CHAPTER 18.71 - VOLUNTARY EARTHQUAKE HAZARD REDUCTION IN EXISTING REINFORCED CONCRETE BUILDINGS AND CONCRETE FRAME BUILDINGS WITH MASONRY INFILLS

18.71.010 - Purpose.

The purpose of this Chapter is to promote public safety and welfare by reducing the risk of death or injury that may result from the effects of earthquakes on concrete buildings and concrete frame buildings with masonry infills. The Northridge Earthquake caused widespread damage to these buildings, including some collapses.

The recent Great Hanshin Earthquake in Kobe, Japan, also caused several hundred of these buildings to collapse. These nonductile concrete buildings are frequently used in Long Beach for department stores, office buildings, hotels, parking structures and some mid-rise condominiums. Their performance in an earthquake is essential to the life and safety of their occupants and the overall stability of the local economy. This Chapter provides voluntary retrofit standards that, when fully followed, will substantially improve the seismic performance of these buildings but will not necessarily prevent all earthquake damage.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.020 - Scope.

The provisions of this Chapter may be applied to all buildings designed under Building Codes in effect prior to January 13, 1976, or built with building permits issued prior to January 13, 1977, having concrete floors and/or concrete roofs supported by reinforced concrete walls or concrete frames and columns, and/or concrete frames with masonry infills.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.030 - Definitions.

For purposes of this Chapter, the applicable definitions and notations in Sections 1602, 1613.2 and 1902 of the California Building Code adopted in Chapter 18.40 and the following definition shall apply:

"Masonry infill" means the unreinforced or reinforced masonry wall construction within a reinforced concrete frame.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.040 - General requirements.

When the owner of each building within the scope of this Chapter causes an investigation of the existing construction, a structural analysis shall be made of the building by a registered design profession licensed by the State of California.

Exception: Regular concrete shear wall buildings, of four (4) stories in height and under, may be shown to be in conformance with this Chapter by filing a report signed by a registered design profession licensed by the State of California containing the information specified in Section 18.71.090.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.050 - Criteria selection.

A. Basis for analysis. The building shall be analyzed to determine the displacements caused by inertial force effects determined in accordance with the dynamic lateral analysis procedure of Section 18.71.060. The building structural system shall provide a complete load path for resisting the effects of seismic loading. The capacity of all parts of the structural system shall exceed the demand calculated by the dynamic analysis using the effective stiffnesses determined by a nonlinear analysis of the elements.

Exception: Buildings conforming to the requirements of Subsections 18.71.050.D.2 and 18.71.050.D.3 may be analyzed using the procedure specified in Sections 18.71.070 and 18.71.080, respectively.

B. Site geology and soil characteristics. In the absence of a soils investigation, the soil site class shall be taken as Type D.
C. Configuration requirements.
    1. General. Each structure shall be designated as structurally regular or irregular.
    2. Regular structures. Regular structures have no significant physical discontinuities in plan or vertical configuration or in their lateral-force-resisting systems such as the irregular features described below.
        a. Irregular structures have significant physical discontinuities in configuration or in their lateral-force-resisting systems. Irregular features include, but are not limited to, those described in Tables 12.3-1 and ASCE 7-05 Section 12.3-2.
        b. Structures having one (1) or more of the features listed in Table 12.3-2 of ASCE 7-05 shall be designated as having a vertical irregularity.

Exception: Where none of the story drift ratios under equivalent lateral forces is greater than 1.3 times the story drift ratio of the story above, the structure may be deemed to not have the structural irregularities of Type 1 or 2 listed in Table 12.3-2 of ASCE 7-05. The story drift for this determination shall be calculated including torsional effects.

        c. Structures having one (1) or more of the features listed in Table 12.3-1 of ASCE 7-05 shall be designated as having a plan irregularity.

d. Irregular structures conforming to the requirements of Subsection 18.71.050.D and Section 18.71.080 may be considered regular if the plan and vertical irregularities are removed by the addition of lateral load-resisting systems.

D. Selection of lateral analysis procedure.

1. General. Any structure may be analyzed using the dynamic lateral analysis procedures of Section 18.71.060. The equivalent lateral force procedure or the simplified analysis may be used for structures conforming to the requirements on the use of those analyses.
2. Equivalent lateral force. The equivalent lateral force procedure of Section 18.71.070 may be used for regular structures or irregular structures having plan irregularity only of not more than four (4) stories.
3. Simplified analysis. Regular structures of not more than four (4) stories conforming to the requirements of Section 18.71.080 may be analyzed for a prescribed strength of their systems and elements.

E. Alternative procedures.

1. General. Alternative lateral analysis procedures using rational analyses based on well-established principles of mechanics may be used in lieu of those prescribed in this Chapter when approved by the Building Official.
2. Seismic isolation. Seismic isolation (Chapter 17 of ASCE 7-05, Seismic Design Requirements for Seismically Isolated Structures), energy dissipation and damping systems may be used to reduce story drift when approved by the Building Official. The isolated structure shall comply with the drift requirements of Section 18.71.060.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.060 - Dynamic lateral analysis procedure.

A. General. Structures shall be analyzed for seismic forces acting concurrently on the orthogonal axes of the structure. The effects of the loading on two (2) orthogonal axes shall be combined by the square root of the sum of the squares (SRSS) methods.

B. Ground motion. The seismic ground motion values shall be determined in accordance with ASCE 7-05 and may be one of the following:

1. The elastic design response spectrum shall be seventy-five percent (75%) of the response spectrum described in ASCE 7-05 Section 11.4.5.
2. A site-specific response spectrum shall be seventy-five percent (75%) of the site-specific response spectrum described in ASCE 7-05 Section 11.4.7.

C. Mathematical model. The three-dimensional (3D) mathematical model of the physical structure shall represent the spatial distribution of mass and stiffness of the structure to an extent which is adequate for the calculation of the significant features of its dynamic response. All concrete and masonry elements shall be included in the model of the physical structure.

Exception: Concrete or masonry partitions that are adequately isolated from the concrete frame members and the floor above.

Cast-in-place reinforced concrete floors with span-to-depth ratios less than three (3) to one (1) may be assumed to be rigid diaphragms. Other floors, including floors constructed of precast elements with or without a reinforced concrete topping, shall be analyzed in conformance with ASCE 7-05 Section 12.3.1.3 to determine if they must be considered as flexible diaphragms. The effective in-plane stiffness of the diaphragm, including effects of cracking and discontinuity between precast elements, shall be considered. Ramps that interconnect floor levels shall be modeled as having mass appropriately distributed on that element. The lateral stiffness of the ramp may be calculated as having properties based on the uncracked cross-section of the slab exclusive of beams and girders.

D. Effective stiffness.

1. General. The effective stiffness of concrete and masonry elements or systems shall be calculated as the secant stiffness of the element or system with due consideration of the effects of tensile cracking and compression strain. The secant stiffness shall be taken from the force-displacement relationship of the element or system. The secant stiffness shall be measured as the slope from the origin to the intersection of the force-displacement relationship at the assumed displacement. The force-displacement relationship shall be determined by a nonlinear analysis. The force-displacement analysis shall include the calculation of the displacement at which strength degradation begins.

Exception: The initial effective moment of inertia of beams and columns in shear wall or infilled frame buildings may be estimated using Table 71-B. The ratio of effective moment of inertia used for the beams and for the columns shall be verified by Formulas (71-1), (71-2) and (71-3). The estimates shall be revised if the ratio used exceeds the ratio calculated by more than twenty percent (20%).

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr}$$

(71-1)

WHERE:

$$M_{cr} = \frac{f_r\, I_g}{y_t}$$

(71-2)

and

$$f_r = 7.5 \sqrt{f'_c}$$

(71-3)

2. Infills. The effective stiffness of an infill shall be determined from a nonlinear analysis of the infill and the confining frame. The effect of the infill on the stiffness of the system shall be determined by differencing the force-displacement relationship of the frame-infill system from the frame-only system.
3. Model of infill. The mathematical model of an infilled frame structure shall include the stiffness effects of the infill as a pair of diagonals in the bays of the frame. The diagonals shall be considered as having concrete properties and only axial loads.

Their lines of action shall intersect the beam-column joints. The secant stiffness of the force-displacement relationship, calculated as prescribed in Subsection 18.71.060.D.2, shall be used to determine the effective area of the diagonals. The effective stiffness of the frame shall be determined as specified in Subsection 18.71.060.D.1. Other procedures that provide the same effective stiffness for the combination of infill and frame may be used when approved by the Building Official.

4. Effective stiffness of elements and systems. The effective stiffness shall be determined by an iterative method. The mathematical model using assumed effective stiffness shall be used to calculate dynamic displacements. The effective stiffness of all concrete and masonry elements shall be modified to represent the secant stiffness obtained from the nonlinear force displacement analysis of the element or system at the calculated displacement. A re-analysis of the mathematical model shall be made using the adjusted effective stiffness of existing and supplemental elements and systems until closure of the iterative process is obtained. A difference of ten percent (10%) from the effective stiffness used and that recalculated may be assumed to be closure of the iterative process.

E. Description of analysis procedures.

1. Response spectrum analysis. Response spectrum analysis is an elastic dynamic analysis of a structure utilizing the peak dynamic response of all modes having a significant contribution to total structural response. Peak modal responses are calculated using the ordinates of the appropriate response spectrum curve that correspond to the modal periods. Maximum modal contributions are combined in a statistical manner to obtain an approximate total structural response.
2. Number of modes. The requirement of Subsection 18.71.060.E.1 may be satisfied by demonstrating that for the modes considered, at least ninety percent (90%) of the participating mass of the structure is included in the calculation of response for each principal horizontal direction.
3.

Combining modes. The peak displacements for each mode shall be combined by recognized methods. Modal interaction effects of three-dimensional (3D) models shall be considered when combining modal maxima.

4. Torsion. The three-dimensional (3D) analysis shall be considered as including all torsional effects including accidental torsional effects.

F. Material characteristics. The stress-strain relationship of concrete, masonry and reinforcement shall be determined by testing or from published data. The procedure for testing and determination of stress-strain values shall be as prescribed in one (1) of the following:

1. Concrete. The compressive strength of existing concrete shall be determined by tests on cores sampled from the structure or may be taken from information given on the construction documents and confirmed by limited testing. A default value of horizontal shear stress may be used in Subsection 18.71.080.E.1 without testing of the compressive strength of the existing concrete.

   a. The cutting of cores shall not significantly reduce the strength of the existing structure. Cores shall not be taken in columns. Existing reinforcement shall not be cut.

   b. If the construction documents do not specify a minimum compressive strength of the classes of concrete, five (5) cores per story, with a minimum of ten (10) cores, shall be obtained for testing. Exception: If the coefficient of variation of the compressive strength does not exceed fifteen percent (15%), the number of cores per story may be reduced to two (2) and the minimum number of tests reduced to five (5).

   c. When the construction documents specify a minimum compressive strength, two (2) cores per story, per class of concrete, shall be taken in the areas where that concrete was to be placed. A minimum of five (5) cores shall be obtained for testing. If a higher strength of concrete was specified for columns than the remainder of the concrete, cores taken in the beams for verification of the specified strength of the beams shall be substituted for tests in the columns. The strength specified for columns may be used in the analyses if the specified compressive strength in the beams is verified.

   d. The sampling for the concrete strength tests shall be distributed uniformly in each story. If the building has shear walls, a minimum of fifty percent (50%) of the cores shall be taken from the shear walls. Not more than twenty-five percent (25%) of the required cores shall be taken in floor and roof slabs. The remainder of cores may be taken from the center of beams at mid-span. In concrete frame buildings, seventy-five percent (75%) of the cores shall be taken from the beams.

   e. The mean value of the compressive stresses obtained from the core testing for each class of concrete shall be used in the analyses. Values of peak strain that is associated with peak compressive stress may be taken from published data for the nonlinear analyses of reinforced concrete elements.

2.

Solid grouted reinforced masonry. The compressive strength of solid grouted concrete block or brick masonry may be taken as two thousand (2,000) psi. The strain associated with peak stress may be taken as 0.0025.

3. Partially grouted masonry. A minimum of five (5) units shall be removed from the walls and tested in conformance with ASTM C90-03 Specification for Load Bearing Concrete Masonry Units. Compressive strength of the masonry may be determined in accordance with Chapter 21 of the California Building Code adopted in Chapter 18.40, assuming Type S mortar. The strain associated with peak stress may be taken as 0.0025.
4. Unreinforced masonry.
   a. The stress-strain relationship of existing unreinforced masonry shall be determined by in-place cyclic testing. The test procedure shall conform to Section 18.71.100.
   b. One (1) stress-strain test per story and a minimum of five (5) tests shall be made in the unreinforced masonry infills. The location of the tests shall be uniformly distributed throughout the building.
   c. The average values of the stress-strain values obtained from testing shall be used in the nonlinear analyses of frame-infill assemblies or in the calculation of the effective diagonal brace that is used in the simplified analysis procedure of Section 18.71.080.
5. Reinforcement. The yield stress of each type of new or existing reinforcement shall be taken from Table 71-C unless the reinforcement is sampled and tested for yield stress. The axial reinforcement in columns of post-1933 buildings shall be assumed to be hard grade unless noted otherwise on the construction documents.
6. Combination of concrete and masonry materials. Combinations of masonry and concrete infills shall be assumed to have equal strain. The secant moduli at peak stress of the masonry and concrete shall be used to determine the effective transformed area of the composite material.

G. Story drift limitation.

1. Definition. Story drift is the displacement of one (1) level relative to the level above or below calculated by the response spectrum analysis using the appropriate effective stiffness.
2. Limitation. The story drift is limited to that displacement that causes any of the following effects:
   a. Compressive strain of 0.003 in the frame confining infill or in a shear wall.
   b. Compressive strain of 0.004 in a reinforced concrete column unless the engineer can show by published experimental research that the existing confinement reinforcement justifies higher values of strain.
   c. Peak strain in masonry infills as determined by experimental data or by physical testing as prescribed in Section 18.71.100.
   d. Displacement that was calculated by the nonlinear analysis as when strength degradation of any element began.

Exception: This Subsection may be taken as the displacement that causes a strength degradation in that line of resistance equal to ten percent (10%) of the sum of the strength of the elements in that line of resistance.

e. A story drift of 0.015 using the dynamic analysis procedure or the forces specified in Section 18.71.070. This limitation shall not supersede the limitations of Subsections 18.71.060.G.2.a through 18.71.060.G.2.d.

H. Compressive strain determination.

1. General. The compressive strain in columns, shear walls and infills may be determined by the nonlinear analysis or a procedure that assumes plane sections remain plane.
2. Axial and flexural loading. The compressive strain shall be determined for combined flexure and axial loading. The flexural moments shall be taken from the response spectrum model for frame or shear wall buildings, and from the substructure model for infill frames. The axial loads shall have the following combination of effects, where L is unreduced live load:

U = 1.0D + 0.3L + 1.0E(71-4)

U = 0.9D + 1.0E(71-5)

I. Shear strength limitation. The required in-plane shear strength of all columns, piers and shear walls shall be the shear associated with the moments induced at the ends of columns or piers and at the base of shear walls by the story displacements. No strength reduction factors shall be used in the determination of strength.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.070 - Equivalent lateral force procedure.

A. General. Structures shall be analyzed for prescribed forces acting concurrently on the orthogonal axes of the building. The effects of the loading on the two (2) orthogonal axes shall be combined as required by Subsection 18.71.060.A.

B. Base Shear for Analysis. The base shear used to determine story drifts shall be determined using seventy-five percent (75%) of the base shear as determined in accordance with ASCE 7-05 Section 12.8.1.

Where:

R = 1.4 for concrete frame buildings with masonry infill and all other reinforced concrete buildings.

Exception: R = 1.0 for single-story buildings. The R value in ASCE 7-05 Table 12.2-1 for new building design shall not be used for story drift determination.

C.

Structure period. The value of T may be determined by either Method A or B as prescribed by ASCE 7-05 Section 12.8.2. The structure period calculated by Method B need not be limited to a percent of the value obtained by Method A.

D. Vertical distribution of forces. The base shear shall be distributed over the height of the structure in conformance with Formula (71-6).

$$C_{vx} = \frac{w_x h_x^{k}}{\sum_{i=1}^{i=n} w_i h_i^{k}}$$

(71-6)

Where:

C_{vx} = Vertical distribution factor to be applied to V to obtain the story force at level x.

k = An exponent related to building period as follows:

For buildings having a period of 0.4 seconds or less,

k = 1.0

For buildings having a period of 2.0 seconds or more,

k = 2.0

For buildings having a period between 0.4 and 2.0 seconds, k may be taken as two (2) or determined by linear interpolation between one (1) and two (2).

E. Horizontal distribution of shear. The effective stiffness of elements shall be used for the horizontal distribution of shear.

F. Horizontal torsional moments. Provision shall be made for increased displacements resulting from horizontal torsion. The effects of torsional moments shall be included in the determination of the effective stiffness of elements and systems. Reinforced concrete floors may be considered as rigid diaphragms.

G. Effective stiffness. The effective stiffness of concrete and masonry elements shall be determined as prescribed in Subsection 18.71.060.D.

H. Material characteristics. Material characteristics shall be determined as prescribed in Subsection 18.71.060.F.

I. Story drift limitations. Story drift limits shall be as prescribed in Subsection 18.71.060.G.

J.

Compressive strain determination. Compressive strain shall be determined as prescribed in Subsection 18.71.060.H.

K. Shear strength limitation. The in-plane shear strength shall equal or exceed the shear forces determined as prescribed in Subsection 18.71.060.I.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.080 - Simplified analysis procedure.

A. General. Structures conforming to the requirements of this Section may be analyzed for having a required strength by a simplified analysis procedure.

B. Required features of the building. The building shall conform to all the following features, or the building shall be analyzed by the equivalent lateral force procedure or the dynamic lateral force procedure as prescribed by Subsection 18.71.050.D.

1. The lateral-resisting elements of the building shall be reinforced concrete shear walls or frames with solid masonry infills and infills which have openings in the masonry infills not exceeding ten percent (10%) of the gross area of the infill panel which has the opening(s).
2. The effective shear area of reinforced concrete shear walls on each orthogonal axis shall be calculated by passing a horizontal plane through each story level. The height of the plane shall be that height where the area of the shear walls is a minimum.
3. The reinforced concrete elements shall have no visible deterioration of concrete or reinforcement.
4. The vertical elements in the lateral-load-resisting system shall not have significant strength discontinuities; the story strength in any story shall not be less than ninety percent (90%) of the strength of the story above.
5. The lateral-force-resisting elements in all story levels shall form a system that is not subject to significant torsion. Significant torsion is the condition where the distance between the story center of rigidity and the story center of mass is greater than twenty percent (20%) of the width of the structure in the corresponding plan dimension.
6. The minimum ratio of area of reinforcement to gross area of wall in existing reinforced concrete shear walls shall be 0.0015 in both the vertical and horizontal direction or the minimum ratio of axial reinforcement in the columns of frames containing infills shall be 0.01.
7. The ratio of total height to base length of cantilevered or coupled shear walls shall be two (2) or less. The ratio of clear height to in-plane depth of piers in a shear wall shall be two (2) or less. Shear walls or piers having a height to in-plane depth ratio greater than two (2) shall be given an effective shear area of one-half (1/2) their area.
8. All concrete frames with infilled panels conforming to Subsection 18.71.080.B.1 above shall have total height to base length ratios of two (2) to one (1) or less.

C. Analysis procedure.

1.

General. Supplemental elements may be added to the existing building to bring the structure into conformance with Subsection 18.71.090.B.

2. Seismic loading. The seismic loading shall be calculated by Subsection 18.71.070.B. The loading of each story level shall be calculated by Formula (71-6) of Subsection 18.71.070.D.
3. Relative rigidities. The relative rigidity of reinforced concrete shear walls may be based on the stiffness of uncracked sections. The relative rigidity of infill panels may be calculated using a common modulus of elasticity. Use of a combination of infills and reinforced concrete or masonry shear walls on any orthogonal axis is prohibited.
4. Required calculations. The calculations may be limited to computation of loads on the reinforced concrete shear walls or infilled frame panels that comply with Subsection 18.71.080.B and computation of the drag and tie forces that develop a complete load path. The loads shall include torsional effects.

D. Required strength of systems and elements.
   1. The capacity of all parts of the structure shall exceed the demand calculated by use of the loading specified in Section 18.71.070.
   2. The strength of infilled frame systems used for lateral load resistance in this Section shall be calculated using only the infilled frames that conform to Subsection 18.71.080.B.1.
E. Shear stress limit.
   1. The maximum horizontal shear stress in new and existing reinforced concrete shear walls shall not exceed two (f'c)1/2. For the purpose of this Chapter, the horizontal shear stress may be taken as eighty (80) psi without testing as required by Subsection 18.71.060.F.1.
   2. The in-plane shear stress in any masonry infilled panel shall not exceed thirty (30) psi. The calculation of shear stresses shall use net section area and only the area of the infilled masonry.

Exception: The in-plane strength of an infill panel without openings may be calculated by procedures described in published research that were verified by experimental testing and approved by the Building Official.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.090 - Minimum requirements for a limited structural analysis.

A. General. Structures conforming to the requirements of this Section may be shown to be in conformance with this Chapter by submission of the report described in this Section.
B. Required features of the building. The building shall conform to all of the following features or the building shall be analyzed as prescribed by Subsection 18.71.050.D.
   1. The lateral load-resisting elements of the building shall be reinforced concrete shear walls.
   2. The minimum ratio of area of reinforcement to gross area of the wall shall be 0.0015 in both the vertical and horizontal directions.

3. The reinforced concrete elements shall have no visible deterioration of concrete or reinforcement.
4. The area of concrete shear walls on each orthogonal axis at the first (1st) floor level shall be one and one-half percent (1.5%) of the area of the first floor of the building, where n is the number of floor and roof levels.
5. The area of the shear walls in all stories above the first (1st) floor shall not be more than one hundred percent (100%) or less than eighty percent (80%) of the area of shear walls at the first (1st) floor.
6. The concrete shear walls in all stories above the first (1st) floor shall be directly above the shear walls at the first (1st) floor which are used to calculate the percent of shear wall area to floor area.
7. The wall area must be uniformly distributed such that at least eighty percent (80%) of the wall area used in the calculation is symmetrically placed about the center of the building.
8. The area of the shear walls on each orthogonal axis shall be calculated by passing a horizontal plane through the first (1st) story level. The height of the plane shall be that height where the area of the shear walls is a minimum.
9. The ratio of total height to base width of cantilevered or coupled shear walls shall be two (2) or less. The ratio of the clear height to in-plane depth of piers in a shear wall shall be two (2) or less. Shear walls or piers having a height to depth ratio greater than two (2) shall be given an effective area of one-half (1/2) of their area.

C. Information required in the report.
    1. The report shall include data, sketches, plans and calculations that show conformance with the features given in this Section.
    2. The registered design professional of record shall meet with the representative of the Department at the site to review the report.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.100 - Determination of the stress-strain relationship of existing unreinforced masonry.

A. Scope. This Section covers procedures for determining the expected compressive modulus, peak strain and peak compressive stress of unreinforced brick masonry used for infills in frame buildings.
B. General procedure. The outer wythe of multiple wythe brick masonry shall be tested by inserting two (2) flat jacks into the mortar joints of the outer wythe. The prism height, the vertical distance between the flat jacks, shall be five (5) bricks high. The test location shall have adequate overburden and/or vertical confinement to resist the flat jack forces.
C. Preparation for the test. Remove a mortar joint at the top and bottom of the test prism by saw cutting or drilling and grinding to a smooth surface. The cuts for inserting the flat jacks shall not have a deviation from parallel of more than three-eighths inch (3/8"). The deviation from parallel shall be

measured at the ends of the flat jacks. The width of the saw cut shall not exceed the width of the mortar joint. The length of the saw cut on the face of the wall may exceed the length of the flat jacks by not more than twice the thickness of the outer wythe plus one inch (1").

D. Required equipment. The flat jacks shall be rectangular or with semicircular ends to mimic the radius of the saw blade used to cut the slot for the flat jack. The length of the flat jack shall be eighteen inches (18") maximum and sixteen inches (16") minimum. This length shall be measured on the longest edge of a flat jack with semi-circular ends. The maximum width of the flat jack shall not exceed the average width of the wythe of brick that is loaded. The minimum width of a flat jack shall be three and one-half inches (3-1/2") measured out-to-out of the flat jack. The flat jack shall have a minimum of two (2) ports to allow air in the flat jack to be replaced by hydraulic fluid. The unused port shall be sealed after all the air is forced out of the flat jack. The thickness of the flat jack shall not exceed three-quarters (3/4) of the minimum height of the mortar joint. It is recommended that the height of the flat jack be about one-half (1/2) of the width of the slot cut for installation of the flat jack. The remaining space can be filled with steel shim plates having plan dimensions equal to the flat jack.

E. Data acquisition equipment. The strain in the tested prism shall be recorded by gages or similar recording equipment having a minimum range of one ten-thousandth (1/10,000) of an inch. The compressive strain shall be measured on the surface of the prism and shall have a gage length, measured vertically on the face of the prism, of ten inches minimum (10"). The gage points shall be fixed to the wall by drilled-in anchors or by anchors set in epoxy or similar material. The support for the data-recording apparatus shall be isolated from the wall by a minimum of one-sixteenth inch (1/16") so that the gage length used in the calculation of strain can be taken as the measured length between the anchors of the equipment supports. The gaging equipment shall be as close to the face of the prism as possible to minimize the probability of erroneous strain measurements caused by bulging of the prism outward from its original plane.

The compressive strain data shall be measured at a minimum of two (2) points on the vertical face of the prism. These points shall be the one-third (1/3) points of the length of the flat jacks plus or minus one-half inch (1/2"). As an alternative, the strain may be measured at three (3) points on the face of the prism.

These points shall be spaced at one quarter (1/4) of the flat jack length plus or minus one-half inch (1/2").

Horizontal gages at mid-height of the prism may be used to record Poisson strain, but this gage should be considered as recording data secondary in importance to the vertical gages and its placement shall not interfere with placing the vertical gaging as close as possible to the face of the prism.

F. Loading and recording data. The loading shall be applied by hydraulic pumps that add hydraulic fluid to the flat jacks in a controlled method. The application of load shall be incremental and held constant while strains are being recorded. The increasing loading for each cycle of loading shall be divided into a minimum of four (4) equal load increments. The strain shall be recorded at each load step. The decrease in loading shall be divided into a minimum of two (2) equal unloading increments. Strain shall be recorded on the decreasing load steps. The hydraulic pressure shall be reduced to zero (0) and the permanent strain caused by this cycle of loading shall be recorded. This procedure shall be used for each cycle of loading.

The load applied in each cycle of load shall be determined by estimating the peak compressive stress of the existing brick masonry. The hydraulic pressure needed to cause this peak compressive stress in the prism shall be calculated by assuming the area of the loaded prism is equal to the area of the flat jack. A maximum of one-third (1/3) of this pressure, rounded to the nearest twenty-five (25) psi, shall be applied in the specified increments to the peak pressure prescribed for the first cycle of loading. After recording the strain data, this pressure shall be reduced in a controlled manner to each of the specified increments for unloading and for recording data. The maximum jack pressure on the subsequent cycles shall be one-half (1/2), two-thirds (2/3), five-sixths (5/6) and estimated peak pressure. If the estimated peak compressive stress is less than the existing peak compressive stress, the cyclic loading and unloading shall continue using increments of increasing pressure equal to those used prior to the application of estimated peak pressure.

All strain data shall be recorded to one ten-thousandth (1/10,000) of an inch. Jack pressure shall be recorded in increments of twenty-five (25) psi pressure.

G. Quality control. The flat jack shall be calibrated before use by placing the flat jack between bearing plates of two inches (2") minimum thickness in a calibrated testing machine. A calibration curve to convert hydraulic pressure in the flat jack to total load shall be prepared and included in the report of the results of testing. Flat jacks shall be recalibrated after three (3) uses.

The hydraulic pressure in the flat jacks shall be indicated by a calibrated dial indicator having a subdivision of twenty-five (25) psi or less. The operator of the hydraulic pump shall use this dial indicator to control the required increments of hydraulic pressure in loading and unloading.

H. Interpretation of the data. The data obtained from the testing required by Subsection 18.71.060.F.4.b shall be averaged both in expected peak compressive stress and the corresponding peak strain. The envelope of the averaged stress-strain relationship of all tests shall be used for the material model of the masonry in the infilled frame. If two (2) strain measurements have been made on the surface of the prism, these strain measurements shall be averaged for determination of the stress-strain relationship for the test. If three (3) strain measurements have been made on the surface of the prism, the data recorded by the center gage shall be given a weight of two (2) for preparing the average stress-strain relationship for the test.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.110 - Evaluation of existing structural conditions.

The registered design professional of record shall report any observed structural conditions and structural damage that, in the registered design professional's judgment, have imminent life-safety effects on the structure and recommend repairs. Evaluations and repairs shall be reviewed and approved by the Department.

(ORD-16-0026 § 1(Exh. A), 2016)

18.71.120 - Materials of construction.

A. General. In addition to the seismic analysis required elsewhere in this Chapter, the registered design professional responsible for the seismic analysis of the building shall record the information required by this Section on the approved construction documents.
B. Information required. The construction documents shall accurately reflect the results of the engineering investigation and design, and show all pertinent dimensions and sizes for plan review and construction. The following shall be provided:
    1. The construction documents of the existing construction shall be adequately dimensioned and furnish adequate details in schedules, notes and sections to fully describe the existing building. The construction documents shall include a foundation plan, floor and roof plans which indicate new work, and existing construction;
    2. Elevations of the structural system showing sizes and dimensions;
    3. Schedules, sections and details showing reinforcement of walls, slabs, beams, joists, girders, columns and foundations;

Exception: If copies of the original construction documents are submitted for information during the plan check, the information required by Subsections 18.71.120.B.1 through 18.71.120.B.3 may be limited to areas of and adjacent to new construction on a complete outline at that level of the building;

    4. Sections and details showing attachments and joining of new and existing structures. All reinforcement in the existing structure shall be shown in these sections and details;
    5. Specifications and/or general notes fully describing demolition, materials and methods, testing and inspection requirements.

C. Registered design professional of record's statement. The responsible registered design professional of record shall state on the approved construction documents the following:
    1. "I am responsible for this building's seismic strengthening design in compliance with the minimum seismic resistance standards of Chapter 18.71 of the Long Beach Municipal Code." or when applicable:
    2. "The registered special inspector, required as a condition of the use of structural design stresses requiring continuous inspection, will be responsible to me as required by Section 1704.1 of the California Building Code adopted in Chapter 18.40."

TABLE 71-A

RATING CLASSIFICATIONS CLASSIFICATION TYPE OF BUILDING

CLASSIFICATION	TYPE OF BUILDING
Group I	Essential buildings
Group II	Buildings with occupant load of 5,000 or more, or assembly rooms of 1,000 occupants or more, and malls as defined elsewhere in the code.
Group III	1,000 to 4,999 occupants
Group IV	300 to 999 occupants
Group V	All others

TABLE 71-B

INITIAL EFFECTIVE MOMENT OF INERTIA OF CONCRETE MEMBERS

MEMBER	RANGE
Rectangular beams	0.30 - 0.5 I_g
T- and L-shaped beams	0.25 - 0.45 I_g
Columns P > 0.5 $f_c'A_g$	0.7 - 0.9 I_g
Columns P = 0.2 $f_c'A_g$	0.5 - 0.7 I_g
Columns P = - 0.05 $f_c'A_g$	0.3 - 0.5 I_g

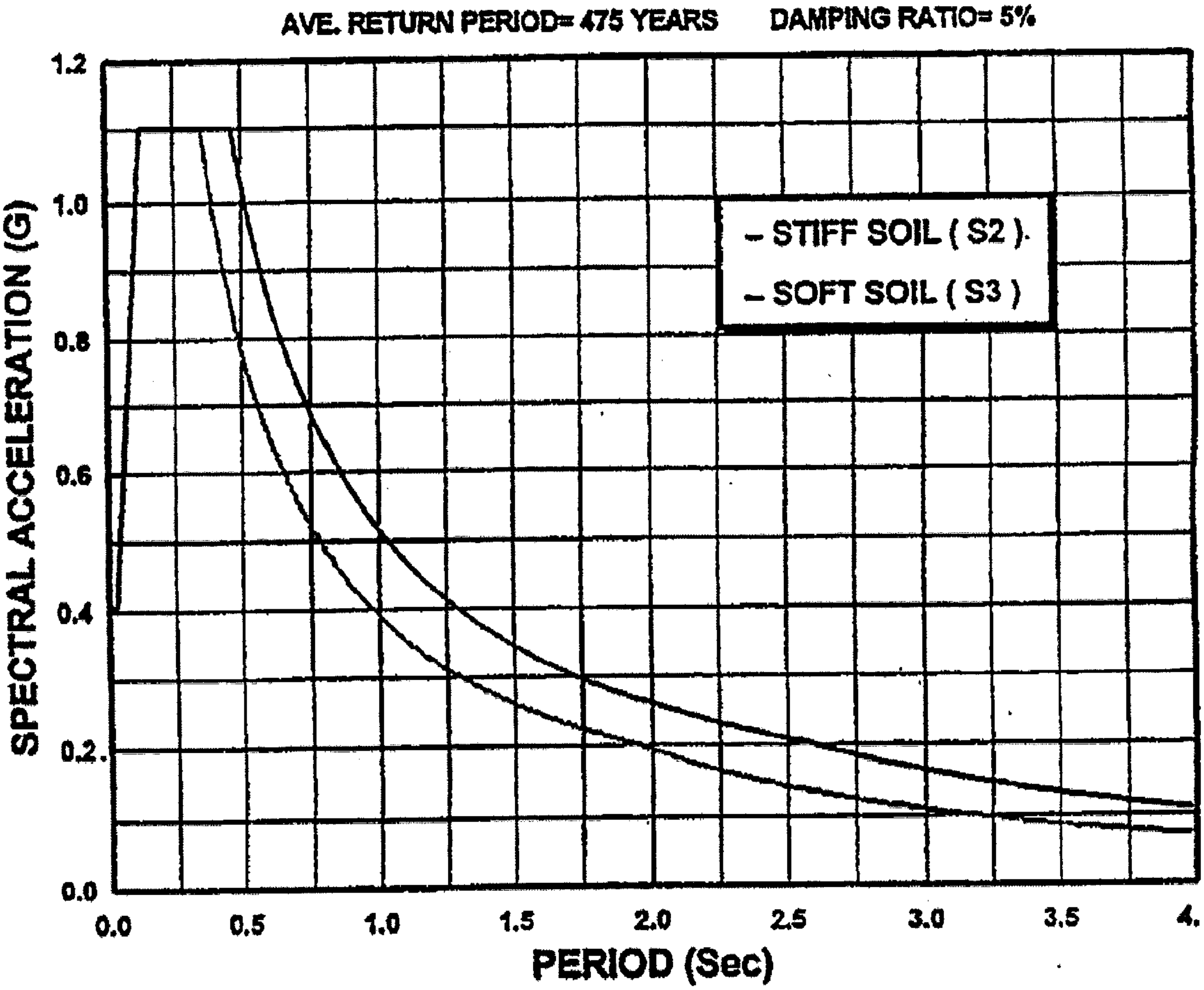
TABLE 71-C

ASSUMED YIELD STRESS OF EXISTING REINFORCEMENT

TYPE OF REINFORCEMENT AND ERA	ASSUMED YIELD STRESS, ksi
Pre-1940 — Structural and intermediate grade, plain and deformed	45
Pre-1940 — Twisted and hard grade	55
Post-1940 — Structural and intermediate grade	45
Post-1940 — Hard grade	60
ASTM A 615 Grade 40	50
ASTM A 615 Grade 60	70

For SI: 1 ksi = 6.894 MPa.

FIGURE 71-1 RESPONSE SPECTRA SHAPES



(ORD-16-0026 § 1(Exh. A), 2016)