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**GOVERNMENT OF INDIA
MINISTRY OF RAILWAYS**

**Specifications for Geogrid to be used as
reinforcement/stabilisation for Railway Formation**

Specification No. RDSQ/2018/GE: IRS-0004 Part-III

**February 2020
Geo-technical Engineering Directorate,
Research Designs and Standards Organisation
Manak Nagar, Lucknow – 11**



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Specifications for Geogrid to be used as Reinforcement/Stabilisation for Railway Formation

(A) Properties of Geogrid

The geogrid used as reinforcement/stabilisation layer shall have following properties, when tested as per the latest edition of the test method indicated therein, for Railway application:

Table A.1

Sl. No.	Property	Test Method	Value
I	Material/Polymer		
1	Material/Polymer	-	Polypropylene
II	Mechanical Properties		
1.	Tensile Strength at 2% Strain (**) (i) For use below ballast in existing line (ii) For use below blanket in new line	ISO 10319-2015	10 KN/m x 10 KN/m* 9 KN/m x 9 KN/m*
2.	Strain at Ultimate Tensile Strength (**)	ISO 10319-2015	6-15 %
3.	Aperture Stability/Torsional Rigidity Modulus (**) (i) For use below ballast in existing line (ii) For use below blanket in new line	ASTM-D7864-2015	Average Torsional Stiffness ≥ 0.33 N-m/deg ≥ 0.40 N-m/deg
4.	Junction Efficiency (**)	ASTM-D7737-2015	90%
III	Durability Characteristics		
1.	Resistance to Installation damage (% tensile strength at 2% strain) (**)	ASTM-D5818-2018	90%
2.	Resistance to Chemical Degradation (% Average Ultimate rib Tensile Strength) (**)	ASTM D6213-2017	100%
3.	Resistance to U.V. Light Weathering (% strength retained in breaking strength) after 500 hrs of exposure (**)	ASTM-D4355-2018	95%
4.	Minimum retained Ultimate Tensile Strength (**)	EN ISO-13438-2004	50% (tested as per Clause B.4.2 of EN:13250-2016, for 100 Year Service Life)

MD: Machine Direction (Longitudinal to the roll) X CD (90° of Machine Direction): Transverse Direction (Across the roll width)

** Values marked are Minimum Average Roll Value (MARV), which is derived statistically as average value minus two standard deviations.

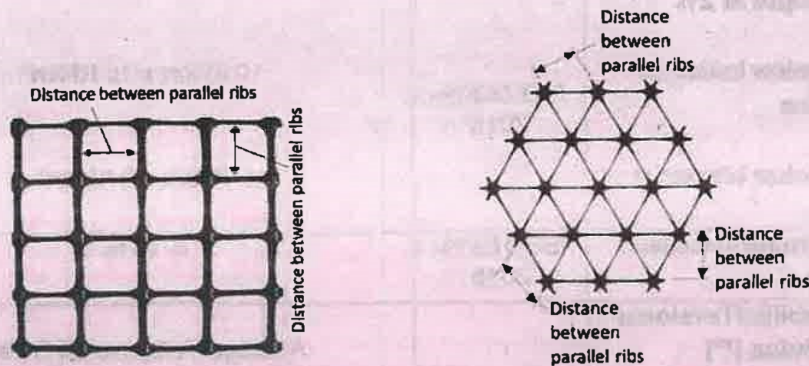


Note:

1. The adherence to above listed specification should be checked by testing the samples at IIT, NIT, Government labs or any other NABL accredited lab.
2. Aperture Opening of Geogrid:
 - For use below ballast in existing line, the distance between parallel ribs of the geogrid should be $60\text{mm} \pm 5\text{mm}$.
 - For use below blanket in new line, the distance between parallel ribs of the geogrid should be $30\text{mm} \pm 5\text{mm}$.

Aperture size/opening specified above is the clear distance between inner faces of ribs.

Reference diagrams are as given below for illustrations.



(Ref. ISO 10319-2015)

3. The particle grading for the installation damage test result determined in accordance with ASTM D5818 shall use Ballast grading as defined in IRS-GE-1 June 2016, for use below bottom of ballast in existing line and Blanket grading as defined in RDSO/2018/GE-IRS-0004(D) part-IV July 2019, for use below in blanket layer in new line.
4. The product being supplied by the manufacturer should have been successfully used as per functional requirement for similar Railway application (reinforcement / stabilization) at minimum 3 locations, with minimum 3 years India/International experience at one of the locations, and certificate duly certified by client/executive which is a government agency/PSU, should be submitted as an evidence for satisfactory performance.
5. Manufacturing of geogrid shall be performed in accordance with the manufacturer's QAP for quality control.
6. To ensure proper quality assurance and reproducibility of the product, following stipulations are as under:
 - i) The manufacturer of the Geogrid should have ISO: 9001 and CE Certification of the product being supplied. The manufacturer of Geo-synthetics should have a well-documented Quality Assurance Procedure (QAP)/Factory Production Control (FPC) Manual, covering every specific product produced on specific production site, which shall be referred/stipulated in the ISO: 9001 and CE Certification. The QAP/FPC Manual shall consist of a permanent internal production control system to ensure that product being manufactured conforms to the requisite properties and it addresses following items:
 - (a) Produce design requirement and criteria.
 - (b) Acceptance criteria of raw/incoming material and procedures to ensure that these are met.
 - (c) Relevant features of the plant and production process; giving frequency of inspections, checks & tests, together with values/criteria required on equipment and action(s) to be taken when control values or criteria are not obtained.
 - (d) Tests on finished products – Size of the samples and frequency of sampling with results obtained.

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- (e) Details of alternative tests and procedures, if any, and their correlation with reference tests.
 - (f) Calibration of equipment having influence on test results.
 - (g) Records to be maintained for various inspections, checks and tests carried out during factory production.
 - (h) Assessment of results of various inspections, checks and tests carried out during factory production; where possible and applicable.
 - (i) System of traceability and control of designs, incoming materials and use of materials.
 - (j) Corrective action for non-conforming materials and finished products.
 - (k) Training, job description and responsibility of the personnel involved in the manufacturing process.
- ii) Any subsequent changes in raw materials, manufacturing procedures or the control scheme that effects the properties of a product shall be recorded/revised in the QAP/FPC Manual and certified by the ISO: 9001 and CE Certification.
 - iii) Surveillance of QAP/FPC Manual shall be undertaken at least once per year. The surveillance shall include a review of the test plan(s) and production processes for each product to determine if any changes have been made since the last assessment or surveillance. The significance of changes shall be assessed.
 - iv) Records of all in-house test results, as per QAP/FPC Manual, shall be shown to the purchaser, whenever requested by the purchaser

(B) Packing, Handling, Storage and Laying of Geogrid

- (i) A tag or other method of identification shall be attached to each roll indicating the following:
 - (a) Manufacturer or Supplier Name
 - (b) Product name and Style
 - (c) Roll Number
 - (d) Lot or Batch Number
- (ii) Geogrids shall be stored in a manner that prevents excessive mud, wet concrete, epoxy or other deleterious materials from coming in contact with and affixing to the geogrid.
- (iii) If the geogrid comes in the protective wrapping, it should be kept in wrapped condition till their storage and installation. After unwrapping, the geogrid should be installed and covered within a maximum period of 1 month.
If the Geogrid is supplied in unwrapped condition, it should be installed and covered within a maximum period of 1 month from the date of manufacturing. In case Geogrid is supplied after more than a month's period to the site it should be ensured that it conforms to Resistance to UV light weathering criteria before laying.
- (iv) Prior to laying of geogrid as reinforcement layer, the surface shall be properly prepared, ruts should be made good and dressed to the specified lines and levels.
- (v) Geogrid reinforcement shall be placed flat, pulled tight and held in position by pins or suitable means until the subsequent layer is placed. Geogrid should be rolled out on the compacted surface parallel to the centre line of track.
- (vi) The minimum overlap shall be of

CBR (%)	Overlap
Greater than 3	300 mm
1-3	600 mm

Overlaps must be maintained during the filling operation. This is generally achieved by placing small heaps of fill locally over the overlaps ahead of main filling operation.

- (vii) No vehicle shall be allowed on geogrid unless it is covered by at least 150mm thick overlying material.

(C) Measurement for Payment of Geogrid

The geogrid shall be measured in square metres, with no allowance for overlapping at transverse & longitudinal joints. The contract unit rate for the accepted quantities of geogrid shall be in full compensation for furnishing, preparing, hauling and placing geogrid including all labour, freight, tools, equipment and incidentals to complete the work as per specifications.

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(D) Acceptance Criteria

Conformance testing on the geogrid delivered to the site shall be undertaken by the Contractor in accordance with the requirements of Clause.

D.1 General

The Chief Engineer (open line/Construction) or equivalent in PSU's shall be the accepting authority and shall accept test certificates, verifying compliance with Clause (A), for tests carried out, in accordance with this Technical Specification, on the materials to be used for the specific project. In addition, Contractor's quality system shall demonstrate that the specified minimum frequency of testing has been maintained and ensuring traceability of the material.

Presently Tests Aperture Stability/Torsional Rigidity Modulus are not carried out in India, therefore upto one year, Manufacturer certificate is required for the procurement of Geogrid. All manufacturers should develop Testing facilities in one year time and this should be carried out as routine testing of Geogrid. The test certificates shall not be older than 12 months on the date of the supply to the site.

D.2 Site sampling

a) Frequency for test other than durability tests

Where the total required batch size for the Contract is less than 5000 m², sampling and testing need not be undertaken. If the material supplied is higher than 5000 m² on-site sampling shall be carried out in accordance with ASTM D4354 at the frequency stated in Table D.2.

Table D.2 – On Site sampling frequency

Batch or order size defined as the lot size	Number of rolls to be sampled representing the lot
The initial 10,000 m ² or part thereof	1
Each subsequent 20,000 m ² or part thereof	1

The representative sample shall be no less than four linear metres along the roll for the full production width but not within two metres of the start or end of the roll.

Identification information including the geogrid supplier, type, batch identification, and details of the order represented by sample, sample date and roll directional markings shall be shown on or attached to the test reports.

b) Frequency for Durability Tests

Random checks on material supplied to project sites once every 5,00,000 sqm or once in a 3 year whichever is earlier for each manufacturer.

D.3 Acceptance

A lot shall be deemed to achieve conformance, if all samples tested comply with the Technical Specification. If a lot fails to achieve conformance, the lot may be re-sampled in accordance with Clause D.2 to verify whether the lot conforms or not. If it still does not conform to the technical specifications, the lot should be rejected.

The geogrid shall not be placed prior to the acceptance as per para D.1 above.

D.4 Audit testing

During audit testing, samples may be selected from the site and accordingly arrangement for audit testing has to be done, regardless of the quantity of geogrid supplied.

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Annexure-1A**PROFORMA REGARDING FEEDBACK OF GEOSYNTHETICS (GEOGRID, GEOTEXTILE etc.) LAID AT PROBLEMATIC LOCATION IN OPEN LINE****1. General Details:**

Laid from Km: To..... On UP/DN/Single Line.....
Between Stations:
Section.....
Division.....
Railway.....
Work done in Month/Year.....
Maximum Permissible Speed of section Axle load.....

	Officer	Name	HQ	Telephone Nos.
1.	CE In charge			
2.	CTE			
4.	Sr.DEN (CO)			
5.	Sr.DEN/DEN			
6.	AEN			
7.	SSE In charge			

2. As per para 7.2 of document "Rationalisation of Formation Layer Thickness on Indian Railway Track" Specification No. RDSO/2018/GE: IRS-0004(D) -Part IV, July 2019

- a) Regarding use of Geogrid in Formation Rehabilitation in existing lines, where track parameters gets disturbed frequently, It is recommended to use Geogrid as per RDSO specification for CBR of sub-grade 4 to 8. For sub-grade of CBR less than 4 the cases to be sent to RDSO for approval. Generally geogrid will not be required for subgrade having CBR more than 8. However, if it is required, cases to be referred to RDSO for approval. Non-woven Geotextile just below geogrid at the bottom of ballast may be used where no blanket is available and SQ1 or SQ2 soil exists at the top of formation, to prevent the upward migration of the fine particles from top of formation to the ballast so that clean ballast may not be contaminated.
- b) When geogrid is laid using Ballast Cleaning Machine (BCM) during deep screening of ballast, by adding suitable attachments with BCM for holding and laying geotextile & geogrid rolls. During the subsequent deep screening cycles, care should be taken not to disturb about 50-100 mm thickness of bottom most layer of ballast, which will not only avoid entanglement of geosynthetics with BCM but this layer will act as a confining layer also for geosynthetics improving their efficiency.

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3. Details/Specifications of Geosynthetics (Geogrid, Geotextile. etc.) laid
(a) Geogrid: (Geogrid with minimum specification as prescribed by RDSO)

- i. When Geogrid was laid:
- ii. Procedure of laying of Geogrid:
- iii. Cost of laying of Geogrid :
- iv. Test done on Geogrid, before laying (should be enclosed):
- v. Depth of Geogrid laid from rail level:
- vi. Specifications:

(b) Non-Woven Geotextile: (Specification of Non-woven Geotextile to be used as separator /filtration in Railway formation Specification No. RDSO/2018/GE: IRS-0004- Part-I is already issued to all Zonal Railways & PSUs for trial purpose)

- i. When Geotextile was laid:
- ii. Procedure of laying of Geotextile:
- iii. Cost of laying of Geotextile:
- iv. Test done on Geotextile, before laying (should be enclosed):
- v. Depth of Geotextile laid from rail level:
- vi. Specifications:

(c) If any other type of material used, please give the detail:

4. Sectional Details of the section before laying of Geosynthetics (Geogrid, Geotextile.etc.):

Gauge	No. of lines.	Max. Speed	GMT per year	GMT Passed	Construction Year	Open to traffic/Year

5. History of Section and trouble faced/ important incidents before laying of Geosynthetics (Geogrid, Geotextile. etc.)

6. Details of rehabilitation measures taken in past before laying of Geosynthetic (Geogrid, Geotextile. etc.) in problematic location:

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7. Frequency of Machine Tamping before and after laying of Geosynthetics (Geogrid, Geotextile. etc.):

Machine Tamping				
Year/km	Before laying	Year/km	After laying	Remarks

8. Track Quality Index Values of Previous Three Years before and after laying of Geosynthetics (Geogrid, Geotextile. etc.):

Date of TRC Run	Track Quality Index (TQI)/Composite Track Quality index		Date of OMS Run	Oscillation monitoring System(OMS) data	
	Before laying	After laying		Before laying	After laying

9. Last deep screening before and after laying Geosynthetics (Geogrid, Geotextile. etc.):

Deep screening				Remark
Before laying		After laying		
KM	Month/year	KM	Month/year	

10. Formation details before and after laying of Geosynthetics (Geogrid, Geotextile. etc.):

	Km	Max. Bank height (m)	Formation Width	Condition of Cess	Side slope	Cross slope
Before laying						
After laying						

11. Condition of turfing/pitching, if any done in the section where Geosynthetics (Geogrid, Geotextile. etc.) laid:

12. Details of track attentions before and after laying of Geosynthetic (Geogrid, Geotextile. etc.) in problematic location:

Track attention /Year				
Year/KM	Before laying	Year/KM	After laying	Remark

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13. Speed Restrictions imposed before and after laying of Geosynthetic (Geogrid, Geotextile. etc.) in problematic location:

Speed restriction imposed						
Before laying			After laying			Remark
Year	Km	SR	Year	Km	SR	

14. a) Classification of embankment & ground soils:

Bank soil	Ground soil

b) CBR Value of subgrade soil

c) Cu (uniformity coefficient) of subgrade soil

d) Blanket provided: Yes/No

If provided thickness of blanket layer

15. Ballast cushion in control section as well as in trial section after opening traffic.

Control section		Trial section	
Clean ballast cushion(cm)	Total ballast cushion (cm)	Clean ballast cushion(cm)	Total ballast cushion (cm)

16. Maintenance efforts during summers & monsoons before and after laying of Geosynthetic (Geogrid, Geotextile. etc.) in problematic location

Before laying	After laying

17. Instrumentation scheme:

After laying of geogrid instrumentation is required to be done to check the efficacy of geogrid used. The instrumentation scheme given here is tentative and for guidance purpose only, the detailed scheme should be decided by Railways and results shall be shared with RDSO along with instrumentation scheme adopted at site.

➤ For this instrumented section is divided in two part

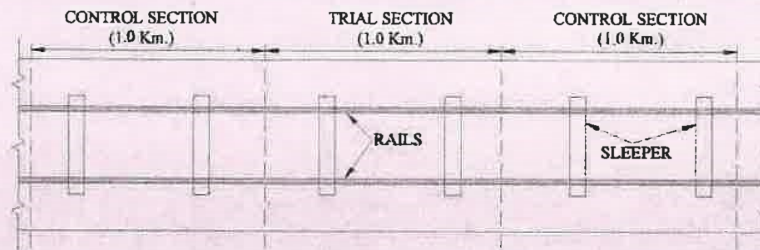
- trial section and
- control section

Trial section: instrumented stretch after laying of geogrid

Control section: instrumented stretch without laying of geogrid

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Control section and trial section should be in the same block section and should be adjacent to each other to study the effect of geogrid under same condition of track/ traffic under same environment, vis a vis normal track without application of geogrid.



Trial section is kept between two control section and both the section should be instrumented as per the tentative scheme described below.

- Stress measurement using Pressure cell below bottom of sleeper in the line of rail (below rail seat) in control as well as in trial section.
- Stress measurement using Pressure cell at bottom of ballast under both the rail (below rail seat) in control as well as in trial section.
- Settlement measurement at top of formation in both control as well as in trial section.
- Load cell may also be placed below bottom of sleeper in the line of rail (below rail seat) in control as well as in trial section to determine the actual load.
- Instrumentation should be done at least four locations in both control as well as in trial section.
- Readings of pressure cell, load cell and settlement are required be taken regularly and proper record should be maintained for at least two year of train operations.
- After installation of Geogrid regular inspection should be carried out to monitor the damage to geogrid if any after every three month at two to three location in trial stretch.
- Cross section and plan of embankment showing details of instrumentation done & location of geogrid laid and separate sketch for details of instrumentation in longitudinal direction of instrumented stretch to be enclosed.

18. Any other relevant data/information: Such as consultancy rendered by other party etc. before laying of Geosynthetic (Geogrid, Geotextile. etc.) in problematic location.

19. Any other relevant data/information:

Signature of Railway Official:

Name:

Designation:

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Annexure-1B**PROFORMA REGARDING FEEDBACK AFTER LAYING OF GEOSYNTHETICS
(GEOGRID, GEOTEXTILE etc.) FOR NEW CONSTRUCTION****(Feedback is to be given after commencement of train operation on trial
section for a period of two years)****1. General Details:**

Laid from Km: To On UP/DN/Single Line.....
Between Stations:
Section.....
Division.....
Railway.....
Work done in Month/Year.....
Maximum Permissible Speed of section Axle load.....

	Officer	Name	HQ	Telephone Nos.
1.	CE In charge			
2.	CTE			
4.	Sr.DEN (CO)			
5.	Sr.DEN/DEN			
6.	AEN			
7.	SSE Incharge			

2. As per para 7.0 of document "Rationalisation of Formation Layer Thickness on Indian Railway Track" (Specification No. RDSO/2018/GE: IRS-0004(D) -Part IV, July 2019):

- To reduce the thickness of the Blanket Layer (which is costly granular material obtained by quarrying or mining) in case of new constructions, on techno-economic considerations and/or to reduce the adverse impact on environment due to quarrying/mining, geogrid can be used as a stabilisation element to form a mechanically stabilised layer.
- Regarding geogrid for use below blanket, in new lines for reduction in specified thickness of blanket layer, use of Geo-grid shall be considered at places where it is economical to use it in combination with blanket as it reduces the requirement of thickness of blanket. Zonal Railways and Construction units must submit the design of reinforced formation layer along with design methodology using Geo-grid with minimum specification as prescribed by RDSO.
- To prevent upward migration of fines from prepared sub-grade/sub-grade causing contamination of layer on top of it (which reduces the strength & drainage capacity of this layer of better quality material) and also to prevent penetration of coarse particles of layer on top of prepared sub-

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grade/sub-grade into soft/ fine grained particles of prepared sub-grade/sub-grade a suitable non-woven Geo-textile layer may be used as "separator layer" in the following cases. The Specification of Non-woven Geotextile to be used as separator /filtration in Railway formation Specification No. RDSO/2018/GE: IRS-0004- Part-I is already issued to all Zonal Railways & PSUs for trial purpose.

- (a) Below blanket layer if SQ2 soil is used in prepared sub-grade in two layer system.
- (b) Below blanket layer if SQ1 or SQ2 soil is used in sub-grade in single layer system.

3. Technical Details:

- a. Year and month of construction:
- b. Year and month of opening of traffic:
- c. Height of embankment:
- d. Designed side slope:
- e. System of construction adopted i.e. two layer or single layer:
- f. CBR Values of formation layer i.e. Blanket, Prepared subgrade, Subgrade/fill layer and subsoil:
- g. Ev2 value at top of each finished formation layer i.e. Blanket, Prepared subgrade, Subgrade/fill layer and subsoil :
- h. Specification of blanket confirming the RDSO specification: Yes/No
- i. Thickness of blanket:

4. Details/Specifications of Geosynthetics (Geogrid, Geotextile. etc.) laid

(a) Geogrid: (Geogrid with minimum specification as prescribed by RDSO)

- i. When Geogrid was laid:
- ii. location at which Geogrid laid:
- iii. Cost of laying of Geogrid:
- iv. Specifications:
- v. Test done on Geogrid, before laying (should be enclosed):

(b) Non-woven Geotextile: (Specification of Non-woven Geotextile to be used as separator /filtration in Railway formation Specification No. RDSO/2018/GE: IRS-0004- Part-I is already issued to all Zonal Railways & PSUs for trial purpose)

- i. When Geotextile was laid:
- ii. At what level in formation (between subgrade & prepared subgrade or between subgrade/prepared subgrade & blanket):
- iii. Cost of laying of Geotextile:
- iv. Specifications:
- v. Test done on Geotextile, before laying (should be enclosed):

5. Instrumentation scheme: After laying of geogrid instrumentation is required to be done to check the efficacy of geogrid used. The instrumentation scheme given here is tentative and for guidance purpose only, the detailed scheme should be decided by Railways and results shall be shared with RDSO along with instrumentation scheme adopted at site.

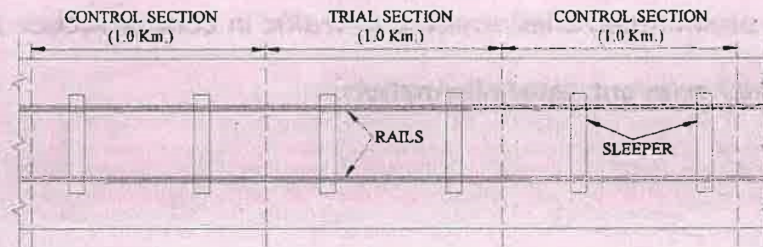
➤ For this instrumented section is divided in two part

- trial section and
- control section

Trial section: instrumented stretch after laying of geogrid

Control section: instrumented stretch without laying of geogrid

Control section and trial section should be in the same block section and should be adjacent to each other to study the effect of geogrid under same condition of track/ traffic under same environment, vis a vis normal track without application of geogrid.



- In control section thickness of blanket layer will be governed by RDSO document "Rationalisation of Formation Layer Thickness on Indian Railway Track" specification No. RDSO/2018/GE:IRS-0004(D) -Part IV, July 2019 as per soil type i.e. SQ1, SQ2 or SQ3 in Subgrade/Prepared Subgrade.
- In trial section reduction in thickness of blanket layer will be determined by design of reinforced formation layer using Geo-grid of minimum specification as prescribed by RDSO.
- Trial section is kept between two control section and both the section should be instrumented as per the tentative scheme described below.
 - a. Stress measurement using Pressure cell at bottom of blanket (i.e. at top of subgrade/prepared subgrade) in the line of both the rails (under the rail seat) in control as well as in trial section.
 - b. Stress measurement using Pressure cell at 1m from top of blanket under both the rails (under the rail seat) in control as well as in trial section.
 - c. Load cell may also be placed below bottom of sleeper in the line of rail (below rail seat) in control as well as in trial section to determine the actual load.
 - d. Settlement measurement at top of formation in both control as well as in trial section.
 - Instrumentation should be done at least four locations in both control as well as in trial section.

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- Readings of pressure cell, load cell and settlement are required be taken regularly and proper record should be maintained for at least two year of train operations.
6. After installation of Geogrid regular inspection should be carried out to monitor the damage to geogrid if any after every three month at two or three location in trial stretch.
 7. Cross section and plan of embankment showing details of instrumentation done & location of geogrid laid and separate sketch for details of instrumentation in longitudinal direction of instrumented stretch to be enclosed.
 8. Any problem faced after opening of traffic in control section and trial section
 9. Any other relevant data/information:

Signature of Railway Official:

Name:

Designation:

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