

# ICC-ES Evaluation Report

**ESR-1770**

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**DIVISION: 03 00 00—CONCRETE**
**Section: 03 11 19—Insulating Concrete Forming**
**REPORT HOLDER:**
**LACUNA, INC., dba APEX BLOCK CORP.**
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**EVALUATION SUBJECT:**
**APEX BLOCK™ INTERLOCKING SYSTEM**
**1.0 EVALUATION SCOPE**
**Compliance with the following codes:**

- 2009 *International Building Code*® (IBC)
- 1997 *Uniform Building Code*® (UBC)

**Properties evaluated:**

- Structural
- Fire resistance
- Noncombustible construction

**2.0 USES**

The APEX Block™ Interlocking System consists of individual blocks that form a permanent formwork system for reinforced concrete beams, lintels, walls, foundation walls and retaining walls. Walls constructed as described in this report are permitted to be used as load-bearing and nonload-bearing walls resisting axial, racking and transverse loads in Type II, III, and V construction in accordance with the IBC and UBC. The APEX Block™ Interlocking System is also classified as three-hour fire-resistance-rated, limited load-bearing wall when constructed in accordance with this report.

**3.0 DESCRIPTION**
**3.1 General:**

The APEX Block™ Interlocking System consists of APEX Blocks, concrete and reinforcement.

**3.2 Materials:**

APEX Blocks are manufactured from a mixture of recycled expanded polystyrene (EPS) aggregate, Type I or II portland cement, a proprietary accelerant solution and water. Recycled expanded polystyrene (EPS) aggregate used in the manufacturing of APEX Blocks must be approved in accordance with the approved quality documentation.

**3.2.1 APEX Blocks™:** The dry weight of a standard APEX Block is between 52 and 55 pounds (23.6 and 25 kg). A standard block is nominally 10 inches thick (254 mm), 16 inches high (406 mm) and 48 inches long (1219 mm). Each standard block is one solid piece of material molded with 6-inch vertical and horizontal cores. When stacked in the final position, the blocks form vertical and horizontal cavities where reinforcement and concrete are placed. See Figure 1 for details of the block. APEX Blocks™ have a flame-spread index of 25 or less and a smoke-development index of 50 or less when tested in accordance with ASTM E 84.

**3.2.2 Concrete:** Block cores must be filled at the jobsite with normal-weight concrete having carbonate or siliceous aggregate with a <sup>3</sup>/<sub>8</sub>-inch (9.5 mm) maximum aggregate size and an 8-inch (203 mm) slump. The concrete must have a minimum compressive strength of 3,000 psi (20.7 MPa) at 28 days. Concrete must comply with the requirements of Section 1905 of the IBC or UBC, as applicable.

**3.2.3 Reinforcement:** ASTM A 615 Grade 60 deformed steel reinforcing bars must have a minimum yield strength of 60 ksi (414 MPa) and must comply with Section 1907 of the IBC or UBC.

**4.0 DESIGN AND INSTALLATION**
**4.1 Design:**

General design requirements are described in Sections 4.1.1 through 4.1.4.

**4.1.1 Design and Construction in Accordance with the IBC and UBC:** The design of cast-in-place, reinforced concrete structural members formed by the APEX Block™ Interlocking System must conform to Chapters 16 and 19 of the IBC or UBC, as applicable, with the following requirements:

1. Minimum horizontal reinforcement must be No. 4 ASTM A 615 Grade 60 deformed reinforcing bars spaced 16 inches (405 mm) on center.
2. Minimum vertical reinforcement must be No. 4 ASTM A 615 Grade 60 deformed steel reinforcing bars spaced a maximum of 16 inches (405 mm) on center for structures located in exposure C areas having a UBC basic (fastest mile) wind speed greater than 70 mph (102 km/h) or an IBC basic (3-second gust) wind speed of 85 mph (123 km/h). The reinforcing bar sizes may need to be increased, depending upon demand loads, as a result of the structure being designed under Chapters 16 and 19 of the IBC and UBC.

3. Development and splices of steel reinforcing bars must be in accordance with Section 1901.2 of the IBC or Section 1912 of the UBC, as applicable.
4. Design may be based on the assumption that the APEX Block™ Interlocking System is a solid-concrete wall having an equivalent rectangular section thickness,  $b_{eq}$ , equal to 4.5 inches (114 mm).
5. The strength-reduction factor,  $\phi$ , is in accordance with Section 1901.2 of the IBC or Section 1909.3 of the UBC, as applicable.
6. A grid-factor,  $\Psi$ , with a value of 0.85, and the strength-reduction factor specified in Section 1901.2 of the IBC or 1909.3 of the UBC, must be used cumulatively in the design of the structural concrete formed by the APEX Block™ Interlocking System.

7. For members subject to shear and flexure, such as lintels, the nominal shear strength for in-plane applied loads provided by the concrete is determined as follows:

$$V_c = 2 \phi \Psi b_{eq} d \sqrt{f'_c} \quad (\text{English units}).$$

$$V_c = 0.16 \phi \Psi b_{eq} d \sqrt{f'_c} \quad (\text{SI units}).$$

where:

$b_{eq}$  = Width of an equivalent rectangular section equal to 4.5 inches (114 mm).

$d$  = Distance from extreme compression fiber to centroid of tension reinforcement (inches or mm).

$f'_c$  = Specified compressive strength of concrete (psi or MPa).

$\phi$  = Strength reduction factor in accordance with applicable codes.

$\Psi$  = Grid-factor equal to 0.85.

8. In-plane racking shear strength of shear walls is determined as follows:

$$F_v = \phi \Psi L_u b_{eq} \sqrt{f'_c} \quad (\text{English units}).$$

$$F_v = \phi \Psi L_u b_{eq} \sqrt{f'_c} \quad (\text{SI units}).$$

where:

$b_{eq}$  = Width of an equivalent rectangular section equal to 4.5 inches (114 mm).

$f'_c$  = Specified compressive strength of concrete (psi or MPa).

$L_u$  = Total length of shear wall panel (inches or mm).

$\phi$  = Strength reduction factor in accordance with applicable codes.

$\Psi$  = Grid-factor equal to 0.85.

9. The length of wall considered the effective length for concentrated vertical loads must be based on the design of a concrete bond beam at the top of the wall engineered to distribute vertical concentrated loads to vertical concrete cores.
10. Roof and floors must be anchored and supported at the wall in accordance with Section 1604.8.2 of the IBC or Section 1633.2 of the UBC, as applicable. Ledger bolts must have the minimum diameter and spacing specified by the registered design professional and shown on the building plans approved by the code official. The horizontal reinforcement at each roof and floor level must be in accordance with the design, and must be a minimum of one No. 4 reinforcing bar.

11. Walls subject to axial loading or combined flexural and axial loading must be designed as compression members in accordance with Section 1901.2 of the IBC or Section 1910 of the UBC and Section 4.1.1 of this report.

12. Anchorage to foundations must comply with Chapter 19 of the IBC.

#### 4.1.2 Alternative Design as Slender Walls

**4.1.2.1 UBC:** Alternate design of concrete walls formed by the APEX Blocks™ may comply with Section 1914.8 of the UBC, using the assumption that the APEX wall has a solid-concrete wall having an equivalent thickness of 4.5 inches (119 mm) for walls with 6-inch-diameter (152 mm) cores (steel assumed to be placed at the centroid of the  $b_{eq}$ ), and providing that the following is considered in the design: any case in which the vertical service-load stress exceeds  $0.04f'_c$ .

**4.1.2.2 IBC:** Alternate design of concrete walls formed by the APEX Blocks™ may comply with Section 14.8 of the ACI 318, as referenced by the IBC, using the assumption that the APEX wall has a solid-concrete wall having an equivalent thickness of 4.5 inches (119 mm) for walls with 6-inch-diameter (152 mm) cores (steel assumed to be placed at the centroid of the  $b_{eq}$ ).

**4.1.3 Prescriptive Design—Method 1 (UBC Only):** For buildings regulated by the UBC, the following prescriptive design approach for a two-story building specified in this section is permitted to be used in lieu of calculations required by Section 4.1.1 of this report:

1. Structures are limited to seismic zones 0, 1 and 2, and are limited to two stories and maximum 10-foot (3048 mm) unsupported wall heights. See Figures 4 and 5 for two-story height limits.
2. Maximum total roof live and dead load is 50 psf (2.4 kN/m<sup>2</sup>), and the maximum total floor live and dead loads are 75 psf (2.6 kN/m<sup>2</sup>), with a maximum applied load eccentricity of 5<sup>1</sup>/<sub>2</sub> inches (140 mm).
3. The maximum superimposed load applied vertically at the top of the wall (roof and floor) is 2,500 pounds per linear foot (36.5 kN/m).
4. Maximum basic wind speed is 100 miles per hour (161 km/h) in Exposure C locations as defined in Chapter 16, Division II, of the UBC.
5. Vertical and horizontal wall reinforcements must be spaced in accordance with Table 1 of this report, and placement must comply with Section 1914.3 of the UBC.
6. Wall openings must be vertically and horizontally reinforced.
7. Roof and floors must be anchored and supported at the wall in accordance with Section 1633.8 of the UBC.
8. Edger bolts must have the minimum diameter and spacing specified on the building plans approved by the code official.
9. Allowable in-plane shear loads specified in Table 2 of this report must be greater than, or equal to, design loads.
10. Anchorage to foundations must comply with Section 1915.8 of the UBC.
11. The horizontal reinforcement at each roof and floor level must consist of a minimum of one No. 5 reinforcing bar.

**4.1.4 Alternate Design-Method II:** In lieu of calculations required by Section 4.1.1 of this report, the structural design of APEX walls is permitted to comply with the Prescriptive Method for Insulating Concrete Forms in Residential Construction (publication No. EB118), dated May 1998, published by the Portland Cement Association (PCA), subject to all applicability and use limits for post-and-beam ICF wall systems.

**4.1.5 Fire-resistance-rated Construction:** Structural concrete wall assemblies reinforced as required by design may be used as three-hour load-limited fire-resistance-rated walls. The maximum axial load is limited to 30 percent of the nominal strength of the wall as determined by structural analysis by the registered design professional.

#### **4.2 Installation:**

**4.2.1 General:** Installation must be in accordance with manufacturer's (APEX) published installation instructions and this report. See Figure 2 for suggested details.

**4.2.2 Footings:** The APEX Block™ Interlocking System must be supported on concrete footings complying with Chapter 18 of the IBC or UBC. Vertical reinforcing bars, embedded in the footing, must extend into the base of the block wall system a minimum of 24 inches (610 mm), or a length complying with Section 1901.2 of the IBC (or Section 1912 of the UBC), whichever is greater.

**4.2.3 Block Placement:** APEX Block™ Interlocking System blocks may be oriented horizontally or vertically provided horizontal and vertical reinforcement is placed in accordance with the approved building plans.

**4.2.4 Reinforcement:** Horizontal reinforcement is permitted to rest directly on the APEX Block™ Interlocking System material in the cells of the blocks. Vertical reinforcement must be placed in accordance with the design drawings and the applicable code before concrete is poured. Lap splices for the reinforcement must comply with requirements of Section 1901.2 of the IBC or Section 1912 of the UBC.

**4.2.5 Concrete:** Concrete must fill all cores of the APEX Block™ Interlocking System wall blocks. Concrete can be placed in lifts in compliance with the published installation instructions. Consolidation of concrete during the pour may be performed by "rodding" the cores (pulling or pushing a piece of rebar into the wet concrete in the cores from the top of the wall). Field verification of a proper pour can be accomplished by pushing a 1/4-inch-diameter (3.2 mm) steel rod through the face shell of the blocks into the concrete core and noting upon its withdrawal the presence of wet concrete on the rod.

**4.2.6 Wood Ledgers:** When wood ledgers are attached to the APEX Block™ Interlocking System, the face shell of the APEX Block™ Interlocking System block may remain in place. Wood ledgers are attached by cutting 6-inch-diameter (152 mm) holes into the face shell of the block at the location of a horizontal or vertical core, at spacing required by the design, before the placement of the concrete. A dam is used to hold the headed anchor bolt centered in the hole. When concrete is poured into the wall system, the holes provided for the headed anchor bolts form a connection from the ledger board to the concrete core. Wood ledgers may be attached to APEX Block™ with mechanical expansion or epoxy anchors when specified by the registered design professional and approved by the code official.

**4.2.7 Wood Plates:** When wood plates are anchored to the top of the wall (see Figure 2), anchor bolts are cast-in-place or mechanical expansion/epoxy anchors are used,

as specified by the registered design professional and approved by the code official.

#### **4.3 Interior Finish:**

APEX Blocks™ may be exposed to the interior of the building without a thermal barrier since the APEX wall panels satisfactorily pass NFPA 286 testing. When an interior finish such as gypsum wall board or plaster is applied, attachment of the covering must be in accordance with the APEX published installation instructions and applicable codes.

#### **4.4 Exterior Finish:**

**4.4.1 Above Grade:** Exterior walls must be finished with a weather-resistant exterior wall envelope that complies with Section 1403 of the IBC, such as the Ultrakote One-Coat Stucco System installed with a water-resistive barrier as provided in ICC-ES [ESR-1471](#). Wall coverings must be attached to the concrete core within the form using fasteners designed to support the weight of the wall covering and to resist applicable wind loads, to the satisfaction of the code official. Negative wind pressure capacity of the exterior finish material must be the same as that recognized in the code for generic materials or that recognized in a current ICC-ES evaluation report for proprietary materials.

**4.4.2 Below Grade:** Wall surfaces must be damp-proofed and, when required by the local building department, waterproofed in accordance with Section 1805 of the IBC, or Appendix 18 of the UBC. Damp-proofing and waterproofing materials must be approved by APEX Construction Systems, Inc., and the code official.

#### **4.5 Foundation Walls:**

The APEX Block™ Interlocking System used as a foundation stem wall supported on concrete footings-must be designed in accordance with this report.

#### **4.6 Retaining Walls:**

The APEX Block™ Interlocking System used as a retaining wall with reinforcement must be designed in accordance with this report.

#### **4.7 Crawl Spaces:**

In underfloor crawl spaces, the APEX Block™ Interlocking Wall System is permitted to be exposed to the crawl space, provided ventilation complies with Section 2304.11.9 of the IBC or Section 2306.7 of the UBC, as applicable.

#### **4.8 Fire-resistance-rated Construction:**

Wall assemblies constructed from minimum 10-inch-thick (254 mm) APEX Blocks™ have a three-hour fire resistance rating for walls that are nonload-bearing and limited load-bearing, as explained in Section 4.1.5 of this report. The APEX Block™ Interlocking System must be installed in accordance with Section 4.2 of this report. The cores of the APEX Block™ Interlocking System must be filled with normal-weight concrete in accordance with Section 3.2.2 of this report. The concrete must be reinforced with steel reinforcing bars in accordance with this report and the approved building plans.

#### **4.9 Special Inspection:**

IBC: Special inspection and verification of concrete construction are required in accordance with Section 1704.4 and Table 1704.4 of the IBC.

UBC: Special inspection is required for placement of reinforcing steel and concrete and concrete cylinder testing as noted in Section 1701 of the UBC.

## 5.0 CONDITIONS OF USE

The APEX Block™ Interlocking 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 APEX Block™ Interlocking System blocks are manufactured, identified, and installed in accordance with this report and the manufacturer's published installation instructions. In the case of a conflict, this report governs.
- 5.2 When required by the code official, calculations showing compliance with this report must be submitted for approval. The calculations and details must be prepared by a registered design professional when required by the statutes of the jurisdiction in which the project is located.
- 5.3 Special inspection must be provided in accordance with Section 4.9 of this report.
- 5.4 Wood members in contact with concrete for plates of window and door framing must be treated with an approved wood preservative in accordance with the applicable code, and must be attached with hot-dipped galvanized steel fasteners complying with IBC Section 2304.9.5 or UBC Section 2304.3, as applicable.
- 5.5 Design of structural concrete with APEX Block™ must be in accordance with Section 4.1 of this report.
- 5.6 The APEX Block™ Interlocking System is limited to use as a structural concrete wall lateral-force resisting system in Seismic Design Categories A and B under the IBC, or Seismic Zones 0, 1 and 2 under the UBC.
- 5.7 Headers and lintels over window and door wall openings must be designed as reinforced concrete beams in accordance with the IBC or UBC. In addition, supports of headers and lintels must be designed as reinforced concrete columns in accordance with the IBC or UBC.
- 5.8 APEX Block™ Interlocking System blocks are manufactured by APEX Construction Systems, Inc., in Phoenix, Arizona, under a quality control program with inspections by UL LLC (AA-668).

## 6.0 EVIDENCE SUBMITTED

Data in accordance with the ICC-ES Acceptance Criteria for Concrete Floor, Roof, and Wall Systems and Concrete Masonry Wall Systems (AC15), dated February 2010; and quality documentation.

## 7.0 IDENTIFICATION

Each package of blocks bears a label with the APEX Block™ logo and trademark, the evaluation report number (ESR-1770), and the name and logo of the inspection agency (UL LLC.).

**TABLE 1—APEX WALL REINFORCING SCHEDULE FOR THE PRESCRIPTIVE DESIGN APPROACH SPECIFIED IN SECTION 4.1.3 OF THIS EVALUATION REPORT (UBC ONLY)** <sup>1,2,3,4,5,6</sup>

WALL CONDITION	SEISMIC ZONES	REINFORCING	
		Horizontal	Vertical
Crawl space wall and above-grade wall	0, 1, 2A, 2B	#4 ea. cell	#4 ea. cell
Basement wall with height of backfill "H" < 5'-0"	All	#4 ea. cell	#4 ea. cell
Basement wall with height of backfill 5'-0" < "H" < 8'-0"	All	#5 ea. cell	#5 ea. cell

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 psf = 0.48 kN/m<sup>2</sup>, 1 plf = 14.6 N/m, 1 mph = 1.61 km/h, 1pcf = 16 kg/m<sup>3</sup>, 1 psi = 0.0069 MPa, 1 ksi = 6.72 MPa.

<sup>1</sup>Maximum floor and roof joist spans are 25 feet and based on total floor load = 75 psf and total roof load = 50 psf. Other loading combinations are allowed, with a maximum total superimposed load (roof+floor) on the top of the wall equal to 2,500 plf with eccentricity of 5½ inches each case.

<sup>2</sup>Maximum allowable wind pressure is based on 100 mph, Exposure C (120 mph 3-second gust).

<sup>3</sup>Assume equivalent fluid pressure of soil = 35 pcf.

<sup>4</sup>Concrete: f'c = 3,000 psi, minimum. All voids must be filled.

<sup>5</sup>Reinforcing steel: Fy = 60 ksi. All reinforcing must be lapped as follows: #4 – 24 inches, #5 – 30 inches. Corner bars must be provided with 24-inch legs at every course at all corners and intersections.

<sup>6</sup>Drain behind basement wall must be 4 inches diameter minimum perforated pipe.

**TABLE 2—ALLOWABLE IN-PLANE SHEAR CAPACITY OF APEX BLOCK SHEAR WALLS FOR THE PRESCRIPTIVE DESIGN APPROACH SPECIFIED IN SECTION 4.1.3 OF THIS EVALUATION REPORT (UBC ONLY)**<sup>1</sup>

WALL LENGTH "L"	ALLOWABLE IN-PLANE SHEAR CAPACITY (plf)
1'-4" < L < 4'-0"	0
4'-0" < L < 6'-0"	400
6'-0" < L < 8'-0"	600
L > 8'-0"	800

For **SI**: 1 foot = 304.8 mm. 1 plf = 14.6 N/m.

<sup>1</sup>Walls must be reinforced with horizontal and vertical rebar in accordance with Table 1.

**TABLE 3—LINTEL REINFORCING SCHEDULE FOR THE PRESCRIPTIVE DESIGN APPROACH SPECIFIED IN SECTION 4.1.3 OF THIS EVALUATION REPORT (UBC ONLY)** <sup>1,2,3</sup>

MAXIMUM LOAD PER FOOT	OPENING LENGTH IN WALL									
	2'-0"	3'-0"	4'-0"	6'-0"	8'-0"	10'-0"	12'-0"	14'-0"	16'-0"	18'-0"
	LINTEL REINFORCING SCHEDULE									
100 plf	#4	#4	#4	#4	#4	2-#4	2-#4	2-#5	2-#5	2-#5
200 plf	#4	#4	#4	#4	#4	2-#4	2-#4	2-#5	2-#5	2-#5
400 plf	#4	#4	#4	#4	#4	2-#4	2-#5	2-#5	-	-
600 plf	#4	#4	#4	#4	#4	2-#5	-	-	-	-
800 plf	#4	#4	#4	#4	2-#4	-	-	-	-	-
1,000 plf	#4	#4	#4	#4	-	-	-	-	-	-
1,200 plf	#4	#4	#4	-	-	-	-	-	-	-
1,500 plf	#4	#4	#4	-	-	-	-	-	-	-
2,000 plf	#4	#4	-	-	-	-	-	-	-	-
2,500 plf	#4	#4	-	-	-	-	-	-	-	-

For **SI**: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 plf = 14.6 N/m.

<sup>1</sup>Vertical reinforcement must be a minimum of two #3 stirrups every vertical cell, spaced at 4¾ inches on center or #4 stirrups at every vertical cell over the entire length of the lintel.

<sup>2</sup>Lintel reinforcing must extend a minimum of 2'-0" past the edge of the opening or provide 90-degree standard hooks.

<sup>3</sup>This reinforcement schedule is based on lintels having a depth such that the distance from the extreme compression fiber to the centroid of the flexural reinforcement is a minimum of 19 inches.

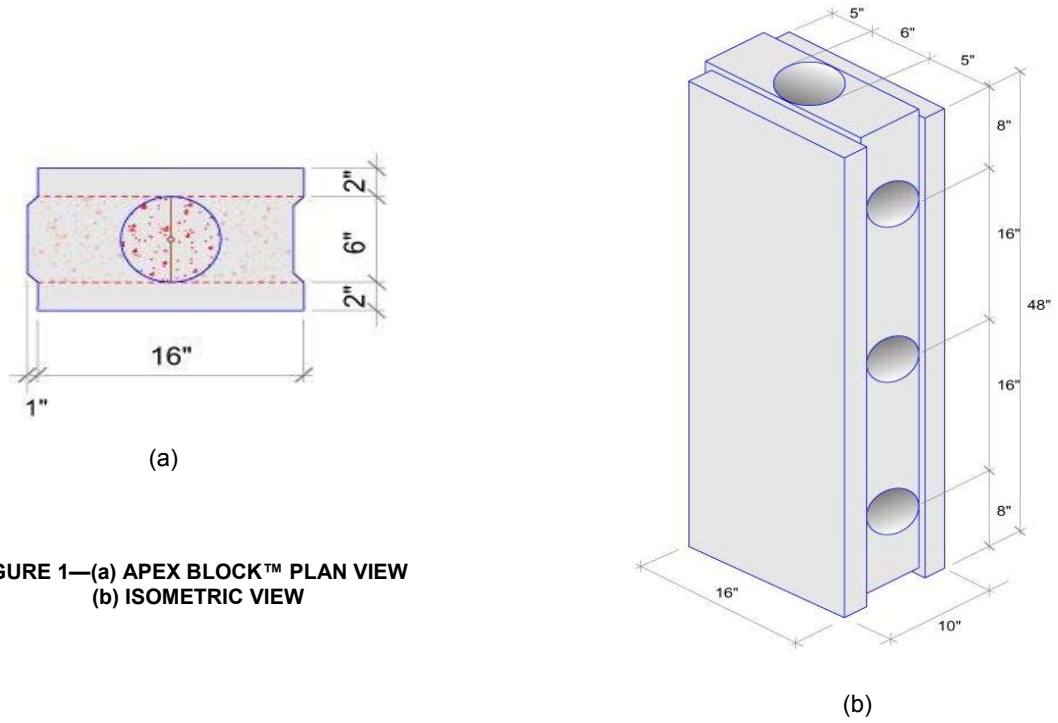


FIGURE 1—(a) APEX BLOCK™ PLAN VIEW  
(b) ISOMETRIC VIEW

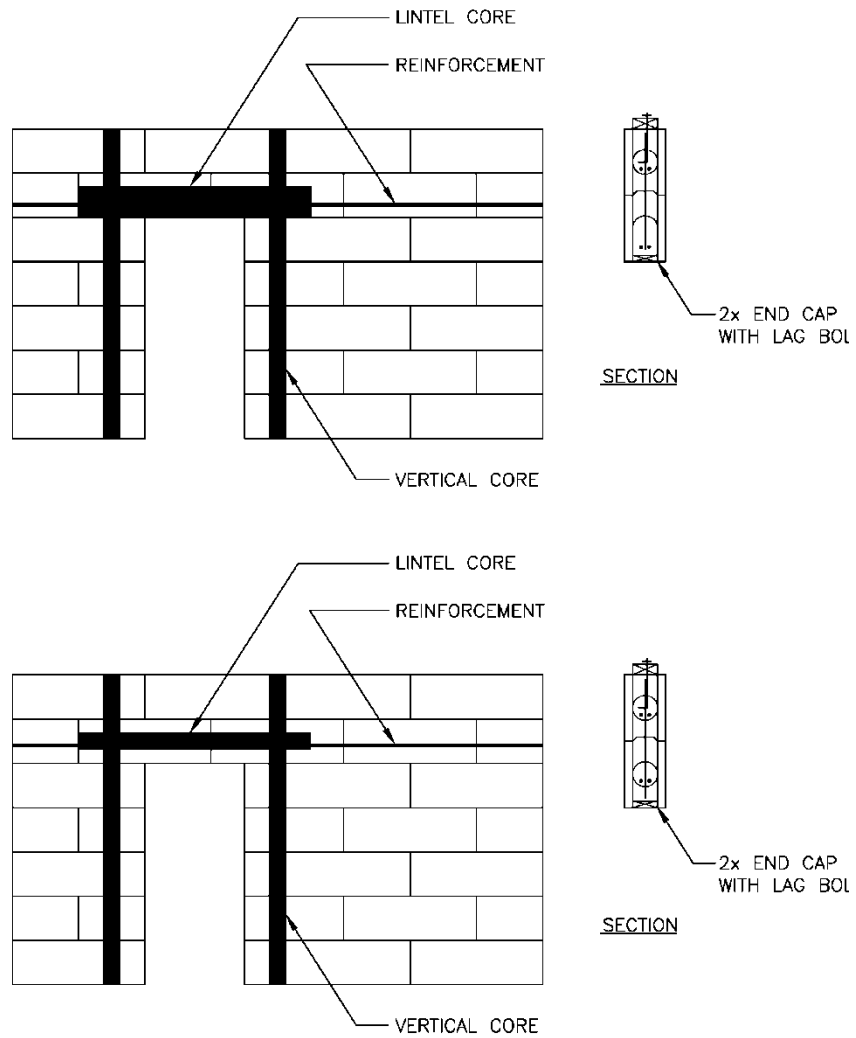
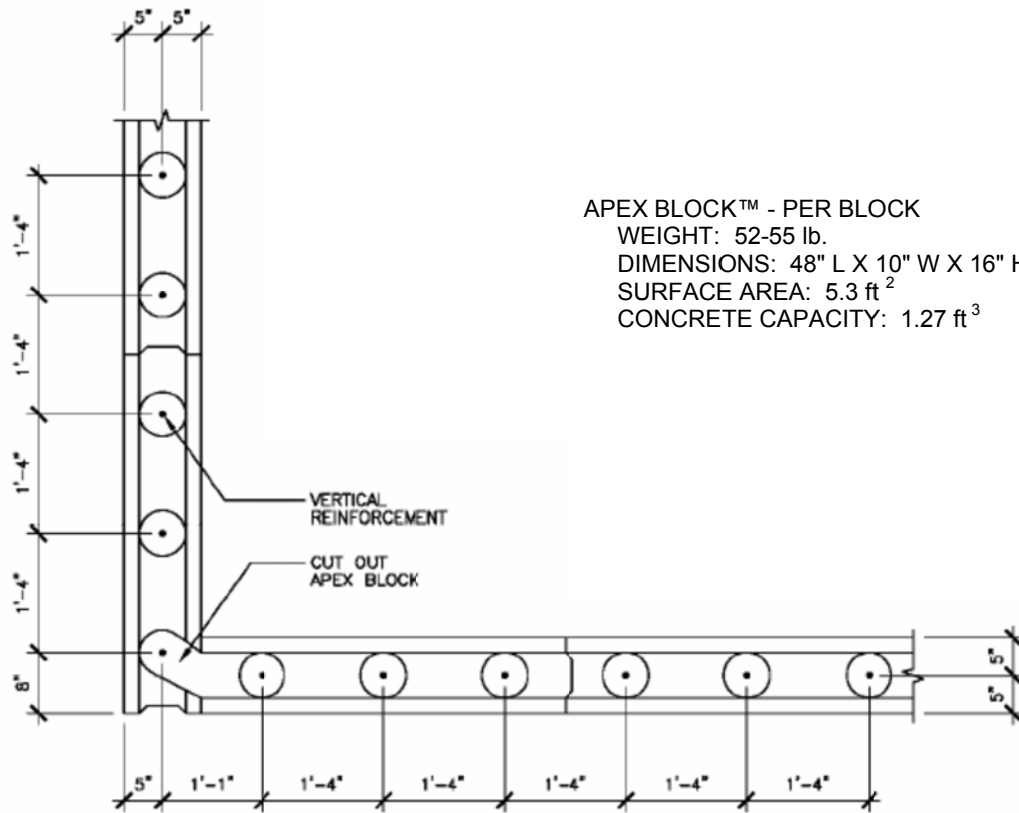
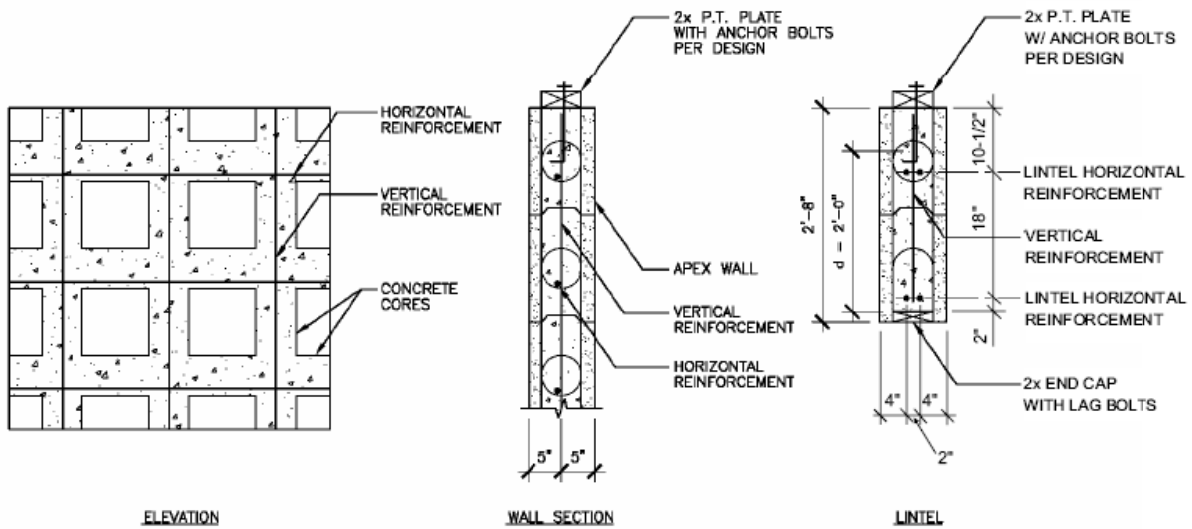


FIGURE 2—LINTEL AND APEX BLOCK™ LAYOUT (ALSO SEE FIGURE 3)



APEX BLOCK™ - PER BLOCK  
 WEIGHT: 52-55 lb.  
 DIMENSIONS: 48" L X 10" W X 16" H  
 SURFACE AREA: 5.3 ft<sup>2</sup>  
 CONCRETE CAPACITY: 1.27 ft<sup>3</sup>

PLAN VIEW

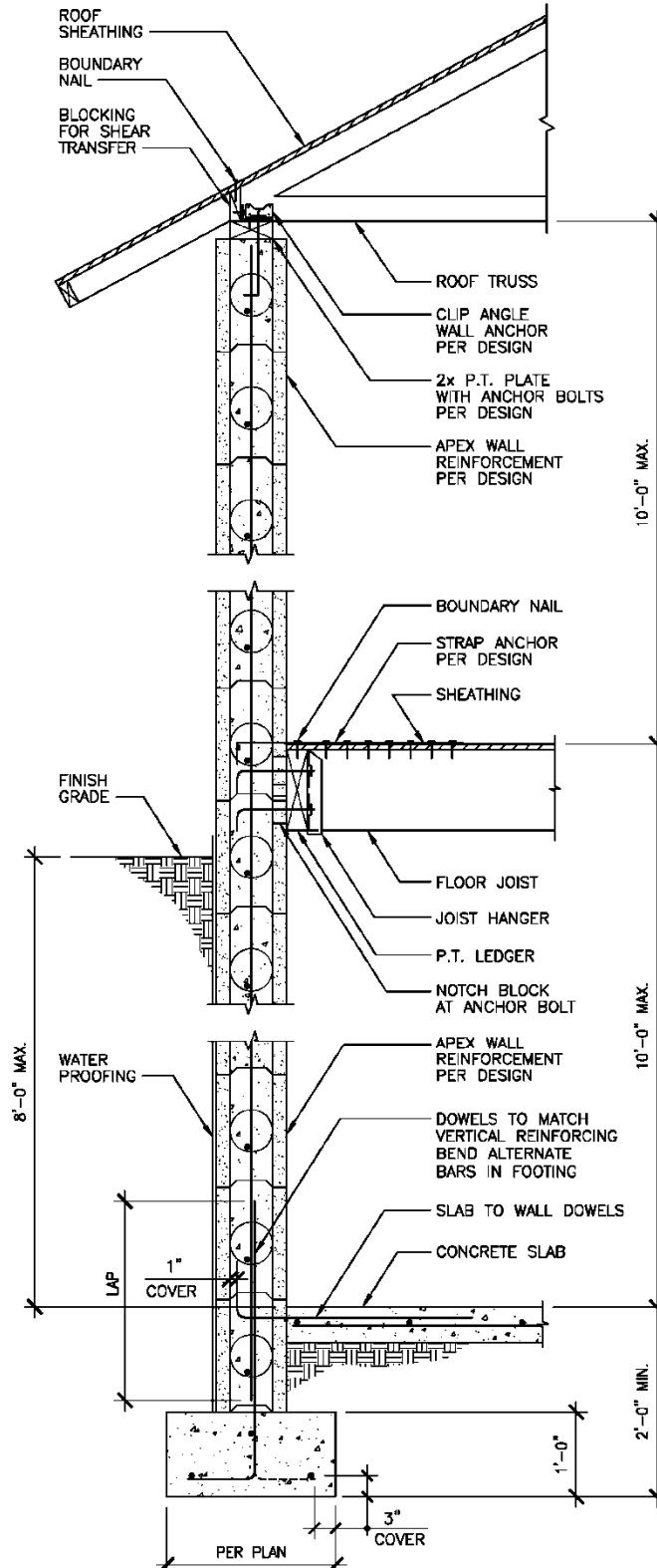


ELEVATION

WALL SECTION

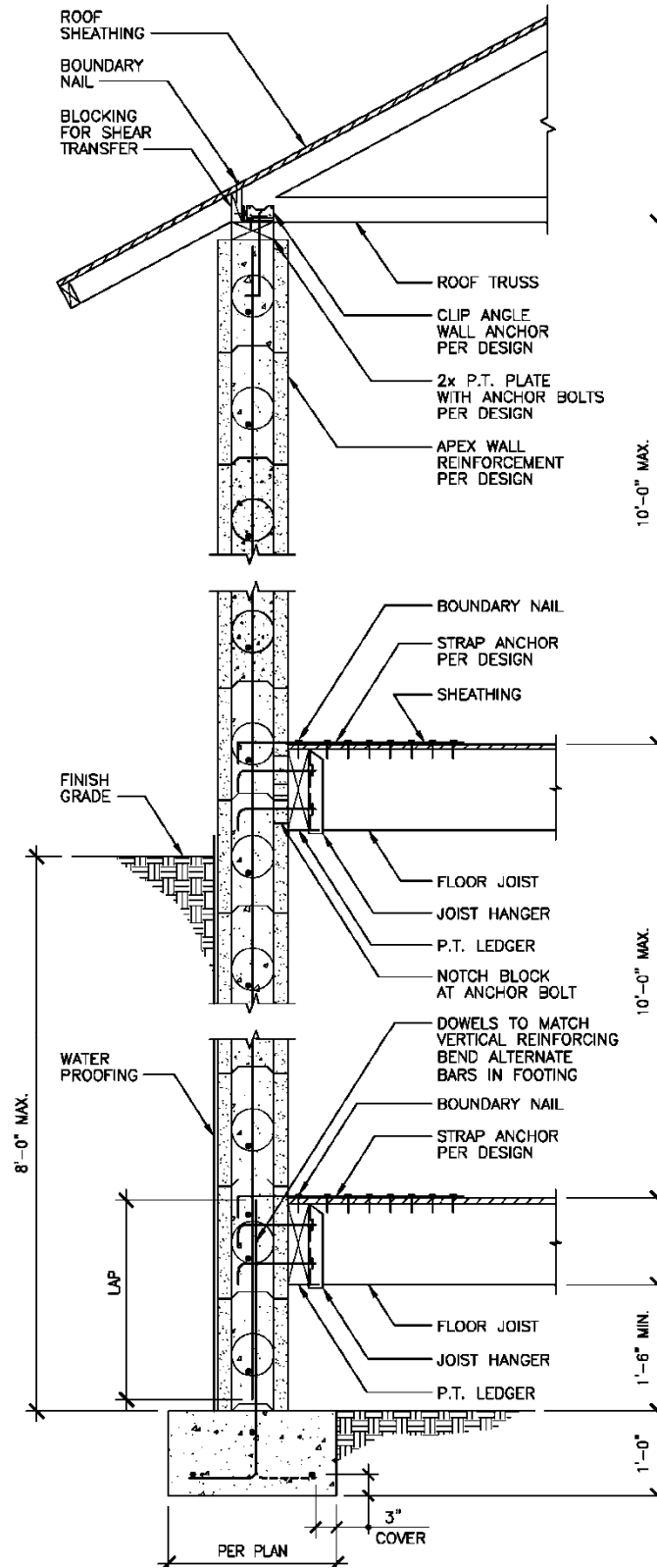
LINTEL

FIGURE 3—REINFORCEMENT PLACEMENT



**FIGURE 4—TWO-STORY HEIGHT LIMIT DETAIL WHEN USING THE PRESCRIPTIVE DESIGN APPROACH SPECIFIED IN SECTION 4.1.3 OF THIS EVALUATION REPORT (UBC ONLY).**





**FIGURE 5—TWO-STORY HEIGHT LIMIT DETAIL WHEN USING THE PRESCRIPTIVE DESIGN APPROACH SPECIFIED IN SECTION 4.1.3 OF THIS EVALUATION REPORT (UBC ONLY).**