TECHGRID GEOGRID FOR REINFORCED SOIL WALL

DT: 20/21 -2-2015
CONTENTS

• TECHFAB INDIA
  AN OVERVIEW

• REINFORCED SOIL WALL MATERIALS

• TECHGRID GEOGRID & RSW TESTING & DESIGN

• TECHGRID RSW CASE STUDIES CREDENTIALS
At the Heart of Geosynthetic Activity

STARTED IN THE YEAR 2003

With a Dream to give India “World Class Geosynthetic Products” With Indigenous Manufacturing Facility Under One Roof

Urban Roads
Ground Improvement
Airports
Highways
RE Walls
Coastal Protection
River Training
Manufacturing Plants

- Woven Geotextiles (2003, Silvassa)
- Polymer Gabions (2004, Silvassa)
- Techgrid Geogrids (2005, Silvassa)
- Techdrain PVD (2008, Silvassa)
- Nonwoven Geotextiles (2009, Daman)
- Metal Gabions (2010, Daman)

Year of Start of commercial production

Location of Plant

Silvassa
Daman
REINFORCED SOIL WALL MATERIALS
Reinforced Soil – Milestones

- Henry Vidal files patent for reinforced earth
- First major steel RE structures built in France
- 1st Geosynthetic (PET straps) reinf. wall built in France
- 1st Geotextile reinforced wall built in France
- First geogrid (Tensar) developed
- First Geogrid reinforced wall
- PET geogrids launched
- First RSW in India at Ludhiana
- TechGrid, the 1st Indian geogrid
Massive vs. Reinforced soil retaining walls
At the Heart of Geosynthetic Activity

TYPICAL CROSS SECTION FOR GEOSYNTHETIC REINFORCED SOILRETAINING WALL
Materials - RSW

- Reinforcement – Steel strips, Geotextiles, Geogrid, Geostrap, Geogrid strips etc.
- Facing – Precast concrete discrete panels, segmental blocks, gabions, welded-mesh supported wrapped face
- Reinforced fill / Retained fill / Foundation fill
- Leveling pad / Crash Barrier – Friction Slab
- Fixtures and accessories
MATERIALS
TECHGRID GEOGRID
High speed computerized warping unit
At the Heart of Geosynthetic Activity

Weft Insertion Warp Knitting Machine
Knitted Fabric
At the Heart of Geosynthetic Activity

Coating
Uniaxial Geogrid

TGU40 / TGU60 / TGU80 / TGU100 / TGU120 / TGU150 / TGU200 / TGU250 / TGU300

Biaxial Geogrid

TGB30 / TGB60 / TGB90
Polyester yarn

- High tenacity, high modulus, low creep
- Low shrinkage
- Molecular weight > 25,000 (g/mol)
- Carboxyl End Groups < 30 (mmol/Kg)
TechGrid – Knitted and PVC coated Geogrid

Coating

- Dimensional stability
- Protection from installation damage
- Protection from UV, chemical and biological damage

Weft insertion warp knitted structure – high tenacity polyester yarns
MATERIALS
RSW FACINGS
Facings - Functions

• Formwork to contain fill during compaction
• Stabilize fill against raveling, erosion etc.
• To protect the reinforcement
• Aesthetics
• To enable anchors to function as a tie-back
Facings - Selection

- Aesthetics
- Facing – reinforcement connection
- Construction
- Ability to accommodate movements
- Ability to accommodate horizontal curves
- Ability to accommodate changes in vertical profile
- Cost
Facings - Types

- Modular concrete blocks
- Segmental concrete panels
- Discrete concrete panels
- Welded wire mesh
- Gabions
- Wraparound
MODULAR CONCRETE BLOCK -FACING

REINFORCED SOIL WALL -FACING
Reinforced Soil Wall with Techgrid Geogrids & Segmental Block Facing at Atlanta, USA
SEGMENTAL CONCRETE PANEL -FACING

ISOMETRIC VIEW

REINFORCED SOIL WALL -FACING
DISCRETE CONCRETE PANEL -FACING

ISOMETRIC VIEW

REINFORCED SOIL WALL -FACING
At the Heart of Geosynthetic Activity

WELDED WIRE MESH -FACING

REINFORCED SOIL WALL -FACING

WELDED WIRE MESH
15 m high Reinforced soil wall – DND Flyover
At the Heart of Geosynthetic Activity

WRAP AROUND - FACING
Other components

- Connection for panels
- Leveling pad
- Coping
- Bearing pad
- Geotextile
- Drainage Bay
At the Heart of Geosynthetic Activity

GEOGRID TESTING
50 KN Tensile testing machine with laser extensometer
Independent third-party testing at TRI / SGI / BTRA …

- Mass per unit area
- Wide width and single rib tensile strength
- Creep
- Installation damage
- Pull-out
- Geogrid-block connection strength
- Molecular weight and CEG of yarn
Long-term Design Strength (TD)

\[ T_D = \frac{T_{ult}}{RF_{CR} \cdot RF_{ID} \cdot RF_D} \]

- \( RF_{CR} \): Reduction factor for creep
- \( RF_{ID} \): Reduction factor for installation damage
- \( RF_D \): Reduction factor for durability
Stepped Isothermal Method (SIM) Creep tests
Installation damage testing at TRI
At the Heart of Geosynthetic Activity

COVER SOIL/AGGREGATE IS UNIFORMLY SPREAD AND IMPACTED USING FIELD-SCALE EQUIPMENT AND PROCEDURES

THE DENSITY OF COMPACTED SOIL IS MEASURED

THE STEEL PLATES ARE TILTED TO FACILITATE EXHUMATION
Test Results

Retained strengths for each of the tested geosynthetic styles are presented in Table 1.

Table 1. Retained Strength for Tested Geosynthetics

<table>
<thead>
<tr>
<th>Style</th>
<th>Gradation 1 (Coarse gravel)</th>
<th>Gradation 3 (Sand)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Retained</td>
<td>RF&lt;sub&gt;ED&lt;/sub&gt;</td>
</tr>
<tr>
<td>Techgrid U60</td>
<td>92.8</td>
<td>1.08</td>
</tr>
<tr>
<td>Techgrid B30 MD</td>
<td>94.3</td>
<td>1.06</td>
</tr>
<tr>
<td>Techgrid B30 XD</td>
<td>88.1</td>
<td>1.14</td>
</tr>
</tbody>
</table>

Conclusion

TRI is very pleased to present this report for installation damage testing of soil reinforcing geosynthetics. If you have any questions or require any additional information, please call me at 1-864-242-2220.

Sincerely,

C. Joel Sprague, P.E.
Senior Engineer

cc: Sam Allen
Reduction Factor for Durability

- Molecular weight > 25,000 & CEG < 30
- Tests for chemical degradation (exposure to acids and alkalies)
- Tests for biological degradation
- Test for ultraviolet degradation

- RFD = 1.15
Coefficient of interaction

Coefficient of interaction for direct sliding

Coefficient of interaction for pullout
TechGrid - Pullout testing at TRI
Pull-out testing

Figure 1. Pullout Box and Tell-tails in a Typical Test
**Coefficients of interaction - Sand**

**Table 3. Summary of Pullout Test Results**

Soil(s): Sand ($\phi = 43.4^\circ$)  
Geosynthetic Type: Techgrid U40 and U80

<table>
<thead>
<tr>
<th>Test #</th>
<th>Width of Geogrid (m)</th>
<th>Embedment Length Initial (m)</th>
<th>Normal Load (kPa)</th>
<th>Approx. Soil Depth (m)</th>
<th>Peak Tensile Capacity (kN/m)</th>
<th>Mode of Failure</th>
<th>Pullout Interaction Coefficient*, $C_i$</th>
</tr>
</thead>
<tbody>
<tr>
<td>U40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.6</td>
<td>1.2</td>
<td>10</td>
<td>0.3</td>
<td>22.5</td>
<td>Pullout</td>
<td>0.99</td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
<td>1.2</td>
<td>24</td>
<td>1.1</td>
<td>51.0</td>
<td>Rupture</td>
<td>0.94</td>
</tr>
<tr>
<td>U80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.6</td>
<td>1.2</td>
<td>20</td>
<td>2.3</td>
<td>42.0</td>
<td>Pullout</td>
<td>0.93</td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
<td>1.2</td>
<td>45</td>
<td>2.3</td>
<td>77.5</td>
<td>Rupture</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Geosynthetic Tensile Strength (ASTM D 6637) = 40 and 80 kN/m

\[ C_i = \frac{P}{(C \sigma'_v L_e \tan \phi) \text{ (for geosynthetics)}} \]

Where: 
- $P$ = pullout resistance per unit width; 
- $C$ = effective unit perimeter - 2 for geosynthetics; 
- $\sigma'_v$ = effective vertical stress; 
- $L_e$ = embedment length

(* Note: A soil’s $\phi$ angle is normal load dependent.)
Connection strength testing

Typical Full Test Set-up & Normal Load Application

Typical Pullout & Displacement Measuring Set-up
Figure 1. Connection Strength versus Normal Load – Techgrid U40 vs. Keystone Vantage

\[ T_p = N \tan 36.8 + 12.1 \]
\[ T_b = N \tan 9.6 + 14.5 \]

Connection Strength
TechGrid U40 & Keystone Vantage

At the Heart of Geosynthetic Activity
Site specific design

- Wall geometry
- Loadings
- Fill properties
- Foundation soil properties
- Water
- Seismic
Wall geometry

- Longitudinal profile
- Cross-section
- Back slope at crest of wall
- Slope in front of toe
- Multi-tiered structures
Longitudinal profile
Back slope at crest of wall
Slope at toe
Wall founded on embankment
Multi-tiered walls
TFI CASE STUDIES
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 (Km 108.000) 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
**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 Bhabhe & Associates Pvt. Ltd.
**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.
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
**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.
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
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
**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)
Project Description

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

Client: National Highway Authority of India

Contractor: Larsen & Toubro Ltd.

Consultant: ICT Pvt. Ltd., New Delhi
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
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
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
Reinforced Soil Wall for the Approach Ramps To Rail Over Bridges at Beas

Project: Construction of ROB at Beas
Client: PWD, B & R, Punjab
Consultants: M/s B&S Engg. Consultants Ltd
Height Max: 7.0 M
At the Heart of Geosynthetic Activity

RSW APPROACH RAMP TO RAIL OVER BRIDGE, PATIALA (PUNJAB), INDIA

PROJECT : Construction of 4 Lanes Approaches to Rail Over Bridge on Level Crossing No. C-21 on Rajpura-Dhuri- Bhatinda Railway Line at Patiala

CLIENT : P.I.D.B. & P.W.D. (B& R), Punjab

CONSULTANT : M/s B&S Engg. Consultants Ltd

CONTRACTOR : S. P. Singla Cons. Pvt. Ltd., New Delhi

MAX. HEIGHT : 7.00 m

FACIA : Modular/Segmental Block
At the Heart of Geosynthetic Activity

RSW APPROACH RAMP TO RAIL OVER BRIDGE, JAGRAON (PUNJAB), INDIA

PROJECT: construction of R.O.B. at level crossing No. A-34 on Ludhiana Ferozepur Railway Line on Jagraon - Raikot Road at Jagraon

CLIENT: P.I.D.B. & P.W.D. (B& R), Punjab

CONTRACTOR: S.P. Singla Constructions Pvt. Ltd., New Delhi

MAX. HEIGHT: 7.65 m.

FACIA: Modular/Segmental Block
REINFORCED SOIL WALL FOR THE APPROACH RAMP TO RAIL OVER BRIDGE, KALOL (GUJRAT)

**PROJECT**: Construction of R.O.B. in lieu of L.C.No.-231A near Kalol, on Kalol – Mansa- Vijapur road (S.H.No.-138)

**CLIENT**: Government of Gujrat R & B Department

**MAX. HEIGHT**: 6.20 m
At the Heart of Geosynthetic Activity

R S Wall at Northeast Georgia, USA

<table>
<thead>
<tr>
<th>Client:</th>
<th>R S Wall, Northeast Georgia, USA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultant:</td>
<td>REDI Engineering, Georgia, USA</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Retaining Wall, Georgia, USA</td>
</tr>
</tbody>
</table>
At the Heart of Geosynthetic Activity
Project Description

Project: Reinforced soil walls for Monsoon Palace, Aamby Vallry (Pune)
Contractor: M/s Spectrum Engineers, Vadodara.
Architect: M/s Prabhatkar B Bhagwat, Landscape Architects & Environmental Planners, Ahmedabad.
At the Heart of Geosynthetic Activity
Project Description

Project: Reinforced soil walls with Weld Mesh Facing, Lonavala (Maharashtra)

Length & Height: 120m- Length 2 to 11mtrs - Height.

Product: TechGrid - Geogrid, Techgeo Nonwoven Geotextile; TechFab Metal Gabions Weld Mesh.
At the Heart of Geosynthetic Activity
At the Heart of Geosynthetic Activity

Select RE Wall Projects - TechGrid + Discrete Panel Facing

<table>
<thead>
<tr>
<th>Place/ Name of the project</th>
<th>NH/ SH</th>
<th>Height of the RE wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pathankot</td>
<td>NH</td>
<td>13</td>
</tr>
<tr>
<td>Alwar</td>
<td>SH</td>
<td>11</td>
</tr>
<tr>
<td>Udaipur</td>
<td>NH</td>
<td>10</td>
</tr>
<tr>
<td>Jalandhar-Amritsar</td>
<td>NH</td>
<td>10</td>
</tr>
<tr>
<td>RoB at Ferozpur</td>
<td>SH</td>
<td>9.0</td>
</tr>
<tr>
<td>Khalilabad, UP</td>
<td>NH</td>
<td>8.5</td>
</tr>
<tr>
<td>RoB at Beas</td>
<td>SH</td>
<td>8.5</td>
</tr>
<tr>
<td>Flyover at Samalkha, Panipat</td>
<td>NH</td>
<td>8.5</td>
</tr>
<tr>
<td>RoB at Fazilka</td>
<td>SH</td>
<td>6.5</td>
</tr>
<tr>
<td>Flyover at Chinchwad, Pune</td>
<td>SH</td>
<td>5.0</td>
</tr>
</tbody>
</table>
## Select RE Wall Projects - TechGrid + Segmental Panel Facing

<table>
<thead>
<tr>
<th>Place/ Name of the project</th>
<th>NH / SH</th>
<th>Height of RE wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muzzafarnager - RoB/Flyovers</td>
<td>NH</td>
<td>12.5</td>
</tr>
<tr>
<td>Palanpur - Swaroopgunj</td>
<td>NH</td>
<td>12</td>
</tr>
<tr>
<td>Vadodara - Bharuch</td>
<td>NH</td>
<td>12</td>
</tr>
<tr>
<td>Jadcherla - Kothagatta, AP</td>
<td>NH</td>
<td>10</td>
</tr>
<tr>
<td>Anand, Gujarat</td>
<td>SH</td>
<td>9</td>
</tr>
<tr>
<td>Sirhind, Punjab</td>
<td>SH</td>
<td>8.5</td>
</tr>
<tr>
<td>Nagpur</td>
<td>NH</td>
<td>7.5</td>
</tr>
<tr>
<td>Kota</td>
<td>SH</td>
<td>7.0</td>
</tr>
<tr>
<td>Chinchwad, Pune</td>
<td>SH</td>
<td>7.0</td>
</tr>
<tr>
<td>Hapur-Garhmukteshwar</td>
<td>NH</td>
<td>6.5</td>
</tr>
<tr>
<td>Bikaner</td>
<td>SH</td>
<td>5.0</td>
</tr>
</tbody>
</table>
Select RE Wall Projects - TechGrid + Segmental Block Facing

<table>
<thead>
<tr>
<th>Place/ Name of the project</th>
<th>NH / SH</th>
<th>Height of RE wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyderabad Outer Ring Road</td>
<td>SH</td>
<td>15</td>
</tr>
<tr>
<td>Hyderabad (APSIDC)</td>
<td>SH</td>
<td>15</td>
</tr>
<tr>
<td>Gwalior</td>
<td>NH</td>
<td>9</td>
</tr>
<tr>
<td>Suchipind, Punjab</td>
<td>SH</td>
<td>8.5</td>
</tr>
<tr>
<td>Salem-Namakkal</td>
<td>NH</td>
<td>8.5</td>
</tr>
<tr>
<td>Bhatinda</td>
<td>SH</td>
<td>7</td>
</tr>
<tr>
<td>Kalol, Gujarat</td>
<td>SH</td>
<td>7</td>
</tr>
<tr>
<td>Jagraon, Punjab</td>
<td>SH</td>
<td>6.5</td>
</tr>
<tr>
<td>Abohar</td>
<td>SH</td>
<td>6.5</td>
</tr>
<tr>
<td>Patiala</td>
<td>SH</td>
<td>6.0</td>
</tr>
<tr>
<td>Hirabaug, Surat</td>
<td>SH</td>
<td>5.0</td>
</tr>
</tbody>
</table>
## Select RE Wall Projects - TechGrid + Welded Wiremesh Facing

<table>
<thead>
<tr>
<th>Place/ Name of the project</th>
<th>NH / SH</th>
<th>Height of RE wall</th>
</tr>
</thead>
<tbody>
<tr>
<td>DND Flyway</td>
<td>SH</td>
<td>15.0</td>
</tr>
<tr>
<td>Katra (tunnel)</td>
<td>-</td>
<td>10</td>
</tr>
<tr>
<td>Wardha (coal handling plant)</td>
<td>-</td>
<td>10</td>
</tr>
</tbody>
</table>
RS Walls - Summary

More than 12Lacs SQM of reinforced soil walls for approaches to flyovers / RoBs / underpasses have been successfully constructed using TechGrid Geogrid – using different facings – discrete panels, segmental panels, segmental blocks, welded wire mesh etc. for maximum height up to 20 meter.
Thank you