ICC-ES Evaluation Report

ESR-1784

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Subject to renewal February 2025

This report also contains:

- CBC Supplement

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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:** **VERSA-LOK RETAINING WALLS**	**EVALUATION SUBJECT:** **VERSA-LOK RETAINING WALL SYSTEMS**	

1.0 EVALUATION SCOPE

Compliance with the following codes:

■ 2021, 2018, 2015, 2012, and 2009 *International Building Code*® (IBC)

Property evaluated:

■ Physical

2.0 USES

The Versa-Lok Retaining Wall Systems consist of modular concrete units, pins, unit core and drainage fill, with or without geogrid, for the construction of conventional gravity retaining walls or geogrid-reinforced-soil retaining walls, respectively.

3.0 DESCRIPTION

3.1 Versa-Lok Units and Wall Systems:

Versa-Lok modular concrete units are available in four configurations: Versa-Lok Standard Unit, Versa-Lok Square Foot Unit, Versa-Lok Cobble unit, and Versa-Lok Accent Unit. Versa-Lok Retaining Wall Systems are available in three configurations: Versa-Lok Standard Unit System, Versa-Lok Mosaic System, and Versa-Lok Square Foot Unit System. Versa-Lok Standard Unit System and Versa-Lok Square Foot Unit System are constructed with Versa-Lok Standard Units and Versa-Lok Square Foot Units, respectively. Versa-Lok Mosaic System is a multi-block system with blocks of varying widths and heights configured in a repeating panel that consists of one Standard Unit, one Cobble Unit and two Accent units. See Table 1 for wall systems and modular concrete units.

To provide interlock/setback and alignment of the units, the Versa-Lok units have pin holes and slots. Two pins per each unit are inserted into the holes of upper units and into slots of the units below. For Standard Unit System and Square Foot Unit System, the Versa-Tuff pin is used. For the Mosaic system, the Snap-off pin is used so pin height can be adjusted for the shorter Accent units; see Figures 3 through 7 for unit configurations and dimensions, Figure 8 for pin configurations and dimensions, and Table 1 for unit nominal weights.

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, and maximum water absorption of 13 pcf (208 kg/m^3).

3.2 Pins:

Glass-reinforced nylon Versa-Tuff pins and Versa-Tuff Snap-off pins provide alignment of units during placement, a positive connection between units and geogrid reinforcement, and contribute to the shear strength between the units. Both Versa-Tuff and Versa-Tuff Snap-off pins are made of same material and have 6.75 inches (172 mm) tall and 0.5 inches (12 mm) in diameter . The Versa-Tuff Snap-off pins used with Mosaic system can have the top 2 inches (1 mm) snapped off when pinning the shorter Accent units.

3.3 Unit Core and Drainage Fill:

Unit core and drainage fill must be ¾- to 1-inch (19 to 25 mm), clean, crushed stones, placed inside the unit cores of Versa-Lok Square Foot units, and between and behind all Versa-Lok units. The unit core and drainage fill provides additional weight to the completed wall section for stability, local drainage at the wall face, and a filter zone to keep the backfill soils from filtering out through the space between units.

3.4 Geogrid:

The Versa-Grid geogrids listed in Tables 2 and 3 are proprietary materials manufactured by Strata Systems Inc., and used to increase the height of Versa-Lok walls above the height at which the walls are stable under the self-weight of the units as a gravity system. Geogrids are synthetic materials specifically designed for use as soil reinforcement.

3.5 Base Leveling Pad Material:

Base leveling pad material must consist of maximum ¾-inch-diameter (19 mm) crushed stone compacted to at least 95 percent of maximum dry density as determined per ASTM D698 (90 percent per ASTM D1557).

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 Versa-Lok Segmental Retaining Walls (SRWs) must be based on structural and 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 the reinforced 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, as applicable.

External stability analysis must be similar to that required for conventional retaining walls, and must consider base (lateral) sliding. Internal stability analysis of SRWs without reinforced soil must consider movement between courses. Internal stability analysis of the SRWs with geogrid-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 checks) 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 in accordance with IBC Section 1807.2.3 for SRWs without a reinforced soil mass.

Minimum safety factors used in design (for internal stability checks) 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. The registered design professional must prepare wall design such that the minimum safety factors prescribed in this section for all other failure modes are maintained. 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 IBC Section 1803 is required, which must provide information on the project site soils and back fill material. 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 investigation report must also specify safety factors for tensile and pullout of the geogrid. Where the wall is assigned to Seismic Design Category (SDC) C, D, E or F, the site-specific soils report must include the

information as required by IBC Section 1803.5.11. Where the wall is assigned to Seismic Design Category (SDC) D, E or F, the site-specific soils report must include the information as required by IBC Section 1803.5.12 that specifies additional requirements in addition to those in Section 1803.5.11. A site-specific soils investigation report must provide soil classifications for the foundation, retained and minimum acceptable reinforced soil fill for the wall design engineer to use in determining geogrid interaction and strength values.

4.1.2 Gravity Retaining Walls: The gravity wall system relies on the weight and geometry of the Versa-Lok units to resist lateral earth pressures and other lateral loads. 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 2. Figure 2 shows a typical cross section of a Versa-Lok gravity retaining wall.

4.1.3 Geogrid-Reinforced-Soil Retaining Walls

4.1.3.1 General: The geogrid-reinforced-soil retaining walls rely on the weight and geometry of the Versa-Lok units and the geogrid-reinforced soil mass to act as a coherent gravity mass to resist lateral earth pressures. The design of a reinforced soil structure must be specific to the Versa-Lok unit selected, soil reinforcement strength and soil interaction, soil strength properties, interaction between geogrid and modular concrete units, and structure geometry. Inter-unit shear capacity equations are provided in Table 2. Geogrid-to-block pullout resistance equations are provided in Table 3. Figure 1 shows a typical cross section of a Versa-Lok geogrid-reinforced-soil retaining wall.

4.1.3.2 Structural Analysis: Structural Analysis: Structural analysis must be based on accepted engineering principles, and the IBC. The analysis must 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. Geotechnical analysis including global stability analysis must be provided as described in Section 4.1.1 in the site-specific soil investigation.
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 Versa-Lok units during construction. Vertical spacing is typically limited to 2 times the depth of the unit.
2. Tension calculations for each respective layer of geogrid 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.
3. Connection capacity must be checked for each Versa-Lok-System interface (see Table 3) and compared to the tensile forces in the geogrids.
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 applying the applicable geogrid interaction and sliding coefficient adjustment factors.
5. After completion of the internal stability analysis and geogrid layout, sliding along each respective geogrid layer must be checked, including shearing through the wall face (see Table 2).

4.2 Installation:

The wall system units are assembled in a running bond or varying (random) bond pattern, except for the Mosaic system, which is installed as a repeating panel pattern. The wall system units are assembled without mortar or grout, stacked, interlocked, and aligned at the design setback using two Versa-Tuff high-strength, glass-reinforced nylon pins per unit. The system may include horizontal layers of structural geogrid reinforcement in the backfill soil mass. Requirements for installation of the Versa-Lok Wall System are as follows:

1. Excavate as needed for leveling pad and reinforced fill zone extents.
2. Inspect excavations for adequate bearing capacity of foundation soils and observation of groundwater conditions by a qualified geotechnical engineer.
3. Install a 6-inch-thick (152 mm) leveling pad of crushed stone, compacted to at least 90 percent of the maximum dry density as determined by ASTM D1557 (95 percent per ASTM D698). (An unreinforced plain concrete footing or pad in accordance with IBC Section 1809.8 may be utilized in place of the crushed stone pad.)
4. Install the first base of Versa-Lok units, ensuring units are level from side to side and front to back. Check the alignment and leveling in all directions and make sure that all the blocks are fully in contact with the leveling pad and are properly supported.
5. Units with cores (cavities) within the unit must be filled with unit core drainage fill described in Section 3.3 of this report. Also, this same drainage aggregate must be placed between and behind all units, and must extend back a minimum of 1 foot (305 mm) behind the all wall units. See Figures 1 and 2 of this report. Place drainage pipe within drainage aggregate, if applicable.
6. Clean the top surface of the units to remove loose aggregate and place the second course of units on the base course of units, at the design setback.
7. Install two Versa-Tuff pins per unit into the appropriate upper unit holes (to achieve design setback) to the receiving slots in the units below.
8. At designated elevation per the design, install geogrid reinforcing to within 1 inch (25.4 mm) of the outer face of the wall. Check to ensure the proper orientation of the geogrid reinforcement is used so the strong direction is perpendicular to the face. Adjacent rolls are placed side by side; no overlap is required. Pull the entire length of geogrids taut to remove slack and any folds or wrinkles from the geogrids before placing backfill.
9. Place and compact backfill behind wall units and drainage aggregate, and over the geogrid reinforcing layers (where present), in appropriate lift thickness to ensure compaction. 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 (95 percent per ASTM D698). 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. The reinforced backfill must be placed and compacted no lower than the top unit-elevation to which the geogrid placement is required.
10. Place capping units (if applicable) to complete the wall. The cap units must be fixed to the units using a concrete adhesive in accordance with manufacturer's installation instructions.

4.3 Special inspection:

Special inspection must be provided in accordance with Section 1705.4 of the 2021, 2018, 2015 and 2012 IBC, or Section 1704.5 of the 2009 IBC, as applicable. The inspector's responsibilities include verifying the following:

1. The modular concrete unit configuration and dimensions.
2. Versa-Lok unit identification including evaluation report number (ESR-1784).
3. Foundation preparation.
4. Versa-Lok unit placement, including alignment and inclination.
5. Pin installations, including locations, proper fit between blocks, and installation sequence with respect to the geogrid placement.
6. Geogrid reinforcement type (manufacturer and model number) and placement.
7. Backfill placement and compaction.
8. Drainage provisions.

5.0 CONDITIONS OF USE:

The Versa-Lok Retaining Wall Systems described in this report comply with, or are 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 systems are 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 IBC Section 1803, as noted in Section 4.1.1 of this report, must be provided for each project site.

5.4 In areas where repeated freezing and thawing under saturated conditions occur, evidence of compliance with freeze-thaw durability requirements of ASTM C1372 must be furnished to the code official for approval prior to construction.

5.5 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.

5.6 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 systems must comply with the recommendations of the soils engineer and the appropriate sections of the NCMA Design Manual for Segmental Retaining Walls, and must be approved by the code official.

5.7 Under the 2021 IBC, project specifications or soil and water conditions that have sulfate concentrations identified in ACI 318-19 Table 19.3.1.1 as severe (S2) or very severe (S3), shall include mix designs for the concrete masonry and grout that comply with the content of ACI 318-19 Table 19.3.1.1

5.8 Under the 2018 and 2015 IBC, project specifications or soil and water conditions that have sulfate concentrations identified in ACI 318-14 Table 19.3.1.1 as severe (S2) or very severe (S3), shall include mix designs for the concrete masonry and grout that comply with the content of ACI 318-14 Table 19.3.1.1.

5.9 Under the 2012 IBC, project specifications or soil and water conditions that have sulfate concentrations identified in ACI 318-11 Table 4.2.1 as severe (S2) or very severe (S3), shall include mix designs for the concrete masonry and grout that comply with the content of ACI 318-11 Table 4.3.1.

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

5.11 This report evaluates 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 April 2021.

7.0 IDENTIFICATION

7.1 Each pallet of concrete units is identified with the report holder's name (Versa-Lok) and manufacturing address (One McNear Brickyard Road, San Rafael, CA 94901), the name of the product, the unit type (Standard, Cobble, Accent, Square Foot), and the evaluation report number (ESR-1784). Boxes of Versa-Tuff pins are identified by labels bearing the Versa-Lok Retaining Wall Systems name and address, and the evaluation report number (ESR-1784).

7.2 The report holder's contact information is the following:

VERSA-LOK RETAINING WALLS
2025 Centre Pointe Boulevard
Mendota Heights, MN 55120-1221
(651) 770-3166
www.versa-lok.com

TABLE 1—VERSA-LOK WALL UNITS – NOMINAL WEIGHTS

Wall Systems	Units Within Each Wall System	Nominal Weight (lbs)
Standard	Standard Unit	**82**
Mosaic	Standard Unit	**82**
	Cobble Unit	**38**
	Accent Unit	**38**
Square Foot	Square Foot Unit	**87**

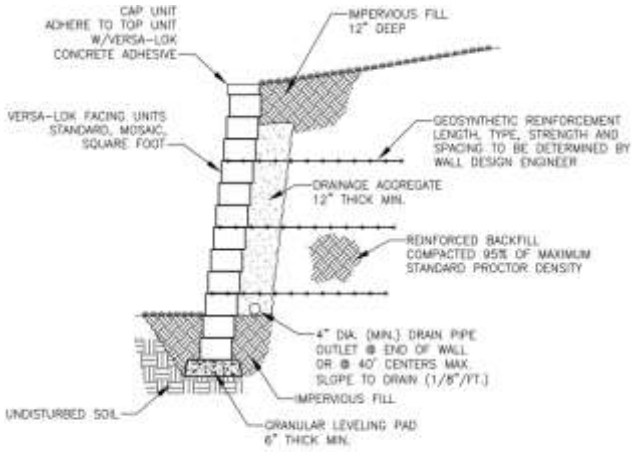

FIGURE 1—TYPICAL SECTION—REINFORCED

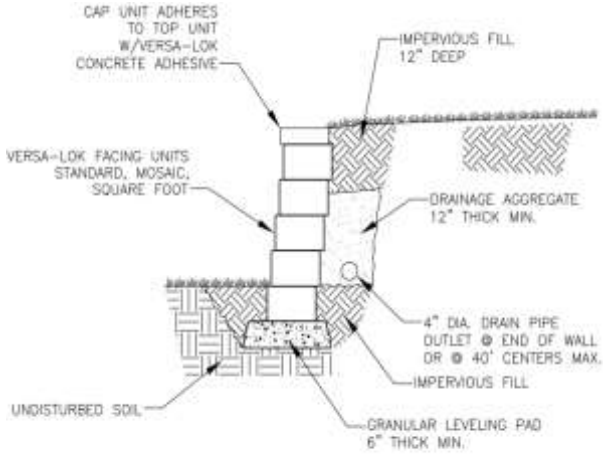

FIGURE 2—TYPICAL SECTION—UNREINFORCED

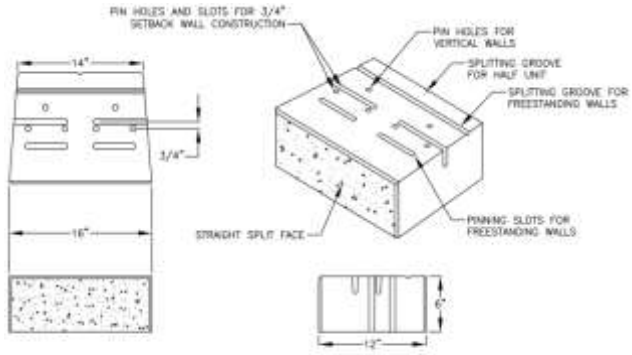

FIGURE 3—VERSA-LOK UNIT

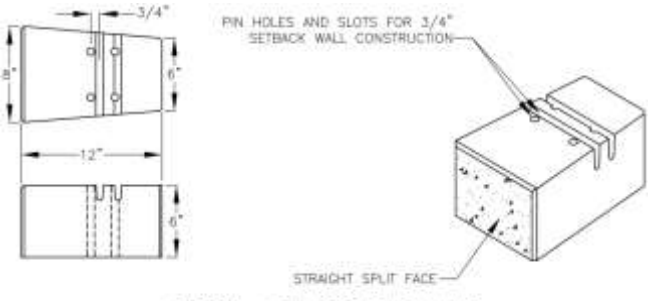

FIGURE 4—VERSA-LOK COBBLE UNIT

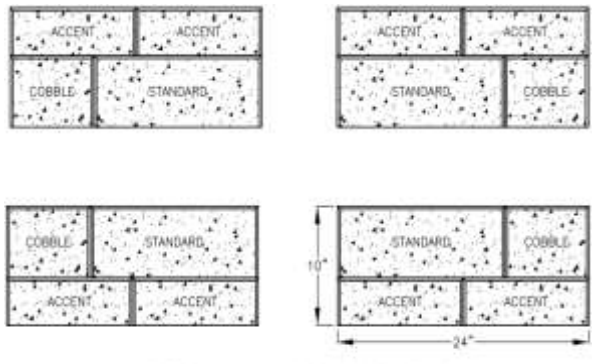

FIGURE 5—VERSA-LOK MOSAIC PANELS

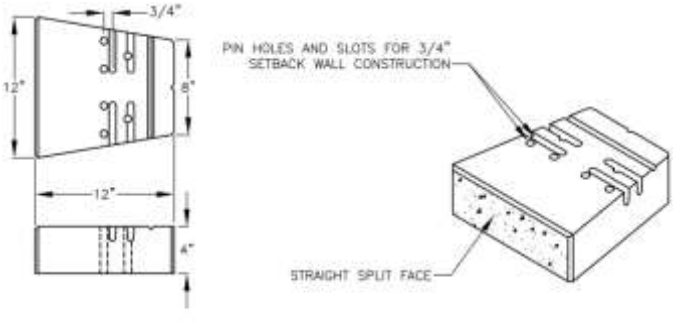

FIGURE 6—VERSA-LOK ACCENT UNIT

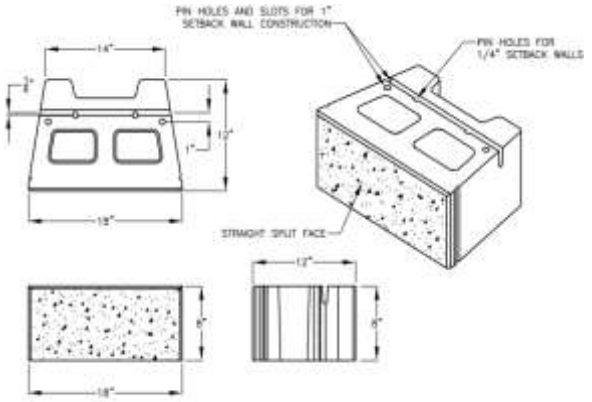

FIGURE 7—VERSA-LOK SQUARE FOOT UNIT

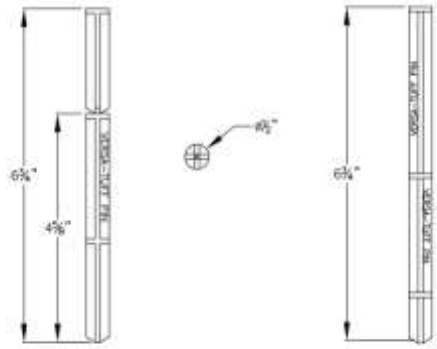

FIGURE 8—VERSA-TUFF SNAP-OFF PIN AND VERSA-TUFF PIN

TABLE 2—INTER–UNIT SHEAR RESISTANCE EQUATIONS

Wall Systems		Peak Shear Strength (lbs/ft)		Serviceablity Shear Strength[2] (lbs/ft)	
		Equation	Maximum	Equation	Maximum
WITHOUT GEOGRID					
Standard		F = 364 + 0.94 N	5532	F = 180 + 0.65 N	3753
Mosaic		F = 477 + 0.64 N	4009	F = 92 + 0.58 N	3293
Square Foot		F = 869 + 0.82 N	5379	F = 170 + 0.84 N	4790
WITH GEOGRID					
Standard	Versa-Grid sVG 3.0	F = 401 + 0.75 N	2274	F = 230 + 0.68 N	1928
	Versa-Grid sVG 5.0	F = 832 + 0.55 N	2758	F = 271 + 0.49 N	1987
	Versa-Grid sVG 8.0	F = 774 + 0.65 N	4337	F = 407 + 0.57 N	3532
Mosaic	Versa-Grid sVG 3.0	F = 547 + 0.64 N	2153	F = 19 + 066 N	1675
	Versa-Grid sVG 5.0	F = 633+ 0.54 N	2523	F = 17 + 0.65 N	2292
	Versa-Grid sVG 8.0	F = 513 + 0.66 N	4143	F = 214 + 0.63 N	3679
Square Foot	Versa-Grid sVG 3.0	F = 532 + 0.68 N	2223	F = 9 + 0.7 N	1824
	Versa-Grid sVG 5.0	F = 790 + 0.58 N	2812	F = 7 + 0.7 N	2447
	Versa-Grid sVG 8.0	F = 1031 + 0.53 N	3942	F = 837 + 0.46 N	3363

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

[1]The inter-unit shear resistance F [lb/linear foot (N/m)] of the Versa-Lok System at any depth is a function of superimposed normal (applied) load, N [lb/linear foot N/m)].
[2]The serviceability shear strength is based on prescribed deformation criterion, which is either ¾ inch (19 mm) or a value equal to 2 percent of the unit height, whichever is less.

TABLE 3—GEOGRID-TO-BLOCK PULLOUT RESISTANCE EQUATIONS[1]

Wall Systems		Peak Connection Strength (lbs/ft)		Serviceablity Connection Strength (lbs/ft)[2]	
		Equation	Maximum	Equation	Maximum
Standard	Versa-Grid sVG 3.0	F = 519 + 0.23 N	1086	F = 515 + 0.07 N	687
	Versa-Grid sVG 5.0	F = 698 + 0.3 N	1748	F = 126 + 0.39 N	1491
	Versa-Grid sVG 8.0	F = 882 + 0.35 N	2808	F = 280 + 0.21 N	1435
Mosaic	Versa-Grid sVG 3.0	F = 786 + 0.45 N	1906	F = 708 + 0.25 N	1330
	Versa-Grid sVG 5.0	F = 1279 + 0.28 N	2257	F = 778 + 0.3 N	1826
	Versa-Grid sVG 8.0	F = 1999 + 0.27 N	3478	F = 1034 + 0.15 N	1855
Square Foot	Versa-Grid sVG 3.0	F = 1003 + 0.23 N	1577	F = 601 + 0.25 N	1225
	Versa-Grid sVG 5.0	F = 1625 + 0.36 N	2885	F = 1127 + 0.15N	1652
	Versa-Grid sVG 8.0	F = 1713 + 0.36 N	3700	F = 1159 + 0.04 N	1380

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

DIVISION: 32 00 00—EXTERIOR IMPROVEMENTS
Section: 32 32 00—Retaining Walls
Section: 32 32 23—Segmental Retaining Walls

REPORT HOLDER:

VERSA-LOK RETAINING WALLS

EVALUATION SUBJECT:

VERSA-LOK RETAINING WALL SYSTEMS

1.0 REPORT PURPOSE AND SCOPE

Purpose:

The purpose of this evaluation report supplement is to indicate that the Versa-Lok Retaining Wall Systems, described in ICC-ES evaluation report ESR-1784, have also been evaluated for compliance with the code noted below.

Applicable code edition:

2022 *California Building Code* (CBC)

For evaluation of applicable Chapters adopted by the California Office of Statewide Health Planning and Development (OSHPD) AKA: California Department of Health Care Access and Information (HCAI) and the Division of State Architect (DSA), see Sections 2.1.1 and 2.1.2 below.

2.0 CONCLUSIONS

2.1 CBC:

The Versa-Lok Retaining Wall Systems, described in Sections 2.0 through 7.0 of the evaluation report ESR-1784, comply with CBC Chapter 18, provided the design and installation are in accordance with the 2021 *International Building Code*® (IBC) provisions noted in the evaluation report and the additional requirements of CBC Chapter 16, 17 and 18, as applicable.

2.1.1 OSHPD:

The applicable OSHPD Sections and Chapters of the CBC are beyond the scope of this supplement.

2.1.2 DSA:

The applicable DSA Sections and Chapters of the CBC are beyond the scope of this supplement.

This supplement expires concurrently with the evaluation report, reissued February 2024, and revised May 2024.