

**A Draft Model Ordinance  
for the  
Seismic Retrofit  
of  
Hazardous  
Unreinforced Masonry  
Buildings**

A Report  
by the  
Seismic Safety Commission



State of California  
Seismic Safety Commission  
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## Executive Summary

This 1990 Draft Model Ordinance is recommended by the Seismic Safety Commission for local government consideration as a model for an earthquake hazard mitigation program for unreinforced masonry bearing wall buildings. Adoption of this Draft Model Ordinance by local governments can fulfill some of the requirements of the state's Unreinforced Masonry Building Law, Section 8875 of the Government Code.

## **Background**

The Seismic Safety Commission published an earlier Draft Model Ordinance for the seismic retrofit of unreinforced masonry buildings (URMs) in December of 1985 (SSC Report No. 85-06). It was published again in 1987 in the Appendix to the Guidebook as a recommended hazard mitigation program for local governments. Most local governments with URM mitigation programs have adopted versions of the Commission's earlier Model Ordinance which is based on retrofit standards from the City of Los Angeles and recommendations from the Structural Engineers Association of Southern California.

In November 1988, the Commission asked the Structural Engineers Association of California (SEAOC) to develop technical revisions to the Model Ordinance. The Building Standards Commission assisted in this effort by providing travel funds. In April 1989, the California Building Officials (CALBO) were also asked to develop revised administrative revisions for URMs. Over the past year, volunteers from SEAOC and CALBO developed statewide consensus standards that are acceptable to both organizations. The SEAOC/CALBO Joint Recommended Unreinforced Masonry Building Seismic Strengthening Provisions were recently approved by the SEAOC Seismology Committee and CALBO's ad hoc committee. By May 1990 SEAOC will be completing minor refinements to the provisions, but these should not deter local governments from applying the 1990 Draft Model Ordinance.

The International Conference of Building Officials (ICBO) published URM seismic retrofit standards in 1985 and again in 1987 in Appendix Chapter 1 of the Uniform Code for Building Conservation (UCBC). These provisions are similar to the 1987 Model Ordinance. Code change proposals for the 1991 Edition of the UCBC are currently pending and are based on this 1990 Draft Model Ordinance. The ICBO Code change proposal number is BC-403-90-2-UCBCUG. ICBO will vote on this proposal at their annual convention in Denver in September 1990.

The Seismic Safety Commission reviewed and adopted the SEAOC/CALBO provisions as their recommended Draft Model Ordinance on February 8, 1990.

The Commission recommends that local governments, which plan to adopt or amend local ordinances to reduce earthquake hazards in unreinforced masonry bearing wall buildings, consider this Draft Model Ordinance as a basis for their local ordinances.

## Revisions to the Draft Model Ordinance

Major changes incorporated in the Seismic Safety Commission's 1990 Draft Model Ordinance are listed below:

- Incorporates the ABK method of seismic strengthening which was developed by an NSF grant in the early 1980's by the joint venture of Agbabian-Barnes-Kariotis (ABK). This method can reduce retrofit costs especially in buildings with numerous interior walls and can provide levels of seismic safety that are comparable to conventional seismic retrofit methods. The ABK method is now referred to as the "Special Procedures" in the proposed revised model ordinance. Conventional design methods are now called "General Procedures."
- Incorporates earthquake performance lessons learned from strengthened unreinforced masonry buildings from the 1987 Whittier, California Earthquake:
  - Accounts for the quality of mortar in interior or "collar" joints of unreinforced masonry walls.
  - Specifies the spacing of wall anchors at corners of buildings.
  - Specifies the attention to heavy ceiling systems which may inadvertently cause damage to the structural system.
- Incorporates testing and inspection requirements developed from the extensive application and administration by building departments in Southern California.
- Increases the earthquake force requirements for buildings with 100 or fewer occupants designed using the General Procedures from 10 percent of gravity to 13 percent.
- Recommends that essential URM facilities such as hospitals comply with current Uniform Building Code seismic safety standards for new construction.



# SEISMIC SAFETY COMMISSION

## DRAFT MODEL ORDINANCE

for the  
SEISMIC RETROFIT  
of

### UNREINFORCED MASONRY BEARING WALL BUILDINGS

#### General

#### Sec. A2341

(a) **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 established primarily to reduce the risk of life loss or injury. Compliance with these standards will not necessarily prevent loss of life or injury or prevent earthquake damage to rehabilitated buildings.

(b) **Scope.** The provisions of this Chapter shall apply to all existing buildings in Seismic Zones 3 and 4 having at least one unreinforced masonry bearing wall. Except as provided herein, all other provisions of the Building Code shall apply.

EXCEPTIONS: This Chapter shall not apply to:

1. Detached one or two family dwellings and detached apartment houses containing less than 5 dwelling units and used solely for residential purposes.
2. Essential Facilities as defined in Table 23-K of the Building Code.
3. Hazardous Facilities as defined in Table 23-K of the Building Code.

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

(c) **Definitions.** For the purposes 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 A2346(d)3. A crosswall is not a shear wall.

CROSSWALL SHEAR CAPACITY is the length of the crosswall times the allowable shear value,  $v_{cLo}$ .

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,  $v_{uD}$ .

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 wall plane without vertical elements in one or more stories which resist the required lateral forces.

POINTING is the partial reconstruction of the bed joints of a URM 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 25 percent of that required by the Building Code for reinforced masonry.

UNREINFORCED MASONRY BEARING WALL. A URM wall which provides the vertical support for a floor or roof for which the total superimposed load is over 100 pounds per linear foot of wall.

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.

(d) **Symbols and Notations.** For the purposes of this Chapter, the applicable symbols and definitions in the Building Code shall also apply.

A = Area of unreinforced masonry pier, square inches.

- $A_b$  = 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 23-P of the Building Code and Table A-23-A of this Chapter.
- $D$  = In-plane width dimension of pier, inches, or depth of diaphragm, feet.
- DCR = Demand-capacity ratio specified in Section A2346(d).
- $F_{wx}$  = Force applied to a wall at level x, pounds.
- $H$  = Least clear height of opening on either side of pier, inches.
- $h/t$  = Height/thickness ratio of URM wall. Height  $h$  is measured between wall anchorage levels.
- $L$  = Span of diaphragm between shear walls, or span between shear wall and open front, feet.
- $L_o$  = Length of crosswall, feet.
- $L_i$  = Effective span for an open front building specified in Section A2346(d)8, 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,  $\sum v_c L_o$ , pounds.
- $V_{ca}$  = Total shear capacity of crosswalls in the direction of analysis immediately above the diaphragm level being investigated,  $\sum v_c L_o$ , pounds.
- $V_r$  =  $0.5P_D(D/H)$ , the rocking shear 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 shear test per UBC Standard 23-40.

$v_a$  = Allowable shear stress for unreinforced masonry, psi.

$v_c$  = Allowable shear value for a crosswall sheathed with any of the materials given in Tables A-23-C or A-23-D, pounds per foot.

$v_t$  = Mortar shear strength as specified in Section 2343(c)3E.

$v_{to}$  = Mortar shear test values as specified Section 2343(c)3E.

$v_u$  = Allowable shear value for a diaphragm sheathed with any of the materials given in Tables A-23-C or A-23-D, pounds per foot.

$\Sigma v_{uD}$  = Sum of diaphragm shear capacities of both ends of the diaphragm.

$\Sigma \Sigma v_{uD}$  = For diaphragms coupled with crosswalls  $\Sigma \Sigma v_{uD}$  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.

$\Sigma W_d$  = 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.

**GENERAL REQUIREMENTS****Section A2342**

(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. Accurately 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. Accurately dimensioned wall elevations showing openings, piers, wall classes as defined in section A2343(c)3E, thicknesses, and heights, wall shear test locations, 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 utilized 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 A2347.

**MATERIAL REQUIREMENTS****Section A2343**

(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 force resisting system shall be in sound condition or shall be removed and replaced with new material.

(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 or exceed the minimum standards established by this Chapter shall be removed and replaced by new materials or alternatively shall have its structural functions replaced by new materials and anchored to supporting elements.

2. **Lay-Up of Walls.** The facing and backing shall be bonded so that not less than 10 percent of the exposed face area is composed of solid headers extending not less than 4 inches into the backing. The clear distance between adjacent full-length headers shall not exceed 24 inches vertically or horizontally. Where the backing consists of two or more wythes, the headers shall extend not less than 4 inches into the most distant wythe or the backing wythes shall be bonded together with separate headers whose area and spacing conform to the foregoing. Wythes of walls not bonded as described above shall be considered as veneer. The veneer wythe shall not be included in the effective thickness used in calculating the height to thickness and the shear capacity of the wall.

3. **Mortar. A. Tests.** The quality of mortar in all masonry walls shall be determined by performing in-place shear tests in accordance with UBC Standard 24-40. Alternative methods of testing may be approved by the Building Official.

**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 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 per wall or line of wall elements providing a common line of resistance to lateral forces.

(iii) In any case, not less than one per 1500 square feet of wall surface nor less than a total of eight.

**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:

$$v_{to} = (V_{test} - P_{D+L}) / A_p \dots \dots \dots (43-1)$$

(ii) Individual unreinforced masonry walls with  $v_{to}$  consistently less than 30 psi shall be entirely pointed prior to retesting.

(iii) The mortar shear strength,  $v_t$ , is the value in psi that is exceeded by 80% of all of the mortar shear test values,  $v_{to}$ .

(iv) Unreinforced masonry with mortar shear strength,  $v_t$ , less than 30 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. See Section A2345(b).

**G. Pointing.** All deteriorated mortar joints in unreinforced masonry walls shall be pointed according to UBC Standard No. 24-42. Nothing shall prevent pointing with mortar of all the masonry wall joints before the tests are made.



**QUALITY CONTROL****Section A2344**

(a) **Pointing.** All preparation and mortar pointing shall be done 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 Standard 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 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 24-41.

**Exception:** Special inspection may be provided during installation in lieu of testing.

**ALLOWABLE DESIGN VALUES****SECTION A2345**

(a) **Allowable Values.** 1. Allowable values for existing materials are given in Table A-23-C and for new materials in Table A-23-D. The one-third increase in allowable values is not allowed for values in these tables.

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 33 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 70 percent.



(b) **Masonry Shear.** The allowable unreinforced masonry shear stress,  $v_a$ , shall be determined for each masonry class from the following equation:

$$v_a = 0.1v_t + 0.15P_D/A \dots \dots \dots (45-1)$$

The mortar shear test value,  $v_t$ , shall be determined in accordance with Section A2343, and not exceed 100 psi for the determination of  $v_a$ .

The one-third increase in allowable values 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 100 psi. The one-third increase in allowable stress of the Building Code is allowed.

(d) **Masonry Tension.** Unreinforced masonry shall be assumed as having no tensile capacity.

(e) **Masonry Shear Modulus.** The shear modulus ( $E_v$ ) for unreinforced masonry, for relative rigidity analyses when masonry is used to resist lateral forces in combination with other materials, may be assumed as  $10,000v_t$ , unless substantiated by tests.

(f) **Existing Tension Anchors.** The allowable resistance values of the existing anchors shall be 40 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 of the Building Code is not allowed for existing tension anchors.

(g) **Foundations.** For existing foundations new total loads may be increased over existing loads by 25% for dead load only and increased 50% for dead load plus seismic load. Higher values may be justified only in conjunction with a geotechnical investigation.

**ANALYSIS AND DESIGN****Section A2346**

(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.

(b) **Selection of Procedure.** Buildings shall be analyzed by the General Procedure of Section A2346(c) which is based on Chapter 23 of the Building Code or, when applicable, buildings may be analyzed by the Special Procedure of A2346(d).

(c) **General Procedure.**

1. **Minimum Design Lateral Forces.** Buildings shall be analyzed to resist minimum lateral forces assumed to act noncurrently in the direction of each of the main axes of the structure in accordance with the following:

$$V = 0.33ZW \dots\dots\dots(46-1)$$

2. **Lateral Forces on Elements of Structures.** Parts or portions of structures shall be analyzed as required in Chapter 23 of the Building Code.

**Exceptions:** i. Unreinforced masonry walls for which height to thickness ratios do not exceed ratios set forth in Table A-23-B need not be analyzed for out-of-plane loading. Unreinforced masonry walls which exceed the allowable h/t ratios of Table A-23-B shall be braced according to Section A2347(e).

ii. Parapets complying with Section A2347(f) need not be analyzed for out-of-plane loading.

3. **Shear Walls (In-Plane Loading).** Shear walls shall comply with subsection A2346(e).

(d) **Special Procedure. 1. Limits for the Application of Subsection A2346(d).** 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 6 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 or steel braced frames or special moment resisting frames (see Section 2312 of the Building Code) each with a maximum overall height-to-length ratio of 1-1/2 to 1.

D. The lateral force resisting system shall be regular as defined in the Building Code. Except for a single story building with an open front, a minimum of two lines of vertical lateral force-resisting elements shall be parallel to each axis of the building.

2. **Lateral Forces on Elements of Structures.** With the exception of the diaphragm provisions in subsection A2346(d), elements of structures shall comply with subsection A2346(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 A-23-C or A-23-D. Spacing of crosswalls shall not exceed 40 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.

**Exception:** 1. Crosswalls need not be provided at all levels in accordance with subsection A2346(d)4B(iv).

2. Existing crosswalls need not be continuous below a wood diaphragm at/or within four feet of grade provided:

(i) Shear connections and anchorage requirements Section A2346(d)7 are satisfied at all edges of the diaphragm.

(ii) Crosswalls with total shear capacity of  $.07\sum W_d$  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:

$$DCR = [0.33W_d + V_{ca}] / 2v_u D \dots\dots (46-2)$$

and DCR shall not exceed 2.5.

**B. Crosswall Shear Capacity.** Within any 40 feet measured along the span of the diaphragm, the sum of the crosswall shear capacities shall be at least 30 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 A-23-1, falls within Regions 1, 2, or 3.

**B. Demand-Capacity Ratios.** Demand-Capacity Ratios shall be calculated for the diaphragm according to the following formulas:

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

$$DCR = 0.83ZW_d / \sum V_u D \dots\dots\dots (46-3)$$

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

$$DCR = 0.83ZW_d / (\sum V_u D + V_{cb}) \dots\dots\dots (46-4)$$

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

$$DCR = 0.83Z \sum W_d / (\sum \sum V_u D + V_{cb}) \dots\dots\dots (46-5)$$

DCR shall be calculated at each level for the set of diaphragms at and above the level under consideration.

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

$$DCR = 0.83Z\sum W_d / \sum v_u D \dots\dots\dots (46-6)$$

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

**D. Collectors.** An analysis shall 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 calculating demand capacity ratios per Section A2346(d)4B, 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:

$$V = 1/2 Z C_p W_d \dots\dots\dots (46-7)$$

or

$$V = v_u D \dots\dots\dots (46-8)$$

## **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,

$$F_{wx} = 0.33Z(W_{wx} + W_d/2) \dots\dots\dots (46-9)$$

but need not exceed

$$F_{wx} = 0.33ZW_{wx} + v_u D \dots\dots\dots (46-10)$$

(ii) For buildings with crosswalls in all levels:

$$F_{wx} = 0.25Z(W_{wx} + W_d/2) \dots\dots\dots (46-11)$$

but need not exceed

$$F_{wx} = 0.25Z(W_{wx} + \sum W_d(v_u D / \sum \sum v_u D)) \dots\dots\dots (46-12)$$

and need not exceed

$$F_{wx} = 0.25ZW_{wx} + v_u D \dots\dots\dots (46-13)$$

**B. Wall Story Shear.** The wall story shear shall be the sum of the wall story forces at and above the level of consideration.

$$V_{wx} = \sum F_{wx} \dots\dots\dots (46-14)$$

**C. Shear Wall Analysis.** Shear walls shall comply with subsection A2346(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 A2346(d) 6A and the interstory drift ratio shall be limited to 0.005.

**7. Out of Plane Forces - URM Walls. A. Allowable URM Wall Height to Thickness Ratios.** The provisions of Section A2346(c) 2 are applicable except the allowable h/t ratios given in Table A-23-B shall be determined from Figure A-23-1 as follows:

(i) In Region 1, h/t ratios for "buildings with crosswalls" may be used if qualifying crosswalls are present in all stories.

(ii) In Region 2, h/t ratios for "buildings with crosswalls" may be used whether or not qualifying crosswalls are present.

(iii) In Region 3, h/t ratios for "all other buildings" shall be used whether or not qualifying crosswalls are present.

**B. Walls with Diaphragms in Different Regions.** When diaphragms above and below the wall under consideration have DCRs in different regions of Figure A-23-1, the lesser h/t 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,  $L_1$ ,** for use in Figure No. A-23-1 shall be determined in accordance with the following formula:

$$L_1 = 2[(W_w/W_d) \cdot L + L] \dots \dots \dots (46-15)$$

**B. Diaphragm Demand/capacity ratio** shall be calculated as:

$$DCR = 0.83Z(W_d + W_w)/[(v_u D) + V_C] \dots \dots \dots (46-16)$$

**(e). Analysis of Vertical Elements of the Lateral Force-Resisting System.** Applicable to both General Procedure and Special Procedure Buildings.

**1. Existing URM Walls. A. Flexural Rigidity.** Flexural rigidity may be neglected in determining the rigidity of an URM wall.

**B. Shear Walls with Openings.** Wall piers shall be analyzed according to the following procedure:

(i) For any pier,

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

$$V_a = v_a D t \dots \dots \dots (46-17)$$

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

$$V_r = 0.5 P_D D / H \dots \dots \dots (46-18)$$

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

(1) **Rocking Mode.** Where all piers at a level have shear capacities capable of sustaining rocking, i.e., the pier shear capacity is greater than or equal to the pier rocking shear capacity for each pier, 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 each pier at that level:  $V_a \geq V_r$ .....(46-19)

and for the wall at that level:

$$V_{wx} \leq \sum V_r$$
.....(46-20)

(2) **Non-rocking Mode.** Where at least one pier at a level is incapable of sustaining a rocking mode, i.e., the pier shear capacity is less than the pier rocking shear capacity, forces in the wall at that level,  $V_{wx}$ , shall be distributed to each pier,  $V_p$ , in proportion to  $D/H$ , such that  $V_{wx} = \sum V_p$ .

For at least one pier at that level:

$$V_a < V_r$$
.....(46-21)

For each pier at that level:

$$V_p \leq V_a$$
.....(46-22)

and

$$V_p \leq V_r$$
.....(46-23)

If  $V_p > V_r$  in one or more piers, omit such piers from the analysis and repeat the procedure for the remaining piers or strengthen and reanalyze the wall.

(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:

$$V_r = (0.50P_D + 0.25P_w)D/H$$
 .....(46-24)

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 A2346(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 A2346(e)3B.

**B. Moment Resisting Frames.** A moment frame shall not be used with a URM wall in a single line of resistance unless the wall has piers that are capable of sustaining rocking in accordance with A2346(e)1B and the frames are designed to carry 100% of the lateral forces.

## DETAILED SYSTEM DESIGN REQUIREMENTS

## SECTION A2347

## (a) General.

(b) **Wall Anchorage.** 1. **Anchor Locations.** All unreinforced masonry walls shall be anchored at the roof and floor levels as required in Section A2346(c)2. Ceilings with substantial rigidity and abutting masonry walls shall be connected to walls with tension bolts at a maximum anchor spacing of 6 feet. Ceiling systems with substantial mass shall be braced at the perimeter to diaphragms.

2. **Anchor Requirements.** Anchors shall be tension bolts through the wall as specified in Table No. A-23-D, or by an approved equivalent at a maximum anchor spacing of 6 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 200 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 5b in Table A-23-D may be used.

(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 2312(h)2E.

(e) **Wall Bracing.** 1. **General.** Where a wall height-thickness ratio exceeds the specified limits, the wall may be laterally supported by vertical bracing members per Section A2347(e)2 or by reducing the wall height by bracing per Section A2347(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 10 feet. Deflection of such bracing members at design loads shall not exceed one-tenth of the wall thickness.

**3. Wall Height 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 6 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 (1-1/2) times the thickness of the parapet wall. If the required parapet height exceeds this maximum height, a bracing system designed for the force factors specified in Table 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 (12) 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 (6) 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 24 inches with a maximum supported area of two (2) 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 of an inch in thickness (1" X 8" X 1/16") 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 17 inches on centers horizontally. As an alternate, such ties may be laid in every fourth course vertically at a spacing not to exceed nine (9) 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.

(i) **Adjacent Buildings.** 1. Where elements of adjacent buildings, do not have a separation of 5 inches, the allowable height/thickness ratios for "buildings with crosswalls" per Table A23B shall not be used in the direction of consideration.

2. Where buildings do not have a separation of at least 5 inches and the diaphragm levels of the adjoining structures differ by more than one and one-half time 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.

**ADMINISTRATIVE PROVISIONS****Section A2348**

(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 100 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 40 feet apart in each story. Crosswalls shall be full-story height with a minimum length of 1-1/2 times the story height.

2. Any building used for its intended purpose, as determined by the building official for less than 20 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 code of less than 20 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 code of 20 occupants or more.

(b) **Rating Classifications.** The rating classifications identified in Table A-23-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 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 270 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 270 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 120 days after service of the order, plans for the installation of wall anchors in accordance with the requirements specified in Section A2347; or

D. Within 270 days after service of the order, plans for the demolition of the building.

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. A-23-F. These time limits shall begin to run from the date the order is served in accordance with Section A2348(d)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 electing to comply with Item 2C of this subsection are also required to comply with Items 2B or 2D of this subsection provided, however, that the 270-day period provided for in Item 2B or 2D and the time limits for obtaining a building permit and to complete structural alterations or building demolition set forth in Table A-23-F shall be extended in accordance with Table No. A-23-G. Each such extended time limit shall begin to run from the date the order is served in accordance with Section A2348(d), except that the time limit to commence structural alterations or demolition shall begin to run from the date the building permit is issued.

(d) **Administration. 1. Order - Service.** A. The building official shall, in accordance with the priorities set forth in Table No. A-23-G, issue an order as provided in this section to the owner of each buildings within the scope of this Chapter.

B. Prior to the service of an order as set forth in Table No. A-23-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. A-23-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. A-23-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 to 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 A2348(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 60 days from the service date of the order described in Section A2348(d)3. Any such appeal shall be decided by the Board no later than 90 days after writing and the grounds thereof shall be stated clearly and concisely. Appeals or requests for modifications from any other determinations, orders or actions by the building official pursuant to the 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 this 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 A2348(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 90 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.



**TABLE NO. A-23-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. A-23-B**  
**ALLOWABLE VALUE OF HEIGHT-THICKNESS RATIO OF**  
**UNREINFORCED MASONRY WALLS**

Wall Types	Seismic Zone 3 Buildings	Seismic Zone 4 Buildings with Crosswalls <sup>1</sup>	Seismic Zone 4 All Other Buildings
Walls of one-story buildings	16	16 <sup>2,3</sup>	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 A2346(d) only. See Section A2346(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 A2343 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% mortar coverage.

<sup>3</sup>Where a visual examination of the collar joint indicates not less than 50% mortar coverage and the tested mortar shear strength,  $v_t$ , when established in accordance with Sections A2343 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. A-23-C**  
**ALLOWABLE VALUES FOR EXISTING MATERIALS**

EXISTING MATERIALS OR CONFIGURATIONS OF MATERIALS <sup>1</sup>	ALLOWABLE VALUES
<p><b>1. HORIZONTAL DIAPHRAMS<sup>4</sup></b></p> <p>a. Roofs with straight sheathing and roofing applied directly to the sheathing.</p> <p>b. Roofs with diagonal sheathing and roofing applied directly to the sheathing.</p> <p>c. Floors with straight tongue-and-groove sheathing.</p> <p>d. Floors with straight sheathing and finished wood flooring with board edges offset or perpendicular.</p> <p>e. Floors with diagonal sheathing and finished wood flooring.</p>	<p>100 lbs. per foot for seismic shear</p> <p>250 lbs. per foot for seismic shear</p> <p>100 lbs. per foot for seismic shear</p> <p>500 lbs. per foot for seismic shear</p> <p>600 lbs. per foot for seismic shear</p>
<p><b>2. CROSSWALLS<sup>2, 4</sup></b></p> <p>a. Plaster on wood or metal lath</p> <p>b. Plaster on gypsum lath</p> <p>c. Gypsum wall board, unblocked edges</p> <p>d. Gypsum wall board, blocked edges</p>	<p>Per side: 200 lbs. per foot for seismic shear</p> <p>175 lbs. per foot for seismic shear</p> <p>75 lbs. per foot for seismic shear</p> <p>125 lbs. per foot for seismic shear</p>

TABLE NO. A-23-C  
ALLOWABLE VALUES FOR EXISTING MATERIALS (Cont.)

EXISTING MATERIALS OR CONFIGURATIONS OF MATERIALS <sup>1</sup>	ALLOWABLE VALUES <sup>4</sup>
<p>3. EXISTING FOOTINGS, WOOD FRAMING, STRUCTURAL STEEL, AND REINFORCED STEEL</p> <p>a. Plain concrete footings</p> <p>b. Douglas fir wood.</p> <p>c. Reinforcing steel.</p> <p>d. Structural Steel.</p>	<p><math>f'_c = 1500</math> psi unless otherwise shown by tests</p> <p>Allowable stress same as No. 1 D.F.<sup>3</sup></p> <p><math>f_t = 18,000</math> lbs. per square inch maximum.<sup>3</sup></p> <p><math>f_t = 20,000</math> lbs. per square inch maximum.<sup>3</sup></p>

<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 A2345.

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

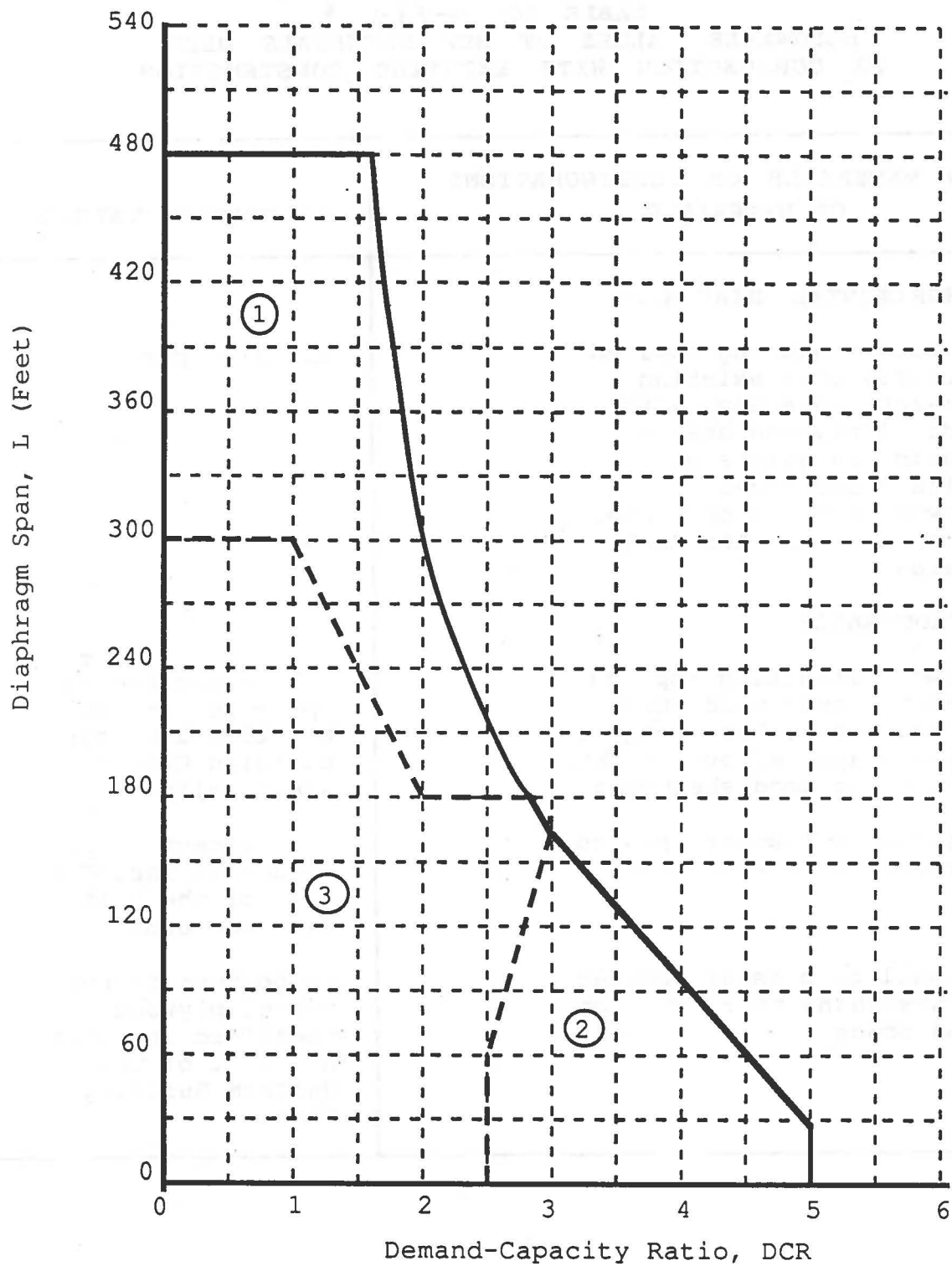


FIGURE NO. A-23-1. ACCEPTABLE DIAPHRAGM SPAN

**TABLE NO. A-23-D 4**  
**ALLOWABLE VALUES OF NEW MATERIALS USED**  
**IN CONJUNCTION WITH EXISTING CONSTRUCTION**

NEW MATERIALS OR CONFIGURATIONS OF MATERIALS	ALLOWABLE VALUES <sup>4</sup>
<p><b>1. HORIZONTAL DIAPHRAGMS</b></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> <p><b>2. CROSSWALLS</b></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>225 lbs. per foot</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. A-23-D 4  
**ALLOWABLE VALUES OF NEW MATERIALS USED  
 IN CONJUNCTION WITH EXISTING CONSTRUCTION**  
 (continued)

NEW MATERIALS OR CONFIGURATIONS OF MATERIALS	ALLOWABLE VALUES <sup>4</sup>
<p><b>4. TENSION BOLTS</b></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><b>5. SHEAR BOLTS</b></p> <p>Bolts embedded a minimum of 8 inches into unreinforced masonry walls. Bolts shall be centered 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>133 percent of the values for plain masonry specified for solid 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><b>6. COMBINED TENSION AND SHEAR BOLTS</b></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>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</p> <p>Shear: Same as for shear bolts</p> <p>Tension: Same as for tension bolts</p> <p>Shear: Same as for shear bolts</p>

**TABLE NO. A-23-D 4**  
**ALLOWABLE VALUES OF NEW MATERIALS USED**  
**IN CONJUNCTION WITH EXISTING CONSTRUCTION**

(continued)

NEW MATERIALS OR CONFIGURATION OF MATERIALS	ALLOWABLE VALUES <sup>4</sup>
<p><b>7. INFILLED WALLS</b></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><b>8. REINFORCED MASONRY</b></p> <p>Masonry piers and walls reinforced per Chapter 24.</p>	<p>Same as values specified in Section 2409.</p>
<p><b>9. REINFORCED CONCRETE</b></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 A2344.

<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. A-23-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. A-23-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	180 days <sup>1</sup>	3 years
Wall Anchors	180 days	270 days <sup>2</sup>	1 year

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

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

**TABLE A-23-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	100 or more	1 year	180 days
III-A	100 or more	1 year	1 year
III-B	More than 50 but Less than 100	1 year	2 years
III-C	More than 19 but Less than 51	1 year	3 years
IV (Lowest Priority)	Less than 20	1 year	4 years

**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" or "N" 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 be come "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.

## **COMMENTARY**

TO BE DEVELOPED

## **DESIGN EXAMPLES**

TO BE DEVELOPED

## **REFERENCES**

- A. "The Methodology for Mitigation of Seismic Hazards in Existing Unreinforced Masonry Buildings," by ABK, A Joint Venture, developed under National Science Foundation contract number NSF-C-PFR78-19200. The loads and shear values that are used in this ordinance were factored to working stress values from those used in the Methodology.
- B. Notes prepared by the Ad Hoc Hazardous Building Committee of the SEAOSC for the October 1986 seminars.
- C. "Code" shall mean the Uniform Building Code, 1988 edition.

