work to TechFab India Industries Ltd with the following scope of work:

Detailed engineering of the reinforced soil walls including design, material specifications, construction drawings and construction methodology.

Supply of TechGrid Geogrids and nonwoven geotextile.

Supervision of construction.

The Challenge

The design of the walls involved several challenges:

The maximum height of the ramp was about 10.0 m

The fill considered in the design is a composite of good quality Murrum and locally available slag material.

The loading considered is the live load of moving truck for transportation of the coal is 100 MT.

The facing batter of the walls had to be kept as low as possible.

The Solution

After a careful evaluation of the project requirements and site conditions a geogrid reinforced soil wall with a welded wire mesh supported wrapped face was finalized as the most optimum solution.

TechGrid knitted and PVC coated polyester geogrids, manufactured by TechFab India at their state of the art ISO 9001: 2000 certified plant in Silvassa, were used as the soil reinforcement. TechGrid geogrids area manufactured from select grades of high tenacity, high molecular weight polyester yarns using an advanced weft insertion warp knitting process and coated with a specially formulated PVC plastic. The high performance characteristics of these world class geogrids enabled the walls as high as 15 m, to be designed safely and economically.

The facing comprised a geogrid wrapped face supported by L shaped galvanized welded wire mesh panels with galvanized steel ties at 500 mm spacing. The packing with locally available slag was provided to enhance the rigidity of the facing and to protect the fill material. A nonwoven geotextile filter was used behind the rubble to contain the fill material, which was a composite of good quality murrum and locally available slag material.

The overall inward batter of the facing was approximately 5°.

Ability to accommodate appreciable amounts of differential settlements was one of the major reasons for adopting this type of facing.

The design of the walls was carried out using the FHWA-NHI-00-043 guidelines and comprised checks for external, internal and global stability under static and seismic conditions.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd.

The project was successfully completed in April 2008.

For further details kindly contact:

TECHGRID GEOGRID REINFORCED SOIL WALLS WITH WRAP-AROUND & VEGETATED FACIA

Project Description

Project : Construction of RSRW with Wrap Around & Vegetated Facia near Tunnel No 1 at Katra (J&K)

Owner : Northern Railways.

Contractor : Konkan Railway Corporation Ltd / Progressive Construction Ltd.

Proof Check : Indian Institute of Technology, Delhi.

RSRW with Wire Mesh Facia At Katra (J&K)

RSRW with Wire Mesh Facia At Katra (J&K)

RSRW with Wire Mesh Facia At Katra (J&K)

RSRW with Wire Mesh Facia At Katra (J&K)

Salient Features of the Reinforced Soil Walls

Wall Facing Area:	1080 Sqm
Wall Height:	10 m
Soil Reinforc ement:	TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength Of 40 to 250 KN/m
Facing:	Geogrid Wrapped face supported by galvanized welded wire mesh panels with random rubble packing.
Design Methodology:	BS 8006 (Static) FHWA-NHI-00-043 (Seismic)
TFIIL's scope of work:	Detailed engineering design and drawings, supply of geogrids, welded wire mesh panels, supervision of construction.
Proof Check ing:	Designs and drawings were proof-checked by IIT Delhi

The Project

Indian Railways had taken up the arduous task of linking the Kashmir Valley with Jammu by a rail network of 343 km. The work on first phase (56 km) between Jammu to Udhampur was completed in 2005 and services are operational on this route. The link 25 Km between Udhampur to Katra Vaishnodevi is under construction and may be completed by 2007. The work on 119 km track from Qazigund to Baramulla is nearing completion. The 138 km stretch between Katra to Qazigund was commenced in 2003. However this stretch is one of the most difficult and un-parallel to any rail linking project built in India so far. It involves 104 km of tunneling wherein one tunnel is about 10.9 km long under a rock cover of 2000 m below the Pirpanjal range of Himalayas.

This herculean task of 138 km has been entrusted to two public sector companies, from Katra to Laole between Km 30 to Km 120 to Konkan Railway Corporation Ltd (KRCL) and from Laole to Qazigund between Km 120 to 168 to IRCON International.

In Konkan Railway section, to execute entire 90 km track, construction of 225 km access road is necessary which has become a bottleneck to complete this project on time. Roads are to be built first and the railway tunnels later. The sector has a complicated topography consisting of deep gorges & heavy sliding zones.

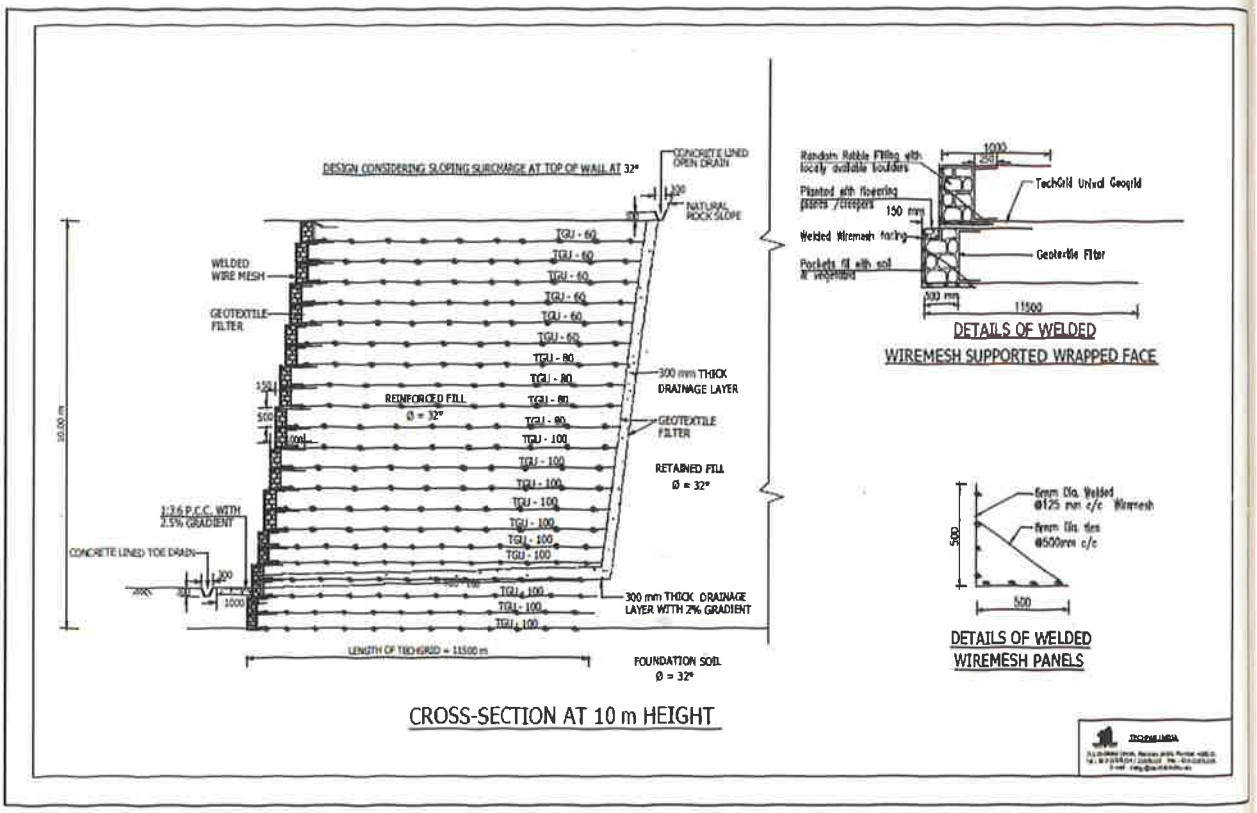
The Challenge

The entire Railway Track meanders through young Himalayan Mountains which consist of sinking / slide zones. One such tough zone has been noticed at Tunnel No 1 at Katra (J&K) where the portal got buried under the slush & muck during the construction of the tunnel. This tunnel was being constructed by M/s Progressive Construction Ltd.

Following the slide the work was suspended for sometime, further discussion and proposals were undertaken with various consultants and agencies to avoid such unfortunate incidents in future.

Finally, the existing muck was cleared and a false tunnel 30 m length was constructed from the face of the tunnel. The Portal of the Tunnel consists of more than 100 m high slide zone, which is very vulnerable to land slide and washing away of the foundation soil form the both side of the portal, it was proposed to have Reinforced Soil Walls on both the sides of the tunnel.

The Solution



TYPICAL CROSS SECTION

M/s Progressive Construction Ltd (PCL) contacted TechFab India Industries Ltd for providing the techno-commercial offer for the protection of tunnel against the landslide occurring in the highly seismic prone zone.

After a careful evaluation of the project requirements and site conditions a geogrid reinforced soil wall with a welded wire mesh supported wrapped face was finalized as the most optimum solution.

TechGrid knitted and PVC coated polyester geogrids, manufactured by TechFab India at their state of the art ISO 9001: 2000 certified plant in Silvassa, were used as the soil reinforcement. TechGrid geogrids area manufactured from select grades of high tenacity, high molecular weight polyester yarns using an advanced weft insertion warp knitting process and coated with a specially formulated PVC plastic. The high performance characteristics of these world class geogrids enabled the walls as high as 10 m, to be designed safely and economically.

The facing comprised a geogrid wrapped face supported by L shaped galvanized welded wire mesh panels with galvanized steel ties at 500 mm spacing. Ability to accommodate appreciable amounts of differential settlements was one of the major reasons for adopting this type of facing. After completion of the project the facia was vegetated, to give it additional stability against the erosion.

The proposed Reinforced Soil Wall would act as impact resistance pad on both sides of the tunnel taking the load of the slush/ muck which may come over the tunnel with high momentum endangering the foundation if the portal.

The design of the walls was carried out using the BS 8006 (static) FHWA-NHI-00-043(seismic) guidelines and comprised checks for external, internal and global stability under static and seismic conditions. The design calculations and construction drawings were proof-checked by Indian Institute of Technology Delhi.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd.

The project was successfully completed in July 2008.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHGRID GEOGRID REINFORCED SOIL WALLS

WITH SEGMENTAL PANEL FACING

Project Description

Project : Four Laning of Nagpur-Hyderabad Section of NH-7 from km: 123.00 to 153.00, Contract Package No.: NS-61 (MH)

Owner : National Highways Authority of India

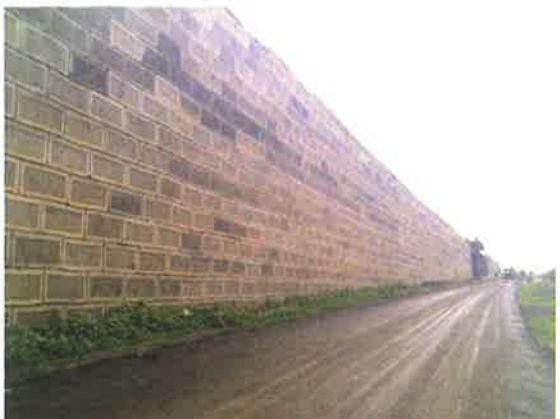
Contractor : M/s Ideal Road Builders Pvt. Ltd., Mumbai

Consultant : M/s. BCEOM-AARVEE Associates, New Delhi

RSRW at Nagpur-Hyderabad Section

RSRW at Nagpur-Hyderabad Section

RSRW at Nagpur-Hyderabad Section



RSRW at Nagpur-Hyderabad Section

Salient Features of the Reinforced Soil Walls

Wall Facing Area: 11781 Sqm

Wall Height: 13.0 m Maximum

Soil Reinforcement: TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength Of 40 to 250 KN/m

Facing: Segmental Panel Facia

Design Methodology: BS 8006 (Static); FHWA-NHI-00-043 (Seismic)

TFIIL's scope of work: Detailed engineering design and drawings, supply of geogrids, supply of moulds for casting of panels, supervision of construction

The Project

IRB Ltd has awarded the work of Reinforced Soil Retaining Wall to M/s TechFab (India) Industries Ltd. The scope of work include, design of reinforced soil wall, their approval, submission of drawings, supply of moulds and supervision at site. The selection of panel facia is also as per the client requirement, for that newer mould has been made to have a corrugation finish at the front face.

The Challenge

Size of the panel has been selected by the client, i.e. 1.25m x 0.6m. It has been decided to use this panel with PET Geogrid with friction / tongue and groove connection. Designs must be checked for the connection strength for this type of panel-Geogrid arrangement.

The Solution

Testing has been done at IIT-Madras for the friction based connection for Techgrid-PET with this panel type. Design has been checked and verified with consideration of test results and ensured the tension in Geogrid is less than the available connection strength at particular normal pressure.

Table-1 shows the property of the reinforced infill, retained fill and foundation soil taken into consideration in the designs.

Table-1

Property/Fill	Cohesion (C) - KN/m^2	Angle of Internal Friction (ϕ) - Degrees	Unit Weight (γ) - KN/m^3
Reinforced Infill Soil	0	34	20
Retained Soil	0	34	20
Foundation Soil	0	30	18

The design of the walls was carried out using the FHWA-NHI-00-043 guidelines and comprised checks for external, internal and global stability under static and seismic conditions. Construction of the wall was carried out under the supervision of TechFab India Industries Ltd.

The project was successfully completed in February 2010.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHGRID GEOGRID REINFORCED SOIL WALLS

WITH DESCRETE PANEL FACIA

Project Description

Project : Four Lanning Of Lucknow-Muzaffarpur Section on NH-28, Civil Contractor Package No. LMNHP EW-II (WB), Package 06 (Km 208.00 - Km 251.70)

Client : National Highway Authority of India

Contractor : BSCPL Infrastructure Ltd.

Consultant : Roughton International - Consulting Engineers Group Ltd. (JV)

Erection of RS Wall

Erection of RS Wall

Elevation of RS Wall

Elevation of RS Wall

Salient Features of the Reinforced Soil Walls

Wall Facing Area:	18100 Sqm
Wall Height:	1.5m to 7.5m and 2.0m to 9.5m
Soil Reinforc ement:	TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength of 40 to 250 KN/m
Facing:	Descrete Panel Fascia
Design Methodology:	BS 8006: 1995 (Static Condition) FHWA-NHI-00-043 (Seismic Condition)
TFIIL's scope of work:	Detail designs & drawings, supply of Geogrids, Moulds for Discrete Panels, Nonwoven Geotextile & Supervision of construction

The Project:

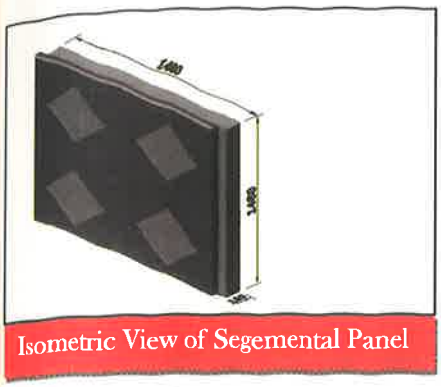
M/s BSCPL Infrastructure Limited has awarded the work of Reinforced soil wall to M/s Techfab India Industries Ltd. The scope of work include, design of reinforced soil wall, their approval, submission of drawings, supply of moulds and supervision at site. Reinforced soil wall structure with height ranging from 1.5 meter to 9.5 meter.

The Challenge:

There is a poor soil strata area for foundation, for which the safe bearing capacity has been worked out lesser than the required bearing pressure at particular height. Need is arises for the ground improvement to increase the safe bearing capacity.

The Solution:

Detailed soil investigation has been carried out and based on the borelog data, ground improvement analysis has been done with replacement at various depths from ground level with good quality granular fill. Also layers of Geosynthetic material has been suggested along with the replacement.



Isometric View of Segemental Panel

Table-1

Property/Fill	Cohesion (C) - KN/m^2	Angle of Internal Friction (ϕ) -	Unit Weight (γ) - KN/m^3
Reinforced Infill Soil	0	30	20
Retained Soil	0	30	20
Foundation Soil	0	30	18

The design of the walls was carried out using the BS 8006: 1995 for Static Condition & FHWA-NHI-00-043 for Seismic Condition, which comprised checks for external, internal and global stability under static and seismic conditions.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd's supervision.

The project was successfully completed in September 2009.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHGRID GEOGRID REINFORCED SOIL WALLS WITH DISCRETE PANEL FACIA

Project Description

Project : Construction of Flyover At NanaVarchha on Varchha Road in Surat.

Owner : Surat Municipal Corporation

Contractor : Rajkamal Infrastructures Pvt. Ltd.

Consultant : S N Bhobhe & Associates Pvt. Ltd.

Flyover At Nana Varchha

Flyover At Nana Varchha

Flyover At Nana Varchha

Salient Features of the Reinforced Soil Walls

Wall Facing Area: 3760 Sqm

Wall Height: 9m

Soil Reinforcement: TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength of 40 to 250 KN/m

Facing: Discrete Panel Facia

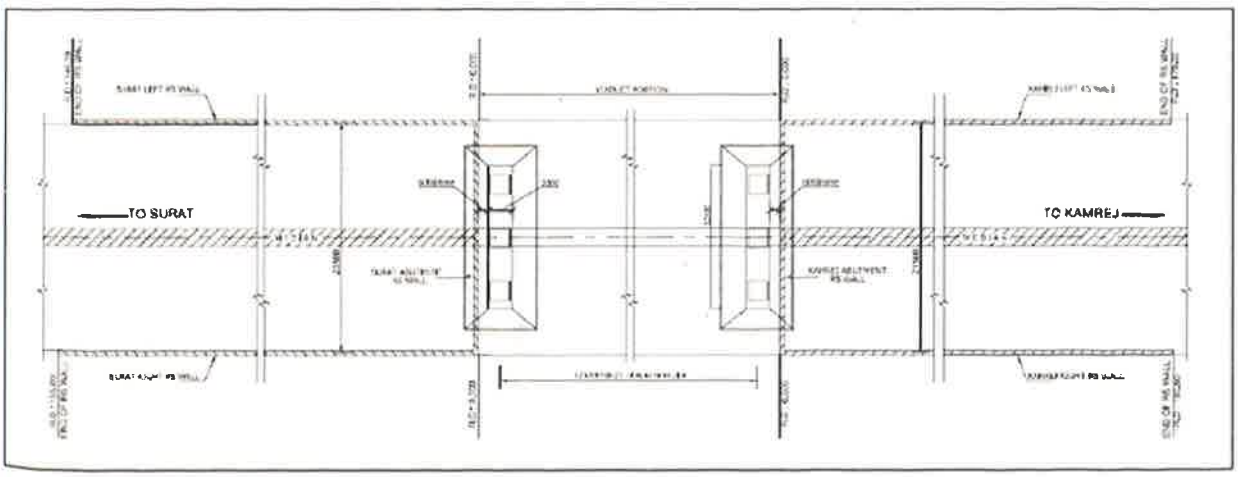
Design Methodology: BS 8006: 1995 (Static Condition)

FHWA-NHI-00-043 (Seismic Condition)

TFIIL's scope of work: Detail designs & drawings, supply of Geogrids, Moulds for Discrete Panels, Nonwoven Geotextile & Supervision of construction

The Project

Surat Municipal Corporation awarded the work of construction of Flyover at NanaVarchha on Varchha Road in Surat to M/s Rajkamal Infrastructures Pvt. Ltd. TechFab India Industries Ltd was awarded with the project for providing the detail designs and drawings for the Flyover with RS Wall. The Project consisted of RS Wall on Surat Left Side (146m) & Surat Right Wall (155m) and Kamrej Left Side (179m) & Kamrej Right Wall (180.5m) and their abutments. TechFab India Industries Ltd provided the detailed designs and drawings for the project.



KEY PLAN

The Solution

After a careful evaluation of the project requirements and the existing site conditions a geogrid reinforced soil wall with discrete panel fascia was considered as the feasible solution.

TechGrid knitted and PVC coated polyester geogrids, manufactured by TechFab (India) Industries Ltd at their state of the art ISO 9001: 2000 certified plant in Silvassa, were used as the soil reinforcement. TechGrid geogrids are manufactured from select grades of high tenacity, high molecular weight polyester yarns using an advanced weft insertion warp knitting process and coated with a specially formulated PVC plastic. The high performance characteristics of these world class geogrids enabled the walls as high as 9m, to be designed safely and economically.

Properties considered in the design of the RS Wall are shown in Table-1.

The fascia type used was a discrete panel type of size 1.48m x 1.48m x 0.18m. Due to the shape and size of the panel it was able to absorb differential settlement of magnitude significantly higher than other panel types.

Isometric View of Discrete Panel

Table - 1

Property/Fill	Cohesion (C) - KN/m²	Angle of Internal Friction (ϕ) - Degrees	Unit Weight (γ) - KN/m³
Reinforced Infill Soil	0	32	20
Retained Soil	0	32	20
Foundation Soil	0	30	18

The borehole and foundation soil test report showed very low friction angle and high cohesion. So in designing the RS wall it was considered that after excavation of 2.25m foundation depth the foundation soil was again excavated for 500 mm depth and replaced with compacted fill according the approved quality. Therefore the Total depth of excavation at the site was taken as 2.75 m from existing service road level. Also, the unsuitable soils were removed and replaced with compacted fill of approved quality where it is required.

The design of the walls was carried out using the BS 8006: 1995 for Static Condition & FHWA-NHI-00-043 for Seismic Condition, which comprised checks for external, internal and global stability under static and seismic conditions.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd's supervision.

TECHGRID GEOGRID REINFORCED SOIL WALLS WITH SEGMENTAL PANEL FACIA

Project Description

Project : Reinforced soil walls with segmental panels facia system for ROBs Jadcherala-Kotakatta Road Project (KJRP) (Andhra Pradesh)

Client : National Highway Authority of India

Contractor : Larsen & Toubro Ltd.

Consultant : ICT Pvt. Ltd., New Delhi

Erection of RS Wall

Completed RS Wall

Elevation of RS Wall

Elevation of RS Wall

Salient Features of the Reinforced Soil Walls

Wall Facing Area:	31054 Sqm
Wall Height:	10m
Soil Reinforc ement:	TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength of 40 to 250 KN/m
Facing:	Segmental Panel Fascia
Design Methodology:	BS 8006: 1995 (Static Condition) FHWA-NHI-00-043 (Seismic Condition)
TFIIL's scope of work:	Detail designs & drawings, supply of Geogrids, Moulds for Discrete Panels, Nonwoven Geotextile & Supervision of construction

The Project:

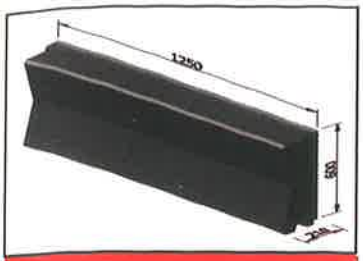
L & T ECC Ltd. has awarded the work of Reinforced soil wall to M/s Techfab India Industries Ltd. The scope of work include, design of reinforced soil wall, their approval, submission of drawings, supply of moulds and supervision at site. There are approaches for ROBs, flyovers and vehicular underpass for reinforced soil work. The work location is spreaded at three locations, viz. Jadcherla (Ch.80), Divitapally (Ch.87) and Bhoothpur (Ch.92) of Jadcherla & Kothakota section of NH 7.

The Challenge:

Size of the panel has been selected by the client, i.e. 1.25m x 0.6m. It has been decided to use this panel with PET Geogrid with friction / tongue and groove connection. Designs must be checked for the connection strength for this type of panel-Geogrid arrangement,

The Solution:

Testing has been done at IIT-Madras for the friction based connection for Techgrid-PET with this panel type. Design has been checked and verified with consideration of test results and ensured the tension in Geogrid is less than the available connection strength at particular normal pressure.



Isometric View of Segemental Panel

Table-1

Property/Fill	Cohesion (C) - KN/m^2	Angle of Internal Friction (ϕ) -	Unit Weight (γ) - KN/m^3
Reinforced Infill Soil	0	36	23.2
Retained Soil	0	36	23.2
Foundation Soil	0	30	18

The design of the walls was carried out using the BS 8006: 1995 for Static Condition & FHWA-NHI-00-043 for Seismic Condition, which comprised checks for external, internal and global stability under static and seismic conditions.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd's supervision.

The project was successfully completed in February 2009.

For further details kindly contact:

Tech Fab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHGRID GEOGRID REINFORCED SOIL WALLS WITH SEGMENTAL PANEL FACIA

Project Description

Project : Strengthening & Widening of Road at Palanpur - Swaroopgunj Package on NH-14

Client : National Highway Authority of India

Contractor : L&T, ECC Division, Ahmedabad

Consultant : Aarvee Associates

Closure View of RS Wall

Elevation of RS Wall

Closure View of RS Wall

Elevation of the Wall

Salient Features of the Reinforced Soil Walls

Wall Facing Area:	55,349 Sqm
Wall Height:	10m
Soil Reinforcement:	TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength of 40 to 250 KN/m
Facing:	Segmental Panel Fascia
Design Methodology:	BS 8006: 1995 (Static Condition) FHWA-NHI-00-043 (Seismic Condition)
TFIIL's scope of work:	Detail designs & drawings, supply of Geogrids, Moulds for Discrete Panels, Nonwoven Geotextile & Supervision of construction

The Project:

L & T ECC Ltd. has awarded the work of Reinforced soil wall to M/s Techfab India Industries Ltd. The scope of work include, design of reinforced soil wall, their approval, submission of drawings, supply of moulds and supervision at site. There are approaches for ROBs, flyovers and vehicular underpass for reinforced soil work. Total stretch for the project is starts from the Palanpur in Gujarat state to Swaroopgunj in Rajasthan state, India.

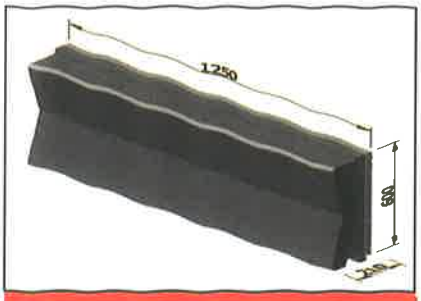
The Challenge:

Size of the panel has been selected by the client, i.e. 1.25m x 0.6m. It has been decided to use this panel with PET Geogrid with friction / tongue and groove connection. Designs must be checked for the connection strength for this type of panel-Geogrid arrangement,

The Solution:

Testing has been done at IIT-Madras for the friction based connection for Techgrid-PET with this panel type. Design has been checked and verified with consideration of test results and ensured the tension in Geogrid is less than the available connection strength at particular normal pressure.

Table-1



Isometric View of Segemental Panel

Property/Fill	Cohesion (C) - KN/m²	Angle of Internal Friction (□) -	Unit Weight (□) – KN/m³
Reinforced Infill Soil	0	35	20
Retained Soil	0	35	20
Foundation Soil	0	30	18

The design of the walls was carried out using the BS 8006: 1995 for Static Condition & FHWA-NHI-00-043 for Seismic Condition, which comprised checks for external, internal and 'global stability under static and seismic conditions.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd's supervision.

The project was successfully completed in November 2009.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHGRID GEOGRID REINFORCED SOIL WALLS WITH DESCRETE PANEL FACIA

Project Description

Project : Reinforced soil walls with discrete panels facia system for flyovers & ROBs of NH-76, EW-II (RJ-III), Udaipur (Rajasthan)

Client : National Highway Authority of India

Contractor : Ranjit Tarmat - JV

Consultant : Span Consultant

Erection of RS Wall

Completed RS Wall

Elevation of RS Wall

Elevation of RS Wall

Salient Features of the Reinforced Soil Walls

Wall Facing Area:	25500 Sqm
Wall Height:	10m
Soil Reinforc ement:	TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength of 40 to 250 KN/m
Facing:	Descrete Panel Fascia
Design Methodology:	BS 8006: 1995 (Static Condition) FHWA-NHI-00-043 (Seismic Condition)
TFIIL's scope of work:	Detail designs & drawings, supply of Geogrids, Moulds for Discrete Panels, Nonwoven Geotextile & Supervision of construction

The Project:

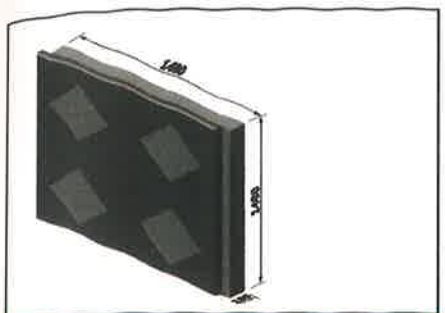
M/s Roman-Tarmat - a joint venture has awarded the work of Reinforced soil wall to M/s Techfab India Industries Ltd. The scope of work include, design of reinforced soil wall, their approval, submission of drawings, supply of moulds and supervision at site. Reinforced soil wall structure with height ranging from 1 meter to 10 meter, for rehabilitation and upgrading of NH-76, Gogunda to Udaipur section Km 73+000 to Km 104+724, East - west Corridor Package RJ-III.

The Challenge:

Work done should be within the stipulated time period, which included the casting erection and casting of crash barrier as well as friction slab. Total reinforced soil wall facia is 25500 sqm.

The Solution:

With the increased Nos. of Mould for panel casting and work as per the planned schedule, has completed the project within stipulated time period.



Isometric View of Segemental Panel

Table-1

Property/Fill	Cohesion (C) - KN/m²	Angle of Internal Friction (ϕ) -	Unit Weight (γ) - KN/m³
Reinforced Infill Soil	0	34	20
Retained Soil	0	34	20
Foundation Soil	0	30	18

The design of the walls was carried out using the BS 8006: 1995 for Static Condition & FHWA-NHI-00-043 for Seismic Condition, which comprised checks for external, internal and global stability under static and seismic conditions.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd's supervision.

The project was successfully completed in May 2008.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHGRID GEOGRID REINFORCED SOIL WALLS

WITH SEGMENTAL PANEL FACIA

Project Description

Project : Six Laning of Km 108+700 To Km 192+000 on Vadodara – Bharuch Section of NH-8 in the State of Gujarat on BOT Basis.

Client : L&T Vadodara Bharuch Tollway Limited

Contractor : L&T, ECC Division, Ahmedabad

Consultant : SAI Consultants, Ahmedabad

Elevation of RS Wall

Elevation of RS Wall

Abutment of RS Wall

Completed Wall

Salient Features of the Reinforced Soil Walls

Wall Facing Area:	68,323 Sqm
Wall Height:	10m
Soil Reinforc ement:	TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength of 40 to 250 KN/m
Facing:	Segmental Panel Fascia
Design Methodology:	BS 8006: 1995 (Static Condition) FHWA-NHI-00-043 (Seismic Condition)
TFIIL's scope of work:	Detail designs & drawings, supply of Geogrids, Moulds for Discrete Panels, Nonwoven Geotextile & Supervision of construction

The Project:

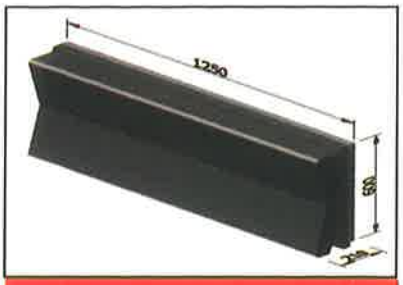
L & T ECC Ltd. has awarded the work of Reinforced soil wall to M/s Techfab India Industries Ltd. The scope of work include, design of reinforced soil wall, their approval, submission of drawings, supply of moulds and supervision at site. There are two ROB approaches, eleven flyovers and one vehicular underpass for reinforced soil work for approaches. Total stretch length of the project is around 70 Km, which starts from Vadodara city to Bharuch city in Gujarat, India.

The Challenge:

Area is located, where the black cotton soil is available up to the depth of 3 to 8m. It was difficult to achieve required safe nearing capacity at the depth to 1 to 1.5 meter. Maximum height of the reinforced soil wall is 10 meter as it has to connect the ROB's as well as Flyover's.

The Solution:

Detailed soil investigation has been carried out to know the actual extent of black cotton soil. Area, where the depth of soil is up to 2.0 to 2.5 meter has been replaced with good quality granular fill. Other areas, where the depth of black cotton soil is on higher side, it has been replaced up-to 2.5 meter, then provide the plate form with the layers of Geosynthetic material with granular fill with maximum of 500mm to 750mm. Over the plate form leveling pad has been placed for the erection work. Also to ensure the increased safe bearing capacity, plate load test has been done for verification.



Isometric View of Segemental Panel

Table-1

Property/Fill	Cohesion (C) - KN/m²	Angle of Internal Friction (ϕ) -	Unit Weight (γ) - KN/m³
Reinforced Infill Soil	0	35	20
Retained Soil	0	35	20
Foundation Soil	0	30	18

The borehole and foundation soil test report showed existence of black cotton soil in the area where the RS Wall was to be constructed. Thereby experts advice was taken and multi layers of good soil were provided by excavating the black cotton soil to achieve the required safe bearing capacity that will be sufficient to withstand the bearing pressure exerted by the weight of the infill and other external loads.

The design of the walls was carried out using the BS 8006: 1995 for Static Condition & FHWA-NHI-00-043 for Seismic Condition, which comprised checks for external, internal and global stability under static and seismic conditions.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd's supervision.

The project was successfully completed in August 2009.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

USE OF METAL GABION WALL FOR EARTH RETENTION & PROTECTION WORKS

Project Description

Project: Supply and Execution of Gabion Wall at Four Laning of Hazaribagh – Ranchi Section of NH-33 in the state of Jharkhand under NHDP Phase – III on BOT (Annuity) basis.

Client: National Highways Authority of India (NHAI).

Main Contractor: Hazaribagh Ranchi Expressway Ltd (JV Company of ITNL and Punj Lloyd).

Sub Contractor: GR Infraprojects Ltd (GRIL).

Product: TechFab Metal Gabion

TechGeo Nonwoven Geotextile PR 20 (200 Gsm)

Manufacturer: TechFab (India) Industries Ltd.

TechFab Metal Gabion -Longitudinal View

TechFab Metal Gabion Installation

CASE HISTORY

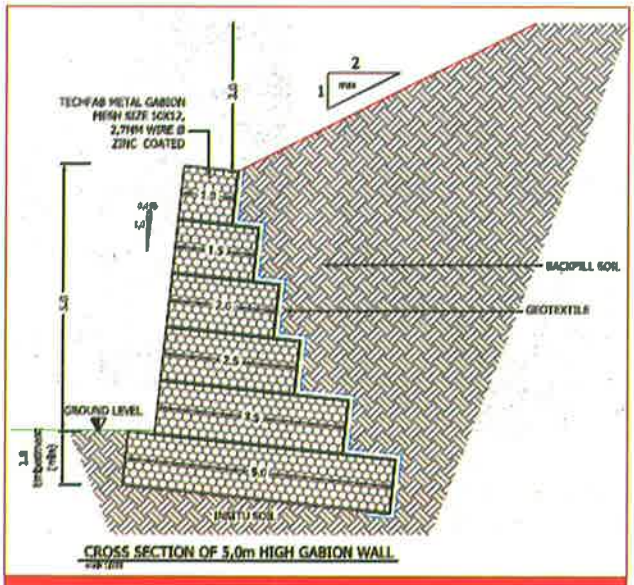
The Challenge

"Ghanti" is around 10Km length of hill stretch along Ranchi – Hazaribagh road section of NH-33. Due to steep hill section and numbers of hair pin bends, traffic movement on this stretch of road had been very slow and even well below the NHAI guideline of maximum speed for traffic movement of 40Km/hr. With an objective to speed up the traffic movement and faster accessibility, NHAI undertook plan to re-align this road stretch to make the road more or less straight and with smooth curve portion. Additionally, for further safety of vehicle and stability of hill side road embankment, extensive protection work was considered using Steel Gabion technology in valley side.

Thereby, TechFab (India) Industries Ltd suggested TechFab Metal Gabion and TechGeo Nonwoven Geotextile to serve the required purpose. The project was awarded to Hazaribagh Ranchi Expressway Ltd (JV Company of ITNL and Punj Lloyd) which in turn had subcontracted the work to GR Infraprojects Ltd (GRIL). GR Infraprojects Ltd (GRIL) awarded the supply and execution of Metal Gabion and Nonwoven Geotextile to M/s TechFab India Infrastructure LLP (a subsidiary of TechFab India Industries Ltd, formed to provide end-to-end design and build solutions in the field of Infrastructure enhanced with Geosynthetics).

The Solution

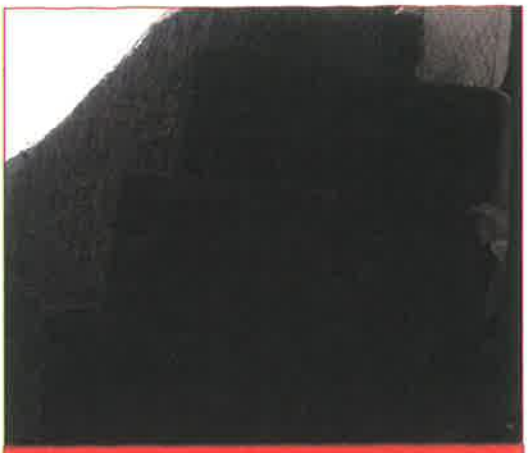
Gabion Retaining walls are flexible structures which are very suitable in case of retaining structures in deep valley. Gabions can take settlement which may occur in such regions. Walls of varying height (1m to 6m) with surcharge slope of 1V:2H was proposed. TechGeo Nonwoven Geotextile PR 20 was placed at the rear end of gabion wall which acts as filter.



Cross Section of 5.0m high Metal Gabion Wall

Gabion construction is fast and can be done using unskilled labours hence the project was completed in time.

TechFab Metal Gabion Wall -Top View



TechFab Metal Gabion Wall -Side View

TechFab Metal Gabion and TechGeo Nonwoven Geotextile satisfied all the technical parameters for their effective usage. Thereby, TechFab India Infrastructure LLP successfully supplied and executed 15,000 Cum of TechFab Metal Gabion and 10,000 Sqm of TechGeo Nonwoven Geotextile PR 20 (200 Gsm). The execution was successfully completed in time. The department was happy with the material quality and in time execution of project, whereby awarded us with the completion certificate as follows:

G R INFRAPROJECTS LTD

To whom it may Concern

This is to certify that M/S Techfab India Infrastructure LLP has supplied & installed "TECHFAB METAL GABION" & PR 20(200 GSM) Non woven Geotextiles of 15000 cum & 10000 Sqm respectively for the project of " Four Laning of Hazaribagh - Ranchi Section of NH-33 in the State of Jharkhand under NHDP Phase III on BOT (Annuity) Basis" against W/O No. WO/CO/RCH-HAZ/04 Dt. 28.8.11.

"TECHFAB METAL GABION" & "GEOTEXTILE " Supplied by M/S. Techfab India Infrastructure LLP was as per our specified technical requirement and to the satisfaction of our department.

"TECHFAB METAL GABION" & "GEOTEXTILE " Supplied by M/S. Techfab India Infrastructure LLP enabled us to complete the scheduled activity in time.

We hope to continue our relationship in future and wish M/S. Techfab India Infrastructure LLP a success for all their present and future operations.

Jaynandan Kumar

Project Coordinator

JAINANDAN KUMAR
Project Coordinator
GR INFRAPROJECTS LTD.

Completion Certificate
Supply & Execution of TechFab Metal Gabion and TechGeo Nonwoven Geotextile

Benefits of TechGeo Nonwoven Geotextile

1. Acts as a "Filter" by preventing the backfill material from being washed out through Gabion face.
2. Acts as a "Separator" between the backfill material and the Gabion facia and thereby prevents the mixing of the tow.

Benefits of TechFab Metal Gabion over Conventional RCC Retaining Wall

TechFab Metal Gabion was suggested for retaining and erosion control purposes in lieu of the conventional R.C.C Retaining Wall for achieving the following advantages:

1. Flexible structure which can accommodate differential settlement.
2. Free draining structure with no pore pressure development behind wall.
3. Easy in construction, as it does not require skilled labourers.
4. Does not require curing time as in case of R.C.C Retaining wall.
5. Eco-friendly, as the vegetation growth over it, is compatible with surrounding environment.
6. Does not corrode under areas which are in constant / partial submergence.
7. Cost incurred is very less compared to R.C.C Retaining Wall and depends only on the local availability of boulders.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHGRID GEOGRID REINFORCED SOIL WALLS

WITH SEGMENTAL PANEL FACING

Project Description

Project : Meerut-Muzaffarnagar BOT (Ch: 52+250 To 131+000) Section Of NH 58 In The State Of Uttar Pradesh.

Owner : National Highways Authority of India

Contractor : M/s N.C.C Ltd.

Consultant : M/s. BCEOM

RSRW at Meerut - Muzaffarnagar

RSRW at Meerut - Muzaffarnagar

Vehicular Under Pass -1

Vehicular Under Pass-2

Salient Features of the Reinforced Soil Walls

Wall Facing Area: 24,416 Sqm

Wall Height: 12.6 m Maximum

Soil Reinforc ement: TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength Of 40 to 250 KN/m

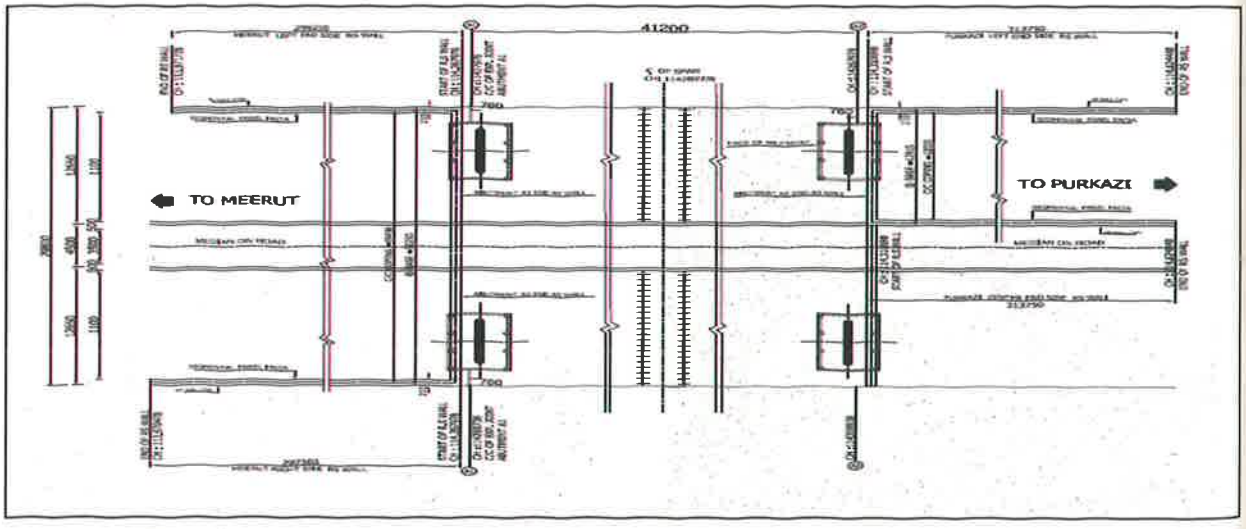
Facing: Segmental Panel Facia

Design Methodology: FHWA-NHI-00-043

TFIIL's scope of work: Detailed engineering design and drawings, supply of geogrids, supply of moulds for casting of panels, supervision of construction

The Project

N.C.C. Ltd has awarded the work of Reinforced Soil Retaining Wall to M/s TechFab (India) Industries Ltd. The scope of work include, design of reinforced soil wall, their approval, submission of drawings, supply of moulds and supervision at site. There was 1 ROB and two underpasses at Ch 118 and Ch 122 for reinforced soil work for approaches. The site was located on section of NH 58 (Meerut - Muzaffarnagar) in the state of Uttar Pradesh (U.P.) The wall height for the ROB ranges from 5.5m to 12.6m; for Underpass at Ch 118 wall height ranges from 2.3m to 7.0m and for Underpass at Ch 122 wall height ranges from 1.5m to 7.0m.



KEY PLAN

The Challenge

- Bearing Capacity & Settlement Analysis for the Reinforced Soil Wall were done rigorously.
- Two types of strata were found below the ground level:
- Brown Sandy Silt / clayey silt of low to medium plasticity
- Loose / medium dense / dense brown fine / silty sand
- Global Stability of the RSR Wall was checked using ReSSA 3.0 Software and found safe.
- For wall facing height ≤ 6m no special ground treatment was required as per the calculations.
- For wall facing heights > 6m, a compacted granular layer of 500 mm thickness was provided below the founding level of Reinforced Soil Wall.

The Solution

After a careful evaluation of the project requirements and site conditions a geogrid reinforced soil wall with segmental panel facing was finalized as the most optimum solution.

TechGrid knitted and PVC coated polyester geogrids, manufactured by TechFab India at their state of the art ISO 9001: 2000 certified plant in Silvassa, were used as the soil reinforcement. TechGrid geogrids area manufactured from select grades of high tenacity, high molecular weight polyester yarns using an advanced weft insertion warp knitting process and coated with a specially formulated PVC plastic. The high performance characteristics of these world class geogrids enabled the walls as high as 12.6 m, to be designed safely and economically.

Table-1 shows the property of the reinforced infill, retained fill and foundation soil taken into consideration in the designs.

Table-1

Property/Fill	Cohesion (C) - KN/m^2	Angle of Internal Friction (ϕ) - Degrees	Unit Weight (γ) - KN/m^3
Reinforced Infill Soil	0	34	20
Retained Soil	0	34	20
Foundation Soil	0	30	18

The design of the walls was carried out using the FHWA-NHI-00-043 guidelines and comprised checks for external, internal and global stability under static and seismic conditions. Construction of the wall was carried out under the supervision of TechFab India Industries Ltd.

The project was successfully completed in August 2010.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHFAB INDIA

CASE HISTORY

REINFORCED SOIL WALL

FOR

MONSOON PALACE, AAMBY VALLEY

Project Description

Project : Reinforced Soil Wall for Monsoon Palace, Aamby Valley.

Owner : **Mr. Anjum G. Bilakhia,**
Plot No. 219, 221 to 226,
Half Acre Area,
Village-Devgar, Taluka-Mulshi,
North Lake at Aamby Valley City,
Lonawala, District -Pune.

Contractor : M/s Spectrum Engineers, Vadodara.

Architect : **M/s Prabhakar B Bhagwat,** Landscape Architects & Environmental Planners, Ahmedabad.

Product : TechGrid Uniaxial Geogrid TGU

(Knitted & Polymer Coated Polyester Geogrid with CE Mark, BBA Certification & IRC Approved)

Manufacturer: TechFab (India) Industries Ltd.

Salient Features of the Project

Facing Area: 4500.00 Sqm

Length of Stretch: 300.0 m

The Challenge

Monsoon Palace is being built by Mr. Anjum G. Bilakhia at Half Acre Area, Village-Devgar, Taluka-Mulshi, North Lake at Aamby Valley City, Lonawala, District -Pune.

The Palace is surrounded by hilly terrain and running streams. Due to high embankments and steep slopes of basically murrum soil, it was necessary to have a retaining wall for reinstatement purposes. Since these walls were outer walls surrounding the monsoon palace, the client and architect was willing to have an aesthetic and viable solution compared to the conventional solution of RCC wall.

Reinforced Soil Wall provides an aesthetic as well as an economical solution for the retention of earth / slopes as compared to the conventional RCC Wall. Reinforced Soil Wall can accommodate differential settlement which RCC wall can't withstand and gets distressed with cracks.

With consideration to the techno-economics of the project, the client/architect decided to award the project to TechFab India Industries Ltd.

The Solution

TechFab (India) Industries Ltd suggested the use of TechGrid Uniaxial Geogrid TGU of Ultimate Tensile Strength varying from 40 KN/m to 250 KN/m. These Polyester Uniaxial Knitted Geogrids are used as primary reinforcements to the existing steep slopes. Geomembrane was provided below the top drain to prevent any ingress of precipitation or runoff water. Design of Reinforced Soil Wall was done by considering the maximum possible vehicular load and other surcharge loads as per the IRC. ReSSA 3.0 Software was used to carry out the Global Stability Check for the designed Rein forced Soil Wall.

By giving this solution of Reinforced Soil Wall, client has developed extra land of around 2 acres.

TechGrid Geogrid TGU Series are manufactured from superior grades of polyester filament yarn with high tenacity, high tensile modulus, low creep and low shrinkage. TGU Series are Uniaxial

Geogrids with high strength in the machine direction and are suitable for soil reinforcement applications requiring strength primarily in one direction. Products are available with machine direction strengths ranging from 40 KN/m to 250 KN/m.

Yarns with high molecular weight (> 25,000) and low carboxyl end groups (< 30) are used to ensure durability of the Geogrids used in permanent structures. The knitted grid is then given high quality polymeric coating using a specially formulated PVC compound. The coating completely saturates and envelopes the polyester yarn bundles forming a protective cover enhancing – dimensional stability of the Geogrid, resistance to installation damage and protection from the environment.

TechGrid Geogrid TGU Series for Soil Reinforcement

Inclusion of TechGrid Geogrid TGU Series transforms a compacted fill into a coherent composite material. When the soil strains in response to applied loads, tensile forces are generated in the Geogrid because of the excellent interaction between the Geogrid and soil. The tensile forces developed in the reinforcement keeps the reinforced soil mass in stable equilibrium.

Long-term Design Strength

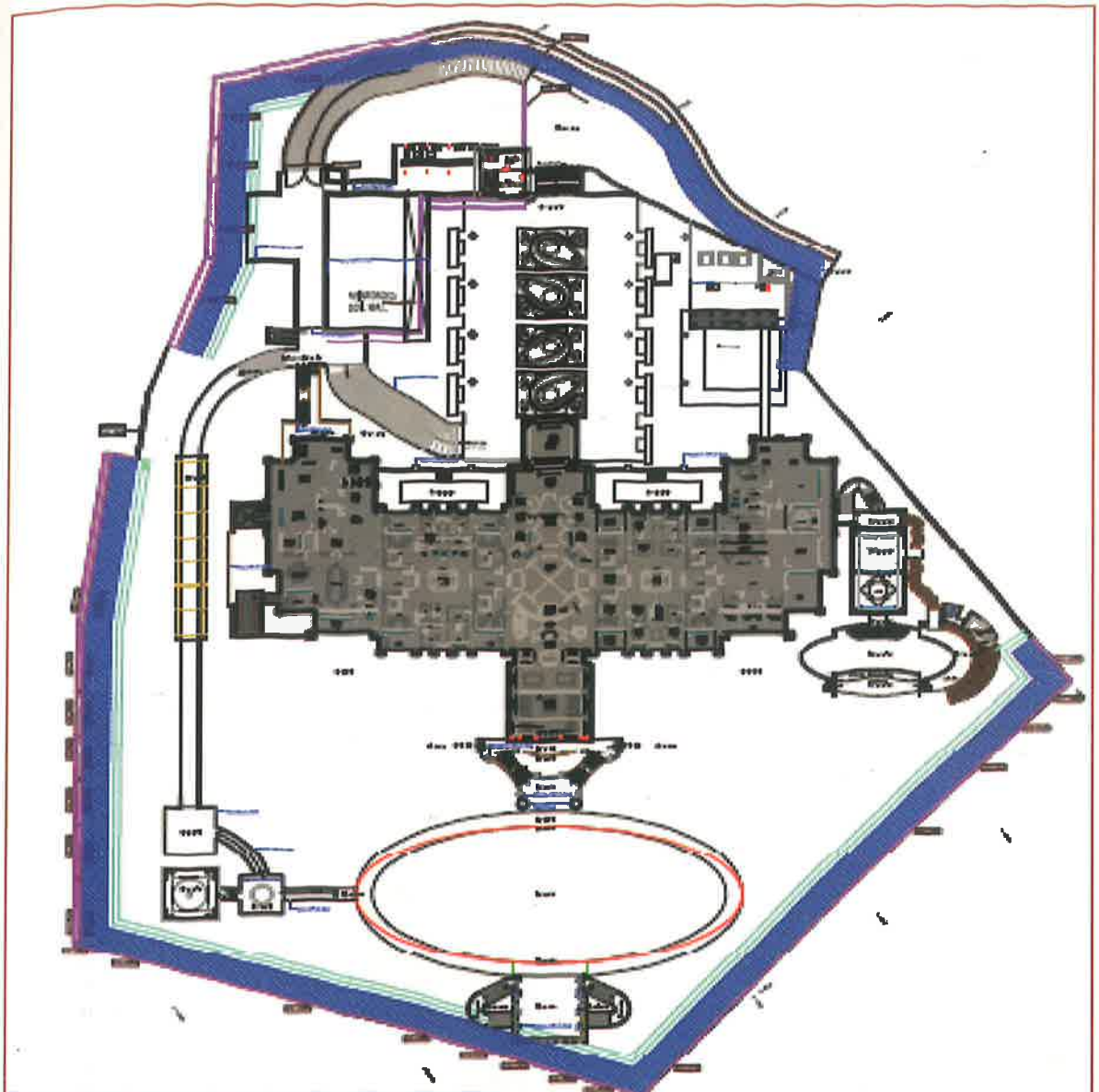
Design of the Geogrid reinforcement is based on the long-term design strength, i.e., the minimum assured strength of the reinforcement at the end of the design life of the structure.

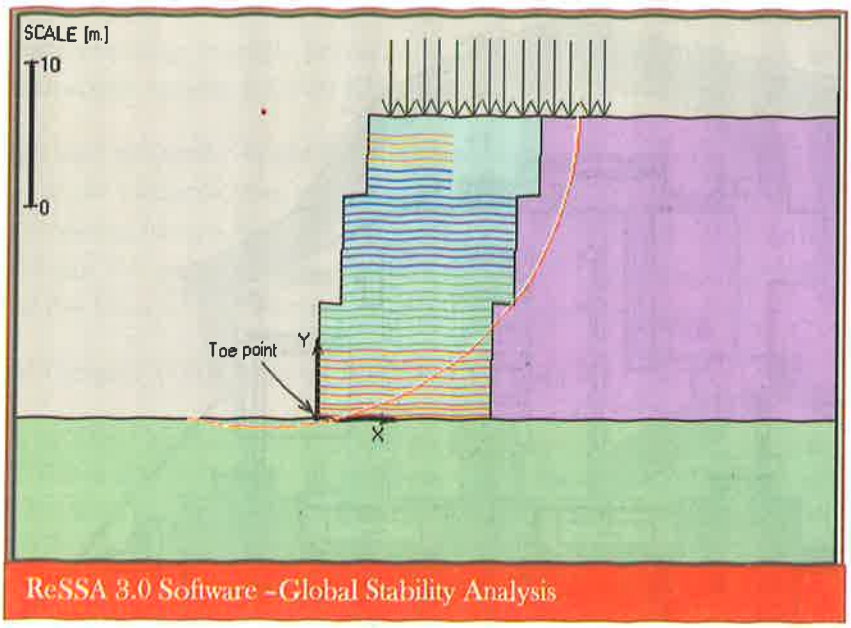
The long-term design strength (T_D) is calculated as follows:

$$TD = \frac{Tult}{RFcr\ RFid\ RFd}$$

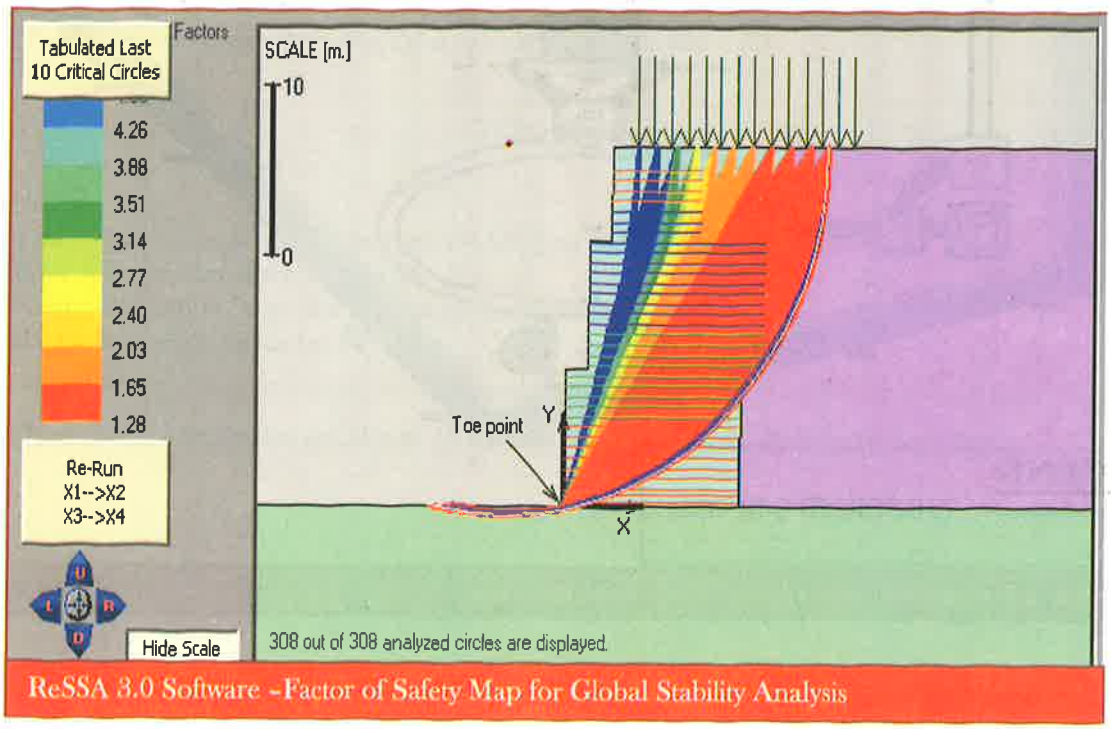
Where:
Tult = Peak ultimate tensile strength (MARV) as per ASTM D 6637
RFcr = Reduction factor for creep;
RFid = Reduction factor for installation damage
RFd = Reduction factor for durability

Please find below the plan and Design Analysis report carried out for Reinforced Soil Wall:

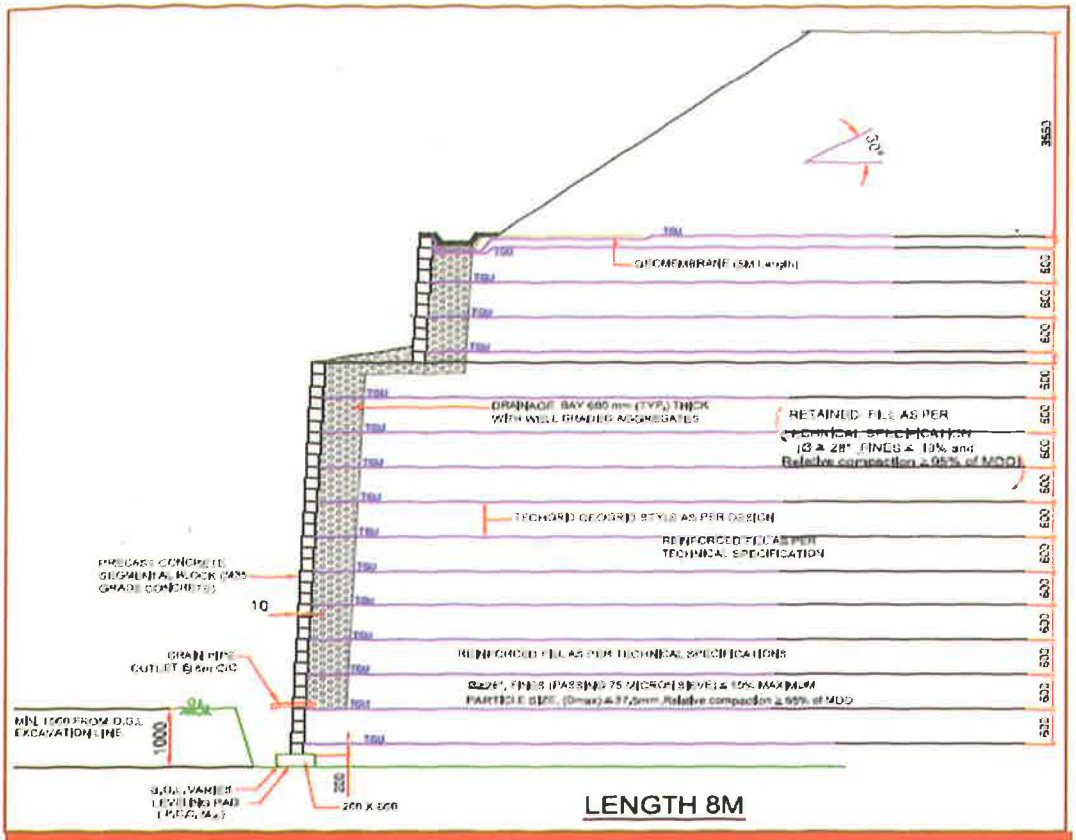




ReSSA 3.0 Software -Global Stability Analysis



ReSSA 3.0 Software -Factor of Safety Map for Global Stability Analysis



Typical Cross Section of Reinforced Soil Wall for Slope Protection

Road Map of Pune, Maharashtra, India

Design, drawings and the use of TechFab India Industries Ltd's TechGrid Uniaxial Geogrid TGU for Reinforcement of existing steep slopes were approved in principle by the Client / Architect of the project.

Execution

Based on the approval given by the Client / Architect for the suitability of the design and drawings as given by TechFab India Industries Ltd, the execution work was awarded to the contractor M/s Spectrum Engineers. Modular Blocks were used as facia to support the reinforced / back fill. Since modular blocks are relatively smaller in size, they are easy to cast and are able to follow the curve profile as and when required. The execution was carried out stage wise as per the design and drawings furnished by TechFab India Industries Ltd.

Applications of TechGrid TGU:

- Reinforced Soil Retaining Walls
- Steep Slopes

Benefits of TechGrid TGU:

- Used as reinforcing medium.
- High Tensile Strength ranging from 40 KN/m to 250 KN/m
- Low creep and low shrinkage
- Highly durable & resistant to acids & alkalis present in soil

The project was successfully completed in March 2012.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

TECHFAB INDIA

CASE HISTORY

TECH GRID

TECHGRID GEOGRID REINFORCED SOIL WALLS

WITH MODULAR BLOCK FACIA

Project Description

Project : Construction Of Eight Lane Access Controlled Expressway As Outer Ring Road To Hyderabad City, Phase - II Pedda Amberpet (Km 95.000) To Bongulur (Km108.000) For Hyderabad Urban Development Authority at Hyderabad, Andhra Pradesh

Owner : M/s Hyderabad Urban Development Authority

Contractor : M/s KMC Construction Ltd

Consultant : M/s Louis Berger Group Inc

Front Elevation of Two Tier RS Wall

Front Elevation of Two Tier RS Wall

Salient Features of the Reinforced Soil Walls

Wall Facing Area: 11,500 Sqm

Wall Height: 17m

Soil Reinforcement: TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength Of 40 to 250 KN/m

Facing: Modular Block Facia

Design Methodology: BS-8006 1995 for static and seismic with FHWA-NHI-00-043

TFIIL's scope of work: Detail designs & drawings, supply of Geogrids, Panels, Nonwoven Geotextile & Supervision of construction

The Project:

Project of eight lanning express Hyderabad outer ring road have been awarded to various contractors. M/s KMC Construction Ltd. has awarded the work of reinforced soil wall facia with block as a facia and Knitted and PVC coated polyester Techgrid (TFI-Geogrid) as reinforcing member. M/s Techfab India Industries Ltd. has give a total scope of design, drawings, their approval from Independent Consultant, supply of block making machine and supervision at site.

The Challenge:

Height of Reinforced soil wall is on higher side, around 15 to 17 meter. Considering the soil profile bore log data, need arises to make it safe in global stability analysis.

The Solution

The design of the walls was carried out using the BS-8006 / FHWA-NHI-00-043 guidelines and comprised checks for external, internal and global stability under static and seismic conditions. Considering the global stability analysis the berm has been given for the height more than 10 meter. Minimum 1 meter of berm has been given for the wall height above 10 meter. Global stability checked has been performed for the two tiered wall, along with the external and internal stability checks.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd's supervision.

The project was successfully completed in March 2010.

TECHFAB INDIA

CASE HISTORY

TECH GRID

TECHGRID GEOGRID REINFORCED SOIL WALLS WITH WELDED WIRE MESH FACING TO RETAIN APPROACHES TO A FLYOVER

Project Description

Project : Construction of DND – Mayur Vihar Link Road Phase I & II

Owner : Noida Toll Bridge Company Ltd. (NTBCL)

Contractor : K R Anand, Delhi

Consultant : Halcrow Consulting India Ltd.

Welded Wire Mesh Cage

Flyover Under Construction

15 m high wall at Mayur Vihar End

Project Photo - After Completion

Salient Features of the Reinforced Soil Walls

Wall Facing Area:	1600 Sqm
Wall Height:	14.0 to 15.0m on Mayur Vihar End and 9.0 to 10.0 m on DND end
Soil Reinforc ement:	TechGrid knitted & PVC coated polyester Geogrids with Tensile Strength Of 40 to 200 KN/m
Facing:	Geogrid Wrapped face supported by galvanized welded wire mesh panels with random rubble packing with batter of 5°
Design Methodology:	FHWA-NHI-00-043
TFIIL's scope of work:	Detailed engineering design and drawings, supply of geogrids, welded wire mesh panels and geotextile, supervision of construction
Proof Check ing:	Designs and drawings were proof-checked by IIT Delhi

The Project

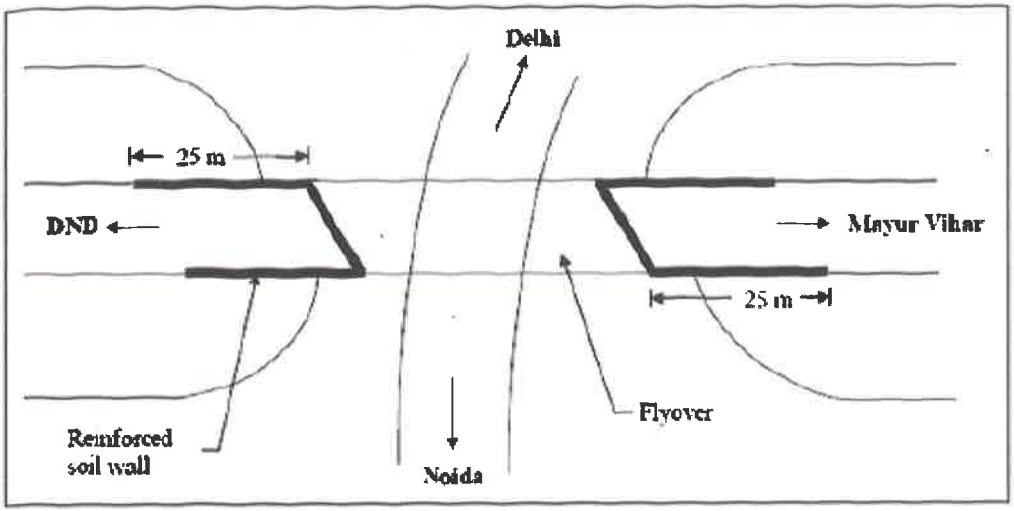
The Noida Toll Bridge Company Ltd. (NTBCL) has been promoted by Infrastructure Leasing and Financial Services Ltd. (IL&FS) as a special purpose vehicle to develop, construct, operate and maintain the eight lane DND Flyway(including a bridge across the Yamuna river) connecting South Delhi to Noida on a Build Own Operate Transfer (BOOT) basis. The company's principal source of revenue is from the levy of tolls on commuters on this facility. NTBCL constructed a DNC-Mayur Vihar Link Road to attract the large population living in the Trans-Yamuna area of Mayur Vihar to use DND Flyway to increase its revenue.

This DND-Mayur Vihar Link Road required the construction of a flyover, whose approach embankments had a maximum height of 9.0m on the DND end and 14.0 m on the Mayur Vihar End. Since there was no constraint with respect to right-of-way, the approaches consisted of normal embankments. However, retaining walls were to be constructed as closure walls behind the abutment piers and 25m long return walls at both ends of the flyover.

TECHFAB INDIA

CASE HISTORY

TECH GRID



KEY PLAN

NTBCL decided to use reinforced soil technology for the construction of retaining walls in view of their proven performance and cost economy. The design of the walls involved several technical difficulties and the construction had to be completed within a short time. After a rigorous evaluation of various aspects, NTBCL accepted the geogrid reinforced soil wall with a welded wire mesh facing proposed by TechFab India as best suited to the project and suite requirements and awarded the work to TechFab India with the following scope of work:

- Detailed engineering of the reinforced soil walls and ground improvement including design, material specification, construction drawings and construction methodology.
- Supply of TechGrid geogrids, galvanized welded wire mesh panels and nonwoven geotextile
- Supervision of construction

The Challenge

- The facing batter of the closure walls had to be kept as low as possible, to avoid any problems with respect to the design of approach slabs.

The Solution

After a careful evaluation of the project requirements and site conditions a geogrid reinforced soil wall with a welded wire mesh supported wrapped face was finalized as the most optimum solution.

TechGrid knitted and PVC coated polyester geogrids, manufactured by TechFab India at their state of the art ISO 9001: 2000 certified plant in Silvassa, were used as the soil reinforcement. TechGrid geogrids area manufactured from select grades of high tenacity, high molecular weight polyester yarns using an advanced weft insertion warp knitting process and coated with a specially formulated PVC plastic. The high performance characteristics of these world class geogrids enabled the walls as high as 15 m, to be designed safely and economically.

The facing comprised a geogrid wrapped face supported by L shaped galvanized welded wire mesh panels with galvanized steel ties at 500 mm spacing. A 350 mm thick random rubble was provided to enhance the rigidity of the facing and to protect the fill material. A nonwoven geotextile filter was used behind the rubble to contain the fill material, which was a fine sand. The overall inward batter of the facing was approximately 5°.

Ability to accommodate appreciable amounts of differential settlements was one of the major reasons for adopting this type of facing.

The fill material was relatively fine-grained sand dredged from the Yamuna river. The design angle of shearing resistance of the compacted sand was 35°.

The ground treatment consisted of the partial excavation and removal of the upper layer of the loose sandy clayey silt/silt sand and replacement with a compacted layer of sand reinforced with TechGrid TGB-90 biaxial geogrids with a tensile strength of 90 KN/m in both machine and cross machine directions.

The design of the walls was carried out using the FHWA-NHI-00-043 guidelines and comprised checks for external, internal and global stability under static and seismic conditions. The design calculations and construction drawings were proof-checked by Indian Institute of Technology Delhi.

Construction of the wall was carried out under the supervision of TechFab India Industries Ltd.

The project was successfully completed in March 2009.

For further details kindly contact:

TechFab India Industries Ltd.

CASE HISTORY

TECHFAB INDIA

COST SAVING IN GABION TYPE RETAINING WALL

VS

R.C.C RETAINING WALL

Project Description

Project : Construction of Gabion Retaining Wall on SH-55 Shikrapur-Nhavra-Inamgaon on Ghod River Bridge at Km 105.000, Taluka - Shirur, District -Pune, Maharashtra.

Owner : PWD Region Pune, PWD East-Division, Pune.

Product : TechGeo Nonwoven Geotextile PR-20

(Meets requirement of Type -II of IRC SP 59-2002)

TechFab Metal Gabion / Mattresses (Zinc + PVC Coated)

Manufacturer: TechFab (India) Industries Ltd.

Bridge on River Ghod at Km 105.0, Shirur

Erosion Visible Near Bridge Abutment

Salient Features of the Project

Metal Gabion Quantity: 839.50 Cum

Length of Stretch: 51.0 m

Width of Stretch: 8.0 m

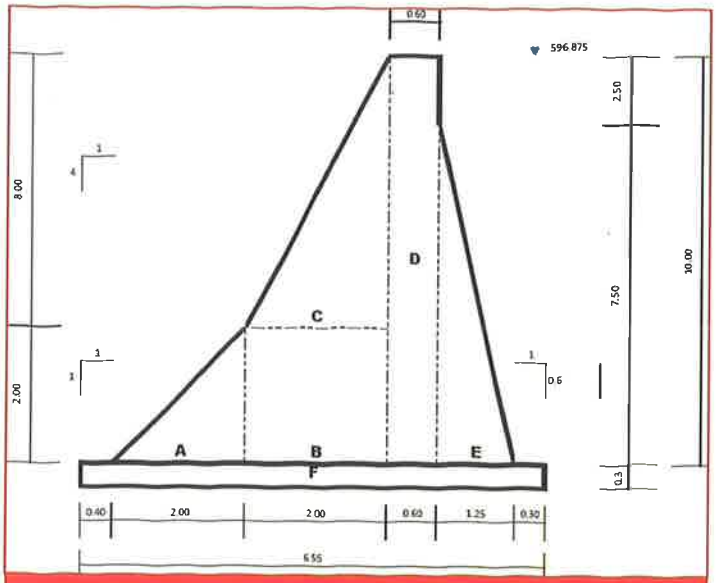
Site Cond ition: Stretch passes through rich black cotton soil area

The Challenge

Public Works Department, Shirur Sub Division, Shirur, Pune was facing the challenge of severe erosion near the abutment of the Ghod river bridge, located on SH-55 Shikrapur-Nhavra-Inamgaon at Km 105.000, Taluka – Shirur, District -Pune, Maharashtra. The Ghod river bridge is geographically important one, as it joins the Shirur Taluka (District -Pune) on one side and Shreegonda Taluka (District - Ahmednagar) on the other.

The bridge on the river Ghod is of submerged type with High Flood Level (H.F.L) being significantly greater than the Finished Road Level (F.R.L). The given stretch of bridge was passing through rich black cotton soil area having a very low CBR value of 1.37. Because of the above stated reasons and due to high water current of approximately 4.10 m/sec, severe erosion was observed near the abutment of the bridge on the Inamgaon side and also on the road adjoining the bridge on both the sides.

In order to protect the area, the Department had decided to go for a R.C.C Retaining Wall with M-15 grade of concrete.



Cross Section of R.C.C Retaining Wall (M-15 concrete)

CASE HISTORY

TECHFAB INDIA

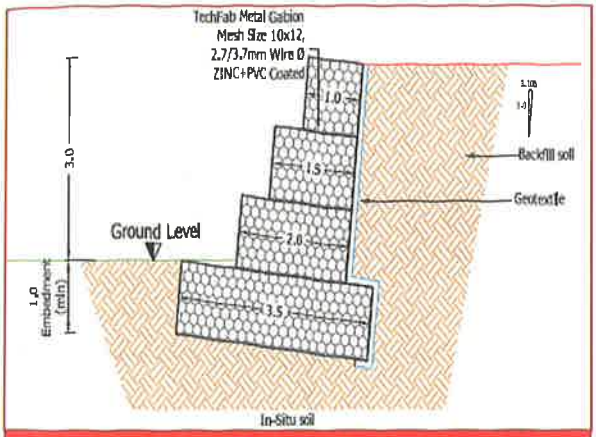
The Solution

TechFab (India) Industries Ltd suggested the use of TechFab Metal Gabions and Nonwoven Geotextile PR-20 for the retaining and erosion protection purposes at the given site comprising of black cotton soil & high water current.

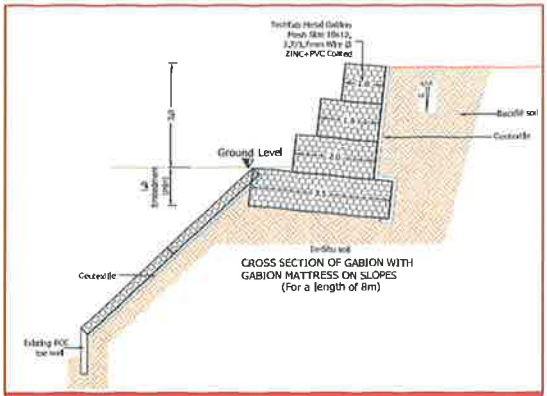
The design and the use of TechFab India Industries Ltd Metal Gabion and Nonwoven Geotextile PR-20 for retaining and erosion control were approved in principle by the Executive / Deputy Executive Engineer of P.W.D, Pune.

TechFab Metal Gabion of various heights depending upon the FRL's was suggested up to a length of 31.0m on the Right Side and 21.0m on the Left side of the road adjoining the bridge on the river Ghod, in order to retain the soil and protect it from water from the river Ghod. Moreover, a drain was suggested with TechFab Metal Gabion for a length of 26m and 18m on the Right and Left side respectively.

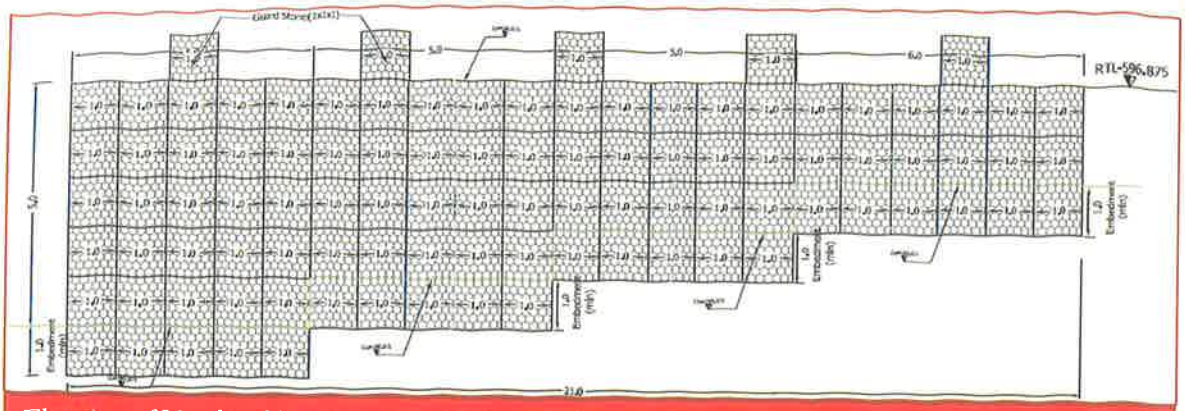
Also, the free fall area around the abutment was suggested to be protected with TechFab Metal Gabion along with Mattresses along the slope, touching the existing R.C.C Toe Wall.



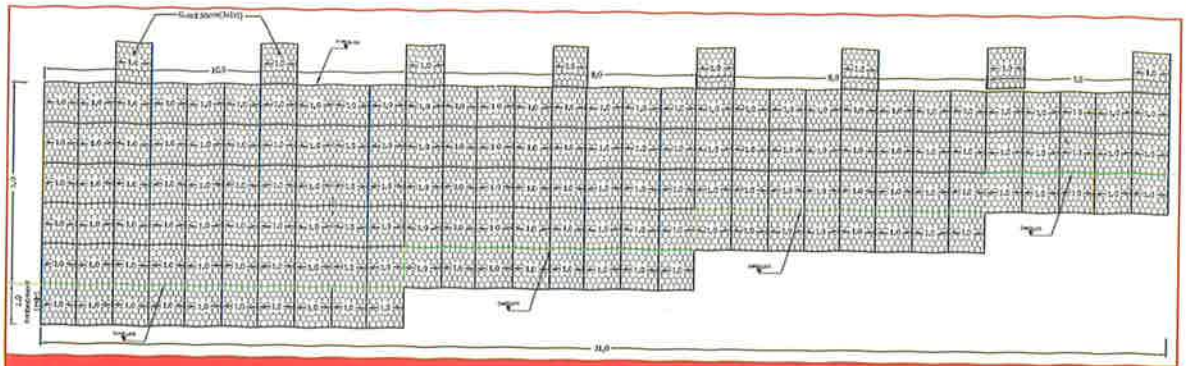
Cross Section of 4m high Gabion Wall



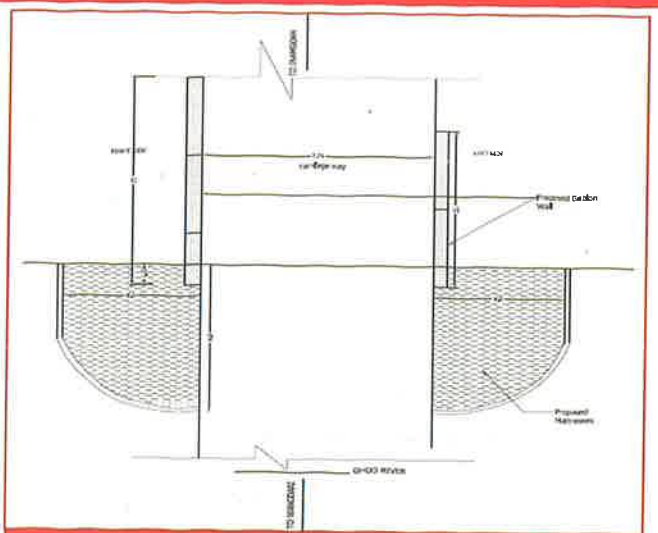
Cross Section of Gabion with Gabion Mattress on the Slopes (for a length of 8m)



Elevation of Metal Gabion Retaining Wall on LHS of Road Adjoining Ghod River Bridge



Elevation of Metal Gabion Retaining Wall on RHS of Road Adjoining Ghod River Bridge



Plan showing Gabion Wall & Mattress Location

CASE HISTORY

TECHFAB INDIA

TechGeo Nonwoven Geotextile PR-20 was suggested to be used behind the TechFab Metal Gabion Retaining Wall and below the Mattresses & drain suggested as earlier. TechGeo Nonwoven Geotextile acts as a separation, filtration and erosion control media. TechGeo PR series is a Nonwoven geotextile manufactured from high quality polypropylene staple fibers. The fibers are mechanically bonded through needle-punching to form a strong, flexible and dimensionally stable fabric structure, with optimum pore sizes and high permeability. The geotextile is resistant to chemicals and biological organisms normally found in soils and are stabilized against degradation due to exposure to ultraviolet radiation. TechGeo Nonwoven Geotextile PR-20 meets the requirements for IRC SP 59-2002 Type -II.

Benefits

TechFab Metal Gabion was suggested for retaining and erosion control purposes in lieu of the conventional R.C.C Retaining Wall for achieving the following advantages:

- Flexible structure which can accommodate differential settlement.
- Free draining structure with no pore pressure development behind wall.
- Easy in construction, as it does not require skilled labourers.
- Does not require curing time as in case of R.C.C Retaining wall.
- Eco-friendly, as the vegetation growth over it, is compatible with surrounding environment.
- Does not corrode under areas which are in constant / partial submergence.
- Cost incurred is very less compared to R.C.C Retaining Wall and depends only on the local availability of boulders.

Conclusion

Rigorous cost analysis was carried out and it was found that for the given stretch of work, TechFab Metal Gabion Retaining Wall costs Rs 17.52 Lacs whereas an R.C.C Retaining Wall of the dimension and grade given by the PWD Department, Pune, costs Rs 52.79 Lacs, which is a cost saving of 67%.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

Reinforced soil wall ,section of NH-8 between Dahisar and Surat

PROJECT BRIEF:

The section of National Highway (NH-8), between Dahisar (suburb of Mumbai) and Surat has been plagued with high-traffic density consisting of heavy vehicles. In order to ease the traffic, the National Highway Authority of India decided to construct 16 new structures over chainage 300 to 375 and widen the road to six lanning. Reinforced Soil Walls were selected for their ease in construction in constrained spaces, cost benefits and quality assurances. Strata proposed the use of StrataBlock system on the basis of its cost and time advantages, amongst other things.

- **Project Title:** Strata India sets New Benchmark in RS Wall Construction
- **Client:** National Highway Authority of India (NHAI)
- **Contractor:** IRB Infrastructure Developers Ltd.
- **Project Size:** 106,366 sqm
- **Max.** Height: 11.5 m
- **Project type:** Construction of Reinforced Soil Walls using StrataGrid
- **Location:** Surat - Dahisar (NH-8 in the Gujarat section)
- **System Offered:** StrataGrid + StrataBlock
- **Design Consultant:** STUP Consultants Pvt. Ltd.
- **Completion Year:** 2011
- **Duration:** 6 months

CHALLENGE:

The biggest challenge for Strata had been time constraints. Even though the casting of blocks started on time, the erection of the structures was delayed due to the prolonged and erratic monsoon season in 2010. Thus the hurdle faced, was in erecting all 16 structures before the next monsoon season which gave Strata only ten months to complete all the structures. To complete a project of this scale, Strata had to accelerate and provide extra capacity and resources.

STRATA SOLUTION:

Strata's professional team at both the head office and at the project site coordinated their activities on a daily basis. A unique and advanced technology software (called "Site Tracker") was custom built for this project, which recorded the various reports and updates regarding the construction of the structures. For smooth management and greater efficiency, the erection stages were divided into three independent projects and two separate casting yards were established.

The StrataBlock system has been used as they have a built-in slope, are self aligning and are cast with an inter-locking system. The structures were designed using Federal Highway Administration – National Highway Institute (FHWA-NHI) guidelines and comprised checks for external, internal and global stability under static and seismic conditions. To make the structure look aesthetically pleasing corner blocks and expansion joint blocks were incorporated by the design team. Strata provided a turnkey solution right from supplying raw materials, designing the structures, casting of all the blocks, to the final construction of the relevant structures.

BENEFITS TO CLIENT:

Strata not only helped the project meet its deadline, but also helped maximize the projects profitability to the owner/client by allowing it to open on schedule.

Reinforced soil wall approaches to the VUPs on the Meerut-Muzaffarnagar Stretch

PROJECT BRIEF:

The National Highway connecting Meerut to Muzaffarnagar needed a site solution that would not only be aesthetically pleasing, technically sound but would also create a seamless travel at all the Meerut – National Highway intersections. Strata Geosystems (India) Pvt. Ltd. along with Gayatri Projects Ltd. was involved in the construction of Geogrid reinforced soil wall approaches to the VUPs on the Meerut – Muzaffarnagar stretch. The system offered was a combination of StrataGrid reinforced soil wall with a panel fascia - StrataWall.

- **Project Title:** Decongest National Highway 58
- **Owner:** National Highway Authority of India (NHAI)
- **Contractor Name:** Gayatri Projects Ltd.
- **Project Size:** 11,700 sqm
- **Max. Height of Wall:** 7.63 m
- **Project Type:** Construction of reinforced soil wall using StrataGrid as soil reinforcement
- **Location:** Meerut- Muzaffarnagar (NH – 58 in the state of Uttar Pradesh)
- **System Offered:** Geogrid with Panel Fascia
- **Consultant:** EGIS – BCEOM International Ltd.
- **Completion Year:** 2010

CHALLENGE:

The biggest hurdle lay in the designing of the walls involved, as it was identified that the side walls were making an acute corner with the abutment and sufficient space was not available to place the StrataGrid. Compaction of soil in the acute corner presented several difficulties. The design and detailing of the soil reinforcement for the acute angle corners was a challenge. This required innovative and lateral thought process.

STRATA SOLUTION:

Strata's professional team at both the head office and at the project site coordinated their activities on a daily basis. A unique and advanced technology software (called "Site Tracker") was custom built for this project, which recorded the various reports and updates regarding the construction of the structures. For smooth management and greater efficiency, the erection stages were divided into three independent projects and two separate casting yards were established.

The StrataBlock system has been used as they have a built-in slope, are self aligning and are cast with an inter-locking system. The structures were designed using Federal Highway Administration – National Highway Institute (FHWA-NHI) guidelines and comprised checks for external, internal and global stability under static and seismic conditions. To make the structure look aesthetically pleasing corner blocks and expansion joint blocks were incorporated by the design team. Strata provided a turnkey solution right from supplying raw materials, designing the structures, casting of all the blocks, to the final construction of the relevant structures.

BENEFITS TO CLIENT:

Strata not only helped the project meet its deadline, but also helped maximize the projects profitability to the owner/client by allowing it to open on schedule.

STRATA
Geosystems (India) Pvt Ltd

Head Office: 317, Tantia Jogani Industrial Premises, J. R. Boricha Marg,
Lower Parel (East), Mumbai – 400 011, India.

Sales Offices: Delhi, Hyderabad, Bengaluru | Tel.: +91 22 4063 5100 | Fax: +91 22 4063 5199 | Email: info@strataindia.com

Reinforced soil wall-Section of NH 8 connecting Surat and Bharuch.

PROJECT BRIEF:

The section of the National Highway (NH – 8), connecting Surat to Bharuch needed a site solution that would create additional roadway access to the prevailing high density in order to ease the traffic on the National Highway. The National Highway Authority decided to construct three flyovers and one vehicular underpass. The StrataBlock reinforced soil wall system was selected due to its ease in construction in constrained spaces, cost benefits and quality assurances.

> **Project Title:** Speeding up the journey from Surat to Bharuch

> **Owner:** National Highway Authority of India

> **Contractor Name:** IRB Infrastructure Developers Ltd.

> **Project Size:** 28,000 sqm

> **Max. Height of Wall:** 10.5m

> **Project Type:** Construction of Reinforced Soil Wall using StrataGrid

> **Location:** Surat - Bharuch (NH- 8 in the state of Gujarat)

> **System Offered:** StrataGrid + StrataBlock

> **Consultant:** STUP Consultants Pvt. Ltd.

> **Completion Year:** 2009

CHALLENGE:

In addition to erection of the structures, a large quantum of blocks were to be casted. The biggest challenge faced by the design team was that each location faced unique problems ranging from erratic soil conditions to seepage water. The onsite soil investigation report, which was carried out to assess the bearing capacity of the soil indicated the soil was weak which could lead to excessive settlement of the structures. The results of the Standard Penetration Test (SPT) showed a variation from 7 to 21 indicating erratic ground conditions. The depth also varied from 1.5m to 4.0m. From 3.0m downwards, the soil profile consisted of blackish yellow plastic silt clay with sand and natural moisture content which was less than the plastic limit. Seepage (ground) water was present near the base (leveling pad) of the proposed site of construction of reinforced soil wall. About 25m of the area was subjected to seepage water.

STRATA SOLUTION:

Based on the prevailing soil conditions, reinforced soil wall system was the most preferred solution for this project. StrataGrid and StrataBlock units were used for the construction of the reinforced soil wall due to their proven performance and easy installation procedure. The StrataBlock system has been used as it has a built-in-slope, is self-aligning and cast with an inter-locking system. Faced with problems of tough soil properties and ground water, the innovative design team at Strata revamped the designs of the structures to address these problems. Federal Highway Administration – National Highway Institute (FHWA) guidelines were followed and at the same time comprised checks for external, internal and global stability under static and seismic conditions. The weakened soil at the site was replaced by well compacted granular soil. The soil below the leveling pad was replaced with graded free draining soil wrapped in geotextile. To address the factor of water pressure the spacing of the StrataGrid reinforcement was reduced above the leveling pad to provide stronger reinforcement.

BENEFITS TO CLIENT:

Strata Geosystems (India) Pvt Ltd, not only completed the structures on time after tackling difficult challenges but also provided the client with superior quality service which was well appreciated by the client. Regular coordination with the client and monitoring the progress of the project on site as well as from the head office was done by the company. This level of efficiency enabled the client to start traffic on the structures on time.

ROB FOR CONNECTIVITY BETWEEN MUNDRA AND NH8A

Mundra , Gujarat, India

GROUND IMPROVEMENT

Technique: Stone Columns + ParaLink

Problem

Mundra Special Economic Zone is located in Kutch District, Gujarat and is one of the largest SEZ in India. An ROB was proposed over the railway line that cuts across the connectivity road between Mundra and NH8A. The approaches of ROB were proposed to be retained by ParaWeb Reinforced Soil wall system However, foundation soil comprising primarily of sandy silt with clay was found to have inadequate load bearing capacity to bear the load of retaining walls.

Keeping in mind the high water table and high consolidation settlements, such a ground improvement technique was to be proposed which would improve bearing capacity of soil, reduce post-construction settlement and also facilitate process of implementation. Thus, considering all these factors, stone column technique with a geosynthetic raft was adopted.

Solution

The stone column technique, also known as vibro-replacement or vibro-displacement, is a ground improvement process where vertical columns of compacted aggregate are formed through the soils to be improved (Refer Photo 1)

Primary purpose of soil improvement by stone column technique is mainly to increase the bearing capacity of foundation soil and also to reduce post construction settlement.

Stone column derives its support from lateral resistance provided by the surrounding soil caused by:

- bulging of the uncemented stone column under the load
- the resistance due to surcharge effect
- the bearing support offered by intervening soil.

Client Name:

M/s Mundra Port & Special Economic Zone Ltd.

Client Name:

M/s Mundra Port & Special Economic Zone Ltd.

Contractor name:

M/s. Chetan Engineers

Products used:

High Strenght Geogrid ParaLink™

Construction info:

Construction Start:	April 2009
Construction End:	June 2010

Fig. 1 Project Location

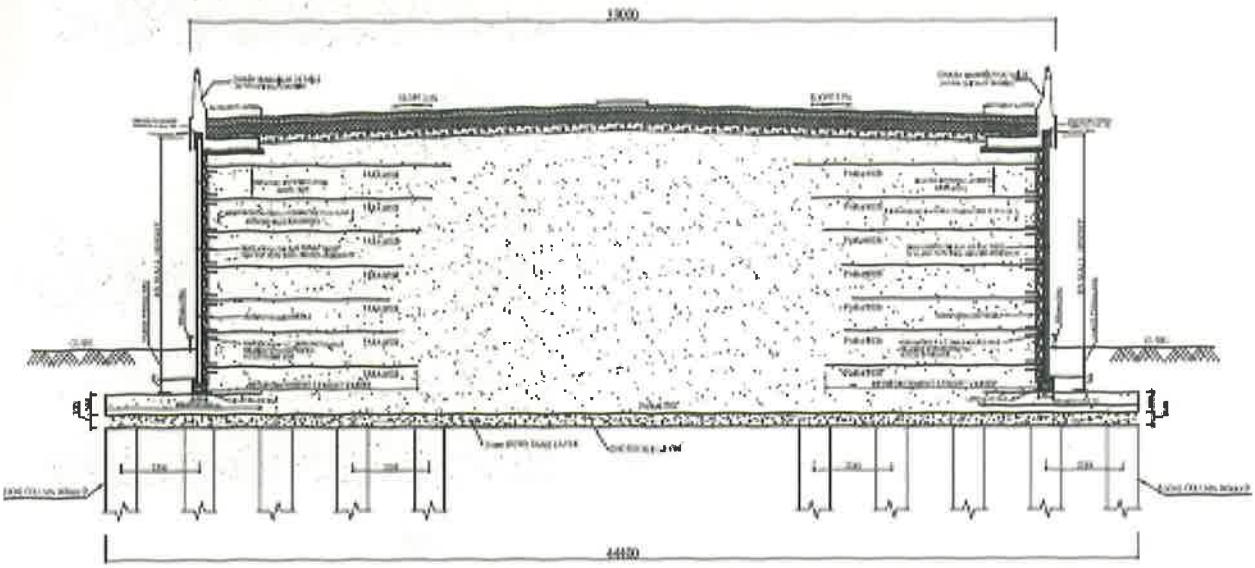
Fig 1 Project location

Wall Height in m	Settlement in mm
8.8	200
8.0	180
7.2	160
6.4	120
5.6	100

Table 1 Estimated settlement at different wall heights

Photo 1 Installing stone columns

The geosynthetic raft is ParaLink™, which are monoaxial array of geosynthetic strips having uni-directional strength ranging from 100 to 1350 kN/m. The purpose of providing ParaLink™ as basal reinforcement is to ensure proper distribution of the load from the superstructure to the stone columns and reduce differential settlements.



TYPICAL CROSS SECTION OF REINFORCED SOIL WALL FOR PARALINK LAYING - NORTH SIDE

Fig. 2 Typical cross section drawing--North side of the approach

ParaLink™ was laid throughout the entire zone both in the North and South side of the structure. The surface of the stone column was covered with a free draining granular fill compacted to 95% of Modified Proctor density.

Present Status of the Project: The Structure is completed successfully. It is an aesthetically pleasing strucutre with perfect alingment.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot No. 04, Jasola District Center, New Delhi– 110044
Tel No.– 011 43798400, Fax No.– 011 4654 6330
Web site: www.maccaferri-india.com, Email: technical@maccaferri-india.com

MACCAFERRI

CASE HISTORY
RETENTION WORKS FOR HAJJ HOUSE
Calicut, Kerala, India

ENVIRONMENTAL/SLOPE PROTECTION
Product: TMS/Para Link/Geotextile

Problem
Hajj Committee had developed Hajj house at Calicut, Kerala. In the vicinity of the building there was high level difference between finished level and existing ground level varying from 8m to 13m with exposed rock at existing ground level; hence as a temporary arrangement soil was dumped on which road was proposed to be developed. The dumped soil had started to slide at various locations; therefore to protect the slope a suitable retention measure was essential.
In a place like Kerala where monsoon is heavy continuously for 3-4 months, there is every chance of reduction of strength (especially cohesion) for lateritic kind of deposit. The soil in the surrounding is lateritic in nature. Lateritic soil have a peculiar characteristics of having high shear strength in dry conditions while in contact with water the shear parameters reduce drastically. Flexible structure with enough permeability to dissipate the excess pore water pressure that may develop in retained fill would be an ideal solution.


Photo 1 Area to be protected

Solution
Considering the heights to be retained, expected loads, site constraints and client requirements Maccaferri proposed a Paramesh System-very quick & easy to construct. Paramesh system consists of gabion facia units with an integrated double twist mesh as secondary reinforcement and ParaLink (Geogrid) as reinforcing element.
Non- woven Geotextile were used behind the gabion facia units in order to act as a separator and filter, which allows free movement of water and prevent backfill soil to enter in the voids in between stone filling with gabions facia.
With Maccaferri solution client spend only half cost when compared to conventional solution like RCC wall, which was another alternative solution. Simple drainage arrangements were provided on top of slope and within the structure in anticipation of heavy pore water pressure.


Photo 2 Construction in progress


Photo 3 Construction in progress

Client Name:

Hajj Committee, Kerala.

Main contractor name:

Nirmaan Construction Pvt. Ltd.

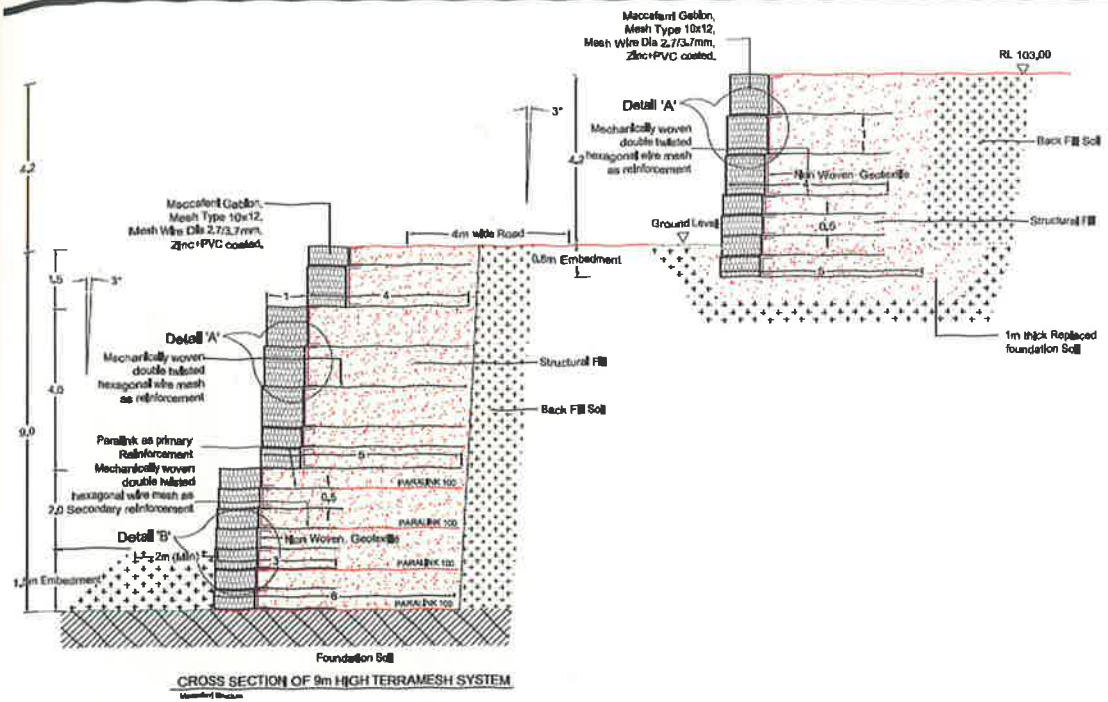
Products used:

Terramesh System=740 Sqm. ParaLink=3240 Sqm

Construction info:

Construction Start:	February-2011
Construction End:	May-2011

MACCAFERRI



Cross section of the solution adopted

Construction of Geosynthetics Reinforced soil retaining structure for widening of Temple approach road, Kanaka Durga Temple, Vijayawada, Andhra Pradesh

Project Data:

Project: Construction of 22m Height Two -Tiered Geosynthetics Reinforced Soil Retaining wall.
Project owner: Government of Andhra Pradesh
Project contractor: Geosol Associates.
Product Installed: PEC 75, PEC100, PEC150, PEC200

Introduction:

Vijayawada is a bustling city in the state of Andhra Pradesh and located on the Chennai – Kolkata National Highway No:5. This city is considered to be a commercial hub for various agri based products which include rice, chilly, sugarcane and etc. with in Andhra Pradesh and Tamilnadu.

These city abodes a temple for deity Kanaka Durga and the temple located on a hill shrine famously known as Kanaka Durga Temple.

The temple has 1km long hill road connecting the foot hill to the hill top where the temple is located. This temple attracts large number of pilgrims during the festival seasons especially Vijaya Dasami and Bhavani Deeksha.

The existing width of the approach road is very narrow at Choultry turn and Om circle and unable to handle the traffic intensity during festival seasons. On one such occasion, during the heavy congestion of traffic on the hill road resulted in some fatalities.

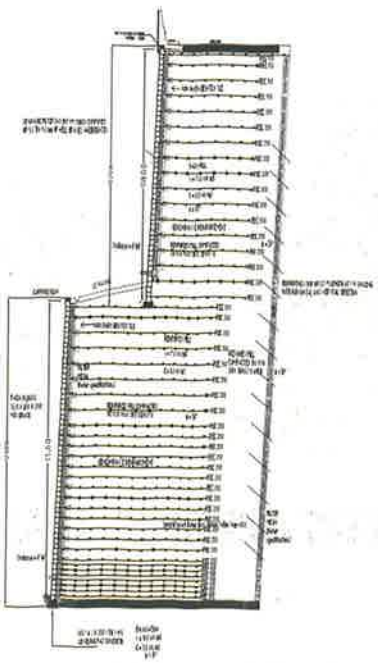
The state government authority drew action plan to solve this problem and decided to widen this road at these two locations. It was decided to build retaining walls and stabilize the slope at these two locations. Apart from that, it gains extra space on top of the retaining walls.

Problem and Solution:

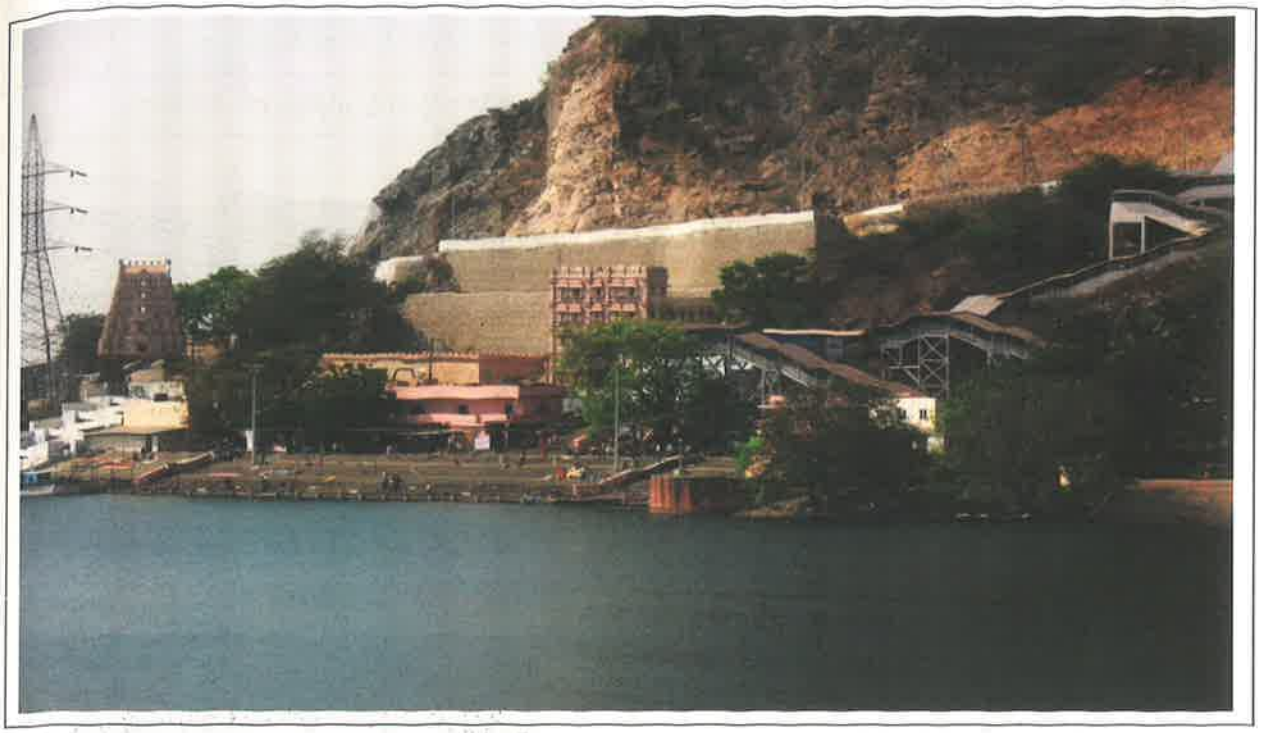
Widening of the hill approach road is an engineering challenge considering its close proximity to the National Highway no. 5, which is a very busy road. Transportation of backfill soils to build 22m & 42m high retaining walls at a space constraint working area and to manage the safety of the public and the workers during the construction stage is another challenge to the construction team.

The engineer of the project decided to choose Geosynthetics reinforced soil technology against rigid reinforced concrete structure due to its flexibility to tolerate with the differentiate settlement, cost effectiveness of the system and most important the safety of the structure. The fascia of the Wall is chosen to build with segmental blocks for its ease of handling during construction.

Proposed site for widening



TYPICAL CROSS SECTION



Completed Two-Tiered Wall view from Krishna River

The reinforced soil technology uses soil reinforcement made of Geosynthetics installed horizontally to the designed length and strength in each layer within the backfill soil in successive layers of backfill to absorb the tensile stresses generated within the soil mass

This technology required using a free draining select backfill to make sure the pore water pressure is relieved during saturation and doesn't pose problems to the stability of the structure during its function. However the backfill soil available does contain more than 36 % fine material , which is more than 15%, as recommended in accordance to FHWA –NHI-10-024 (Standard code of practice for design of reinforced soil retaining walls).

Considering the cost economics to transport a select backfill from a distant location vis-à-vis using a locally available backfill, the engineer preferred to use a **High Tenacity Composite Reinforcing Geotextile** which is made of 100% Polypropylene continuous filament non-woven geotextile stitched with high tenacity polyester yarns.

The Non-Woven used in the composite offers in-plane drainage and separation function with helps to dissipate the pore water pressure within the soil in quicker time, while the polyester yarns provide necessary reinforcement function.

The 22m wall is designed to have two tiers with bottom tier having 12m and the top tier having 10m respectively.

Tencate Polyfelt PEC composites geotextile having tensile strengths ranging from 75kN/m, 100kN/m, 150kN/m & 200kN/m are used as soil reinforcement.

In order to provide resistance against sliding at the interface of the rock face of the hill slope and the reinforced soil mass, it was proposed to use 3m long steel anchors made of strips (40mm x 5mm) @ 1.5m c/s both horizontally and vertically.

In order to provide sufficient drainage system to discharge the internal water from the hill, chimney drain along with a drainage blanket at the bottom of the wall were constructed.

Performance: The wall is found to be satisfactory after 3 year after completion and is in very stable condition.

GARWARE – WALL ROPES LTD (Geosynthetics Division)

Slope Protection by Gravity Retaining Wall at Lanjigarh, Orissa

Product: Steel Gabions, Woven Geotextile

Problem:

As a part of plant expansion, a chimney is constructed adjacent to the existing hill slope. The level difference between the hill top and toe of chimney was varying upto 32 m. A suitable retaining wall is required to retain the hill slope from slope failures and to safeguard the chimney and road.

Picture 1. Existing slope profile to be retained

Solution :

In order to protect the chimney and adjacent land from slope failure a two tier Gabion Gravity retaining wall is proposed. The slope stability scheme is as mentioned below

1. Height of bottom tier wall is 12m (including embedment).
2. An intermediate berm of 9.5m wide
3. Height of top tier wall is 11m (including embedment).
4. Slope surcharge of 10m height above top tier gabion retaining wall.
5. A Geotextile layer is proposed behind the gabion wall for filtration purpose.

Picture 2. Filling of gabions with boulders

Client:

Vedanta Alluminium Ltd.

Contractor:

Garware – Wall Ropes Ltd.

Products used:

Steel gabions	: 8700 Cu.M
Woven geotextile	: 3650 Sq.M

Construction info:

Year - 2010

Picture 3. Construction of Gabion Retaining Wall in progress

Picture 4. Two tier Gabion Retaining Wall after construction

Picture 5. Longitudinal elevation of two tier Gabion Retaining Wall after construction

Advantages:

1. Flexibility: Gabions tolerate differential settlement without fracture. This is especially important when building on unstable ground or in marine or river applications where waves or currents are a consideration.
2. Permeability: Hydrostatic heads do not develop behind gabion structures because of their permeable nature. They are free draining structures ideal for slope stabilization and retaining walls.
3. Durability: The durability of gabion structures increase with age. As consolidation takes place, silt and soil collect in the voids and vegetation becomes established.
4. Cost Effectiveness: Requiring unskilled labour and limited plant, a gabion structure can be built anywhere at low cost.
5. Speedy Construction: speed of construction is very fast as the time is not lost like RCC walls for curing and simultaneous back filling is possible.
6. Ecology: Gabions permit the growth of vegetation and maintain the existing environment; they provide attractive and natural building blocks for decorative landscaping.

Present Status:

The two tier gabion wall is constructed and the performance of the wall is found to be satisfactory.

3. Case studies on River Bank – Shore Protection and Erosion Control

Sr No.	Case study	Company Name
52	Shore Protection at Udappa, Andhra Pradesh	Garware Wall Ropes Ltd.
53	Shore Protection Works at Hazira, Gujarat	Garware Wall Ropes Ltd.
54	Nourishment / Rebuilding of spurs and Bank protection works for Eroding zone of Nischintapur,Parganas(south)	Meccaferri Environmental Solutions Pvt. Ltd.
55	Erosion protection works along banks of Bramhapurtra River, Rohmoria , Assam.	Meccaferri Environmental Solutions Pvt. Ltd.
56	Muck Disposal From Rampur Hydroelectric Power plant.	Meccaferri Environmental Solutions Pvt. Ltd.
57	Erosion Control Measures for the Bhagirathi River at Prachin Mayapur – Nabadwip in District of Nadia, West Bengal	Kusumgar Corporates Pvt Ltd.
58	Protection against Sea Erosion of coast at Village Fansa & Tata wadi, Umbergaopn, Pardi.	Kusumgar Corporates Pvt Ltd.
59	Erosion Control Project at Titthal Beach Valsad.	Kusumgar Corporates Pvt Ltd.
60	Ganga River Erosion Control Project	Kusumgar Corporates Pvt Ltd.
61	Protection of shoreline and restoration of eroded beach at Dahanu, Maharashtra, India.	Techfab (India) Industries Ltd.
62	River Bank Protection of Churni River , West Bengal	Techfab (India) Industries Ltd.
63	Slope protection of Swan River in the State of Himachal Pradesh	Techfab (India) Industries Ltd.
64	Protection of the embankment from erosion-Mahisagar River	Techfab (India) Industries Ltd.
65	Shore Erosion Prevention and Reclamation of Eroded Beach, Dahanu Port	Techfab (India) Industries Ltd.
66	Riverbank protection project in Assam	Techfab (India) Industries Ltd.

GARWARE – WALL ROPES LTD. (Geosynthetics Division)

Shore Protection at Uppada, Andhra Pradesh

Product: Geotextile tube, geotextile bags, woven geotextile, PP rope gabions

Problem:

Coastal area (length-1.463 km) of Uppada village in East Godavari district, Andhra Pradesh was subjected to severe sea erosion for the past several years.

Considering the importance and need, a suitable erosion protection sea wall was required to safeguard the villages and other monuments along the coast.

Photo1. Laying of geotextile and bags

Solution:

A geotextile tube sea wall was proposed to be built along the coast line to prevent the erosion. The materials identified for the construction includes geotextile tubes, geotextile bags woven geotextile and polypropylene rope gabions.

Geotextile tubes made of polypropylene woven geotextile, each 20m length and 3m diameter has been used as the core of the sea wall.

Photo2. Spreading of geotextile tube in position

Client:

Irrigation & CAD Department, Govt. of Andhra Pradesh

Contractor:

Garware – Wall Ropes Ltd.

Photo4. Typical cross-section of geotextile tube sea wall (2 + 1 configuration) along with PP roe gabion as armour layer

Photo5. Geotextile tube sea wall after completion

Advantages:

1. Proven and effective system across the globe for protecting shorelines, rebuilding beaches, reclaiming land, break waters & other marine works.
2. Sea sand as fill material – hence better option for places with less stone availability
3. Durable Structures – material selection based on established international guidelines and severe marine conditions of sea.
4. Easy to install – hydraulic filling using pumps to fill the dredged sand
5. PP rope gabions - highly flexible and allows immediate dissipation of hydrostatic pressure
6. Established cost effective system

Present Status:

The performance of geotextile tube sea wall with polymer rope gabions as armour layer is well appreciated after the recent cyclones. Regular maintenance of these structures is required to increase the long-term performance.

GARWARE – WALL ROPES LTD. (Geosynthetics Division)

Shore Protection Works at Hazira, Gujarat

Product: Geotextile Containers, Woven Geotextile, PP rope gabions

Problem:

A reclamation work has been planned as a part of port terminal development. Towards this, the area on the southern side of the existing land based drilling platform needed to be reclaimed to create the port back-up facility. To retain the reclamation material as well as to protect the proposed back-up yard from the severe marine and tidal environment, a peripheral shore protection system was required for a length of 2.25 Km. Further, as a part of reclamation work, slope of height 10m was to be protected against erosion by the waves.

Photo1. Apron using PP rope gabions

Solution:

Considering the benefits of using geosynthetics and its wide range of applications in coastal protection works, a shore protection system using geosynthetic materials was adopted. Based on the design parameters, shore protection system with geotextile containers as core material and with stone armour layers was designed. Dredged material was used to fill the geotextile containers which acted as a barrier to prevent outgress of dredged material into the sea.

Geotextile containers were manufactured from high strength woven geotextiles and are filled with locally available dredged sand. These containers were stacked one above the other to form the required slope. Polypropylene rope gabions filled with stones were provided as launching apron to prevent scouring of the toe.

Photo2. Steel frames to support geotextile containers

Client:

Adani Hazira Port Pvt. Ltd.

Contractor:

Garware – Wall Ropes Ltd.

Products used:

Geotextile container	: 18,000 Nos
PP rope gabion	: 30,000 Cu.M
Woven geotextile	: 2,00,000 Sq.M

Construction info:

Year - 2011

Photo3. Shore protection work after construction

Photo4. Arial view - before land reclamation

Photo5. Arial view - After land reclamation

Advantages:

1. Retain the back filled dredged sand during reclamation to prevent the outgress into the sea
2. Temporary shore protection (2 to 3 years) till the armour layer is constructed
3. Fill material - use of locally available dredged sand
4. Easy and speed rate of installation
5. Cost effective - The cost of present system is one-fifth when compared to conventional systems. Cost saving obtained is 80%.

Present Status:

In general, the overall system was found to be in good condition. Subsequently, primary and secondary rock armours are to be placed over the core geosystem to safe guard against the harsh marine environment.

MACCAFERRI

CASE HISTORY

NOURISHMENT/REBUILDING OF SPURS & BANK PROTECTION WORKS FOR ERODING ZONE OF NISCHINTAPUR

Kulpi, Parganas(South), India

RIVER BANK PROTECTION WORKS

Product: MacBag

Problem:

In Nishchintpur, Hoogley river flows through western part of the Sundarban Delta in West Bengal. As per oceanography studies of Jadhavpur university, it came to know by the tide gauge record that the sea is arising at the rate of 3.14 mm every year. Due to the rising of sea level and high rise tides, part of the river bank has lost about 80 Sqkm of land during last 20 years. Homes and lands washed away with water and life of the people is badly affected due to the hungry tides of the river. To overcome from the above problem, different types/ combinations of bank protection measures needed to be adopted

Solution:

In order to protect bank from waves and current, transverse structures needed to be provided which will deflect the water away from river bank. Spurs are best option to reduce impact of water on the bank. As affected bank is so long i.e 5-6 Km, Kolkata Port Trust (KoPT) has suggested to construct spurs in series to resist the current. Another advantage of this arrangement is, after time elapses, silt will accumulate in between spurs thus forms permanent bank. For construction of spurs, following methodology is adopted.

Wherever construction of bank, sufficient land is not available, KoPT has suggested to provide polymeric gabions filled with geotextile bag for the stretch of 750m.

The construction steps shall be listed as below:

- Multifilament woven Geotextile as a filter is placed with the help of fascine grid having side lapping of minimum 400 mm & horizontal of minimum 250mm.
- Building of new spurs & Nourishment of existing spurs with geotextile bags, so that they can get almost a permanent bank after certain time due to siltation.
- Geotextile bags Suggested which are made of Polypropylene multifilament woven fabric.
- Laterite blocks to cover and protect the spurs made from geotextile bag.

Client Name:

Kolkata Port Trust

Photo 1 Site eroded due to wave effect

Photo 2 Erosion effect on site

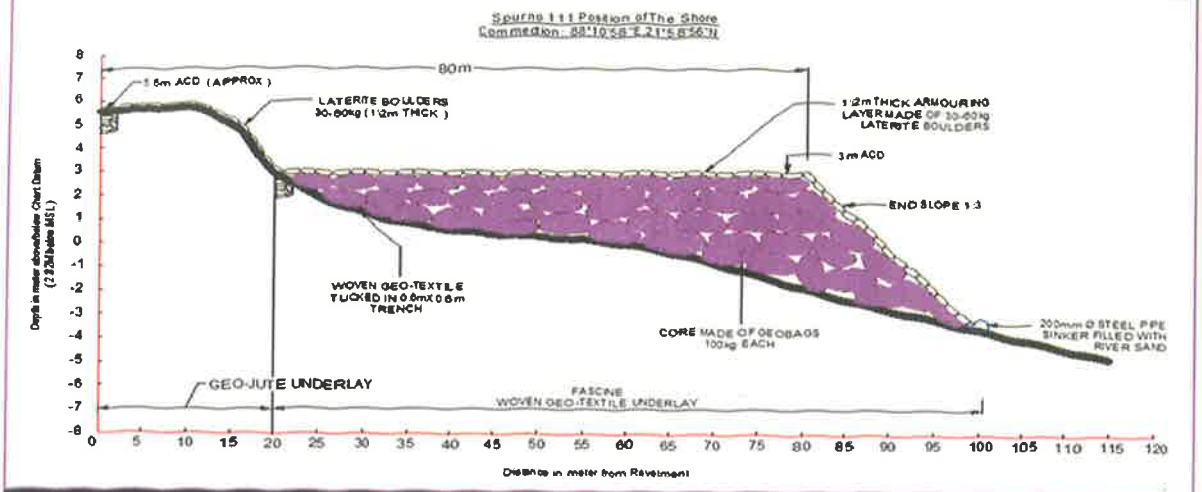


Diagram 1. Arrangement Drawing

Specifications of Geotextile Filter:

- Mass per Unit Area: 240 Gsm (min).
- Tensile Strength: 40 KN/m or equivalent both warp and weft at 15% elongation.
- Apparent opening size (A.O.S):- 150 - 200 microns.

Specifications of MacBag:

- Mass per Unit Area: **240 Gsm (min).**
- Tensile Strength: **40 KN/m or equivalent** both warp and weft at **15%** elongation.
- Apparent opening size (A.O.S):- **100microns (maximum).**

Photo 4 Arranging Geobags

Photo 5 Arranged Geobags

Present Status of the Project

The Project is completed and structure serving the purpose.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot no. 4, Jasola District Center, New Delhi – 110 044
Tel: +91- 11- 4379 8404, 4379 8400, Fax: +91- 11- 4654 6330
E-mail: technical@maccaferri-india.com - Web site: www.maccaferri-india.com

MACCAFERRI

CASE HISTORY

EROSION PROTECTION WORKS ALONG BANKS OF BRAHMAPUTRA RIVER

Rohmoria, Assam, India

ENVIRONMENTAL / HYDRAULICS / EROSION PROTECTION

Product: Gabion, Geotextile Bags

Problem

Brahmaputra River is one of the major and aggressive rivers in Asia. Over the past 20 years, the river has destroyed many paddy fields, homes, schools and plantations in the village of Rohmoria. To mitigate the problem of bank erosion, Water Resource Department of Assam had proposed to carry out emergent measures for bank protection works in Rohmoria village, Dibrugarh district. The anti-erosion work using MacBags (Geotextile bags) for river bank protection works are being implemented in a 2.60 kilometer stretch along the Brahmaputra River from Bogoritolia to Kasuoni that was been identified as highly affected zone. It is estimated that 18000Ha area is benefitted from the entire scheme.

Photo 1 Scouring of the banks of Brahmaputra River

Solution

The scheme was proposed by Water Resources Department to protect bed and bank. Proper bank and toe protection works was the key to the system proposed.

This was followed by well dressed bank slope and the height of slope was approximately 5.5m. The bank and bed protection were carried with MacBags placed on geotextile filter layer. Peripheral strips of Steel Gabion and PP rope gabions filled with layers of geotextile bags were placed at regular intervals to impart further stability to the scour protection measure. High quality Non woven Geotextile materials as a filter and separator to protect the bank slope beneath the MacBag revetments was used.

The PP rope gabions filled with MacBags in two layers were installed at the toe of the slope excavation. The high quality Non woven Geotextile filter was then laid and MacBags in three layered system were laid or placed on the slope. The PVC coated Double Twisted wire mesh Gabions were used on the slopes in rib form which were also filled with MacBags.

Photo 2 Filling & transportation of MacBags™

Client Name:

Water Resources Department, Assam

Contractor name:

Maccaferri Environmental Solution Pvt Ltd

Products used:

Approximate 800,000 no.s of MacBags, 2600 no.s of Polypropylene rope gabion and 3300 no.s of gabion (zn+pvc), 64300 sqm of non woven geotextile filter

Construction info:

Construction Start:	October-2011
Construction End:	April-2012

Photo 3 Construction— Stretches to be protected

The whole project consists of two parts. They are
1. RCC Porcupine screens which were installed (by other local contractors) in the upstream and downstream of the stretches, which also helped in the River Bank protection.
2. Geotextile Bag revetments for River erosion

Photo 4 River bank dressed to 1V:3H slope

Installation:
Methodology involved first excavation of Sand from the sand chars situated on the other bank, screening and filling into the MacBags and then the bag mouths were secured by using a portable double needle chain stitching machines. Since such a large quantity had to be executed within such a short period of time, enormous resources in terms of manpower, machineries and equipments had to be mobilized and employed.

After conducting periodic bathymetric survey bags had to be dumped from large sized flat bed boats on the bed extending upto the length of scour apron to ensure uniform coverage. In some stretches, dry bed scour apron with bags were also installed.

The major challenges faced during the project were,

1. Scarcity of stones:
The North Eastern region has scarcity of stones, therefore MacBags made of high quality Non Woven needle punched Geotextile with excellent seam strength, UV strength, superior hydraulic and mechanical properties was chosen.
2. Less working window:
As in typical North Eastern states Assam also faces very limited working season of 5 months. In the northern part of Assam along the Bramhaputra River the water level varies and fluctuates creating problems for working. Also, as the day light period is less hence shortened working period.

Photo 5 Unloading of MacBags™ on the river bank

Around 400-500 labour were deployed from stitching to placement of MacBags. On an average of 125,000 numbers of bags per month was laid. Maccaferri supplied and installed 8 lakh MacBags successfully.

In June 2012, the flood situation in Assam deteriorated more than 1,000 villages and water level in other villages was about five feet high. The anti-erosion work constructed in April 2012 was totally submerged under water and in some part flood water passed over the protection work. The erosion protection measures constructed with MacBags™ survived the flood and protected the banks. After flood, considerable amount of silt deposits was noted which is an indication of success of anti-erosion works along the river banks.

Photo 6 Condition of MacBags™ & River Bank after flood

Present status:
The construction is complete and structure serving the purpose.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot No. 04, Jasola District Center, New Delhi– 110044
Tel No.– 011 43798400, Fax No.– 011 4654 6330
Web site: www.maccaferri-india.com, Email: technical@maccaferri-india.com

MACCAFERRI

CASE HISTORY

MUCK DISPOSAL FROM RAMPUR HYDROELECTRIC POWERPLANT

Shimla, Himachal Pradesh

ENVIRONMENTAL/RIVER BANK PROTECTION

Product: BioMac

Problem:

The hydroelectric power plant was to be executed by the Sutlej Jal Vidyut Nigam (SJVN) near the Sutlej River. The project site is located near Jhakri village, upstream of Rampur Bushahr town in Shimla district.

It is strongly recommended to have estimates for muck generation and quantity that is proposed for reuse, as it could be a very serious concern if it finds a path in river Satluj.

It was also advised to adopt scientific technology for preparation of muck disposal sites including landscaping to avoid deteriorating impacts on river ecology. Mostly muck disposal sites identified by the SJVNL are on right bank of river as most of the village settlements are along the left bank of the river.

Photo 1 Slope before installation of Biomac

Solution:

With consideration of specified problem, it was decided to dump the muck on the upper slopes of the Sutlaj river. To avoid the muck from falling down into the river, slope protection was proposed. For environmental purpose, it was required to protect the slope with the solution which allows growth of vegetation. Hence, Coir Mat - BioMac C is selected to serve the purpose.

Biomac® C is an "extended life" erosion control blanket manufactured from 100% coconut (coir) fiber. The blanket is covered on the top and bottom with a UV stabilized polypropylene netting, which is stitched together to create an even mat. The coconut fiber is evenly distributed between the nets. The edges of the mat are rolled and stitched to create a closed edge and prevent unraveling. Biomac® C has an expected design life of approximately 36 months in normal conditions.

Photo 2 View of Biomac roll

Client Name:

Rampur Hydro electric Project

Main contractor name:

Applications

Biomac® C is used for short term erosion control and revetment protection to assist in the establishment of vegetation on:

- Steep slopes and embankments up to 1:1;
- Areas exposed to high rainfall;
- Ditches and water courses with low energy flows.

Biomac® C is used in combination with soil bioengineering techniques such as live fascines, to reduce surface runoff, and live stakes as an anchoring device for the system. Biomac® C can be used in combination with other ecological systems such as Green Gabions® and EnviroLogs® for protection, restoration and erosion mitigation of wetlands.

Benefits

- Provides immediate erosion control and high moisture containment to help establish vegetation.
- Creates hospitable conditions for plant invasion and establishment.
- The polypropylene netting provides initial root reinforcement at the early stage of vegetation establishment.

Materials

Fiber: 100% Coconut Fiber
Netting: Top: UV stabilized polypropylene
Bottom: UV stabilized polypropylene
Thread: UV stabilized polypropylene

Photo 4 Laying of Biomac

Photo 5 Photographs installation of Biomac

Photo 6 Close up view of BioMac

Photo 7 Vegetated Slope

Present Status of the Project

The project is completed in 2009. Very good vegetation has grown on the protected slope.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot no. 4, Jasola District Center, New Delhi – 110 044
Tel: +91- 11- 4379 8404, 4379 8400, Fax: +91- 11- 4654 6330
E-mail: technical@maccaferri-india.com - Web site: www.maccaferri-india.com

KUSUMGAR CORPORATES PVT. LTD.

101/102, Manjushree, N.S. Road No. 5,
V.M. Road, Vile Parle (West)Mumbai 400 056
Tel:022-26184341/26184350 Fax : 022-2611 5651
info@kusumgar.com, www.kusumgar.com

EROSION CONTROL MEASURES FOR THE BHAGIRATHI RIVER AT PRACHIN MAYAPUR - NABADWIP IN THE DISTRICT OF NADIA, WEST BENGAL

Product : 240 Gem PPMF Geotextile

Problems :

Erosion is the perennial problem of the banks of Bhagirathi River in West Bengal. Every year villages after villages are eroded. Nabadwip, birth place of Shri Chaitnya Mahaprabhu was in danger of being eroded by the Bhagirathi river. President of Jila Parishad of Nadia district has approached us for the solution of problem.

Before Use of Geotextile

Solution :

Geotextile is used between soil and rip-rap and/or geobags to prevent the erosion of soil. The geotextile is used in lieu of a conventional graded aggregate filter. In this application, large armor stones and geobags are placed to protect the soil against erosion and wave attack. The use of geotextile in this application provides substantial savings over conventional aggregate systems with far greater control during the construction, particularly underwater applications.

Laying of Woven Geo filter using Bamboo Strips

The three main criteria that must be met for these applications are :

- **The Geotextile must be capable of retaining the soil particles beneath the geotextiles. Apparent opening size of the geotextiles depends upon the particle.**
- **The geotextiles must have sufficient permeability to permit the passage of water, thus relieving hydrostatic pressure behind the geotextile mattress.**
- **The geotextiles must have adequate tensile strength.**

Dumping of Geobags

240 gsm woven fabrics geotextile made from multifilament yarn has been used as a filter media over the river bed about 30 m inside the river over which geo bags have been dumped to keep the filter bed in position. For the river bank protection at Bhagirathi, it is suggested to have high survivability since large size geo bags of 1.5 m diameter and 1.0 height have been used. More than 15% elongation is required since the fabric has to take the shape of uneven ground surface, armors in the ground, bamboo roots if any.
On the bank spun bonded Nonwoven 250 gsm has been used as a filter media.
After the installation of Geosynthetics, there is no further erosion in that region till date.

River Bank after Geotextile Installation

Department Name:

Nadia Irrigation, West Bengal

Contractor Name :

Jashjit Mukherjee

Product Used

240 gsm PPMF Geotextile

Construction info :

Construction Start :	March 2007
Construction end :	July 2007

River after Geotextile Installation

EROSION CONTROL PROJECT AT TITTHAL BEACH, VALSAD

Product : 250 GSM Woven Multifilament Polypropylene Geotextile

Problem :

Titthal beach is a beach long Arabian sea located 5 Km west of Valsad town in Gujrat. The beach is famous for its black sand.
The beach and its surrounded area are eroded due to continuous impact of waves and tides. The velocity of waves is often is high as 5 m per sec. The erosion may cause danger to the inhabitants residing near the sea beach.

Solutions :

Rip-rap and synthetic woven geotextile has been used for the protection of bank. HDPE Geobags are placed between rip rap and geotextile for puncture or tear. The geotextile is placed along the bank. The geotextile is unrolled and loosely laid on the smooth graded slope. The machine direction of geotextile is placed perpendicular to the slope direction.

Department Name:

Erosion control project at Titthal Beach, Valsad

Contractor Name :

Vama Constructions Co.

Product Used :

250 GSM Woven PPMF Geofabric

Construction info :

Construction Start :	Jan 2012
Construction end :	June 2012

Laying of Geotextile

Laying Of Geotextile

PROTECTION AGAINST SEA EROSION Of COAST AT VILLAGE FANSA & TATA WADI, UMBERGAON, PARDI.

Product : 240 GSM Woven Multifilament Polypropylene Geotextile

Problems :

The beach and its surrounded area are eroded due to continuous impact of waves and tides. Often the height of waves is more than 5.0 m. The velocity of waves is often is high as 4-5 m per sec. The erosion is a serious danger to nearby villages.

Laying of Geotextile

Solution :

Geotextile synthetic and boulders have been used for the protection of bank. Geobags are placed between rip-rap and geotextile to protect the later from puncture or tear. The geotextile is placed along the bank. The geotextile is unrolled and loosely laid on the smooth graded slope along the bank. The machine direction of geotextile is placed perpendicular to the slope direction.

Client Name:

Narmada Water Resource And Kalpsar Department

Contractor Name:

Sahara Infrastructure & Jai Shakti Construction

Product Used :

240 gsm PPMF Woven Geotextile

Construction info :

Construction Start :	**Jan 2012**
Construction end :	**May 2012**

After Completion of project

After Completion of project

GANGA RIVER EROSION CONTROL PROJECT AT RAGHUPUR SITE NAUGACHIA (BIHAR)

Product : Woven Geofabrics & Geobags

Problems:

The Ganga River passes through the Naugachia district of Bihar. The river is perennial and along its course meanders in many regions. As a result of meandering accompanied by velocities of the order of 1 to 3 m/sec, the banks and the bed which comprise of silty sand and silty clay respectively gets eroded every year.

At this location the river is about 100m. In wide and the water level as measured in April varies from 5m near the bank to about 15m. In the middle of the river. The erosion causes financial as well as human loss and distress.

Solution:

The Geosynthetic filter fabric is placed on the bank to prevent the erosion of the soil. The fabric allows the water flow in both direction, but does not allow the soil to pass through.

Due to this erosion is controlled. Geobags of 1m x 1 m x 1m is put on the geofilter fabric to keep the same in proper position as well as preventing from UV degradation.

Department Name:

Ganga River Erosion control project at Bihar

Contractor Name :

Proper Construction

Product Used :

Woven Geobags & Geofabric

Construction info :

Construction start :	Feb 2007
Construction end :	November 2008

Erosion of River Bank

Filling of Geobags

Geobags Laid on Riverbank

TechFab Techtubes for Protection of Shoreline and Restoration of Eroded Beach at Dahanu, Maharashtra,India

CASE STUDY

Client : Maharashtra Coastal Department

Project : Project of shoreline and restoration of beach at Dahanu in Maharashtra

Contractor : Gohel & company

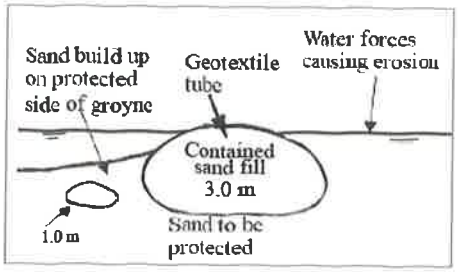
Installation Year : 2011

Product used : Tech-Tube TT10, 20m in length

Overview

Dahanu is located on the western coast of India, facing Arabian Sea on the border of Maharashtra and Gujrat. The 1500m long beach is continuously eroding due to abrasive action of the sea waves. The increasing erosion of the beach has also endangered the adjoining structures and habitation near this location.

The conventional methods for restoration of the beach and erosion control have been tried and found ineffective, The TECH-tubes made of engineered high strength woven fabric,have been thought of as an effective solution to the problem due to their capability of controlling the shore erosion caused by strong wave action on the one hand and facilitating the natural deposition of sand layer behind them in longer term. The geotextile tubes that have been proven worldwide as an effective alternative to conventional methods of shore protection, erosion control, and reclamation was proposed as a solution to the problem here. These systems have been successfully installed in various parts of the world for the construction of different type of marine and coastal structures.The schematic diagram of the proposed solution is shown here. The system has three components a) Main tube (3.0m theoretical dia.) b) Anchor tube (1.0m theoretical dia.) and. c) Scour Apron made of high strength woven geotextile to prevent scouring of the base. The above system performs as erosion control mechanism for protection of shoreline and depositionof natural sand behind it. On the present project site the problem was that of continuous erosion of shoreline due to wave action.



To solve the problem a Groyne was proposed made of 3.0m theoretical diameter Tech-tube and an anchor tube of 1.0m theoretical diameter was installed in front of this as an anchor toe.

Installation:

Submersible slurry pumps were deployed to fill the Tech-tubes.A sand slurry mix of 70% water and 30% sand was pumped through 10 BHP pumps. This mix was pumped from the excavated pits made specifically to pump the sand slurry. The slurry was pumped into the Tech-tubes through the inlet ports provided on top of the tubes. The pumping operation was conducted in stages and planned according to the tides. After each filling operation the Tech-tubes are left for expulsion of water from fabric and consolidation of sand.

Conclusion:

The Tech-tubes have been installed on part of the eroded beach line. The flexible groyen made up of Tech-tubes is 1.6m high after consolidation. This coastal structure is found to fulfill the desired objective in successful manner.

USE OF TECHGEO NONWOVEN GEOTEXTILE AND TECHGEO NONWOVEN GEOTEXTILE BAGS FOR RIVERBANK PROTECTION

Project Description

Project: Protection works to eroding left bank of river Churni at Rabonbore for a length of 650m in Block - Ranaghat - I, P.S - Ranaghat, Dist. - Nadia, West Bengal, India.

Client: Government of West Bengal, Nadia Irrigation Division, I & W Directorate, Krishnagar, Nadia.

Contractor: M/s TULIP Construction & M/s SUDIP ROYCHOUDHURY.

Product: TechGeo Nonwoven Geotextile PN 25

TechGeo Nonwoven Geotextile Bags 420 Gsm

Manufacturer: TechFab (India) Industries Ltd.

Before Rehabilitation - Churni River Bank

Before Rehabilitation - Churni River Bank

The Challenge

Churni was actually an artificial canal built by the Maharaja Krishna Chandra, King of Nadia, in order to protect the region from the enemies. However, due to the tragic flood over the years, the artificial canal built turned into river, caused erosion at the bank of the river. Effect of erosion was so serious that it caused serious losses in the form of loss of agricultural land, home, property, loss of lives, economic loss are a few to name. Embankment bank protection with conventional methods such as rip-rap had proved to be costly and unyielding over a longer period of time. As clear from the photographs above, the existing embankment slope was severely eroded due to the flood in the river.

Thereby in order to mitigate the erosion, TechFab (India) Industries Ltd suggested the TechGeo Nonwoven Geotextile and TechGeo Nonwoven Geotextile Engineered Fabric Bags with high abrasion resistance. Government of West Bengal, Nadia Irrigation Division, I & W Directorate, Krishnagar, Nadia awarded the protection works to eroding left bank of river Churni at Rabonbore for a length of 650m in Block - Ranaghat - I, P.S - Ranaghat, Dist. - Nadia, West Bengal to M/s TULIP Construction & M/s SUDIP ROYCHOUDHURY.

The Solution

TechFab (India) Industries Ltd suggested the use of TechGeo Nonwoven Geotextile PN25 over the Embankment slope surface, to act as a filter fabric for prevention of soil erosion. Also TechGeo Nonwoven Geotextile Engineered Fabric Bags with high abrasion resistance of 420 Gsm was suggested to be placed at the bank of the river, to reduce the impact of waves over the embankment slope surface.

Execution

To protect the embankment against further erosion, the following step by step procedure was adopted:

1. The existing embankment slope of approximately 25m length was dressed properly to attain a working surface by smoothening out the top soil.
2. A trench of 2' deep x 4' wide was made at the top and bottom end of the embankment slope.

Dressing of the Embankment Slope

Excavation of Trench at the End

3. A layer of TechGeo Needle Punched Nonwoven Geotextile PN25 was laid as Filter Fabric, over the prepared slope surface.

Unrolling of TechGeo Nonwoven Geotextile

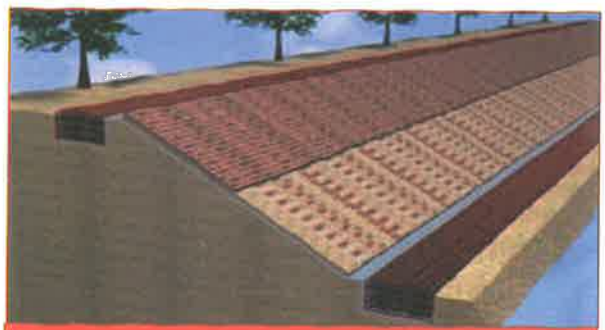
Unrolling of TechGeo Nonwoven Geotextile

4. In order for the TechGeo Nonwoven Geotextile to function properly it should be laid taut over the surface. Therefore, a metal gabion filled with boulders was placed in the top and bottom trench, to secure the TechGeo Nonwoven Geotextile in place.

Metal Gabion Placed at Bottom Trench

Metal Gabion Placed at Bottom Trench

5. The embankment slope covered with TechGeo Nonwoven Geotextile was further protected with two layers of bricks that were readily available.



Two Layers of Brick Placed Along the Slope

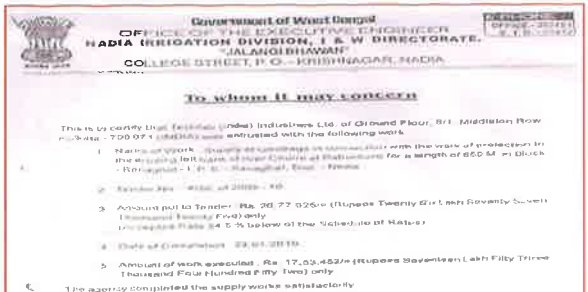
Two Layers of Brick Placed Along the Slope

6. Further, 6500 nos. of TechGeo Nonwoven Geotextile Bags filled with locally available fine sand, were laid in two layers at the edge of the river bed to take care of the soil erosion. The size of each TechGeo Nonwoven Geotextile Bag was 1m x 1.5m with the weight of the each filled bag of approximately 80 to 90 kg. These bags are engineered fabric bags with high abrasion resistance of "Pillow Type" duly "Chain Stitched" in 3 lines at TechFab (India) Industries Ltd's manufacturing facility.

TechGeo Nonwoven Geotextile Bags in Two Layers at the Edge of the River Bed

TechGeo Nonwoven Geotextile Bag Being Filled with Locally Available Fine Sand

TechFab (India) Industries Ltd completed the supply of TechGeo Nonwoven Geotextile Engineered Fabric Bags with high abrasion resistance as per the tender specifications of Naida Irrigation Division, Irrigation & Waterways Directorate, Government of West Bengal and was awarded with the completion certificate as below.



Government of West Bengal
OFFICE OF THE EXECUTIVE ENGINEER
NAIDA IRRIGATION DIVISION, I & W DIRECTORATE,
"JALANGI BHAWAN"
COLLEGE STREET, P.O.- KRISHNAGAR, NADIA

To whom it may concern

This is to certify that Techfab (India) Industries Ltd. of Ground Floor, 8/1, Middleton Row [illegible] was entrusted with the following work.

1. Name of work : Supply of geobags in connection with the work of protection in the existing left bank of river Churni at Ballavpur for a length of 650 M. in Block - Ranaghat - I, P. S. - Ranaghat, Dist. - Nadia.
2. Tender No. : NIDC of 2018 - 19
3. Amount put to Tender : Rs. 20,77,926/- (Rupees Twenty Six Lakh Seventy Seven Thousand Nine Hundred Only) Accepted Rate @ 4.5 % below of the Schedule of Rates.
4. Date of Completion : 23.01.2019
5. Amount of work executed : Rs. 17,53,452/- (Rupees Seventeen Lakh Fifty Three Thousand Four Hundred Fifty Two) only

The agency completed the supply works satisfactorily

Benefits of TechGeo Nonwoven Geotextile Bags

1. TechGeo Nonwoven Geotextile Engineered Fabric Bags with high abrasion resistance provide reinforcement to the edge of the embankment.
2. Reduces the damage to the base embankment considerably.
3. Life of embankment extends exponentially.

Advantages of Geosynthetic Solution v/s Conventional Riprap

1. Reduction in Granular layers.
2. Considerable saving of construction time.
3. Longer life of the embankment even after repeated floods.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai - 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

SLOPE PROTECTION OF SWAN RIVER IN THE STATE OF HIMACHAL PRADESH USING TECHGEO PN 30 AS GEOTEXTILE FILTER CLOTH

TECHFAB INDIA

Project: Swan River Flood Management & Integrated Land Development Project Phase II

GENERAL

The river Swan originates from Joh-Marwari village near Daulatpur Chowk in Amb tehsil in district Una, Himachal Pradesh. The river then flows through district Una and after traversing a distance of 85 km, the river Swan confluences with river Satluj at Anandpur Sahib in Punjab. The Swan River traverses a total distance of 65 km in Himachal Pradesh. The river Swan has a total catchment of 140,000 ha out of which 120,000 (85.7%) ha lies in the Himachal Pradesh. The river is fed by about 73 tributaries during its traverse in Himachal Pradesh.

In district Una, river Swan flows through inter-mountainous valley. The Catchment of river Swan is largely degraded due to significant human interferences. The forests have been cleared to meet the fuelwood, fodder and timber requirements, or for commissioning of various infrastructure projects. This has led to serious drainage problems. As a result, the entire precipitation results in rapid flow into the tributaries which ultimately reach Swan river. It results in flash floods leading to heavy floods causing large scale erosion of land, damage to property and crops, disruption of communication, loss of human lives and livestock, etc. Pebbles, gravel, soil, etc. are deposited in the early reaches of the tributaries and fine sediments consisting of sand, etc. flow with the run off and ultimately get deposited on agriculture fields causing heavy damage to land and property.

The task of flood management of Swan River is therefore of utmost importance. The total cost of the rehabilitation is 160 crores to be funded by Japanese Bank and Govt. of Himachal Pradesh and to be completed within a period of 8 years . The banks are required to be restored & completed by Financial Year 2014. But the authorities are hopeful to get the project completed by Start of Year 2012.

PROJECT DETAILS

The methodology of River Bank Protection was proposed by M/s WAPCOS using Crated Apron , Geotextile and Stone Pitching on the Embankment . The crated aprons at the toe are so provided Swan River experience flash floods every season.

The project comprises of the following main components:-

- Embankment
- Stone spur
- Sluice gate

Embankments & Spurs

The core of the embankment shall be of clayey soil and spur will be in stones duly filled in wire crates. The top width of embankment is 6 m with side slope of 2:1. Free board of 1 m is kept and

seepage protection is through clay core. The details of various protection measures are given in Table below.

Items	Embankments	Spurs
Stone pitching	30 cm thick with stones in 1.5 m x 1.5 m x 0.3 m size of wire crates	Stone core made up of crates of size 1.5m x 1.5m x 0.3m. Well anchored/ connected to the embankment.
Aprons	Aprons of width 6 m to 10 m of hickness 0.6 m in crates of size 1.5 m x 1.5m x 0.3 m in 2 layers (Average width 6.0 to 7.0 m)	Aprons of width 15 m made up of stones in crates of 1.5m x 1.5m x 0.3 m in single layer.
Filter bed	Conventional Filter Bed shall be replaced by using PP , Non-Woven Needle Punched Geo provided under launch apron and pitching.	Geo-fabric filter under spur and its apron.

Techgeo PN 30 as Geotextile Filter

The proposed Filter Cloth was seen as a replacement of conventional filter media comprising of graded aggregates hence was replaced with more effective PP Non Woven Geotextile of 300 GSM to control the properties as per the requirement of design by M/s WAPCOS.

Separation

TechGeo acts to separate two layers of soil that have different particle size distributions, This prevents base materials from penetrating into underlying soft subgrade soils, thus maintaining design thickness and integrity of the layer.

Filtration

This allows water to move through the soil while retaining all upstream soil particles. It is used to prevent soils from migrating into drainage aggregate or pipes while maintaining flow through the system.

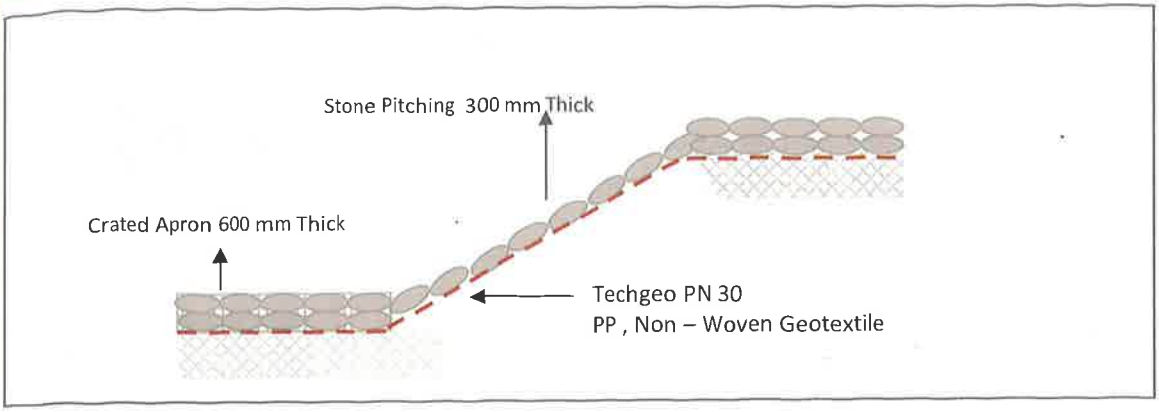
Drainage

TechGeo acts as a drain to carry fluid flow through less permeable soils. It dissipates pore water pressures at the base of embankments.

Specification of Techgeo PN 30

Property	*Test Method*	*Value*
Physical		
Mass per unit area	ASTM D 5261	300g/m^2
Thickness	ASTM D 5199	2.8 mm
Mechanical		
Grab Tensile Strength	ASTM D 4632	1150N
Grab Elongation	ASTM D 4632	50%
Wide Width Tensile Strength	ASTM D 4595	19.00 KN
CBR Puncture	ASTM D 6241	3900 N
Trapezoidal Tear	ASTM D 4533	475 N
Hydraulic		
Apparent Opening Size(dry)	ASTM D4751	150µm
Permeability	ASTM D4491	160 lts/sqm/sec
Endurance		
Ultraviolet resistance @ 500 hours	ASTM D 4355	70%

TYPICAL DRAWING



SLOPE PROTECTION WORKS AT SWAN RIVER

APRONS

Aprons of width 6 m to 10 m of thickness 0.6 m in crates of size 1.5 m x 1.5m x 0.3 m in 02 layers (Average width 6.0 to 7.0 m)

STONE PITCHING

300 mm thick with stones in 1.5 m x 1.5 m x 0.3 m size of wire crates

CASE STUDY:

Owner	:	Irrigation Department, Vadodara Circle, Vadodara, Gujarat
Contractor	:	M/s Rajkamal Builders, Ahmedabad, Gujarat
Site Location	:	At Mahisagar River, near Sindhrot village, Vadodara
Completion Date	:	30th June 2008
Product used	:	Copper & Polymer Gabion

DESCRIPTION OF THE PROJECT:

Irrigation Department proposed the construction of a weir across the Mahisagar river to ensure a perennial source of water on the upstream side and to facilitate recharging of the ground water table in the surrounding areas. Total height of the weir is 9.0 meters from the river bed level. The department was interested in an alternative to the conventional RCC wing walls of the weir to make the project more economical and to reduce the completion time.

THE SOLUTION:

The predominantly sandy materials of the bank are prone to erosion due to the water currents. The Design Circle of the Irrigation department finalized a solution wherein copper and polymer gabions underlain by a geotextiles was used to protect the embankment from erosion by river water currents. Gabions fabricated from copper & polymer ropes were used in view of their excellent flexibility and resistance to corrosion and the ease and speed of construction, which made it possible to complete the work in time.

For further details contact:

Techfab India Industries Ltd.

712, Embassy Center, Nariman Point, Mumbai 400021, India

Phone : +91-22-2287 6224 / 6225 Fax : +91-22-2287 6218

Email: anant@techfabindia.com tfi@vsnl.net / office@techfabindia.com

TECHFAB INDIA

GEOTEXTILE TUBE FOR SHORE EROSION PREVENTION AND RECLAMATION OF ERODED BEACH

TECHNOLOGY PROVIDER:

M/S TECHFAB INDIA INDUSTRIES LTD.

SYNOPSIS:

Indian coastlines are having severe erosion issues. Various options are worked out and accordingly the solutions are applied to the coast line of the Dahanu for erosion prevention. Use of other options such as Concrete blocks and Boulder filled Gabion walls are not lasting long life and also having higher maintenance cost. Geotextile tube has been designed considering the height of protection and study the behavior of Geotextile tube while filling and after filling, by providing monitoring gauges.

PROJECT DETAILS AND STUDY OBJECTIVES:

India has a long coastline extending 7517 Kms, The entire coast of India is susceptible to coastline erosion problems. On the western coast, Dahanu port is located at a distance about 110 Km. North of Mumbai, Maharashtra (Latitude 19 -57' N and Longitude 72-44'-30" E) The Dahanu beach starting from Dahanu creek towards North has a cuspate- shape for a distance of about 3.0 Km extending north of the creek. The beach length of about 2500 m, immediately North of Dahanu creek, had been subjected to erosion for years. Beach length of about 1500 m suffered due to the erosion problem of severe magnitude. At the high tide stages the water levels as well as waves were reaching up to the adjoining habitation. To protect the habitation Casurina trees were thickly planted in a stretch of the beach, due to severe erosion many of these trees uprooted and collapsed. To safeguard the trees, concrete platform were casted near the root zone. These platforms have also been damaged severely due to the wave action near the coast.

Fig-1(a) : Casurina Trees Roots Protected by Concrete

Fig-1(b) : Casurina Trees Eroded concrete Base

In order to resolved the problem of coastal erosion at the beach, which is extensively used for the recreational activities of tourists also, a study was carried out by CWPRS Pune and remedial measures were suggested for controlling the coast erosion and minimizing it's impact on nearby habitation. Three stretches were identified and three different types of solutions were implemented.

Initially for 700m length, a Bund was constructed 40 m offshore by chain of Concrete Blocks for the protection of houses/huts near the coast. Another stretch of 700 m was protected using Stone filled PVC coated Gabions. These solutions though reported to support the Sand Deposition, but considerable damage has been reported due to wave action and these solutions required huge cost towards maintenance.

TECHFAB INDIA

Fig 2(a): Techtube at the Time of Installation

Fig 2(b): Techtube after 9 months- 800mm Sand Deposition

OBJECTIVES AND DETAILS OF THE STUDY:

Geotextile Tubes fabric undergoes several stress cycles during it's installation as well as during it's life cycle. Theoretically the tube fabric is subjected to maximum stresses, both in circumferential and axial, directions at the time of filling. Under the study stresses coming on a 3.0 m diameter tube were monitored under field conditions using strain gauges. The recorded values are compared with the calculated maximum circumferential stresses as per Palmerton (2002). Stresses are monitored at different fill heights, filling pressures and varied tidal conditions. The effect of change of phase of fill material on fabric stresses are was also observed. Maximum stresses along the circumference are noted at different time and at fill heights and presented as stress diagrams, and compared with theoretical values. Under the study during every filling operation the Strains were measured at different angles along the circumference. These strains were recorded for various filling height; other parameter recorded was the Pressure at the Filling Port.

STUDY METHODOLOGY AND DATA COLLECTION:

In order to monitor and record the stresses along the Geotextile Tube, **Strain Gauge strips** were pasted with epoxy on the Tube Fabric. Total 54 nos. Sensors were installed along the tube periphery and 54 set of Moisture Proof wires were drawn from these Sensors up to the Data logger, where all the micro-strains were recorded. The data from the data logger was transferred to a Computer. The following figure present the schematic diagram of the mechanism adopted for the recording of the stain data generating due to the actions of sea waves on Geotextile tube during the filling process

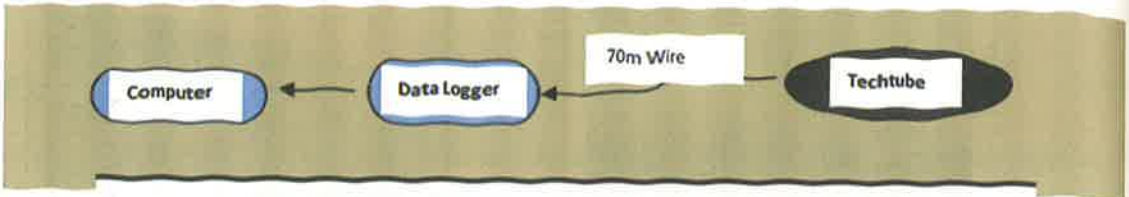
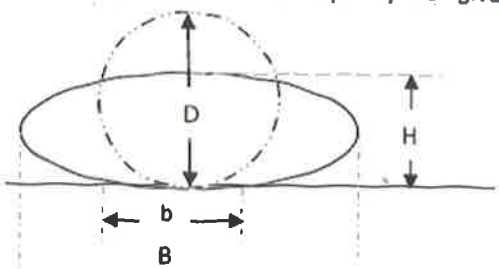


Fig 7 : Flow Chart for Data Recording from Techtube to the Computer.

THEORETICAL BASIS:

During the present study the micro strains on the Geotextile Tube were recorded using the Strain Gauges. The maximum strain recorded was 1.65% at filling port pressure of 0.8 bar. The installation was done on a firm foundation. The theoretical relation between various engineering parameters of Geotextile Tubes of diameter 'D' at low strains less than 15% and filled to maximum capacity is as given below:

Maximum Filled Height	:	**H= 0.60D**
Filled Width	:	**B= 1.40D**
Base Contact width	:	**b= 0.90D**
Cross sectional Area	:	**A= 0.65D²**



Palmerton (2002) proposed a procedure using membrane theory for calculating maximum circumferential stress (σ_c) for Geotextile tubes of diameter D=3.0m; 4.0m; and 5.0m. The relationship is shown as per the Fig: 9 below-

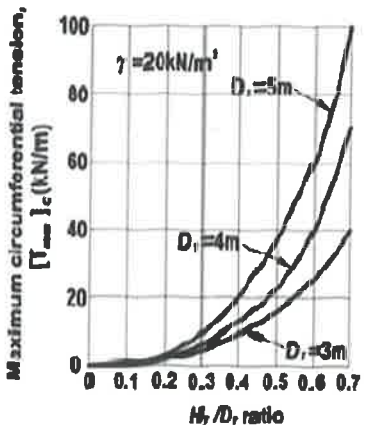


Fig 9: Maximum Circumferential Stress on A geotextile Tube According to Palmerton (2002)

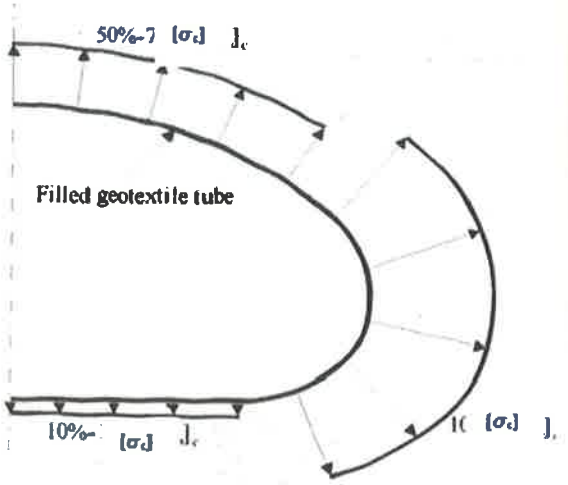


Fig 10: Distribution of Circumferential Stress on A geotextile Tube

As per the above, for the 3.0 m diameter Geotextile Tube, on which the strain measurements were carried out, the maximum circumferential stresses, should be:

Bulk density of fill, γ= 2000Kg/m^3; H/D= 0.6

$[\sigma_c]_{max}$ = **22.0 Mpa**

$[\sigma_a]_{max}$= **0.63 x $[\sigma_c]_{max}$ = 13.9Mpa**

CONCLUSION OF THE STUDY:

The following points can be summarized from the data recorded during the study on stress behavior of Techtube Fabric during filling.

- Maximum Filled Ht. achieved : 1.78 M
- Pressure at Filling Port Maintained during filling : 0.8 bar
- The maximum micro strains recorded were 18000-19500
- Maximum strains were recorded after 3/4th filling got completed
- Maximum stresses were observed at the time of Final filling
- The maximum stresses recorded were 28.00 Mpa to 29.5 Mpa; it was observed in the lower part of Techtube, below the seam line. However stresses up to 22-24 Kpa were recorded intermittently on the upper part also during the filling process.

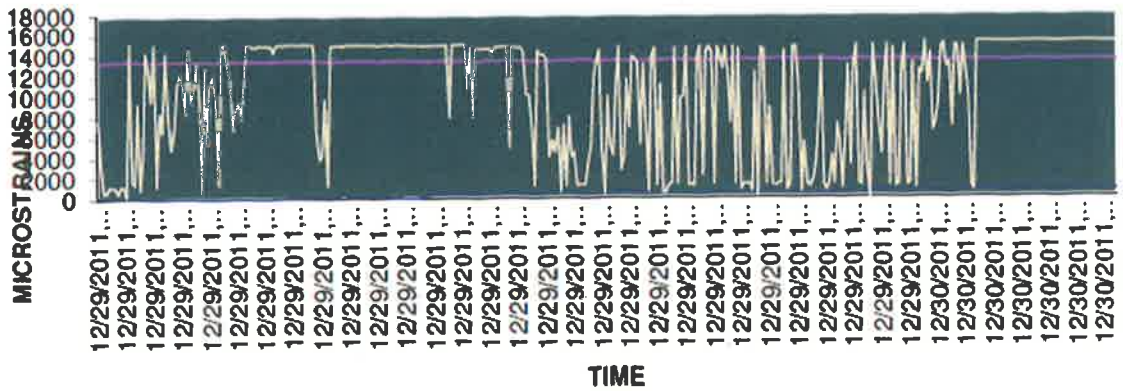
The Geotextile skin of the Tube and it's component parts should have adequate tensile strength to resist the various forces generated during filling as well as during the life time of the structure. The required Ultimate Tensile Strength of the Geotextile Tube Fabric (i/c Seam) is:

$[T_u]_c$ >= F.S $[T_u]_c$

The FS must account for factors such as Geotextile Tensions, Creep, seam factors and Durability. If any specific analysis is not undertaken a minimum FS of 4-5 shall be applied.

With this the required fabric strength should be 150 N/mm2.

A Sample Strain curve with time in sensors is below:



TECHFAB INDIA
TECHGEO

Application of TechGeo Nonwoven Geotextile Bags for River bank protection project in Assam under Assam Integrated Flood Riverbank Erosion Risk Management Agency (AIFRERMA) For ADB Funded Project.

CONCEPTUAL STUDY BY

M/S TECHFAB INDIA INDUSTRIES LTD.

TECHFAB INDIA
TECHGEO

SYNOPSIS:

Techfab India Industries Ltd. has proud to be associated with the prestigious project of flood and erosion management project, funded by Asian Development Bank (ADB). This is a multi dimensional and comprehensive project to eradicate the problems of flood management in longer term on sustained basis and envisaging growth of Assam through alleviation of poverty through sustained development of masses and protection of land. Erosion Control using Nonwoven Geotextile bags along the Brahmaputra reaches is one essential part of the entire project. We have supplied high quality 25 Lakhs Nonwoven Geotextile bags under rigorous quality control regime to this project in record Nine months time.

The 2004 flood demonstrated again that the past approach of addressing erosion and flooding in a non-systematic manner limited to local engineering interventions is not successful. Recognizing the need for a wider investment program, Government asked the ADB for assistance. It was jointly agreed to address the problem in an all encompassing manner, focusing on all three major elements of Integrated Water Resources Development (IWRD), (i) an enabling environment, (ii) the institutional framework, and (iii) management instruments. The three major detrimental aspects of an abundance of water, riverbank erosion, flooding, and related drainage problems, need to be addressed together. The suggested approach needs to be based on a good understanding of the physical environment and the institutional framework, to provide sustainable solutions for the future. In addition, the conceived new approach needs to be demonstrated at sample project locations. The high 2007 flood experienced during this study reiterates the need for a systematic approach. A study team under the Technical Assistance (TA) was fielded between May and September 2007. The team, together with WRD officers, prepared the background for a future investment project at pre-feasibility level starting with the Brahmaputra main stem in general and four priority sites in particular. These sites are high priority areas and planned to form the starting point for future continuous interventions that could be progressively extended to cover larger areas in Assam. In response to the task, the phase 1 study is structured in four parts:

Part I provides background about the problem of flooding and erosion in Assam,

Part II outlines a Flood and Riverbank Erosion Management (FREM) framework, and

Part III summarizes concepts and expected economic benefits for managing flood and riverbank erosion along the first four pre-selected priority project sites.

has lead to wide-spread risk adverse behavior of the rural population. Land-loss and related uncertainty will continue in future if not addressed in a systematic manner. The widening of the river makes the Assam State Government an increasingly large landowner while mostly poor rural households loose land. Poverty reduction of erosion victims can take place through the rehabilitation of slum dwellers or the reduction of vulnerability through the protection of their land from erosion. **Riverbank Erosion** is slowly acknowledged as the main problem hampering effective flood protection of the Assam valley however, there is an unclear concept of how to address erosion. There is additional strong indication that erosion is a major factor of river instability due to the very large amount of sediment intrusion from bank erosion itself. This sediment causes further instability downstream, triggers more bank erosion, and apart from loss of land and flood protection hampers navigation.

SELECTION OF SOLUTION:

A key outcome of this study and suggestion for the subsequent feasibility study is the recommendation to provide enhanced security against flooding and riverbank erosion along the selected reaches, this means

(I) Dramatically reducing the risk of land erosion and sudden devastating flooding due to embankment breaches.

(II) In terms of technical interventions this means
(a) Strengthening the existing embankments including the closure of gaps along the tributaries,
(b) Securing the embankments from riverbank erosion, and
(c) Introducing a range of non-structural measures with knowledge development to enhance the risk management capacity.

(iii) In terms of institutions this means changing from short term technical interventions to a long-term risk management approach.

In view of scarce availability of Stone, Geotextile Bag armors were proposed as Embankment Protection system for erosion control. In the identified stretches of Gumi, Palasbari and Dibrugarh, requirement of total 25 Lakhs bags was projected.

BIDDER - MANUFACTURER – SUPPLIER:

A Global tender was called for the procurement of the same. Techfab India qualified in the bidding process and won all the three packages for supply of Geotextile bags.

There was a very stringent and rigorous QC Monitoring process, that was followed by Techfab, as per this process at a regular frequency the samples of the bags produced in Plant have been sent for Third Party Testing in any Independent and accredited lab as per ISO 17025, The random samples of the produced Geotextile bags were tested in reputed and accredited Labs like TRI –US, BTRA, SASMIRA. The average results surpassed the specified quality parameters with a reasonable margin. Like UV Resistance was around 80%, Abrasion resistance was 78-84%, Tensile Strength was 24-28 Kn/m against required of 20 Kn/m, Seam Strength was 84%.

Techfab supplied the entire ordered material in record time of 8 months starting from January 1st 2012, which also was an achievement as we completed the supplies well ahead of prescribed time schedule.

TECHFAB INDIA
TECHGEO

AIFRERMA, ASSAM GEOTEXTILE BAG TECHNICAL SPECIFICATIONS:

4. Physical, Mechanical and Hydraulic Property

4.1 The Geo-textile fabric shall be manufactured from polypropylene or polyester fabric and shall be non-woven and needle-punched and not solely thermally bonded. The thermal bond shall not influence the flexibility of the sand bags including their launching behavior under water. The Purchaser reserves the right to ask for specific assurance certificates should there be doubts on the flexibility of the bags.

4.2. The required porosity of Geo-Textile fabric shall be minimum 80%. Porosity is a calculated value out of tested material characteristics and the specific weight of the fibers.

4.3. *Technical Values and Test Standards*: The properties of the Geo-Textile to be delivered to the Site shall be tested according to the relevant standards in their latest version and meet or exceed the technical values of the following table:

Properties	Test Standard	Test Values
Opening size O_{90} *2	EN ISO 12956	≥ 0.06 and ≤ 0.08 mm
Mass per unit area	BS EN 965	≥ 400 g/m²
CBR puncture resistance	EN ISO 12236	≥ 4000 N
Tensile strength (machine direction or MD and cross machine direction or CMD) *1	EN ISO 10319	≥ 20.0 kN/m
Elongation at maximum force (MD)	EN ISO 10319	≥ 60% and ≤ 100%
Elongation at maximum force (CMD)	EN ISO 10319	≥ 40% and ≤ 100%
Permeability, (velocity index for a head loss of 50mm – v_{H50})	EN ISO 11058	≥ $2*10^{-3}$ m/s
Abrasion	following RPG of BAW, Germany, O_{90} according to EN ISO 12956 and thickness according to BS EN 9641	After test: tensile strength ≥ 75% of specified tensile strength, thickness ≥ 75% of original value, $O_{90} \leq 0.09$ *2 mm
UV resistance	ASTM D4355 *3	≥ 70% of original tensile strength before exposure

*1 In case of non isotropic material ≥ 14 kN/m for machine direction

*2 Based on experienced variations of test results, values should not vary more than 0.01 mm from the specified values in this table

*3 The supplier can follow ISO or any other suitable standard provided the applied energy and testing procedures are equal or higher than the specified standard

CERTIFICATE FOR SUPPLY OF TFI GEOTEXTILE BAGS:

GOVERNMENT OF ASSAM
FLOOD AND RIVER EROSION MANAGEMENT AGENCY OF ASSAM
(FREMAA)

NO.AIFRERM (P) ADMIN/18/2011/63 Dated: 11/09/2012

TO WHOM SO EVER IT MAY CONCERN

M/s Techfab India Industries Limited, Nariman Point, Mumbai, India has been awarded the contract for supply of nonwoven Geotextile Bags and Special Sewing Thread for three lots vide Tender No. AIFRERMA/DIB-POP-Guml/GB-GF-1/2010 for Lot-2 & Lot-3 and AIFRERMA/DIB/GB-GF-1/2011 for Lot-1 under Assam Integrated Flood And Riverbank Erosion Risk Management Agency (AIFRERMA) Govt. of Assam, Beltola, Guwahati. These supplies are meant for Palasbari, Gumi & Dibrugarh protection works.

The ordered Quantity are :

Lot-1 : 924000 Non woven Geobags, 121400 Sqm of Nonwoven Geotextile Filter Sheet and 9000000 Meter of Sewing Thread for Dibrugarh.

Lot-2 : 761404 Non woven Geobags and 6500000 meter of Sewing Thread for Palasbari.

Lot-3 : 693000 Non woven Geobags and 6500000 meter of Sewing Thread for Gumi.

The total order value of all the three lots together is Rs. 25,11,17,230.00.

The supplies are presently going on for all the three lots. The supplies by Techfab India were started from January 2012 and going on as per the contract schedule and these supplies are planned to be completed by September 2012.

Yours faithfully,

Ravi [illegible] IAS
Chief Executive Officer
FREMAA

4. Case studies on Canal lining and Hydraulic control:

Sr No.	Case Study	Company
4.1	Lining for leaking Surface water reservoir, Ratnagiri, Maharashtra	Garware Wall Ropes Ltd.
4.2	Doodhganga Canal Lining, Kolhapur, Maharashtra	Garware Wall Ropes Ltd.
4.3	Pond lining work, Lanjha, Ratnagiri	Maccaferri Environmental Solutions Pvt. Ltd.
4.4	Canal lining by Haryana Irrigation Department, Haryana	Maccaferri Environmental Solutions Pvt. Ltd.
4.5	Raw water reservoir protection, Chennai	Strata Geosystems (India) Pvt. Ltd.

GARWARE – WALL ROPES LTD. (Geosynthetics Division)

Lining for a Leaking Surface Water Reservoir, Ratnagiri, Maharashtra

Product: HDPE geomembrane

Problem:

Initially the surface reservoir bed was lined with concrete and laid subsequently with bituminous felt membrane. However over a period of operations of the water reservoir for 7 years, the bituminous felt developed cracks and the water started leaking through the concrete. The situation aggravated to such an extent that the unit had to be closed down in dry periods due to shortage of water which coupled with huge evaporation losses. The estimated water loss per day was 3500 cum/day. Considering the urgency and requirement to stop the water losses due to seepage, a suitable lining system with long-term performance has to be adopted.

Photo1. Layout of surface water reservoir

Solution:

The depth of water in the reservoir was varying from 0.2 to 8.5 m. Apart from this, presence of various structures within the reservoir and around the periphery of the reservoir was a major challenge for the installation and anchoring of geomembrane.

HDPE geomembrane of 1 mm thick was suggested as lining material for the surface reservoir to arrest the water seepage. A complex lining and anchoring system was designed to anchor the geomembrane with the existing structures to eliminate the water loss.

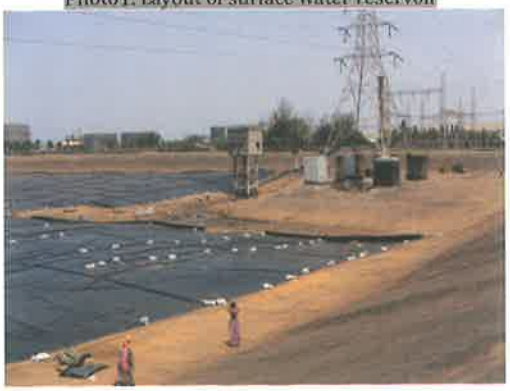


Photo2. Installation of HDPE geomembrane on bed

Client:

Finolex Industries Ltd.

Contractor:

Garware - Wall Ropes Ltd.

Products used:

HDPE Geomembrane : 76,000 Sq.M

Construction info:

Year - 2008 (duration of installation - 45 days)

Photo3. Anchoring of geomembrane at the structures

Photo4. Anchoring of geomembrane below the pipe line

Photo5. Geomembrane lined reservoir in usage

Advantages:

1. No water loss due to seepage after lining the reservoir with HDPE geomembrane
2. Cost effective solution
3. Installation is simple and easier

Present Status:

The water levels in the lined reservoir were being checked periodically. Water losses due to seepage were not observed and the performance of the lined reservoir was found to be satisfactory.

MACCAFERRI

CASE HISTORY
POND LINING WORKS
Lanjha, Ratnagiri

SEEPAGE PREVENTION / HYDRAULIC CONTROL

Product: Geomembrane—Macline SDH, Nonwoven Geotextile

Problem

Lanja is a Tahsil place located in Ratnagiri district of Maharashtra where the basic occupation of people is farming, which requires water. Majority of the water losses from the pond due to seepage which is a threat for the farmers. Therefore the client needed a solution to avoid seepage, in order to retain and make maximum use of water for longer period.

Before Installation

Solution

Considering the existing problem , Maccaferri recommended to form impermeable lining for the pond using Geomembrane Macline.
A Side slope for the pond shall be maintained as 2H: 1V with a Geomembrane Macline SDH (1mm thick) made of HDPE resins. This helps in forming an impermeable lining. Besides, a nonwoven geotextile Mactex N 40.1 shall be placed below geomembrane to avoid installation damages along with Geomembrane on sloping area which will be protected by nonwoven geotextile on top as well as on bottom. A layer of 300 mm thick soil will be placed above geotextile to act as an additional protection layer.Geosynthetic products shall be anchored at the top by providing anchor trenches.
This mechanism was adopted by the Shivatya Farms in Lanja it has served its purpose to save water from seepage

During Installation

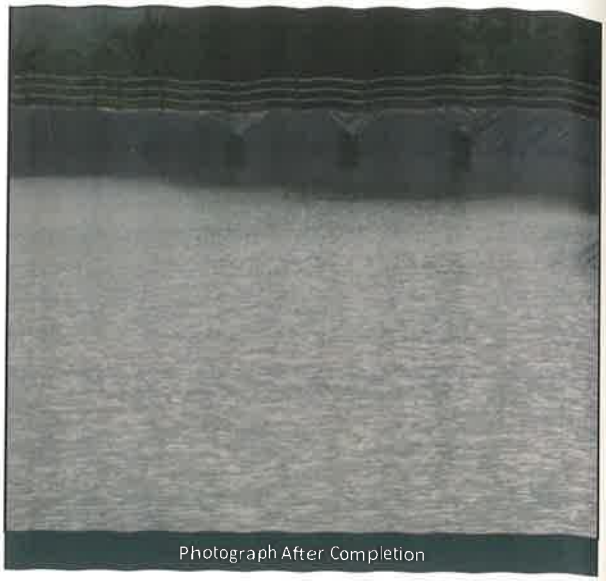
Client Name:

M/s Shivalaya Farms

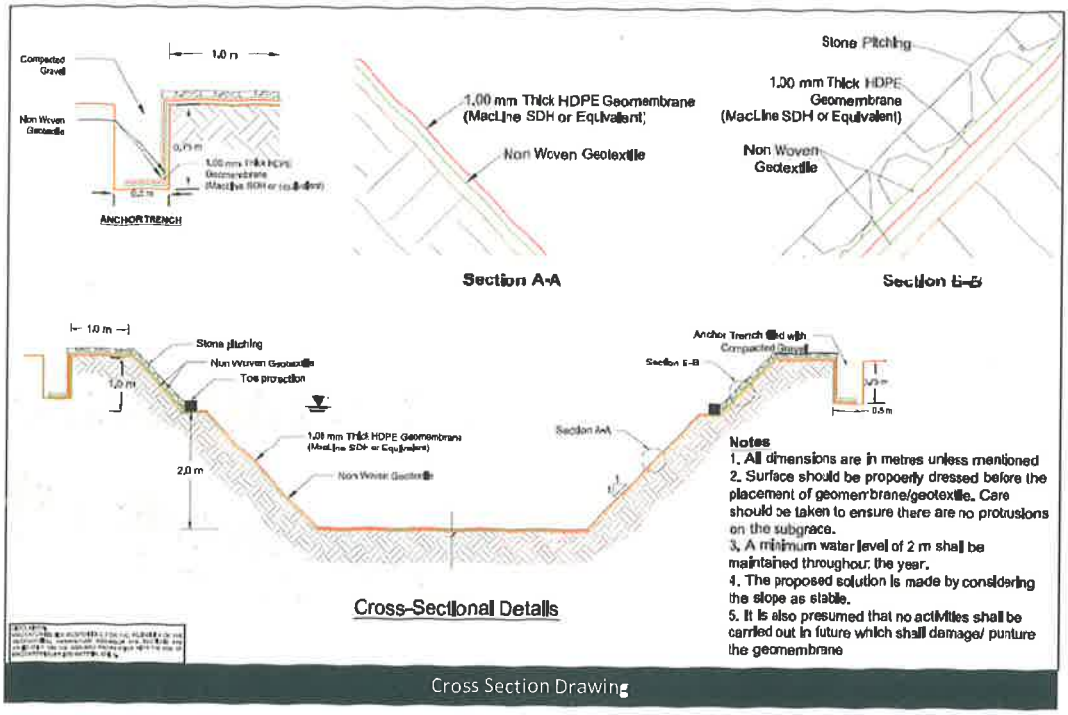
Main contractor name:

M/s Maccaferri Env. Sol. Pvt. Ltd.

Photograph During Construction



Photograph After Completion



Cross Section Drawing

The construction is over and structure is serving its purpose due to its good seepage control properties, environmental balance and aesthetics. The technique and the mechanism both are appreciated by the concerned people.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot No. 04, Jasola District Center, New Delhi– 110044
Tel No.– 011 43798400, Fax No.– 011 4654 6330
Web site: www.maccaferri-india.com, Email: technical@maccaferri-india.com

MACCAFERRI

CASE HISTORY

CANAL LINING BY HARYANA IRRIGATION DEPARTMENT

Haryana, India

CANAL LINING

Product: Mac Drain N- 105 M

Problem

Haryana Irrigation department has taken up construction work of canal with concrete lining. The canal section has a peripheral length of about 16m and the total length of the canal is about 65 km. A major portion of the canal, around 30 km, exists in cut section where high level of pore water pressure is expected to act on the proposed concrete lining.

The expected uplift pressure on concrete lining necessitates provision of elaborate drainage arrangement underneath the lining and as a safeguard an additional thickness for the lining.

Haryana Irrigation department was looking for alternatives solutions which will be technically better and cost effective to overcome from problem.

Photo 1 Site Before Construction

Solution

A Product is required which can replace the conventional granular gravel layer & arrangement of network of perforated pipe provided underneath the lining system.

Due to striking technical features of Geocomposite it was decided to place the drainage composite beneath the concrete lining. By ensuring consistent quality and proper drainage function the proposed geocomposite takes out lots of uncertainties of conventional solution and hence the concrete lining thickness can be reduced to minimum stipulated in codes i.e. 3 to 4 inches.

The Geocomposite performs filtration; drainage and impermeability function all at the same time and with a much simpler operation in the construction process.


Photo 2 Roll of MacDrain N 105M

Product Used:

Mac Drain N- 105 M

- Maccaferri Drainage Composites reduce pore water pressures.
- Simple and fast to install, this system cuts the cost of conventional drainage systems and gives superior performance.


Photo 3 Unrolling of roll

Client Name:

Haryana Irrigation Department

Main contractor name:

Mehta Construction Company

Consultant:

IIT Roorkee, Irrigation Department

Products used:

MacDrain N - 105M 3,49,000 sq m

Construction info:

Construction Start:	February 2009
Construction End:	Year End 2009

Photo 4 Unrolling & Laying of Drainage Composite

Photo 5 Placed Drainage composite at

Solution with Geocomposite:

- Geotextile layer at the base acts as filter.
- The drainage net will do the function of draining off the water with Geotextile layer acting as a filter which will not allow clogging to occur.
- Improved impermeability will be achieved due to presence of geomembranes which will act as second layer of impermeable barrier below concrete lining.
- High level of consistency in quality and is maintained,
- Construction is simple as it is very easy to lay the Geocomposite along the beds and banks.
- Reduction in excavation, elimination of gravel bed, perforated pipe network and slurry seal, and ease of laying Geocomposite results in lower cost of construction. Savings in terms of reduction of concrete lining thickness also adds up. Faster construction also results in savings in establishment cost.
- Proper bonding and sealing shall be ensured between the pressure release valves and the Geocomposite, especially with geomembranes, in order to prevent any escape of water in between the lining and geomembranes.
- Permeability of Geotextile 5 to 10 times the permeability of Soil or higher.

Advantages:

- Better filter function because of controlled quality.
- A much thicker drainage layer can be replaced with a thin layer of geocomposite performing equal or better for the required drainage function.
- Better and consistent quality
- Faster and economical construction
- Cost effective and faster construction

Present Status of the Project

The Project is successfully completed and serving the purpose since time of construction that is year 2009. The client is satisfied with the function of solution and would like to repeat it in upcoming projects.

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot No. 04, Jasola District Center, New Delhi– 110044
Tel No.– 011 43798400, Fax No.– 011 4654 6330
Web site: www.maccaferri-india.com, Email: technical@maccaferri-india.com

Raw water reservoir protection, Chennai

PROJECT BRIEF:

ARS Metals is one of the largest integrated Steel Plants in Southern India, having a fully modern and automated plant for best quality TMT re-bars and mild steel billets. ARS Metals has taken the initiative to integrate a captive power plant at their premises for which a Raw Water Reservoir of approximate capacity of 100,000 m^3 was required to be built. The Raw Water Reservoir was lined with a geomembrane liner as a water barrier. It was decided to protect the geomembrane and prevent it from uplift with a layer of concrete fill geocells, which proved to be a more cost effective solution as compared to conventional options of lining of PCC or concrete tiles.

> **Project Title:** Raw Water Reservoir Protection

> **Client:** M/s ARS Metals Ltd.

> **Location:** Chennai, Tamil Nadu, India

> **Solution** : Geomembrane Liner Protection on slopes and base of Raw Water Reservoir

> **Product:** StrataWeb SW35 – 75mm

> **Quantity**: 15,000 sqm

STRATA SOLUTION/ DESIGN SOLUTION:

Considering the time factor, economy and technical issues, a solution comprising the use of StrataWeb geocells was engineered. The steep slope angles necessitated StrataWeb of lesser cell size; hence the SW35 style was used. 75mm depth of cell was found to be an optimized solution considering technical and commercial feasibility. High strength PP tendons of diameter 6mm and of ultimate strength 6 kN were used @ 500mm c/c vertical spacing. For cell to cell and flap to flap connections between StrataWeb panels, high strength cable ties and pneumatic staplers were used as per requirement.

PROCEDURE/ CONSTRUCTION OVERVIEW:

StrataWeb panels of size 2.6m X 5.6m were used. At the base, adjoining panels were joined with stapler pins and were spread fully to cover the base. Concrete (M15 with 100mm slump) was placed with a boom placer and dressing was done manually. The thickness of finished concrete was 100mm. On the slopes, the panels were anchored within surface trenches (about 500mm and 1,000mm width). Concreting was done within the trenches to secure the geocell system at the top. High strength tendons were passed through the geocells along the 2.6m direction (@ 500mm c/c) with special precautions at the ends. The tendons passing through the ends had to be intertwined between the two ends in order to make it act as a single unit. The geocells along the other direction were connected to each other with high strength cable ties. Concrete (M15 with 100mm slump) was poured from top to bottom and made to flow on the slopes with manual dressing using spades and floats.

RESULTS:

In spite of heavy rain in Tamil Nadu during November and December which drastically reduced the tempo of work, the project was completed successfully within the stipulated time schedule. No other solution could have been executed within a shorter period or lesser cost, considering the steep slopes (and its associated limitations) and the rain water accumulation issues at the base. The water reservoir is now ready to store water for usage in the thermal power plant.

STRATA
Geosystems (India) Pvt Ltd

Head Office: 317, Tantia Jogani Industrial Premises, J. R. Boricha Marg, Lower Parel (East), Mumbai – 400 011, India.

Offices: Delhi, Hyderabad, Bengaluru | Tel: +91 22 4063 5100 | Fax: +91 22 4063 5199 | Email: info@strataindia.com

GARWARE – WALL ROPES LTD. (Geosynthetics Division)

Doodhganga Canal Lining, Kolhapur, Maharashtra

Product: HDPE geomembrane, Nonwoven geotextile

Problem:

A portion of the canal lined with concrete had failed completely leading to seepage losses upto 30%. Seepage from the concrete lined canal was not controlled which has reflected in water logging of adjoining creek and land areas. Considering the requirement to stop the water losses due to seepage, a suitable lining system with long-term performance has to be adopted.

Photo1. Existing concrete canal

Solution:

To effectively prevent the seepage losses, geosynthetic lining using HDPE geomembrane, 1 mm thick was recommended. Nonwoven geotextile was used to protect the geomembrane from installation damage. At the top, 75 mm thick concrete cover of M10 grade was used to prevent damage and vandalism of liners and for effective performance of the liner in the long run.

Photo2. Cleaning of canal in progress

Client:

Doodhganga Canal Division

Contractor:

Garware - Wall Ropes Ltd.

Products used:

HDPE geomembrane : 66,000 Sq.M
Nonwoven geotextile : 1,32,000 Sq.M

Construction info:

Year : 2006 - Ongoing

Photo3. Installation of geomembrane and geotextile

Photo4. Construction of top concrete layer

Photo5. Water flow in canal after completion of geomembrane lining

Advantages:

1. No water loss due to seepage after geomembrane lining
2. High direct and indirect benefits
3. Installation is simple and easier

Present Status:

The execution work is in progress and only can be done during the closure period of canal (10-14 days after every 45 days of running canal period) and during November to March every year. The installation of lining is completed for 1500 m length in a total length of 3000 m.

For the lined canal stretch, we have received the performance remarks from the client which highlights that 100% water losses due to seepage were stopped and the performance of the lined canal was found to be satisfactory.

5.Landfill:

Sr No.	Case Study	Company
5.1	Closure and capping of Industrial Sludge pond at Vishakapatnam, Andhra Pradesh	Garware Wall Ropes Ltd.
5.2	Municipal solid waste Land-Fill in Assam	Techfab (India) Industries Ltd.
5.3	Landfill project for Pincol Para Garulia Municiple Coorporation, West Bengal	Maccaferri Environmental Solutions Pvt. Ltd.

GARWARE – WALL ROPES LTD. (Geosynthetics Division)

Closure & Capping of Industrial Sludge Pond at Vishakapatnam, Andhra Pradesh

Product: Woven geotextile, HDPE Geomembrane, Geosynthetic clay liner, Geocomposite drain

Problem:

The existing landfill facility (Sludge Pond – 1) has attained its full capacity with industrial sludge upto 7.0 to 8.0 m depth. The top exposed surface of the pond covers an area of 55,000 Sq.M. The pond has to be covered (capped) to prevent any further leachate generation due th e precipitation an d infiltration o rain wate r. As the sludge surface wa s soft and having l ess strength to withstand the load from the construction equipment, fill material, top liner system including cover vegetative soil, special techniques have to be deployed to increase the bearing capacity of the surface.

Photo1. Sludge pond before closure

Solution:

Based on the detailed geotechnical investigations and laboratory test results, it was observed that the industrial sludge is highly fine grained in nature with unit weight of 17.0 kN/CuM and cohesion 4.0 kPa; expressing the behavior of intermediate to high compressible clays.

Geotextile stabilized soil layer technique comprising of multi-layered high strength woven geotextiles using finger fill soil placement technique was adopted to achieve the required bearing capacity for the closure. High strength woven geotextiles were used in the project in a multilayer configuration meeting the design criteria.

Once the stabilization process was complete, the top liner system with vegetative soil was constructed in such a manner to facilitate surface water runoff without causing ponding or erosion of the final cover.

Photo2. Construction of geotextile stabilized soil layer system over sludge using finger fill soil placement technique

Client:

Hindustan Zinc Ltd., Vishakapatnam

Contractor:

Garware – Wall Ropes Ltd.

Products used:

Woven Geotextile : 1,55,000 Sq.M

HDPE Geomembrane : 60,000 Sq.M

Construction info

Year - 2011

Photo3. Construction of top liner system over geotextile stabilized layer

Photo4. After completion of construction of top liner system

Photo5. View of sludge pond after completion

Advantages:

1. Provide initial access for construction on soft sludge
2. Support the load coming from the fill material, top liner system/ closure and construction equipment
3. Easy and speed rate of installation
4. Cost effective

Present Status:

Construction of geotextile stabilized soil layer is a major challenge on the soft sludge and has been successfully completed. The performance of the closure and capping of the sludge pond is found to be satisfactory.

CASE HISTORY

TECHFAB INDIA

NONWOVEN GEOTEXTILE TECHGEO PR-20 FOR MUNICIPAL SOLID WASTE LAND-FILL IN ASSAM

Project Description

Name of Project:	Construction of Municipal Solid Waste Landfill Facility at Tezpur (Assam).
Owner:	Tezpur Municipal Corporation, Govt of Assam.
Implementing Agency:	NBCC Ltd.
Contractor:	M/s M P Khaitan Construction Engineers, Kolkata.
Product:	Nonwoven Geotextile TechGeo PR-20.
Nonwoven Quantity:	8000 Sqm
Manufacturer:	TechFab (India) Industries Ltd., Mumbai.

Objective of the Project

Modern landfills are highly engineered containment systems, designed to minimize the impact of solid waste (refuse, trash, and garbage) on the environment and human health. In modern landfills, the waste is contained by a liner system. The primary purpose of the liner system is to isolate the landfill contents from the environment and, therefore, to protect the soil and ground water from pollutants like Leachete and Gases originating in the landfill during the chemical processes of Waste decomposition.

lowest permeability liner system. Installation of Liner significantly saves the contamination of Ground water aquifers and adjoining soil.

On the principal of the lining system, the Tezpur Municipal Corporation, Govt. of Assam decided to construct a Solid Waste Landfill Facility at Tezpur, a major town of Assam on the right bank of Brahmaputra river in North Assam and the challenging task was awarded to M/s M P Khaitan Construction Engineers, Kolkata under supervision of implementing agency, NBCC Ltd.

The work was construction of Municipal Solid Waste Facilities like civil work of construction of RCC platform, Landfill site infrastructure, processing plant etc in shortest possible time. Apart from other challenges the contractor had the difficult task of mobilizing the material at such a remote place. After weighing various manufacturers & importers of nonwoven geotextile, the contractor has approached Techfab (India) Industries Ltd. to supply the nonwoven geotextile in shortest possible time. We have taken the task and dispatch the material within 6 days after receiving the order from our state of the art nonwoven geotexitle manufacturing facility at Daman (UT).Thus the contractor has achieved the completion of work in record time.

Polypropylene Needle Punched Staple fiber Nonwoven Geotextile PR-20 applied for providing cushioning & protection form punctures to Geomembarane from soil & solid waste particles and to improve the performance of MSW facilities.

The project was successfully completed by 30/04/ 2010.

For further details kindly contact:

TechFab India Industries Ltd.
711/712, Embassy Centre,
Nariman Point, Mumbai – 400021
Phone: 022-2287 6224/6225 Fax: 022- 2287 6218
Email: anant@techfabindia.com
Web: www.techfabindia.com

MACCAFERRI

CASE HISTORY
LANDFILL PROJECT FOR PINCOL PARA GARULIA MUNICIPLE CORPORATION
West Bengal ,India

ENVIRONMENTAL/LANDFILL
Product: Geomembrane & Geotextile


Photo 1 Site Before Construction

Problem
Due to growing population, not only in the urban areas but also in rural areas, the environmental problem arising from unscientific and indiscriminate disposal of municipal garbage.

The Garulia Municipal authority is one of the municipal body among 27 nos. of Municipal bodies in the district of North 24 Paganas of West Bengal. It is responsible to develop a system for scientific disposal of garbage through composting and engineered landfill.

Municipal landfills and their leachate (water) and air emissions are hazardous. All landfills will eventually fail and leak leachate into ground and surface water. So, there is need of liners which are chemically inert and do not allow gases to pass through their membranes.


Photo 2 Site Before Construction

Solution
The KMDA has designed a landfill which is about total area of 4168 Sqm. The secured landfill consists of 4 slopes of approx 4.5 m height 1500 Sqm for segregation of Biodegradable and non-biodegradable waste. The biodegradable waste will finally be carried out at compost plant for making fertilizers.

The scope of work for Maccaferri was the supply, laying and joining of Geomembrane (1.5mm thick) and Non-woven needle punched Geotextile of 2.0 mm thick (Mactex MXP 200) at the bottom and slopes.

The Geomembrane used contains 2.5% Carbon Black content. This membrane has good environmental crack resistance. Its excellent UV resistance, made it possible to lay it on exposed conditions also.


Photo 3 Unrolling of geomembrane

Client Name:

Garulia Municipal Corporation

Main contractor name:

M/s Prova Construction

Consultant:

Kolkata Metropolitan Development Authority

Products used:

4168 Sq.m of HDPE Geomembrane (1.5 mm thick)

Construction info:

Construction Start:	February-2009
Construction End:	June-2009

Photo 4 Unrolling & Laying of Geomembrane

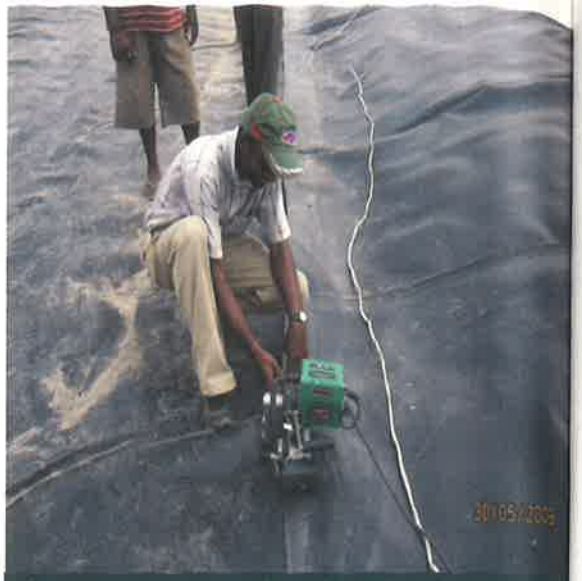


Photo 5 Joining of Geomembrane by wedge welding method

Physical & Mechanical Properties of the Geomembarne used are as follows:

- Density-0.94g/cm3
- Strength at break-48.00 N/mm
- Elongation at break– 800%
- Tear Reistance-210 N
- Puncture Resistance-530 N
- Approximate area - 4168 sq m

Physical & Mechanical Properties of the Geotextile used are as follows:

- Wide width Tensile Strength: 8.3 KN/M
- Elongation at Break: 50.0 %.
- CBR puncture resistance: 1800 N
- Thickness: 2.0 mm
- Weight: 200 gsm.
- Color: Black
- Approximate area – 4060 sq m

Advantages:

- Impermeable and chemically inert
- Better and consistent quality because of controlled quality
- Faster and economical construction
- Cost effective and faster construction

Maccaferri Environmental Solutions Pvt. Ltd.
402, 4th Floor, Salcon Aurum, Plot No. 04, Jasola District Center, New Delhi– 110044
Tel No.– 011 43798400, Fax No.– 011 4654 6330
Web site: www.maccaferri-india.com, Email: technical@maccaferri-india.com

Application of coir geotextiles on roads

U. S. Sarma & Anita Das Ravindranath
Central Coir Research Institute
P.O. - Kalavoor, Dist. - Alappuzha
Kerala-688 522.

Introduction

The coir nettings (geotextiles) are made of coir fibres extracted from the fruit of coconut *(Cocos nucifera)*. These are the strongest fibres in nature and are known to elongate up to 30% of their original length. The coir nettings can withstand long term water logging. The positive effect of application of coir nettings on the embankment of roads to stabilize the slope and establishment of vegetation has been reported widely in the literature.

The Coir Research Institute (CCRI) of Coir Board, Ministry of Micro, Small and Medium Enterprises (MSME), Govt. of India, has earlier undertaken a few collaborative studies with the Cochin University of Science and Technology (CUSAT), College of Engineering and Technology (CoET), Kerala and National Institute of Technology (NIT), Thiruchurapally to establish the uses of coir geotextiles for construction of rural unpaved and paved roads.

This paper reports the utilization of coir nettings as reinforcements of ground soils having California Bearing Ratio [CBR] of less than 2 to improve the bearing capacity. The nettings also enhance filtration, drainage of excess water during rainy season and the soft soil consolidates before the nettings are subjected to the process of natural biodegradation during the period of about 10 years. The paper discusses a few experiment-cum-demonstrations that have been carried out in different parts of India to establish the uses of coir nettings in this field. The CBR of the soft soil treated with coir nettings has been found to increase by 2-4 times while retarding the rutting of the roads. The dust generation is also reduced to the minimum as it prevents the soil fines from flying off. A layer of netting below the bituminous layer is found to stop reflective cracking of the paved roads.

Lab Studies

A study was carried out in collaboration with Cochin University of Science & Technology (CUSAT), Kochi, Kerala to examine the performance of unpaved roads constructed on silty soils using coir geotextile reinforcement through a number of model tests. The strength aspects of coir goetextile were studied by performing CBR tests and Plate Load tests. The reinforcement aspects of coir geotextile were studied through CBR tests on 4 different types of soils. The separator aspects of coir geotextiles were also studied by performing plate load model tests within a test tank. The tests were conducted by applying static loads on base course through a plate of 200mm diameter. The test was repeated by placing geotextile at the interface between soil and base course.

The results of the study indicated that CBR value of the soil reinforced with coir had improved. From the plate load test also, it was found that the settlement can be reduced with coir geotextile. The wheel load tests [Fig.1] simulated the field conditions in a better way to understand the behavior of the pavement. It

Initially, a rural road in a swampy area in Thanneermukkom village in Cherthala district of Kerala State in India was constructed by laying the coir netting over the sub grade. The methodology was adopted as described above. It has been found that even after 8 years, the low volume road is intact and has sustained heavy monsoon rains. Evidently, the rutting has not taken place due to efficient reinforcement, separation, filtration, and drainage properties of coir netting.

Based on the studies carried out at laboratory level and field level by the CCRI in collaboration with the institutes having expertise in the construction of roads in India, the Indian Roads Congress (IRC) has given accreditation to the use of coir geotextiles for use in the construction of roads for which the CCRI has been identified as a nodal institute.

It has mentioned that the coir geotextiles having mass per unit area of 400 to 900g/m^2 [Table 1] could be used which should meet the following specifications:-

Table 1. Specifications of Coir Geotextiles

Specifications	Machine Direction	Cross Machine Direction
Break Load, minimum for Dry coir	8-15 kN/m	3-8 kN/m
Break load, minimum for Wet coir	3-12.5 kN/m	2-5 kN/m
Trapezoidal tearing strength at 25mm gauge length, minimum	0.18-0.50 kN	0.15-0.35 kN

It specifies that the sub grade soil should have a California Bearing Ratio (CBR) of 2% [IRC 37-2001]. Where the CBR of the sub grade is less than 2%, a capping layer of 150mm thickness of material with a minimum CBR of 10% is required to be provided in addition to the sub base layer. The synthetic geotextiles have been used in highway constructions in many developing and developed countries but those are liable to pose environmental problems in the long run, therefore, there is interest in the use of coir geotextiles for such purposes which are not only eco-friendly but are good absorbents of water with minimum swelling and act as good reinforcement, separators and drainage materials.

In the light of accreditation of IRC, the National Rural Roads Development Agency (NRRDA) of Govt. of India has authorized the CCRI to use coir goetextiles in the construction of roads, in 9 states of the country, for a total length of 450kms in the first phase during the year 2011.

Methodology

Poor sub-grade soils pose a great challenge for construction of haul roads and other low volume roads. Coir netting can be successfully used for stabilizing poor sub-grade soils as these can reduce the substantial amount of aggregate required for stabilization just the same way as has been reported with the use of synthetic geotextiles.

Coir netting is spread directly over the roughly levelled poor sub-grade soil. In the case of clayey sub-grades it is recommended to spreading the fabric after placing a layer of sand of 10 mm to 20 mm thickness. The fabric is then surcharged with granular material preferably sand of 30 mm to 50 mm thickness to act as a lower sub-base and it is rolled initially with light rollers and later, if possible, with medium to heavy rollers. A layer of sub-base consisting of coarse aggregate or crushed rock varying in thickness from 200 mm to 300 mm may be placed over the sand layer and compacted. Under the surcharge action of sub-base layer and compaction rolling, the sub-grade loses water content through the filter fabric and gains strength. Unrolling of the netting can be done easily manually and great accuracy in alignment is not required. For multi-lane roads, an overlap of at least 300 mm is preferred where necessary. The fabric over the sub-grade may be spiked, if necessary, by the use of J-shaped wooden spikes driven at random as necessary to keep the netting in place during construction and rolling. Proper placement of netting to ensure lack of continuity with suitable over lapping is important. In the event of a

tear occurring, the damage remains localized and does not spread progressively like in the case of a woven cotton fabric. In this respect, the coir netting can be considered to behave much like any other non-woven synthetic fabric. Any accidental damage does not therefore affect the overall performance of the coir netting. For unstable and wet sub-grades, coir netting provides a satisfactory solution to stability and drainage problems.

Materials

Coir nettings/geotextiles are produced in ten specifications [H_2M_1-H_2M_{10}] as per the Bureau of Indian Standards, which vary in weight from 400 to 1400 g/meter and mesh sizes from 0.75 cm to 2.5 cm respectively. The Bureau of Indian Standards has published specifications for coir geotextiles. In this study H_2M_6 (400 g/m^2) and H_2M_5 (700 g/m^2) geotextiles have been used for application. [Fig.2]. The H_2M_6 and H_2M_5 are made up of Vycome coir yarn that is the typical low twist yarn made in a particular region [Vycome] in the state of Kerala, India for making mats and matting. Open weave coir netting is a woven fabric of two treadles weave in construction, made from coir yarn, in which the warp and weft strands are positioned at a distance to get a mesh (net) effect of 2.5 cm^2, 0.75 cm^2 and 1.27 cm^2. The open weave coir netting is manufactured in the following grades based on the mass:-

a) Grade I- 400g/m^2 (H_2M_6)

b) Grade II-700g/m^2 (H_2M_2, H_2M_5, and H_2M_8)

c) Grade-III 900g/m^2 (H_2M_9)

Fig.2. H_2M_6, H_2M_5, and H_2M_9 Netting of coir

The Coir Board has established a testing laboratory for coir geotextiles at the Central Coir Research Institute, Alleppey, Kerala that is listed in the web site of ASTM [American Society for Testing and Materials] International Directory of Testing Laboratories. Rao and Dutta have discussed in details about testing of coir geotextiles.

The Tables 2 & 3 depicts the comparative properties of coir, jute and synthetic geotextiles. It can be seen that the coir nettings possess considerable strength to perform well under stress and strain due to its very high elongation and strength properties.

TABLE 2. The physical properties of coir fibre

ULTIMATE	
Length (mm)	00.60
Cell length/Diameter	35.00
SINGLE FIBRE	
Length (mm)	150-200
Gravimetric fineness (tex)	40
Breaking load (kg)	0.45
Tenacity (gm/tex)	13.28
Breaking elongation	29.04%
Density (gm/cc)	1.40
Porosity	40%
Moisture Regain at 65% RH	10.5%
Swelling in water (dia)	5%
Rigidity modulus (dynes/cm^2)	1.89

TABLE 3. Comparison of properties of coir netting with other commonly used geotextiles

Trade names	Weight (gm/m2) ASTM D-1910-64	Thickness (mm) ASTM D-1777	Grab tensile Strength(N) ASTM D-1682	Elongation at break (%) ASTM D-1682	Trapezoidal tear strength(N) ASTM D-2263	Type
Coir netting	400-900	6.5	700-1500	30	150-500	Woven
Jute fabric	680-750	1.75-1.85	800-900	15-20	300-350	Woven
Mirafi 600X	–	–	1335	–	534	Woven
Terram (140)	280	1.1	1128	150	343	Non-Woven 75% Polypr. 25% Nylon

Field Studies

The construction of a village road namely, Kumbakkad – Chembakulam Road at Varkala Block in Trivandrum district is shown [Figure 3-5] using coir netting in position within the road structure. The netting acted as a separator to eliminate the punching of aggregate into the soft sub-grade as well as to resist the infiltration of fines from the sub-grade into the aggregate layer thus arresting any tendency for pumping. The drainage system also maintained optimum performance because the fabric did not get clogged under field conditions. The high tensile strength and tear resistance made the coir netting to act as a support membrane to reduce localized distress to the road surface by redistributing traffic loads over a wider area of sub-grade. This had of course resulted in the reduction of thickness of overall road structure resulting in some reduction in the quantity of earthwork as well. It has been reported that with the protection offered by geotextiles to the sub-grade, less sub-base is needed and indeed less sub-grade was needed to be excavated. A length of 100m was chosen on each of the roads as test stretches at each stretch. The stretch was further divided in to four sub stretches. The depth of placement of geotextile and the type of geotextile were varied in these different stretches.

The coir geotextiles placed in this location is H_2M_6. Laying of Geotextiles was done in August 2009 and construction of bitumen layer was done after one year. After that monitoring of settlement is noted continuously. No large settlement is noticed.

Fig.3. Before construction

Fig.4. During construction

Fig.5. After construction

In another study, carried out in collaboration with the NIT, Thiruchirapally, the Vellar Theru Road at Orthanadu Block in Thanjavur district has been constructed. This district is known for granary of Tamilnadu. The major agricultural crop is rice. The area of the district is 3397 sq.m. The geology of this district is sedimentary shown by lower cretaceous and gondwana formations. Depth of ground water level varies from 1 to 15 m. The average rainfall in Thanjavur district is 1288 mm. The project road passes through agricultural area. The link number of the Panchayat road is L049 and the given road length is 1.871 Km., the terrain is plain and the climate is hot and humid with rainfall more than 1000 mm. The road is used by 70 families directly and 30 families indirectly. The sub-grade soil details and traffic volume data are given in Table 2 and 3. The hourly variation of traffic and traffic composition are shown in Figures 5 and 6 respectively. The process of construction of the road is shown [Figure 6-8] from preparation of sub grade, laying of coir netting and finished road.

Fig.6. Finished subgrade

Fig.7.Laying of H_2M_6

Fig.8. Finished Road

Conclusions

From the field and laboratory experiments conducted on weak sub-grades with and without coir geotextile reinforcement, it has been established that reinforcement using coir-geotextile is economically advantageous compared to required thicker sections and/or chemical/mechanical stabilization techniques. Compared to existing methods of stabilization which have practical difficulties in the field, the application of coir geotextile is easier and more standardized.

The coir-geotextile reinforcement is a superior solution for the construction of low volume roads on weak sub-grades. Coir nettings have long life of at least 5 years. They have larger diameter, curvature and possess rigidity to bending. They are of higher toughness, strength, resistant to dampness, rot resistance, resilience, durability, and porosity, besides being hygroscopic, biodegradable, renewable, recyclable and versatile.

Bio-degradability is often considered a disadvantage of coir geotextiles. It is believed that after degradation the strengthening affect of the fabric is lost and the performance of the soil in terms of strength and permeability deteriorates. But coir has been found to be quite resistant to rapid deterioration when embedded permanently in wet soil below. In weak sub-grade consolidated under the overburden with consequent gain in strength with time, the performance of the structure becomes less and less dependent on the fabric. Therefore, long-term bio-degradability does not necessarily influence bearing capacity

References

- S. D. Ramaswamy and M. A. Aziz, (1989). "Jute geotextile for roads", International Workshop on Geotextiles, 22-29 November, Bengaluru, India.
- K. George Joseph and U. S. Sarma, (1997)."Retted (White) Coir Fiber Nettings – The Ideal Choice as Geotextiles for Soil Erosion Control." Proceedings of the Annual Conference of International Erosion Control Association, held at Tennesee, USA, Feb. 25-28, p. 65-76.
- C. Jose, U. S. Sarma, K. R. Anil and M. Kumaraswamy Pillai, (2006). "Application of eco-friendly coir geotextiles for canal/river bank protection." Poster presentation in the Annual Conference of International Erosion Control Association at California, USA.
- C. Jose and U. S. Sarma, (2007). "Versatile coir geotextiles." Poster presentation in the Annual Conference of International Erosion Control Association, at Reno, Nevada, USA, Feb. 12-16.
- U. S. Sarma and A. C. Jose, (2008). "Application of a coir geotextile reinforced mud wall in an area below sea level at Kuttanad, Kerala." Proceedings of the Annual Conference of International Erosion Control Association, held at Orlando, Florida, Feb. 18-22.
- U. S. Sarma and Sesh Kumar Pulipaka, (2009). "Coir based soil less natural grass-instant lawn for soil erosion control", Proceedings of the Annual Conference of International Erosion Control Association, held at Reno, Nevada, USA, February, 9 -12.
- U. S. Sarma, Sesh Kumar Pulipaka and V. S. Vijayaraghavan, (2010). "Prevention of soil erosion through vegetation of mine dumps using coir geotextiles, Proceedings of the Annual Conference of International Erosion Control Association, held at Dallas, Texas, USA February, 16-20.
- Sarma U. S., A. K. Bisaria, Sesh Kumar Pulipaka, and V. S. Vijayaraghavan, (2011). Prospects and problems of use of coir geo-textiles for soil conservation work in forest area, presented and published in the Proceedings of the Annual Conference of International Erosion Control Association, held at Orlando, Florida, February, 20-23.
- Natural fibre geotextiles (jute geotextile and coir Bhoovastra) - Methods of test, (2008), IS 15868: Parts 1-6.
- Open weave coir Bhoovastra-Specification, (2008), IS 15869.
- Use of coir geotextiles (coir Bhoovastra) in unpaved Roads – Guidelines, (2009), IS 15871.
- Application of coir geotextiles (coir woven Bhoovastra) for rain water erosion control in roads, railway embankments and hill slopes-Guidelines, (2009), IS 15872.
- G. V. Rao and R. K. Dutta, (2000). "Testing of Coir Geotextiles". Proceedings of 7th International Conference on Geosynthetics," Nice, France.
- K. S. Beena, (2006). Study on use of coir bhoovastra in pavements, report submitted to the Coir Board of India, Kochi.
- R. A. Jewell, (1996). Soil Reinforcement with Geotextiles, 1st Ed. Construction Industries Research and Information Association, London.

++++++++

CORPORATE PROFILE OF INDIGENOUS MANUFACTURERS

CORPORATE PROFILE OF INDIGENOUS MANUFACTURERS

Sr No.	Company Name
1	CTM Geosynthetics
2	Fibertex Nonwoven A/S
3	Flexituff International Ltd.
4	Garware-Wall Ropes Ltd.(Geosynthetic Division)
5	Kusumgar Coorporates Pvt. Ltd.
6	Maccaferri Environment Solutions Pvt. Ltd.
7	Maruti Rub Plast Ltd.
8	Reliance Industries Limited
9	Shri Ambika Polymers Pvt Ltd.
10	SKAPS Industries India Pvt. Ltd.
11	Strata Geosystems (India) Pvt. Ltd.
12	TechFab India Industries Ltd.
13	TenCate Geosynthetics Asia SDN BHD.

CTM Geosynthetics (A Division of CTM Technical Textiles Ltd.)	
Head-office Address	205, New Cloth Market, Ahmedabad – 380002.
Website	www.ctmgeosynthetics.com
Contact Person & Number	Name of the Person: Mr. Amit Agarwal (Director) Mobile No. 09687988555 Landline No. 079 – 22165163 Fax No. 079 - 22169326 Email ID: info@ctmgeosynthetics.com
Branch offices	As head-office address
Annual Turnover of Geosynthetics division (Rs.in Lacs)	
Year of Establishment	2012
Manufacturing location	At. Budasan Ta. Kadi Dist. Mehsana
Products types	Geo Grids
Capacity in tones and sqr.mtr	
Accreditations	ISO 9001:2008
In-house testing facilities	Yes
Export	Countries Quantity in tones and /or sqr.mtr
Imports	Countries Quantity in tones and /or sqr.mtr
Major customers	

FIBERTEX NONWOVENS A/S

Head-office Address	**Svendborgvej 16 DK-9220** **Aalborg** **DENMARK**
Website	WWW.FIBERTEX.COM
Contact Person & Number	Name of the Person :S.VISWANATHAN Mobile No. +91-9900512784 Landline No. +91-80-41695379 Fax No. Email ID viswa@fibertex.com viswatex2001@yahoo.co.in
Branch offices	Resident Office in India represented by S.VISWANATHAN
Annual Turnover of Geosynthetics division (Rs.in Lacs)	2541 Lakhs
Year of Establishment	1968
Manufacturing location	Aalborg , Czech Republic, France, South Africa
Products types	GeoTextiles, Filtration, Bedding, Furniture
Capacity in tones and sqr.mtr	20,000 TPA
Accreditations	IRC , CE Certified
In-house testing facilities	Yes
Export	Countries Globe Quantity in tones and /or sqr.mtr
Imports	
Major customers	British Roadways, Palm Island, Honkong International Airport

FLEXITUFF INTERNATION LTD

Head-office Address	C 41-50, S.E.Z., Sector 3, Pithampur- 454 775 Dist. Dhar, Madhya Pradesh, INDIA
Website	www.flexituff.com
Contact Person & Number	Name of the Person: Rajeeva Upadhyay/Romit Dutta/Nisha Singh Mobile No.: +91 9748079996/+91 9836391899/+91 8116654258 Landline No.: + 91 33 3221 2690 Email ID: rajeeva@flexituff.com /romit@flexituff.com / geofil.nbs@flexituff.com
Branch offices	Flexituff International Ltd Flat # 304, 3rd Floor Diamond Prestige 41-A, A.J.C.Bose Road Kolkata- 700 017 Tel: + 91 33 3221 2690
Annual Turnover of Geosynthetics division	82 Crores (Geofil Division) (2011-12)
Year of Establishment	1983
Manufacturing location	Flexituff International Ltd. Near Idgaha, Pipalgaon Road, Mahuakheraganj, Kashipur-244713 Tel. No.-05947-266000 & other three locations in India.
Products types	Woven & Nonwoven Geotextile, Geobag, Geotube, FIBCs.
Capacity in tones and sqr.mtr	70,000 MT
Accreditations	ISO 9001 : 2008
In-house testing facilities	GSM, Thickness, Wide Width Tensile Strength, Grab Strength, Trapezoidal Tear Strength, CBR & Static Puncture, Water Permeability, Permittivity, Apparent Opening Size, UV Resistance.
Export	Countries : France, Ireland, Netherlands, Spain, Mexico, UK, Belgium, Italy, Portugal, Greece, Brazil, USA, UAE, Russia, Kenya, Rwanda, Chile, Canada, Switzerland, Australia, Algeria, Japan, New Zealand, China, Egypt, Singapore, Sweden, Israel, Austria, Germany, etc. Value: 570 Crores
Imports	Countries : Australia, China Value: 9 Crores.
Major customers	Walmart USA,B.A.G Corp. USA, Panktil International Ltd, Nebig Verppankegen. Netherlands, ABP Packaging. UK, Jindal Power & steel Ltd, Micro Inks Ltd, Hindustan Unilever Ltd, Wolkem India Ltd, Conitex Sonoco USA Inc.,Lewis Trading Corp.USA, Bihar Water Resource Department, Brahmputra Board, Utter Pradesh Flood Control Div., West Bengal Irrigation, C.P.W.D, W.B.P.W.D.

Garware - Wall Ropes Ltd. ,Geosynthetics Division.

Head-office Address	M/s Garware - Wall Ropes Ltd Plot No. 11, Block D - 1, MIDC, Chinchwad, Pune – 411019, India.
Website	wwwga rwarerqpes. com
Contact Person & Number	Name of the Person : Mr. Tiru Kulkarni Mobile No. : 9326190478 Landline No. : +91-20-3078 0432 Fax No. : +91-20-3078 0350 Email ID : tkulkarni@garwareropes. com
Branch offices	New Delhi, Mumbai, Chennai, Kolkata
Annual Turnover of Geosynthetics division (Rs.in Lacs)	80 Cr
Year of Establishment	1976
Manufacturing location	Pune and Wai - Maharashtra
Products types	Polymer rope gabion, Woven geotextile, Steel gabion, Geotextile tube, Geotextile bag and container, Galvanized steel wire ropenet, Garmat – erosion control mat, HDPE geomembrane, Nonwoven geotextile, Geosynthetic clay liner, Polymer geogrid, geocell, ge onet andg eocompos ite, Ancodrain
Capacity in tones and sqr.mtr	Varying capacities for different products
Accreditations	ISO 9001:2008, IGS member
In-house testing facilities	Woven & nonwoven geotextiles, Metal gabions, Geogrids, Geomembrane, Galvanized steel wire ropenet, Polymer rope gabion
Export	Small exports to Sri Lanka and Singapore
Imports	Confidential

KUSUMGAR CORPORATES PVT. LTD.

Head-office Address	101/102, Manjushree, Corner of N.S. Road No. 5, V.M. Road, JVPD Scheme, Vile Parle (West), Mumbai 400 056. Tel. No. 91-22-6112 5100 Fax No. 91-22- 26115651 Email: info@kusumgar.com
Website	www.kusumgar.com
Contact Person & Number	Name of the Person **DR. M.K. TALUKDAR** Mobile No. 9987267005 Landline No. 91-22-6112 5100 Fax No. 91-22- 26115651 Email ID mktalukdar@kusumgar.com
Branch offices	NIL
Annual Turnover of Geosynthetics division (Rs.in Lacs)	Rs. 100 lacs
Year of Establishment	1970
Manufacturing location	Umbergaon in Valsad District, Gujarat State.
Products types	Woven Multifilament Geotextiles from Polypropylene or Polyester from 140 GSM to 1000 GSM Manufactures other technical textiles like parachute fabrics, protective fabrics for Ballistic Application, Sports Textiles, Medial Textiles etc.
Capacity in tones and sqr.mtr	10 lacs sq.mtr.
Accreditations	ISO 9001-2008
In-house testing facilities	The company has fully equipped laboratory to test technical textiles including Geosynthetics .
Export	Countries NIL Quantity in tones and /or sqr.mtr :

Maccaferri Environmenta Solutions Pvt. Ltd.

Head-office Address	402, 4th Floor, Salcon Aurum, Jasola District Centre New Delhi- 110 044, India
Web site	http://www.maccaferri-india.com/
Contact Person & Number	Name of the Person Mr. Ashish D. Gharpure / Mrs. Minimol Korulla Mobile No. +91 9545533002 / +91 9717568886 Landline No. +91(11) 4379 8400 / +91(20)4100 1900 Fax No. +91(11) 4654 6330 Email ID info@maccaferri-india.com
Branch offices	Mumbai, Kolkata, Chennai, Ahmadabad, Pune
Annual Turnover of Geosynthetics division (Rs. lacs)	
Year of Establishment	1998
Manufacturing location	D-40, MIDC, Ranjangaon, Tal- Shirur, Dist-Pune-412220
Products types	ParaWeb (Polymeric Strip), ParaLink (High Strength Geogrid), Gabion, Reno Mattress, Gabion Mattress, Terramesh System, Green Terramesh, Rockfall Netting, Steelgrid, RoadMesh
Capacity in tones and sqr.mtr	15 lakh sqm of high strength geogrids
Accreditations	CE certification, ISO 9001:2008,
In-house testing facilities	Universal Testing Machine
Export	Countries Middle East, Europe, Japan Quantity in tones and /or sqr.mtr
Imports	Countries Malaysia, Europe Quantity in tones and /or sqr.mtr
Major customers	CPWD, Irrigation Department, Major contractors, Railways, State Govt. PWD, Private Organization and Developers, NHAI

Maruti Rub Plast Pvt. Ltd.	
Head-office Address	A-80, Preet Vihar, Delhi 110092
Website	www.marutirubplast.com
Contact Person & Number	Name of the Person: Mr.Kapil Jain Mobile No. 09873154252 Landline No. 0120-2420336 Fax No. 0120-2420339 Email ID: directors@marutirubplast.com
Branch offices	B-69, Sector-5, Noida 201301
Annual Turnover of Geosynthetics division (Rs.in Lacs)	3-4 Crores
Year of Establishment	2010
Manufacturing location	D-22/23, Site 4, UP SIDC, Greater Noida 201306
Products types	Geogrids, Geotextiles, Geo bags, HDPE Geo membranes, Geo Drain, PVC Geo Membrane
Capacity in tones and sqr.mtr	35 Lacs s.mtr for Geo Grids 77 Lacs sqr.mtr for HDPE Geo Membrane
Accreditations	[illegible]
In-house testing facilities	Complete lab for geo technical products 100 KN Tenius Olsen Universal Testing Machine
Export	Countries – Middle East - Europe Quantity in tones and /or sqr.mtr – 250 Mt
Imports	Countries Quantity in tones and /or sqr.mtr
Major customers	L&T, Afcons, UPSBC, Delhi Metro, Adani Power

Reliance Industries Limited	
Head-office Address	Reliance Corporate Park,Building no 8 ,Ist floor, A wing, Thane Belapur Road, Ghansoli, Navi Mumbai 400701.
Website	www.ril.com
Contact Person &Number	Name of the PersonV.Kannan (Polypropylene) Dr.Anup Kumar Rakshit (Polyester) Mobile No. 9987048023 / 9967007904 Landline No. 022 44780245/ 022 44781208 Fax No. – 22-44710141 Email IDv.kannan@ril.com / anup.rakshit@ril.com
Branch offices	All over India.
Annual Turnover of Geosynthetics division (Rs.in Lacs)	Group Turn over in 2011-12 - 66.8 billion US dollar
Year of Establishment	1977 came into public
Manufacturing location	**Poly propylene::** 4 plants located in Jamnagar, Hazira, Vadodara in Gujarat and Nagothane in Maharastra. **Polyester**::Hazira, Patalganga, Hosierpur, Barabanki, Nagpur, Allahabad &Silvassa.
Products types	**Poly propylene** granules of various MFI suitable for manufacturing geotextile (both tape by tape as well as multifilament types) , Needle punched non woven, gabions, Prefabricated vertical drain tubes , staple fibre etc., **Polyester:** Staple fibre , Regular Filament & IDY yarns suitable for manufacturing of Nonwoven needle punched, thermal bonded Geotextiles, Geogrids, Geo textile bags..etc. Also for woven Geotextiles, Filters, industrial sewing threads..etc.
Capacity in tones and sqr.mtr	Poly propylene – 2.75 millions tons per annum. Polyester staple fibre & filament – 1-70 million tons per annum
Accreditations	ISO-9000; ISO-14000; NABL;..etc OekoTex for Polyester staple &Filamnet.
In-house testing facilities	Full pledged laboratory for on line testing. Product application centre for testing finished products on mechanical, thermal and other physical properties. Polymer testing/ evaluation. Polyester Fibre & Filament Testing- All physical & Chemical Props.

SHRI AMBICA POLYMER PVT. LTD.	
Head-office Address	A/3, IST FLOOR, SAFAL PROFITAIRE, NR AUDA GARDEN, PRAHALADNAGAR, AHMEDABAD 380051
Website	http://www.ambicapolymer.com
Contact Person & Number	Name of the Person : Anuja Malviya Mobile No. : +91 9560556651 Landline No.: +91 79 65453665 Fax No. : n/a Email ID: anuja@ambicapolymer.com
Branch offices	N/A
Annual Turnover of Geosynthetics division (Rs.in Lacs)	35 crores
Year of Establishment	1999
Manufacturing location	HARIYALA (KHEDA), GUJARAT
Products types	PP woven Geotextiles, Agrotextiles, PP woven filtration fabric, needle punch geo textiles, needle punch ground covers, needle punch felt
Capacity in tones and sqr.mtr	5520 MT annually
Accreditations	100% EOU, Govt. recognized export house,
In-house testing facilities	YES. All the tests for relevant ASTM standards for any woven geotextiles can be performed in house
Export	Countries : USA/ UK/EUROPE Quantity in tones and /or sqr.mtr
Imports	Countries Quantity in tones and /or sqr.mtr
Major customers	

SKAPS INDUSTRIES INDIA PVT. LTD.

Head-office Address	1) **SKAPS - USA CORPORATE HEAD OFFICE** 335, ATHENS Dr., ATHENS, GEORGIA 30601 (USA) 2) **SKAPS - INDIA HEAD OFFICE** 1, DARSHAN SOCIETY, 4TH FLOOR – SARASPUR BANK BUILDING JAIN TEMPLE, COMMERCE ROAD, NEAR STADIUM CIRCLE, NAVRANGPURA, AHMEDABAD – 380009. INDIA
Website	www.skaps.com
Contact Person & Number	Name of the Person: UTKARSHA N. PARIKH Mobile No. : 09725004460 Landline No. : 079-26402059 Fax No. : 079 - 26400370 Email ID: utkarsha@skaps.com
Branch offices	NIL
Annual Turnover of Geosynthetics division (Rs.in Lacs)	RS.180 CRS.
Year of Establishment	SKAPS USA – 1996 SKAPS INDIA – 2004
Manufacturing location	1) **100 % EOU UNIT** PLOT NO. A- 20, SURVEY NO. 423, MAHAGUJARAT INDUSTRIAL ESTATE, AHMEDABAD – BAVLA HIGHWAY, VILL. MORAIYA, TA. SANAND, AHMEDABAD. 2) **MUNDRA SEZ UNIT I & II** PLOT # 10, ROAD 12F, SECTOR 12 S, MUNDRA INTEGRATED TEXTILE & APPAREL PARK (MITAP), NR. SHANTIPATH 4, MUNDRA SEZ (MPSEZ) TA: MUNDRA – 370421 DIST: KUTCH, GUJARAT. INDIA
Products types	1) WOVEN GEO TEXTILES 2) NON WOVEN NEEDLE PUNCH GEO TEXTILE 3) GEO NET 4) GEO COMPOSITES 5) PAVING FABRIC
Capacity in tones and sqr.mtr	1) WOVEN TAPE X TAPE - 9000MT & 5,50,00,000 M2 2) PP NEEDLE PUNCH NON WOVEN GEO TEXTILE - 40000 MT & 2,00,00,000 M2 3) PP STAPLE FIBER – 23000 MT
Accreditations	1) ISO – 9000 2) ISO – 14000 3) ISO – 18000 4) NTPEP (AASHTO) 5) BNQ CANADA

SKAPS INDUSTRIES INDIA PVT. LTD.

In-house testing facilities	YES
Export	Countries: USA/ SOUTH AMERICA/MIDDLE EAST/ INDIA Quantity in tones and /or sqr.mtr
Imports	Countries : USA Quantity in tones and /or sqr.mtr
Major customers	N.A

Strata Geosystems (India) Pvt. Ltd.	
Head-office Address	317, Tantia Jogani Industrial Premises, J.R. Boricha Marg, Lower Parel (East), Mumbai - 400 011, Maharashtra, India
Website	www.strataindia.com
Contact Person &Number	Name of the Person: Mr. Narendra Dalmia Mobile No.: (0) 99-67-488188 Landline No. 022-4063 5100 Fax No.: 022- 4063 5199 Email ID: narendra.dalmia@strataindia.com
Branch offices	Delhi, Hyderabad & Bengaluru
Annual Turnover of Geosynthetics division (Rs.in Lacs)	
Year of Establishment	2004
Manufacturing location	Daman, Gujarat, India
Product types	1) StrataGrid (Geogrid) 2) StrataWeb (Geocells) 3) StrataBlock- Block fascia RS wall 4) StrataWall- Panel fascia RS wall 5) BEBO Arch System- Precast arch system
Capacity in tones and sqr.mtr	
Accreditations	x StrataGrid is IRC Accredited x StrataWeb is IRC Accredited x Strata Geosystems (India) Pvt. Ltd. is ISO & CE certified
In-house testing facilities	
Export	Countries Quantity in tones and /or sqr.mtr
Imports	Countries Quantity in tones and /or sqr.mtr

TechFab India Industris Ltd

Head-office Address	712, Embassy Centre , Nariman Point , MUMBAI 400 021
Website	www.techfabindia.com
Contact Person &Number	Name of the Person :- Mr Anant Kanoi Mobile No. +91 9987796210 Landline No. – 022 22876224/5 Fax No. :- 022 2287 6218 Email ID :- office@techfabindia.com,p.salvekar@techfabindia.com,anant@techfabindia.com
Branch offices	Ahmedabad,Delhi,Kolkata,Hyderabad,Chennai
Annual Turnover of Geosynthetics division (Rs.in Lacs)	96 Crores
Year of Establishment	1993
Manufacturing location	Silvassa , Daman
Products types	x Multifilament polypropylene woven geotextiles x Woven polyester multifilament geotextiles x TechGeo nonwoven needle-punched geotextiles x TechGrid knitted and PVC coated polyester geogrids x TechDrain pre-fabricated vertical drains x TGC non-woven composites x Techfab metal Gabion ,Rock fall netting gabions x TechTube : Geotextile Tubes x Geocomposites
Capacity in tones and sqr.mtr	Woven Geotextile : 2400 T Nonwoven : 5040 T Geogrid : 15 million sqmtr Gabions : 7200 T
Accreditations	1) IRC 2) PWD 3) AAI 4) MES 5) PMGSY 6) BBA 7) CIDCO
In-house testing facilities	Our Labs are equipped with all modern testing equipments to test most of the parameters
Export	TechFab India has an Export House Certificate issued by Govt of India
Major customers	Most of the leading contractors in India

TENCATE GEOSYNTHETICS ASIA SDN BHD.	
Head-office Address	14, JALAN SEMENTA, 27/91, SEKSYEN 27, SHAH ALAM SELANGOR DARUL EHSAN, 40400 ,MALAYSIA
Website	www.tencate.com
Contact Person & Number	Name of the Person: C.Nanda Kishore Tel: +9140 27701271 Fax:+9140 27701276 Mobile: +91 9885032806 Email ID: n.kishore@tencate.com
Branch offices	TenCate India Liaison Office A-1, Sector-10 ,Noida -201301 India TenCate India Liaison office Vishwasri GL, Plot No:5, IInd floor, Vijay Nagar colony, Behind Secunderabad Club, Picket, Secunderabad-500003,India
Annual Turnover of Geosynthetics division-Asia (Rs.in Lacs)	350 Crores INR
Year of Establishment	1867
Manufacturing location	14, JALAN SEMENTA, 27/91, SEKSYEN 27, 40400 SHAH ALAM SELANGOR DARUL EHSAN, MALAYSIA and Zuhai, China
Products types	A full range of non woven and woven geotextiles for stabilization, reinforcement and drainage of soft unstable soils, a full range of high tenacity geogrids and soil reinforcement composites and geotubes and geocontainers for marine and industrial dewatering applications as well as soil erosion protection and containment systems.
Capacity in tones and sqr.mtr (Indicative)	1600 MT per month and > 50 million sq. metres per year (Asia)
Accreditations	**Geosynthetic Accreditation Institute – Laboratory Accreditation Program (GAI – LAP), USA according to ISO/IES 17025.**
In-house testing facilities	**ISO 9001** standards is backed by a laboratory **QC/QA** system
Export	Countries :Hong Kong, Singapore, Thailand, Philippines, Indonesia and India,whole of Asia,Australia and newzealand. Quantity in tones and /or sqr.mtr :

TENCATE GEOSYNTHETICS ASIA SDN BHD.

Imports	Countries : NA Quantity in tones and /or sqr.mtr
Major customers	1 AfCons 2 Delhi PWD 3 Delhi Tourism & Transport Development Corp. 4 DLF Developers 5 DS Constructions . Ltd. 6 Econ Piling 7 G.H.Ajwani Construction Pvt. Ltd. 8 Gammon India 9 Garware Wall Ropes 10 Haldia Port Trust 11 Hindustan Construction Co. 12 Hindustan Zink Ltd. 13 IOCL 14 IRCON 15 JSR Constructions(p) Ltd. 16 L&T, ECC 17 Maharshi Geomembrane 18 Mckintosh Burn, Kolkata 19 Nagarjuna Constructions Co. Ltd. 20 Navayuga Engineering Co. 21 NHAI 22 Oriental Structures (P) Ltd. 23 P&C Construction Pvt. Ltd. 24 PATI-BEL 25 Petron Civil Engineering Ltd. 26 Progressive Construction Ltd. 27 Punj Lloyd 28 RBM Pati, Malayasia 29 Sargon Geosynthetics 30 Simplex Concrete Piles 31 Somdatth Builders 32 Sterlight Industries 33 Tarmat Infrastructure & Engg Pvt. Ltd. 34 Trafalgar House 35 Tuticorin Port Trust 36 UP State Bridge Corporation 37 UP,PWD 38 Vijay Nirman 39 West Bengal PWD 40 Z-Tech

Z TECH (INDIA) PVT LTD.

Head-office Address	S 29, 1ST FLOOR, OKHLA PHASE 2 NEW DELHI - 110020
Website	www.ztech-india.com
Contact Person & Number	Name of the Person : DOLA ROYCHOWDHURY Mobile No. : +91 9968281321 Landline No. +91 11 26383931-33 Fax No. +91 11 26383934 Email ID: ztech@airtelmail.in, drc@ztech-india.com
Branch offices	KOLKATA, MUMBAI, CHENNAI, HYDERABAD, AHMEDABAD
Annual Turnover of Geosynthetics division (Rs.in Lacs)	1126 Lacs
Year of Establishment	1995
Manufacturing location	---
Products types	GEOGRIDS, GEOTEXTILES, GEOMEMBRANES, GEOCOMPOSITES, GEOTEXTILETUBES, PVDs, FABRIC FORMS
Capacity in tones and sqr.mtr	---
Accreditations	---
In-house testing facilities	---
Export	Countries -- Quantity in tones and /or sqr.mtr --
Imports	Countries : Malaysia, Netherlands, Belgium, Thailand, China, USA

National Jute Board

National Jute Board (NJB) was constituted as per the **National Jute Board Act 2008** by the Parliament for the purpose of development of jute cultivation, manufacture, marketing and promotion of jute products. It is a corporate body with its office at Kolkata and is headed by the Secretary of Textiles, Government of India.

NJB promotes standardization of jute and jute diversified products like **Jute Geo-textiles (JGT),** assists and encourages studies and research in development of technical textiles. It also sponsors and encourages scientific, technical and economical research related to jute and jute products. It provides support services to entrepreneurs including technical guidance and training. NJB also advises the Central Government on all matters related to development of jute and jute industry including import and export of jute and jute products.

About Indian Technical Textile Association (ITTA)

About Indian Technical Textile Association (ITTA)

- Technical textile sector is one of the most innovative branch of the industry in the world, ranking as one of the five high tech sectors with the greatest potential for development. The success of technical textiles is primarily due to the creativity, innovation and versatility in fibres, yarns and woven/knitted/nonwoven fabrics with applications spanning an enormous range of uses. The ability of technical textiles to combine with each other and with others to create new functional products offer unlimited opportunity for growth.

- In India also technical textiles is one of the fastest growing segment of the Indian economy. It has registered compounded annual rate of growth of 11% during 11th five year plan and the working group report for the twelveth five year plan has projected growth of 20% for technical textiles. This translates into market size increasing from USD 13 billion to USD 36 billion by 2016-17. The growth of the industry has been primarily due to the entrepreneurial ingenuity of the Indian industry supplemented by the schemes of the government of India incentivizing the investment in the sector. The government of India also recognized the need to have the industry's active participation to bring out the issues, concerns and suggest policy framework that would lay the foundation for this sector. Resultantly, Indian Technical Textile Association (ITTA) was formed. ITTA is registered under section 25 of the companies act (1956) in the year 2010 and the formation of the ITTA was facilitated by the Office of the Textile Commissioner, Ministry of Textiles, Government of India.

- ITTA is the only association of the technical textile industry in the country. ITTA membership represents the entire technical textile value chain from raw material to finished goods producers, machinery manufacturers, consultants, centers of excellence and R&D institutes. The objective of ITTA is to promote, support, develop and increase production, consumption and export of technical textile to make India a power house of technical textiles in the days to come.

- Given the fact that government policy have played a critical role in the advancement of technical textiles, ITTA is maintaining a close interaction with government of India in formulation of various policies focusing on removing the ambiguities in the system which are hampering the growth of the sector, helping bring in legislation which will help spur usage in India and recommending fiscal and non fiscal norms which would aid the industry to achieve its true potential.

- **ITTA is dedicated to members success** and aims to become the premier organization that

any aspect of technical textiles to be a part of this exciting journey to become VOICE of Indian technical textile industry.

Membership Benefits

- ITTA regularly engage the central and state governments on issues of relevance to the industry. Members may raise issues with ITTA that have industry wide impact.
- Involve membership participation in various forums/sub groups of ITTA on subjects such as Technology, Exports, Domestic Market, Government Policies, Quality, sector specific groups etc. to help recommend initiatives to be taken to help the segments growth.
- ITTA's value added services to its members to facilitate business and trade in technical textiles and create an ecosystem that promotes growth and profitability- This is being achieved through various activities

  - Dissemination of government policies and schemes.
  - Sharing of International and national news through a monthly e-bulletin
  - Networking events with government and industry experts both in India and overseas.
  - Providing platforms to members to showcase their strengths to the outside world.
  - Strategic alliances with reputed international technical textile associations for mutual benefit.
  - Concessional rates for participation in fairs/subscriptions for magazines
  - Identification and assessment of market growth opportunities.
  - Facilitates technology transfer / JVs with foreign companies.

Board of Directors and office bearers of ITTA:

Shri Mohan Kavrie, MD, Supreme Nowovens	Chairman
Shri M.Senthil Kumar, MD, BKS Textiles	Vice Chairman
Shri V. Kannan, VP, Reliance Industries	Finance Director
Shri Amit Agarwal, Director, CTM Textiles	Hon' Secretary
Shri. Dilip B. Jiwrajka, MD, Alok Industries,	Member
Shri Vayu Garware, MD, Garware Wallropes	Member
Shri P. K. C Bose, MD & CEO, Saertex Industries	Member
Shri Pramod Khosla, CEO, Khosla Profils	Member
Shri D. Pulikeshi, AVP, SRF Limited,	Member
Shri Kamal Kumar Johri, MD, Nobal Hygine	Member
Dr. Ashok N.Desai, Director, BTRA	Member
Shri U.K.Gangopadhyay, Executive Director, SASMIRA	Member
Shri Chandrakant M Khetan, CMD, Entremonde,	Member
Shri Gokul Mehta, Director, Haren Textiles,	Member
Shri Rajesh Somani, Chairman, Lahoti Terra Knitfab Ltd.,	Member
Shri Arun Jariwala, Chairman, SASCMA	Member
Shri Mukesh Vijaywargi, President New Market, Klopmann International Srl.	Member
Shri M.K.Bardhan, Director, Wool Research Association.	Member

---

Mrs. Shashi Singh	Executive Director
Mr. T.V.Bhavadas	Administrative Officer

For membership contact: info@ittaindia.org/ed@ittaindia.org

INDIAN TECHNICAL TEXTILE ASSOCIATION

'A' Block, The Bombay Textile Research Association(BTRA),
Near R-City Mall, L. B. S. Marg, Ghatkopar(W), Mumbai 400086
Tel. :022-25003098 Email : ed@ittaindia.org / info@ittaindia.org
Website : www.ittaindia.org