APPENDIX B
REINFORCEMENT SCHEDULES

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It is recommended that residential builders obtain and utilize this publication in conjunction with this installation manual. This publication can be acquired from the PCA directly by calling 847.966.6200 or at www.cement.org.

TABLE 3.1
MINIMUM WIDTH OF CONCRETE FOOTINGS FOR CONCRETE WALLS (INCHES)

Max. number of stories[5]	Max. roof span[6] (ft)	Max. floor span[7] (ft)	Minimum load-bearing value of soil[8] (psf)											
			1500		2000		2500		3000		3500		4000	
			Ground snow load[9] (psf)											
			30	70	30	70	30	70	30	70	30	70	30	70
Group 1 – 4-inch flat, 6-inch waffle-grid, or 6-inch screen-grid wall thickness[10]														
One story	32	20	20	24	15	18	12	14	10	12	9	10	8	9
		32	22	26	17	19	13	15	11	13	10	11	8	10
	40	20	22	26	16	19	13	16	11	13	9	11	8	10
		32	24	28	18	21	14	17	12	14	10	12	9	10
Two story	32	20	27	30	20	23	16	18	14	15	12	13	10	11
		32	31	34	23	25	19	20	16	17	13	15	12	13
	40	20	29	33	21	25	17	20	14	16	12	14	11	12
		32	32	36	24	27	19	22	16	18	14	15	12	14
Group 2 – 6-inch flat or 8-in waffle-grid wall thickness[10,11]														
One story	32	20	22	25	16	19	13	15	11	12	9	11	8	9
		32	23	27	18	20	14	16	12	13	10	11	9	10
	40	20	23	27	17	20	14	16	12	14	10	12	9	10
		32	25	29	19	22	15	17	12	15	11	12	9	11
Two story	32	20	30	33	22	25	18	20	15	16	13	14	11	12
		32	33	36	25	27	20	22	17	18	14	16	13	14
	40	20	31	35	23	26	19	21	16	18	13	15	12	13
		32	35	39	26	29	21	23	17	19	15	17	13	14
Group 3 – 8-inch flat wall thickness[10,12]														
One story	32	20	25	28	19	21	15	17	12	14	11	12	9	11
		32	27	30	20	23	16	18	13	15	11	13	10	11
	40	20	26	30	20	23	16	18	13	15	11	13	10	11
		32	28	32	21	24	17	19	14	16	12	14	11	12
Two story	32	20	34	38	26	28	21	23	17	19	15	16	13	14
		32	38	41	29	31	23	25	19	21	16	18	14	15
	40	20	36	40	27	30	21	24	18	20	15	17	13	15
		32	39	43	30	33	24	26	20	22	17	19	15	16
Group 4 – 10-inch flat wall thickness[10]														
One story	32	20	28	32	21	24	17	19	14	16	12	14	11	12
		32	30	33	23	25	18	20	15	17	13	14	11	13
	40	20	30	34	22	25	18	20	15	17	13	14	11	13
		32	32	36	24	27	19	21	16	18	14	15	12	13
Two story	32	20	39	43	29	32	24	26	20	21	17	18	15	16
		32	43	46	32	35	26	28	22	23	19	20	16	17
	40	20	41	45	31	34	24	27	20	22	17	19	15	17
		32	44	48	33	36	27	29	22	24	19	21	17	18
Additional footing width for masonry veneer[4,13,14]														
One story			5		3		3		2		2		2	
Two story			6		5		4		3		3		2	

NOTES FOR TABLE 3.1

1. Minimum footing thickness shall be the greater of: the projection of the footing beyond the face of the concrete wall, one-third of the footing width, 6 inches, and 11 inches where vertical wall reinforcement is required to extend into the footing in accordance with Section 6.2.
2. Footings shall have a width that allows for a nominal 2-inch projection from either face of the concrete in the wall to the edge of the footing. Where masonry veneer is supported directly on the footing, the required projection shall be measured from the face of the veneer.
3. Tabulated footing widths are based on the weight of concrete walls as indicated in Table 2.1, plus an allowance of 2 psf for interior wall finish and 11 psf for exterior wall finish. Where two or more wall types are grouped, the greatest weight of all those in the group was used.
4. Masonry veneer is not permitted for multiple dwellings assigned to Seismic Design Category C and all buildings assigned to Seismic Design Category D0, D1 or D2.
5. Basement walls shall not be considered as a story in determining footing widths, because table values assume the building has a basement. Where the building does not have a basement and the height of the foundation wall measured from the top of the footing to the top of the first floor does not exceed 5 feet, footing widths are permitted to be reduced 10%. This reduction also applies to the additional footing width for masonry veneer.
6. For roof spans of less than 32 feet, use footing width for 32 feet roof span. For roof spans between 32 and 40 feet, use footing width for 40 feet roof span, or determine footing width by interpolation.
7. For floor spans of less than 20 feet, use footing width for 20 feet floor span. For floor spans between 20 and 32 feet, use footing width for 32 feet floor span, or determine footing width by interpolation.
8. To determine required footing width for soil bearing values of greater than 2,500 psf that are not shown in the table, multiply the footing width for 1,500 psf soil by 1,500 and divide by the load bearing value of he soil for which the footing width is desired.
9. For ground snow loads between 20 and 70 psf, use footing widths shown for 70 psf or determine by interpolation.
10. See Table 2.1 for tolerance from nominal thickness permitted for flat walls, and thicknesses and dimensions of waffle- and screed-grid walls.
11. Tabulated footing widths based on use of 6-inch nominal flat or 8-inch nominal waffle-grid foundation wall and above-grade wall. Where an 8-inch or 10-inch nominal flat foundation wall is used with an above-grade 6-inch nominal flat or 8-inch nominal waffle-grid wall, use footing width required for 8-inch or 10-inch nominal flat wall, or interpolate midway between footing widths required for the foundation wall and above-grade wall.
12. Tabulated footing widths based on use of an 8-inch nominal flat foundation wall and above-grade wall. Where a 10-inch nominal flat foundation wall is used with an above-grade 8-inch nominal flat wall, use footing width required for a 10-inch nominal flat wall, or interpolate mid-way between footing widths required for the 10-inch nominal flat foundation wall and an 8-inch nominal flat above-grade wall.
13. Where masonry veneer is installed, the tabulated additional footing width is based on an installed weight of 40 psf for the veneer, minus 11 psf to compensate for the exterior finish of 11 psf which is already included. See Note 3.
14. It is assumed that the masonry veneer is supported directly on the footing.

Table 3.12

MINIMUM VERTICAL REINFORCEMENT FOR 6, 8, 10, AND 12 INCH NOMINAL FLAT BASEMENT WALLS

Maximum wall height (ft)	Maximum unbalanced backfill height[7] (ft)	Minimum vertical reinforcement – bar size No. and spacing (in.)											
		Maximum design lateral soil load											
		30 psf/ft				45 psf/ft				60 psf/ft			
		Minimum nominal wall thickness, (in.)											
		6	8	10	12	6	8	10	12	6	8	10	12
5	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
6	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR[12]	NR	NR	4@35	NR[12]	NR	NR
	6	NR	NR	NR	NR	5@48	NR	NR	NR	5@36	NR	NR	NR
7	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	NR	NR	NR	NR	5@47	NR	NR	NR
	6	NR	NR	NR	NR	5@42	NR	NR	NR	6@43	5@48	NR[12]	NR
	7	5@46	NR	NR	NR	6@42	5@46	NR[12]	NR	6@34	6@48	NR	NR
8	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4@38	NR[12]	NR	NR	5@43	NR	NR	NR
	6	4@37	NR[12]	NR	NR	5@37	NR	NR	NR	6@37	5@43	NR[12]	NR
	7	5@40	NR	NR	NR	6@37	5@41	NR[12]	NR	6@34	6@43	NR	NR
	8	6@43	5@47	NR[12]	NR	6@34	6@43	NR	NR	6@27	6@32	6@44	NR
9	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4@35	NR[12]	NR	NR	5@40	NR	NR	NR
	6	4@34	NR[12]	NR	NR	6@48	NR	NR	NR	6@36	5@39	NR[12]	NR
	7	5@36	NR	NR	NR	6@34	5@37	NR	NR	6@33	6@38	5@37	NR[12]
	8	6@38	5@41	NR[12]	NR	6@33	6@38	5@37	NR[12]	6@24	6@29	6@39	4@48[13]
	9	6@34	6@46	NR	NR	6@26	6@30	6@41	NR	6@19	6@23	6@30	6@39
10	4	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	5	NR	NR	NR	NR	4@33	NR[12]	NR	NR	5@38	NR	NR	NR
	6	5@48	NR[12]	NR	NR	6@45	NR	NR	NR	6@34	5@37	NR	NR
	7	6@47	NR	NR	NR	6@34	6@48	NR	NR	6@30	6@35	6@48	NR[12]
	8	6@34	5@38	NR	NR	6@30	6@34	6@47	NR[12]	6@22	6@26	6@35	6@45[13]
	9	6@34	6@41	4@48	NR[12]	6@23	6@27	6@35	4@48[13]	DR	6@22	6@27	6@34
	10	6@28	6@33	6@45	NR	DR	6@23	6@29	6@38	DR	6@22	6@22	6@28

For SI: 1 inch = 25.4 mm; 1 foot = 0.3048 m; 1 psf/ft = 0.1571 kN/m^2/m

NOTES FOR TABLE 3.1.2

1. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi.
2. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section 2.5.7 and Table 2.3.
3. NR indicates no vertical wall reinforcement is required, except for 6-inch nominal walls formed with stay-in-place forming systems in which case vertical reinforcement shall be #4@48 inches on center.
4. Allowable deflection criterion is ***L***/240, where ***L*** is the unsupported height of the basement wall in inches.
5. Interpolation shall not be permitted.
6. Where walls will retain 4 feet or greater of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
7. Refer to Chapter 1 for the definition of unbalanced backfill height.
8. Vertical reinforcement shall be located to provide a cover of 1.25 inches measured from the inside face of the wall. The center of the steel shall not vary from the specified location by more than the greater of 10% of the wall thickness and 3/8-inch.
9. Concrete cover for reinforcement measured from the inside face of the wall shall not be less than ¾-inch (19mm). Concrete cover for reinforcement measured from the outside face of the wall shall not be less than 1 ½ inches for #5 bars and smaller, and not less than 2 inches (51mm) for larger bars.
10. DR means design is required in accordance with the applicable building code, or where there is no code in accordance with ACI 318.
11. Concrete shall have a specified compressive strength of not less than 2,500 psi (17.2MPa) at 28 days, unless a higher strength is required by Note 12 or 13.
12. The minimum thickness is permitted to be reduced 2 inches, provided the minimum specified compressive strength of concrete is 4,000 psi.
13. A plain concrete wall with a minimum nominal thickness of 12 inches is permitted, provided the minimum specified compressive strength of concrete is 3,500 psi.
14. See Table 2.1 for tolerance from nominal thickness permitted for flat walls.

TABLE 3.7
MINIMUM VERTICAL REINFORCEMENT FOR 8-INCH NOMINAL FLAT CONCRETE BASEMENT WALLS

Maximum unsupported wall height (ft)	Maximum unbalanced backfill height[7] (ft)	Minimum vertical reinforcement – bar size No. and spacing (in.)		
		Maximum design lateral soil load		
		30 psf/ft	45 psf/ft	60 psf/ft
8	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6@37
	7	NR	6@36	6@35
	8	6@41	6@35	6@26
9	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6@35
	7	NR	6@35	6@32
	8	6@36	6@32	6@23
	9	6@35	6@25	6@18
10	4	NR	NR	NR
	5	NR	NR	NR
	6	NR	NR	6@35
	7	NR	6@35	6@29
	8	6@35	6@29	6@21
	9	6@34	6@22	6@16
	10	6@27	6@17	6@13

1. Table values are based on reinforcing bars with a minimum yield strength of 60,000 psi, concrete with a minimum specified compressive strength of 2,500 psi, and vertical reinforcement being located at the centerline of the wall. See Section 3.3.
2. Vertical reinforcement with a yield strength of less than 60,000 psi and/or bars of a different size than specified in the table are permitted in accordance with Section 2.5.7 and Table 2.3.
3. NR indicates no vertical reinforcement is required.
4. Deflection criterion is L/240, where L is the height of the basement wall in inches.
5. Interpolation shall not be permitted.
6. Where walls will retain 4 feet or greater of unbalanced backfill, they shall be laterally supported at the top and bottom before backfilling.
7. Refer to Chapter 1 for the definition of unbalanced backfill height.
8. See Sections 3.2.3, 3.2.4, and 3.2.5 for minimum reinforcement required for basement walls supporting above-grade concrete walls.
9. See Table 2.1 for tolerance from nominal thickness permitted for flat walls.

TABLE 3.5
MINIMUM HORIZONTAL REINFORCEMENT FOR CONCRETE BASEMENT WALLS

Maximum unsupported height of basement wall-feet (meters)	Location of horizontal reinforcement
≤ 8 (2.4)	One No. 4 bar within 12 inches (305 mm) of the top of the wall story and one No. 4 bar near mid-height of the wall story
> 8 (2.4)	One No. 4 bar within 12 inches (305 mm) of the top of the wall story and one No. 4 bar near third points in the wall story

1. Horizontal reinforcement requirements are for reinforcing bars with a minimum yield strength of 40,000 psi and concrete with a minimum concrete compressive strength of 2,500 psi.

2. See sections 3.2.3, 3.2.4, and 3.2.5 for minimum reinforcement required for basement walls supporting above-grade concrete walls.

TABLE 4.1
MINIMUM VERTICAL REINFORCEMENT FOR FLAT ABOVE-GRADE WALLS

Max. number of stories[5]	Max. roof span[6] (ft)	Max. floor span[7] (ft)	Minimum load-bearing value of soil[8] (psf)											
			1500		2000		2500		3000		3500		4000	
			Ground snow load[9] (psf)											
			30	70	30	70	30	70	30	70	30	70	30	70
Group 1 – 4-inch flat, 6-inch waffle-grid, or 6-inch screen-grid wall thickness[10]														
One story	32	20	20	24	15	18	12	14	10	12	9	10	8	9
		32	22	26	17	19	13	15	11	13	10	11	8	10
	40	20	22	26	16	19	13	16	11	13	9	11	8	10
		32	24	28	18	21	14	17	12	14	10	12	9	10
Two story	32	20	27	30	20	23	16	18	14	15	12	13	10	11
		32	31	34	23	25	19	20	16	17	13	15	12	13
	40	20	29	33	21	25	17	20	14	16	12	14	11	12
		32	32	36	24	27	19	22	16	18	14	15	12	14
Group 2 – 6-inch flat or 8-in waffle-grid wall thickness[10,11]														
One story	32	20	22	25	16	19	13	15	11	12	9	11	8	9
		32	23	27	18	20	14	16	12	13	10	11	9	10
	40	20	23	27	17	20	14	16	12	14	10	12	9	10
		32	25	29	19	22	15	17	12	15	11	12	9	11
Two story	32	20	30	33	22	25	18	20	15	16	13	14	11	12
		32	33	36	25	27	20	22	17	18	14	16	13	14
	40	20	31	35	23	26	19	21	16	18	13	15	12	13
		32	35	39	26	29	21	23	17	19	15	17	13	14
Group 3 – 8-inch flat wall thickness[10,12]														
One story	32	20	25	28	19	21	15	17	12	14	11	12	9	11
		32	27	30	20	23	16	18	13	15	11	13	10	11
	40	20	26	30	20	23	16	18	13	15	11	13	10	11
		32	28	32	21	24	17	19	14	16	12	14	11	12
Two story	32	20	34	38	26	28	21	23	17	19	15	16	13	14
		32	38	41	29	31	23	25	19	21	16	18	14	15
	40	20	36	40	27	30	21	24	18	20	15	17	13	15
		32	39	43	30	33	24	26	20	22	17	19	15	16
Group 4 – 10-inch flat wall thickness[10]														
One story	32	20	28	32	21	24	17	19	14	16	12	14	11	12
		32	30	33	23	25	18	20	15	17	13	14	11	13
	40	20	30	34	22	25	18	20	15	17	13	14	11	13
		32	32	36	24	27	19	21	16	18	14	15	12	13
Two story	32	20	39	43	29	32	24	26	20	21	17	18	15	16
		32	43	46	32	35	26	28	22	23	19	20	16	17
	40	20	41	45	31	34	24	27	20	22	17	19	15	17
		32	44	48	33	36	27	29	22	24	19	21	17	18
Additional footing width for masonry veneer[4,13,14]														
One story			5		3		3		2		2		2	
Two story			6		5		4		3		3		2	

NOTES FOR TABLE 4.1

1. **Table 4.1** is based on ASCE 7 components and cladding wind pressures for an enclosed building using a mean roof height of 35 ft (10.7 m), interior wall area 4, an effective wind area of 10 ft^2 (0.9 m^2), and topographic factor, K_{zt}, and importance factor, *I*, equal to 1.0.
2. Table is based on concrete with a minimum specified compressive strength of 2,500 psi (17.2 MPa). See Section 4.1.4 for minimum strength of concrete for buildings assigned to Seismic Design Category D_0, D_1, or D_2.
3. See Section 4.1.7 for location of reinforcement in wall.
4. Deflection criterion is ***L****/240*, where ***L*** is the unsupported height of the wall in inches.
5. Interpolation shall not be permitted.
6. See Section 4.1.3 for minimum grade, and size and spacing of vertical wall reinforcement for multiple dwellings assigned to Seismic Design Category C, and all buildings assigned to Seismic Design Category D_0, D_1, or D_2. The more stringent provisions of that section or this table shall apply.
7. Where No 4 reinforcing bars at a spacing of 48 inches (12.19 mm) are specified in the table, bars with a minimum yield strength of 40,000 psi (280 MPa) or 60,000 psi (420 MPa) are permitted to be used.
8. Other than for No. 4 bars spaced at 48 inches (1219 mm) on center, table values are based on reinforcing bars with a minimum yield strength of 60,000 psi (420 MPa). Vertical reinforcement with a yield strength of less than 60,000 psi (420 MPa) and/or bars of a different size than specified in the table are permitted in accordance with Section 2.5.7 and Table 2.3.
9. **Top** means gravity load from roof and/or floor construction bears on top of wall
10. **Side** means gravity load from floor construction is transferred to wall from a wood ledger or cold-formed steel track bolted to side of wall.
11. Where floor framing members span parallel to the wall, the ***top*** bearing condition is permitted to be used.
12. **DR** indicates design required.

Requirements for Lintels and Reinforcement Around Openings

7.1 REINFORCEMENT AROUND OPENINGS

Reinforcement shall be provided around openings in walls equal to or greater than 2 feet (610 mm) in width in accordance with this section and Figure 7.1, in addition to the minimum wall reinforcement required by Chapters 3, 4 and 5. Vertical wall reinforcement required by this section is permitted to be used as reinforcement at the ends of solid wall segments required by Section 5.2.2.2 provided it is located in accordance with Section 7.1.2. Wall openings shall have a minimum depth of concrete over the width of the opening of 8 inches (203 mm) in flat walls and waffle-grid walls, and 12 inches (305 mm) in screen-grid walls. Wall openings in waffle-grid and screen-grid walls shall be located such that no less than one-half of a vertical core occurs along each side of the opening.

7.1.1 Horizontal Reinforcement

Lintels complying with Section 7.2 shall be provided above wall openings equal to or greater than 2 feet (610 mm) in width.

> **Exception:** Continuous horizontal wall reinforcement placed within 12 inches (305 mm) of the top of the wall story as required in Chapters 3 and 4 is permitted to be used in lieu of top or bottom lintel reinforcement required by Section 7.2 provided that the continuous horizontal wall reinforcement meets the location requirements specified in Figures 7.3, 7.4, and 7.5 and the size requirements specified in Tables 7.3 through 7.25.

Openings equal to or greater than 2 feet (610 mm) in width shall have a minimum of one No. 4 bar placed within 12 inches (305 mm) of the bottom of the opening. See Figure 7.1.

Horizontal reinforcement placed above and below an opening shall extend beyond the edges of the opening the dimension required to develop the bar in tension in accordance with Section 2.5.4.

7.1.2 Vertical Reinforcement

In all buildings where the factored roof uplift force from Table 7.1A is less than or equal to 800 plf (11.68 kN/m) and the opening width is equal to or greater than 2 feet (610 mm) and less than or equal to 18 feet (5.5 m), not less than one No. 4 bar (Grade 40 (280 MPa)) shall be provided on each side of the opening. Where the roof uplift force from Table 7.1A is greater than 800 plf (11.68 kN/m) and the opening width is greater than 6 feet (1.8 m), vertical reinforcement shall be provided on each side of openings in accordance with Table 7.1B.

In multiple dwellings assigned to Seismic Design Category C, and all buildings assigned to Seismic Design Category D_0, D_1 or D_2, vertical reinforcement shall comply with the above requirements, but shall not be less than 2 No. 4 bars (Grade 60) or one No. 5 bar (Grade 60 (420 MPa)). See Section 4.1.3.

The vertical reinforcement required by this section shall extend the full height of the wall story and shall be located within 12 inches (305 mm) of each side of the opening. The vertical reinforcement required on each side of an opening by this section is permitted to serve as reinforcement at the ends of solid wall segments in accordance with Section 5.2.2.2, provided it is located as required by the applicable detail in Figure 5.1. Where the vertical reinforcement required by this section is used to satisfy the requirements of Section 5.2.2.2 in waffle- and screen-grid walls, a concrete flange shall be created at the ends of the solid wall segments in accordance with Table 5.4B, footnote 9. In the top most story, the reinforcement shall terminate in accordance with Section 4.1.6.

7.1.3 Wall Segments in Seismic Design Categories C, D_0, D_1 and D_2

For multiple dwellings assigned to Seismic Design Category C and all buildings assigned to Seismic Design Category D_0, D_1 or D_2, wall segments with a length of less than 24 inches (610 mm), shall be provided with not less than No. 3 ties in accordance with Figure 7.2. Ties shall be terminated at each end with a standard hook conforming to Figure 2.6.

> **Exception:** Ties need not be provided in wall segments where flat walls are used to provide all of the required solid wall length.

Ties shall start at ***d***/4 but not more than 3 inches (76 mm) from the top and bottom of the wall segment. Ties shall be spaced at ***d***/2, but not more than 6 inches (152 mm) on center along the height of the wall segment. Where necessary to provide a minimum cover of 1½ inches (38 mm) on all sides of ties, screen- and waffle-grid forms shall be modified by removal of form material, or replaced by flat forms. Ties required by this section are permitted to be used to satisfy the horizontal reinforcement requirements of Section 4.1.3.

7.2 LINTELS

Lintels shall be provided over all openings equal to or greater than 2 feet (610 mm) in width. Lintels with uniform loading shall conform to Sections 7.2.1, 7.2.2, and 7.2.3 or Section 7.2.4. Lintels supporting concentrated loads, such as from roof or floor beams or girders, shall be designed in accordance with the applicable building code, or if there is no code in accordance with ACI 318.

7.2.1 Lintels Designed for Gravity Load-Bearing Conditions

Where a lintel will be subjected to gravity load condition 1 through 5 of Table 7.2, the clear span of the lintel shall not exceed that permitted by Tables 7.3 through 7.16. The maximum clear span of lintels with and without stirrups in flat walls shall be determined in accordance with Tables 7.3 through 7.10, and constructed in accordance with Figure 7.3. The maximum clear span of lintels with and without stirrups in waffle-grid walls shall be determined in accordance with Tables 7.11 through 7.14, and constructed in accordance with Figure 7.4. The maximum clear span of lintels with and without stirrups in screen-grid walls shall be determined in accordance with Tables 7.15 and 7.16, and constructed in accordance with Figure 7.5. The clear span of a lintel subjected to gravity loading conditions and uplift loading conditions (see Section 7.2.2) shall not exceed the smaller of the spans determined for the two conditions.

Where required by the applicable table, No. 3 stirrups shall be installed in lintels at a maximum spacing of ***d***/2 where ***d*** equals the depth of the lintel, ***D***, less the cover of the concrete as shown in Figures 7.3, 7.4, and 7.5. The smaller value of *d* computed for the top and bottom bar shall be used to determine the maximum stirrup spacing. Where stirrups are required in a lintel with a single bar or two bundled bars in the top and bottom, they shall be fabricated like the letter "c" or "s" with 135-degree standard hooks at each end that comply with Section 2.5.5 and Figure 2.6 and installed as shown in Figures 7.3 through 7.5. Where two bars are required in the top and bottom of the lintel and the bars are not bundled, the bars shall be separated by a minimum of 1 inch (25 mm), and stirrups shall be fabricated with 90- or 135-degree standard hooks that comply with Section 2.5.5 and Figure 2.6 and installed as shown in Figures 7.3 and 7.4. For flat, waffle-grid and screen-grid lintels, stirrups are not required in center distance, ***A***, portion of spans in accordance with Figure 7.1 and Tables 7.3 through 7.16, and Tables 7.19 through 7.25.

7.2.2 Lintels Designed for Uplift Loading Conditions

Where the roof uplift force in Table 7.1A exceeds 600 plf (8.76 kN/m), the clear span of a lintel in the top story of a two-story building or first story of a one story building supporting roof framing members shall not exceed that permitted by Tables 7.19 through 7.25 based on the uplift force from Table 7.1A. Where the roof uplift force in Table 7.1A exceeds 600 plf (8.76 kN/m), the clear span of a lintel in the first story of a two-story building or basement of a one-story building supporting an exterior wall of light framed construction which supports roof framing members shall not exceed that permitted by Tables 7.19 through 7.25 based on the uplift force from Table 7.1A. Where the roof uplift force in Table 7.1A exceeds 965 plf (14.09 kN/m), the clear span of a lintel in the first story of a two-story building or basement of a one-story building supporting an exterior wall of concrete construction which supports roof framing members shall not exceed that permitted by Tables 7.19 through 7.25 based on the uplift force from Table 7.1A, less the factored dead load in the table below. If the net uplift force is less than or equal to 600 plf (8.76 kN/m) after subtracting the value from the table below from the force from Table 7.1A, the lintel is not required to be designed for uplift loads.

Wall Group[1] of concrete wall in story above supported by lintel	Factored dead load to be subtracted from force determined from Table 7.1A (plf)
1	325
2	505
3	690
4	875

For SI: 1 plf = 0.0146 kN/m.
1. See Table 2.1 for types of walls within a group.

The maximum clear span of lintels with and without stirrups in flat walls for uplift loading conditions shall be determined in accordance with Tables 7.19 through 7.22, and constructed in accordance with Figure 7.3. The maximum clear span of lintels with and without stirrups in waffle-grid walls for uplift loading conditions shall be determined in accordance with Tables 7.23 and 7.24, and constructed in accordance with Figure 7.4. The maximum clear span of lintels with and without stirrups in screen-grid walls for uplift loading conditions shall be determined in accordance with Table 7.25, and constructed in accordance with Figure 7.5. The clear span of a lintel subjected to uplift loading conditions and gravity loading conditions (see Section 7.2.1) shall not exceed the smaller of the spans determined for the two conditions.

7.2.3 Bundled Bars in Lintels

It is permitted to bundle two bars in contact with each other in lintels if all of the following are observed:

1. Bars no larger than No. 6 are bundled.
2. Where the wall thickness is not sufficient to provide not less than 3 inches (76 mm) of clear space beside bars (total on both sides) oriented horizontally in a bundle, the bundled bars shall be oriented in a vertical plane.
3. Where vertically oriented bundled bars terminate with standard hooks to develop the bars in tension beyond the support (see Section 2.5.4), the hook extensions shall be staggered to provide a minimum of one inch (25 mm) clear spacing between the extensions.
4. Bundled bars shall not be lap spliced within the lintel span and the length on each end of the lintel that is required to develop the bars in tension.
5. Bundled bars shall be enclosed within stirrups throughout the length of the lintel. Stirrups and the installation thereof shall comply with Section 7.2.1.

7.2.4 Lintels Without Stirrups Designed for Non Load-Bearing Conditions

The maximum clear span of lintels without stirrups designed for nonload-bearing conditions of Table 7.2 shall be determined in accordance with this section. The maximum clear span of lintels without stirrups in flat walls shall be determined in accordance with Table 7.17, and the maximum clear span of lintels without stirrups in walls of waffle-grid or screen-grid construction shall be determined in accordance with Table 7.18.

7.2.5 Lintels in Seismic Design Categories C, D_0, D_1 and D_2

For multiple dwellings assigned to Seismic Design Category C and all buildings assigned to Seismic Design Category D_0, D_1 or D_2, lintels with a depth, ***D***, less than 24 inches (610 mm) shall be provided with not less than No. 3 stirrups in accordance with Figure 7.2. Stirrups shall be terminated at each end with a standard hook conforming to Figure 2.6.

Exception: Stirrup reinforcing for lintels where flat walls are used to provide all of the required solid wall length need only comply with Section 7.2.1.

Stirrups shall start at ***d***/4, but not more than 3 inches (76 mm) from each end of the lintel. Stirrups shall be spaced at ***d***/2, but not more than 6 inches (152 mm) on center across the entire length of the lintel. Where necessary to provide a minimum cover of 1½ inches (38 mm) on all sides of stirrups, screen- and waffle-grid forms shall be modified by removal of form material, or replaced by flat forms. Stirrups required by this section are permitted to be used to satisfy the stirrup requirements of Section 7.2.1.

Table 7.2. Lintel Design Loading Conditions[1,2,4]

Description of loads and openings above influencing design of lintel			Design loading condition[3]
Opening in wall of top story of two-story building, or first story of one-story building			
Wall supporting loads from roof, including attic floor, if applicable, and	top of lintel equal to or less than **W**/2 below top of wall		2
	top of lintel greater than **W**/2 below top of wall		NLB
Wall not supporting loads from roof or attic floor			NLB
Opening in wall of first story of two-story building where wall immediately above is of concrete construction, or opening in basement wall of one-story building where wall immediately above is of concrete construction			
LB ledger board mounted to side of wall with bottom of ledger less than or equal to **W**/2 above top of lintel, and	top of lintel greater than **W**/2 below bottom of opening in story above		1
	top of lintel less than or equal to **W**/2 below bottom of opening in story above, and	opening is entirely within the **footprint** of the opening in the story above	1
		opening is partially within the **footprint** of the opening in the story above	4
LB ledger board mounted to side of wall with bottom of ledger more than **W**/2 above top of lintel			NLB
NLB ledger board mounted to side of wall with bottom of ledger less than or equal to **W**/2 above top of lintel, or no ledger board, and	top of lintel greater than **W**/2 below bottom of opening in story above		NLB
	top of lintel less than or equal to **W**/2 below bottom of opening in story above, and	opening is entirely within the **footprint** of the opening in the story above	NLB
		opening is partially within the **footprint** of the opening in the story above	1
Opening in basement wall of two-story building where walls of two stories above are of concrete construction			
LB ledger board mounted to side of wall with bottom of ledger less than or equal to **W**/2 above top of lintel, and	top of lintel greater than **W**/2 below bottom of opening in story above		1
	top of lintel less than or equal to **W**/2 below bottom of opening in story above, and	opening is entirely within the **footprint** of the opening in the story above	1
		opening is partially within the **footprint** of the opening in the story above	5
LB ledger board mounted to side of wall with bottom of ledger more than **W**/2 above top of lintel			NLB
NLB ledger board mounted to side of wall with bottom of ledger less than or equal to **W**/2 above top of lintel, or no ledger board, and	top of lintel greater than **W**/2 below bottom of opening in story above		NLB
	top of lintel less than or equal to **W**/2 below bottom of opening in story above, and	opening is entirely within the **footprint** of the opening in the story above	NLB
		opening is partially within the **footprint** of the opening in the story above	1
Opening in wall of first story of two-story building where wall immediately above is of light framed construction, or opening in basement wall of one-story building, where wall immediately above is of light framed construction			
Wall supporting loads from roof, second floor and top-story wall of light-framed construction, and	top of lintel equal to or less than **W**/2 below top of wall		3
	top of lintel greater than **W**/2 below top of wall		NLB
Wall not supporting loads from roof or second floor			NLB

[1] **LB** means load bearing, **NLB** means non-load bearing, and **W** means width of opening.
[2] **Footprint** is the area of the wall below an opening in the story above, bounded by the bottom of the opening and vertical lines extending downward from the edges of the opening.
[3] For design loading condition "NLB" see Tables 7.17 and 7.18. For all other design loading conditions see Tables 7.3 through 7.16.
[4] A NLB ledger board is a ledger attached to a wall that is parallel to the span of the floor, roof or ceiling framing that supports the edge of the floor, ceiling or roof.

TABLE 7.17
MAXIMUM ALLOWABLE CLEAR SPANS FOR FLAT LINTELS WITHOUT STIRRUPS IN NON-LOAD-BEARING WALLS

Lintel Depth[6], ***D*** (in.)	Number of bars and bar size	Steel yield strength, f_y (psi)	Nominal Wall Thickness (inches)							
			4		6		8		10	
			Construction of wall above lintel							
			Concrete wall	Light framed gable	Concrete wall	Light framed gable	Concrete wall	Light framed gable	Concrete wall	Light framed gable
			Maximum clear span of lintel (ft-inches)							
8	1 – #4	40,000	10-11	11-5	9-7	11-2	7-10	9-5	7-3	9-2
		60,000	12-5	11-7	10-11	13-5	9-11	13-2	9-3	12-10
	1 – #5	40,000	12-7	11-7	11-1	13-8	10-1	13-5	9-4	13-1
		60,000	DR	DR	12-7	16-4	11-6	14-7	10-9	14-6
	2 – #4 1 – #6	40,000	DR	DR	12-0	15-3	10-11	15-0	10-2	14-8
		60,000	DR	DR	DR	DR	12-2	15-3	11-7	15-3
	2 – #5	40,000	DR	DR	DR	DR	12-7	16-7	11-9	16-7
		60,000	DR	DR	DR	DR	DR	DR	13-3	16-7
	2 – #6	40,000	DR	DR	DR	DR	DR	DR	13-2	17-8
		60,000	DR	DR	DR	DR	DR	DR	DR	DR
12	1 – #4	40,000	11-5	9-10	10-6	12-0	9-6	11-6	8-9	11-1
		60,000	11-5	9-10	11-8	13-3	10-11	14-0	10-1	13-6
	1 – #5	40,000	11-5	9-10	11-8	13-3	11-1	14-4	10-3	13-9
		60,000	11-5	9-10	11-8	13-3	11-10	16-0	11-9	16-9
	2 – #4 1 – #6	40,000	DR	DR	11-8	13-3	11-10	16-0	11-2	15-6
		60,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4
	2 – #5	40,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4
		60,000	DR	DR	11-8	13-3	11-10	16-0	11-11	18-4
16	1 – #4	40,000	13-6	13-0	11-10	13-8	10-7	12-11	9-11	12-4
		60,000	13-6	13-0	13-8	16-7	12-4	15-9	11-5	15-0
	1 – #5	40,000	13-6	13-0	13-10	17-0	12-6	16-1	11-7	15-4
		60,000	13-6	13-0	13-10	17-1	14-0	19-7	13-4	18-8
	2 – #4 1 – #6	40,000	13-6	13-0	13-10	17-1	13-8	18-2	12-8	17-4
		60,000	13-6	13-0	13-10	17-1	14-0	20-3	14-1	
	2 – #5	40,000	13-6	13-0	13-10	17-1	14-0	20-3	14-1	
		60,000	DR	DR	13-10	17-1	14-0	20-3	14-1	
20	1 – #4	40,000	14-11	15-10	13-0	14-10	11-9	13-11	10-10	13-2
		60,000	15-3	15-10	14-11	18-1	13-6	17-0	12-6	16-2
	1 – #5	40,000	15-3	15-10	15-2	18-6	13-9	17-5	12-8	16-6
		60,000	15-3	15-10	15-8	20-5	15-9		14-7	20-1
	2 – #4 1 – #6	40,000	15-3	15-10	15-8	20-5	14-11		13-10	
		60,000	15-3	15-10	15-8	20-5	15-10		15-11	
	2 – #5	40,000	15-3	15-10	15-8	20-5	15-10		15-11	
		60,000	15-3	15-10	15-8	20-5	15-10		15-11	
24	1 – #4	40,000	16-1	17-1	13-11	15-10	12-7	14-9	11-8	13-10
		60,000	16-11	18-5	16-1	19-3	14-6	18-0	13-5	17-0
	1 – #5	40,000	16-11	18-5	16-3	19-8	14-9	18-5	13-8	17-4
		60,000	16-11	18-5	17-4		17-0		15-8	
	2 – #4 1 – #6	40,000	16-11	18-5	17-4		16-1		14-10	
		60,000	16-11	18-5	17-4		17-6		17-1	
	2 – #5	40,000	16-11	18-5	17-4		17-6		17-4	
		60,000	16-11	18-5	17-4		17-6		17-8	

For SI: 1 inch = 25.4 mm; 1 psf = 0.0479 kN/m^2; 1 ft = 0.3048 m; Grade 40 = 280 MPa; Grade 60 = 420 MPa

[1] See Table 2.1 for tolerances permitted from nominal thickness.
[2] Table values are based on concrete with a minimum specified compressive strength of 2,500 psi (17.2 MPa). See note 5.
[3] Deflection criterion is ***L***/240, where ***L*** is the clear span of the lintel in inches, or ½-inch (13 mm), whichever is less.
[4] Linear interpolation between lintels depths, ***D***, is permitted provided the two cells being used to interpolate are shaded.
[5] Where concrete with a minimum specified compressive strength of 3,000 psi (20.7 MPa) is used, spans in cells that are shaded shall be permitted to be multiplied by 1.05.
[6] Lintel depth, ***D***, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
[7] DR indicates design required
[8] The maximum clear opening width between two solid wall segments shall be 18 feet (5.5 m). See Section 5.2.1. Lintel spans in table greater than 18 feet are shown for interpolation and information purposes only.

NOTES FOR TABLES 7.19 through 7.22

1. See Table 2.1 for tolerances permitted from nominal thickness.
2. Table values are based on concrete with a minimum specified compressive strength of 2,500 psi. See notes 10 and 12.
3. Table values are based on uniform loading. See Section 7.2 for lintels supporting concentrated loads.
4. Deflection creterion is ***L***/240, where ***L*** is the clear span of the lintel in inches, or ½-inch, whichever is less.
5. Linear interpolation is permitted between roof uplift forces and between lintel depths.
6. The maximum clear span of a lintel shall not exceed 18 feet. Tabular values greater than 18 feet are provided for purposes of interpolation.
7. Lintel depth, ***D***, is permitted to include the available height of wall located directly above the lintel, provided that the increased lintel depth spans the entire length of the lintel.
8. Stirrups shall be fabricated from reinforcing bars with the same yield strength as that used for the main longitudinal reinforcement.
9. Allowable clear span without stirrups applicable to all lintels of the same depth, D. Top and bottom reinforcement for lintels without stirrups shall not be less than the least amount of reinforcement required for a lintel of the same depth and loading conditions with stirrups. All other spans require stirrups spaced at not move than ***d***/2.
10. Where concrete with a minimum specified compressive strength of 2,000 psi is used, clear spans for lintels without stirrups shall be permitted to be multiplied by 1.05. If the increased span exceeds the allowable clear span for a lintel of the same depth and loading condition with stirrups, the top and bottom reinforcement shall be equal to or greater than that required for a lintel of the same depth and loading condition that has an allowable clear span that is equal to or greater than that of the lintel without sitrrups that has been increased.
11. Center distance, ***A***, is the center portion of the span where stirrups are not required. This is applicable to all longitudinal bar sizes and steel yield strengths.
12. Center distance, ***A***, shall be permitted to be multiplies by 1.10 where concrete with a moinimum specified compressive strength of 3,000 psi is used.
13. The maximum clear opening width between two solid wall segments shall be 18 feet. See Section 5.2.1 Lintel spans in table greater than 18 feet are shown for interpretation and informational purposes only.