5607.3 Installation of Wall Ties. The installation of wall ties shall be as follows:

1. The ends of wall ties shall be embedded in mortar joints. Wall tie ends shall engage outer face shells of hollow units by at least ½ inch (12.7mm). Wire wall ties shall be embedded at least 1½ inches (38 mm) into the mortar bed of solid masonry units or solid grouted hollow units.
2. Wall ties shall not be bent after being embedded in grout or mortar.

780 TABLE 5607.1
MORTAR PROPORTIONS[a,b]

PROPORTIONS BY VOLUME (cementitious materials)										
Mortar	Type	Portland cement or blended cement	Mortar cement			Masonry cement			Hydrated lime[c] or lime putty	Aggregate ratio (measured in damp, loose conditions)
			M	S	N	M	S	N		
Cement-lime	M	1	—	—	—	—	—	—	¼	Not less than 2¼ and not more than 3 times the sum of separate volumes of lime, if used, and cement
	S	1	—	—	—	—	—	—	over ¼ to ½	
	N	1	—	—	—	—	—	—	over ½ to 1¼	
	O	1	—	—	—	—	—	—	over 1¼ to 2½	
Mortar cement	M	1	—	—	1	—	—	—	—	
	M	—	1	—	—	—	—	—		
	S	½	—	—	1	—	—	—		
	S	—	—	1	—	—	—	—		
	N	—	—	—	1	—	—	—		
	O	—	—	—	1	—	—	—		
Masonry cement	M	1				—	—	1	—	
	M	—				1	—	—		
	S	½				_	—	1		
	S	—				—	1	—		
	N	—				—	—	1		
	O	—				—	—	1		

For SI: 1 cubic foot = 0.0283 m^3, 1 pound = 0.454 kg.

a. For the purpose of these specifications, the weight of 1 cubic foot of the respective materials shall be considered to be as follows:

Portland Cement	94 pounds	Masonry Cement	Weight printed on bag
Mortar Cement	Weight printed on bag	Hydrated Lime	40 pounds
Lime Putty (Quicklime)	80 pounds	Sand, damp and loose	80 pounds of dry sand

b. Two air-entraining materials shall not be combined in mortar.

c. Hydrated lime conforming to the requirements of ASTM C 207.

780CMR 5608 MULTIPLE WYTHE MASONRY

5608.1 General. The facing and backing of multiple wythe masonry walls shall be bonded in accordance with 780 CMR 5608.1.1, 5608.1.2 or 5608.1.3. In cavity walls, neither the facing nor the backing shall be less than three inches (76 mm) nominal in thickness and the cavity shall not be more than four inches (102 mm) nominal in width. The backing shall be at least as thick as the facing.

Exception: Cavities shall be permitted to exceed the four-inch (102 mm) nominal dimension provided tie size and tie spacing have been established by calculation.

5608.1.1 Bonding with Masonry Headers. Bonding with solid or hollow masonry headers shall comply with 780 CMR 5608.1.1.1 and 5608.1.1.2.

5608.1.1.1 Solid Units. Where the facing and backing (adjacent wythes) of solid masonry construction are bonded by means of masonry headers, no less than 4% of the wall surface of each face shall be composed of headers extending not less than three inches (76 mm) into the backing. The distance between adjacent full-length headers shall not exceed 24 inches (610 mm) either vertically or horizontally. In walls in which a single header does not extend through the wall, headers from the opposite sides shall overlap at least three inches (76 mm), or headers from opposite sides shall be covered with another header course overlapping the header below at least three inches (76 mm).

5608.1.1.2 Hollow Units. Where two or more hollow units are used to make up the thickness of a wall, the stretcher courses shall be bonded at vertical intervals not exceeding 34 inches (864 mm) by lapping at least three inches (76 mm) over the unit below, or by lapping at vertical intervals not exceeding 17 inches (432 mm) with units that are at least 50% greater in thickness than the units below.

5608.1.2 Bonding with Wall Ties or Joint Reinforcement. Bonding with wall ties or joint reinforcement shall comply with 780 CMR 5608.1.2.1 through 5608.1.2.3.

5608.1.2.1 Bonding with Wall Ties. Bonding with wall ties, except as required by 780 CMR

5610, where the facing and backing (adjacent wythes) of masonry walls are bonded with $^3/_{16}$-inch-diameter (4.8 mm) wall ties embedded in the horizontal mortar joints, there shall be at least one metal tie for each 4.5 square feet (0.418 m^2) of wall area. Ties in alternate courses shall be staggered. The maximum vertical distance between ties shall not exceed 24 inches (610 mm), and the maximum horizontal distance shall not exceed 36 inches (914 mm). Rods or ties bent to rectangular shape shall be used with hollow masonry units laid with the cells vertically. In other walls, the ends of ties shall be bent to 90-degree (0.79 rad) angles to provide hooks no less than 2 inches (51 mm) long. Additional bonding ties shall be provided at all openings, spaced not more than three feet (914mm) apart around the perimeter and within 12 inches (305 mm) of the opening.

5608.1.2.2 Bonding with Adjustable Wall Ties. Where the facing and backing (adjacent wythes) of masonry are bonded with adjustable wall ties, there shall be at least one tie for each 2.67 square feet (0.248 m^2) of wall area. Neither the vertical nor horizontal spacing of the adjustable wall ties shall exceed 24 inches (610 mm). The maximum vertical offset of bed joints from one wythe to the other shall be 1.25 inches (32 mm). The maximum clearance between connecting parts of the ties shall be $^1/_{16}$ inch (1.6 mm). When pintle legs are used, ties shall have at least two $^3/_{16}$-inch-diameter (4.8 mm) legs.

5608.1.2.3 Bonding with Prefabricated Joint Reinforcement. Where the facing and backing (adjacent wythes) of masonry are bonded with prefabricated joint reinforcement, there shall be at least one cross wire serving as a tie for each 2.67 square feet (0.248 m^2) of wall area. The vertical spacing of the joint reinforcement shall not exceed 16 inches (406mm). Cross wires on prefabricated joint reinforcement shall not be smaller than No. 9 gage. The longitudinal wires shall be embedded in the mortar.

5608.1.3 Bonding with natural or cast stone. Bonding with natural and cast stone shall conform to 780 CMR 5608.1.3.1 and 5608.1.3.2.

5608.1.3.1 Ashlar Masonry. In ashlar masonry, bonder units, uniformly distributed, shall be provided to the extent of not less than 10% of the wall area. Such bonder units shall extend not less than four inches (102 mm) into the backing wall.

5608.1.3.2 Rubble Stone Masonry. Rubble stone masonry 24 inches (610 mm) or less in thickness shall have bonder units with a maximum spacing of three feet (914 mm) vertically and three feet (914 mm) horizontally, and if the masonry is of greater thickness than 24 inches (610 mm), shall have one bonder unit for each six square feet (0.557 m^2) of wall surface on both sides.

5608.2 Masonry Bonding Pattern. Masonry laid in running and stackbond shall conform to 780 CMR 5608.2.1 and 5608.2.2.

5608.2.1 Masonry Laid in Running Bond. In each wythe of masonry laid in running bond, head joints in successive courses shall be offset by not less than one-fourth the unit length, or the masonry walls shall be reinforced longitudinally as required in 780 CMR 5608.2.2.

5608.2.2 Masonry Laid in Stack Bond. Where unit masonry is laid with less head joint offset than in 780 CMR 5607.2.1, the minimum area of horizontal reinforcement placed in mortar bed joints or in bond beams spaced not more than 48 inches (1219 mm) apart, shall be 0.0007 times the vertical cross-sectional area of the wall.

780 CMR 5609 GROUTED MASONRY

5609.1 General. Grouted multiple-wythe masonry is a form of construction in which the space between the wythes is solidly filled with grout. It is not necessary for the cores of masonry units to be filled with grout. Grouted hollow unit masonry is a form of construction in which certain cells of hollow units are continuously filled with grout.

5609.1.1 Grout. Grout shall consist of cementitious material and aggregate in accordance with ASTM C 476 and the proportion specifications of 780 CMR Table 5609.1.1. Type M or Type S mortar to which sufficient water has been added to produce pouring consistency can be used as grout.

5609.1.2 Grouting Requirements. Maximum pour heights and the minimum dimensions of spaces provided for grout placement shall conform to 780 CMR Table 5609.1.2. If the work is stopped for one hour or longer, the horizontal construction joints shall be formed by stopping all tiers at the same elevation and with the grout one inch (25.4 mm) below the top.

5609.1.3 Grout Space (Cleaning). Provision shall be made for cleaning grout space. Mortar projections that project more than 0.5 inch (12.7 mm) into grout space and any other foreign matter shall be removed from grout space prior to inspection and grouting.

5609.1.4 Grout Placement. Grout shall be a plastic mix suitable for pumping without segregation of the constituents and shall be mixed thoroughly. Grout shall be placed by pumping or by an approved alternate method and shall be placed before any initial set occurs and in no case more than 1½ hours after water has been added. Grouting shall be done in a continuous pour, in

lifts not exceeding five feet (1524 mm). It shall be consolidated by puddling or mechanical vibrating during placing and reconsolidated after excess moisture has been absorbed but before plasticity is lost.

5609.1.4.1 Grout Pumped through Aluminum Pipes. Grout shall not be pumped through aluminum pipes.

5609.1.5 Cleanouts. Where required by the building official, cleanouts shall be provided as specified in 780 CMR 5609. The cleanouts shall be sealed before grouting and after inspection.

5609.1.5.1 Grouted Multiple-wythe Masonry. Cleanouts shall be provided at the bottom course of the exterior wythe at each pour of grout where such pour exceeds five feet (1524 mm) in height.

5609.1.5.2 Grouted Hollow Unit Masonry. Cleanouts shall be provided at the bottom course of each cell to be grouted at each pour of grout, where such pour exceeds four feet (1219 mm) in height.

5609.2 Grouted Multiple-wythe Masonry. Grouted multiple-wythe masonry shall conform to all the requirements specified in 780 CMR 5609.1 and the requirements of 780CMR 5609.2.

5609.2.1 Bonding of Backup Wythe. Where all interior vertical spaces are filled with grout in multiple-wythe construction, masonry headers shall not be permitted. Metal wall ties shall be used in accordance with 780 CMR 5608.1.2 to prevent spreading of the wythes and to maintain the vertical alignment of the wall. Wall ties shall be installed in accordance with 780 CMR 5608.1.2 when the backup wythe in multiple-wythe construction is fully grouted.

5609.2.2 Grout Spaces. Fine grout shall be used when interior vertical space to receive grout does not exceed two inches (51 mm) in thickness. two Interior vertical spaces exceeding two inches (51 mm) in thickness shall use coarse or fine grout.

780 CMR TABLE 5609.1.1
GROUT PROPORTIONS BY VOLUME FOR MASONRY CONSTRUCTION

TYPE	PORTLAND CEMENT OR BLENDED CEMENT SLAG CEMENT	HYDRATED LIME OR LIME PUTTY	AGGREGATE MEASURED IN A DAMP, LOOSE CONDITION	
			Fine	Coarse
Fine	1	0 to 1/10	2¼ to 3 times the sum of the volume of the cementitious materials	—
Coarse	1	0 to 1/10	2¼ to 3 times the sum of the volume of the cementitious materials	1 to 2 times the sum of the volumes of the cementitious materials

780 CMR TABLE 5609.1.2
GROUT SPACE DIMENSIONS AND POUR HEIGHTS

GROUT TYPE	GROUT POUR MAXIMUM HEIGHT (feet)	MINIMUM WIDTH OF GROUT SPACES[a,b] (inches)	MINIMUM GROUT[b,c] SPACE DIMENSIONS FOR GROUTING CELLS OF HOLLOW UNITS (inches x inches)
Fine	1	0.75	1.5 × 2
	5	2	2 × 3
	12	2.5	2.5 × 3
	24	3	3 × 3
Coarse	1	1.5	1.5 × 3
	5	2	2.5 × 3
	12	2.5	3 × 3
	24	3	3 × 4

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm.

a. For grouting between masonry wythes.

b. Grout space dimension is the clear dimension between any masonry protrusion and shall be increased by the horizontal projection of the diameters of the horizontal bars within the cross section of the grout space.

c. Area of vertical reinforcement shall not exceed 6% of the area of the grout space.

5609.2.3 Grout Barriers. Vertical grout barriers or dams shall be built of solid masonry across the grout space the entire height of the wall to control the flow of the grout horizontally. Grout barriers shall not be more than 25 feet (7620 mm) apart. The grouting of any section of a wall between control barriers shall be completed in one day with no interruptions greater than one hour.

5609.3 Reinforced Grouted Multiple-wythe Masonry. Reinforced grouted multiple-wythe masonry shall conform to all the requirements specified in 780 CMR 5609.1 and 5609.2 and the requirements of 780 CMR 5609.3.

5609.3.1 Construction. The thickness of grout or mortar between masonry units and reinforcement shall not be less than ¼ inch (6.4 mm), except that ¼-inch (6.4 mm) bars may be laid in horizontal mortar joints at least ½ inch (12.7 mm) thick, and steel wire reinforcement may be laid in horizontal mortar joints at least twice the thickness of the wire diameter.

5609.4 Reinforced Hollow Unit Masonry. Reinforced hollow unit masonry shall conform to all the requirements of 780 CMR 5609.1 and the requirements of 780 CMR 4609.4.

5609.4.1 Construction. Requirements for construction shall be as follows:

1. All reinforced hollow-unit masonry shall be built to preserve the unobstructed vertical continuity of the cells to be filled. Walls and cross webs forming such cells to be filled shall be full-bedded in mortar to prevent leakage of grout. All head and end joints shall be solidly filled with mortar for a distance in from the face of the wall or unit not less than the thickness of the longitudinal face shells. Bond shall be provided by lapping units in successive vertical courses.
2. Cells to be filled shall have vertical alignment sufficient to maintain a clear, unobstructed continuous vertical cell of dimensions prescribed in 780 CMR Table 5609.1.2.
3. Vertical reinforcement shall be held in position at top and bottom and at intervals not exceeding 200 diameters of the reinforcement.
4. All cells containing reinforcement shall be filled solidly with grout. Grout shall be poured in lifts of eight-foot (2438 mm) maximum height. When total grout pour exceeds eight feet (2438 mm) in height, the grout shall be placed in lifts not exceeding five feet (1524 mm) and special inspection during grouting shall be required.
5. Horizontal steel shall be fully embedded by grout in an uninterrupted pour.

780 CMR 5610 GLASS UNIT MASONRY

5610.1 General. Panels of glass unit masonry located in load-bearing and nonload-bearing exterior and interior walls shall be constructed in accordance with 780CMR 5610.

5610.2 Materials. Hollow glass units shall be partially evacuated and have a minimum average glass face thickness of $^{3}/_{16}$ inch (4.8 mm). The surface of units in contact with mortar shall be treated with a polyvinyl butyral coating or latex-based paint. The use of reclaimed units is prohibited.

5610.3 Units. Hollow or solid glass block units shall be standard or thin units.

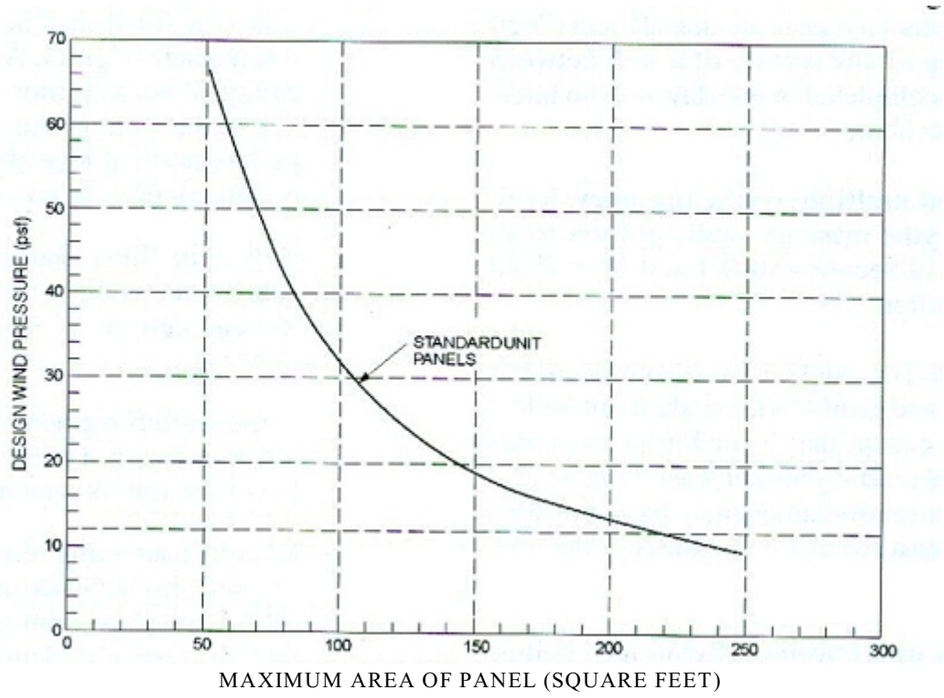
5610.3.1 Standard Units. The specified thickness of standard units shall be at least 3⅞ inches (98 mm).

5610.3.2 Thin Units. The specified thickness of thin units shall be at least 3⅛ inches (79 mm) for hollow units and at least three inches (76 mm) for solid units.

5610.4 Isolated Panels. Isolated panels of glass unit masonry shall conform to the requirements of 780 CMR 5610.4.

5610.4.1 Exterior Standard-unit Panels. The maximum area of each individual standard-unit panel shall be 144 square feet (13.4 m^2) when the design wind pressure is 20 psf (958 Pa). The maximum area of such panels subjected to design wind pressures other than 20 psf (958 Pa) shall be in accordance with 780 CMR Figure 5610.4.1. The maximum panel dimension between structural supports shall be 25 feet (7620 mm) in width or 20 feet (6096 mm) in height.

780 CMR FIGURE 5410.4.1
GLASS UNIT MASONRY DESIGN WIND LOAD RESISTANCE



For SI: 1 square foot = 0.0929 m^2, 1 pound per square foot = 0.0479 kN/m^2.

5610.4.2 Exterior Thin-unit Panels. The maximum area of each individual thin-unit panel shall be 85 square feet (7.9 m^2). The maximum dimension between structural supports shall be 15 feet (4572 mm) in width or ten feet (3048 mm) in height. Thin units shall not be used in applications where the design wind pressure as stated in 780 CMR Table 5301.2(1) exceeds 20 psf (958 Pa).

5610.4.3 Interior Panels. The maximum area of each individual standard-unit panel shall be 250 square feet (23.2 m^2). The maximum area of each thin-unit panel shall be 150 square feet (13.9 m^2). The maximum dimension between structural supports shall be 25 feet (7620mm) in width or 20 feet (6096 mm) in height.

5610.4.4 Curved Panels. The width of curved panels shall conform to the requirements of 780CMR 5610.4.1, 5610.4.2 and 5610.4.3, except additional structural supports shall be provided at locations where a curved section joins a straight section, and at inflection points in multicurved walls.

5610.5 Panel Support. Glass unit masonry panels shall conform to the support requirements of 780 CMR 5610.5.

5610.5.1 Deflection. The maximum total deflection of structural members that support glass unit masonry shall not exceed l/600.

5610.5.2 Lateral Support. Glass unit masonry panels shall be laterally supported along the top and sides of the panel. Lateral supports for glass unit masonry panels shall be designed to resist a minimum of 200 pounds per lineal feet (2918 N/m) of panel, or the actual applied loads, whichever is greater. Except for single unit panels, lateral support shall be provided by panel anchors along the top and sides spaced a maximum of 16 inches (406 mm) on center or by channel-type restraints. Single unit panels shall be supported by channel-type restraints.

Exceptions:

1. Lateral support is not required at the top of panels that are one unit wide.
2. Lateral support is not required at the sides of panels that are one unit high.

5610.5.2.1 Panel Anchor Restraints. Panel anchors shall be spaced a maximum of 16 inches (406 mm) on center in both jambs and across the head. Panel anchors shall be embedded a minimum of 12 inches (305 mm) and shall be provided with two fasteners so as to resist the loads specified in 780 CMR 5610.5.2.

5610.5.2.2 Channel-type Restraints. Glass unit masonry panels shall be recessed at least one inch (25.4 mm) within channels and chases. Channel-type restraints shall be oversized to accommodate expansion material in the opening, packing and sealant between the framing restraints, and the glass unit masonry perimeter units.

5610.6 Sills. Before bedding of glass units, the sill area shall be covered with a water base asphaltic emulsion coating. The coating shall shall be a minimum of ⅛ inch (3.2 mm) thick.

5610.7 Expansion Joints. Glass unit masonry panels shall be provided with expansion joints along

the top and sides at all structural supports. Expansion joints shall be a minimum of ⅜ inch (9.5 mm) in thickness and shall have sufficient thickness to accommodate displacements of the supporting structure. Expansion joints shall be entirely free of mortar and other debris and shall be filled with resilient material.

5610.8 Mortar. Glass unit masonry shall be laid with Type S or N mortar. Mortar shall not be retempered after initial set. Mortar unused within 1½ hours after initial mixing shall be discarded.

5610.9 Reinforcement. Glass unit masonry panels shall have horizontal joint reinforcement spaced a maximum of 16 inches (406 mm) on center located in the mortar bed joint. Horizontal joint reinforcement shall extend the entire length of the panel but shall not extend across expansion joints. Longitudinal wires shall be lapped a minimum of 6 inches (152 mm) at splices. Joint reinforcement shall be placed in the bed joint immediately below and above openings in the panel. The reinforcement shall have not less than two parallel longitudinal wires of size W1.7 or greater, and have welded cross wires of size W1.7 or greater.

5610.10 Placement. Glass units shall be placed so head and bed joints are filled solidly. Mortar shall not be furrowed. Head and bed joints of glass unit masonry shall be ¼ inch (6.4 mm) thick, except that vertical joint thickness of radial panels shall not be less than ⅛ inch (3.2 mm) or greater than ⅝ inch (15.9 mm). The bed joint thickness tolerance shall be minus $^{1}/_{16}$ inch (1.6mm) and plus ⅛ inch (3.2 mm). The head joint thickness tolerance shall be plus or minus ⅛ inch (3.2 mm).

780 CMR 5611 INSULATING CONCRETE FORM WALL CONSTRUCTION

5611.1 General. Insulating concrete form (ICF) walls shall be designed and constructed in accordance with the provisions of 780 CMR 5611 or in accordance with the provisions of ACI 318. When ACI 318 is used to design insulating concrete form foundation walls, project drawings, typical details and specifications shall bear the seal of the Massachusetts-registered architect or Massachusetts-registered professional engineer responsible for design.

5611.2 Applicability Limits. The provisions of 780 CMR 5611.2 shall apply to the construction of insulating concrete form walls for buildings not greater than 60 feet (18288 mm) in plan dimensions, and floors not greater than 32 feet (9754 mm) or roofs not greater than 40 feet (12192mm) in clear span. Buildings shall not exceed two stories in height above-grade. Insulating concrete form walls shall comply with the requirements in 780 CMR Table 5611.2. Walls constructed in accordance with the provisions of 780 CMR 5611.2 shall be limited to buildings subjected to a maximum design wind speed of 150 miles per hour (241 km/h), a maximum ground snow load of 70 psf (3.35 kN/m^2).

780 CMR TABLE 5611.2
REQUIREMENTS FOR ICF WALLS[a,b,c]

WALL TYPE AND NOMINAL SIZE	MAXIMUM WALL WEIGHT (psf)	MINIMUM WIDTH OF VERTICAL CORE (inches)	MINIMUM THICKNESS OF VERTICAL CORE (inches)	MAXIMUM SPACING OF VERTICAL CORES (inches)	MAXIMUM SPACING OF HORIZONTAL CORES (inches)	MINIMUM WEB THICKNESS (inches)
3.5" Flat	44	N/A	N/A	N/A	N/A	N/A
5.5" Flat	69	N/A	N/A	N/A	N/A	N/A
7.5" Flat	94	N/A	N/A	N/A	N/A	N/A
9.5" Flat	119	N/A	N/A	N/A	N/A	N/A
6" Waffle-Grid	56	6.25	5	12	16	2
8" Waffle-Grid	76	7	7	12	16	2
6" Screen-Grid	53	5.5	5.5	12	12	N/A

For SI: 1 inch = 25.4 mm

a. For width "W", thickness "T", spacing, and web thickness, refer to Figures 5611.4 and 5611.5.

b. N/A indicates not applicable

c. Wall weight is based on a unit weight of concrete of 150 pcf (23.6kN/m3). The tabulated values do not include any allowance for interior and exterior finishes.

5611.3 Flat insulating Concrete Form Wall Systems. Flat ICF wall systems shall comply with 780 CMR Figure 5611.3 and shall have reinforcement in accordance with 780 CMR Tables 5611.3(1) and 5611.3(2) and 780 CMR 5611.7.

5611.4 Waffle-grid Insulating Concrete Form Wall Systems. Waffle-grid wall systems shall comply with 780 CMR Figure 5611.4 and shall have reinforcement in accordance with 780 CMR Tables 5611.3(1) and 5611.4(1) and 780 CMR 5611.7. The minimum core dimensions shall comply with 780 CMR Table 5611.4(2).

5611.5 Screen-grid Insulating Concrete Form Wall Systems. Screen-grid ICF wall systems shall comply with 780CMR Figure 5611.5 and shall have reinforcement in accordance with 780 CMR Tables 5611.3(1) and 5611.5 and 780 CMR 5611.7. The minimum core dimensions shall comply with 780CMR Table 5611.4(2).

5611.6 Material. Insulating concrete form wall materials shall comply with 780 CMR 5611.6.

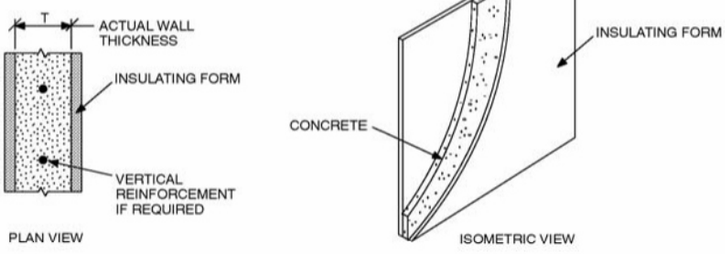
5611.6.1 Concrete Material. Ready-mixed concrete for insulating concrete form walls shall be in accordance with 780 CMR 5402.2. Maximum slump shall not be greater than 6 inches (152 mm) as determined in accordance with ASTM C 143. Maximum aggregate size shall not be larger than ¾ inch (19.1 mm).

Exception: Concrete mixes conforming to the ICF manufacturer's recommendations.

5611.6.2 Reinforcing Steel. Reinforcing steel shall meet the requirements of ASTM A 615, A 706 or A 996.

5611.6.3 Insulation Materials. Insulating concrete forms material shall meet the surface burning characteristics of 780 CMR 5314.1.1. A thermal barrier shall be provided on the building interior in accordance with 780 CMR 5314.1.2 or 780 CMR 5702.3.4.

780 CMR FIGURE 5611.3
FLAT ICF WALL SYSTEM



780 CMR TABLE 5611.3(1)
DESIGN WIND PRESSURE FOR USE WITH 780 CMR TABLES 5611.3(2), 5611.4(1), AND 780 CMR 5611.5 FOR ABOVE GRADE WALLS[a]

WIND SPEED (mph)[e]	DESIGN WIND PRESSURE (psf)					
	Enclosed[b]			Partially Enclosed[b]		
	Exposure[c]			Exposure[c]		
	B	C	D	B	C	D
85	18	24	29	23	31	37
90	20	27	32	25	35	41
100	24	34	39	31	43	51
110	29	41	48	38	52	61
120	35	48	57	45	62	73
130	41	56	66	53	73	85[d]
140	47	65	77	61	84[d]	99[d]
150	54	75	88[d]	70	96[d]	114[d]

For SI: 1 psf = 0.0479 kN/m^2; 1 mph = 1.6093 km/hr

a. This table is based on ASCE 7-98 components and cladding wind pressures using a mean roof height of 35 ft (10.7 m) and a tributary area of 10 ft^2 (0.9 m^2).
b. Buildings in wind borne debris regions as defined in 780 CMR 5202 shall be considered as "Partially Enclosed" unless glazed openings are protected in accordance with 780 CMR 5301.2.2.2 whereby the building shall be considered as "Enclosed." All other buildings shall be classified as "Enclosed."
c. Exposure Categories shall be determined in accordance with 780 CMR 5301.2.1.4.
d. For wind pressures greater than 80 psf (3.8 kN/m^2), design is required in accordance with ACI 318 and approved manufacturer guidelines.
e. Interpolation is permitted between wind speeds.

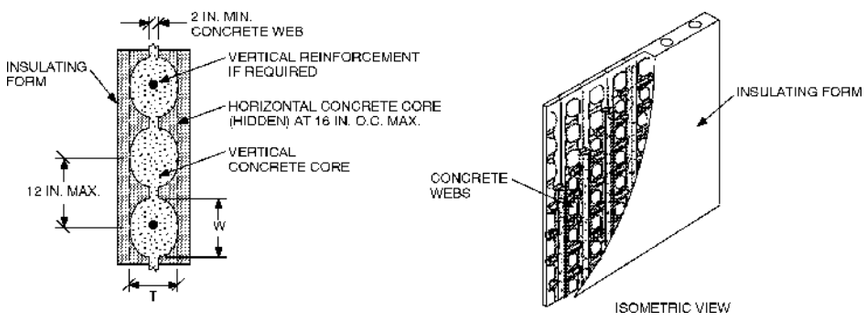
780 CMR TABLE 5611.3(2)
MINIMUM VERTICAL WALL REINFORCEMENT FOR FLAT ICF ABOVE-GRADE WALLS[a,b,c,d]

Design Wind Pressure [780 CMR Table 5611.3(1)] (psf)	Maximum Unsupported Wall Height (feet)	Minimum Vertical Reinforcement[d,e,f]					
		Non-Load Bearing Wall or Supporting Roof		Supporting Light-Frame Second Story and Roof		Supporting ICF Second Story and Roof	
		Minimum Wall Thickness (inches)					
		3.5[g]	5.5	3.5[g]	5.5	3.5[g]	5.5
20	8	#4@48	#4@48	#4@48	#4@48	#4@48	#4@48
	9	#4@48	#4@48	#4@48	#4@48	#4@48	#4@48
	10	#4@38	#4@48	#4@40	#4@48	#4@42	#4@48
30	8	#4@42	#4@48	#4@46	#4@48	#4@48	#4@48
	9	#4@32; #5@48	#4@48	#4@34; #5@48	#4@48	#4@34; #5@48	#4@48
	10	Design Required	#4@48	Design Required	#4@48	Design Required	#4@48
40	8	#4@30; #5@48	#4@48	#4@30; #5@48	#4@48	#4@32; #5@48	#4@48
	9	Design Required	#4@42	Design Required	#4@46	Design Required	#4@48
	10	Design Required	#4@32; #5@48	Design Required	#4@34; #5@48	Design Required	#4@38
50	8	#4@20; #5@30	#4@42	#4@22; #5@34	#4@46	#4@24; #5@36	#4@48
	9	Design Required	#4@34; #5@48	Design Required	#4@34; #5@48	Design Required	#4@38
	10	Design Required	#4@26; #5@38	Design Required	#4@26; #5@38	Design Required	#4@28; #5@46
60	8	Design Required	#4@34; #5@48	Design Required	#4@36	Design Required	#4@40
	9	Design Required	#4@26; #5@38	Design Required	#4@28; #5@46	Design Required	#4@34; #5@48
	10	Design Required	#4@22; #5@34	Design Required	#4@22; #5@34	Design Required	#4@26; #5@38
70	8	Design Required	#4@28; #5@46	Design Required	#4@30; #5@48	Design Required	#4@34; #5@48
	9	Design Required	#4@22; #5@34	Design Required	#4@22; #5@34	Design Required	#4@24; #5@36
	10	Design Required	#4@16; #5@26	Design Required	#4@18; #5@28	Design Required	#4@20; #5@30
80	8	Design Required	#4@26; #5@38	Design Required	#4@26; #5@38	Design Required	#4@28; #5@46
	9	Design Required	#4@20; #5@30	Design Required	#4@20; #5@30	Design Required	#4@21; #5@34
	10	Design Required	#4@14; #5@24	Design Required	#4@ 14; #5@24	Design Required	#4@16; #5@26

For SI: 1 foot = 0.3048 m; 1 inch = 25.4 mm; 1 mph = 1.6093 km/hr.

a. This table is based on reinforcing bars with a minimum yield strength of 40,000 psi (276 MPa) and concrete with a minimum specified compressive strength of 2,500 psi (17.2 MPa).
b. Deflection criterion is *L/240,* where *L* is the height of the wall story in inches.
c. Interpolation shall not be permitted.
d. Reinforcement spacing for 3.5 inch (88.9 mm) walls shall be permitted to be multiplied by 1.6 when reinforcing steel with a minimum yield strength of 60,000 psi (414 MPa) is used. Reinforcement shall not be less than one #4 bar at 48 inches (1.2 m) on center.
e. Reinforcementspacingfor5.5 inch (139.7mm) walls shall be permitted to be multiplied by 1.5 when reinforcing steel with a minimum yield strength of 60,000 psi (414 MPa) is used. Reinforcement shall not be less than one #4 bar at 48 inches (1.2 m) on center.
f. Also see 780 CMR 5611.7.1.2 when applicable.
g. A 3.5-inch wall shall not be permitted if wood ledgers are used to support floor or roof loads. See Section 5611.8.

780 CMR FIGURE 5611.4
WAFFLE-GRID ICF WALL SYSTEM



780 CMR TABLE 5611.4(1)
MINIMUM VERTICAL WALL REINFORCEMENT FOR WAFFLE-GRID ICF ABOVE-GRADE WALLS[a,b,c]

Design Wind Pressure [780 CMR Table 5611.3(1)] (psf)	Maximum Unsupported Wall Height (feet)	MINIMUM VERTICAL REINFORCEMENT[d,e]					
		Non-Load Bearing Wall or Supporting Roof		Supporting Light-Frame Second Story and Roof		Supporting ICF Second Story and Roof	
		Minimum Wall Thickness (inches)					
		6	8	6	8	6	8
20	8	#4@48	#4@48	#4@48	#4@48	#4@48	#4@48
	9	#4@48	#4@48	#4@48	#4@48	#4@48	#4@48
	10	#4@48	#4@48	#4@48	#4@48	#4@48	#4@48
30	8	#4@48	#4@48	#4@48	#4@48	#4@48	#4@48
	9	#4@48	#4@48	#4@48	#4@48	#4@48	#4@48
	10	#4@36; #5@48	#4@48	#4@36; #5@48	#4@48	#4@36; #5@48	#4@48
40	8	#4@36; #5@48	#4@48	#4@48	#4@48	#4@48	#4@48
	9	#4@36; #5@48	#4@48	#4@36; #5@48	#4@48	#4@36; #5@48	#4@48
	10	#4@24; #5@36	#4@36; #5@48	#4@24; #5@36	#4@48	#4@24; #5@36	#4@48
50	8	#4@36; #5@48	#4@48	#4@36; #5@48	#4@48	#4@36; #5@48	#4@48
	9	#4@24; #5@36	#4@36; #5@48	#4@24; #5@36	#4@48	#4@24; #5@48	#4@48
	10	Design Required	#4@36; #5@48	Design Required	#4@36; #5@48	Design Required	#4@36; #5@48
60	8	#4@24; #5@36	#4@48	#4@24; #5@36	#4@48	#4@24; #5@48	#4@48
	9	Design Required	#4@36; #5@48	Design Required	#4@36; #5@48	Design Required	#4@36; #5@48
	10	Design Required	#4@24; #5@36	Design Required	#4@24; #5@36	Design Required	#4@24; #5@48
70	8	#4@24; #5@36	#4@36; #5@48	#4@24; #5@36	#4@36; #5@48	#4@24; #5@36	#4@48
	9	Design Required	#4@24; #5@36	Design Required	#4@24; #5@48	Design Required	#4@24; #5@48
	10	Design Required	#4@ 12; #5@36	Design Required	#4@24; #5@36	Design Required	#4@24; #5@36
80	8	#4@12; #5@24	#4@24; #5@48	#4@12; #5@24	#4@24; #5@48	#4@12; #5@24	#4@36; #5@48
	9	Design Required	#4@24; #5@36	Design Required	#4@24; #5@36	Design Required	#4@24; #5@36
	10	Design Required	#4@ 12; #5@24	Design Required	#4@12; #5@24	Design Required	#4@12; #5@24

For SI: 1 foot = 0.3048 m; 1 inch = 25.4 mm; 1 mph = 1.6093 km/hr.

a. This table is based on reinforcing bars with a minimum yield strength of 40,000 psi (276 MPa) and concrete with a minimum specified compressive strength of 2,500 psi (17.2 MPa).

b. Deflection criterion is *L/240,* where *L* is the height of the wall story in inches.

c. Interpolation shall not be permitted.

d. Reinforcement spacing shall be permitted to be increased by 12 inches (305 mm) when reinforcing steel with a minimum yield strength of 60,000 psi (414 MPa) is used or No. 4 reinforcing bars shall be permitted to be substituted for #5 bars when reinforcing steel with a minimum yield strength of 60,000 psi (414 MPa) is used at the same spacing required for #5 bars. Reinforcement shall not be less than one #4 bar at 48 inches (1.2 m) on center.

e. Also see 780 CMR 5611.7.1.2 when applicable.

780 CMR TABLE 5611.4(2)
DIMENSIONAL REQUIREMENTS FOR CORES AND WEBS IN WAFFLE-GRID AND SCREEN-GRID ICF WALLS[a,b]

WALL TYPE AND NOMINAL SIZE (inches)	MINIMUM WIDTH OF CORE (inches)	MINIMUM THICKNESS OF VERTICAL CORE (inches)	MAXIMUM SPACING OF VERTICAL CORES (inches)	MAXIMUM SPACING OF HORIZONTAL CORES (inches)	MINIMUM WEB THICKNESS (inches)
6^ Waffle-Grid	6.25	5	12	16	2
8^ Waffle-Grid	7	7	12	16	2
6^ Screen-Grid	5.5	5.5	12	12	N/A

For SI: 1 inch = 25.4 mm.

a. For width "W," thickness "T"; spacing, and web thickness, refer to 780 CMR Figures 5611.4 and 5611.5.

b. N/A indicates not applicable.

780 CMR TABLE 5611.5
MINIMUM VERTICAL WALL REINFORCEMENT FOR SCREEN-GRID ICF ABOVE-GRADE WALLS[a,b,c]

DESIGN WIND PRESSURE TABLE 5611.3(1) (psf)	MAXIMUM UNSUPPORTED WALL HEIGHT (feet)	MINIMUM VERTICAL REINFORCEMENT[d,e]		
		Non-Load Bearing Wall or Supporting Roof	Supporting Light-Frame Second Story and Roof	Supporting ICF Second Story and Roof
20	8	#4@48	#4@48	#4@48
	9	#4@48	#4@48	#4@48
	10	#4@48	#4@48	#4@48
30	8	#4@48	#4@48	#4@48
	9	#4@48	#4@48	#4@48
	10	#4@36; #5@48	#4@48	#4@48
40	8	#4@48	#4@48	#4@48
	9	#4@36; #5@48	#4@36; #5@48	#4@48
	10	#4@24; #5@48	#4@24; #5@48	#4@24; #5@48
50	8	#4@36; #5@48	#4@36; #5@48	#4@48
	9	#4@24; #5@48	#4@24; #5@48	#4@24; #5@48
	10	Design Required	Design Required	Design Required
60	8	#4@24; #5@48	#4@24; #5@48	#4@36; #5@48
	9	#4@24; #5@36	#4@24; #5@36	#4@24; #5@36
	10	Design Required	Design Required	Design Required
70	8	#4@24; #5@36	#4@24; #5@36	#4@24; #5@36
	9	Design Required	Design Required	Design Required
	10	Design Required	Design Required	Design Required
80	8	#4@12; #5@36	#4@24; #5@36	#4@24; #5@36
	9	Design Required	Design Required	Design Required
	10	Design Required	Design Required	Design Required

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.6093 km/h.

a. This table is based on reinforcing bars with a minimum yield strength of 40,000 psi (276 MPa) and concrete with a minimum specified compressive strength of 2,500 psi (17.2 MPa).

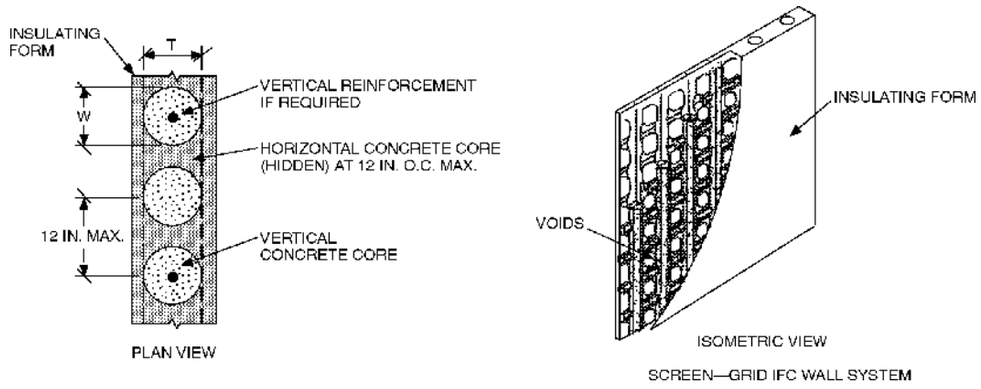
b. Deflection criterion is $L/240$, where L is the height of the wall story in inches.

c. Interpolation shall not be permitted.

d. Reinforcement spacing shall be permitted to be increased by 12 inches (305mm) when reinforcing steel with a minimum yield strength of 60,000 psi (414 MPa) is used. Reinforcement shall not be less than one #4 bar at 48 inches (1.2 m) on center.

e. Also see 780 CMR 5611.7.1.2 when applicable.

780 CMR FIGURE 5611.5
SCREEN-GRID IFC WALL SYSTEM



For SI: 1 inch = 25.4 mm.

5611.7 Wall Construction. Insulating concrete form walls shall be constructed in accordance with the provisions of 780 CMR 5611.7 and 780 CMR Figure 5611.7(1).

5611.7.1 Reinforcement

5611.7.1.1 Location. Vertical and horizontal wall reinforcement shall be placed within the middle third of the wall. Steel reinforcement shall have a minimum concrete cover in accordance with ACI 318.

Exception: Where insulated concrete forms are used and the form remains in place as cover for the concrete, the minimum concrete cover for the reinforcing steel is permitted to be reduced to ¾ inch (19.1mm).

5611.7.1.2 Vertical Steel. Above-grade concrete walls shall have reinforcement in accordance with 780 CMR 5611.3, 5611.4 or 5611.5 and 5611.7.2. All vertical reinforcement in the top-most ICF story shall terminate with a bend or standard hook and be provided with a minimum lap splice of 24 inches (610 mm) with the top horizontal reinforcement.

Above-grade ICF walls shall be supported on concrete foundations reinforced as required for the above-grade wall immediately above, or in accordance with 780 CMR Tables 5404.4(1) through 5404.4(5), whichever requires the greater amount of reinforcement.

Vertical reinforcement shall be continuous from the bottom of the foundation wall to the roof. Lap splices, if required, shall comply with 780CMR 5611.7.1.5. Where vertical reinforcement in the above-grade wall is not continuous with the foundation wall reinforcement, dowel bars with a size and spacing to match the vertical ICF wall reinforcement shall be embedded 40d_b into the foundation wall and shall be lapspliced with the above-grade wall reinforcement. Alternatively, for No. 6 and larger bars, the portion of the bar embedded in the foundation wall shall be embedded 24 inches (610 mm) in the foundation wall and shall have a standard hook.

5611.7.1.3 Horizontal Steel. Concrete walls with a minimum thickness of four inches (102 mm) shall have a minimum of one continuous No. 4 horizontal reinforcing bar placed at 32 inches (812 mm) on center with one bar within 12 inches (305 mm) of the top of the wall story. Concrete walls 5.5 inches (140 mm) thick or greater shall have a minimum of one continuous No. 4 horizontal reinforcing bar placed at 48 inches (1219 mm) on center with one bar located within 12 inches (305 mm) of the top of the wall story.

Horizontal reinforcement shall be continuous around building corners using corner bars or by bending the bars. In either case, the minimum lap splice shall be 24 inches (610 mm). For townhouses in Seismic Design Category C and for all buildings in Seismic Design Categories D_1 and D_2, each end of all horizontal reinforcement shall terminate with a standard hook or lap splice.

5611.7.1.4 Lap Splices. Where lap splicing of vertical or horizontal reinforcing steel is necessary, the lap splice shall be in accordance with 780 CMR Figure 5611.7.1.4 and a minimum of 40d_b, where d_b is the diameter of the smaller bar. The maximum distance between noncontact parallel bars at a lap splice shall not exceed 8d_b.

5611.7.1.5 Standard Hook. Where the free end of a reinforcing bar is required to have a standard hook, the hook shall be a 180-degree bend plus 4d_b extension but not less than 2½ inches, or a 90-degree bend plus 12d_b extension.

780 CMR TABLE 5611.7(1)
MINIMUM WALL OPENING REINFORCEMENT REQUIREMENTS IN ICF WALLS

WALL TYPE AND OPENING WIDTH (L) (feet)	MINIMUM HORIZONTAL OPENING REINFORCEMENT	MINIMUM VERTICAL OPENING REINFORCEMENT
Flat, Waffle-, and Screen-Grid: L < 2 (0.61)	None required	None required
Flat, Waffle-, and Screen-Grid: L ≥ 2 (0.61)	Provide lintels in accordance with 780 CMR 5611.7.3. Provide one No. 4 bar within 12 inches (305 mm) from the bottom of the opening. Top and bottom lintel reinforcement shall extend a minimum of 24 inches (610 mm) beyond the limits of the opening.	***In locations with wind speeds less than or equal to 110 mph, provide one No. 4 bar for the full height of the wall story within 12 inches of each side of the opening. In locations with wind speeds greater than 110 mph, provide two No. 4 bars or one No. 5 bar for the full height of the wall story within 12 inches of each side of the opening.***

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 mile per hour = 1.609 km/h.

NOTE: This table is based on concrete with a minimum specified compressive strengthof 2,500 psi, reinforcing steel withaminimum yield strength of 40,000 psi and an assumed equivalent rectangular cross section. This table is not intended to prohibit the use of ICF manufacturer's tables based on engineering analysis in accordance with ACI 318.

780 CMR TABLE 5611.7(2)
MAXIMUM ALLOWABLE CLEAR SPANS FOR ICF LINTELS
FOR FLAT LOAD-BEARING WALLS[a,b,c,d,f]
NO. 4 BOTTOM BAR SIZE

MINIMUM LINTEL THICKNESS, *T* (inches)	LINTEL DEPTH, *D* (inches)	MAXIMUM CLEAR SPAN, (feet-inches) (Number is Middle of Span, A)[e]					
		Supporting Roof Only		Supporting Light Framed 2nd Story and Roof		Supporting ICF Second Story and Roof	
		Ground Snow Load					
		30 psf	70 psf	30 psf	70 psf	30 psf	70 psf
3.5	8	4-9 (1-2)	4-2 (0-9)	3-10 (0-8)	3-4 (0-6)	3-5 (0-6)	3-1 (0-5)
	12	6-8 (1-11)	5-5 (1-3)	5-0 (1-1)	4-5 (0-10)	4-6 (0-10)	4-0 (0-8)
	16	7-11 (2-9)	6-5 (1-9)	6-0 (1-6)	5-3 (1-2)	5-4 (1-2)	4-10 (1-0)
	20	8-11 (3-5)	7-4 (2-3)	6-9 (1-11)	6-0 (1-6)	6-1 (1-7)	5-6 (1-3)
	24	9-10 (4-1)	8-1 (2-9)	7-6 (2-4)	6-7 (1-10)	6-9 (1-11)	6-1 (1-6)
5.5	8	5-2 (1-10)	4-2 (1-2)	3-10 (1-0)	3-5 (0-9)	3-5 (0-10)	3-1 (0-8)
	12	6-8 (3-0)	5-5 (2-0)	5-0 (1-9)	4-5 (1-4)	4-6 (1-4)	4-1 (1-1)
	16	7-10 (4-1)	6-5 (2-9)	6-0 (2-5)	5-3 (1-10)	5-4 (1-11)	4-10 (1-7)
	20	8-10 (5-3)	7-3 (3-6)	6-9 (3-1)	6-0 (2-4)	6-1 (2-5)	5-6 (2-0)
	24	9-8 (6-3)	8-0 (4-3)	7-5 (3-8)	6-7 (2-11)	6-8 (3-0)	6-0 (2-5)
7.5	8	5-2 (2-6)	4-2 (1-8)	3-11 (1-5)	3-5 (1-1)	3-6 (1-1)	3-2 (0-11)
	12	6-7 (4-0)	5-5 (2-8)	5-0 (2-4)	4-5 (1-10)	4-6 (1-10)	4-1 (1-6)
	16	7-9 (5-5)	6-5 (3-8)	5-11 (3-3)	5-3 (2-6)	5-4 (2-7)	4-10 (2-2)
	20	8-8 (6-10)	7-2 (4-8)	6-8 (4-2)	5-11 (3-3)	6-0 (3-4)	5-5 (2-9)
	24	9-6 (8-2)	7-11 (5-8)	7-4 (5-1)	6-6 (3-11)	6-7 (4-1)	6-0 (3-4)
9.5	8	5-2 (3-1)	4-2 (2-1)	3-11 (1-9)	3-5 (1-5)	3-6 (1-5)	3-2 (1-2)
	12	6-7 (5-0)	5-5 (3-4)	5-0 (3-0)	4-5 (2-4)	4-6 (2-5)	4-1 (1-11)
	16	7-8 (6-9)	6-4 (4-7)	5-11 (4-2)	5-3 (3-3)	5-4 (3-4)	4-10 (2-8)

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per square inch = 6.895kN/m^2, 1 pound per square foot = 0.0479kN/m^2.

a. This table is based on concrete with a minimum specified compressive strength of 2,500 psi, reinforcing steel with a minimum yield strength of 40,000 psi and an assumed equivalent rectangular cross section. When reinforcement with a minimum yield strength of 60,000 psi is used, the span lengths in the shaded cells shall be increased by 1.2 times the table values.

b. This table is not intended to prohibit the use of ICF manufacturer's tables based on engineering analysis in accordance with ACI 318.

c. Deflection criteria: *L*/240.

d. Design load assumptions:

Floor dead load is 10 psf — Attic live load is 20 psf
Floor live load is 30 psf — Roof dead load is 15 psf
Building width is 32 feet — ICF wall dead load is 69 psf
Light-framed wall dead load is 10 psf

e. No. 3 stirrups are required at *d*/2 spacing except no stirrups are required for the distance, (A), shown in the middle portion of the span in accordance with 780 CMR Figure 5611.7(2) and 780 CMR 5611.7.3.2.

f. Interpolation is permitted between ground snow loads and between lintel depths.