TABLE 1617.6.2—continued
DESIGN COEFFICIENTS AND FACTORS FOR BASIC SEISMIC-FORCE-RESISTING SYSTEMS

BASIC SEISMIC-FORCE-RESISTING SYSTEM	DETAILING REFERENCE SECTION	RESPONSE MODIFICATION COEFFICIENT, R^a	SYSTEM OVERSTRENGTH FACTOR, Ω_o^g	DEFLECTION AMPLIFICATION FACTOR, C_d^b	SYSTEM LIMITATIONS AND BUILDING HEIGHT LIMITATIONS (FEET) BY SEISMIC DESIGN CATEGORY[c] AS DETERMINED IN SECTION 1616.3[c]				
					A or B	C	D[d]	E[e]	F[e]
H. Ordinary plain concrete shear walls	1910.2.1	2	2 1/2	2	NL	NP	NP	NP	NP
I. Composite eccentrically braced frames	(14)[k]	8	2	4	NL	NL	160	160	100
J. Composite concentrically braced frames	(13)[k]	5	2	4 1/2	NL	NL	160	160	100
K. Ordinary composite braced frames	(12)[k]	3	2	3	NL	NL	NP	NP	NP
L. Composite steel plate shear walls	(17)[k]	6 1/2	2 1/2	5 1/2	NL	NL	160	160	100
M. Special composite reinforced concrete shear walls with steel elements	(16)[k]	6	2 1/2	5	NL	NL	160	160	100
N. Ordinary composite reinforced concrete shear walls with steel elements	(15)[k]	5	2 1/2	4 1/2	NL	NL	NP	NP	NP
O. Special reinforced masonry shear walls	1.13.2.2.5[o]	5 1/2	2 1/2	4	NL	NL	160	160	100
P. Intermediate reinforced masonry shear walls	1.13.2.2.4[o]	4	2 1/2	2 1/2	NL	NL	NP	NP	NP
Q. Ordinary reinforced masonry shear walls	1.13.2.2.3[o]	3	2 1/2	2 1/4	NL	160	NP	NP	NP
R. Detailed plain masonry shear walls	1.13.2.2.2[o]	2 1/2	2 1/2	2 1/4	NL	NP	NP	NP	NP
S. Ordinary plain masonry shear walls	1.13.2.2.1[o]	1 1/2	2 1/2	1 1/4	NL	NP	NP	NP	NP
T. Light frame walls with shear panels—wood structural panels/sheet steel panels	2306.4.1/ 2211	7	2 1/2	4 1/2	NL	NL	65	65	65
U. Light framed walls with shear panels—all other materials	2306.4.5/ 2211	2 1/2	2 1/2	2 1/2	NL	NL	35	NP	NP
V. Ordinary plain prestressed masonry shear walls	2106.1.1.1	1 1/2	2 1/2	1 1/4	NL	NP	NP	NP	NP
W. Intermediate prestressed masonry shear walls	2106.1.1.2, 1.13.2.2.4[o]	3	2 1/2	2 1/2	NL	35	NP	NP	NP
X. Special prestressed masonry shear walls	2106.1.1.3, 1.13.2.2.5[o]	4 1/2	2 1/2	4	NL	35	35	35	35
3. Moment-resisting Frame Systems									
A. Special steel moment frames	(9)[j]	8	3	5 1/2	NL	NL	NL	NL	NL
B. Special steel truss moment frames	(12)[j]	7	3	5 1/2	NL	NL	160	100	NP
C. Intermediate steel moment frames	(10)[j]	4 1/2	3	4	NL	NL	35[h]	NP[h,i]	NP[h,i]
D. Ordinary steel moment frames	(11)[j]	3 1/2	3	3	NL	NL	NP[h,i]	NP[h,i]	NP[h,i]
E. Special reinforced concrete moment frames	(21.1)[l]	8	3	5 1/2	NL	NL	NL	NL	NL

(continued)

TABLE 1617.6.2—continued
DESIGN COEFFICIENTS AND FACTORS FOR BASIC SEISMIC-FORCE-RESISTING SYSTEMS

BASIC SEISMIC-FORCE-RESISTING SYSTEM	DETAILING REFERENCE SECTION	RESPONSE MODIFICATION COEFFICIENT, R^a	SYSTEM OVERSTRENGTH FACTOR, Ω_o^g	DEFLECTION AMPLIFICATION FACTOR, C_d^b	SYSTEM LIMITATIONS AND BUILDING HEIGHT LIMITATIONS (FEET) BY SEISMIC DESIGN CATEGORY AS DETERMINED IN SECTION 1616.3[c]				
					A or B	C	D[d]	E[e]	F[e]
F. Intermediate reinforced concrete moment frames	(21.1)[l]	5	3	4 1/2	NL	NL	NP	NP	NP
G. Ordinary reinforced concrete moment frames	(21.1)[l]	3	3	2 1/2	NL	NP	NP	NP	NP
H. Special composite moment frames	(9)[k]	8	3	5 1/2	NL	NL	NL	NL	NL
I. Intermediate composite moment frames	(10)[k]	5	3	4 1/2	NL	NL	NP	NP	NP
J. Composite partially restrained moment frames	(8)[k]	6	3	5 1/2	160	160	100	NP	NP
K. Ordinary composite moment frames	(11)[k]	3	3	2 1/2	NL	NP	NP	NP	NP
L. Masonry wall frames	2106	5 1/2	3	5	NL	NL	160	160	100
4. Dual Systems with Special Moment Frames									
A. Steel eccentrically braced frames, moment-resisting connections, at columns away from links	(15)[j]	8	2 1/2	4	NL	NL	NL	NL	NL
B. Steel eccentrically braced frames, nonmoment-resisting connections, at columns away from links	(15)[j]	7	2 1/2	4	NL	NL	NL	NL	NL
C. Special steel concentrically braced frames	(13)[j]	8	2 1/2	6 1/2	NL	NL	NL	NL	NL
D. Special reinforced concrete shear walls	1910.2.4	8	2 1/2	6 1/2	NL	NL	NL	NL	NL
E. Ordinary reinforced concrete shear walls	1910.2.3	7	2 1/2	6	NL	NL	NP	NP	NP
F. Composite eccentrically braced frames	(14)[k]	8	2 1/2	4	NL	NL	NL	NL	NL
G. Composite concentrically braced frames	(13)[k]	6	2 1/2	5	NL	NL	NL	NL	NL
H. Composite steel plate shear walls	(17)[k]	8	2 1/2	6 1/2	NL	NL	NL	NL	NL
I. Special composite reinforced concrete shear walls with steel elements	(16)[k]	8	2 1/2	6 1/2	NL	NL	NL	NL	NL
J. Ordinary composite reinforced concrete shear walls with steel elements	(15)[k]	7	2 1/2	6	NL	NL	NP	NP	NP
K. Special reinforced masonry shear walls	1.13.2.2.5[o]	7	3	6 1/2	NL	NL	NL	NL	NL
L. Intermediate reinforced masonry shear walls	1.13.2.2.4[o]	6 1/2	3	5 1/2	NL	NL	NP	NP	NP
5. Dual Systems with Intermediate Moment Frames[m]									
A. Special steel concentrically braced frames[f]	(13)[j]	4 1/2	2 1/2	4	NL	NL	35[h]	NP[h,i]	NP
B. Special reinforced concrete shear walls	1910.2.4	6	2 1/2	5	NL	NL	160	100	100
C. Ordinary reinforced concrete shear walls	1910.2.3	5 1/2	2 1/2	4 1/2	NL	NL	NP	NP	NP

(continued)

TABLE 1617.6.2–continued
DESIGN COEFFICIENTS AND FACTORS FOR BASIC SEISMIC-FORCE-RESISTING SYSTEMS

BASIC SEISMIC-FORCE-RESISTING SYSTEM	DETAILING REFERENCE SECTION	RESPONSE MODIFICATION COEFFICIENT, R^a	SYSTEM OVERSTRENGTH FACTOR, $\Omega_o{}^g$	DEFLECTION AMPLIFICATION FACTOR, $C_d{}^b$	SYSTEM LIMITATIONS AND BUILDING HEIGHT LIMITATIONS (FEET) BY SEISMIC DESIGN CATEGORY AS DETERMINED IN SECTION 1616.3[c]				
					A or B	C	D[d]	E[e]	F[e]
D. Ordinary reinforced masonry shear walls	1.13.2.2.3[o]	3	3	$2^1/_2$	NL	160	NP	NP	NP
E. Intermediate reinforced masonry shear walls	1.13.2.2.4[o]	5	3	$4^1/_2$	NL	NL	NP	NP	NP
F. Composite concentrically braced frames	(13)[k]	5	$2^1/_2$	$4^1/_2$	NL	NL	160	100	NP
G. Ordinary composite braced frames	(12)[k]	4	$2^1/_2$	3	NL	NL	NP	NP	NP
H. Ordinary composite reinforced concrete shear walls with steel elements	(15)[k]	$5^1/_2$	$2^1/_2$	$4^1/_2$	NL	NL	NP	NP	NP
6. Shear Wall-frame Interactive System with Ordinary Reinforced Concrete Moment Frames and Ordinary Reinforced Concrete Shear Walls	21.1[l] 1910.2.3	$5^1/_2$	$2^1/_2$	5	NL	NP	NP	NP	NP
7. Inverted Pendulum Systems									
A. Cantilevered column systems		$2^1/_2$	2	$2^1/_2$	NL	NL	35	35	35
B. Special steel moment frames	(9)[j]	$2^1/_2$	2	$2^1/_2$	NL	NL	NL	NL	NL
C. Ordinary steel moment frames	(11)[j]	$1^1/_4$	2	$2^1/_2$	NL	NL	NP	NP	NP
D. Special reinforced concrete moment frames	21.1[l]	$2^1/_2$	2	$1^1/_4$	NL	NL	NL	NL	NL
8. Structural Steel Systems Not Specifically Detailed for Seismic Resistance	AISC—335 AISC—LRFD AISI AISC—HSS	3	3	3	NL	NL	NP	NP	NP

For SI: 1 foot = 304.8 mm, 1 pound per square foot = 0.0479 KN/m^2.

a. Response modification coefficient, *R*, for use throughout.
b. Deflection amplification factor, C_d.
c. NL = Not limited and NP = Not permitted.
d. See Section 1617.6.2.4.1 for a description of building systems limited to buildings with a height of 240 feet or less.
e. See Section 1617.6.2.4.1 for building systems limited to buildings with a height of 160 feet or less.
f. Ordinary moment frame is permitted to be used in lieu of intermediate moment frame in Seismic Design Categories B and C.
g. The tabulated value of the overstrength factor, Ω_o, is permitted to be reduced by subtracting $^1/_2$ for structures with flexible diaphragms but shall not be taken as less than 2.0 for any structure.
h. Steel ordinary moment frames and intermediate moment frames are permitted in single-story buildings up to a height of 60 feet, when the moment joints of field connections are constructed of bolted end plates and the dead load of the roof does not exceed 15 pounds per square foot. The dead weight of the portion of walls more than 35 feet above the base shall not exceed 15 pounds per square foot.
i. Steel ordinary moment frames are permitted in buildings up to a height of 35 feet, where the dead load of the walls, floors and roof does not exceed 15 pounds per square foot.
j. AISC 341 Part I or Part III section number.
k. AISC 341 Part II section number.
l. ACI 318, Section number.
m. Steel intermediate moment resisting frames as part of a dual system are not permitted in Seismic Design Categories D, E, and F.
n. Steel ordinary concentrically braced frames are permitted in penthouse structures and in single-story buildings up to a height of 60 feet when the dead load of the roof does not exceed 15 pounds per square foot.
o. ACI 530/ASCE 5/TMS 402 section number.

1617.6.2.4.1 Limited building height. For buildings that have steel-braced frames or concrete cast-in-place shear walls, the height limits in Table 1617.6.2 for Seismic Design Category D or E are increased to 240 feet (73 152 mm) and for Seismic Design Category F to 160 feet (48 768 mm) provided that the buildings are configured such that the braced frames or shear walls arranged in any one plane conform to the following:

1. The braced frames or shear walls in any one plane shall resist no more than 50 percent of the total seismic forces in each direction, neglecting torsional effects.
2. The seismic force in the braced frames or shear walls in any one plane resulting from torsional effects shall not exceed 20 percent of the total seismic force in the braced frames or shear walls.

1617.6.2.4.2 Interaction effects. Moment-resisting frames that are enclosed or adjoined by stiffer elements not considered to be part of the seismic-force-resisting system shall be designed so that the action or failure of those elements will not impair the vertical load and seismic-force-resisting capability of the frame. The design shall consider and provide for the effect of these rigid elements on the structural system at deformations corresponding to the design story drift, Δ, as determined in Section 1617.5.4. In addition, the effects of these elements shall be considered when determining whether a structure has one or more of the irregularities defined in Section 1616.5.1.

1617.6.2.4.3 Deformational compatibility. Every structural component not included in the seismic-force-resisting system in the direction under consideration shall be designed to be adequate for vertical load-carrying capacity and the induced moments and shears resulting from the design story drift, Δ, as determined in accordance with Section 1617.5.4. Where allowable stress design is used, Δ shall be computed without dividing the earthquake force by 1.4. The moments and shears induced in components that are not included in the seismic-force-resisting system in the direction under consideration shall be calculated including the stiffening effects of adjoining rigid structural and nonstructural elements.

Exception: Reinforced concrete frame members not designed as part of the seismic-force-resisting system shall comply with Section 21.11 of ACI 318.

1617.6.2.4.4 Special moment frames. A special moment frame that is used but not required by Table 1617.6.2 is permitted to be discontinued and supported by a stiffer system with a lower response modification coefficient, *R*, provided the requirements of Sections 1620.2.3 and 1620.4.1 are met. Where a special moment frame is required by Table 1617.6.2, the frame shall be continuous to the foundation.

SECTION 1618
DYNAMIC ANALYSIS PROCEDURE FOR THE SEISMIC DESIGN OF BUILDINGS

1618.1 Dynamic analysis procedures. The following dynamic analysis procedures are permitted to be used in lieu of the equivalent lateral force procedure of Section 1617.4:

1. Modal Response Spectral Analysis.
2. Linear Time-history Analysis.
3. Nonlinear Time-history Analysis.

The dynamic analysis procedures listed above shall be performed in accordance with the requirements of Sections 9.5.6, 9.5.7 and 9.5.8, respectively, of ASCE 7.

SECTION 1619
EARTHQUAKE LOADS SOIL-STRUCTURE INTERACTION EFFECTS

1619.1 Analysis procedure. If soil-structure interaction is considered in the determination of seismic design forces and corresponding displacements in the structure, the procedure given in Section 9.5.9 of ASCE 7 shall be used.

SECTION 1620
EARTHQUAKE LOADS—DESIGN, DETAILING REQUIREMENTS AND STRUCTURAL COMPONENT LOAD EFFECTS

1620.1 Structural component design and detailing. The design and detailing of the components of the seismic-force-resisting system shall comply with the requirements of Section 9.5.2.6 of ASCE 7 in addition to the nonseismic requirements of this code except as modified in Sections 1620.1.1, 1620.1.2 and 1620.1.3.

Exception: For structures designed using the simplified analysis procedure in Section 1617.5, the provisions of Sections 1620.2 through 1620.5 shall be used.

1620.1.1 ASCE 7, Section 9.5.2.6.2.5. Section 9.5.2.6.2.5 of ASCE 7 shall not apply.

1620.1.2 ASCE 7, Section 9.5.2.6.2.11. Modify ASCE 7, Section 9.5.2.6.2.11, to read as follows:

9.5.2.6.2.11 Elements supporting discontinuous walls or frames. Columns, beams, trusses or slabs supporting discontinuous walls or frames of structures and the connections of the discontinuous element to the supporting member having plan irregularity Type 4 of Table 9.5.2.3.2 or vertical irregularity Type 4 of Table 9.5.2.3.3 shall have the design strength to resist the maximum axial force that can develop in accordance with the special seismic loads of Section 9.5.2.7.1.

Exceptions:

1. The quantity *E* in Section 9.5.2.7.1 need not exceed the maximum force that can be transmitted to the element by the lateral-force-resisting system at yield.
2. Concrete slabs supporting light-framed walls.

1620.1.3 ASCE 7, Section 9.5.2.6.3. Modify ASCE 7, Section 9.5.2.6.3, to read as follows:

> 9.5.2.6.3 Seismic Design Category C. Structures assigned to Category C shall conform to the requirements of Section 9.5.2.6.2 for Category B and to the requirements of this section. Structures that have plan structural irregularity Type 1a or 1b of Table 9.5.2.3.2 along both principal plan axes, or plan structural irregularity Type 5 of Table 9.5.2.3.2, shall be analyzed for seismic forces in compliance with Section 9.5.2.5.2.2. When the square root of the sum of the squares method of combining directional effects is used, each term computed shall be assigned the sign that will yield the most conservative result.
>
> The orthogonal combination procedure of Section 9.5.2.5.2.2, Item a, shall be required for any column or wall that forms part of two or more intersecting seismic-force-resisting systems and is subjected to axial load due to seismic forces acting along either principal plan axis equaling or exceeding 20 percent of the axial load design strength of the column or wall.

1620.2 Structural component design and detailing (for use in the simplified analysis procedure of Section 1617.5). The design and detailing of the components of the seismic-force-resisting system for structures designed using the simplified analysis procedure in Section 1617.5 shall comply with the requirements of this section in addition to the nonseismic requirements of this code. Buildidngs shall not exceed the limitations of Section 1616.6.1.

Exception: Structures assigned to Seismic Design Category A.

Structures assigned to Seismic Design Category B (see Section 1616) shall conform to Sections 1620.2.1 through 1620.2.10.

1620.2.1 Second-order load effects. Where θ exceeds 0.10 as determined in Section 9.5.5.7.2 in ASCE 7, second-order load effects shall be included in the evaluation of component and connection strengths.

1620.2.2 Openings. Where openings occur in shear walls, diaphragms or other plate-type elements, reinforcement at the edges of the openings shall be designed to transfer the stresses into the structure. The edge reinforcement shall extend into the body of the wall or diaphragm a distance sufficient to develop the force in the reinforcement.

1620.2.3 Discontinuities in vertical system. Structures with a discontinuity in lateral capacity, vertical irregularity Type 5, as defined in Table 1616.5.1.2, shall not be over two stories or 30 feet (9144 mm) in height where the "weak" story has a calculated strength of less than 65 percent of the story above.

Exception: Where the "weak" story is capable of resisting a total seismic force equal to the overstrength factor, Ω_0, as given in Table 1617.6.2, multiplied by the design force prescribed in Section 1617.5, the height limitation does not apply.

1620.2.4 Connections. All parts of the structure, except at separation joints, shall be interconnected and the connections shall be designed to resist the seismic force, F_p, induced by the parts being connected. Any smaller portion of the structure shall be tied to the remainder of the structure for the greater of:

$$F_p = 0.133\, S_{DS}\, w_p \quad \textbf{(Equation 16-58)}$$

or

$$F_p = 0.05\, w_p \quad \textbf{(Equation 16-59)}$$

where:

S_{DS} = The design, 5-percent damped, spectral response acceleration at short periods as defined in Section 1615.

w_p = The weight of the smaller portion.

A positive connection for resisting a horizontal force acting parallel to the member shall be provided for each beam, girder or truss to its support for a force not less than 5 percent of the dead plus live load reaction.

1620.2.5 Diaphragms. Permissible deflection shall be that deflection up to which the diaphragm and any attached distributing or resisting element will maintain its structural integrity under design load conditions, such that the resisting element will continue to support design loads without danger to occupants of the structure.

Floor and roof diaphragms shall be designed to resist F_p as follows:

$$F_p = 0.2\, I_E S_{DS}\, w_p + V_{px} \quad \textbf{(Equation 16-60)}$$

where:

F_p = The seismic force induced by the parts.

I_E = Occupancy importance factor (Table 1604.5).

S_{DS} = The short-period site design spectral response acceleration coefficient (Section 1615).

w_p = The weight of the diaphragm and other elements of the structure attached to the diaphragm.

V_{px} = The portion of the seismic shear force at the level of the diaphragm, required to be transferred to the components of the vertical seismic-force-resisting system because of the offsets or changes in stiffness of the vertical components above or below the diaphragm.

Diaphragms shall provide for both shear and bending stresses resulting from these forces. Diaphragms shall have ties or struts to distribute the wall anchorage forces into the diaphragm. Diaphragm connections shall be positive, mechanical or welded-type connections.

1620.2.6 Collector elements. Collector elements shall be provided that are capable of transferring the seismic forces originating in other portions of the structure to the element providing the resistance to those forces. Collector elements, splices and their connections to resisting elements shall have the design strength to resist the special load combinations of Section 1605.4.

Exception: In structures or portions thereof braced entirely by light-framed shear walls, collector elements, splices and connections to resisting elements need only have the strength to resist the load combinations of Section 1605.2 or 1605.3.

1620.2.7 Bearing walls and shear walls. Bearing walls and shear walls and their anchorage shall be designed for an out-of-plane force, F_p, that is the greater of 10 percent of the weight of the wall, or the quantity given by Equation 16-61:

$$F_p = 0.40\, I_E S_{DS} w_w \qquad \textbf{(Equation 16-61)}$$

where:

I_E = Occupancy importance factor (Table 1604.5).

S_{DS} = The short-period site design spectral response acceleration coefficient (Section 1615.1.3 or 1615.2.5).

w_w = The weight of the wall.

In addition, concrete and masonry walls shall be anchored to the roof and floors and members that provide lateral support for the wall or that are supported by the wall. The anchorage shall provide a direct connection between the wall and the supporting construction capable of resisting the greater of the force, F_p, as given by Equation 16-61 or (400 $S_{DS} I_E$) pounds per linear foot of wall. For SI: 5838 $S_{DS} I_E$ N/m. Walls shall be designed to resist bending between anchors where the anchor spacing exceeds 4 feet (1219 mm). Parapets shall conform to the requirements of Section 9.6.2.2 of ASCE 7.

1620.2.8 Inverted pendulum-type structures. Supporting columns or piers of inverted pendulum-type structures shall be designed for the bending moment calculated at the base determined using the procedures given in Section 1617.4 and varying uniformly to a moment at the top equal to one-half the calculated bending moment at the base.

1620.2.9 Elements supporting discontinuous walls or frames. Columns or other elements subject to vertical reactions from discontinuous walls or frames of structures having plan irregularity Type 4 of Table 1616.5.1.1 or vertical irregularity Type 4 of Table 1616.5.1.2 shall have the design strength to resist special seismic load combinations of Section 1605.4. The connections from the discontinuous walls or frames to the supporting elements need not have the design strength to resist the special seismic load combinations of Section 1605.4.

Exceptions:

1. The quantity, E_m, in Section 1617.1.1.2 need not exceed the maximum force that can be transmitted to the element by the lateral-force-resisting system at yield.
2. Concrete slabs supporting light-framed walls.

1620.2.10 Direction of seismic load. The direction of application of seismic forces used in design shall be that which will produce the most critical load effect in each component. The requirement will be deemed satisfied if the design seismic forces are applied separately and independently in each of the two orthogonal directions.

1620.3 Seismic Design Category C. Structures assigned to Seismic Design Category C (see Section 1616) shall conform to the requirements of Section 1620.2 for Seismic Design Category B and to Sections 1620.3.1 through 1620.3.2.

1620.3.1 Anchorage of concrete or masonry walls. Concrete or masonry walls shall be anchored to floors and roofs and members that provide out-of-plane lateral support for the wall or that are supported by the wall. The anchorage shall provide a positive direct connection between the wall and floor or roof capable of resisting the horizontal forces specified in Equation 16-62 for structures with flexible diaphragms or in Section 9.6.1.3 of ASCE 7 (using a_p of 1.0 and R_p of 2.5) for structures with diaphragms that are not flexible.

$$F_p = 0.8\, S_{DS} I_E w_w \qquad \textbf{(Equation 16-62)}$$

where:

F_p = The design force in the individual anchors.

I_E = Occupancy importance factor in accordance with Section 1616.2.

S_{DS} = The design earthquake spectral response acceleration at short period in accordance with Section 1615.1.3.

w_w = The weight of the wall tributary to the anchor.

Diaphragms shall be provided with continuous ties or struts between diaphragm chords to distribute these anchorage forces into the diaphragms. Where added chords are used to form subdiaphragms, such chords shall transmit the anchorage forces to the main cross ties. The maximum length-to-width ratio of the structural subdiaphragm shall be $2^1/_2$ to 1. Connections and anchorages capable of resisting the prescribed forces shall be provided between the diaphragm and the attached components. Connections shall extend into the diaphragms a sufficient distance to develop the force transferred into the diaphragm.

The strength design forces for steel elements of the wall anchorage system shall be 1.4 times the force otherwise required by this section.

In wood diaphragms, the continuous ties shall be in addition to the diaphragm sheathing. Anchorage shall not be accomplished by use of toenails or nails subject to withdrawal, nor shall wood ledgers or framing be used in cross-grain bending or cross-grain tension. The diaphragm sheathing shall not be considered effective as providing the ties or struts required by this section.

In metal deck diaphragms, the metal deck shall not be used as the continuous ties required by this section in the direction perpendicular to the deck span.

Diaphragm-to-wall anchorage using embedded straps shall be attached to or hooked around the reinforcing steel or otherwise terminated so as to directly transfer force to the reinforcing steel.

1620.3.2 Direction of seismic load. For structures that have plan structural irregularity Type 1a or 1b of Table 1616.5.1.1 along both principal plan axes, or plan structural irregularity Type 5 in Table 1616.5.1.1, the critical direction requirement of Section 1620.2.10 shall be deemed satisfied if components and their foundations are designed for the following orthogonal combination of prescribed loads.

One hundred percent of the forces for one direction plus 30 percent of the forces for the perpendicular direction. The combination requiring the maximum component strength shall be used. Alternatively, the effects of the two orthogonal directions are permitted to be combined on a square root of the sum of the squares (SRSS) basis. When the SRSS method of combining directional effects is used, each term computed shall be assigned the sign that will result in the most conservative result.

The orthogonal combination procedure above shall be required for any column or wall that forms part of two or more intersecting seismic-force-resisting systems and is subjected to axial load due to seismic forces acting along either principal plan axis equaling or exceeding 20 percent of the axial load design strength of the column or wall.

1620.4 Seismic Design Category D. Structures assigned to Seismic Design Category D shall conform to the requirements of Section 1620.3 for Seismic Design Category C and to Sections 1620.4.1 through 1620.4.6.

1620.4.1 Plan or vertical irregularities. For buildings having a plan structural irregularity of Type 1a, 1b, 2, 3 or 4 in Table 1616.5.1.1 or a vertical structural irregularity of Type 4 in Table 1616.5.1.2, the design forces determined from Section 1617.5 shall be increased 25 percent for connections of diaphragms to vertical elements and to collectors, and for connections of collectors to the vertical elements.

Exception: When connection design forces are determined using the special seismic load combinations of Section 1605.4

1620.4.2 Vertical seismic forces. In addition to the applicable load combinations of Section 1605, horizontal cantilever and horizontal prestressed components shall be designed to resist a minimum net upward force of 0.2 times the dead load.

1620.4.3 Diaphragms. Floor and roof diaphragms shall be designed to resist design seismic forces determined in accordance with Equation 16-63 as follows:

$$F_{px} = \frac{\sum_{i=x}^{n} F_i}{\sum_{i=x}^{n} w_i} w_{px} \qquad \textbf{(Equation 16-63)}$$

where:

F_i = The design force applied to Level i.

F_{px} = The diaphragm design force.

w_i = The weight tributary to Level i.

w_{px} = The weight tributary to the diaphragm at Level x.

The force determined from Equation 16-63 need not exceed $0.4S_{DS}I_Ew_{px}$ but shall not be less than $0.2S_{DS}I_Ew_{px}$ where S_{DS} is the design spectral response acceleration at short period determined in Section 1615.1.3 and I_E is the occupancy importance factor determined in Section 1616.2. When the diaphragm is required to transfer design seismic force from the vertical-resisting elements above the diaphragm to other vertical-resisting elements below the diaphragm due to offsets in the placement of the elements or to changes in relative lateral stiffness in the vertical elements, these forces shall be added to those determined from Equation 16-63 and to the upper and lower limits on that equation.

1620.4.4 Collector elements. Collector elements shall be provided that are capable of transferring the seismic forces originating in other portions of the structure to the element providing resistance to those forces.

Collector elements, splices and their connections to resisting elements shall resist the forces determined in accordance with Equation 16-63. In addition, collector elements, splices and their connections to resisting elements shall have the design strength to resist the earthquake loads as defined in the special load combinations of Section 1605.4.

Exception: In structures, or portions thereof, braced entirely by light-framed shear walls, collector elements, splices and their connections to resisting elements need only be designed to resist forces in accordance with Equation 16-63.

1620.4.5 Building separations. All structures shall be separated from adjoining structures. Separations shall allow for the displacement δ_M. Adjacent buildings on the same property shall be separated by at least δ_{MT} where

$$\delta_{MT} = \sqrt{(\delta_{M1})^2 + (\delta_{M2})^2} \qquad \textbf{(Equation 16-64)}$$

and δ_{M1} and δ_{M2} are the displacements of the adjacent buildings.

When a structure adjoins a property line not common to a public way, that structure shall also be set back from the property line by at least the displacement, δ_M, of that structure.

Exception: Smaller separations or property line setbacks shall be permitted when justified by rational analyses based on maximum expected ground motions.

1620.4.6 Anchorage of concrete or masonry walls to flexible diaphragms. In addition to the requirements of Section 1620.3.1, concrete and masonry walls shall be anchored to flexible diaphragms based on the following:

1. When elements of the wall anchorage system are not loaded concentrically or are not perpendicular to the wall, the system shall be designed to resist all components of the forces induced by the eccentricity.
2. When pilasters are present in the wall, the anchorage force at the pilasters shall be calculated considering the additional load transferred from the wall panels to the pilasters. The minimum anchorage at a floor or roof shall not be less than that specified in Item 1.

1620.5 Seismic Design Category E or F. Structures assigned to Seismic Design Category E or F (Section 1616) shall conform to the requirements of Section 1620.4 for Seismic Design Category D and to Section 1620.5.1.

1620.5.1 Plan or vertical irregularities. Structures having plan irregularity Type 1b of Table 1616.5.1.1 or vertical irregularities Type 1b or 5 of Table 1616.5.1.2 shall not be permitted.

SECTION 1621 ARCHITECTURAL, MECHANICAL AND ELECTRICAL COMPONENT SEISMIC DESIGN REQUIREMENTS

1621.1 Component design. Architectural, mechanical, electrical and nonstructural systems, components and elements permanently attached to structures, including supporting structures and attachments (hereinafter referred to as "components"), and nonbuilding structures that are supported by other structures, shall meet the requirements of Section 9.6 of ASCE 7 except as modified in Sections 1621.1.1, 1621.1.2 and 1621.1.3, excluding Section 9.6.3.11.2, of ASCE 7, as amended in this section.

1621.1.1 ASCE 7, Section 9.6.3.11.2: Section 9.6.3.11.2 of ASCE 7 shall not apply.

1621.1.2 ASCE 7, Section 9.6.2.8.1. Modify ASCE 7, Section 9.6.2.8.1, to read as follows:

9.6.2.8.1 General. Partitions that are tied to the ceiling and all partitions greater than 6 feet (1829 mm) in height shall be laterally braced to the building structure. Such bracing shall be independent of any ceiling splay bracing. Bracing shall be spaced to limit horizontal deflection at the partition head to be compatible with ceiling deflection requirements as determined in Section 9.6.2.6 for suspended ceilings and Section 9.6.2.6 for other systems.

Exception: Partitions not taller than 9 feet (2743 mm) when the horizontal seismic load does not exceed 5 psf (0.240 KN/m^2) required in Section 1607.13 of the *International Building Code*.

1621.1.3 ASCE 7, Section 9.6.3.13. Modify ASCE 7, Section 9.6.3.13, to read as follows:

9.6.3.13 Mechanical equipment, attachments and supports. Attachments and supports for mechanical equipment not covered in Sections 9.6.3.8 through 9.6.3.12 or Section 9.6.3.16 shall be designed to meet the force and displacement provisions of Section 9.6.1.3 and 9.6.1.4 and the additional provisions of this section. In addition to their attachments and supports, such mechanical equipment designated as having an I_p = 1.5, which contains hazardous or flammable materials in quantities that exceed the maximum allowable quantities for an open system listed in Section 307 of the *International Building Code*, shall, itself, be designed to meet the force and displacement provisions of Sections 9.6.1.3 and 9.6.1.4 and the additional provisions of this section. The seismic design of mechanical equipment, attachments and their supports shall include analysis of the following: the dynamic effects of the equipment, its contents and, when appropriate, its supports. The interaction between the equipment and the supporting structures, including other mechanical and electrical equipment, shall also be considered.

SECTION 1622 NONBUILDING STRUCTURES SEISMIC DESIGN REQUIREMENTS

1622.1 Nonbuilding structures. The requirements of Section 9.14 of ASCE 7 shall apply to nonbuilding structures except as modified by Sections 1622.1.1, 1622.1.2 and 1622.1.3.

1622.1.1 ASCE 7, Section 9.14.5.1. Modify Section 9.14.5.1, Item 9, to read as follows:

9.Where an approved national standard provides a basis for the earthquake-resistant design of a particular type of nonbuilding structure covered by Section 9.14, such a standard shall not be used unless the following limitations are met:

1. The seismic force shall not be taken as less than 80 percent of that given by the remainder of Section 9.14.5.1.
2. The seismic ground acceleration, and seismic coefficient, shall be in conformance with the requirements of Sections 9.4.1 and 9.4.1.2.5, respectively.
3. The values for total lateral force and total base overturning moment used in design shall not be less than 80 percent of the base shear value and overturning moment, each adjusted for the effects of soil structure interaction that is obtained by using this standard.

1622.1.2 ASCE 7, Section 9.14.7.2.1. Modify Section 9.14.7.2.1 to read as follows:

9.14.7.2.1 General. This section applies to all earth-retaining walls. The applied seismic forces shall be determined in accordance with Section 9.7.5.1 with a geotechnical analysis prepared by a registered design professional.

The seismic use group shall be determined by the proximity of the retaining wall to other nonbuilding structures or buildings. If failure of the retaining wall would affect an adjacent structure, the seismic use group shall not be less than that of the adjacent structure, as determined in Section 9.1.3. Earth-retaining walls are permitted to be designed for seismic loads as either yielding or nonyielding walls. Cantilevered reinforced concrete retaining walls shall be assumed to be yielding walls and shall be designed as simple flexural wall elements.

1622.1.3 ASCE 7, Section 9.14.7.9. Add a new Section 9.14.7.9 to read as follows:

9.14.7.9 Buried structures. As used in this section, the term "buried structures" means subgrade structures such as tanks, tunnels and pipes. Buried structures that are designated as Seismic Use Group II or III, as determined in Section 9.1.3, or are of such a size or length as to warrant special seismic design as determined by the registered design professional, shall be identified in the geotechnical report. Buried structures shall be designed to resist seismic lateral forces determined from a substantiated analysis using standards approved by the building official. Flexible couplings shall be provided for buried structures where changes in the support system, configurations or soil condition occur.

SECTION 1623
SEISMICALLY ISOLATED STRUCTURES

1623.1 Design requirements. Every seismically isolated structure and every portion thereof shall be designed and constructed in accordance with the requirements of Section 9.13 of ASCE 7, except as modified in Section 1623.1.1.

1623.1.1 ASCE 7, Section 9.13.6.2.3. Modify ASCE 7, Section 9.13.6.2.3, to read as follows:

9.13.6.2.3 Fire resistance. Fire-resistance ratings for the isolation system shall comply with Section 714.7 of the *International Building Code.*