

## CHAPTER 18.70 - VOLUNTARY EARTHQUAKE HAZARD REDUCTION IN EXISTING WOOD FRAME RESIDENTIAL BUILDINGS WITH SOFT, WEAK OR OPEN FRONT WALLS

### 18.70.010 - Purpose.

The purpose of this Chapter is to promote the public welfare and safety by reducing the risk of death or injury that may result from the effects of earthquakes on existing wood-frame, multi-unit residential buildings. The ground motion of the Northridge Earthquake caused the loss of human life, personal injury and property damage in these types of buildings. This Chapter creates minimum standards to strengthen the more vulnerable portions of these structures. When fully followed, these minimum standards will substantially improve the performance of these buildings but will not necessarily prevent all earthquake-related damage.

( ORD-16-0026 § 1(Exh. A), 2016)

### 18.70.020 - Scope.

The provisions of this Chapter shall apply to all existing wood frame buildings or portions thereof, designed using the Building Code in effect before January 1, 1995, which are used as hotels, lodging houses, congregate residences or apartment houses where:

- A. The ground floor portion of the wood frame structure contains parking or other similar open floor space that causes soft, weak or open front wall lines as defined in this Chapter and there exists one (1) or more levels above; or
- B. The walls of any story or basement of wood construction are laterally braced with nonconforming structural materials as defined in this Chapter and there exists two (2) or more levels above.

( ORD-16-0026 § 1(Exh. A), 2016)

### 18.70.030 - Definitions.

Notwithstanding the applicable definitions, symbols and notations in this title, the following definitions shall apply for the purposes of this Chapter.

"Apartment house" means any building or portion thereof which contains three (3) or more dwelling units, and for the purposes of this Chapter, includes residential condominiums.

"Aspect ratio" means the ratio of the height of a wall section to its width.

"Congregate residence" means any building or portion thereof which contains facilities for living, sleeping and sanitation, as required by this code, and may include facilities for eating and cooking, for occupancy by other than a family. A congregate residence may be a shelter, convent, monastery, dormitory,

and fraternity or sorority house but does not include jails, hospitals, nursing homes, hotels or lodging houses.

"Cripplewall" means a wood-framed stud wall extending from the top of the foundation wall to the underside of the lowest floor framing.

"Dwelling unit" means any building or portion thereof which contains living facilities, including provisions for sleeping, eating, cooking and sanitation, as required by this code, for not more than one (1) family, or congregate residence for ten (10) or fewer persons.

"Expansion anchor" means an approved mechanical fastener placed in hardened concrete, designed to expand in a self-drilled or pre-drilled hole of a specified size and engage the sides of the hole in one (1) or more locations to develop shear and/or tension resistance to applied loads without grout, adhesive or drypack.

"Groundfloor" means any floor within the wood frame portion of a building whose elevation is immediately accessible from an adjacent grade by vehicles or pedestrians. The ground floor portion of the structure does not include any level that is completely below adjacent grades.

"Guest room" means any room or rooms used or intended to be used by a guest for sleeping purposes. Every one hundred (100) square feet of superficial floor area in a congregate residence shall be considered a guest room.

"Hotel" means any building containing six (6) or more guest rooms intended or designed to be used, rented, hired out to be occupied, or which are occupied for sleeping purposes by guests.

"Level" means a story, basement or under floor space of a building with cripple walls exceeding four feet (4') in height.

"Lodginghouse" means any building or portion thereof containing at least one (1) but not more than five (5) guest rooms where rent is paid in money, goods, labor or otherwise.

"Motel" means a hotel as defined in this Chapter.

"Multi-unit residential buildings" means hotels, lodging houses, congregate residences and apartment houses.

"Nonconforming structural materials" means wall bracing materials for seismic loads whose allowable shear value was reduced or whose maximum allowable aspect ratio was decreased since the original building construction. These methods or materials include, but are not limited to, cement or gypsum plaster, gypsum wall board, diagonal or let-in bracing, straight or diagonal wood sheathing, particle board and structural wood panels.

"Open frontwall line" means an exterior wall line without vertical elements of the lateral-force-resisting system which requires tributary seismic forces to be resisted by diaphragm rotation or excessive cantilever beyond parallel lines of shear walls. Diaphragms that cantilever more than twenty-five percent (25%) of the distance between lines of lateral-force-resisting elements shall be considered excessive. Exterior exit balconies of six feet (6') or less in width shall not be considered excessive cantilevers.

"Retrofit" means an improvement of the lateral-force-resisting system by alteration of existing structural elements or addition of new structural elements.

"Soft wall line" means a wall line whose lateral stiffness is less than required by story drift limitations or deformation compatibility requirements of this Chapter. In lieu of analysis, this may be defined as a wall line in a story where the story stiffness is less than seventy percent (70%) of the story above for the direction under consideration.

"Story strength" means the total strength of all seismic-resisting elements sharing the same story shear in the direction under consideration.

"Wall line" means any length of a wall along a principal axis of the building used to provide resistance to lateral loads. Parallel wall lines separated by less than four feet (4') shall be considered one wall line for the distribution of loads.

"Weak wall line" means a wall line laterally braced with nonconforming structural materials or a wall line in a story where the story strength is less than eighty percent (80%) of the story above in the direction under consideration.

( [ORD-16-0026](#) § 1(Exh. A), 2016)

#### 18.70.040 - General requirements for phased construction.

When the building contains three (3) or more levels, the work specified in this Chapter shall be permitted to be done in the following phases. Work shall start with Phase 1 unless otherwise approved by the Building Official. When the building does not contain the conditions shown in any phase, the sequence of retrofit work shall proceed to the next phase in numerical order.

- A. Phase 1 Work. The first phase of the retrofit work shall include the ground floor portion of the wood structure that contains parking or other similar open floor space.
- B. Phase 2 Work. The second phase of the retrofit work shall include the walls of any level of wood construction with two (2) or more levels above, which are laterally braced with nonconforming structural materials.
- C. Phase 3 Work. The third and final phase of the retrofit work shall include the remaining portions of the building up to, but not including, the top story as specified in Subsection 18.70.050.B.

18.70.050 - Analysis and design.

- A. General. Every building within the scope of this Chapter shall be analyzed, designed and constructed in conformance with this code except as modified herein. No alteration of the existing lateral-force-resisting or vertical load-carrying system shall reduce the strength or stiffness of the existing structure.
- B. Scope. This Chapter requires the alteration, repair, replacement or addition of structural elements and their connections to meet the strength and stiffness requirements herein. The lateral load path analysis shall include the resisting elements and connections from the wood diaphragm above any soft, weak or open front wall lines to the foundation soil interface or reinforced concrete slab or masonry wall supporting elements below. The top story of any building need not be analyzed. The lateral load path analysis for added structural elements shall also include evaluation of the allowable soil bearing and lateral pressures in accordance with Section 1803 of the California Building Code adopted in Chapter 18.40.

Exception: When an open front, weak or soft wall line exists due to parking at the ground level of a two (2) level building and the parking area is less than twenty percent (20%) of the ground floor level, then only the wall lines in the open, weak or soft directions of the enclosed parking area, need comply with the provisions of this Chapter.

- C. Design base shear. The design base shear shall be seventy-five percent (75%) of that currently required by ASCE 7-05 Section 12.8.1.
- D. Vertical distribution of forces. The total seismic force shall be distributed over the height of the structure based on Formula (12.8-11 and 12.8-12) in ASCE 7-05 Section 12.8.3. Distribution of force by story weight shall be permitted for two (2) story buildings. The value of R used in the design of any story shall be less than or equal to the value of R used in the given direction for the story above.
- E. Weak story limitation. The structure shall not exceed thirty feet (30') in height or two (2) levels if the lower level strength is less than sixty-five percent (65%) of the story above. Existing walls shall be strengthened as required to comply with this provision unless the weak level can resist a total lateral seismic force of  $\Omega_o$  per Subsection 18.70.050.C times the design force prescribed in Subsection 18.70.050.D. The story strength for each level of all other structures shall be a minimum of eighty percent (80%) of the story above.
- F. Story drift limitation. The calculated story drift for each retrofitted level shall not exceed the allowable deformation compatible with all vertical load-resisting elements and 0.005 or 0.04/R times the story height. The calculated story drift shall not be reduced by the effects of horizontal diaphragm stiffness but shall be increased when these effects produce rotation. The effects of rotation and soil stiffness shall be included in the calculated story drift when lateral loads are resisted by vertical elements whose required depth of embedment is determined by pole formulas such as Equation (18-1), (18-2) and (18-3)

in Section 1807.3.2 of the California Building Code adopted in Chapter 18.40. The coefficient of variation of subgrade reaction used in the deflection calculations shall be provided from an approved geotechnical engineering report or other approved methods.

G.  $P\Delta$  effects. The requirements of ASCE 7-05 Section 12.8.7 shall apply except as modified herein. All framing elements not required by the design to be part of the lateral-force-resisting system shall be investigated and shown to be adequate for vertical load-carrying capacity when displaced per Subsection 18.70.050.C times the displacements resulting from the required lateral force. The stress analysis of cantilever columns shall use a buckling factor of 2.1 for the direction normal to the axis of the beam.

H. Ties and continuity. All parts of the structure included in the scope of Subsection 18.70.050.B shall be interconnected and the connection shall be capable of resisting the seismic force created by the parts being connected. Any smaller portion of a building shall be tied to the remainder of the building with elements having a strength of 0.1833 times the tributary dead load of the smaller portion.

A positive connection for resisting a horizontal force acting parallel to the member shall be provided for each beam, girder or truss included in the lateral load path. This force shall not be less than 0.08 times the combined tributary dead and live loads or as required by the lateral load path transfer, whichever is greater.

I. Collector elements. Collector elements shall be provided which can transfer the seismic forces originating in other portions of the building to the elements within the scope of Subsection 18.70.050.B that provide resistance to those forces.

J. Horizontal diaphragms. The analysis of shear demand or capacity of an existing plywood or diagonally sheathed horizontal diaphragm need not be investigated unless the diaphragm is required to transfer lateral forces from the lateral-resisting elements above the diaphragm to other lateral-force-resisting elements below the diaphragm due to offset in placement of the elements. Wood diaphragms in structures that support floors or roofs above shall not be allowed to transmit lateral forces by rotation or cantilever. However, rotational effects shall be accounted for when unsymmetric wall stiffness increases shear demands.

Exception: Diaphragms that cantilever twenty-five percent (25%) or less of the distance between lines of lateral-force-resisting elements from which the diaphragm cantilevers may transmit their shears by cantilever provided that rotational effects on shear walls parallel and perpendicular to the load are accounted for.

K. Shear walls. Shear walls shall have sufficient strength and stiffness to resist the tributary seismic loads and shall conform to the special requirements of this Subsection.

1. Gypsum or plaster products. Gypsum or plaster products shall not be used to provide lateral resistance.

2. Wood structural panels.

a.

Drift limit. Wood structural panel shear walls shall meet the story drift limitation of Subsection 18.70.050.F. Conformance to the story drift limitation shall be determined by approved testing or calculation or analogies drawn therefrom and not the use of an aspect ratio. Calculated deflection shall be in accordance with Section 2305.3.2 of the California Building Code adopted in Chapter 18.40 and twenty-five percent (25%) shall be added to account for inelastic action and repetitive loading. Contribution to the deflection from the anchor or tie down slippage shall also be included. The slippage contribution shall include the vertical elongation of the metal, the vertical slippage of the connectors and compression or shrinkage of the wood elements. The vertical slippage shall be multiplied by the aspect ratio and added to the total horizontal deflection. Individual shear panels shall be permitted to exceed the maximum aspect ratio provided the story drift and allowable shear capacities are not exceeded.

- b. Openings. Openings are permitted in shear walls if they do not exceed fifty percent (50%) of the height or width of the shear wall. The remaining portion of the shear wall shall be strengthened for the transfer and increase of all shearing forces caused by the opening. The resulting shear wall shall be analyzed as a mosaic of shear-resisting elements. Blocking and steel strapping shall be employed at the corners of the opening to transfer forces from discontinuous boundary elements into adjoining panel elements.

The effects of openings on the stiffness of the shear wall shall be demonstrated to comply with the requirements of Subsection 18.70.050.F. The stiffness shall be calculated using the properties of the different shear elements making up the shear wall or it shall be demonstrated by approved testing. When shear walls cannot be made to conform to the requirements of this Section because of existing openings, the openings shall be relocated or reduced in width to meet the strength and stiffness requirements of the lateral loads. Relocated and altered openings shall comply with the emergency escape requirements in Chapter 10 of the California Building Code adopted in Chapter 18.40. Relocated and altered openings shall comply with the light and ventilation requirements in Chapter 12 of the California Building Code adopted in Chapter 18.40 or Chapter 3 of the California Residential Code adopted in Chapter 18.41 unless otherwise approved by the Building Official.

- c. Wood species of framing members. Allowable shear values for wood structural panels shall consider the species of the framing members. When the allowable shear values are based on Douglas Fir-larch framing members and framing members are constructed of other species of lumber, the allowable shear values shall be multiplied by the appropriate factors determined in accordance with Chapter 23 of the California Building Code adopted in Chapter 18.40.
3. Mechanical penetrations. Mechanical penetrations in shear walls that exceed the provisions of Chapter 23 of the California Building Code adopted in Chapter 18.40 or the California Building Code adopted in Chapter 18.40 or the California Residential Code adopted in Chapter 18.41 shall be accounted for in the design or the shear wall shall be analyzed as two (2) separate walls on each side of the penetration.

4.

Substitution for three inch (3") nominal width framing members. Two (2) two inch (2") nominal width framing members shall be permitted in lieu of any required three inch (3") nominal width framing member when the existing and new framing member are of equal dimensions, are connected as required to transfer the in-plane shear between them and the sheathing fasteners are equally divided between them.

5. Hold-down connectors.
  - a. Expansion anchors in tension. Expansion anchors that provide tension strength by friction resistance shall not be used to connect hold down devices to existing concrete or masonry elements. Expansion anchors shall be permitted to provide tension strength by bearing.
  - b. Required depth of embedment. The required depth of embedment or edge distance for the anchor used in the hold down connector shall be provided in the concrete or masonry below any plain concrete slab unless satisfactory evidence is submitted to the Building Official that shows that the concrete slab and footings are of monolithic construction.
  - c. Required preload of bolted hold-down connectors. Bolted hold down connectors shall be preloaded to reduce slippage of the connector. Preloading shall consist of tightening the nut on the tension anchor after the placement but before the tightening of the shear bolts in the panel flange member. The tension anchor shall be tightened until the shear bolts are in firm contact with the edge of the hole nearest the direction of the tension anchor. Hold down connectors with self-jigging bolt standoffs shall be installed in a manner to permit preloading.

( [ORD-16-0026](#) § 1(Exh. A), 2016)

#### 18.70.060 - Materials of construction.

- A. New materials. All materials approved by this title, including their appropriate allowable stresses and minimum aspect ratios, shall be permitted to meet the requirements of this Chapter.
- B. Allowable foundation and lateral pressures. Allowable foundation and lateral pressures shall be permitted to use the values from Table 1806.2 of the California Building Code adopted in Chapter 18.40. The coefficient of variation of subgrade reaction shall be established by an approved geotechnical engineering report or other approved methods when used in the deflection calculations of embedded vertical elements as required in Subsection 18.70.050.F.
- C. Existing materials. All existing materials shall be in sound condition and constructed in conformance to this code before they can be used to resist the lateral loads prescribed in this Chapter. The verification of existing material conditions and their conformance to these requirements shall be made by physical observation reports, material testing or record drawings as determined by the responsible registered design professional of record and approved by the Building Official.
  1. Horizontal wood diaphragms. Existing horizontal wood diaphragms that require analysis under Subsection 18.70.050.J shall be permitted to use Table A-23-C of [Chapter 18.68](#) this title for their allowable values.

2. Wood structural panel shear walls.
  - a. Allowable nail slip values. When the required drift calculations of Subsection 18.70.050.K.2.a rely on the lower slip values for common nails or surfaced dry lumber, their use in construction shall be verified by exposure. The use of box nails and unseasoned lumber may be assumed without exposure. The verification of surfaced dry lumber shall be by identification conforming to Chapter 23 of the California Building Code adopted in Chapter 18.40.
  - b. Reduction for clipped nail heads. When exposed nails do not meet the nominal head sizes required for hand-driven nails in Chapter 23 of the California Building Code adopted in Chapter 18.40, the allowable shear capacity for wood structural panel shear walls shall be proportionately reduced. The reduction shall be a percentage of the reduction in the nail head area below the required nail head area including tolerances.
  - c. Plywood panel construction. When verification of the existing plywood materials is by use of record drawings alone, the panel construction for plywood shall be assumed to be of three (3) plies.
  - d. Framing members of other species. When verification of the existing wood material is by use of record drawings, the allowable shear capacity shall be multiplied by the reduction factor of 0.82 for buildings built on or after 1960. Buildings built before this period shall use the reduction factor 0.65. When verification of the existing wood material is by identification in conformance to Chapter 23 of the California Building Code adopted in Chapter 18.40, the allowable shear capacity shall be determined in accordance with Subsection 18.70.050.K.2.c.
3. Lumber. When the existing dimensioned lumber is not identified in conformance to Chapter 23 of the California Building Code adopted in Chapter 18.40, the allowable stresses shall be permitted for the structural elements specified below.

Posts and Beams	Douglas Fir-larch No. 1
Joists and Rafters	Douglas Fir-larch No. 2
Studs, Blocking	Hem Fir Stud

4. Structural steel. All existing structural steel shall be permitted to use the allowable stresses for Grade A36. Existing pipe or tube columns shall be assumed to be of minimum wall thickness unless verified by testing or exposure.
5. Strength of concrete. All existing concrete footings shall be permitted to use the allowable stresses for plain concrete with a compressive strength of two thousand (2,000) psi. The strength of existing concrete with a record compressive strength greater than two thousand (2,000) psi shall be verified



by testing, record drawings or Department records.

6. Existing sill plate anchorage. Existing cast-in-place anchor bolts shall be permitted to use the allowable service loads for bolts with proper embedment when used for shear resistance to lateral loads.

( ORD-16-0026 § 1(Exh. A), 2016)

#### 18.70.070 - Required information on construction documents.

- A. General. The construction documents shall show all necessary dimensions and materials for plan review and construction and shall accurately reflect the results of the engineering investigation and design.
- B. Existing construction. The construction documents shall show the existing diaphragm and shear wall sheathing and framing materials, fastener type and spacing, diaphragm and shear wall connections, continuity ties, and collector elements. The plans shall also show the portion of the existing materials that needs verification during construction.
- C. New construction.
  1. Foundation plan elements. The foundation plan shall include the size, type, location and spacing of all anchor bolts with the required depth of embedment, edge and end distance; the location and size of all columns for braced or moment frames; referenced details for the connection of braced or moment frames to their footing; and referenced sections for any grade beams and footings.
  2. Framing plan elements. The framing plan shall include the width, location and material of shear walls; the width, location and material of frames; references on details for the column-to-beam connectors, beam-to-wall connections, and shear transfers at floor and roof diaphragms; and the required nailing and length for wall top plate splices.
  3. Shear wall schedule, notes and details. Shear walls shall have a referenced schedule on the construction documents that includes the correct shear wall capacity in pounds per foot; the required fastener type, length, gauge and head size; and a complete specification for the sheathing material and its thickness. The schedule shall also show the required location of three-inch (3") nominal or two (2) two-inch (2") nominal edge members; the spacing of shear transfer elements, such as framing anchors or added sill plate nails; the required hold down with its bolt, screw or nail sizes; and the dimensions, lumber grade and species of the attached framing member.

Notes shall show required edge distance for fasteners on structural wood panels and framing members; required flush nailing at the plywood surface; limits of mechanical penetrations; and the sill plate material assumed in the design. The limits of mechanical penetrations shall also be detailed showing the maximum notching and drilled hole sizes.

4. General notes. General notes shall show the requirements for material testing, special inspection, structural observation and the proper installation of newly added materials.
- 5.

Registered design professional of record's statement. The responsible registered design professional of record shall provide the following statements on the approved construction documents:

- a. "I am responsible for designing this building's seismic strengthening in compliance with the minimum seismic resistance standards of Chapter 18.70 of the Long Beach Municipal Code."

and when applicable:

- b. "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 of the Long Beach Municipal Code."

( ORD-16-0026 § 1(Exh. A), 2016)