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Date: 19th December 2022

To,
The Chairman,
GEO- SYNTHETICS SECTIONAL
TXD 30/A2.28

Dear Sir,

In one of the groups, I found this code which was circulated for wide circulation. I Was a little curious to go through the draft code. While going through the same, certain points cropped up in my mind and thought I should pen them down.

In case the committee feels that the same are relevant, one may think of incorporating the same.

Submitting the same for consideration.

Thanking you,

Yours sincerely,

Dr. Anand Katti

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S. No.	Cl. No.	CLAUSE CONTENT	COMMENT	REVISION
1	4.1.2.	Broken Slope	Change nomenclature	Broken back slope
2	4.1.2.	Water front reinforced soil wall.		Please include submerged wall
3	Figure 4.1 & Figure 4.5	Typical Cross Section of Reinforced Soil Walls	Filter media should be up to GL/ SRL, embedment depth missing, ΔL & ΔH, Alternate fill.	Reassess the figure
4	4.2.1.1.	The maximum effective design friction angle shall be limited to 34°.	Maximum effective friction angle need not be limited. **FHWA** specifies 40°. Include **SP:102** ref of 38° degree - **CL 3.2** last paragraph.	
5	4.2.1.1.	Additionally, it is recommended that the maximum particle size of the reinforced fill shall be limited to 19 mm	Particle size passing 75mm and shall be w.r.t RFID. Refer **FHWA-24 CL 3.5.2.b** - RFID less than equal to 1.7	

6	4.2.1.2	In addition, the groundwater levels above the proposed base of construction must be determined to evaluate hydrostatic stresses in the retained zone and plan an appropriate drainage scheme to control ground water conditions.		In addition, the groundwater levels above the proposed base of construction must be determined to evaluate hydrostatic stresses in the retained zone and plan an appropriate drainage scheme to control ingress water conditions.
7	4.2.1.2	If reinforced fill material is pond ash, the same material must be used for retained backfill.	Remove the statement or modify	If reinforced fill material is pond ash, the same material may be used for retained backfill.
8	4.2.2.2	The zinc coating shall confirm to relevant IS code. A sacrificial thickness of minimum 0.50 mm shall be provided on all sides while designing.		The zinc coating shall conform to relevant IS code. A sacrificial thickness of minimum 0.50 mm shall be provided on all sides.
9	4.2.3	The minimum thickness of the panels shall be 160 mm (excluding any architectural finishing).	**IRC: SP: 102- Cl 3.4** - Min thickness of panel 140 mm	The minimum thickness of the panels shall be 140 mm (excluding any architectural finishing).
10	4.2.3		include corrosion, precautions to be taken while using steel. OR Add footnote.	Sacrificial steel shall be considered such that the connectors perform over the life of structure.

11	4.2.4	Pond ash, 600 mm wide drainage bay shall be used and a non-woven geotextile shall be provided as a separation/filtration layer between the drainage aggregates and the reinforced fill material.		Pond ash, 600 mm wide drainage bay shall be used and a non-woven geotextile shall be provided as a separation and filtration layer between the drainage aggregates and the reinforced fill material.
12	4.2.4	Min. 600 mm	Min. width of drainage bay shall be 300 mm	
13	4.2.4	The chimney drain should be designed to carry the discharge and should be provided vertically at the back of the reinforced fill and continued in a horizontal extent to a depth well below the toe of the Reinforced Soil wall and lead to a drain meant to carry the discharge away from the Reinforced Soil wall.	Include separation layer (geotextile)	
14	4.3.2	This design philosophy has been gaining ground in areas of structural engineering practice in many parts of the word such	typo	This design philosophy has been gaining ground in areas of structural engineering practice in many parts of the world such as India, United States, Canada, Europe, etc.

		as India, United States, Canada, Europe, etc.		
15	4.3.3	In addition to the applicable loads as mentioned in Table 4.1, if the Gap Slap pedestal is resting on the Reinforced soil wall.	typo	In addition to the applicable loads as mentioned in Table 4.1, if the Gap Slab pedestal is resting on the Reinforced soil wall.
16	4.3.4	Internal Stability mode involves the failure of reinforcement and depends on mainly three factors i.e., tensile resistance of reinforcement against rupture, soil-reinforcement interaction for pull out and internal sliding.		Internal Stability mode involves the failure of reinforcement and depends on mainly four factors i.e., tensile resistance of reinforcement against rupture, soil-reinforcement interaction for pull out, internal sliding and connection.
17	4.3.6.	The requirements of the project such as wall design height, batter angle, backslope and toe slope, loading conditions, performance criteria, and construction constraints must be defined prior to proceeding with the design.	list out the points included in performance criteria	
18	4.3.8.1.	4.3.8.1. Wall Embedment Depth	Define embedment depth - excluding levelling pad - only fascia	

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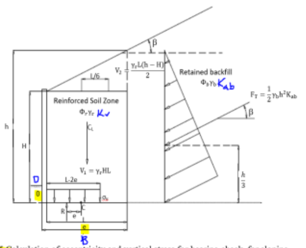
19	4.3.8.4.	RS walls with modular blocks where the connection capacity is by friction, the maximum vertical spacing of reinforcement shall be minimum of twice the block depth (measured from front face of block to the rear face of block) or 600 mm.		No more than 1 intervening block shall be left without primary reinforcement (along with diagram) and 800mm
20	eq. (4-1)	φ_β	notation	φ_b
21	Fig 4.13	γ_(EV-MIN) = 1.35	typo	γ_(EV-**MAX**) = 1.35
22	Fig 4.15			
23	Fig 4.17	 Figure 4.15 Calculation of eccentricity and vertical stress for bearing check, for sloping backslope condition	Revise the complete figure as per FHWA-24	
24	Fig 4.19		Revise the complete figure as per FHWA-24 also 1.0 does not apply to polymeric strap	
25	Fig on pg. 86		Revise 4.3.13.2. Check notations and drawings.	
26	Table 4.7	Sacrificial thickness to be allowed on each surface exposed to corrosion		Table 4.7 Sacrificial thickness to be allowed on steel surface exposed to corrosion
27	eq. (4-37)		RFD instead of RFD x RFW. Refer 8.18	

28	4.3.14.	The value for ultimate connection strength derived at laboratories, shall be always more than 1.25 times to the TMAX.		Origin? Needs to be deleted
29	4.3.14. & Eq (4-58)	CR_{CR}		Needs to be checked - Remove "Long term"
30	4.4.1a)	• The design acceleration coefficient should be taken equal to Zone factor based on the seismic zone as given in Table 4.10 as per IS 1893-Part1.		• The design acceleration coefficient should be calculated based on Zone factor based on the seismic zone as given in Table 4.10 as per IS 1893-Part1.
31	Figure 4.33			All dimensions in mm, slope shall be redefined or removed - no reference for the same

	5.1.2	• Steep Slopes: Reinforced soil slopes with face inclinations steeper than 45° to the horizontal are termed steep slopes. Some form of facing should be provided for steep slopes to facilitate placement and compaction of fill adjacent to the slope face, to enable anchorage of reinforcement in the active zone and to provide erosion protection.		• Steep Slopes: Reinforced soil slopes with face inclinations steeper than 45° to the horizontal are termed steep slopes. Some form of ***hard or soft*** facing should be provided for steep slopes to facilitate placement and compaction of fill adjacent to the slope face, to enable anchorage of reinforcement in the active zone and to provide erosion protection.
	5.1.3	• Because of the inclination of the slope, the disturbing forces are less for a reinforced soil slope and hence the demand for soil reinforcement is likely to be less compared to reinforced soil walls.		• Because of the inclination of the slope, the ***activating*** forces are less for a reinforced soil slope and hence the demand for soil reinforcement is likely to be less compared to reinforced soil walls.
	5.2.1	The major applications of reinforced soil slopes are in the construction of embankments and hillside fills with steeper side slopes, reinstatement of failed slopes and increasing the surficial stability and		The major applications of reinforced soil slopes are in the construction of embankments ***& Reinforced Soil walls*** and hillside fills with steeper side slopes, reinstatement of failed slopes and increasing the surficial stability

		achieving better compaction and stability of slope faces.		and achieving better compaction and stability of slope faces.
	5.3.1	Geogrids, woven geotextiles, reinforced non-woven composite geotextiles and mechanically woven double twisted hexagonal wire mesh made from galvanized and polymer coated steel wire mesh may be used as soil reinforcement for the construction of reinforced soil slopes.		Geogrids, woven geotextiles *<u>/ knitted geotextiles</u>*, reinforced non-woven composite geotextiles and mechanically woven double twisted hexagonal wire mesh made from galvanized and polymer coated steel wire mesh may be used as soil reinforcement for the construction of reinforced soil slopes.
	5.3.2	Manufactured materials like aggregates and sands produced by crushing sound rocks and conforming to these specifications also may be used as reinforced fill. Pond/ bottom/ fly ash used as reinforced fill shall conform to the requirements of section 3.1.5.		Manufactured materials like aggregates and sands produced by crushing sound rocks and conforming to these specifications also may be used as reinforced fill. Pond/ bottom/ ~~fly~~ ash used as reinforced fill shall conform to the requirements of section 3.1.5.
	5.3.2	The reinforced fill shall extend the free/rear end of the reinforcement by at least 300 mm.		The reinforced fill shall extend the free/rear end of the reinforcement by at least *<u>500 mm</u>*.

	5.4.1	Where three-dimensional effects are significant, the designer must make an evaluation and use appropriate numerical methods or other techniques.		Where three-dimensional effects *<u>such as embankments at narrow valley, hairpin bends</u>* are significant, the designer must make an evaluation and use appropriate numerical methods or other techniques.
	5.4.3	Table 5.1	Check Min FOS in static condition.	
	5.4.4.1	When the analysis indicates that the required minimum factor of safety is not achieved against one or more external modes of failure, several options are available to increase the factor of safety: • Reduce slope angle • Increase reinforcement length • Use better quality fill • Ground improvement • Use light-weight fill • Use high strength reinforcement or mattress at the base • Internal drainage		When the analysis indicates that the required minimum factor of safety is not achieved against one or more external modes of failure, several options are available to increase the factor of safety: • Reduce slope angle • Increase reinforcement length • Use better quality fill • Ground improvement • Use light-weight fill • Use high strength reinforcement or mattress at the base • Internal drainage • Use of intermediate berms

	5.4.5.1	For slopes having simple geometry, loading conditions and soil profile, chart solutions available in literature could be used for preliminary design and also to verify the results of computer programs.	Chart solutions are not available. Shall be checked and removed if not available.	
	5.4.9	In the case of important reinforced soil slopes located in seismic zones IV and V, whose function may be critically affected by displacements caused by earthquakes or which are of exceptional height or with very poor foundations, pseudo-static analysis may be supplemented with more advanced methods if required.		In the case of important reinforced soil slopes located in seismic zones ***III,*** IV and V, whose function may be critically affected by displacements caused by earthquakes or which are of exceptional height or with very poor foundations, pseudo-static analysis may be supplemented with more advanced methods if required.
		The minimum factor of safety against liquefaction should be greater than or equal to 1.2. If the calculated factor of safety against liquefaction is less than 1.2, suitable ground improvement should be	Widely used FOS is 1 [Boulanger & Idriss (2014)].	

		carried out prior to the construction of the reinforced soil slope.		
	5.4.10.2	Shallow Slopes – Well-graded Soils	Appropriate cover for erosion protection	
	5.4.12.1		Add	Protection shall be provided for all kind of slopes
	6.3.1	a) True Abutment: In a “true abutment”, the bridge beams are directly supported on a spread footing called ‘bank seat’ or ‘beam seat’ which is directly rested on reinforced soil mass.	Only single span	
		b) False Abutment: Here the bridge beams are rested on a RCC cap supported by a group of piles embedded inside reinforced soil mass transferring the load to the ground. The load of the approach slab and any horizontal loads on the RS mass that may come from pile is generally ignored, if adequate distance is maintained.	Multiple spans allowed	

	6.4	The fines content shall be limited to 10% with no clay or organic content. Fly ash and Silty sand shall not be used as reinforced fill material for RS abutments.		The fines content shall be limited to 10% with no clay or organic content. *Pond* ash and Silty sand shall not be used as reinforced fill material for RS abutments.
	6.5.1 - Table 6.1	* The dynamic loading has to be considered for "Seismic Zone" as per IS 1893 (Part I), 2002	Reference for latest code.	* The dynamic loading has to be considered for "Seismic Zone" as per IS 1893 (Part I), 2016
	Table 6.3 & 6.4		Check with FHWA 24 - Part II (Table 3.4.1.1.)	
			Load Combination Nomenclature shall be checked. Recommended Load Case A, B etc.	
	6.5.7.2	Eq. 6.1	Shall be checked with FHWA.	
	Fig on page 161	Fig on page 161	Typo errors, shall be checked with FHWA.	
	6.5.7.3	• 1.1 at top and 0.8tan fr at 6 m or below with soil as reinforced fill for polymeric straps or geostrips. 1.0 at top and 0.7tan fr at 6 m or below with fly ash as reinforced fill for polymeric straps or geostrips.		• 1.1 at top and 0.8tan fr at 6 m or below with soil as reinforced fill for polymeric straps or geostrips. 1.0 at top and 0.7tan fr at 6 m or below with *pond* ash as reinforced fill for polymeric straps or geostrips.

	Fig 6.11		Check nomenclature	
			Example with calculations required	
	Fig 7.1		Add weep holes in the figure.	
	Fig 9.1		Revise drawing as per BS-8006	
	Fig 9.11	Note: Strips of filter cloth shall be placed on back face of panel, over panel joints. filter cloth shall be adhered to back face of panels using a non-water-soluble adhesive		Note: Strips of filter cloth shall be placed on back face of panel, over panel joints. filter cloth shall be adhered to back face of panels using an *appropriate* adhesive
	Fig 9.12		Detailing below ground level required.	
	Fig 9.16 to 9.18		Drainage blanket in backfill shall start from below the ground (entry point avoided). Shall be along natural slope / cut line in all the figures.	
	Fig 9.19		Remove dimensions or write note - for illustrative purpose only in all figures	
	Fig 9.25 & 9.26	Note: The geocomposite must be properly covered and bonded so that soil cannot enter the geocomposite.		Note: Since it is not continuous in nature there is a chance of it getting clogged. Hence there shouldn't be soil intrusion in the geocomposite*

	Fig 9.36		In the figure drain is shown over bottom tier, in front of top tier. Another arrangement with our drain shall also be included.	
32	10.1.1	20 mm construction joints may be placed at every 20 m stretch length. The grade of concrete for levelling pad shall be M15.	Regular interval or wherever required	
33	Table 10.1		Remove "Climatic condition" from SPECIFICATIONS	
34	Table 10.1		Trial pits in Monitoring	
35	Figure 10-1		Coping beam & min 50 mm soil cover missing	
36	10.1.2		include "geogrid shall also be separated/ cut at slip joint location"	
37	10.1.4.2		include "50mm soil cover shall be provided between overlapping geogrids"	
38	10.1.6.2		Vertical obstruction - transition slab. Detailing using 1-layer geocell needs to be added	
39	10.1.6.3		point regarding encasement of utility pipes along with diagram shall be added	
40	Figure 10-11		Length of grids at corner is lesser than adjacent grids. It shall be as per design.	Convex concave grid arrangement fig

41	10.1.8		Well compacted fill shall be provided up to foundation depth in all conditions (whether the bottom stratum is weak or strong).	

iGrip Conclave-2023

Comments and Points for

Newly Drafted BIS RE Wall Code

G R Infraprojects Limited

3rd – 4th March 2023

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b) ***Geotechnical Category B*** are specialized systems of reinforced soil structures that fall outside the conventional indicated as Category A, such as:

a) True abutments
b) Tall reinforced soil structures (height > 8m)
c) Reinforced soil structures with foundations requiring ground improvement
d) Reinforced soil systems involving abnormal risks, complex profiles, unusual or exceptionally subsoil conditions, or difficult loading conditions
e) Systems in highly seismic zones (Zone 4 and Zone 5)
f) Systems in probable areas of scour, areas subjected to flooding and sudden drawdown, site instability, or persistent ground movements for any reason

Subsurface investigations for Geotechnical Category A structures shall require standard detailed geotechnical investigations. Geotechnical Category B structures shall require additional investigations necessary to those circumstances that classify the structure and its components under that Category.

2.3 INFORMATION REQUIRED FROM THE SUBSURFACE INVESTIGATION

AR Anand Raghuwanshi
Required Testing/Investigations should be listed.
21 February 2023, 05:22 PM
Reply

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- Bearing capacity of reinforced soil structure: 1.5 times the height of the reinforced soil structure
- Overall bearing capacity of embankment: Width of embankment
- Settlement: 4 times the width of embankment/hill-side fill
- Liquefaction: 25 m

The depth of boreholes/soundings shall be sufficient to obtain the required information for all weak/compressible/liquefiable strata within the zone of interest.

AR Anand Raghuwanshi

Not possible in case of 6 or 8 lane.

02 March 2023, 03:32 PM

Reply

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Table 2 Recommendations for minimum depth of boreholes

Type of reinforced soil structures	Minimum depth of boreholes/soundings
Reinforced soil walls and slopes retaining embankments; closure walls of approach embankments; true abutments	Least of the following: (1) (2) (3) • Four times the height of the reinforced soil structure • Two times the average width of embankment • 30 m
Hillside reinforced soil walls and slopes	Least of the following: (1) (3) • Four times the height of the reinforced soil structure • 30 m
Basal reinforced embankments	Least of the following: (1) (2) (3) • Two times the average width of embankment • 30 m

(1) Boreholes may be terminated if the rock or weathered rock with SPT N ≥ 100 is encountered at a depth ≥ 10m; in such cases drilling into rock is not usually required. When rock is encountered at a depth less than 10 m, the continuity of rock strata must be ensured by drilling a minimum of 3 m into the rock.

(2) At locations with deep deposits of compressible soils, boreholes/soundings shall extend to all layers of organic soils and fine-grained soils (clays/silts) with a consistency ranging from very soft to stiff (SPT N < 15 or undrained shear strength < 100 kPa), within the zone of interest. Caution must be exercised at sites where silt/clay strata alternate with sand/gravel strata. At such locations, the depth of exploration should be decided based on the understanding of local geology and past experience.

(3) In seismic zones IV and V minimum depth of boreholes and soundings shall not be less than 25 m unless the rock is encountered at a lesser depth.

Anand Raghuwanshi
Not accepted
02 March 2023, 03:34 PM
Reply

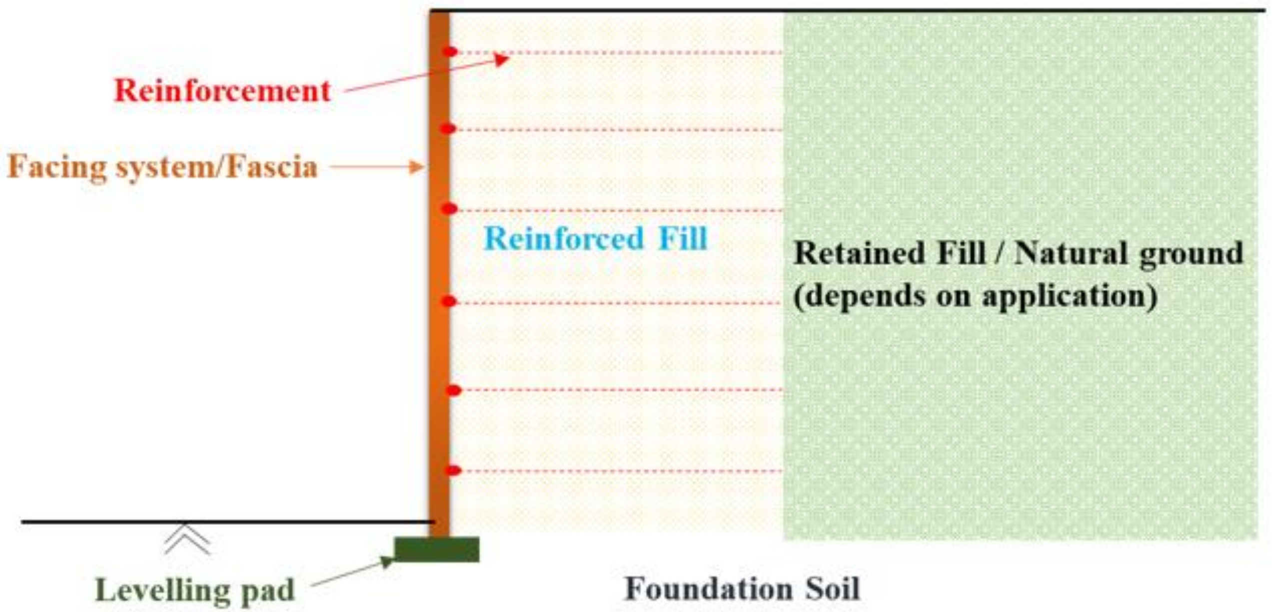

Fig. 3.1 Schematic showing different fills in a Reinforced Soil Structure (Not to scale)

While using metallic reinforcement or metallic connection system, it should be ensured that the fill's electro-chemical properties are satisfactory and would not cause or trigger corrosion of the reinforcement. The soil shall have a resistivity of more than 5000 ohm-cm at saturation. The water extract from the soil should not have chlorides more than 100 ppm, sulphates do not exceed 200 ppm, and pH ranges from 5 to 10. Metallic reinforcement should

Anand Raghuwanshi

If any additional space required in Reinforced zone after geogrid, please mention in figure

21 February 2023, 05:32 PM

Reply

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Table 3.1 Select Granular Fill requirements for Reinforced Soil walls

Gradation (IS 2720 Part 4)	IS Sieve Size	Per cent Passing
	75 mm	100
	425 micron	60-90
	75 micron	15

Notes:

1) The plasticity index (IS 2720 Part 5) should be less than or equal to 6, and Cu should be greater than 2
2) Fill containing soil greater than 15% passing 75-micron sieve, but less than 10% of particles smaller than 15 microns are acceptable. The PI should be less than 6, and the drained angle of internal friction should not be less than 30^0.
3) By keeping in mind about the construction survivability of geosynthetics and epoxy coated reinforcements, it is recommended that the maximum particle size for these materials be reduced to 19 mm for geosynthetics and epoxy and PVC coated steel reinforcements unless construction damage assessment tests are or have been performed on the reinforcement combination with the specific or similarly graded large size granular fill.
4) The materials shall be substantially free of shale or other soft, poor durability particles. The material shall have a magnesium sulphate soundness loss of less than 30 percent after four cycles or a sodium sulphate value less than 15 percent after five cycles (Soundness test as per IS 2386 – Part V).

AR Anand Raghuwanshi

Not as per the MORTH

As per MORTH 425 micron passing - 0 - 60%.

Reply

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3.1.3 DESIGN STRENGTH OF REINFORCED FILL MATERIALS

The angle of internal friction should not be less than 30^0 (IS 2720 Part 11 or IS 2720 Part 12 or IS 2720 Part 13). In all cases, the cohesion of the reinforced fill is to be neglected.

3.1.4 RETAINED BACKFILL AND NATURAL RETAINED SOIL

AR **Anand Raghuwanshi**

If any max limit of Phi, please mention.

Reply

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Under no circumstances, multiple fill materials should be used for a given stretch of wall/ slope.

Metallic reinforcement should not be used in the pond ash with a resistivity of less than 3,000 ohm-cm. The pond ash should not show chlorides more than 100ppm, sulphates do not exceed 200ppm, and pH ranges from 5 to10 when metallic reinforcement is used.

During the construction, every care should be taken for proper drainage of the reinforced fill portion, and it shall be ensured that there is no movement of particles of pond ash through the

under different conditions is given in section 9.

Table 3.3 Gradation requirements for Drainage Bay (IS 2720 Part 4)

S. No	Sieve Opening size, mm	Percentage Finer
1	37.5	90-100
2	20.0	80-100
3	12.5	0-20

AR Anand Raghuwanshi

What is desirable range for polymeric r/f.

Reply

AR Anand Raghuwanshi

Do not agree with this drainage gradation. MORTH clause 2504.2.2 must be followed.

Reply

Table 3.6 Requirements of Woven Geotextile – Walls and slopes
(Made from virgin polymer of Polyester)

Property	Value	Test Method
Ultimate Tensile Strength (Machine Direction: MD)	$\geq 60kN/m$	IS 16635
Ultimate Tensile Strength (Cross Direction: CD)	$\geq 20kN/m$	IS 16635
Elongation at Ultimate strength (MD&CD)	$\leq 15\%$	IS 16635
Chemical resistance, strength retained after 72 h immersion	$\geq 70\%$	IS 17363
• Molecular weight should be greater than 25000 g/mol • Carboxyl end groups < 30 mmol/kg • The design strength of reinforcement should be calculated as per section-4		

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Reinforced concrete panels	All units shall be free of cracks or defects that would interfere with the unit's proper placing or significantly impair the structure's strength or permanence. Concrete panels shall be made of minimum of M-35 concrete. Minimum thickness of **160 mm**. Minimum steel requirement as per IS: 456
Precast concrete modular Blocks	As per Manufacturer specifications
Bearing pads	As per Manufacturer specifications
Soil bags for wraparound fascia	As per Manufacturer specifications
Vegetation	Slopes section 5.5.2 (Locally available should be preferred) **RECP:** As per Manufacturer specifications
Levelling Pad—PCC	Plain cement concrete (PCC) with minimum strength of 15 MPa
Steel/polymer Connections to Geosynthetic	As per Manufacturer specifications
Gabion: Woven wire mesh	IS 16014
Welded steel mesh fascia	As per Manufacturer specifications

Anand Raghuwanshi

Including aesthetic or not, please clear.

Reply

Anand Raghuwanshi

Minimum req dimension should be mentioned.

02 March 2023, 03:36 PM

Reply

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Test methods for Polymeric Reinforcement

BIS IS 16635 : 2017	**Tensile strength/elongation** **Wide-width**
IS 13162 : PART 2 : 1991 (REAFFIRMED 2019) :	**UV resistance**
BIS IS 17363 : 2020	**chemical resistance**
BIS IS 14739 : 1999 (REAFFIRMED 2019)	**Tensile creep**
BIS IS 17368 : 2020	**Installation damage**
BIS IS 17365 : 2020	**Long-term strength guidelines**

AR **Anand Raghuwanshi**

Also clarify about the validity of test report.

02 March 2023, 02:13 PM

Reply

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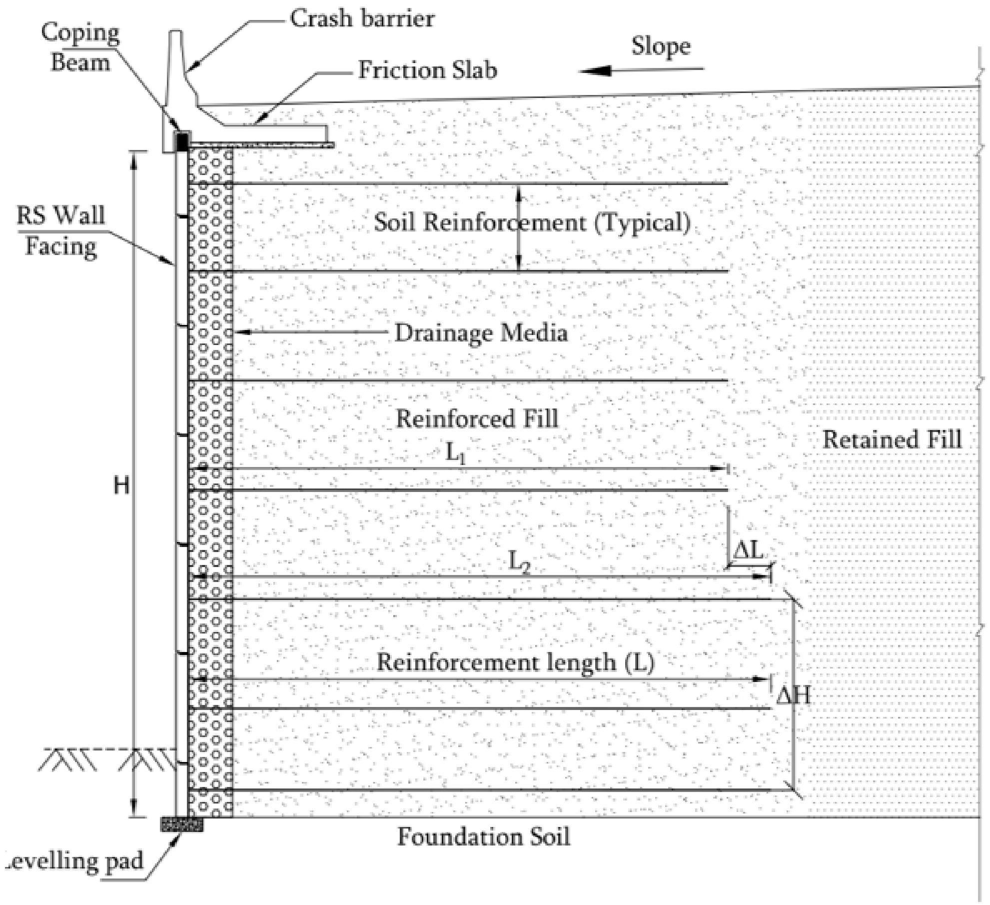

Figure 0.1 Typical Cross Section of Reinforced Soil Walls

AR Anand Raghuwanshi

Drainage media depth upto the pad level or SRL/OGL, please confirm.

Reply

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Cohesion of the reinforced soil fill is neglected in the design. The maximum effective design friction angle shall be limited to 34°.

Additionally, it is recommended that the maximum particle size of the reinforced fill shall be limited to 19 mm for polymeric reinforcements, epoxy and PVC coated metallic reinforcements such that these reinforcements do not get damaged during installation. For

Anand Raghuwanshi

1. Allow Upto 38 degree with additional factor

22 February 2023, 01:50 PM

Reply

4.2.1.2. Retained Backfill

The key properties required for retained backfill are the strength and unit weight based on evaluation and testing of subsurface or borrow pit data. As with reinforced fill, a cohesion value of zero is conservatively recommended for the long-term effective strength of the retained backfill. The strength properties are required for the determination of the coefficient of earth pressure used in design as well as overall stability analysis. In addition, the groundwater levels above the proposed base of construction must be determined to evaluate hydrostatic stresses in the retained zone and plan an appropriate drainage scheme to control ground water conditions.

Anand Raghuwanshi

Zero C-value is not possible all time with borrow area material.

Reply

4.2.3. Facing Systems

Facing is an important component of Reinforced Soil Systems. Facings such as full height panels, discrete/segmental concrete panels, modular concrete blocks, welded wire grid, woven steel wire mesh, gabions and wrap around systems are commonly used for reinforced soil walls.

AR Anand Raghuwanshi

Geocell is missing in facing element.

Reply

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4.2.4. Drainage Considerations

In normal conditions in order to ensure that no hydrostatic as well as pore pressure is developed in the Reinforced Soil Structure, adequate drainage measures need to be taken. A drainage bay of minimum 600 mm width at the back of the facing shall be provided as an adequate drainage measure. Additionally, the aggregates shall not be friable, flaky, elongated and are sound in strength. The materials shall meet the requirements as described in **Section 3 Materials.**

Alternatively, drainage composite with combination of drainage bay of 300 mm shall be provided behind the facing of RS walls for ensuring adequate drainage. However, it is not recommended to use Drainage Composite when Pond ash is used as reinforced fill. In case of Pond ash, 600 mm wide drainage bay shall be used and a non-woven geotextile shall be provided as a separation/filtration layer between the drainage aggregates and the reinforced fill material.

AR Anand Raghuwanshi

About use of only geo-composite..???

Reply

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***Note: Traffic Loads**

As per IRC:78, Clause 710.6.9 live load due to traffic (q_T) is considered equivalent to 1.2m of the earth fill. The minimum value of live load shall be 24kPa. q_T refers to Traffic Load.

For Railways, Airports and Aviation projects, etc. the live load values shall be increased accordingly considering the heavy axle load.

AR Anand Raghuwanshi

Please refer relevant code.

02 March 2023, 02:20 PM

Reply

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Table 0.3 Minimum Embedment Depths for Reinforced Soil Walls

Slope in front of Wall	**Minimum Depth (d) to Top of Levelling Pad**
All Geometries	1000 mm minimum
Horizontal (walls)	H/20
Horizontal (abutments)	H/10
3H:1V	H/10
2H:1V	H/7
1.5H:1V	H/5

Anand Raghuwanshi

Also confirm for pad resting on rocky strata.

Reply

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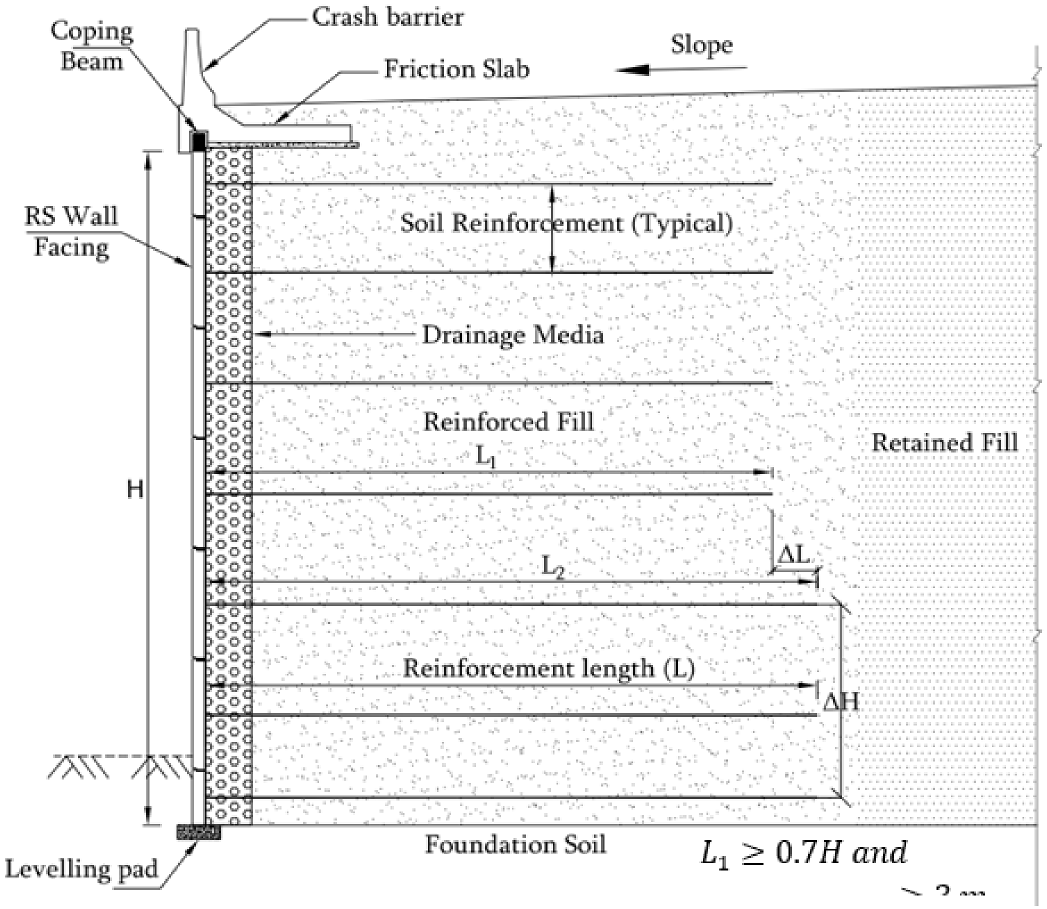

Figure 0.5 Geometric Reinforcement Distribution Criteria of RS wall

Anand Raghuwanshi

Why the filter media required upto the pad level.?

Reply

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4.3.8.4. Vertical Spacing of Soil Reinforcements

The spacing of reinforcement shall be established based on the design principles. The general practice is to keep the vertical spacing constant and increase the density of reinforcement with depth by increasing the coverage ratio of reinforcement. However, the criteria of constant spacing may be relaxed in situations as per the structure requirements. The vertical spacing of the primary reinforcement shall not be greater than 800 mm for all types of facing systems (Example: Segmental/Discrete Panels, Gabion Mesh Units, etc.) and for all types of soil reinforcements (Example: Geogrids, Geostrips, Metallic Reinforcements, etc.) in order to provide a coherent reinforced soil mass. Depending upon the type and dimensions of facing units, the vertical spacing may be limited to a lower value to satisfy the stability of RS walls. However the criteria of maximum vertical spacing of reinforcement is limited to 800 mm. RS walls with modular blocks where the connection capacity is by friction, the maximum vertical spacing of reinforcement shall be minimum of twice the block depth (measured from front face of block to the rear face of block) or 600 mm. In case of wrap around facing RS walls, the maximum spacing shall not be greater than 500 mm to avoid bulging.

4.3.9. Earth Pressure Coefficient Calculation

AR Anand Raghuwanshi

1. Spacing of Primary reinforcement or with secondary r/f also
2. Also need to confirm the spacing of bottom most and top most geogrid.

Reply

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For example - Coverage Ratio of a geogrid strip of effective width equal to 240 mm with 2 connections and 2 strips in each connection for an average width of panel 2000mm is as below:

$$R_c = \frac{Width\ of\ Geogrid\ strip\ \times No.of\ connectors\ \times No.of\ strips\ per\ connector}{Average\ width\ of\ panel}$$

$$R_c = \frac{240\ \times 2\ \times 2}{2000} = 0.48$$

AR Anand Raghuwanshi

Please Clarify the max length of design

23 February 2023, 10:10 AM

Reply

4.3.15. Check for Settlements, Vertical and Lateral Wall Movements

Settlements arising due to internal compression are normally small once compaction is done effectively. However, the facing should be able to cope up with the internal compression. The total settlement can affect the functionality of the structure in a specific manner and differential settlements produces severe effects on the completed structure. Therefore, it should be ensured that the construction and post construction settlements are within the acceptable limits. The maximum settlement limits for various components and conditions shall be per Table 4.9.

Table 0.9 Maximum Settlement Limits for Various components and conditions*

Fascia Type (In Order of Flexibility)	Longitudinal Differential Settlement	Total Settlement (mm)	Post Construction Settlement after 10 Years of Operation (mm)
Full height panels	1V : 500H	100	100 (see Note 5)
Discrete precast concrete panels, with initial joint width of 20mm, bearing pads, L/H ≈ 1	1V : 100H	100 to 300	
Precast concrete segmental blocks	1V : 200H	100 to 300	
Steel wire grid / mesh , gabions	1V : 50H	100 to 300	
Wrap around with geogrids; geocells	1V : 20H	100 to 500	

Anand Raghuwanshi
Confirm depth below pad level for analysis of settlement and SBC computation.
Reply

Anand Raghuwanshi
1. Longitudinal Differential Settlement terms are not clear.
2. total settlement limits to be reverify.
Reply

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2. Post and Beam Railings

   Flexible post and beam barriers shall be placed at a distance of minimum 1.0 m from the wall face, driven 1.5 m below pavement grades and positioned such that it does not damage the soil reinforcements. Each of the upper two reinforcement shall be designed for an additional horizontal load of 2.2 kN/m of wall, for a total additional load of 4.4 kN/m.

4.4.3. Super flood Events and Scour

Anand Raghuwanshi

Confirm outer face or inner face

Reply

Anand Raghuwanshi

Depth of embedment for MBCB is as per the CB crash test,

01 March 2023, 10:25 AM

Reply

4.5.2 Trapezoidal Walls

RS wall resting on rock or any other foundation material which will have minimal post construction settlements i.e. foundation stratum with SPT N value greater than 50 or sound rock. The wall shall be designed for external and internal stability analysis. Global stability and compound stability analysis shall also be performed.

Following are the design rules for such type of RS wall:

(i) Wall shall be represented by a rectangular block (L_o, H) as shown in Figure 4.30 having same total height and same cross sectional area as the stepped section for external stability calculation.

(ii) Maximum tensile force line is same as in rectangular walls as per the extensibility of the reinforcement.

(iii) Minimum base length of 0.4H or 3 m whichever is greater, with the difference in length between the consecutive zones being less than 0.15H.

For internal stability calculations, wall is divided in rectangular sections and for each section the appropriate length L (L_1, L_2 and L_3) is used for pull-out calculations as given for simple geometry RS walls.

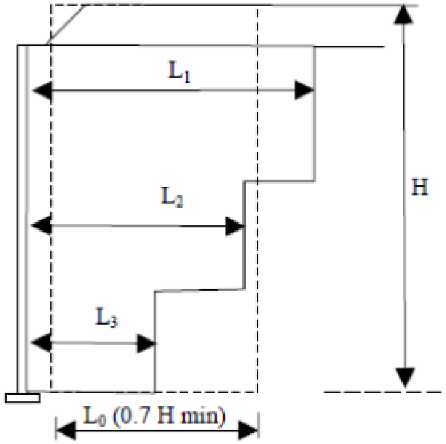


Figure 0.30 Dimensioning of RS wall with uneven reinforcement lengths

Anand Raghuwanshi

Detail design mechanism to be add in code

Reply

4.5.3 Back to Back Walls

Back to back walls are those which are near to each other such that the reinforced portion of wall come within the active zone. As the wall comes closer, earth pressure by the backfill on the reinforced block decreases and at a point where the overlapping of the reinforcement is greater than $0.3H_2$ as shown in Figure 4.31 (where, H_2 is the height of the shorter wall) the earth pressure becomes zero. For situation, when the wall is at a distance such that $D > H_1 \tan (45^{\circ} - \Phi/2)$ as shown in Figure 4.32, where there is no interference of active wedge with the reinforced volume, the walls will behave independently and stability shall be obtained accordingly.

In between the immediate geometries as discussed above, the earth pressure shall be linearly interpolated for analysing sliding and overturning.

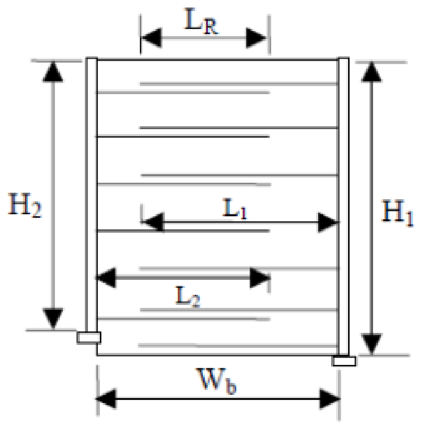


Figure 0.31Overlap is $0.3H_2$ and more, no Earth Pressure from backfill. H_1 is taller wall and H_2 is shorter wall.

Anand Raghuwanshi

1. Also mention about the slenderness ratio of wall.
2. Minimum length of r/f..?

Reply

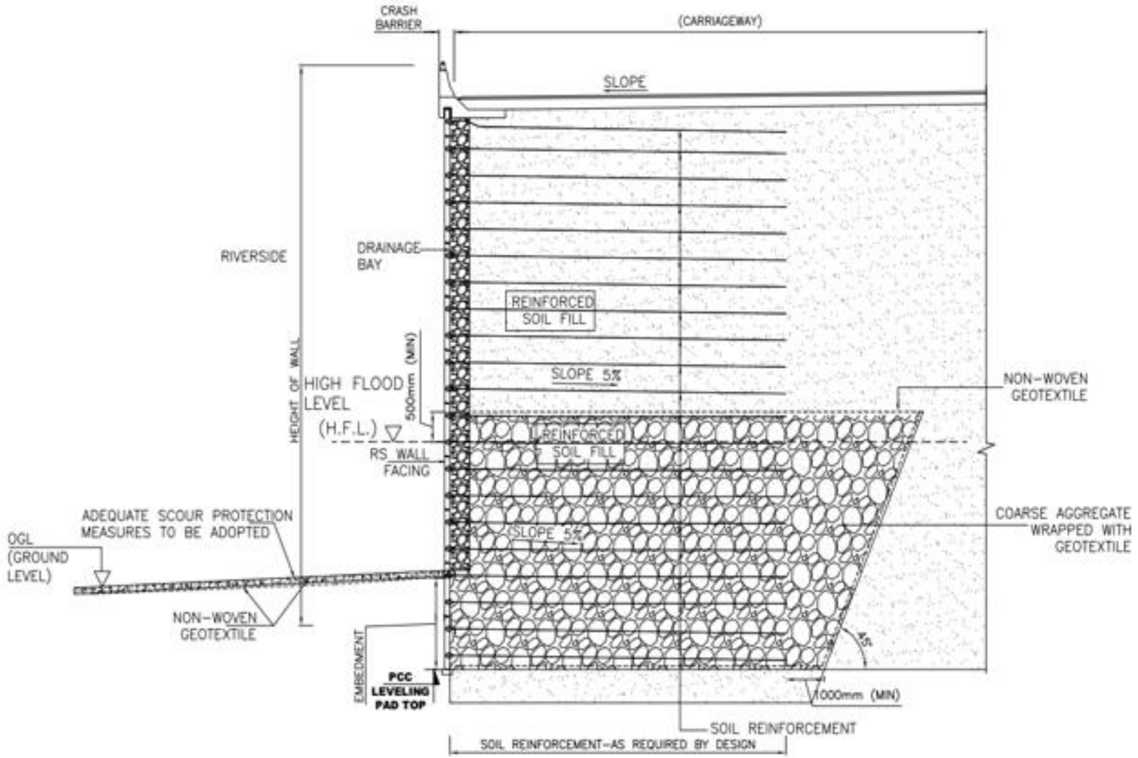
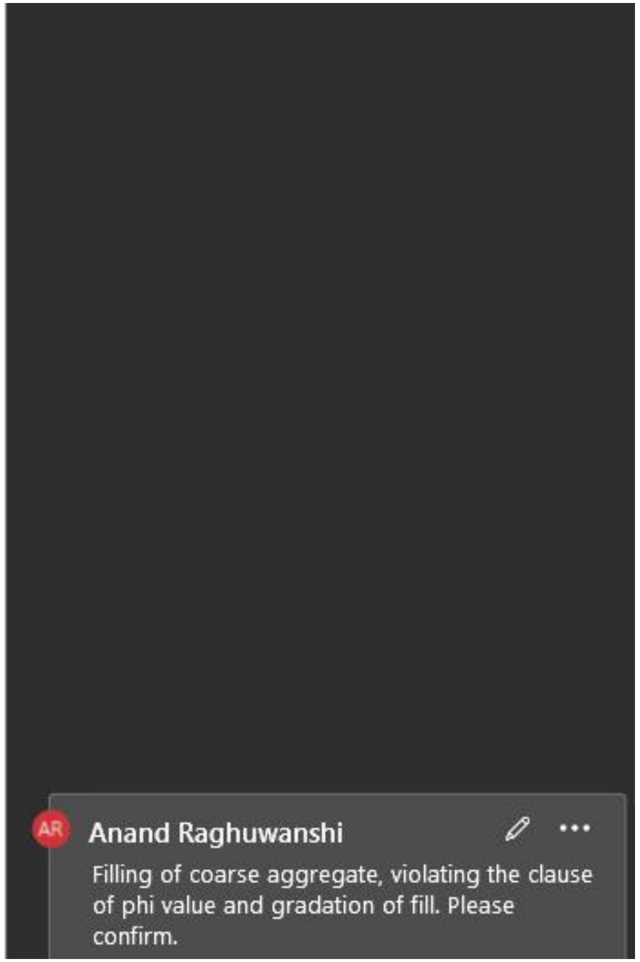


Figure 0.33 Typical Cross Section of Water front RS wall

The following special measures shall be considered in design and construction of any water front retaining structure:



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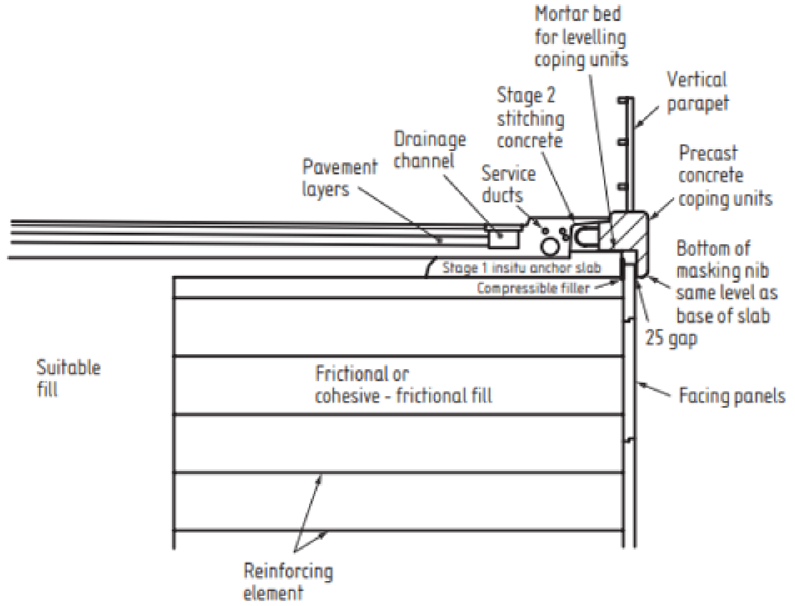

Figure 14 Typical drainage detailing for full height geosynthetic reinforced soil retaining structure edge
(Typical panel fascia – Drawing not to scale)

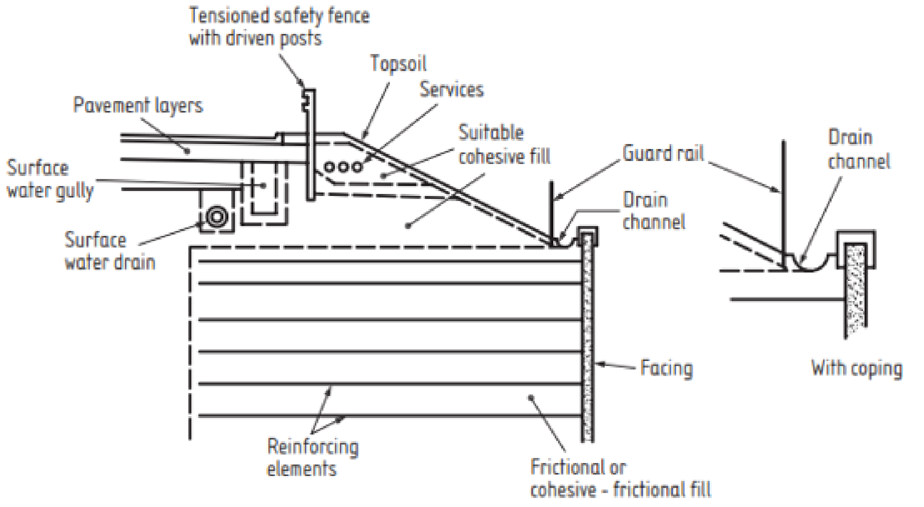

Figure 15 Typical drainage detailing for partially high geosynthetic reinforced soil retaining structure edge
(Typical facing panel)

Anand Raghuwanshi
Req as per Our CB

Anand Raghuwanshi
Req as per IRC

10.1.1 Reinforced Soil Wall Top & Bottom Elements

The top surface of the wall should be graded such that water drains away from the wall. A grassed swale or concrete ditch can be used behind the facing to collect and remove water.

The primary bottom of wall element is a leveling pad. Figure 10-2 shows common details of a leveling pad. Some considerations for the leveling pad are as follows:

- The leveling pad should be constructed with plain cement concrete. The common thickness of the leveling pad is 150 mm and width is such that it extends 75 mm beyond the thickness of the facing unit. The strength and thickness of the leveling pad should allow cracking if needed to relieve stress concentrations that can occur during differential settlements. 20 mm construction joints may be placed at every 20 m stretch length. The grade of concrete for leveling pad shall be M15.
- The width of the leveling pad may be increased for precast concrete facing units at

AR Anand Raghuwanshi

50mm

02 March 2023, 04:18 PM

Reply

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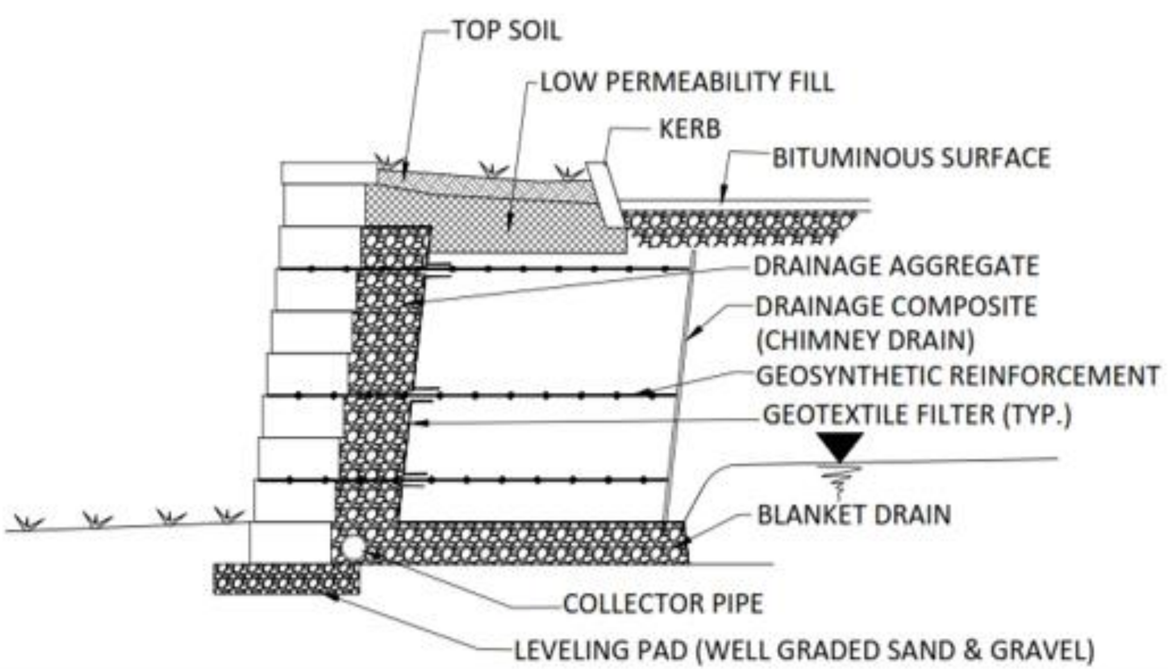
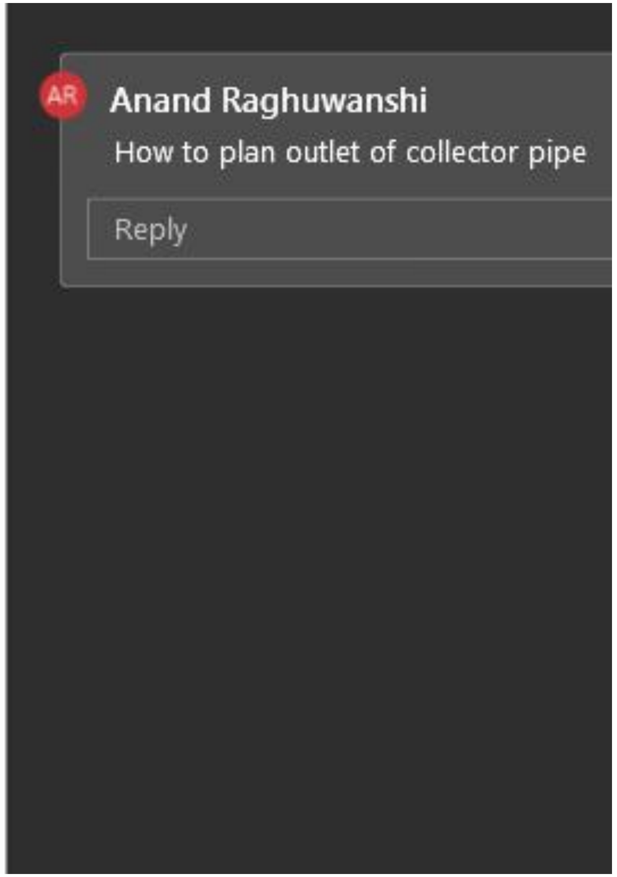


Figure 22 Drainage features for consideration when water is present in reinforced soil structure (Typical precast concrete block fascia)



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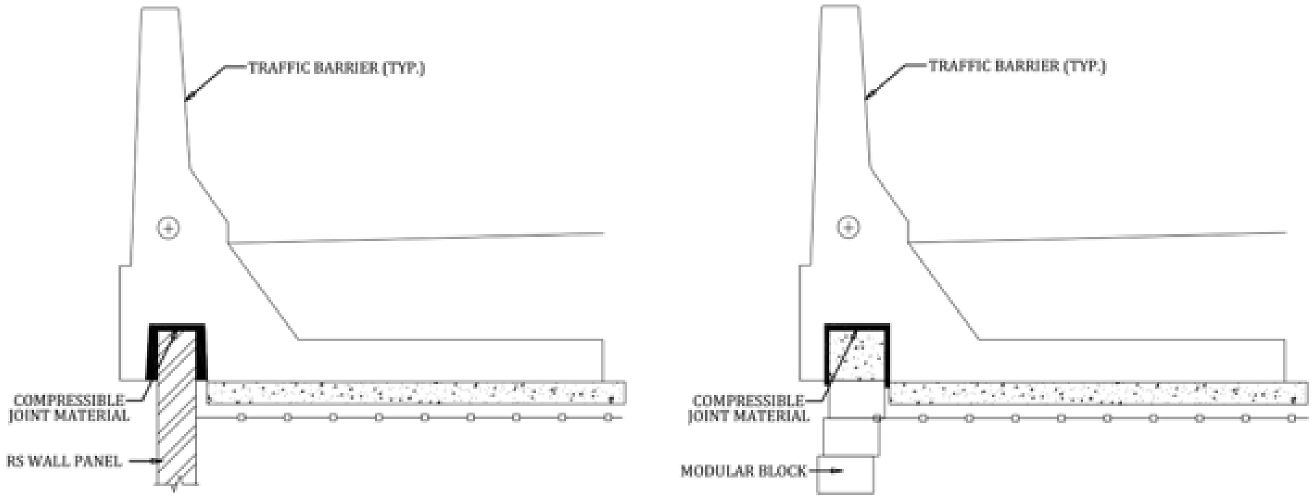

(a) Barrier on top of panels

(b) Barrier on top of Modular Block Units

Figure 10-1. Example traffic barrier for Reinforced Soil walls:
(a) barrier on top of panel facing, (b) barrier on top of modular block units.

AR Anand Raghuwanshi

Unable to fix top grid bcus of CB and GSB layer

Reply

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Impervious liner such as geomembrane to be provided 100mm below drain near top of RS Wall.

Suitable slope protection measures such as – coir mat with vegetation, synthetic mat with vegetation, geocell mattress filled with aggregate, geocell with vegetative soil cover that is followed by a layer of nonwoven geotextile.

Fill material used in sloped surcharge shall have specifications same as that of reinforced soil. The fill shall be compacted to 97% of the maximum laboratory density obtained from modified proctor compaction test. Fill within 0.5 m of the bottom of pavement (subgrade) shall be compacted to a minimum of 98% of the maximum dry density (MDD).

AR Anand Raghuwanshi

Not a impervious soluation for Slope RE wall, so if any addition measure req, in design, pls confirm.

Reply

AR Anand Raghuwanshi

Why????
Embankment stability is not possible with NP soil

02 March 2023, 09:52 AM

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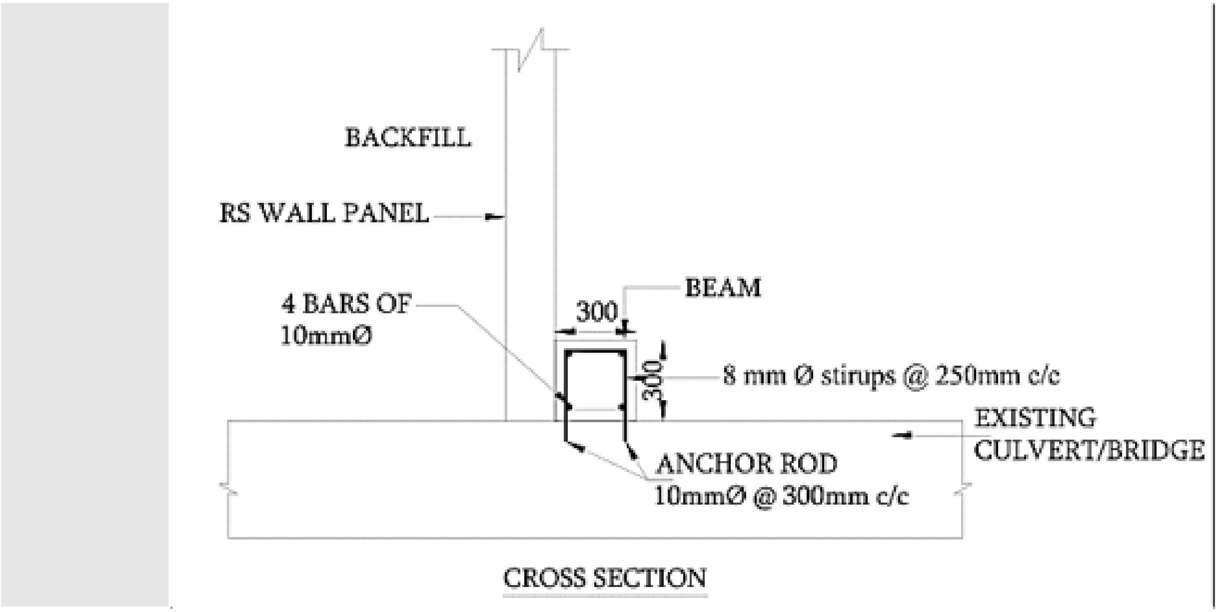
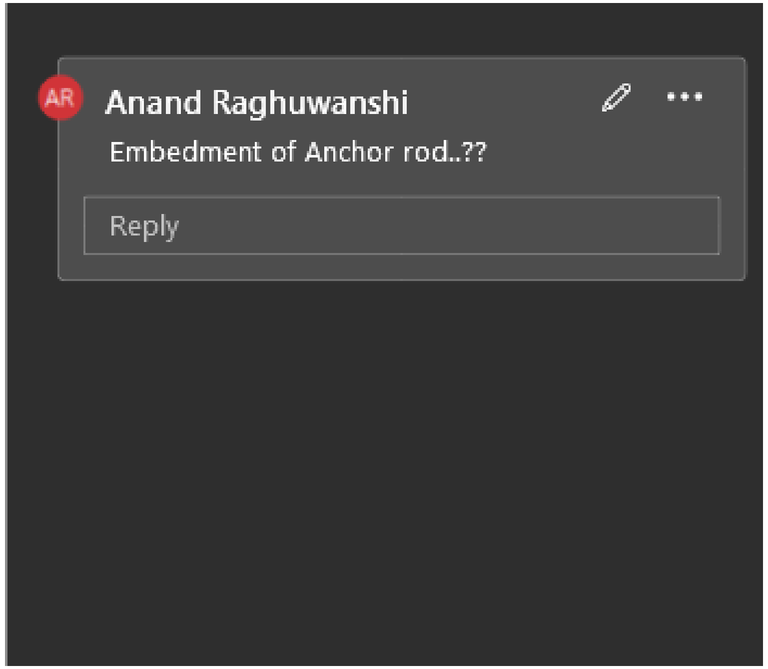

BACKFILL
RS WALL PANEL
4 BARS OF
10mmØ
300
BEAM
300
8 mm Ø stirups @ 250mm c/c
EXISTING
CULVERT/BRIDGE
ANCHOR ROD
10mmØ @ 300mm c/c
CROSS SECTION


AR
Anand Raghuwanshi
Embedment of Anchor rod..??
Reply

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10.2.9 Successive face element erection and batter

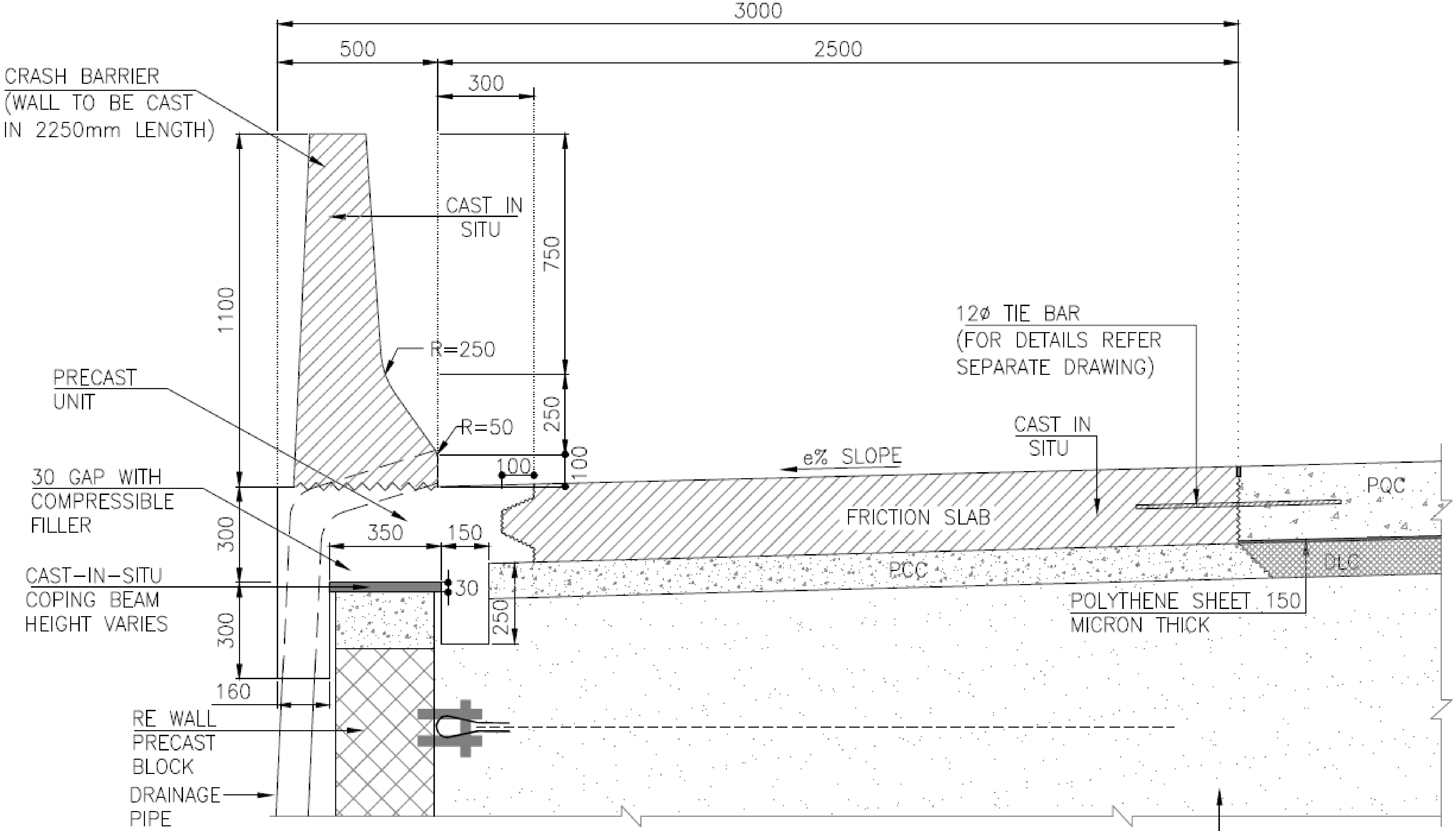
Clean the top surface of the facing unit placed in the first row with a stiff broom or brush to remove all soil, debris etc. before proceeding with subsequent layer.

AR Anand Raghuwanshi

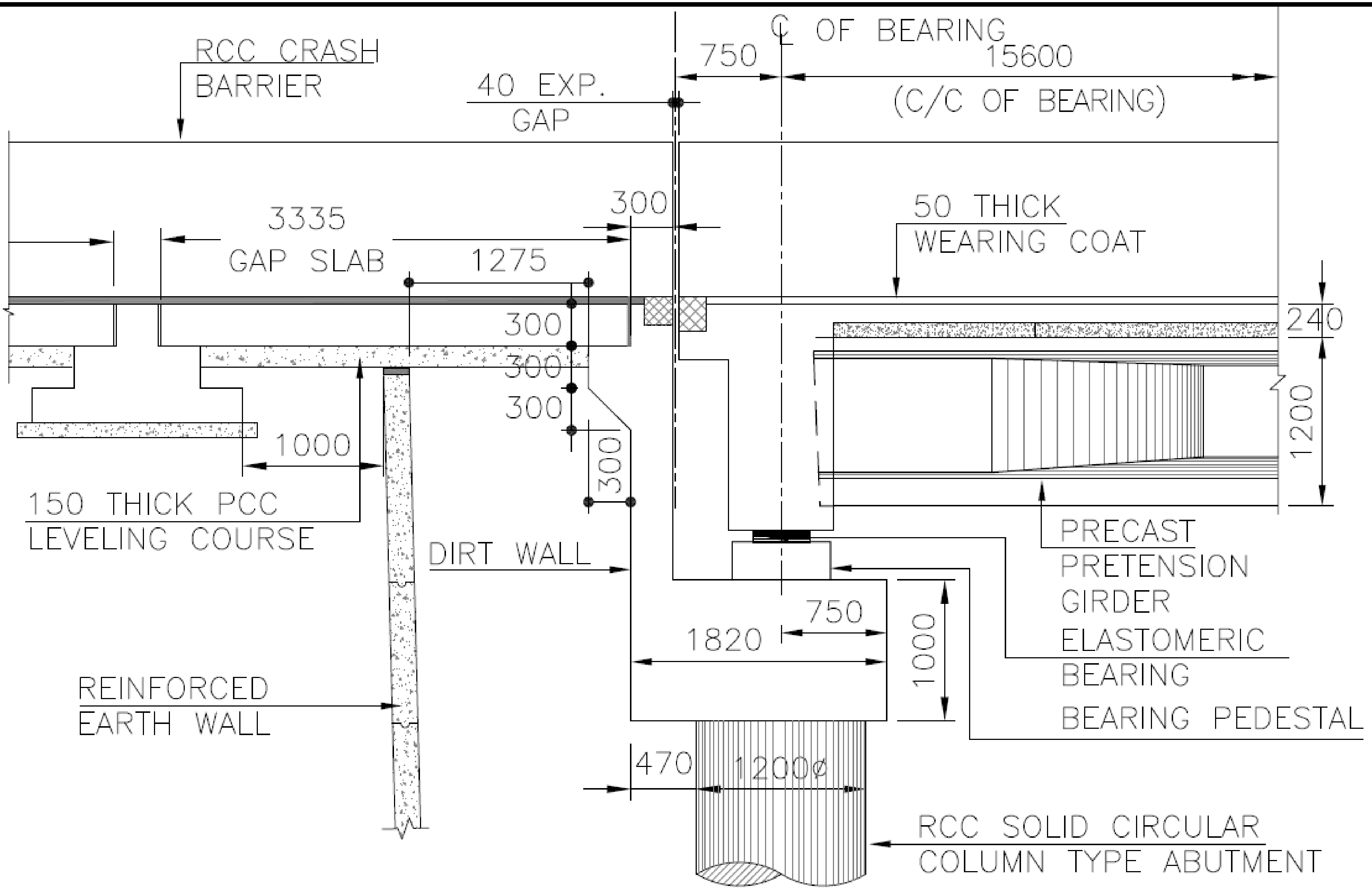
Value of min. and max. batter should be defined.

02 March 2023, 03:27 PM

Reply



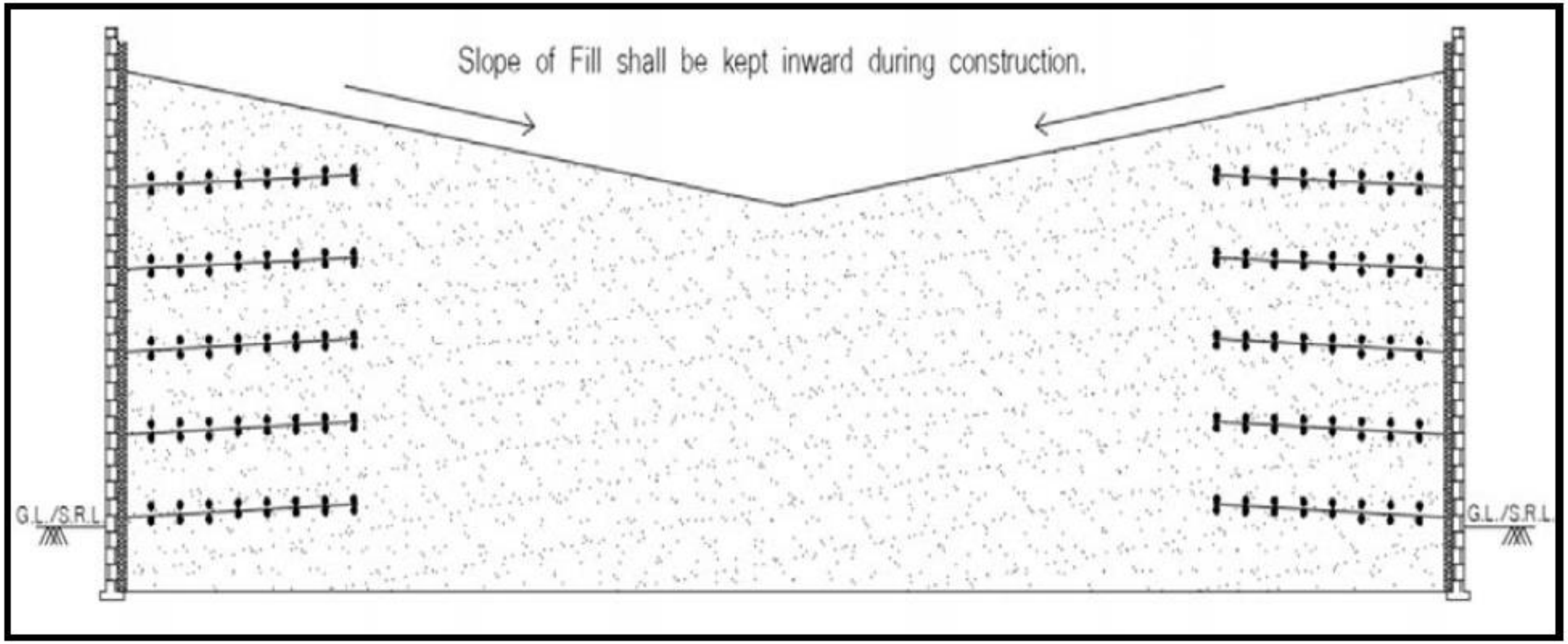
SECTION AT A-A



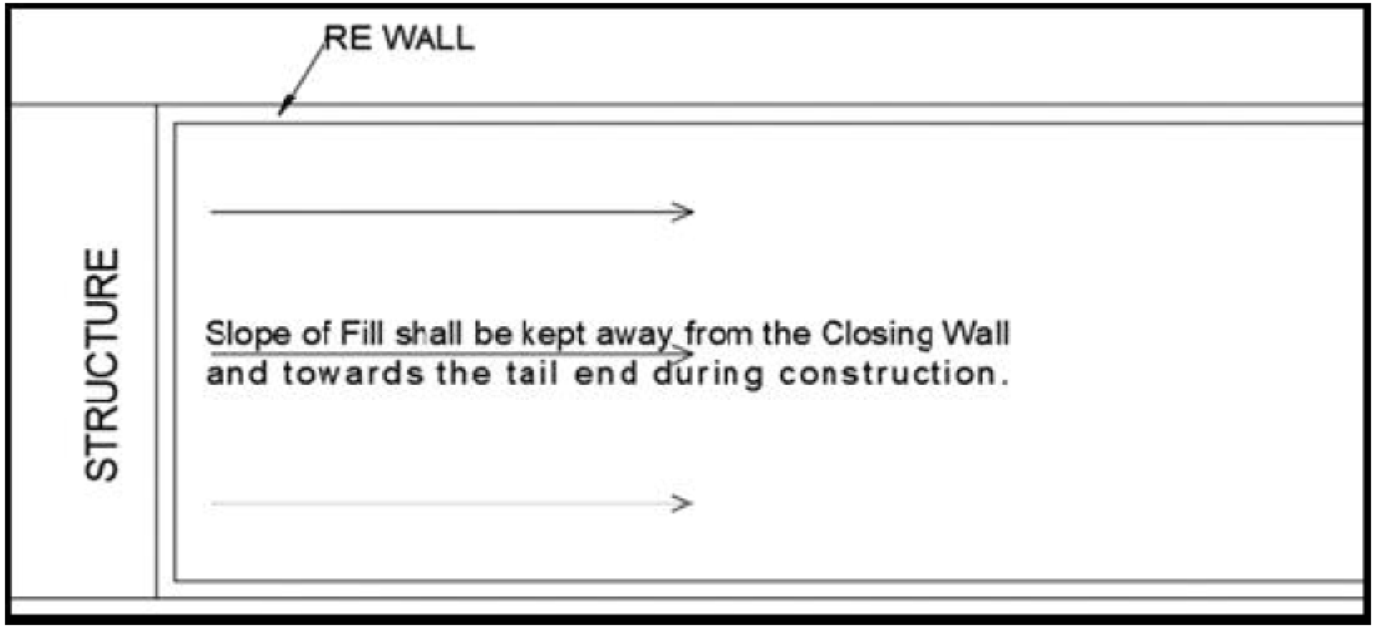
DETAIL-``X"

(SCALE 1:75)

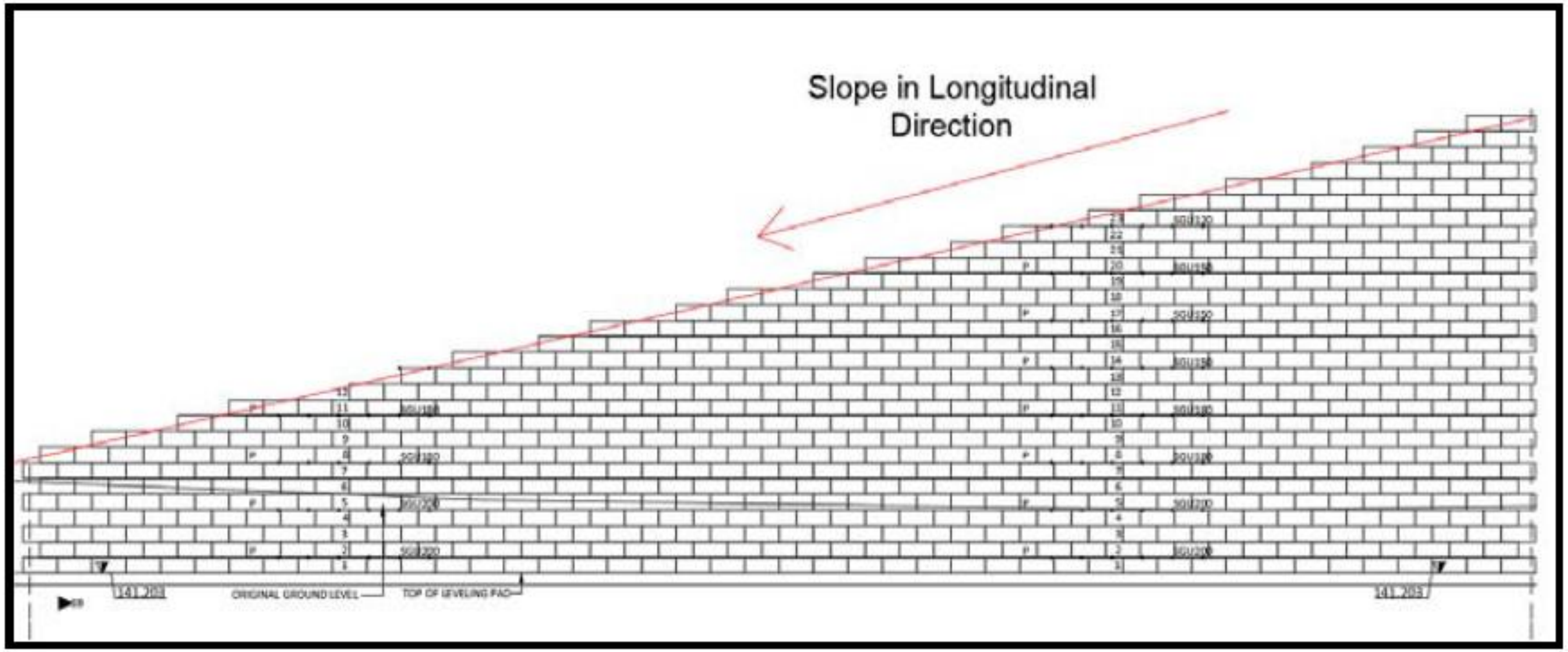
4. During construction of walls up to the subgrade bottom level, the Slope of backfill/bed shall be kept inwards towards the median so that surface runoff water is channelized towards the median (retained fill portion) to prevent the flow of soil along with water.



In case of Closing Wall, the slope of fill shall be kept opposite to the direction of closing wall and towards the tail end.



6. The longitudinal Slope of wall erection shall be kept towards the lower height side so that surface runoff water is drained out through the median.



Points for adding in code

1. Design methodology for rectification of RE wall (Block and panel both).
2. Methodology for Monitoring of repaired wall.
3. Allowable limits of cracks in panel and block, and methodology for cracks filling.
4. Solved example of each type of wall design should be added.
5. Specifications for RE wall in front of lined and unlined canal.
6. Section for Coping beam for Slope RE wall, wall with CB, and MBCB.
7. Retained fill parameters shall be same as embankment fill.
8. Details of shoulder protection in case of RE wall with MBCB.
9. Thickness of the filter media (300mm, 450mm, 600mm) needs to be included as per the zonal rainfall intensity.

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info@tensar.in

Ref : Tensar/2023/017
Date : 28th June 2023

To,
Shri J K Gupta
Head – Textile Department
TXD, Bureau of Indian Standards
New Delhi

Subject: Comments on Draft BIS code on Geosynthetic Reinforced Soil Structures — Code of Practice – Doc. No. TXD 30 (20465) September 2022

Dear Sir,

We, Tensar Geosynthetics India Private Limited are a fully owned subsidiary of Tensar International United Kingdom. Tensar is a world-leading geosynthetic manufacturer and provider of ground stabilization and soil reinforcement solutions.

We have come across a draft BIS code being published for Reinforced Soil (RS) Structures, and we have put together a few general points to which we would like to draw your attention to. We are working on comprehensive comments and the same shall be submitted shortly for your due review.

1. The major point of concern is the way "Polymeric reinforcement" is presented in the code. Clause 3.2.2 of the draft code specifications describes the polymeric reinforcement for walls and slopes of different forms i.e. strips, grids, or sheets. But the table below the said clause specifies the Geogrids as only polyester. Please refer to the snapshot of the table below.

Reinforcement for Walls and Slopes:

Geogrids – Polyester	As per IS 17373
Straps - Polyester	As per IS 17372

2. The specification code in its current form ignores the other types of geogrids used for soil reinforcement applications i.e., geogrids manufactured using High-Density Polyethylene (HDPE) as raw material.

HDPE geogrids are being used as soil reinforcements in Reinforced Soil Structures since the 1980s and several structures are already constructed and are under construction in India. There are several Indian (MORTH, RDSO, etc) and international (FHWA, GEO guide, etc) codes of standards/guidelines that recommend HDPE geogrids for use in Reinforced soils walls and slopes.

3. In view of the above, all the types of soil reinforcements should be allowed in the proposed BIS standard and choice of selection of type geogrid (PET or HDPE) should be left with engineers depending on the project specific requirements. For example,

   a. In the case of sites having RS walls/slope structures exposed to aggressive fills, hazardous wastes, and saline environments, the polyester geogrids cannot be used.
   b. The reinforced soil structures proposed for railway projects, specifically require the use of HDPE geogrids, as the wagons commonly transport aggressive liquids whose spillage and infiltration in backfill can affect the durability of geogrids.

4. Another point is the Design Philosophy presented in cl. 1.7 and section 4 of the code which recommends use of LRFD approach of design for Reinforced Soil Walls and Abutments. Presently, the design methodology used in India as per Indian standards like IRC SP 102 & RDSO GE R 73 is based on British Standard BS 8006 (static design) & FHWA NHI 00 043 (seismic design). The LRFD approach is new to the practicing engineers, designers, and approving authority, and they need to be made more conversant with LRFD method proposed. We suggest including some typical design calculation examples in the code, which will help making LRFD method more familiar and will promote its better adoption in India.

5. The code covers the Design of Basal Reinforcement in section 8. The theory of design presented in cl. 8.4 for Basal mattress over embankment appears to be taken from BS 8006. The slip line field theory presented in this clause is applicable to the cellular basal geo-mattress fabricated using HDPE geogrids. As per clause cl. 8.3.2.9 of BS 8006, the Basal mattress is defined as geocells of thickness 1.0m. The research papers referenced in cl. 8.4 of the draft BIS code also refers to the basal mattress of 1.0m height made from HDPE geogrids. Hence it is pertinent to include HDPE geogrids in the proposed BIS standard.

   Also, it should be clarified that the slip line field theory cannot be used for small geocells of 150mm/ 300mm thickness.

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A Division of CMC

6. We have observed that many of the recommendations in the code are verbatim extracts from international standards like AASHTO & BS 8006, we suggest the same should be included in the list of references in Annex A of the draft standard.

We hope you will consider these points for making the code more inclusive.

For Tensar Geosynthetics India Private Limited

Tensar Geosynthetics India Pvt. Ltd. * Mumbai *

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