

---

# SEGMENTAL RETAINING WALL SYSTEMS OF PRECAST CONCRETE UNITS: 2019 CBC

---

**Disciplines:** Structural

**History:** Issued 08/12/22 Under 2019 CBC  
Last Revised 11/07/17 As IR 16-3 Under  
Prior CBC  
Original Issue 09/01/99

---

Division of the State Architect (DSA) documents referenced within this publication are available on the [DSA Forms](#) or [DSA Publications](#) webpages.

## PURPOSE

This Interpretation of Regulations (IR) clarifies the design, construction and quality assurance requirements for segmental retaining wall (SRW) systems used on DSA projects.

## SCOPE

This IR is applicable to gravity type retaining walls assembled of precast concrete units, referred to as SRW systems, which are an alternative to conventional retaining systems. Approval of SRW systems requires compliance with the conditions of this IR and acceptance by DSA. Only soil-reinforced SRW systems are acceptable on DSA projects. The reinforced soil mass may consist of cohesive or cohesionless soil, subject to the recommendations of a geotechnical report.

Retaining walls less than 4-feet above the top of the foundation and not supporting a surcharge may be designated as exempt from DSA review and approval in accordance with *IR A-22: Construction Projects and Items Exempt From DSA Review*. However, such walls shall meet the manufacturer's specifications and the applicable design and wall system requirements described below.

## BACKGROUND

SRW systems consist of facing units anchored to a reinforced soil mass that provides gravity load for resistance to overturning and lateral sliding. Geosynthetic grid materials (i.e., geogrid) are used to anchor the facing units and to reinforce the soil mass. For further information on SRW systems refer to the National Concrete Masonry Association (NCMA) Design Manual for Segmental Retaining Walls, 3rd Edition (DMSRW), Section 2.

### 1. GEOTECHNICAL REQUIREMENTS

A California licensed geotechnical engineer, in accordance with California Building Code (CBC) Section 1803A, shall prepare a soil investigation report for the project site. Recommendations for the preparation of reinforced soil mass and slope stability above and below the retaining wall (if necessary) shall be addressed in the report.

The design of SRW systems shall include lateral pressure due to earthquake motion, per CBC Section 1803A.5.12, Item #1 and Section 1807A.2.2. The additional seismic lateral earth pressure shall be reviewed and accepted by the California Geological Survey (CGS). Refer to CGS Note 48, Item #11A.

---

## SEGMENTAL RETAINING WALL SYSTEMS OF PRECAST CONCRETE UNITS: 2019 CBC

### 2. DESIGN REQUIREMENTS

Design of the SRW systems shall comply with the CBC, NCMA DMSRW, American Association of State Highway and Transportation Officials (AASHTO) LRFD Bridge Design Specifications (BDS), 8<sup>th</sup> Edition, and this section.

#### 2.1 General Limitations

**2.1.1** SRW system shall be qualified by an evaluation report complying with *IR A-5: Acceptance of Products, Materials, and Evaluation Reports*.

**Exception:** SRW systems without a complying evaluation report may be used up to a maximum height of 10'-0" above the top of the foundation when submitted and approved by DSA as an alternate method of construction per California Administrative Code (CAC) Section 4-304. Refer to *Procedure (PR) 18-01: Request for Alternate Design, Materials and Methods of Construction* and form *DSA 1-AMM: Request for Alternate Design, Materials and Methods of Construction*.

**2.1.2** SRW systems shall not be constructed in a location that will cause the wall to receive loads from any existing or new building foundation. Structures shall not be supported by SRW systems. The minimum setback shall be a 1 horizontal to 1 vertical projection from the tail of the lowest geogrid.

**2.1.3** SRW precast concrete units shall comply with American Society for Testing and Materials (ASTM) Standard C1372: Standard Specification for Dry-Cast Segmental Retaining Wall Units.

#### 2.2 Design Criteria

The design shall include the effect of all surcharge loads, potential settlement, and sloping soil conditions for both gravity and seismic analyses.

**2.2.1** Seismic analysis will be required for walls in accordance with CBC Section 1807A.2. The seismic design criteria shall be determined by the geotechnical engineer per Section 1 above in consideration of the properties of the SRW system.

**2.2.2** Where structures or fire access lanes adjacent to the SRW would be impacted by wall movement, the horizontal acceleration coefficient per NCMA DMSRW Section 9.4 shall be based on no lateral wall deflection (i.e.,  $d_{\text{seismic}} = 0$ ) during the design basis seismic event, unless a detailed analysis acceptable to DSA is performed which considers the soil movement and the impact to these elements.

**2.2.3** Design factors of safety for systems and design criteria shall be based on and comply with NCMA DMSRW Tables 5-1 and 5-2, including minimum width of reinforced zone, minimum wall embedment, minimum anchorage length of geogrid in wall blocks, and maximum wall batter.

**2.2.4** The vertical spacing of the geogrid shall not exceed 32-inches nor twice the depth of the block unit, whichever is less. An additional layer of geogrid shall be provided in the top 12-inches of all SRW; this top geogrid layer may be sloped down to avoid and pass below the aggregate base at driveways and parking lots.

---

## **SEGMENTAL RETAINING WALL SYSTEMS OF PRECAST CONCRETE UNITS: 2019 CBC**

### **2.3 Design Documentation**

The wall design shall be prepared by a California registered structural engineer. Complete design calculations of the SRW system shall be submitted to DSA for review with the project submission. SRW are not permitted as deferred submittals. Construction drawings shall provide complete plans, sections and details of the SRW system, including the following information:

**2.3.1** Locations and elevations of the top and bottom of all wall sections including the foundations, minimum wall embedment, and water table.

**2.3.2** Geogrid type, location and embedment lengths behind the interior face of the block units. A plan view shall show the interaction of geogrid layouts at wall corners, curves, or bends in accordance with Section 5.8 below.

**2.3.3** Soil gradation requirements, assumed soil design properties (such as density, soil friction angle, etc. for reinforced and retained fills) and placement/compaction specifications for all backfill materials and block unit fill material, including any special compaction or construction equipment considerations based upon proximity to wall face.

**2.3.4** Location and size of all holes or openings to be cut into the geogrid. Such penetrations may be required for fence posts, light poles, and other components. Any additional geogrid reinforcement and details required to accommodate penetrations shall be provided on the drawings.

### **2.4 Global Stability Analysis**

A global stability analysis, per NCMA DMSRW Section 12.4, shall be prepared, stamped and signed by a California registered geotechnical or civil engineer. The global stability analysis shall be submitted to DSA for review with the project submission. Where the analysis indicates soil displacement, any structure or fire access lane in front or behind the wall shall be able to withstand this displacement; otherwise soil strengthening shall be provided to limit the displacement to a tolerable level or relocate these elements beyond the critical slip plane.

## **3. WALL SYSTEM REQUIREMENTS**

All SRW block units shall have a mechanical interlocking mechanism between adjacent units, such as formed lips, pins or keys that will resist horizontal movement out of the plane of the wall. The geogrid shall be mechanically anchored to the block units through the use of aggregate interlock, pins, pipes, etc. Formed lips in block units will not provide adequate anchorage unless configured to mechanically engage the geogrid.

Adequacy of the mechanical interlock must be maintained if separation in block courses due to settlement of the lower course, uplift of the upper course or bulging of the surface between geogrid layers occurs. The design performance objective of SRW systems is to limit course separations to 1/4-inch maximum for the life of the wall.

### **3.1 Installation**

**3.1.1** Installation of SRW systems shall be in conformance with the manufacturer's instructions, product evaluation report (when applicable), NCMA DMSRW and AASHTO BDS.

**3.1.2** The backfill materials for reinforced soil mass, retained soil and foundation soil shall be placed and compacted, and the drain gravel shall be placed, as required by the DSA-approved construction documents and CBC Section 1803A.1.

**3.1.3** Regardless of the geogrid spacing, compaction of the reinforced backfill/retained soil shall not exceed eight inches in thickness per NCMA DMSRW Section 5.10.1.

---

## SEGMENTAL RETAINING WALL SYSTEMS OF PRECAST CONCRETE UNITS: 2019 CBC

### 3.2 Geogrid

**3.2.1** Acceptable geogrid suppliers and grid types shall be identified and their allowable long-term design strength and pullout of grid-to-block values provided.

**3.2.2** In retaining wall systems with corners, the geogrid layers shall be staggered at adjacent walls to avoid overlap of grids and permit planar installation at each level. Geogrid layers in different plan orientations need not be staggered vertically when explicitly permitted by the evaluation report provided the design complies with any capacity reductions, geometry limitations, or other requirements given in the report.

**3.2.3** Penetrations in the geogrid reinforcement are not permitted except as shown on the DSA-approved construction drawings per Section 2.3.4 above. Proposed penetrations not shown on the DSA-approved construction drawings shall be submitted to and approved by DSA in accordance with *IR A-6: Construction Change Document Submittal and Approval Process* prior to cutting geogrid.

**3.2.4** Geogrid shall comply with Section 2.2.4 above.

### 3.3 Drainage

Drainage pipes and granular drainage backfill shall be provided between the facing units and the reinforced soil mass. The granular drainage backfill shall be composed of clean free-draining gravel materials, extending full height and length of the wall at a minimum thickness of 1'-0" and shall meet the compaction requirements specified in the manufacturer's specifications. Surface drainage at the top and bottom of the wall shall be directed away from the wall.

## 4. TESTING AND INSPECTION

Testing and inspection shall be performed by the geotechnical engineer or his/her qualified representative per CBC Section 1705A.6.1, and as described in Appendix A below. The design professional shall add the applicable items listed in Appendix A below to the form *DSA 103: List of Required Structural Tests and Special Inspections* in the user-defined "other" category.

### 4.1 Material Certification

**4.1.1** The precast units used in SRW systems shall comply with CBC Chapter 19A and ASTM C1372. A letter of certification shall be provided with the units indicating the manufacturer's name and address, name of product and unit type. The certification shall include applicable laboratory compressive strength and absorption test results.

**4.1.2** Letter(s) of certification shall be provided for the supplied geogrid, indicating the supplier's name and address, name of product and the product designation meeting the requirements of the project design. The letter of certification shall include the roll numbers and identification procedures, sampling procedures and the results of the quality control tests which include flexural rigidity, tensile strength and modulus and junction strength for each batch of resin and each shift's production used.

**4.1.3** Certification letters required by Sections 4.1.1 and 4.1.2 above shall be submitted to the design professional in responsible charge, the project inspector, the laboratory of record and the school district.

### 4.2 Soil Testing

Soil properties, such as soil type, soil classification, moisture content, density, compaction, shear strength and gradation, for all backfill materials shall be tested for compliance with the design criteria. The geotechnical engineer shall determine the appropriate frequency for these tests. The frequency shall not be less than the following:

---

## SEGMENTAL RETAINING WALL SYSTEMS OF PRECAST CONCRETE UNITS: 2019 CBC

**4.2.1** Moisture, density, and compaction test per ASTM D1557: Test every 2-foot vertical and 100-foot horizontal, or fraction thereof, in reinforced, retained and foundation zones.

**4.2.2** Shear strength test per ASTM D3080: One test for every backfill type and source, minimum two tests. Perform tests prior to start of backfill operation. Perform gradation tests on these samples to be used as a baseline described below.

**4.2.3** Gradation test per ASTM D422/C136: One test for every 4,000 square feet of wall facing area, or fraction thereof, per each backfill type and source. The gradation results shall be correlated with the baseline gradation tests from the shear strength tests. The geotechnical engineer shall establish an acceptance range for these gradation tests based on the baseline tests. If a gradation test falls out of the acceptance range, a shear strength test shall be performed on the suspect backfill.

### 4.3 Reporting Requirements

#### 4.3.1 Progress Reports

Detailed daily reports are required for all material testing and special inspection activities that occur at the project site. Reports shall be forwarded to the project inspector within one day of the test and/or inspection. Reports of all material tests performed by the laboratory of record shall be distributed in accordance with CAC requirements.

#### 4.3.2 Verified Reports

At the conclusion of earthwork-related material testing and special inspection activities, the geotechnical engineer shall submit verified report form *DSA 293: Geotechnical Verified Report* to the design professional in responsible charge, DSA, the project inspector and the school district.

---

### REFERENCES:

- California Code of Regulations Title 24
- Part 1: California Administrative Code
- Part 2: California Building Code, Section 1807A.2

---

This IR is intended for use by the DSA staff and by design professionals to promote statewide consistency for review and approval of plans and specifications as well as construction oversight of projects within the jurisdiction of DSA, which includes State of California public schools (K–12), community colleges and state-owned or state-leased essential services buildings. This IR indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered by DSA.

This IR is subject to revision at any time. Please check DSA's website for currently effective IRs. Only IRs listed on the webpage at <https://www.dgs.ca.gov/dsa/publications> at the time of project application submittal to DSA are considered applicable.

## SEGMENTAL RETAINING WALL SYSTEMS OF PRECAST CONCRETE UNITS: 2019 CBC

### APPENDIX A: REQUIRED VERIFICATION AND INSPECTION

Verification and Inspection		Continuous	Periodic
1.	Verify excavations are extended to proper depth.		X
	Prior to placement of drainage fill and compacted fill, observe subgrade and verify that site has been prepared properly.		X
2.	Perform classification, gradation and testing of:		
	a. Reinforced fill materials		X
	b. Retained fill materials		X
	c. Foundation fill materials		X
	d. Drainage fill materials		X
3.	Inspect placement and verify use of proper material, density and lift thicknesses of:		
	a. Reinforced fill materials	X	
	b. Retained fill materials	X	
	c. Foundation fill materials	X	
	d. Drainage fill materials	X	
4.	Verify compaction of:		
	a. Reinforced fill		X
	b. Retained fill		X
	c. Foundation fill		X
	d. Drainage fill		X
5.	Inspect placement and leveling of leveling pad to ensure intimate contact between the units and aggregate.	X	
6.	Verify block dimensions, identification and manufacturer's certification.		X
7.	Inspect block placement, alignment and inclination.	X	
8.	Verify reinforcement (i.e., geogrid) type, proper identification and manufacturer's certification.		X
9.	Inspect reinforcement (i.e., geogrid) placement that includes elevation, length and orientation of strong direction.	X	
10.	Inspect connection of reinforcement (i.e., geogrid) to block, including mechanical device and overlap length.	X	
11.	Verify placement of block fill and wall embedment.	X	
12.	Verify wall elevations, front and back slope conditions.		X