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ESR-3060

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DIVISION: 32 00 00—EXTERIOR IMPROVEMENTS

SECTION: 32 32 00—RETAINING WALLS

SECTION: 32 32 23—SEGMENTAL RETAINING WALLS

REPORT HOLDER:

TECHO-BLOC

5255 ALBERT-MILLICHAMP
SAINT-HUBERT, QUEBEC J3Y 8Z8
CANADA

EVALUATION SUBJECT:

TECHO-BLOC RETAINING WALL SYSTEM

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Section: 32 32 00—Retaining Walls
Section: 32 32 23—Segmental Retaining Walls

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EVALUATION SUBJECT

TECHO-BLOC RETAINING WALL SYSTEM

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2009, 2006 and 2003 *International Building Code®* (IBC)
- 2009, 2006 and 2003 *International Residential Code®* (IRC)

Properties evaluated:

Physical properties

2.0 USES

The Techo-Bloc retaining wall system is used in the construction of dry-stacked, vertical, segmental landscaping and retaining walls, with or without a mass of reinforced soil, stabilized by horizontal layers of geosynthetic reinforcement materials.

3.0 DESCRIPTION

3.1 General:

The Techo-Bloc retaining wall system consists of modular concrete units (Suprema Type A units) and HDPE (high-density polyethylene) connectors that are installed with or without geosynthetic reinforcement (geogrid) materials.

3.2 Materials:

3.2.1 Techo-Bloc Suprema Type A Unit: The Techo-Bloc Suprema Type A unit is illustrated in Figure 1.

The top of each unit is identified by a notch near the front face of the block. The unit has two grooves (slots) on the upper side and two grooves (slots) on the underside that are approximately parallel to the front and rear faces of the units. The grooves are provided for installation of HDPE connectors.

All units are made with normal-weight aggregates, and comply with ASTM C1372, including having a minimum 28-day compressive strength of 3000 psi (21 MPa) on the net area. Refer to Figure 1 for the unit dimensions and weight.

3.2.2 HDPE Connectors: The connectors are made from HDPE. The connectors are hollow rectangular tubes with the following dimensions: 28.5 ± 1 mm (1.122 ± 0.039 inch) width, 70 ± 1 mm (2.756 ± 0.039 inch) length, and 23 ± 1 mm (0.906 ± 0.039 inch) height. The connectors fit into the grooves of the Techo-Bloc units and provide for alignment of the units.

3.2.3 Base Leveling Pad Material: Base leveling pad material must consist of maximum $^{3}/_{4}$-inch-diameter (19 mm) crushed stone compacted to at least 95 percent of the maximum dry density as determined per ASTM D698 (90 percent per ASTM D1557), or normal-weight concrete (reinforced or nonreinforced as specified by the registered design professional).

3.2.4 Drainage Fill: Drainage fill must be $^{3}/_{4}$-inch (19 mm) clean, crushed-stone material that is placed in the cavities of all units, the space between the units and behind the units (drainage zone).

3.2.5 Backfill Material: Backfill material placed behind the drainage zone as the reinforced soil mass must be soil that is free of organic material, construction debris, and boulders; or as specified by the registered design professional. Backfill used in the reinforced fill mass must consist of suitable fine-grained or coarse-grained soil placed in lifts compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557 or 95 percent per ASTM D698, unless more stringent requirements are prescribed by the soils engineer based on site-specific conditions.

3.2.6 Geosynthetic Reinforcement Material (Geogrid): The geogrid material for use with the Techo-Bloc wall system recognized in this evaluation report is Miragrid® 3XT, manufactured by Tencate Geosynthetics North America.

3.2.7 Geotextile: The geotextile filter fabric material must be specified by the registered design professional, and is intended to separate the granular material of the leveling pad and drainage material behind the wall from the surrounding soil as described in Section 4.2 of this evaluation report.

4.0 DESIGN AND INSTALLATION

4.1 Design:

4.1.1 General: Structural calculations must be submitted to the code official for each wall system installation. The design of Techo-Bloc segmental retaining walls (SRWs) must be based on accepted geotechnical principles for gravity and soil-reinforced structures. The system must be designed as a gravity or reinforced-soil retaining wall that depends on the weight and geometry of the concrete units and soil to resist lateral earth pressures and other lateral forces. Lateral earth pressures are determined using either Coulomb or Rankine earth pressure theory. The design must include evaluation of both external and internal stability of the structure and include consideration of external loads such as surcharges and seismic forces.

External stability analysis must be similar to that required for conventional retaining walls, and must consider base (lateral) sliding, overturning, bearing capacity (and excessive settlement), and overall (deep-seated) slope stability. Internal stability analysis of SRWs without reinforced soil must consider movement between courses. Internal stability analysis of the SRWs with reinforced soil must consider the maximum allowable reinforcement tension, pull-out resistance of reinforcement behind the active failure zone (excessive movement of geosynthetic through the reinforced soil zone), and the connection strength of geosynthetic reinforcement material to the SRW concrete units or blocks, and movement between courses.

Minimum safety factors used in design (for external stability check) for SRWs, with and without a geogrid-reinforced soil mass, must be 1.5 for deep-seated (global) stability and 2.0 for bearing capacity. The minimum safety factors must be 1.5 for lateral sliding and 2.0 for overturning for SRWs with a geogrid-reinforced soil mass. The minimum safety factors against lateral sliding and overturning must be 1.5 (2009 IBC Section 1807.2.3, 2006 and 2003 IBC Section 1806.1, 2009 IRC Section R404.4, and 2006 IRC Section R404.5, as applicable), for SRWs without a reinforced soil mass. Minimum safety factors used in design (for internal stability) must be 1.5 for peak connection strength between the geosynthetic material and SRW units, and for peak shear strength between SRW units with or without geosynthetic material. Seismic safety factors for all limit states related to SRW design may be 75 percent of the corresponding minimum allowable static safety factors.

A site-specific soils investigation report in accordance with 2009 IBC Section 1803, 2006 or 2003 IBC Section 1802, or 2009, 2006 or 2003 IRC Section R401.4, as applicable, is required. The soils investigation report must provide a global slope stability analysis that considers the influence of site geometry, subsoil properties, groundwater conditions, and existing (or proposed) slopes above and below the proposed retaining wall. The soils report also must specify the soil-reinforcement and interaction coefficients, including the coefficient of interaction for pullout and coefficient of direct sliding; and include derivation of the ultimate tensile strength of the geogrid material (according to ASTM D4595), and the applicable safety factors for deriving the ultimate strength, long-term design strength and allowable tensile strength of the geogrid. The soils investigation report must also specify safety factors for tensile rupture and pullout of the geogrid. Where the wall is located in an area subject to the 2009 IBC, in Seismic Design Categories C through F, the site-specific soils report must include the information as required by 2009 IBC Section 1803.5.11. Where the wall is located in an area where the 2009 IBC is enforced, in Seismic Design Categories D through F, the site-specific soils report must include the information as required by 2009 IBC Section 1803.5.12. Where the SRW is located in an area subject to the 2006 IBC or 2003 IBC, in Seismic Design Category C, the site-specific soils report must include the information as required by IBC Section 1802.2.6; where the wall is located in an area subject to the 2006 IBC or 2003 IBC, in Seismic Design Category D, E, or F, the site-specific soils report must include the information as required by IBC Section 1802.2.7. Under the 2009, 2006 or 2003 IRC, the Techo-Bloc SRWs may be constructed provided an engineering design is submitted in accordance with IRC Section R301.1.3.

4.1.2 Gravity Segmental Retaining Walls: The gravity SRW system relies on the weight and geometry of the Techo-Bloc modular concrete units to resist lateral earth pressures and other lateral forces. Gravity wall design must be based on standard engineering principles for modular (segmental) concrete retaining walls**.** Inter-unit shear capacity equations are provided in Table 1. Figure 2 shows a typical cross section of a Techo-Bloc gravity retaining wall.

4.1.3 Geogrid-reinforced SRWs:

4.1.3.1 General: The geogrid-reinforced-soil SRWs rely on the weight and geometry of the dry, vertically stacked Techo-Bloc modular concrete units and the geogrid-reinforced soil mass to resist lateral earth pressures. The design of a reinforced soil structure must be specific to the Techo-Bloc modular concrete units, soil reinforcement (geogrid material) strength and soil interaction, soil strength properties, and structure geometry. Figure 3 shows a typical cross section of a Techo-Bloc geogrid-reinforced retaining wall.

4.1.3.2 Structural Analysis: Structural analysis must be based on accepted engineering principles and the IBC. The analysis must, at a minimum, include all items noted in Sections 4.1.3.2.1 and 4.1.3.2.2 of this report. All contact surfaces of the units must be maintained in compression.

4.1.3.2.1 External Stability Analysis:

1. The minimum length of the reinforced mass is 0.6 times the height of the wall (as measured from the top of the leveling pad to the top of the wall) or as required to satisfy a safety factor of 1.5 on sliding at the base, whichever is greater.
2. The minimum safety factor for overturning the reinforced mass is 2.0, considering the mass as a rigid body rotating about the toe of the wall.
3. Global stability analysis must be provided for walls with slopes below the toe of the wall, walls on soft foundations, walls that will be designed for submerged conditions, or tiered walls.
4. After completion of the external stability analysis and determination of the geogrid layout, investigation is necessary of total and differential settlement of the soils, which may have varying soil strengths along the length and width of the segmental retaining wall with geogrid-reinforced soil.

4.1.3.2.2 Internal Stability Analysis:

1. Geogrid spacing must be based on local stability of the Techo-Bloc units during construction. Maximum vertical spacing is limited to two times the depth of the unit.

2. Tension calculations for each respective layer of reinforcing must be provided. Tension is based on the earth pressure and surcharge load calculated from halfway to the layer below to halfway to the layer above. Calculated tension must not exceed the allowable geogrid strength.
3. Connection capacity must be checked for each connection of geogrid to the Techo-Bloc units (see Table 2). The calculated connection capacity must be equal to or greater than the calculated tension for each layer.
4. A calculation check must be made on pullout of the upper layers of geogrid from the soil zone beyond the theoretical Coulomb or Rankine failure plane. The pullout capacity must be equal to or greater than the calculated tension after the applicable geogrid interaction and sliding coefficient adjustment factors are applied.
5. After completion of the internal stability analysis and geogrid layout, sliding along each respective geogrid layer must be checked, including shearing through the connection at the wall face.

4.2 Installation:

The wall system units are assembled in a running bond pattern. The wall system units are assembled without mortar or grout, utilizing the Techo-Bloc HDPE connectors. The system may include horizontal layers of structural geogrid reinforcement in the backfill soil mass. Requirements for installation of the Techo-Bloc Segmental Retaining Wall System are as follows:

1. Excavate for leveling pad and reinforced fill zone if geogrid reinforcement is to be installed. The trench must accommodate at least a 6-inch-deep (152 mm) leveling pad and the height of the wall buried in the ground, which is the larger value of the 10 percent of the wall height and 6 inches. The width of the trench must allow for a horizontal space of at least 6 inches (152 mm) at the front of the wall and 12 inches (305 mm) at the back for drainage fill.
2. Inspect excavations for adequate bearing capacity of foundation soils and observation of groundwater conditions by a qualified geotechnical engineer.
3. Cover the base and back of the trench with geotextile (filter fabric). Extend the geotextile towards the back of the excavation, and wrap around the drainage zone, so that the geotextile covers the drainage fill and terminates adjacent to the top of the wall, once the geotextile is in place.
4. Install a minimum 6-inch-thick (152 mm) leveling pad using crushed stone as described in Section 3.2.3 of this report, compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557 (95 percent per ASTM D698). An unreinforced concrete pad in accordance with 2009 IBC Section 1809.8 or 2006 or 2003 IBC Section 1805.4.2.3, as applicable; or a reinforced concrete pad, as specified by the registered design professional, may be utilized in place of the crushed stone pad.
5. Place the first course of full-size Techo-Bloc blocks of the same height on the compacted leveling pad according to the predetermined layout. Check the alignment and leveling in all directions and make sure that all the blocks are fully in contact with the leveling pad and properly supported. Place the exposed surfaces of the blocks side by side. There must be no space between the exposed faces of the adjacent blocks.
6. At the back of the wall and on the compacted leveling pad, lay a minimum 4-inch-diameter (102 mm) perforated drain pipe. Connect this drain to the existing drainage system so that it clears the water accumulated behind the wall. Make sure that the pipe is surrounded by a minimum of 4 inches (102 mm) of clean stones and maintain a minimum slope of $^1/_4$ inch per foot (6.4 mm per 304.8 mm), with unrestricted flow towards outlets away from the wall and its backfill and to the existing drainage system.
7. Backfill the rear of the wall (drainage zone) and the space between the adjacent units with drainage fill described in Section 3.2.4 of this report or as specified by the registered design professional for site-specific design. All cavities in the units must be filled with the clean stone also.
8. Clean the top surface of each block to remove loose aggregate before laying the next course.
9. Install the HDPE connectors into the grooves of blocks. The wall will be vertical if connectors are fitted into the front groove, and battered (inclined) if connectors are fitted into the back groove. Refer to installation step 10, below, for the connector location related to the subsequent course.
10. Lay the subsequent courses so that the segmental concrete units are placed in running bond (running joint) fashion and so that one HDPE connector fits into the end of each upper course block unit and connects two upper blocks (with about equal attachment length) with one lower block, backfilling the rear of the wall every 8-inch (203 mm) maximum fill height (lift thickness), using the same method outlined in step 8, above. Make sure the subsequent courses are laid so that the vertical seams are offset from the blocks below.
11. Provisions for adequate subsurface drainage must be determined by the soils engineer, and must be implemented at appropriate steps of the wall construction.
12. For geogrid-reinforced retaining walls: Cover the clean stone (drainage fill) located directly behind the wall units with a geotextile. The HDPE connectors must be placed before the geogrid is installed and connectors must be fitted into the grooves of the blocks. Place the geogrid according to the type, level (elevation) and length per the site-specific design. Make sure the geogrid is placed above the HDPE connectors. Position the geogrid so that the main reinforcement direction (strong direction) is perpendicular to the length of the wall and the geogrid end extends to the outer front face of the wall. The geogrid must be continuous along its full embedment length. Splicing of the geogrid in the main reinforcement direction is not permitted. Adjacent rolls are placed side by side; no overlap is required. The geogrid must be installed horizontally over the compacted drainage fill and backfill and over the previous course of blocks. The next course of the blocks is placed in the same manner. Pull on the back of the geogrid to remove slack and maintain its tension by stakes or pins (into the ground).
13. For geogrid-reinforced retaining walls: Place and compact backfill over the geogrid reinforcing layer in appropriate lift thickness (8 inches maximum per

step 10, above) to ensure compaction. Refer to Section 3.2.5 of this report for backfill material description. The backfill soil properties, lift thickness, and degree of compaction must be determined by the soils engineer based on site-specific conditions. In cut-wall applications, if the reinforced soil has poor drainage properties, a granular drainage layer of synthetic drainage composite should be installed to prevent buildup of hydrostatic pressures behind the reinforced soil mass. Provisions for adequate subsurface drainage must be determined by the soils engineer.

14. For geogrid-reinforced retaining walls: Placement of Techo-Bloc units, geogrid reinforcement, drainage fill, geotextile and compacted backfill, is repeated. The reinforced backfill must be placed, and compacted no lower than the top unit-elevation to which geogrid placement is required. Heavy equipment must not be used less than 3 feet (914 mm) behind the blocks. Construction equipment must not drive directly over the geogrid.
15. Position the course of capping stones (if applicable) or the final course of the blocks to complete the wall. The capping stones or final course of blocks must be fixed to the blocks using concrete adhesives and there must be no spaces between the blocks.

4.3 Special Inspection:

Special inspection must be provided in accordance with IBC Section 1704.5 (IBC and IRC). The inspector's responsibilities include verifying the following:

1. The modular concrete unit type (Suprema Type A) and dimensions.
2. Product identification, including evaluation report number (ESR-3060).
3. Foundation preparation.
4. Techo-Bloc unit placement, including proper alignment and inclination.
5. HDPE connector installations, including locations, proper fit between blocks, and installation sequence with respect to the geogrid placement.
6. Geosynthetic reinforcement type (Miragrid 3XT) and placement.
7. Backfill placement and compaction.
8. Drainage provisions.

5.0 CONDITIONS OF USE

The Techo-Bloc Retaining Wall System described in this report complies with, or is a suitable alternative to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

5.1 The system is designed and installed in accordance with this report, the manufacturer's published installation instructions, and accepted engineering principles. If there is a conflict between this report and the manufacturer's published installation instructions, the more stringent requirement governs.

5.2 The wall design calculations are submitted to, and approved by, the code official. The calculations must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.

5.3 A site-specific soils investigation in accordance with 2009 IBC Section 1803, 2006 or 2003 IBC Section 1802, or 2009, 2006 or 2003 IRC Section R401.4, as applicable, as noted in Section 4.1.1 of this report, must be provided to the code official for each project site.

5.4 Special inspection must be provided for backfill placement and compaction, geogrid placement (when applicable), and block installation, in accordance with Section 4.3 of this report.

5.5 Details in this report are limited to areas outside of groundwater. For applications where free-flowing groundwater is encountered, or where wall systems are submerged, the installation and design of the system must comply with the recommendations of the soils engineer and the appropriate sections of the most recent edition of the NCMA Design Manual for Segmental Retaining Walls, and must be approved by the code official.

5.6 Under the 2009 IBC, project specifications for soil and water conditions that include sulfate concentrations identified in ACI 318-08 Table 4.2.1 as severe (S2) or very severe (S3), must include mix designs for concrete, masonry and grout that comply with the intent of ACI 318-08 Table 4.3.1. See 2009 IBC Section 1904.5.

5.7 Under the 2006 IBC, project specifications for soil and water conditions that include sulfate concentrations identified in ACI 318-05 Table 4.3.1 as severe or very severe, must include mix designs for concrete, masonry and grout that comply with the intent of ACI 318-05 Table 4.3.1. See 2006 IBC Section 1904.3.

5.8 Under the 2003 IBC, project specifications for soil and water conditions that include sulfate concentrations identified in IBC Table 1904.3 as severe or very severe, must include mix designs for concrete, masonry and grout that comply with the intent of IBC Table 1904.3.

5.9 Under the 2009, 2006 or 2003 IRC, the Techo-Bloc segmental retaining wall system may be constructed provided an engineering design is submitted in accordance with IRC Section R301.1.3.

5.10 This report covers only the connection strength of the geogrid material when attached to the concrete units as described in Section 4.2. Physical properties of the geogrid material or its interaction with the soil have not been evaluated.

6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Segmental Retaining Walls (AC276), dated October 2004 (editorially revised May 2011), including Section 3.1.1.1 for freeze-thaw durability.

7.0 IDENTIFICATION

Each pallet of concrete units is identified with the manufacturer's name (Techo-Bloc) and address, the name of the product (Suprema), the unit type (Type A), and the evaluation report number (ESR-3060). HDPE connectors are provided with each shipment of blocks, and are identified by the same product label as the concrete units.

TABLE 1—INTER-UNIT SHEAR RESISTANCE[1]

UNIT		PEAK (ULTIMATE) SHEAR STRENGTH (pounds/linear foot)		SERVICEABILITY SHEAR STRENGTH (pounds/linear foot)[2]	
		Equation	Maximum	Equation	Maximum
WITHOUT GEOGRID					
Suprema, Type A unit		F = 208+ 0.73 N	3733	F = 174 + 0.51 N	2273
WITH GEOGRID					
Suprema, Type A unit	Miragrid 3XT	P = 369 + 0.46 N	2535	P = 193 + 0.45 N	2355

For **SI:** 1 lb/linear ft. = 14.6 N/m.

[1]The inter-unit shear resistance, F or P [lb/linear foot of unit (N/m)], of the Techo-Bloc units at any depth is a function of the superimposed normal (applied) load, N [lb/linear foot of unit (N/m)].

[2]The serviceability shear strength is based on a prescribed deformation criterion, which is either $^3/_4$ inch (19 mm) or a value equal to 2 percent of the block height, whichever is less.

TABLE 2—GEOGRID-TO-BLOCK PULLOUT RESISTANCE [1]

GEOGRID		PEAK CONNECTION STRENGTH (pounds/linear foot)		SERVICEABILITY CONNECTION STRENGTH[2] (pounds/linear foot)	
		Equation	Maximum	Equation	Maximum
Suprema, Type A unit	Miragrid 3XT	P = 1222 + 0.04 N	1435	P = 407 + 0.05 N	660

For **SI:** 1 lb/linear ft. = 14.6 N/m.

[1]Where N = superimposed normal (applied) load (lb/linear foot of geogrid measured along the wall length direction).

[2]The serviceability connection strength is based on a maximum ¾ inch (19 mm) of geogrid displacement.

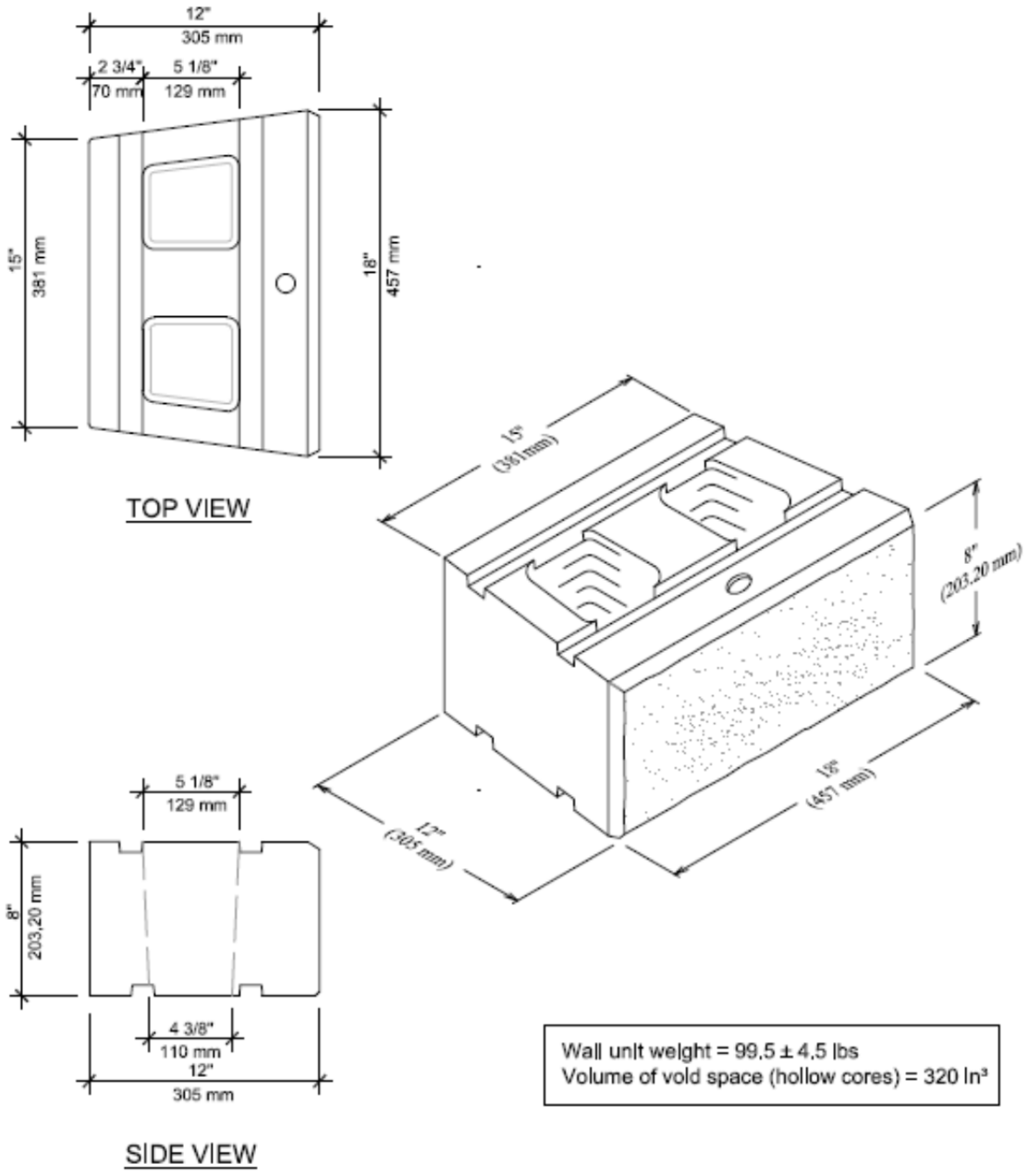

FIGURE 1—TECHO-BLOC UNIT: SUPREMA

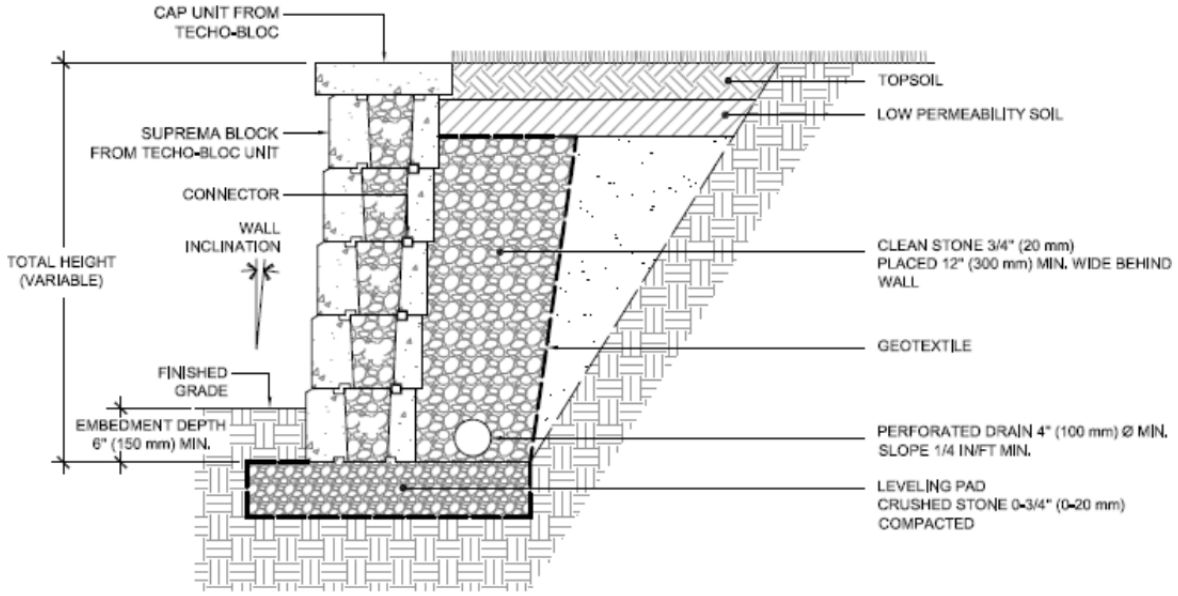

FIGURE 2—TECHO-BLOC GRAVITY WALL (TYPICAL CROSS SECTION)

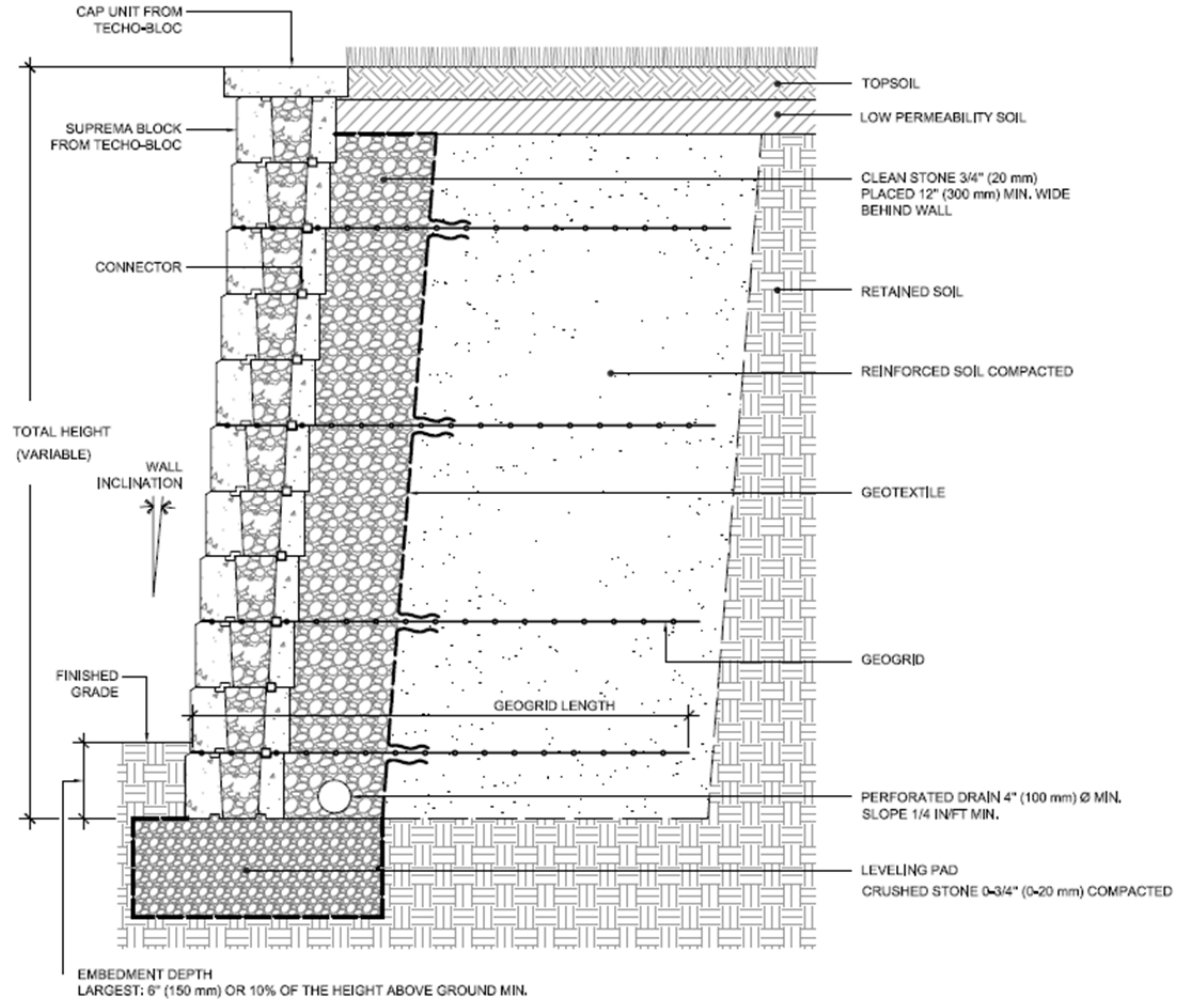

FIGURE 3—TECHO-BLOC GEOGRID-REINFORCED WALL (TYPICAL CROSS SECTION)