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ALLAN BLOCK RETAINING WALL SYSTEMS

CSI Sections:
32 00 00 Exterior Improvements
32 32 00 Retaining Walls
32 32 23 Segmental Retaining Walls

1.0 RECOGNITION

Allan Block Retaining Wall Systems recognized in this report have been evaluated for use in conventional Segmental Retaining Wall (SRW) and Coherent Gravity retaining walls (geogrid reinforced retaining walls). The structural performance and durability properties of the Allan Block Retaining Wall Systems comply with the intent of the provisions of the following codes and regulations:

- 2024, 2021, 2018, 2015, and 2012 International Building Code® (IBC)
- 2022 California Building Code (CBC) – attached Supplement

2.0 LIMITATIONS

Use of the Allan Block Retaining Wall Systems recognized in this report are subject to the following limitations:

2.1 The wall systems are manufactured, identified, and installed in accordance with this report, approved constriction documents (calculations), and the manufacturer's published installation instructions, and this report. Where there is a conflict, the more restrictive requirements shall govern.

2.2 Engineering calculations and drawings, in accordance with recognized engineering principles shall be prepared by a registered design professional, when required by the statutes of the jurisdiction in which the project is to be constructed and provided for approval to the building official. Design of Allan Block Retaining Wall Systems shall consider lateral earth pressures from soil loads, external and internal stability, and shall consider surcharge and seismic forces, when applicable.

2.3 The physical properties and soil interaction of the geogrid material, other than the connection strength to the blocks, have not been evaluated and are outside the scope of this report.

2.4 Projects which the licensed design professional has assigned exposure categories and classes for deleterious amounts of water soluble sulfate ions, detailed in Table 19.3.1.1 of ACI 318-19 (2024 and 2021 IBC), ACI 318-14 (2018 and 2015 IBC), and Table 4.2.1 (2012 IBC), as applicable, classified as severe or very severe, (S2 or S3, respectively), shall include concrete and masonry designs that meet the requirements of ACI 318 Table 19.3.2.1 (2021, 2018, and 2015 IBC) and ACI 318 Table 4.3.1 (2012 IBC), as applicable.

2.5 A geotechnical report shall be provided in accordance with IBC Section 1803. The report shall additionally include the following performance characteristics of the geogrid material and soil reinforcement: ultimate tensile strength, long-term design strength, allowable tensile strength, interaction coefficients for pullout and direct sliding, and the safety factors for tensile rupture and pullout. Structures assigned to Seismic Design Category C through F; the report shall meet the requirements of Section 1803.5.11. Structures assigned to Seismic Design Category D through F, the report shall meet the requirements of Section 1803.5.12.

2.6 Test data showing the freeze-thaw requirements in ASTM C1372 Section 5.2 shall be submitted to the building official for approval prior to construction where conditions of freeze and thaw are of concern with saturated soils.

2.7 Special Inspections are required as detailed in Section 3.6.1 of this report, when backfill is placed and compacted, units are installed, and geogrid is placed, as applicable.

2.8 Details included in this report do not include construction where the wall is installed in free-flowing ground water or submerged in water. Designs that require these situations shall be submitted to the building official for approval and may use the NCMA Design Manual for Segmental Retaining Walls.

2.9. When required by the 2024 IBC, guards shall be provided in accordance with 2024 IBC Section 1807.2.5.

2.10 The Allan Block Retain Wall Systems recognized in this report are produced in Gilroy, California, and Riverside, California.

3.0 PRODUCT USE

3.1 General: Allan Block Retaining Wall Systems and dry-cast segmental retaining wall (SRW) units in this report are used for the construction of conventional gravity and geosynthetic reinforced retaining walls. The modular dry-cast SRW units are dry stacked to form walls used to retain soil.

3.2 Design: Calculations shall meet the requirements of Section 2.2 of this report. The design of retaining wall systems that utilize the dry-cast SRW units are based on the geometry and weight (Table 1 of this report) and are used to resist lateral earth pressures and other forces required to be resisted by retaining walls. The minimum lateral earth pressures shall be as set forth in IBC Section 1807.2.2. Structural analysis of the wall shall be completed using accepted geotechnical principles of gravity and soil-reinforced structures, Allan Block Engineering Manual for the "Allan Block Retaining Wall Systems" (2018 Version), and the National Concrete Masonry Association "Design Manual for Segmental Retaining Walls, 3rd Edition 5th Printing". The design professional shall include the design, suitable fine grain or coarse grain materials used in the reinforced soil mass, and the design of the drainage.

The design of all retaining walls shall include an external stability analysis and include overturning, base sliding, bearing capacity, excessive settlement, and overall slope stability.

Foundation requirements for walls shall be determined and detailed by the design engineer. The wall foundation may consist of 6-inches (152 mm) of granular fill which has been compacted to a minimum of 95 percent of the maximum dry density. The maximum dry density shall be determined in accordance with ASTM D698. The wall foundation may also be constructed using unreinforced concrete and designed in accordance with Section 1808 of the IBC.

The backfill of the retaining walls, including the material, shall be detailed by the engineer and shall include lift thickness, degree of compaction, and width behind the block. Hydrostatic pressures shall be considered in the design and detailed. Hydrostatic pressures as a result of poor drainage shall be designed to have drainage layers and/or drains.

The design of the masonry retaining wall system shall comply with Chapter 21 of the IBC and Section 1807.2.

3.2.1 Safety Factors: Safety factors used for conventional gravity retaining walls and coherent gravity retaining walls are detailed in Section 3.3 and 3.4 of this report, respectively. Seismic safety factors are permitted to be 70 percent of all minimum allowable static safety factors.

3.3 Conventional Gravity Segmental Retaining Wall (SRW): Movement between courses of the dry cast SRW units shall be considered in the internal stability analysis.

The following minimum safety factors shall be applied; 1.5 for global stability, 2.0 for bearing capacity, 1.5 for lateral sliding and overturning as detailed in IBC Section 1807.2.3, and 1.5 for peak shear strength (internal stability) between units. Load combinations for these analyses shall comply with IBC Section 1807.2.3.

Allan Block Retaining units used in conventional gravity retaining walls (SRW) have maximum heights as detailed in Table 2 of this report.

3.4 Coherent Gravity Retaining Walls (Geogrid-reinforced Retaining Walls):

The design of geogrid reinforced retaining walls using Allan Block Retaining wall units requires that all contact surfaces are maintained in compression. The overall design is dependent upon the specific system including the unit selected, wall geometry, the soil reinforcement strength, soil interaction, soil strength properties, and the geogrid selected.

The following minimum safety factors shall be applied; 1.5 for global stability, 2.0 for bearing capacity, 1.5 for lateral sliding and 2.0 for overturning, 1.5 for peak connection strength between unit and geo-grid material, and 1.5 for peak shear strength between units. Load combinations for these analyses shall comply with IBC Section 1807.2.3.

Sliding, including sheering through the connection at the wall face, at each geogrid layer shall be accounted for in the design after the internal stability analysis is completed as detailed in Section 3.4.2.

3.4.1 External Stability Analysis: The external stability analysis shall consider sliding at the base and the wall mass length (geogrid lengths). The minimum wall mass length shall be designed to resist the greatest value of the factored sliding or 60 percent of the wall height. Calculating the weight of the reinforced soil when determining if the wall will resist overturning, shall consider the coherent wall mass as a rigid object that rotates about the bottom front edge (toe) of the wall.

Walls that have slopes below the toe of the wall, on soft foundations, terraced (tiered), or submerged conditions shall include a global stability analysis.

3.4.2 Internal Stability Analysis: During the construction phase, the spacing of each geogrid layer shall be based on the local stability of the Allan Block unit. Spacing is to be no more than 2-course or 16-inches, whichever is less.

Tensions values for each layer of geogrid shall be included in the design and shall not be greater than the allowable geogrid strength. The tension value shall consider the pressure and surcharge load, and the height of the section shall be considered the distance from the top of the backfill to the bottom of the zone supported by the layer of grid minus the distance from the top of the backfill to the top of the zone supported by the layer of geogrid.

Geogrid layers beyond the theoretical failure plane (Coulomb or Rankine theories): The calculated tension values shall be determined with the geogrid interaction and sliding coefficient adjustment factors, and shall be less than or equal to the pullout capacity

3.5 Design Values: Table 4 of this report details the interface shear strength (peak connection strength) between each block type. The values in this table can be used with or without geogrid material. Calculated connection capacities shall be greater than the calculated geogrid to block pullout resistance (peak connection strength) values/equations for each geogrid type as detailed in Table 5 of this report.

3.6 Installation: Allan Block Retaining walls are built by dry-stacking units and aligning the vertical lip and notch. Each vertical lip aligns the top units with a setback of approximately $^{3}/_{8}$ to $1^{1}/_{2}$- inches (9mm to 38 mm) from the unit on which it is set. A 3 inch (76 mm) minimum offset is maintained between joints of the adjacent course. Alignment tolerances of wall construction are ¾-inch (19.1 mm) in 10 feet (3 M) for horizontal and vertical directions. Walls may be constructed with a curved layout with a minimum curve radius of 4-feet (1.23 M), for both interior and exterior curves. Typical wall inclination is between 3 to 12 degrees approximately and is dictated by each block's vertical lip-to-notch stacking.

3.6.1 Special Inspections: Special Inspections shall be required in accordance with Sections 1705.1.1, 1705.4, and 1705.6 of the IBC. The inspector shall verify; product identification, unit type and dimensions, identification of the unit in accordance with Section 5 of this report, foundation preparation, unit placement as detailed in this report, the placement and compaction of backfill in accordance with the design, and drainage specifications and water management in accordance with the design and the geogrid placement, manufacturer, and type.

4.0 PRODUCT DESCRIPTION

4.1 General: Allan Block Walls System dry cast SRW Units are modular concrete units manufactured in eight different configurations in the AB collection. AB Stone, AB Classic, AB Vertical, AB Rocks, AB Fieldstone 812 with Short and Long Anchoring Unit, and AB Fieldstone 824 with Short and Long Anchoring Unit have been evaluated in this report. The dry cast SRW units are manufactured to meet IBC Section 1807.2.4 and ASTM C1372 and the net area of the blocks have a minimum compressive strength of 3,000 psi (21 MPa). Descriptions of the units, including dimensions and weight, are detailed in Table 1 of this report.

4.2 Accessories: Allan Block Walls System dry cast SRW Units may be finished with optional capstones. Capstone details are found in Figure 1 of this report.

4.3 Geogrid: The Geogrid is a flexible, synthetic mesh which is used with the combination of retaining wall units to create slope stabilization and earth retention. The products evaluated for use with Allan Block Wall Systems in this report can be found in Table 3 of this report.

5.0 IDENTIFICATION

Allan Block units are stored and shipped on pallets, which are identified by the Allan Block name and trademark, product name, and evaluation report number (ER-958).

The IAPMO Uniform Evaluation Service Mark of Conformity may also be used as shown below:

IAPMO UES ER-958

6.0 SUBSTANTIATING DATA

6.1 Test reports are from laboratories in compliance with ISO/IEC 17025.

6.2 Data in accordance with ICC-ES Acceptance Criteria for Segmental Retaining Walls (AC276), approved April 2021, editorially revised June 2024.

7.0 STATEMENT OF RECOGNITION

This evaluation report describes the results of research completed by IAPMO Uniform Evaluation Service on Allan Block Retaining Wall Systems to assess conformance to the codes shown in Section 1.0 of this report and serves as documentation of the product certification. Products are manufactured at locations noted in Section 2.10 of this report under a quality control program with periodic inspection under the supervision of IAPMO UES.

For additional information about this evaluation report please visit www.uniform-es.org or email us at info@uniform-es.org

AB Capstone

AB Fieldstone Capstone

FIGURE 1 - CAPSTONE

TABLE 1- Allan Block Unit Types and Specifications

Block Type	Figure	Dimensions (Height x Depth x Width) and Unit Weight (inch and lbs)	Lip Depth (inch)	Notch Depth (inch)
AB Stones		8 x 12 x 18 70 +/- 5 lbs	2.0	0.42
AB Classic		8 x 12 x 18 70 +/- 5 lbs	2.0	1.1
AB Three		8 x 12 x 18 70 +/- 5 lbs	1.5	1.1
AB Rocks		8 x 12 x 18 70 +/- 5 lbs	2.58	2

Block Type	Figure	Dimensions (Height x Depth x Width) and Unit Weight (inch and lbs)	Lip Depth (inch)	Notch Depth (inch)
AB Fieldstone 812 with Short Anchorage Unit		8 x 12.75 x 12 60 +/- 5 lbs	1.568	0.883
AB Fieldstone 812 with Long Anchorage Unit		8 x 23.676 x 12 90 +/- 5 lbs	1.568	0.883
AB Fieldstone 824 with Short Anchorage Unit		8 x 12.75x24 125 +/- 5 lbs	1.568	0.883
AB Fieldstone 824 with Long Anchorage Unit		8 x 23.676 x 24 185 +/- 5 lbs	1.568	0.883

For SI Units: 1 lb =4.45 N

TABLE 2-Conventional Retaining Walls for Unreinforced Allan Block Unit Maximum Wall Heights (feet)[1,2]

Soil Classification	Angle of Friction (degrees)	Conditions Above Retaining Wall						
		Level Slope	5:1 Slope	4:1 Slop	3:1 Slope	2:1 Slope	100 psf Surcharge	250 psf Surcharge
12 Degree								
Firm Clay	26	3.0	2.5	2.4	2.2	1.3	1.4	1.3
Silty Clay	28	3.7	3.2	3.0	2.8	1.9	1.8	1.4
Mixed Silts	30	4.6	4.0	3.8	3.5	2.7	2.7	1.4
Silty Sand	32	5.5	5.0	4.8	4.4	3.6	3.7	1.4
Clean Sand	34	6.0	5.6	5.4	5.2	4.7	4.3	1.9
6 Degree								
Firm Clay	26	2.7	2.3	2.1	1.9	1.1	0.8	n/a
Silty Clay	28	3.3	2.8	2.7	2.4	1.7	1.4	n/a
Mixed Silts	30	4.0	3.5	3.3	3.0	2.3	2.1	0.8
Silty Sand	32	4.3	4.0	3.9	3.8	3.0	2.9	0.8
Clean Sand	34	4.6	4.3	4.2	4.1	3.7	3.2	1.1
3 Degree								
Firm Clay	26	2.5	2.1	2.0	1.8	1.1	0.6	n/a
Silty Clay	28	3.0	2.6	2.4	2.2	1.5	1.11	n/a
Mixed Silts	30	3.5	3.1	3.0	2.7	2.1	1.7	n/a
Silty Sand	32	3.7	3.5	3.4	3.3	2.7	2.4	0.9
Clean Sand	34	3.9	3.7	3.6	3.5	3.2	2.6	0.9
AB Fieldstone SAU – 6 Degree								
Firm Clay	26	2.9	2.5	2.4	2.1	1.3	1.1	n/a
Silty Clay	28	3.6	3.1	2.9	2.7	1.9	1.7	n/a
Mixed Silts	30	4.4	3.8	3.6	3.3	2.6	2.5	0.6
Silty Sand	32	4.7	4.4	4.3	4.1	3.3	3.3	0.8
Clean Sand	34	5.0	4.7	4.6	4.4	4.0	3.6	1.5
AB Fieldstone LAU – 6 Degree								
Firm Clay	26	5.1	4.3	4.1	3.9	2.2	3.3	1.0
Silty Clay	28	6.3	5.4	5.1	4.7	3.3	4.4	1.5
Mixed Silts	30	7.7	6.7	6.4	5.8	4.4	5.8	2.9
Silty Sand	32	8.2	7.7	7.5	7.2	5.8	6.7	4.5
Clean Sand	34	8.8	8.2	8.0	7.7	7.0	7.2	5.4

For SI Units; , 1 foot = 305 mm

[1] The angle in degrees is the wall angle and measured from vertical towards the backfill.
[2] Seismic forces have not been accounted for in these values.

TABLE 3-Geogrid Material Type and Grades

Light Grade	Medium Grade	Heavy Grade
Miragrid 3XT	Miragrid 5XT	Miragrid 8XT
-	Miragrid 7XT	Miragrid 10XT
Strata 200	Strata 350	-

TABLE 4- Shear Interaction Between Allan Block Units Without Geosynthetic Reinforcement (Geogrid)

Block Type	Ultimate Connection Strength Equations, P lb/ft		Service Connection Strength Equations, P lb/ft[2]	
	Segment 1[1]	Maximum	Segment 1 [1]	Maximum
AB Collection- Nominal 2 inch Leading Lip				
AB Stones AB Classics AB Rocks	Vu=2614 lb/ft +Ntan(42°)	5620	Vu=379.5 lb/ft +Ntan(6.8°)	2215
AB Collection- Nominal 1.5 inch Leading Lip -				
AB Three (AB Vertical)	Vu=1381.6 lb/ft +Ntan(32.2°)	3497	Vu=350.5 lb/ft +Ntan(29.2°)	2314
AB Fieldstone Collection				
812 with SAU & LAU 824 with SAU & LAU	Vu=1697.3 lb/ft +Ntan(54.1°)	5830	Vu=569.3 lb/ft +Ntan(32.6°)	3590

For SI Units: 1lb/ft = 14.6 N/M

[1] N is the superimposed normal (applied) load. The geogrid is measured along the wall length to determine the weight per foot.

[2] The service state connection strength is determined using a maximum displacement of geogrid of ¾-inch (19.1 m).

TABLE 5-Connection Capacities for Coherent Gravity Retaining Walls (Geogrid-reinforced Retaining Walls)

Geogrid Type and Grade	Ultimate Connection Strength Equation, P, lb/ft		Service Connection [2] Strength Equations, P, lb/ft	
	Segment 1[1]	Maximum	Segment 1[1]	Maximum
AB Fieldstone				
Strata 200	Tu=1327.5 lb/ft + Ntan(10.6°)	1813	T_{s1}=850.64 lb/ft + Ntan(5.4°)	1140
Strata 350	Tu=1722.9 lb/ft + Ntan(10.2°)	2413	T_{S1}=983.45 lb/ft + Ntan(3.4°)	1225
AB Three (AB Vertical)				
Miragrid 5XT	Tu=1157.3 lb/ft + Ntan(14.3°)	1781.6	T_{S1}=936 lb/ft + Ntan(5.94°)	1199.1
Miragrid 7XT	Tu=1049.8 lb/ft + Ntan(28.2°)	2569.6	T_{S1}=864.7 lb/ft + Ntan(18.4°)	1918.6
Miragrid 8XT	Tu=1013.4 lb/ft + Ntan(35.2°)	3494.6	T_{S1}=838 lb/ft + Ntan(24.85°)	2398.3
Miragrid 10XT	Tu=935.3 lb/ft + Ntan(20.8°)	2850.5	T_{S1}=921.6 lb/ft + Ntan(16°)	2137.9
AB Classics and AB Rocks				
Strata 200	Tu=1382.6 lb/ft + Ntan(17.8°)	2087	T_{S1}=715.5 lb/ft + Ntan(1.6°)	802
Strata 350	Tu=1256.9 lb/ft + Ntan(12.2°)	1979	T_{S1}=785.4 lb/ft + Ntan(7.1°)	1178
AB Stones				
Miragrid 3XT	Tu=859.2 lb/ft + Ntan(23.4°)	1892	T_{S1}=592.3 lb/ft + Ntan(14.1°)	1148
Miragrid 5XT	Tu=1188.9 lb/ft + Ntan(18°)	1898.1	T_{S1}=751.7 lb/ft + Ntan(12.1°)	1236.8
Miragrid 7XT	Tu=1063.5 lb/ft + Ntan(25.6°)	2565.5	T_{S1}=644.8 lb/ft + Ntan(19.3°)	1815.8

For SI Units: 1lb/ft = 14.6 N/M

[1] N is the superimposed normal (applied) load. The geogrid is measured along the wall length to determine the weight per foot.

[2] The service state connection strength is determined using a maximum displacement of geogrid of ¾-inch (19.1 m).

CALIFORNIA SUPPLEMENT

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1.0 RECOGNITION

Allan Block Retaining Wall Systems as evaluated and represented in IAPMO UES Evaluation Report ER-958 and with changes as noted in this supplement are a satisfactory alternative for use in buildings built under the following codes (and regulations):

- 2022 California Building Code (CBC)

2.0 LIMITATIONS

Use of the Allan Block Retaining Wall Systems recognized in this report is subject to the following limitations:

2.1 The systems described in the report shall be designed and installed in accordance with the provisions applicable to the 2021 IBC in ER-958; Chapters 16, 16A, 17, 17A, 21, 21A, Section 1807.2, and Section 1807A.2 of the CBC, as applicable. Calculations using recognized engineering principles as described in the CBC shall be prepared by a California registered design professional and provided to the building official for approval.

2.2 This supplement expires concurrently with ER-958.