SDCI

Director's Rule 6-2023

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Subject: A Method for the Seismic Improvement of Unreinforced Masonry (URM) Buildings	**Code and Section Reference:** 2018 Seattle Existing Building Code Sections 101.13 and 303.1.7	
	Type of Rule: Code Interpretation	
	Ordinance Authority: SMC 3.06.040	
Index: 2018 Seattle Existing Building Code	**Approved** **Date** (Signature on file signed 9/22/23) Nathan Torgelson, Director, DCI	

Background

In response to Resolution 32033, which recommends the phasing in of a mandate for seismic retrofits of Unreinforced Masonry (URM) buildings, a task group comprised of SDCI technical staff and practicing engineers was convened in 2022 to update the 2012 Draft URM Retrofit Standard to address: (i) updated codes; (ii) improved understanding of seismic hazards; and (iii) to clarify the technical content of the document. On June 30th 2023, an updated draft of the URM Retrofit Technical Standard was published and is available on SDCI's URM website. This Director's Rule is adopting a component of the Draft URM Retrofit Technical Standard as a method for the seismic retrofit of a URM building. This Director's Rule and the updated 2023 Draft Technical Standard will be used to inform a compliance pathway for a future ordinance requiring the mandatory retrofit of URM buildings.

This Director's Rule provides designers a method for the voluntary seismic improvement of a URM building. This Rule directly addresses testing and quality of the existing masonry construction and

mitigates four main elements: wall anchorage (tension anchors), diaphragm shear transfer (shear anchors), out-of-plane wall bracing, and parapet/appendage bracing.

In Seattle Existing Building Code (SEBC) Section 303.1.7, voluntary seismic improvements are permitted when the proposed structural alterations "do no worse" to the existing structure, and when the alteration work meets the requirements for new construction, i.e. "new meets new". When seismic improvements are not required by the building code, a voluntary seismic improvement can provide any level of improvement and does not set a minimum standard beyond the requirements of Section 303.1.7. It should be noted that a voluntary seismic improvement on its own does not trigger a Substantial Alteration designation.

Existing methods for the evaluation and design of voluntary seismic improvements are identified in SEBC 303.4.2. This Director's Rule provides designers an alternate method, as permitted by SEBC 101.13, for the voluntary seismic improvement of a URM building.

ASCE 7-22 is directly referenced in this Rule as an option of determining the seismic hazard as it allows the use of multiperiod response spectrum for certain site classes that otherwise may require a site-specific ground motion analysis.

Purpose

The purpose of this Director's Rule, which may be referenced as part of a voluntary seismic improvement project, is to establish a method for the seismic retrofit of URM buildings with the goal of improving seismic performance.

Rule

1. General Requirements

Unreinforced Masonry (URM) buildings are defined as buildings with one or more *unreinforced masonry bearing walls*, generally constructed prior to 1945 and unlawful after adoption of the 1973 Uniform Building Code on May 7, 1977.

This Rule provides a method for the voluntary seismic improvement of URM buildings that may be used in conjunction with SEBC 303.1.7 Voluntary Seismic Improvements. When this Rule is used, the construction documents shall include a statement on the structural notes to demonstrate that the building has been evaluated and/or retrofitted to comply with this Rule. Compliance with SEBC 303.1.7 must still be demonstrated.

Use of this Rule does not meet the seismic regulations of Substantial Alterations required by SEBC Section 307.1.2.

2. Definitions

For the purpose of this Rule, the applicable definitions in the SBC and SEBC shall also apply.

BED JOINT. The horizontal layer of mortar on which a masonry unit is laid.

CROSSWALL. A new or existing wood-framed wall(s) sheathed with any material with a cumulative length of at least 50 percent of the diaphragm depth between diaphragm chords. Individual walls shall have a maximum height-to-length ratio of 1.5 to be considered a crosswall. The minimum crosswall length may be reduced to 25% of the diaphragm depth if it can be shown that the crosswalls do not consist of unblocked gypsum wall board.

POINTING. The process of removal of deteriorated mortar from between masonry units and placement of new mortar. Also known as *repointing* or *tuckpointing* for purposes of this rule.

REPOINTING. See "*Pointing*."

SUBSTANTIAL ALTERATIONS. See Seattle Existing Building Code Section 307.1.1 for definition.

TUCKPOINTING. See "*Pointing*."

UNREINFORCED MASONRY (URM). Includes burned clay, concrete or sand-lime brick, hollow clay block, or hollow clay tile.

UNREINFORCED MASONRY BEARING WALL. An *unreinforced masonry* wall that provides the primary support for vertical loads from floors or roofs and relies on the tensile strength of masonry units, mortar and grout in resisting design loads.

3. Qualification Criteria

Buildings that demonstrate compliance with, or are altered to comply with, qualification criteria (1)-(7) of this section are permitted to be strengthened in compliance with Section 4 of this Rule.

(1) The building is no more than 6 stories above the seismic base of the structure.

(2) The building shall not be classified as Risk Category IV.

(3) The building does not have a Weak Story vertical irregularity as defined by ASCE 7-16 as referenced by the SBC.

(4) The building has a mortar shear strength, v_{to}, as determined by Section 4.2, of 30 psi or more for all masonry classes.

(5) The building has wood or plywood diaphragms at all levels above the base of the building.

(6) The building does not have straight sheathed floor or roof diaphragms.

Exceptions:

i. Straight sheathed floor diaphragms with finished wood flooring with offset or perpendicular board edges.

ii. Straight sheathed floor or roof diaphragms without finished wood flooring with offset or perpendicular board edges where any of the following conditions are met:

(1) The building has *crosswalls* below the non-compliant level at a spacing that does not exceed 40 feet on center; or

(2) The diaphragm span is less than 24 feet and the diaphragm aspect ratio is less than 2-to-1.

(7) The building has or will be provided with a minimum of two lines of vertical elements of the lateral force resisting system parallel to each axis located near or on the perimeter of the building. Where the lateral force resisting system is a masonry wall:

i. The piers shall have a height-to-width ratio that does not exceed 2 to 1.

ii. The piers shall occupy not less than 40 percent of the wall's length.

Lateral force resisting frames or walls added to provide a minimum of two lines of vertical elements of the lateral force resisting system shall comply with the seismic regulations for *Substantial Alterations* per the Seattle Existing Building Code.

Exception:

Item seven qualification criteria for masonry walls do not apply if the applicant submits a report prepared by a licensed Structural Engineer that shows all walls comply with a maximum demand/capacity ratio of 2.5 for in-plane forces. One of the following two methods shall be used to determine the demand/capacity ratio:

i. ASCE 41 Chapter 16: Special Procedure for *Unreinforced Masonry* where seismic hazard is determined using Section 4.1 of this Rule with $S_{XS} = S_{DS}$ and $S_{X1} = S_{D1}$; or

ii. Appendix A1 of the Seattle Existing Building Code where seismic hazard is determined using Section 4.1 of this Rule.

4. Seismic Improvement Method

Elements shall comply with, or be altered to comply with, the requirements listed in this section for wall anchorage (tension anchors), diaphragm shear transfer (shear anchors), out-of-plane wall bracing, and parapet/appendage bracing.

Structural testing and inspection for new and existing construction materials shall be in accordance with the building code, except as modified by this Rule. Where special inspections and tests are required in this Rule, they shall be performed by an *approved agency*. Evaluation of the condition of existing materials and testing results is the responsibility of the *structural engineer in responsible charge*.

4.1 Seismic Hazard

For application of this Seismic Improvement Method, spectral response acceleration parameters, S_{DS} and S_{D1}, shall be determined by using one of the following methods.

(1) 75 percent of the values established in ASCE 7-16 as referenced by the 2018 Seattle Building Code; or

(2) 75 percent of the values established in ASCE 7-22, and the Site class, as defined in ASCE 7-22, shall be determined by a qualified geotechnical engineer. In lieu of a geotechnical engineer determination, site class may be determined utilizing available Seattle Department of Construction and Inspections (SDCI) map, DR 2-2023 Update of ECA Liquefaction-Prone Areas Map, that defines Liquefaction Prone Areas (type ECA5). Where

the project site is Type ECA5, site class E shall be used. Where the site is not ECA5, the default site class shall be used.

4.2 Materials Requirements

4.2.1 Unreinforced Masonry Classes. Existing *unreinforced masonry* shall be categorized into one or more classes based on shear strength, quality of construction, state of repair, deterioration, and weathering. Classes are defined for whole walls, not for small areas of masonry within a wall. Discretion in the definition of classes of masonry is permitted to avoid unnecessary testing.

4.2.2 Condition of Existing Materials. Existing materials used as part of the required vertical load-carrying or seismic force-resisting system shall be evaluated by on-site investigation and determined to be in good condition (free of degraded mortar, degraded masonry units and/or significant cracking); or shall be repaired, enhanced, retrofitted or removed and replaced with new materials.

4.2.2.1 Mortar joint deterioration shall be patched by *pointing* or *repointing* of the eroded joint in accordance with Section 4.2.3.3. Existing significant cracks in solid unit unreinforced and solid grouted hollow unit masonry shall be repaired.

4.2.3 Testing of Masonry. All *unreinforced masonry* (URM) walls used to carry vertical loads or resist seismic forces parallel and perpendicular to the wall plane shall be tested. The shear tests shall be taken at locations representative of the mortar conditions throughout the building. Test locations shall be determined by the design professional in charge. Results of all tests and their locations shall be recorded, and these results shall be submitted to the Code Official for approval as part of the structural analysis.

The minimum number of tests per masonry class shall be determined as follows:

(1) At each story, not less than one test per wall or line of wall elements providing a common line of resistance to seismic forces;

(2) Not less than one test per 1,500 ft^2 (140 m^2) of wall surface or not less than a total of eight tests.

Exception to (1) and (2): Required tests at all other stories besides the first and top stories may be reduced to one test per wall line per two stories with approval of the Code Official. Condition of masonry at skipped levels shall be similar to adjacent levels and tested results at adjacent levels shall show low variation in shear strength.

4.2.3.1 In-place Mortar Tests. Mortar shear test values, v_{to}, shall be obtained by one of the following:

(1) ASTM C1531

(2) Alternative methods of testing may be approved by the Code Official for masonry walls other than brick or where in-place testing is not practical because of crushing or other failure mode of the masonry.

4.2.3.2 Minimum Quality of Mortar

(1) Mortar shear test values, v_{to}, in pounds per square inch, shall be obtained for each in-place shear test in accordance with the following equation:

$$v_{to} = (V_{test}/A_b) - P_{(D+L)} \quad \text{(Equation 1)}$$

V_{test} = Load at first observed movement
A_b = Total area of the *bed joints* above and below the test specimen.
$P_{(D+L)}$ = Stress resulting from actual dead plus live loads in place at the time of testing.

(2) Individual *unreinforced masonry* walls with more than 50 percent of mortar test values, v_{to}, less than 30 pounds per square inch (207 kPa) shall be pointed prior to construction and retested.

(3) The lower bound mortar shear strength, v_{tL}, is defined as the mean minus one standard deviation of the mortar shear test values, v_{to}.

(4) *Unreinforced masonry* with mortar shear strength, v_{tL}, less than 30 pounds per square inch (207 kPa) shall be pointed and retested or shall have its structural function replaced, and shall be anchored to supporting elements of the building. When existing mortar in any wythe is pointed to increase its shear strength and is retested, the condition of the mortar in the adjacent *bed joints* of the inner wythe or wythes and the opposite outer wythe shall be examined for extent of deterioration. The shear strength of any wall class shall be not greater than that of the weakest wythe of that class.

4.2.3.3 Pointing. Deteriorated mortar joints in *unreinforced masonry* walls shall be pointed in accordance with the following requirements:

(1) Joint Preparation. Deteriorated mortar shall be cut out by means of a toothing chisel or nonimpact power tool until sound mortar is reached, to a depth not less than ¾ inch (19.1 mm) or twice the thickness of the joint, whichever is less, but not greater than 2 inches (50 mm). Care shall be taken not to damage the masonry edges. After cutting is complete, all loose material shall be removed with a brush, or air or water stream.

(2) Mortar Preparation. The mortar mix shall be proportioned as required by the construction specifications and manufacturer's approved instructions.

(3) Packing. The joint into which the mortar is to be packed shall be dampened but without free-standing water. The mortar shall be tightly packed into the joint in layers not exceeding ¼ inch (6.4 mm) deep until

it is filled; then it shall be tooled to a smooth surface to match the original profile.

Nothing shall prevent *pointing* of any masonry wall joints before testing is performed in accordance with Section 4.2.3.

Preparation and mortar *pointing* shall be performed with special inspection.

Exception: Incidental *pointing* may be performed without special inspection subject to the approval of the Code Official.

4.3 Testing of Anchors

4.3.1 Existing Wall Anchors. Existing wall anchors used as all or part of the required tension anchors shall be tested in pullout according to Section 4.3.3.1. Not fewer than four anchors tested per floor shall be tested in pullout, with not fewer than 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 10 percent of the total number of existing tension anchors at each level.

Exception: Existing tension anchors that extend entirely through the wall and meet the criteria in Table 1 need not be tested.

4.3.2 New Wall Anchors. New wall anchors embedded in URM walls resisting tension forces or a combination of tension and shear forces shall be subject to special inspection, prior to placement of the anchor and grout or adhesive in the drilled hole. Five percent of all anchors resisting tension forces shall be subject to a direct-tension test, and an additional 20 percent shall be tested using a calibrated torque wrench. Testing shall be performed in accordance with Section 4.3.3.

Exception: New bolts that extend through the wall with steel plates on the far side of the wall need not be tested.

4.3.3 Tests of Anchors in Unreinforced Masonry Walls. Tests of anchors in *unreinforced masonry* walls shall be in accordance with Section 4.3.3.1 through 4.3.3.3. Results of all tests shall be reported to the authority having jurisdiction. The report shall include the test results of maximum load for each test; pass-fail results; corresponding anchor size and type; orientation of loading; details of the anchor installation, testing apparatus and embedment; wall thickness; and joist orientation and proximity to the tested anchor.

4.3.3.1 Direct Tension Testing of Existing Anchors and New Anchors. The test apparatus shall be supported by the masonry wall. The test procedure for prequalification of tension anchors shall comply with ASTM E488. Existing wall anchors shall be given a preload of 300 pounds (1335 N) before establishing a datum for recording elongation. The tension test load shall be the lesser of the target test load or the load recorded at 1/8 inch (3.2 mm) relative movement between the existing anchor and the adjacent masonry surface. New embedded tension anchors shall be subject to a direct tension load of not less than 2.5 times the design load but not less than 1,500 pounds (6672 N) for five minutes.

Exception: Where obstructions occur, the distance between the anchor and the test apparatus support shall be not less than one-half the wall thickness for existing anchors and 75% of the embedment length for new embedded anchors.

4.3.3.2 Torque testing of new anchors. Anchors 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 pounds
5/8-inch-diameter bolts:	50 foot pounds
3/4-inch-diameter bolts:	60 foot pounds

4.3.3.3 Prequalification tests for bolts and other types of anchors. ASTM E488 or the test procedure in Section 4.3.3.1 is permitted to be used to determine tension or shear strength values for anchors greater than those permitted by Table 2. Anchors shall be installed in the same manner and using the same materials as will be used in the actual construction. Not fewer than five tests for each bolt size and type shall be performed for each class of masonry in which they are proposed to be used. The tension and shear strength values for such anchors shall be the lesser of the average ultimate load divided by 5.0 or the average load at which 1/8 inch (3.2 mm) elongation occurs for each size and type of anchor and class of masonry.

4.4 Design Strengths

(1) Strength values for existing materials are given in Table 1 and for new materials in conjunction with existing materials in Table 2.

(2) The strength reduction factor, ϕ, shall be taken equal to 1.0.

(3) The use of materials not specified herein shall be based on substantiating research data or engineering judgment, as approved by the Code Official.

Table 1: Strength Values for Existing Materials		
Existing Materials or Configuration of Materials [a]		**Strength Values** **X 14.594 for N/m**
Horizontal diaphragms	Roofs with straight sheathing and roofing applied directly to the sheathing.	300 lbs. per ft. for seismic shear
	Roofs with diagonal sheathing and roofing applied directly to the sheathing.	750 per ft. for seismic shear
	Floors with straight tongue-and-groove sheathing.	300 per ft. for seismic shear
	Floors with straight sheathing and finished wood flooring with board edges offset or perpendicular.	1,500 per ft. for seismic shear
	Floors with diagonal sheathing and finished wood flooring.	1,800 per ft. for seismic shear
	Metal deck welded with minimal welding. [b]	1,800 per ft. for seismic shear
	Metal deck welded for seismic resistance. [c]	3,000 per ft. for seismic shear
Tension Anchors	Rosette-style anchors, ½-inch minimum diameter, extending entirely through *unreinforced masonry* wall with bearing plates on the far side of a wall 30 square inches of area.	5,400 lbs. per anchor for three-wythe minimum walls 2,700 lbs. for two-wythe walls

For SI: 1 inch= 25.4mm, 1 square inch= 645.16mm^2, 1 pound = 4.4 N, 1 pound per square inch= 6894.75 N/m^2, 1 pound per foot= 14.43 N/m.

a. Material must be sound and in good condition

b. Minimum 22-gage steel deck with welds to support satisfying the standards of the Steel Deck Institute.

c. Minimum 22-gage steel deck with ¾-inch diameter plug welds at an average spacing not exceeding 8 inches and with sidelap welds appropriate for the deck span.

Table 2: Strength Values of New Materials Used in Conjunction with Existing Construction		
New Materials or Configuration of Materials		**Strength Values**
Tension Anchors [e]	Anchors extending entirely through *unreinforced masonry* wall secured with bearing plates on far side of a wall 30 square inches of area. [b, c]	5,400 lbs. per anchor for three-wythe minimum walls. 2,700 lbs. for two-wythe walls.
Shear bolts [d, e]	Anchors embedded not less than 8 inches into *unreinforced masonry* walls; anchors should be centered in 2 ½ inch diameter holes with dry-pack or nonshrink grout around the circumference of the anchor.	The value for plain masonry specified for solid masonry TMS 402; and no value larger than those given for ¾ inch bolts should be used.
Combined tension and shear anchors [e]	Through-anchors- anchors meeting the requirements for shear and for tension anchors. [b, c]	Tension- same as for tension anchors. Shear- same as for shear anchors.
	Embedded anchors- anchors extending to the exterior face of the wall with a 2 ½ inch round plate under the head and drilled at an angle of 22 ½ degrees to the horizontal; installed as specified for shear anchors. [a, b, c]	Tension- 3,600 lbs. per anchor. Shear- same as for shear anchors.

For SI: 1 inch= 25.4 mm, 1 square inch= 645.16mm^2, 1 pound- 4.4 N, 1 degree= 0.017 rad, 1 pound per foot- 14.43N/m, 1 foot= 304.8mm.

a. Embedded anchors to be tested as specified in Section 4.3.2.

b. Anchors shall be ½ inch minimum diameter.

c. Drilling for anchors shall be done with an electric rotary drill; impact tools should not be used for drilling holes or tightening anchors and shear bolt nuts.

d. Other bolt sizes, values and installation methods may be used, provided that a testing program is conducted in accordance with Section 4.3.3.3. The strength value shall be determined by multiplying the calculated allowable value, determined in accordance with Section 4.3.3.3, by 3.0, and the usable value shall be limited to not greater than 1.5 times the value given in the table. Bolt spacing shall not exceed 6 feet on center and shall be not less than 12 inches on center.

e. An alternative adhesive anchor bolt system is permitted to be used providing: its properties and installation conform to an ICC Evaluation Service Report; and the report states that the system's use is in *unreinforced masonry* as an acceptable alternative to Sections 4.3.2 and 4.5 or TMS 402, Section 2.1.4. The report's allowable values shall be multiplied by a factor of three to obtain strength values and the strength reduction factor, ϕ, shall be taken equal to 1.0.

4.5 Wall Anchorage (Tension Bolts)

4.5.1 General. *Unreinforced masonry* walls shall be anchored at the roof and floor levels for out-of-plane tension forces in accordance with 4.5.2 and 4.5.3 of this Rule. Wall anchors shall be secured to the framing members parallel or perpendicular to the wall to develop the required forces in accordance with the Seattle Building Code.

4.5.2 Wall Anchorage Forces. Anchorage of masonry walls to each floor or roof shall resist a minimum force determined as 0.9 S_{DS} times the tributary weight or 200 pounds per linear foot (2920 N/m), whichever is greater, acting normal to the wall at the level of the floor or roof.

S_{DS} = Design spectral acceleration at short period, in *g* units.

4.5.3 Anchor spacing.

Maximum anchor spacing is 6 feet (1829 mm) with a minimum of two anchors on walls 6 feet (1829 mm) or shorter in length.

Anchors at corners. At the roof and floor levels, tension anchors shall be provided within 2 feet (610 mm) horizontally from the inside of the corners of the walls.

4.6 Diaphragm Shear Transfer (Shear Bolts)

4.6.1 Diaphragm shear transfer demand, V_d. Diaphragms shall be connected to *unreinforced masonry* wall elements with connections capable of developing the diaphragm-loading tributary to the wall elements given by the lesser of the following equations:

$$V_d = 1.2\, S_{D1}\, C_p\, W_d \quad \text{(Equation 2)}$$

$$V_d = v_d\, D \quad \text{(Equation 3)}$$

S_{D1} = Design spectral acceleration at 1-second period, in g units.
C_p = Horizontal Force Factor per Table 3
W_d = Total dead load tributary to the diaphragm along the wall under consideration, pounds (N).
v_d = Existing diaphragm shear strength determined per Table 1.
D = Depth of the diaphragm, feet (m).

Table 3: 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.	0.50
Diaphragms with double or multiple layers of boards with edges offset, and blocked plywood systems.	0.75
Diaphragms of metal deck without topping:	
Minimal welding or mechanical attachment	0.6
Welded or mechanically attached for seismic resistance	0.68

4.6.2 Anchor Requirements. Anchors transmitting shear forces shall have a maximum spacing of 6 feet (1829 mm) with a minimum of two anchors on walls 6 feet (1829 mm) or shorter in length, and they shall have nuts installed over malleable iron or plate washers where bearing on wood, and heavy-cut washers where bearing on steel. At the roof and floor levels, both shear anchors shall be provided within 2 feet (610 mm) horizontally from the inside of the corners of the walls.

4.7 Out-of-Plane Wall Bracing

4.7.1 General. Where an *unreinforced masonry* wall height-to-thickness ratio exceeds the limits of Table 4, the wall shall be laterally supported by vertical bracing members per Section 4.7.2 or by reducing the wall height by bracing per Section 4.7.3. Bracing members shall be connected to the horizontal floor and roof diaphragms per Section 4.7.4.

4.7.2 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 of the unsupported height of the wall or 10 feet (3048 mm). Deflection of such bracing members at design loads shall not exceed one-tenth of the wall thickness. Design loads shall be determined by multiplying the weight of the wall by 0.4 S_{DS} and shall not be less than 10 percent of the wall weight. Spacing of anchors attaching to the vertical bracing member shall be as required by design, but shall not be less than 6 feet on center.

4.7.3 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 6 feet (1829 mm) on center. Bracing elements shall be detailed to minimize the horizontal displacement of the wall by the vertical displacement of the floor or roof. Design loads shall be determined by multiplying the weight of the wall by $0.4S_{DS}$ and shall not be less than 10 percent of the wall weight.

4.7.4 Bracing Attachment. Bracing members shall be connected to the floor and roof diaphragms using blocking, nailing, or other means, in accordance with the Seattle Building Code. The brace connection to the diaphragm shall be capable of resisting a force of 0.9 S_{DS} times the weight of the wall tributary to the brace.

Table 4: Allowable Value of Height-to-Thickness Ratio of Unreinforced Masonry Walls[a]

Wall Types	**$0.13_g \le S_{D1} < 0.25_g$**	**$0.25_g \le S_{D1} < 0.4_g$**	**$S_{D1} \ge 0.4_g$ All other Buildings**
Walls of one-story buildings	20	16	13
First-story wall of multiple story building	20	18	15
Walls in top story of multiple-story building	14	14	9
All other walls	20	16	13

For SI: 1 pound per square inch = 6894.75 N/m^2

a. Alternative height-to-thickness ratios are permitted to be considered, subject to approval by the Code Official.

4.8 Parapets and Appendage Bracing

4.8.1 General. *Unreinforced masonry* parapets and exterior wall appendages not conforming to this Rule shall be removed, or stabilized or braced to ensure that the parapets and appendages remain in their original positions. Where a parapet is removed or altered, the resulting parapet shall be no less conforming to the provisions of the Seattle Building Code for fire protection than it was prior to the alteration.

The maximum height of an unbraced *unreinforced masonry* parapet above the lower of either the level of tension anchors or the roof sheathing shall not exceed the height-to-thickness ratio shown in Table 5. If the required parapet height exceeds this maximum height, a bracing system designed for the forces per 4.8.2 shall support the top of the parapet.

The height of a URM parapet above any wall anchor shall be not less than 12 inches (305 mm).

Exception: If a reinforced concrete beam is provided at the top of the wall, the height above the wall anchor is permitted to be not less than 6 inches (152 mm).

Table 5: Maximum Allowable Height-to-Thickness Ratio for Parapets

	S_{D1}		
	$0.13_g \le S_{D1} < 0.25_g$	$0.25_g \le S_{D1} < 0.4_g$	$S_{D1} \ge 0.4_g$
Maximum allowable height-to-thickness ratios	2.5	2.5	1.5

4.8.2 Parapet Bracing Forces. Anchorage of parapet wall to the roof shall resist a minimum force determined as 0.48 S_{DS} times the tributary weight acting normal to the wall at the level of the floor or roof.

4.8.3 Additional Requirements. Where provided, parapet bracing shall be spaced at a maximum of 8 feet on center. Where the tension roof anchors are not adequate or non-existent, roof construction must be tied to the parapet per Section 4.5 of this Rule.