

**Chapter 16.17****STRENGTHENING OF UNREINFORCED MASONRY BUILDINGS****Sections:**

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**Section 16.17.010 Purpose.**

The purpose of this chapter is to promote public safety and welfare by reducing the risk of death or injury that may result from the effects of earthquakes on existing unreinforced masonry bearing wall buildings.

The provisions of this chapter are intended as minimum standards for structural seismic resistance and established primarily to reduce the risk of life loss or injury. Compliance with these provisions will not necessarily prevent loss of life or injury, or prevent earthquake damage to rehabilitated buildings. (Ord. 5921 § 1, 1991)

**Section 16.17.020 Scope.**

The provisions of this chapter shall apply to all existing buildings having at least one unreinforced masonry bearing wall. Except as provided herein, all other provisions of the Building Code shall apply.

**Exceptions:**

1. Detached one- or two-family dwellings and detached apartment houses containing less than five dwelling units and used solely for residential purposes.
2. Wood framed structures two stories or less in height supported by unreinforced masonry foundation walls of less than thirty inches in height.
3. This chapter shall not apply to "Essential facilities" and "Hazardous facilities" as defined in Table No. 23-K of the Building Code.
4. Buildings such as warehouses, mausoleums, crypts, or other similar structures where human occupancy is low and infrequent as determined by the Building Official.

This chapter does not require alteration of existing electrical, plumbing, mechanical or fire safety systems unless they are removed or altered during the seismic retrofit process. (Ord. 5921 § 1, 1991)

**Section 16.17.025 Definitions.**

For the purpose of this chapter, the applicable definitions in the Building Code shall also apply.

"Collar joint" is the vertical space between adjacent wythes and may contain mortar.

"Crosswall" is a wall that meets the requirements of Section 16.17.055(D)(3).

"Crosswall shear capacity" is the length of the crosswall times the allowable shear value,  $v_c L_o$ .

"Diaphragm edge" is the intersection of the horizontal diaphragm and a shear wall.

"Diaphragm shear capacity" is the depth of the diaphragm times the allowable shear value,  $v_u D$ .

"Flexible diaphragm" is a diaphragm of wood construction or other construction of similar flexibility.

"Normal wall" is a wall perpendicular to the direction of seismic forces.

"Open front" is an exterior building wall plane on one side only without vertical elements of the lateral force resisting system in one or more stories.

"Pointing" is the partial reconstruction of the bed joints of an unreinforced masonry wall as defined in UBC Standard No. 24-42.

"Unreinforced masonry (URM) wall" is a masonry wall in which the area of reinforcing steel is less than twenty-five percent of the minimum required by the Building Code for reinforced masonry.

"Unreinforced masonry bearing wall" is a URM wall which provides the vertical support for a floor or roof for which the total superimposed load exceeds one hundred pounds per linear foot of wall.

"Warehouse" is a building used exclusively for the purpose of storage of goods, where due to such use, human occupancy is low and infrequent. Such buildings may require the posting of a sign identifying the structures approved use and specifying maximum occupancy levels.

"Yield story drift" is the lateral displacement of one level relative to the level above or below at which yield stress is first developed in a frame member. (Ord. 5921 § 1, 1991)

### **Section 16.17.030 Symbols and notations.**

For the purpose of this chapter, the applicable symbols and notations in the Building Code shall also apply.

$A$  = area of unreinforced masonry pier, square inches.

$A_b$  = total area of the bed joints above and below the test specimen for each in-place shear test.

$C_p$  = numerical coefficient as specified in Section 2312(g) and given in Table No. 23-P of the Building Code and Table No. A-1-A of this chapter.

$D$  = in-plane width dimension of pier, inches, or depth of diaphragm, feet.

$DCR$  = demand-capacity ratio specified in Section 16.17.055(D)(3)(a), Exception (B)(iii).

$F_{WX}$  = force applied to a wall at level  $x$ , pounds.

$H$  = least clear height of opening on either side of pier, inches.

$h/t$  = height-to-thickness ratio of URM wall. Height,  $h$ , is measured between wall anchorage levels and/or slab-on-grade.

$L$  = span of diaphragm between shear walls, or span between shear wall and open front, feet.

$L_O$  = length of crosswall, feet.

$L_i$  = effective diaphragm span for an open front building specified in Section 16.17.055(D)(8)(a), feet.

$P_D$  = superimposed dead load at the top of the pier under consideration, pounds.

$P_{D+L}$  = actual dead plus live load in place at the time of testing, pounds.

$P_W$  = weight of wall, pounds.  
 $V_a$  =  $V_a A$ , the allowable shear in any URM pier, pounds.  
 $V_{cb}$  = total shear capacity of crosswalls in the direction of analysis immediately below the diaphragm level being investigated,  $\hat{a}v_{cL0}$ , pounds.  
 $V_{ca}$  = total shear capacity of crosswalls in the direction of analysis immediately above the diaphragm level being investigated,  $\hat{a}v_{cL0}$ , pounds.  
 $V_r$  = pier rocking shear capacity of any URM wall or wall pier, pounds.  
 $V_{WX}$  = total shear force resisted by a shear wall at the level under consideration, pounds.  
 $V_p$  = shear force assigned to a pier on the basis of its relative shear rigidity, pounds.  
 $V_s$  = shear force assigned to a spandrel on the basis of the shear forces in the adjacent wall piers and tributary dead plus live loads.  
 $V_{test}$  = load in pounds at incipient cracking for each in-place masonry shear test per UBC Standard No. 24-40, pounds.  
 $v_a$  = allowable shear stress for unreinforced masonry, psi.  
 $v_c$  = allowable shear value for a crosswall sheathed with any of the materials given in Tables No. A-1-C or A-1-D, pounds per foot.  
 $v_t$  = mortar shear strength as specified in Section 16.17.040(C)(2)(d)  
 $v_{to}$  = mortar shear test values as specified in Section 16.17.040(C)(2)(d).  
 $v_u$  = allowable shear value for a diaphragm sheathed with any of the materials given in Tables No. A-1-C or A-1-D, pounds per foot.  
 $\hat{a}v_u D$  = sum of diaphragm shear capacities of both ends of the diaphragm.  
 $\hat{a}\hat{a}v_u D$  = for diaphragms coupled with crosswalls,  $\hat{a}\hat{a}v_u D$  includes the sum of shear capacities of both ends of diaphragms coupled at and above the level under consideration.  
 $W_d$  = total dead load tributary to a diaphragm, pounds.  
 $\hat{a}W_d$  = total dead load tributary to all of the diaphragms at and above the level under consideration, pounds.  
 $W_W$  = total dead load of an unreinforced masonry wall above the level under consideration or above an open front of a building, pounds.  
 $W_{WX}$  = dead load of a URM wall assigned to Level x halfway above and below the level under consideration. (Ord. 5921 § 1, 1991)

### **Section 16.17.035 General requirements**

A. General. All buildings shall have a seismic resisting system conforming with Section 2303(b) of the Building Code, except as modified by this chapter.

B. Alterations and Repairs. Alterations and repairs required to meet the provisions of this chapter shall comply with all other applicable requirements of the Building Code unless specifically provided for in this chapter.

C. Requirements for Plans. The following construction information shall be included in the plans required by this chapter:

1. Dimensioned floor and roof plans showing existing walls and the size and spacing of floor and roof framing members and sheathing materials. The plans shall indicate all existing and new crosswalls and their materials of construction. The location of the crosswalls and their openings shall be fully dimensioned or drawn to scale on the plans.

2. Dimensioned wall elevations showing openings, piers, wall classes as defined in Section 16.17.040(C)(2)(f), thicknesses, heights, wall shear test locations, and cracks or damaged portions requiring repairs. The general condition of the mortar joints and if and where the joints require pointing. Where the exterior face is veneer, the type of veneer, its thickness and its bonding and/or ties to the structural wall masonry shall also be reported.

3. The type of interior wall and ceiling surfaces.

4. The extent and type of existing wall anchorage to floors and roof when used in the design.

5. The extent and type of parapet corrections which were previously performed, if any.

6. Repair details, if any, of cracked or damaged unreinforced masonry walls required to resist forces specified in this chapter.

7. All other plans, sections, and details necessary to delineate required retrofit construction including those items in Section 16.17.060. (Ord. 5921 § 1, 1991)

#### **Section 16.17.040 Material requirements.**

A. General. All materials permitted by this chapter, including their appropriate allowable design values and those existing configurations of materials specified herein, may be utilized to meet the requirements of this chapter.

B. Existing Materials. All existing materials utilized as part of the required vertical load carrying or lateral force-resisting system shall be in sound condition or shall be repaired or removed and replaced with new materials.

C. Existing Unreinforced Masonry.

1. General. All unreinforced masonry walls utilized to carry vertical loads or seismic forces parallel and perpendicular to the wall plane shall be tested as specified in this subsection. All masonry that does not meet the minimum standards established by this chapter shall be removed and replaced with new materials or alternatively shall have its structural functions replaced with new materials and shall be anchored to supporting elements.

2. Mortar.

a. Tests. The quality of mortar in all masonry walls shall be determined by performing in-place shear tests in accordance with U.B.C. Standard No. 24-40. Alternative methods of testing may be approved by the Building Official for masonry walls other than brick.

b. Location of tests. The shear tests shall be taken at locations representative of the mortar conditions throughout the entire building, taking into account variations in workmanship at different building height levels, variations in weathering of the exterior surfaces, and variations in the condition of the interior surfaces due to deterioration caused by leaks and condensation of water and/or by the deleterious effects of other substances contained within the building. The exact test location shall be determined at the building site by the engineer in responsible charge of the structural design work. An accurate record of all such tests and their location in the building shall be recorded and these results shall be submitted to the Building Department for approval as part of the structural analysis.

c. Number of tests. The minimum number of tests per class shall be as follows:

i. At each of both the first and top stories, not less than two tests per wall or line of wall elements providing a common line of resistance to lateral forces.

ii. At each of all other stories, not less than one test per wall or line of wall elements providing a common line of resistance to lateral forces.

iii. In any case, not less than one test per 1,500 square feet of wall surface nor less than a total of eight tests.

d. Minimum quality mortar.

i. Mortar shear test values,  $v_{to}$ , in psi shall be obtained for each in-place shear test in accordance with the following equation:

$$v_{t0} = (V_{\text{test}} - P_{D+L})/A_b \dots\dots\dots (A1-1)$$

- ii. Individual unreinforced masonry walls with  $v_{t0}$  consistently less than thirty psi shall be entirely pointed prior to retesting.
- iii. The mortar shear strength,  $v_t$ , is the value in psi that is exceeded by eighty percent of all of the mortar shear test values,  $v_{t0}$ .
- iv. Unreinforced masonry with mortar shear strength,  $v_t$ , less than thirty psi shall be removed or pointed and retested.
- e. Collar joints. The collar joints shall be inspected at the test locations during each in-place shear test, and estimates of the percentage of the surfaces of adjacent wythes which are covered with mortar shall be reported along with the results of the in-place shear tests.
- f. Unreinforced masonry classes. All existing unreinforced masonry shall be categorized into one or more classes based on shear strength, quality of construction, State of repair, deterioration and weathering. A class shall be characterized by the allowable masonry shear stress determined in accordance with Section 16.17.050 (B). Class shall be defined for whole walls, not for small areas of masonry within a wall.
- g. Pointing. All deteriorated mortar joints in unreinforced masonry walls shall be pointed according to U.B.C. Standard No. 24-42. Nothing shall prevent pointing with mortar of all the masonry wall joints before the tests are made, except as required in Section 16.17.045 (A). (Ord. 5921 § 1, 1991)

**Section 16.17.045 Quality control.**

- A. Pointing. All preparation and mortar pointing shall be performed with special inspection.  
Exception: At the discretion of the Building Official, incidental pointing may be performed without special inspection.
- B. Masonry Shear Tests. In-place masonry shear tests shall comply with UBC Standard No. 24-40.
- C. Existing Wall Anchors. Existing wall anchors utilized as all or part of the required tension anchors shall be tested in pullout according to UBC Standard No. 24-41. The minimum number of anchors tested shall be four per floor, with two tests at walls with joists framing into the wall and two tests at walls with joists parallel to the wall, but not less than ten percent of the total number of existing tension anchors at each level.
- D. New Bolts. One-fourth of all new shear bolts and combined tension and shear bolts in unreinforced masonry walls shall be tested according to UBC Standard No. 24-41.  
Exception: Special inspection in accordance with the Building Code may be provided during installation in lieu of testing. (Ord. 5921 § 1, 1991)

**Section 16.17.050 Allowable design values**

- A. Allowable Values.
  - 1. Allowable values for existing materials are given in Table No. A-1-C and for new materials in Table No. A-1-D.
  - 2. Allowable values not specified in this chapter shall be as specified elsewhere in the Building Code. Allowable values not specified in this chapter for dead load plus seismic load may be increased thirty-three percent. Allowable values not specified in this chapter for existing building elements with a combination of dead load plus floor live load plus seismic load may be increased seventy percent.
- B. Masonry Shear. The allowable unreinforced masonry shear stress,  $v_a$ , shall be determined for each masonry class from the following equation:

$$v_a = 0.1v_{t0} + 0.15P_D/A \dots\dots\dots (A1-2)$$

The mortar shear test value,  $v_{tO}$ , shall be determined in accordance with Section 16.17.040 2(d) and not exceed one hundred psi for the determination of  $v_a$ .

The one-third increase in allowable values in Section 2303(d) of the Building Code is not allowed for  $v_a$ .

C. Masonry Compression. Where any increase in dead plus live compression stress occurs, the allowable compression stress in unreinforced masonry shall not exceed one hundred psi. The one-third increase in allowable stress in Section 2303(d) of the Building Code is allowed.

D. Masonry Tension. Unreinforced masonry shall be assumed as having no tensile capacity.

E. Existing Tension Anchors. The allowable resistance values of the existing anchors shall be forty percent of the average of the tension tests of existing anchors having the same wall thickness and joist orientation. The one-third increase in allowable stress in Section 2303(d) of the Building Code is not allowed for existing tension anchors.

F. Foundations. For existing foundations new total dead load may be increased over existing dead load by 25 percent. New total dead load plus live load plus seismic forces may be increased over existing dead load plus live load by fifty percent. Higher values may be justified only in conjunction with a geotechnical investigation. (Ord. 5921 § 1, 1991)

**Section 16.17.055 Analysis and design.**

A. General. Except as modified herein, the analysis and design relating to the structural alteration of existing buildings shall be in accordance with the Building Code.

The elements of buildings required to be analyzed by this chapter shall be as specified in Table No. A-1-H.

B. Selection of Procedure. Buildings shall be analyzed by the general procedure of Section 16.17.055(C) which is based on Chapter 23 of the Building Code or, when applicable, buildings may be analyzed by the Special Procedure of Section 16.17.055(D).

C. General Procedure.

1. Minimum design lateral forces. Buildings shall be analyzed to resist minimum lateral forces assumed to act non-concurrently in the direction of each of the main axis of the structure in accordance with the following:

$$V=IKCSW.....(A1-3)$$

The value of IKCS need not exceed the values set forth in the Table No. A1-I based on the applicable rating classification of the building.

TABLE A1-I  
HORIZONTAL FORCE FACTORS  
BASED ON RATING CLASSIFICATION

RATING CLASSIFICATION	IKCS
I	0.186
II	0.133
III & IV	0.100

2. Lateral forces on elements of structures. Parts or portions of structures shall be analyzed as required in Chapter 23 of the Building Code but need not be more than the value from the following equation:

$$F_p = IC_p SW_p.$$

For the purpose of this subsection, the product of "IS" need not exceed the values set forth in the attached Table A1-J. The value of Cp need not exceed the values set forth in the attached Table A1-K.

a. Exceptions:

i. Unreinforced masonry walls for which height-to-thickness ratios do not exceed ratios set forth in Table No. A-1-B need not be analyzed for out-of plane loading. Unreinforced masonry walls which exceed the allowable h/t ratios of Table No. A-1-B shall be braced according to Section 16.17.060(E).

ii. Parapets complying with Section 16.17.060(F) need not be analyzed for out-of-plane loading.

3. Shear walls (in-plane loading). Shear walls shall comply with Section 16.17.055(E).

D. Special Procedure.

1. Limits for the application of Section 16.17.055(E). The Special Procedure of this subsection may only be applied to buildings with the following characteristics:

a. Flexible diaphragms at all levels above the base of structure.

b. A maximum of six stories above the base of the building.

c. The vertical elements of the lateral force-resisting system shall consist predominantly of masonry or concrete shear walls.

d. New vertical elements of the lateral force-resisting system consisting of steel-braced frames or special moment-resisting frames shall have a maximum overall height-to-length ratio of 1-1/2 to 1. (See Section 2312 of the Building Code.)

e. Except for single-story buildings with an open front on one side only, a minimum of two lines of vertical elements of the lateral force-resisting system parallel to each axis of the building. (See Section 16.17.055(D)(8) for open front buildings.)

2. Lateral forces on elements of structures. With the exception of the diaphragm provisions in Section 16.17.055(D), elements of structures shall comply with Section 16.17.055(C)(2).

3. Crosswalls. Crosswalls shall meet the requirements of this subsection.

a. Crosswall definition. A crosswall is a wood-framed wall sheathed with any of the materials described in Tables No. A-1-C or A-1-D. Spacing of crosswalls shall not exceed forty feet on center measured perpendicular to the direction of consideration, and shall be placed in each story of the building. Crosswalls shall extend the full story height between diaphragms.

i. Exceptions:

(A) Crosswalls need not be provided at all levels in accordance with Section 16.17.055(D)(4)(b)(iv).

(B) Existing crosswalls need not be continuous below a wood diaphragm at or within four feet of grade provided:

(i) Shear connections and anchorage requirements of Section 16.17.055(D)(5) are satisfied at all edges of the diaphragm.

(ii) Crosswalls with total shear capacity of  $0.20W_d$  interconnect the diaphragm to the foundation.

(iii) The demand capacity ratio of the diaphragm between the crosswalls that are continuous to their foundations shall be calculated as:

$$DCR = [0.33W_d + V_{ca}]/2v_uD \dots \dots \dots (A1-4)$$

and DCR shall not exceed 2.5.

b. Crosswall shear capacity. Within any forty feet measured along the span of the diaphragm, the sum of the crosswall shear capacities shall be at least thirty percent of the diaphragm shear capacity of the strongest diaphragm at or above the level under consideration.

c. Existing crosswalls. Existing crosswalls shall have a length-to-height ratio between openings of not less than 1.5. Existing crosswall connections to diaphragms need not be

investigated as long as the crosswall extends to the framing of the diaphragm above and below.

d. New crosswalls. New crosswall connections to the diaphragm shall develop the crosswall shear capacity. New crosswalls shall have the capacity to resist an overturning moment equal to the crosswall shear capacity times the story height. Crosswall overturning moments need not be cumulative over more than two stories.

e. Other crosswall systems. Other systems, such as special moment-resisting frames, may be used as crosswalls provided that the yield story drift does not exceed one inch in any story.

4. Wood diaphragms.

a. Acceptable diaphragm span. A diaphragm is acceptable if the point (L,DCR) on Figure No. A-1-1, falls within Regions 1, 2, or 3.

b. Demand-capacity ratios. Demand-capacity ratios shall be calculated for the diaphragm at any level according to the following formulas:

i. For a diaphragm without qualifying crosswalls at levels immediately above or below:

$$DCR = 0.83Z W_d / \hat{v}_u D \dots\dots\dots(A1-5)$$

ii. For a diaphragm in a single-story building with qualifying crosswalls:

$$DCR = 0.83Z W_d / (\hat{v}_u D + v_{cb}) \dots\dots\dots(A1-6)$$

iii. For diaphragms in a multi-story building with qualifying crosswalls in all levels:

$$DCR = 0.83Z \hat{W}_d / (\hat{v}_u D + v_{cb}) \dots\dots\dots(A1-7)$$

DCR shall be calculated at each level for the set of diaphragms at and above the level under consideration. In addition, roof diaphragm shall also meet the requirements of Formula (A1-6).

iv. For a roof diaphragm and the diaphragm directly below if coupled by crosswalls:

$$DCR = 0.83Z \hat{W}_d / \hat{v}_u D \dots\dots\dots(A1-8)$$

c. Chords. An analysis for diaphragm flexure need not be made and chords need not be provided.

d. Collectors. An analysis of diaphragm collector forces shall be made for the transfer of diaphragm edge shears into vertical elements of the lateral force resisting system. Collector forces may be resisted by new or existing elements.

e. Diaphragm openings.

i. Diaphragm forces at corners of openings shall be investigated and shall be developed into the diaphragm by new or existing materials.

ii. In addition to the demand capacity ratios of Section 16.17.055(D)(4)(b), the demand capacity ratio of the portion of the diaphragm adjacent to an opening shall be calculated using the opening dimension as the span.

iii. Where an opening occurs in the end quarter of the diaphragm span  $v_u D$  for the demand capacity ratio, calculation shall be based on the net depth of the diaphragm.

5. Diaphragm shear transfer. Diaphragms shall be connected to shear walls with connections capable of developing a minimum force given by the lesser of the following formulas:

$$V = 0.50Z C_p W_d \dots\dots\dots(A1-9)$$

using the  $C_p$  values in Table No. A-1-A, or

$$V = v_u D \dots\dots\dots(A1-10)$$

6. Shear walls (in-plane loading)--special procedure.

a. Wall story force. The wall story force distributed to a shear wall at any diaphragm level shall be the lesser value calculated as:

i. For buildings without crosswalls,

$$F_{WX} = 0.33Z (W_{WX} + W_d / 2) \dots\dots\dots(A1-11)$$

but need not exceed

$$F_{WX} = 0.33ZW_{WX} + v_U D \dots\dots\dots (A1-12)$$

- ii. For buildings with crosswalls in all levels:  
 $F_{WX} = 0.25Z(W_{WX} + W_D/2) \dots\dots\dots (A1-13)$

but need not exceed

$$F_{WX} = 0.25Z[W_{WX} + \alpha W_D (v_U D / \alpha v_U D)] \dots\dots\dots (A1-14)$$

and need not exceed

$$F_{WX} = 0.25ZW_{WX} + v_U D \dots\dots\dots (A1-15)$$

b. Wall story shear. The wall story shear shall be the sum of the wall story forces at and above the level of consideration:

$$V_{WX} = \alpha F_{WX} \dots\dots\dots (A1-16)$$

c. Shear wall analysis. Shear walls shall comply with Section 16.17.055(E).

d. Moment frames. Moment frames used in place of shear walls shall be designed as required in Chapter 23 of the Building Code except that the forces shall be as specified in Section 16.17.055(D)(6)(a) and the interstory drift ratio shall be limited to 0.005, except as further limited in Section 16.17.055(E)(3)(b).

7. Out-of-plane forces--unreinforced masonry walls.

a. Allowable unreinforced masonry wall height-to-thickness ratios. The provisions of Section 16.17.055(C)(2) are applicable except that the allowable height-to-thickness ratios given in Table No. A1-B shall be determined from Figure A1-1 as follows:

i. In Region 1, height-to-thickness ratios for buildings with crosswalls may be used if qualifying crosswalls are present in all stories.

ii. In Region 2, height-to-thickness ratios for buildings with crosswalls may be used whether or not qualifying crosswalls are present.

iii. In Region 3, height-to-thickness ratios for all other buildings shall be used whether or not qualifying crosswalls are present.

b. Walls with diaphragm in different regions. When diaphragms above and below the wall under consideration have DCRs in different regions of Figure A1-1, the lesser height-to-thickness ratio shall be used.

8. Buildings with open fronts. A building with an open front on one side shall have crosswalls parallel to the open front and shall be designed by the following procedure:

a. Effective diaphragm span,  $L_i$ , for use in Figure No. A1-1 shall be determined in accordance with the following formula:

$$L_i = 2[(W_W/W_D) \times L + L] \dots\dots\dots (A1-17)$$

b. Diaphragm demand/capacity ratio shall be calculated as:

$$DCR = 0.83Z(W_D + W_U) / [(v_U D) + V_C] \dots\dots\dots (A1-18)$$

E. Analysis of Vertical Elements of the Lateral Force-Resisting System. Applicable to both general procedure and special procedure buildings.

1. Existing unreinforced masonry walls.

a. Flexural rigidity. Flexural components of deflection may be neglected in determining the rigidity of an unreinforced masonry wall.

b. Shear walls with openings. Wall piers shall be analyzed according to the following procedure:

i. For any pier,

(A) The pier shear capacity shall be calculated as:

$$V_a = v_a D t \dots\dots\dots (A1-19)$$

(B) The pier rocking shear capacity shall be calculated as:

$$V_r = 0.5 P_D D / H \dots\dots\dots (A1-20)$$

ii. The wall piers at any level are acceptable if they comply with one of the following modes of behavior:

(A) Rocking controlled mode. When the pier rocking shear capacity is less than the pier shear capacity, i.e.  $V_r < V_a$  for each pier in a level, forces in the wall at that level,  $V_{wx}$ , shall be distributed to each pier,  $V_p$ , in proportion to  $P_D D/H$ .

For the wall at that level:

$$V_{wx} < \hat{a} V_r \dots \dots \dots (A1-21)$$

(B) Shear controlled mode. Where the pier shear capacity is less than the pier rocking capacity, i.e.  $V_a < V_r$  in at least one pier in a level, forces in the wall at that level,  $V_{wx}$ , shall be distributed to each pier,  $V_p$ , in proportion to  $D/H$ .

For each pier at that level:

$$V_p \leq V_a \dots \dots \dots (A1-22)$$

and

$$V_p \leq V_r \dots \dots \dots (A1-23)$$

If  $V_p \leq V_a$  for each pier and  $V_p > V_r$  for one or more piers, such piers shall be omitted from the analysis, and the procedure shall be repeated for the remaining piers, unless the wall is strengthened and reanalyzed.

iii. Masonry pier tension stress. Unreinforced masonry wall piers need not be analyzed for tension stress.

c. Shear walls without openings. Shear walls without openings shall be analyzed as for walls with openings except that  $V_r$  shall be calculated as follows:

$$V_r = (0.50P_D + 0.25P_W)D/H \dots \dots \dots (A1-24)$$

2. Plywood sheathed shear walls. Plywood sheathed shear walls may be used to resist lateral loads for buildings with flexible diaphragms analyzed according to provisions of Section 16.17.055(C). Plywood sheathed shear walls may not be used to share lateral loads with other materials along the same line of resistance.

3. Combinations of vertical elements.

a. Lateral force distribution. Lateral forces shall be distributed among the vertical resisting elements in proportion to their relative rigidities except that moment frames shall comply with Section 16.17.055(E)(3)(b).

b. Moment-resisting frames. A moment frame shall not be used with an unreinforced masonry wall in a single line of resistance unless the wall has piers that are capable of sustaining rocking in accordance with Section 16.17.055(E)(1)(b) and the frames are designed to carry one hundred percent of the lateral forces and the interstory drift ratio shall be limited to 0.005. (Ord. 5921 § 1, 1991)

**Section 16.17.060 Detailed system design requirements.**

A. Wall anchorage.

1. Anchor locations. All unreinforced masonry walls shall be anchored at the roof and floor levels as required in Section 16.17.055(C)(2). Ceilings with substantial rigidity and abutting masonry walls shall be connected to walls with tension bolts at a maximum anchor spacing of six feet. Ceiling systems with substantial mass shall be braced at the ceiling perimeter to the roof or floor diaphragms.

2. Anchor requirements. Anchors shall be tension bolts through the wall as specified in Table No. A1-D, or by an approved equivalent at a maximum anchor spacing of six feet. All existing wall anchors shall be secured to the joists to develop the required forces. The Building Official may require testing to verify the adequacy of the embedded ends of existing wall anchors.

3. Minimum wall anchorage. Anchorage of masonry walls to each floor or roof shall resist a minimum force determined by Section 2312(g)2 of the Building Code or two hundred

pounds per linear foot, whichever is greater, acting normal to the wall at the level of the floor or roof. Existing wall anchors, installed under previous permits, must meet or must be upgraded to meet the requirements of this chapter.

4. Anchors at corners. At the roof and all floor levels, both shear and tension anchors shall be provided within two feet horizontally from the inside of the corners of the walls.

5. Anchors with limited access. When access to the exterior face of the masonry wall is prevented by proximity of an existing building, wall anchors conforming to Item 5 in Table No. A1-D may be used.

B. Diaphragm Shear Transfer. Shear bolts shall have a maximum bolt spacing of six feet.

C. Collectors. Collector elements shall be provided which are capable of transferring the seismic forces originating in other portions of the building to the element providing the resistance to those forces.

D. Ties and Continuity. Ties and continuity shall conform to Section 2313(h)2E of the Building Code.

E. Wall Bracing.

1. General. Where a wall height-to-thickness ratio exceeds the specified limits, the wall may be laterally supported by vertical bracing members per Section 16.17.060(E)(2) or by reducing the wall height by bracing per Section 16.17.060(E)(3).

2. Vertical Bracing Members. Vertical bracing members shall be attached to floor and roof construction for their design loads independently of required wall anchors. Horizontal spacing of vertical bracing members shall not exceed one-half the unsupported height of the wall nor ten feet. Deflection of such bracing members at design loads shall not exceed one-tenth of the wall thickness.

3. Intermediate Wall Bracing. The wall height may be reduced by bracing elements connected to the floor or roof. Horizontal spacing of the bracing elements and wall anchors shall be as required by design but shall not exceed six feet on center. Bracing elements shall be detailed to minimize the horizontal displacement of the wall by the vertical displacement of the floor or roof.

F. Parapets. Parapets and exterior wall appendages not conforming to this chapter shall be removed, or stabilized or braced to ensure that the parapets and appendages remain in their original position.

The maximum height of an unbraced unreinforced masonry parapet above the lower of either the level of tension anchors or roof sheathing, shall not exceed one and one-half times the thickness of the parapet wall. Parapet height may be a maximum of two and one-half times its thickness in other than Seismic Zone No. 3 and 4. If the required parapet height exceeds this maximum height, a bracing system designed for the force factors specified in Table No. 23-P of the Building Code for walls shall support the top of the parapet. Parapet corrective work must be performed in conjunction with the installation of tension roof anchors.

The minimum height of a parapet above the wall anchor shall be twelve inches.

EXCEPTION: If a reinforced concrete beam is provided at the top of the wall, the minimum height above the wall anchor may be six inches.

G. Veneer.

1. Unreinforced masonry walls which carry no design loads other than their own weight may be considered as veneer if they are adequately anchored to new supporting elements.

2. Veneer shall be anchored with approved anchor ties, conforming to the required design capacity specified in the Building Code and placed at a maximum spacing of twenty-four inches with a maximum supported area of two square feet.

EXCEPTION: Existing veneer anchor ties may be acceptable provided the ties are in good condition and conform to the following minimum size, maximum spacing and material requirements.

Existing veneer anchor ties shall be corrugated galvanized iron strips not less than one inch in width, eight inches in length and one-sixteenth inch in thickness or equal and shall be located and laid in every alternate course in the vertical height of the wall at a spacing not to exceed seventeen inches on centers horizontally. As an alternate, such ties may be laid in every fourth course vertically at a spacing not to exceed nine inches on centers horizontally.

3. The location and condition of existing veneer anchor ties shall be verified as follows:

a. An approved testing laboratory shall verify the location and spacing of the ties and shall submit a report to the Building Official for approval as a part of the structural analysis.

b. The veneer in a selected area shall be removed to expose a representative sample of ties (not less than four) for inspection by the Building Official.

H. Truss and Beam Supports. Where trusses and beams other than rafters or joists are supported on masonry, independent secondary columns shall be installed to support vertical loads of the roof or floor members. The loads shall be transmitted down to adequate support.

EXCEPTION: Secondary supports are not required in Seismic Zone Nos. 1, 2A and 2B.

I. Adjacent Buildings.

1. Where elements of adjacent buildings do not have a separation of at least five inches, the allowable height-to-thickness ratios for buildings with crosswalls per Table No. A1-B shall not be used in the direction of consideration.

2. Where buildings do not have a separation of at least five inches and the diaphragm levels of the adjoining structures differ by more than one and one-half times the wall thickness, supplemental vertical gravity load carrying members shall be added to support the loads normally carried by the wall and such members shall not be attached to the wall. The loads shall be transmitted down to the foundation. (Ord. 5921 § 1, 1991)

#### **Section 16.17.065 Administrative provisions.**

A. Definitions. For the purposes of this chapter, the applicable definitions in the Building Code shall also apply.

"High-risk building" is any building, other than an essential or hazardous building, having an occupant load of one hundred occupants or more as determined by Section 3302(a) of the Building Code.

EXCEPTION: A high-risk building shall not include the following:

1. Any building having exterior walls braced with masonry crosswalls or woodframe crosswalls spaced less than forty feet apart in each story. Crosswalls shall be full-story height with a minimum length of one and one-half times the story height.

2. Any building used for its intended purpose, as determined by the Building Official, for less than twenty hours per week.

"Low-risk building" is any building, other than an essential or hazardous building, having an occupant load as determined by Section 3302(a) of the Building Code of less than twenty occupants.

"Medium-risk building" is any building, not classified as a high-risk building or an essential or hazardous building, having an occupant load as determined by Section 3302(a) of the Building Code of twenty occupants or more.

B. Rating Classifications. The rating classifications identified in Table No. A1-E are hereby established and each building within the scope of this chapter shall be placed in one such rating classification by the Building Official. The total occupant load of the entire building as determined by Section 3302(a) of the Building Code shall be used to determine the rating classification.

EXCEPTION: For purposes of this chapter, portions of buildings constructed to act independently when resisting seismic forces, and have required exits with independent travel paths, may be placed in separate rating classifications.

### C. Compliance Requirements.

1. The owner of each building within the scope of this chapter shall, upon service of an order and within the time limits set forth in this chapter, cause a structural analysis to be made of the building by an engineer or architect licensed by the State to practice as such and, if the building does not comply with earthquake standards specified in this chapter, the owner shall cause it to be structurally altered to conform to such standards or shall cause the building to be demolished.

2. The owner of a building within the scope of this chapter shall comply with the requirements set forth above by submitting to the Building Official for review within the Stated time limits:

a. Within three hundred sixty days after service of the order, a structural analysis, which is subject to approval by the Building Official, and which shall demonstrate that the building meets the minimum requirements of this chapter; or

b. Within three hundred sixty days after service of the order, the structural analysis and plans for structural alterations of the building to comply with this chapter; or

c. Within one hundred eighty days after service of the order, plans for the installation of wall anchors in accordance with the requirements specified in Section 16.17.060; or

d. Within three hundred sixty days after service of the order, plans for the demolition of the building;

e. Applications for demolition of qualified historical buildings shall be reviewed in accordance with the Cultural Resources Ordinance, Title 20 of the Municipal Code.

3. After plans are submitted and approved by the Building Official, the owner shall obtain a building permit and then commence and complete the required construction or demolition within the time limits set forth in Table No. A1-F. These time limits shall begin to run from the date the order is served in accordance with Section 16.17.065(E)(2), except that the time limit to commence structural alteration or demolition shall begin to run from the date the building permit is issued.

4. Owners complying with Paragraphs 2c and 2e of this subsection are also required to comply with Paragraphs 2b and 2d of this subsection provided, however, that the three hundred sixty-day period provided for in Paragraphs 2b or 2d and the time limits for obtaining a building permit and to complete structural alterations or building demolition set forth in Table A1-F shall be extended in accordance with Table No. A1-G. Each such extended time limit shall begin to run from the date the order is served in accordance with Section 16.17.065(E), except that the time limit to commence structural alterations or demolition shall begin to run from the date the building permit is issued.

Owners not complying with Paragraphs 2C and 2E of this subsection shall comply with Paragraphs 2B or 2D within the time limits shown in Table A1-F. Buildings not complying shall be declared hazardous and be vacated and abated in accordance with City ordinances.

### D. Special Requirements for Historic Buildings.

1. Plans for seismic upgrading of qualified historical buildings shall be reviewed by the Cultural Heritage Board. The basis of review shall be the Design Guidelines and the Secretary of the Interior's Standards and with the following requirements:

a. Features of architectural or historic significance shall be retained and reattached, braced, or stabilized, as required.

b. In-wall anchors shall be used on historic buildings instead of through-wall anchors, especially on the principal facade. Through-wall anchors on other facades may be permitted, provided that their locations and treatment are approved by the Cultural Heritage Board or its staff.

c. Closure of historic openings on the principal facade shall not be permitted and shall be discouraged on secondary facades. If closure of such openings on secondary facades is unavoidable, the materials used shall be compatible with the existing exterior materials of the

secondary facade wall.

d. Historic parapets shall be braced rather than removed.

e. Historic architectural veneer posing a safety hazard shall be stabilized and reanchored to the building.

2. The purpose and intent of the plan review and guidelines shall be to minimize the effects of seismic strengthening on the exterior appearance of the building.

3. In the case of a qualified historical building, plans showing proposed test and core locations shall be submitted for review and approval by the Cultural Heritage Board or its staff in order to minimize the effect on the exterior appearance of the building. Repairs after testing shall match original adjacent existing.

4. This chapter does not require alteration of existing electrical, plumbing, mechanical or fire-safety systems.

E. Administration.

1. Order--Service.

a. The Building Official shall, in accordance with the priorities set forth in Table No. A1-G, issue an order as provided in this section to the owner of each building within the scope of this chapter.

b. Prior to the service of an order as set forth in Table No. A1-G, a bulletin may be issued to the owner as shown upon the last equalized assessment roll or to the person in apparent charge or control of a building considered by the Building Official to be within the scope of this chapter. The bulletin may contain information the Building Official deems appropriate. The bulletin may be issued by mail or in person.

2. Order--Priority of Service. Priorities for the service of the order for buildings within the scope of this chapter shall be in accordance with the rating classification as shown on Table No. A1-G. Within each separate rating classification, the priority of the order shall normally be based upon the occupant load of the building. The owners of the buildings housing the largest occupant loads shall be served first. The minimum time period prior to the service of the order as shown on Table No. A1-G shall be measured from the effective date of this chapter. The Building Official may, upon receipt of a written request from the owner, order such owner to bring his building into compliance with this chapter prior to the normal service date for such building set forth in this chapter.

3. Order--Contents. The order shall be in writing and shall be served either personally or by certified or registered mail upon the owner as shown on the last equalized assessment roll, and upon the person, if any, in apparent charge or control of the building. The order shall specify that the building has been determined by the Building Official to be within the scope of this chapter and, therefore, is required to meet the minimum seismic standards of this chapter. The order shall specify the rating classification of the building and shall be accompanied by a copy of Section 16.17.065(C), which sets forth the owner's alternatives and time limits for compliance.

4. Appeal from Order. The owner of the building may appeal the Building Official's initial determination that the building is within the scope of this chapter to the Board of Appeals established by Section 204 of the Building Code. Such appeal shall be filed with the Board within sixty days from the service date of the order described in Section 16.17.065(E)(3). Any such appeal shall be decided by the Board no later than ninety days after writing and the grounds thereof shall be stated clearly and concisely. Appeals or requests for modifications from any other Building Official pursuant to this chapter shall be made in accordance with the procedures established in Sections 105 and 106 of the Building Code.

5. Recordation. At the time that the Building Official serves the aforementioned order, the Building Official shall also file with the office of the County Recorder a certificate stating that the subject building is within the scope of the chapter and is a potentially earthquake hazardous building. The certificate shall also state that the owner thereof has been ordered to structurally

analyze the building and to structurally alter or demolish it where compliance with this chapter has not been demonstrated.

If the building is either demolished, found not to be within the scope of this chapter, or is structurally capable of resisting minimum seismic forces required by this chapter as a result of structural alterations or an analysis, the Building Official shall file with the office of the County Recorder a form terminating the status of the subject building as being classified within the scope of this chapter.

6. Enforcement. If the owner in charge or control of the subject building fails to comply with any order issued by the Building Official pursuant to this chapter within any of the time limits set forth in Section 16.17.065(C), the Building Official shall verify that the record owner of this building has been properly served. If the order has been served on the record owner, then the Building Official shall order that the entire building be vacated and that the building remain vacated until such order has been complied with. If compliance with such order has not been accomplished within ninety days after the date the building has been ordered vacated or such additional time as may have been granted by the Board of Appeals, the Building Official may order its demolition in accordance with the provisions of Section 203 of the Building Code.

7. Should the City fail to enact a financial incentives program to facilitate the herein ordinance on or before December 31, 1991, the time provisions requiring compliance shall be tolled from December 31, 1991, until such time as a financial incentives program approved by the City Council is adopted. (Ord. 5921 § 1, 1991)

TABLE NO. A1-A  
HORIZONTAL FORCE FACTOR  $C_p$

CONFIGURATION OF MATERIALS	$C_p$
Roofs with straight or diagonal sheathing and roofing applied directly to the sheathing, or floors with straight tongue and groove sheathing.	0.5
Diaphragms with double or multiple layers of boards with edges offset and blocked plywood systems.	0.75

TABLE NO. A1-B  
ALLOWABLE VALUE OF HEIGHT-THICKNESS RATIO OF  
UNREINFORCED MASONRY WALLS

Wall Types	Seismic Zone 2B and 3 Buildings	Seismic Zone 4 Buildings With Crosswalls	Seismic Zone 4 All Other Buildings
Walls of one-story buildings	16	$16^{2,3}$	13

First-story wall of multi-story building	18	16	15
Walls in top story of multi-story buildings	14	14 <sup>2,3</sup>	9
All other walls	16	16	13

<sup>1</sup>Applies to the Special Procedures of Section A109(d) only. See Section A109(d)7 for other restrictions.

<sup>2</sup>This value of height-to-thickness ratio may be used only where mortar shear tests in accordance with Section A103 establish a tested mortar shear strength,  $v_t$ , of not less than 100 psi or where the tested mortar shear strength,  $v_t$ , is not less than 60 psi and a visual examination of the collar joint indicates not less than 50 percent mortar coverage.

<sup>3</sup>Where a visual examination of the collar joint indicates not less than 50 percent mortar coverage and the tested mortar shear strength,  $v_t$ , when established in accordance with Section A103 is greater than 30 psi but less than 60 psi, the allowable height-to-thickness ratio may be determined by linear interpolation between the larger and smaller ratios in direct proportion to the tested mortar shear strength,  $v_t$ .

TABLE NO. A1-C  
ALLOWABLE VALUES FOR EXISTING MATERIALS

EXISTING MATERIALS OR CONFIGURATIONS OF MATERIALS <sup>1</sup>	ALLOWABLE VALUES
1. HORIZONTAL DIAPHRAGMS <sup>4</sup>	
a. Roofs with straight sheathing and roofing applied directly to the sheathing.	100 lbs. per foot for seismic shear
b. Roofs with diagonal sheathing and roofing applied directly to the sheathing.	250 lbs. per foot for seismic shear
c. Floors with straight tongue-and-groove sheathing.	100 lbs. per foot for seismic shear
d. Floors with straight sheathing and finished wood flooring with board edges offset or perpendicular.	500 lbs. per foot for seismic shear
e. Floors with diagonal sheathing and finished wood flooring.	600 lbs. per foot for seismic shear
2. CROSSWALLS <sup>2,4</sup>	

a. Plaster on wood or metal lath.	Per side: 200 lbs. per foot for seismic shear
b. Plaster on gypsum lath.	175 lbs. per foot for seismic shear

TABLE NO. A1-C  
ALLOWABLE VALUES FOR EXISTING MATERIALS (Cont.)

EXISTING MATERIALS OR CONFIGURATIONS OF MATERIALS <sup>1</sup>	ALLOWABLE VALUES <sup>4</sup>
c. Gypsum wall board, unblocked edges.	75 lbs. per foot for seismic shear 125 lbs. per foot for seismic shear
d. Gypsum wall board, blocked edges.	
3. EXISTING FOOTINGS, WOOD FRAMING, STRUCTURAL STEEL, AND REINFORCED STEEL	$f'_c = 1,500$ psi unless otherwise shown by tests.
a. Plain concrete footings.	Allowable stress same as No. 1 D.F. <sup>3</sup>
b. Douglas fir wood.	$f_t = 18,000$ lbs. per square inch maximum. <sup>3</sup>
c. Reinforcing steel.	$f_t = 20,000$ lbs. per square inch maximum. <sup>3</sup>
d. Structural steel.	

<sup>1</sup>Material must be sound and in good condition.

<sup>2</sup>Shear values of these materials may be combined, except the total combined value shall not exceed 300 lbs. per foot.

<sup>3</sup>Stresses given may be increased for combinations of loads as specified in Section A108.

<sup>4</sup>A one-third increase in allowable stress is not allowed.

TABLE NO. A1-D <sup>4</sup>  
ALLOWABLE VALUES OF NEW MATERIALS USED  
IN CONJUNCTION WITH EXISTING CONSTRUCTION

NEW MATERIALS OR CONFIGURATIONS OF MATERIALS	ALLOWABLE VALUES <sup>4</sup>
<p>1. HORIZONTAL DIAPHRAGMS</p> <p>Plywood sheathing applied directly over existing straight sheathing with ends of plywood sheets bearing on joists or rafters and edges of plywood located on center of individual sheathing boards.</p>	225 lbs. per foot
<p>2. CROSSWALLS</p> <p>a. Plywood sheathing applied directly over wood studs. No value shall be given to plywood applied over existing plaster or wood sheathing.</p> <p>b. Drywall or plaster applied directly over wood studs.</p> <p>c. Drywall or plaster applied to sheathing over existing wood studs.</p>	<p>1.33 times the value specified in Table No. 25-K-1 Uniform Building Code for shear walls.</p> <p>100 percent of the values in Table No. 47-I of the Uniform Building Code.</p> <p>50 percent of the values plywood specified in Table No. 47-I of the Uniform Building Code.</p>

TABLE NO. A1-D <sup>4</sup>  
ALLOWABLE VALUES OF NEW MATERIALS USED  
IN CONJUNCTION WITH EXISTING CONSTRUCTION  
(continued)

NEW MATERIALS OR CONFIGURATIONS OF MATERIALS	ALLOWABLE VALUES <sup>4</sup>
<p>4. TENSION BOLTS</p> <p>Bolts extending entirely through unreinforced masonry walls secured with bearing plates on far side of a 3 wythe minimum wall with at least 30 square inches of area.<sup>2,3</sup></p>	<p>1800 lbs. per bolt</p> <p>900 lbs. for 2 wythe walls</p>
<p>5. SHEAR BOLTS</p> <p>Bolts embedded a minimum of 8 inches into unreinforced masonry walls. Bolts shall be centered</p>	133 percent of the values for plain masonry specified for solid

<p>in 2 1/2-inch-diameter hole with the dry-pack or non-shrink grout around circumference of bolt.<sup>1,3</sup></p> <p>6. COMBINED TENSION AND SHEAR BOLTS</p> <p>a. Through Bolts - Combined Shear and Tension</p> <p>Bolts meeting the above requirements for tension bolts and shear bolts.<sup>1,2,3</sup></p> <p>b. Embedded Bolts - Combined Shear and Tension</p>	<p>masonry in Tables No. 24-E of Uniform Building Code. No values larger than those given for 3/4-inch bolts shall be used.</p> <p>Tension: Same as for tension bolts Shear: Same as for shear bolts</p>
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TABLE NO. A1-D<sup>4</sup>  
ALLOWABLE VALUES OF NEW MATERIALS USED  
IN CONJUNCTION WITH EXISTING CONSTRUCTION  
(continued)

NEW MATERIALS OR CONFIGURATIONS OF MATERIALS	ALLOWABLE VALUES <sup>4</sup>
<p>Bolts extending to the exterior face of the wall with a 2 1/2-inch round plate under the head and drilled at an angle of 22 1/2 degrees to the horizontal. Installed as specified for shear bolts.<sup>1,2,3</sup></p>	<p>Tension: Same as for tension bolts Shear: Same as for shear bolts</p>
<p>7. INFILLED WALLS</p> <p>Reinforced masonry infilled openings in existing unreinforced masonry walls. Provide keys or dowels to match reinforcing.</p>	<p>Same as values specified for unreinforced masonry walls.</p>
<p>8. REINFORCED MASONRY</p> <p>Masonry piers and walls reinforced per Chapter 24.</p>	<p>Same as values specified in Section 2409.</p>
<p>9. REINFORCED CONCRETE</p> <p>Concrete footings, walls and piers reinforced as specified in Chapter 26 of the Uniform Building Code and designed for tributary loads.</p>	<p>Same as values specified in Chapter 26 of the Uniform Building Code.</p>

<sup>1</sup>Bolts to be tested as specified in Section A107.

<sup>2</sup>Bolts to be 1/2-inch minimum in diameter.

<sup>3</sup>Drilling for bolts and dowels shall be done with an electric rotary drill. Impact tools shall not be used for drilling holes or tightening anchors and shear bolt nuts.

<sup>4</sup>A one-third increase in allowable stress is not allowed.

TABLE NO. A1-E  
RATING CLASSIFICATIONS

TYPE OF BUILDING	CLASSIFICATION
Essential Building	I
Hazardous Building	I
High-Risk Building	II
Medium-Risk Building	III
Low-Risk Building	IV

TABLE NO. A1-F  
TIME LIMITS FOR COMPLIANCE

Required Action By Owner	Obtain Building Permit Within	Commence Construction Within	Complete Construction Within
Structural Alterations or Building Demolition	1 year <sup>1</sup>	180 days <sup>2</sup>	3 years
Wall Anchors	180 days <sup>1</sup>	270 days <sup>2</sup>	1 year

<sup>1</sup>Measured from date of service of order.

<sup>2</sup>Measured from date of building permit issuance.

TABLE A1-G  
EXTENSIONS OF TIME AND SERVICE PRIORITIES

Rating Classification	Occupant Load	Extension of Time if Wall Anchors are Installed	Periods for Service of Order
I (Highest Priority)	N/A	N/A	N/A
II-A	300 or more	---	360 days
II-B	100 to 299	1 year	540 days
III-A	100 or more	1 year	2 years

III-B	More than 50 but Less than 100	1 year	3 years
III-C	More than 19 but Less than 51	1 year	4 years
IV (Lowest Priority)	Less than 20	1 year	5 years

TABLE NO. A1-H  
ELEMENTS REGULATED BY THIS CHAPTER

BUILDING ELEMENTS	SEISMIC ZONE				
	1	2A	2B	3	4
Parapets	M	M	M	M	M
Walls, Anchorage	M	M	M	M	M
Walls, h/t Ratios			M	M	M
Walls, In-place Shear			M	M	M
Diaphragms, Shear Transfer			M	M	M
Diaphragms, Demand-Capacity Ratios <sup>1</sup>				M	M

<sup>1</sup>Applies only to buildings designed according to the Special Procedures of Section A109(d).

TABLE NO. A1-I  
HORIZONTAL FORCE FACTORS BASED  
ON RATING CLASSIFICATION

RATING IKCS  0.186 0.133 0.100
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TABLE NO. A1-J  
HORIZONTAL FORCE FACTORS AIS@  
FOR PARTS OR PORTIONS OF STRUCTURES

RATING  
IS

1.50  
1.00  
0.75

TABLE NO. A1-K  
HORIZONTAL FORCE FACTOR AC\_@ FOR PARTS OR PORTIONS OF  
BUILDINGS OR OTHER STRUCTURES

Part or Portion of Buildings	Direction of Force	Value of C_
Exterior bearing and non-bearing walls; interior bearing walls and partitions; interior nonbearing walls and partitions over 10 feet in height; masonry fences over 6 feet in height.	Normal-to-flat surface	0.20
Cantilever parapet and other cantilever walls, except retaining walls.	Normal-to-flat surface	1.00
Exterior and interior ornamentations and appendages.	Any direction	1.00
(continued)		

TABLE NO. A1-K  
HORIZONTAL FORCE FACTOR AC\_@ FOR PARTS OR PORTIONS OF  
BUILDINGS OR OTHER STRUCTURES  
(continued)

Part or Portion of Buildings	Direction of Force	Value of C_
When connected to or a part of a building tower, tank, towers and tanks plus	Any direction	0.20

contents, racks over 8 feet 3 inches in height plus contents, chimneys, smokestacks and penthouses.		
When connected to or a part of a building: Rigid and rigidly mounted equipment and machinery not required for continued operation of essential occupancies.	Any horizontal direction	0.20
Tanks plus effective contents resting on the ground.	Any direction	0.12
Floors and roofs acting in the plane of as diaphragms.	0.12 the diaphragm	
Prefabricated structural elements, other than walls, with force applied at center of gravity of assembly.	Any horizontal direction	0.30
Connections for exterior panels or elements.	Any direction	2.00

TABLE NO. A1-K  
HORIZONTAL FORCE FACTOR  $C_{ac}$  FOR PARTS OR PORTIONS OF BUILDINGS OR OTHER STRUCTURES  
(continued)

NOTES for Table No. A1-K

See Section 9608(b) for use of  $C_{ac}$ .

When located in the upper portion of any building with a ratio of 5 to 1 or greater, the value shall be increased by 50 percent.

For flexible and flexibly mounted equipment and machinery, the appropriate values for  $C_{ac}$  shall be determined with consideration given to both the dynamic properties of the equipment and machinery and to the building or structure in which it is placed.

The  $W_{ac}$  for storage racks shall be the weight of the racks plus contents. The value of  $C_{ac}$  for racks over two storage support levels in height shall be 0.16 for the levels below the top two levels.

The design of the equipment and machinery and their anchorage is an integral part of the design and specification of such equipment and machinery. The structure to which the equipment or machinery is mounted shall be capable of resisting the anchorage forces (see

also Section 2312(k))

Floor and roofs acting as diaphragms shall be designed for a minimum force resulting from a  $C_u$  of .12 applied to  $W_u$  unless a greater force results from the distribution of lateral forces in accordance with Section 2312(e).

#### UNIFORM BUILDING CODE STANDARD NO. 24-40 IN-PLACE MASONRY SHEAR TESTS

See Appendix Chapter 1, Uniform Code for Building Conservation

The bed joints of the outer wythe of the masonry shall be tested in shear by laterally displacing a single brick relative to the adjacent bricks in the same wythe. The head joint opposite the loaded end of the test brick shall be carefully excavated and cleared. The brick adjacent to the loaded end of the test brick shall be carefully removed by sawing or drilling and excavating to provide space for a hydraulic ram and steel loading blocks. Steel blocks, the size of the end of the brick, shall be used on each end of the ram to distribute the load to the brick. The blocks shall not contact the mortar joints. The load shall be applied horizontally, in the plane of the wythe, until either a crack can be seen or slip occurs. The strength of the mortar shall be calculated by dividing the load at the first crack or movement of the test brick by the nominal gross area of the sum of the two bed joints.

#### UNIFORM BUILDING CODE STANDARD NO. 24-41 TESTS OF ANCHORS IN UNREINFORCED MASONRY WALLS

See Appendix Chapter 1, Uniform Code for Building Conservation

##### Existing Anchors

The test apparatus shall be supported on the masonry wall at a minimum distance of the wall thickness from the anchor tested. Existing wall anchors shall be given a preload of 300 pounds prior to establishing a datum for recording elongation. The tension test load reported shall be recorded at 1/8-inch relative movement of the anchor and the adjacent masonry surface. Results of all tests shall be reported. The report shall include the test results as related to the wall thickness and joist orientation.

##### Combined Shear and Tension Bolts

Combined shear and tension bolts embedded in unreinforced masonry walls shall be tested using a torque calibrated wrench to the following minimum torques:

1/2-inch-diameter bolts--40 foot lbs.

5/8-inch-diameter bolts--50 foot lbs.

3/4-inch-diameter bolts--60 foot lbs.

All nuts shall be installed over malleable iron or plate washers when bearing on wood and heavy cut washers when bearing on steel.

## UNIFORM BUILDING CODE STANDARD NO. 24-42 POINTING OF UNREINFORCED MASONRY WALLS

See Appendix Chapter 1, Uniform Code for Building Conservation

### POINTING

The old mortar should be cut out, by means of a toothing chisel or a special painter's grinder, to a uniform depth of 3/4", or until sound mortar is reached. Care must be taken not to damage the brick edges. All dust and debris must be removed from the joint by brushing, blowing air or rinsing with water.

Mortar mix shall be Type "S" proportions as called for in the construction specifications. The tuck-pointing mortar should be pre-hydrated to reduce excessive shrinkage. The proper pre-hydration process is as follows:

All dry ingredients should be thoroughly mixed. Only enough clean water should be added to the dry mix to produce a damp, workable consistency which will retain its shape when formed into a ball. The mortar should stand in this dampened condition for one to one and one-half hours.

The joints to be tuck-pointed should be dampened, but to ensure a good bond, the brickwork must absorb all surface water. Water should be added to the pre-hydrated mortar to bring it to a workable consistency (somewhat drier than conventional mortar). The mortar should be packed tightly into the joints in thin layers (1/4" maximum). Each layer should become "thumbprint hard" before applying the next layer. The joints should be tooled to match the original profile after the last layer of mortar is "thumbprint hard."

### RELAYING OF BRICK

Replacement bricks must match the originals with respect to size, color, and texture where exposed. A tuck-pointing toothing chisel should be used to cut out the mortar which surrounds the affected units. Power driven impact tools are not allowed. Once the units are removed, all of the old mortar shall be carefully chiseled out and all dust and debris shall be swept out with a brush.

If used brick is to be relayed, it shall be cleaned of all old mortar. The brick surfaces in the wall shall be dampened before new units are placed, but the masonry should absorb all surface moisture to ensure a good bond. The appropriate surfaces of the surrounding brickwork and the replacement brick should be buttered with mortar. The replacement brick should be centered in the opening and pressed into position. The excess mortar should be removed with a trowel. Pointing around the replacement brick will help to ensure full head and bed joints. When the mortar becomes "thumbprint hard," the joints shall be tooled to match the original profile.