Example #1: Garage-Front Wind Application

Given

2006 or 2009 IBC, Wind Design, 2,500 psi concrete
Seismic Design Category A, R = 3
20-ft Floor & 30-ft Roof Span Tributary to Frame
Vertical Loads:
  Roof – 20 psf Dead, 20 psf Live
  Floor – 15 psf Dead, 40 psf Live
Wall Weight = 12 psf
Nominal top plate height = 8'-0"
Garage Opening = 16'-0" wide x 7'-0" tall
Total ASD Force to Frame, V_{frame}= 3,000 + 5,000 = 8,000 lbs
10" wide x 6" tall curb with 12" tall step (height above footing)

Select Frame

Step 1: Check if Ordinary Moment Frame is Permitted

Seismic Design Category A – no limit on use of OMF, **OK**✓

Step 2: Check R Value

Seismic loads calculated using R = 3 – Loads do not need to be converted, **OK**✓

Step 3: Select Nominal Height and Width

Nominal frame height: 8 ft.

Nominal frame width: 16 ft.

Step 4: Check Vertical Loading

W_{DL} = 20 psf x 30'/2 + 15 psf x 20'/2 + 12 psf x 8' = 546 plf < 800 plf, **OK**✓

W_{RLL}= 20 psf x 30'/2 = 300 plf < 400 plf, **OK**✓

W_{FLL}= 40 psf x 20'/2 = 400 plf = 400 plf, **OK**✓

Vertical loads are less than frame design uniform load. Therefore, use Maximum Shear values.

Step 5: Select Strong Frame™ Ordinary Moment Frame Model

Using allowable load table for 8 ft. nominal height frames on pages 22 to 23, select 16 ft. wide frame with a Maximum Shear greater than applied shear:

For OMF912-16x8: Allowable ASD shear = 11,045 lbs > 8,000 lbs, Shear **OK**✓

Step 6: Check W_{max}

Check of W_{max} not required when frame is selected using Maximum Shear, **OK**✓

Step 7: Check Ordinary Moment Frame Dimensions

Using tables at the top of page 22:

Clear-opening width: W1 = 16'-4" > 16'- 0", **OK**✓

Outside frame width: W2 = 18'-4" < 20-ft", **OK**✓

Clear-opening height: H3 + curb height above slab = 6'-6¾" + 6" =7'-0¾"> 7'- 0", **OK**✓

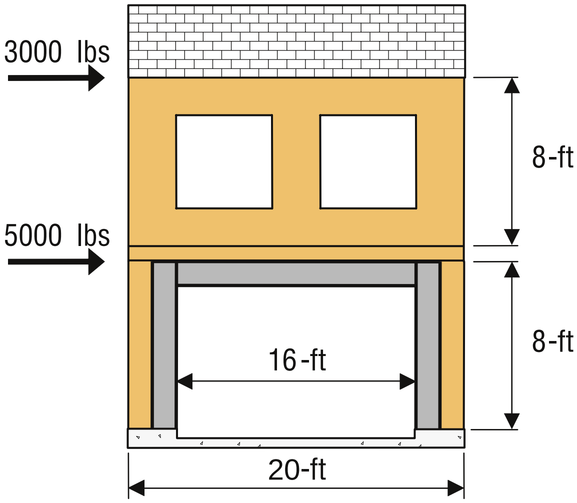
Step 8: Select Bolt Tightening Requirements

For Seismic Design Category A with R = 3 – Specify snug-tight bolts for end plate connection

Step 9: Select Top Plate Fasteners

Using allowable load table on page 23: Select (21) - ¼" x 3½" Strong-Drive® SDS screws

Design for load combinations with overstrength not required in Seismic Design Category A



Tension Anchorage Design

Step 1: Determine Concrete Condition

Concrete is uncracked

Note: Designer must determine whether cracked or uncracked concrete is applicable based on the project conditions in accordance with ACI 318 Appendix D.

Step 2: Select Anchorage Design Method

Use Simplified design method

Step 3: Determine Tension Reaction

No calculation of reactions required for Simplified design method

Step 4: Select Minimum Footing Size for Tension

Using Table 1.1 on page 39:

C9 column 8-ft tall, wind loading, uncracked concrete: W = 19", d_e = 6"

Step 5: Determine Anchorage Assembly Strength

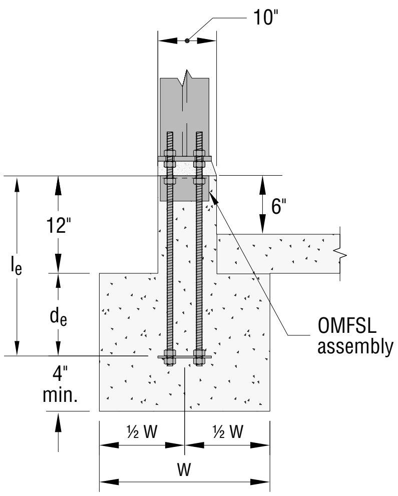
From Table 1.1, footnote 3, anchorage strength for Simplified design is determined based on shear anchorage.

Step 6: Determine Rod Length and Footing Size

For 12" tall step (above footing): Required l_e = d_e+12" = 18"

Select OMFSL9-24-KT, l_e= 18½" (see figure below), **OK**✓

Minimum footing depth = 18½" - 12"(step) + 4" = 10½"



SIMPSON Strong-Tie

Example #1: Garage Front Wind Application (cont.)

SHEAR ANCHORAGE DESIGN

Step 1: Select Anchorage Assembly Type

Select OMFSL anchorage assembly for ease of installation and to allow installation flush with edge of concrete curb

Step 2: Select Anchorage Design Method

Use Simplified design method

Step 3: Determine Shear Reactions

No calculation of reactions required for Simplified design method

Step 4: Determine Inside and Outside End Distance

Using Table 2.1 on page 41:

C9 column 8-ft tall, Maximum Shear with uniform load, 10" curb: Minimum inside end distance = 6"

C9 column 8-ft tall, Maximum Shear with uniform load, 10" curb: Minimum outside end distance = 7½"

Step 5: Determine Anchorage Assembly Strength

Using Table 2.1 on page 41:

C9 column 8-ft tall, Maximum Shear with uniform load, 10" curb: Standard strength OMFSL (value not shaded)

Step 6: Verify Ordinary Moment Frame Dimensions

Since end distances exceed minimum with nailer flush with concrete (4½"), check overall frame width. Using tables at the top of page 22:

W1 = 16'-4"

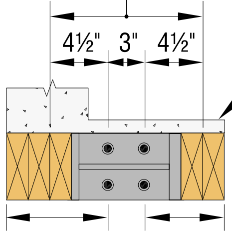
W2 = 18'-4"

Clear-opening width = W1 – 2[(inside end) – (4½")] = (16'-4") – 2[(6") – (4½")] = 16'-1" > 16'- 0", **OK**✓

Outside frame width = W2 + 2[(outside end) – (4½")] = (18'-4") + 2[(7½") – (4½")] = 18'-10" < 20'-0", **OK**✓

SUMMARY

Strong Frame Model:	OMF912-16x8
End-Plate Bolts:	Snug-tight
Top-Plate Fasteners:	(21) - ¼" x 3½" SDS screws
Anchorage Assembly:	OMFSL9-24-KT
Outside end distance:	7½"
Inside end distance:	6"
Minimum footing size for anchorage:	19"x19"x10½"



Notes:

1. Design of anchorage using the Simplified design method as shown is simplest. Design using Detailed design method with calculated reactions based on applied lateral and vertical loading may result in more economical anchorage designs (see Example #2).
2. Footing size shown is based on anchorage design only. Actual footing/grade beam size and reinforcing must be determined by Designer based on project specific geometry and allowable soil bearing pressures.
3. Overturning load on steel beam from shear wall above is not shown for simplicity; Designer must include overturning forces in steel beam check as required.
4. Wind roof uplift load on Strong Frame™ ordinary moment frame not shown. Designer must include roof wind uplift forces on frame check as required.
5. Out of plane load on Strong Frame™ ordinary moment frame not shown. Designer must include out of plane wind forces on frame check as required. See detail 14/SF3 page 65 for more information.

Example #2: 1st of 3-Story Seismic Application

Given

2006 or 2009 IBC, Seismic Design, 3,000 psi concrete

Seismic Design Category D, R = 6.5, Ω_0 = 2.5

S_{DS} =1.5 g

20-ft Floor & 20-ft Roof Span Tributary to Frame

Apartment building, wood-frame construction

Vertical Loads:

Roof – 16 psf Dead, 20 psf Live

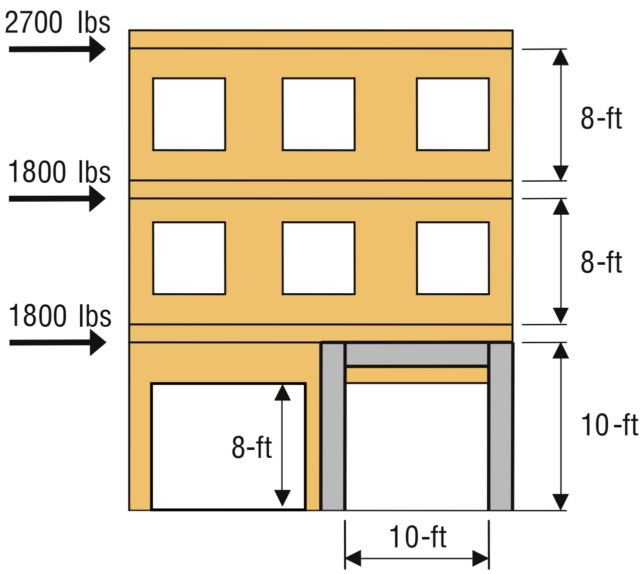
Floor – 15 psf Dead, 40 psf Live

Wall Weight = 12 psf

Opening = 10'-0" wide x 8'-0" tall

Total ASD Force to Frame, V_{frame} = 2,700 + 1,800 + 1,800 = 6,300 lbs

Slab on grade with 10" tall step (height above footing)



SELECT FRAME

Step 1: Check if Ordinary Moment Frame is Permitted

Use of ordinary moment frame in multi-story structures in Seismic Design Category D is limited by ASCE 7-05 Section 12.2.5.7:

Light-frame construction – Wood-frame construction, **OK**✓

Height less than 35 ft – Height = 29 ft, **OK**✓

Tributary roof and floor dead load ≤ 35 psf
– Roof dead load = 16 psf, **OK**✓

– Floor dead load = 15 psf, **OK**✓

Tributary exterior wall dead load ≤ 20 psf
– Wall weight = 12 psf, **OK**✓

Step 2: Check R Value

Seismic loads are calculated using R=6.5 – Convert forces to R=3.5 forces for OMF selection:

V_{frame} = (6.5/3.5) x 6,300 = 11,700 lbs

Note: In accordance with ASCE 7-05 Sections 12.2.3.1 and 12.2.3.2 for combinations of lateral systems, shear walls in the stories above the moment frame may be designed for forces with R=6.5, and the ordinary moment frame and shear walls in the same story that resist lateral loads in the same direction as the frame must be designed for forces based on R=3.5.

Step 3: Select Nominal Height and Width

Nominal frame height: 10 ft.

Nominal frame width: 10 ft.

Step 4: Check Vertical Loading

Since S_{DS} = 1.5 g > 1.0 g, include additional vertical seismic load effects in dead load check (footnote 2, page 27):

W_{DL} = (16 psf x 20'/2) + (2 x 15 psf x 20'/2) + (12 psf x 8' x 2) = 652 plf

(1.0 + 0.14S_{DS})W_{DL} = (1.0 + (0.14x1.5))x(652 plf) = 789 plf < 800 plf, **OK**✓

W_{RLL}= 20 psf x 20'/2 = 200 plf < 400 plf, **OK**✓

W_{FLL}= 2 x 40 psf x 20'/2 = 800 plf > 400 plf, Exceeds Limit

Uniform vertical loads exceed frame design uniform load. Therefore, use Minimum Shear values to select frame.

Step 5: Select Strong Frame™ Ordinary Moment Frame Model

Using allowable load table for 10 ft. nominal height frames on pages 26 to 27, select 10 ft. wide frame with a Minimum Shear greater than applied shear:

For OMF1212-10x10: Allowable ASD shear = 11,920 lbs > 11,700 lbs, Shear **OK**✓

Step 6: Check W_{max}

Maximum total gravity load (IBC Eq. 16-13 governs):
W = W_{DL} + 0.75 (E_v + W_{FLL} + W_{RLL})
where E_v = 0.14$S_{DS}W_{DL}$
= [652 + 0.75 ((0.14 x 1.5 x 652) + 800 +200)] x 10'
= 1,505 plf x 10'
= 15,050 lbs.

Note: Designer must determine governing load combination per applicable building code.

From table on page 26 for OMF1212-10x10:

W_{max} = 40,000 lbs > 15,050 lbs, Vertical Load **OK**✓

Step 7: Check Ordinary Moment Frame Dimensions

Using tables at the top of page 26:

Clear-opening width:	W1 = 10'-2" > 10'- 0", **OK**✓
Outside frame width:	W2 = 12'-8" < 13'- 0", **OK**✓
Clear-opening height:	H3 = 8'-6¾" > 8'- 0", **OK**✓

Step 8: Select Bolt Tightening Requirements

For Seismic Design Category D – Pretensioned bolts required for end plate connection

Step 9: Select Top-Plate Fasteners

In Seismic Design Category D, design connection of top plate to OMF to include load combinations with overstrength for collector loads. Assume half of total shear is delivered through collector:

E_{mh} = 2.5 x (11,700 lbs/2) + (11,700 lbs/2) = 20,475 lbs

SDS screw allowable shear = 1.6 x 340 lbs = 544 lbs

Number of screws = (20,475 lbs)/(544 lbs) = 38

Select (38) - ¼" x 3½" SDS screws (2 rows @ 6" o.c., staggered)

Example #2: 1st of 3-Story Seismic Application (cont.)

TENSION ANCHORAGE DESIGN

Step 1: Determine Concrete Condition

Concrete is cracked

Note: Designer must determine whether cracked or uncracked concrete is applicable based on the project conditions in accordance with ACI 318 Appendix D.

Step 2: Select Anchorage Design Method

Use Detailed design method

Step 3: Determine Tension Reaction

Option 1 – Use tabulated maximum tension reaction for OMF1212-10x10 on page 26:

Maximum Column Reactions – Tension: T = 9,995 lbs

Option 2 – Calculate tension reaction for project loads (see page 27, footnote 5)

$T = (V \times h - M_R)/L$

V = 11,700 lbs,

h = 10'-¾" - 6" = 9'-6¾"

L = 10'-2" + 12" + 3" = 11'-5" (column centerline dimension)

$M_R = ½ (0.6 – 0.14S_{DS})wL^2$
= ½(0.6 – 0.14x1.5)(652 plf) (11'-5")^2 = 16,570 ft-lbs

T = ((11,700 lbs x 9'-6¾") – 16,570 ft-lbs) / 11'-5" = 8,350 lbs

Step 4: Select Minimum Footing Size for Tension

Using Table 1.2 on page 39 and reaction from Option 2 in Step 3:

C12 column, seismic loading, cracked concrete,
T = 8,350 lbs: W = 42", d_e = 13"

Step 5: Determine Anchorage Assembly Strength

Using Table 1.2 on page 39, footnote 6:

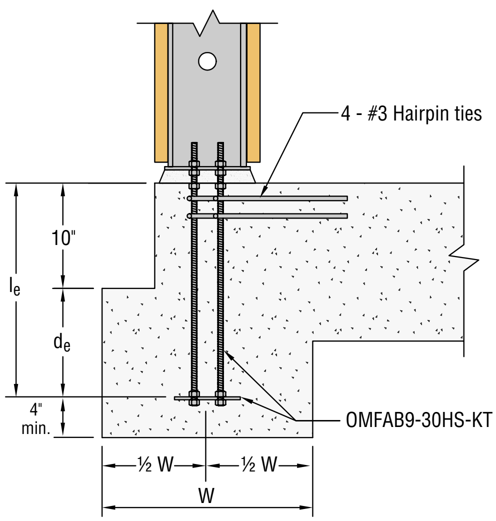
C12 column, 10 ft tall, seismic loading: High strength anchorage assembly required

Step 6: Determine Rod Length and Footing Size

For slab on grade with 10" step height: Required $l_e = d_e + 10" = 23"$

Select OMFAB9-30HS-KT, l_e=24" (see figure below), **OK**✓

Minimum footing depth = 24" - 10" (curb) + 4" = 18"



SHEAR ANCHORAGE DESIGN

Step 1: Select Anchorage Assembly Type

Select OMFAB for high capacity at foundation corner

Step 2: Select Anchorage Design Method

Use Detailed design method

Step 3: Determine Shear Reactions

Option 1 – Use tabulated maximum seismic shear reaction for OMF1212-10x10 on page 26:

Maximum Column Reactions – Shear for Seismic with R=3.5, Ω_0=2.5: V = 15,600 lbs

Option 2 – Calculate shear reaction for project loads (see page 27, footnotes 15 and 4)

$R_H = (\Omega_0 V/2) + X(2/3wL)$

$\Omega_0 = 2.5$

V = 11,700 lbs

X = 0.112

$w = W_{DL} + E_v$ = 789 plf
Note: Designer must determine governing load combination per applicable code.

L = (10'-2") + (3") + (12") = 11'-5"

R_H = (2.5)(11,700 lbs / 2) + (0.112)(2/3)(789 plf)(11'-5") = 15,300 lbs

Step 4: Determine Reinforcement

Using Table 3.2 on page 44 and reaction from Option 2 in Step 3:

C12 column, slab-on-grade, seismic loading: 4 - #3 hairpins, allowable shear = 23,690 lbs > 15,300 lbs, **OK**✓

Step 5: Determine Anchorage Assembly Strength

Using Table 3.2 on page 44:

C12 column, slab-on-grade, seismic loading, 4 - #3 hairpins: High strength OMFAB (value shaded)

SUMMARY

Strong Frame Model:	OMF1212-10x10
End-Plate Bolts:	Pretensioned
Top-Plate Fasteners:	(38) - ¼" x 3½" SDS screws
Anchorage Assembly:	OMFAB9-30HS-KT
Reinforcement:	4 - #3 hairpins
Minimum footing size for anchorage:	42"x42"x18"

Notes:

1. Footing size shown is based on anchorage design only. Actual footing/grade beam size and reinforcing must be determined by Designer based on project specific geometry and allowable soil bearing pressures.
2. Overturning load on steel beam from shear wall above is not shown for simplicity; Designer must include shear wall overturning forces in steel beam check as required.
3. Design of diaphragms, including the requirements of ASCE 7-05 Section 12.2.3.2, is not shown and is the responsibility of the Designer.