

## **City of Berkeley Soft Story Seismic Engineering Evaluation Report Framework**

### **APPLICABILITY**

The following is a framework for the detailed seismic engineering evaluation report required by section 19.39.070 of the Berkeley Municipal Code. This report is required for all existing wood frame multi-unit residential buildings or portions thereof that contain five or more dwelling units, as defined in the City of Berkeley zoning ordinance, and that were designed under a building permit applied for before the adoption of the 1997 Uniform Building Code, where either a soft, weak, or open front wall line occurs supporting one or more levels above. Refer to the code for complete applicability requirements.

### **REQUEST TO BE REMOVED FROM INVENTORY**

Section 19.39.050C and D outline the procedure for having a building removed from the Inventory. Some supporting information must accompany all requests for removal in order to be fairly evaluated. Complete compliance with the below framework is not required for a removal request. However, the request should contain the information requested in parts 1.1 and 1.2, a description of the structure's vertical and lateral systems, as well as a statement of reason for removal. Additional information may be requested by the Building Official.

Unreinforced Masonry Buildings (URM) that contain some wood framed elements are not considered subject to this ordinance. URM buildings are to be retrofitted as required by chapter 19.38 of the Berkeley Municipal Code. If the building is a URM, submit a request with the basic information listed in the above paragraph and state that the building is a URM and should therefore be removed from the Inventory.

Wood framed buildings can be removed from the Inventory if found to not have a soft, weak, or open front wall line. Refer to section 2.1.1. Evaluation report must be submitted in accordance with the below framework.

### **GENERAL SUBMISSION REQUIREMENTS**

The report is to follow the subsequent framework and be submitted in both electronic PDF and printed formats. The PDF software is Adobe Acrobat and is available for free online at [www.adobe.com](http://www.adobe.com). The electronic copy of the report as

well as the required electronic plans indicated within the framework shall be submitted on a CD. Paper copies of the original plans shall be submitted on minimum 11x17 size paper. Plans shall be to scale and legible.

## **1. INTRODUCTION**

### **1.1. Building Data**

This section of the report shall include all of the pertinent information to describe the building. At a minimum it is to contain the address, type of construction, type of occupancy, number of stories, number of units, the square footage given based on each different use and total, the date of original construction and the date of any subsequent additions or substantial structural alterations of the building. This section shall also mention whether or not the building has a non-wood podium base at the first level. When available include copies of building permits and plans from city records available at Permit Service Center. Include an overall photo of the building.

### **1.2. Investigators**

This section of the report shall include all of the pertinent information to describe the owner and the engineer conducting the investigation. At a minimum it is to contain the name, address, phone, fax, and email of the investigating engineer and the owner. It shall also contain the registration number and expiration date of the investigating engineer.

### **1.3. Investigation**

This section of the report shall include all of the pertinent information to describe the extent of the investigation performed on the building. At a minimum it is to contain the date of the site visit and a list of the reviewed documents at the time of the investigation. Furthermore the condition of the building is to be described as well as any noticed major distress to the structure or finishes.

Please note that a list of original construction plans may be available through the City of Berkeley. If original plans are available, through the city or otherwise, they are to be attached to this report in printed and PDF format. A site visit shall still be performed and any structural deviations noted during the site visit shall be stated in this report.

If original plans are not available, destructive or non-destructive investigation shall be performed on the perceived soft, weak, or open front wall line level to determine the sheathing, fasteners, fastener spacing and holdowns or steel frame sizes and connections at all principle lines of lateral resistance. Additionally, at any lateral resisting element with more than four kips of calculated uplift (working stress level loading) investigation shall be done to identify the foundation under such element. In lieu of investigation of the

foundation it can be assumed that the foundation will require retrofit and such retrofit shall be noted in Section 3. In the case of multiple repetitive living units a representative sample may be used. In no case shall the sample of living units be less than 10%. Only those wall lines that are investigated may be considered part of the lateral system during the evaluation of the structure. The extent of the investigation performed shall be described in this section. Provide complete documentation, including photos, of the investigation performed in Appendix B of this report.

In an effort to limit the cost and invasiveness of the required investigation if plans are unavailable, additional investigation to determine the lateral systems of the floors other than the soft, weak, or open front wall line story in question need not be done. The lateral system of the soft, weak, or open front wall line story in question need not be compared to the other levels and section 2.1.1 of the evaluation may be skipped. Proceed directly to section 2.1.2.

#### 1.4. Structure

This section of the report shall include all of the pertinent information to describe the construction of the building. At a minimum it is to contain a description of the vertical and lateral framing systems, including any deviations from the available plans noticed during the site investigation. Include a description of the floor and roof framing systems with approximate weights. For example:

Typical Floor Weight:		Typical Roof Weight:	
Floor Finish	1.0psf	Concrete Tile	9.0psf
1 1/2" Lt. Wt. Concrete	13.8psf	1/2" Plywood	1.5psf
3/4" Plywood	2.3psf	Wood Framing	3.0psf
Wood Framing	3.0psf	Insulation	1.0psf
Insulation	1.0psf	Ceiling Framing	1.5psf
Gypsum Ceiling	2.2psf	Gypsum Ceiling	2.2psf
Misc.	<u>0.7psf</u>	Misc.	<u>1.3psf</u>
	Total Floor DL - 24.0psf		Total Roof DL - 19.5psf
Wall Weights over Floor Area	<u>15psf</u>	Wall Weights over Roof Area	<u>7.5psf</u>
	Total Floor Seismic DL - 39.0psf		Total Roof Seismic DL - 27.0psf

Clearly describe the lateral framing system of the soft, weak, or open front wall line in question and include the differences between that floor and the floors above, unless not required to per section 1.3.

Additionally if original plans are not available, destructive or non-destructive investigation shall be provided at a minimum of one location of one floor and the roof to determine the framing systems. Include the documentation of this investigation in Appendix B. Also, provide to scale sketches, in printed and PDF format, of the plan of the soft, weak, or open front wall line story in

question, including details if deemed necessary, showing the information found during investigation. At a minimum these sketches should include the lateral system of the soft, weak, or open front wall line story including any information regarding the sheathing, fasteners, fastener spacing, holdowns, steel frames, frame connections, and foundation information found during investigation. Also include a schematic floor plan of the level above and any other level that varies significantly from that level.

**2. EVALUATION**

**2.1. Wood Framed Portion of the Structure**

**2.1.1. Basic Structural Checklist**

All wood framed structures shall be evaluated for story strength and stiffness. Table A4-A of the 2003 IEBC Chapter A4 shall be completed based upon that evaluation. The evaluation shall be made based on each line of resistance considered independently. Supporting calculations are to be included in Appendix A. If all items, excluding “Deterioration of Wood”, are found to be compliant, then the structure does not have a soft timber framed story and the remainder of section 2.1 can be skipped.

**BASIC STRUCTURAL CHECKLIST**

C	NC	N/A	TABLE A4-A – BUILDING SYSTEM
			LOAD PATH: The structure shall contain one complete load path for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation.
			WEAK STORY: The strength of the lateral-force-resisting system in any story shall not be less than 80 percent of the strength in an adjacent story above or below.
			SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the stiffness in an adjacent story above or below, or less than 80 percent of the average stiffness of the three stories above or below.
			VERTICAL DISCONTINUITIES: All vertical elements in the lateral-force-resisting systems shall be continuous to the foundation.
			DETERIORATION OF WOOD: There shall be no signs of decay, shrinkage, splitting, fire damage or sagging in any of the wood members, and none of the metal accessories shall be deteriorated, broken or loose.
			WALL ANCHORAGE: Exterior concrete or masonry walls shall be anchored for out-of-plane forces at each diaphragm level with steel anchors or straps that are developed into the diaphragm. Straps shall be minimum 7 gage.

**2.1.2. Supplemental Structural Checklists**

If the building is found to have one or more items of Table A4-A noncompliant, then complete the following supplemental structural checklists: Tables A4-B, A4-C, and A4-D. These tables are not meant to

be a checklist of items to be strengthened, but a checklist of items to be considered when determining the strengthening plan for the structure per Section 3.1.

**C NC N/A TABLE A4-B – LATERAL-FORCE-RESISTING SYSTEM**

			REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to two.
			SHEAR STRESS CHECK: The shear stress in the shear walls shall be less than the following values: 5-Ply structural panel sheathing: 400 plf (5.8 kN/m) 3-Ply structural panel and diagonal sheathing: 200 plf (2.9 kN/m) Straight sheathing: 80 plf ( 1.2 kN/m)
			STUCCO (EXTERIOR PLASTER) SHEAR WALLS: Multistory buildings shall not rely on exterior stucco walls as the primary lateral-force-resisting system.
			GYPSUM WALLBOARD OR PLASTER SHEAR WALLS: Interior plaster or gypsum wallboard shall not be used as shear walls on buildings over one story in height.
			NARROW WOOD SHEAR WALLS: Narrow wood shear walls with an aspect ratio greater than 2:1 for life safety shall not be used to resist lateral forces developed in the building.
			WALLS CONNECTED THROUGH FLOORS: Shear walls shall have interconnection between stories to transfer overturning and shear forces through the floor.
			HILLSIDE SITE: For a sloping site greater than 1 vertical in 3 horizontal and with greater than one-half story above the base, the base shear in the downhill direction, including forces from the base-level diaphragm, shall be resisted through primary anchors from diaphragm struts or collectors provided in the base-level framing to the foundation.
			CRIPPLE WALLS: All cripple walls below first-floor-level shear walls shall be braced to the foundation with shear elements.
			OPENINGS: Walls with garage doors or other large openings shall be braced with plywood shear walls or shall be supported by adjacent construction through substantial positive ties.
			HOLD-DOWN ANCHORS: All walls shall have properly constructed hold-down anchors.

**C NC N/A TABLE A4-C – CONNECTIONS**

			WOOD POSTS: There shall be a positive connection of wood posts to the foundation.
			WOOD SILLS: All wood sills shall be bolted to the foundation.
			GIRDER/COLUMN CONNECTION: There shall be a positive connection between the girder and the column support.
			WOOD SILL BOLTS: Sill bolts shall be spaced at 6 feet or less, with proper edge distance provided for wood and concrete.

**C NC N/A TABLE A4-D – DIAPHRAGMS**

			DIAPHRAGM CONTINUITY: The diaphragms shall not be composed of split-level floors. In wood buildings, the diaphragms shall not have expansion joints.
			ROOF CHORD CONTINUITY: All chord elements shall be continuous, regardless of changes in roof elevation.
			STRAIGHT SHEATHING: All straight-sheathed diaphragms shall have aspect ratios less than 2:1.
			SPANS: All wood diaphragms with spans greater than 24 feet shall consist of wood structural panels or diagonal sheathing. Wood commercial and industrial buildings may have rod-braced systems.
			UNBLOCKED DIAPHRAGMS: All unblocked wood-structural-panel diaphragms shall have horizontal spans less than 40 feet and shall have aspect ratios less than or equal to 4:1.

### **2.1.3. Analyze the Wood Portion of Structure**

If the building is found to have one or more items of Table A4-A noncompliant, then provide a lateral analysis of the wood portion of the structure using section A403.3 of the 2003 IEBC load levels and all subsequent provisions. Each orthogonal direction can be considered independently of the other. A structure can meet the Table A4-A requirements in one direction and not the other. This would require further analysis and possibly repair in the non compliant direction only. Similarly each line of resistance should be considered independently of each other and soft, weak, or open front wall lines should be reported.

If original plans are available provide an analysis of the lateral resisting system shown on the plans on all levels (excluding the top level) to determine the elements of the lateral force resisting system that are deficient and require strengthening. Refer to Table A4-E of the 2003 IEBC for allowable values for existing materials.

If original plans are not available, provide an analysis of the lateral resisting elements found during investigation and make reasonable engineering assumptions for the levels above. Take into account the overturning effects of the levels above. State all assumptions clearly.

For purposes of comparing the stiffness of adjacent stories, any reasonable material and fixity assumptions are acceptable, as long as similar material and fixity assumptions are made for the two stories being compared.

Compare the aggregate strength of all walls in each principal direction with the required lateral loads specified in Chapter A4. Present this as a percentage of required strength in each direction. Although this figure is not used in determining if a structure is compliant, it does provide a single value that describes the resilience of the structure.

The prescriptive measures in section A405 of the 2003 IEBC may be used in lieu of the above described analysis to determine the strengthening program if the building meets the requirements of exception 2 of 2003 IEBC section A403.1. The report must still be completed as described above, including plans or sketches. Present the results of the prescriptive measures as the strengthening plan in section 3.1.

### **2.2. Podium Base (where applicable)**

If the wood framed structure is constructed over a concrete or structural steel podium structure (typically a parking garage) then, in addition to the previous sections, this section must be completed. If the wood framed structure is located directly on grade this section can be omitted.

### **2.2.1. Basic Podium Check**

If the podium is laterally supported by concrete shear walls, then check the lateral system for the exception of section A403.12 of the City of Berkeley Amendments to Chapter A4 of the 2003 IEBC. If the podium is support by concrete shear walls that do not meet the exception or if it is supported by another lateral system, then an analysis is required per the following section.

### **2.2.2. Analyze the Podium**

Provide a lateral analysis of the podium using section A403.12 of the City of Berkeley Amendments to Chapter A4 of the 2003 IEBC. If original plans are available provide an analysis of the lateral resisting system shown on the plans to determine the elements of the lateral force resisting system that are deficient and require strengthening.

If original plans are not available, destructive or non-destructive investigation to determine the reinforcing, strength of materials, and sizes is required. All elements considered in the analysis shall be verified or appropriately extrapolated from the investigation data obtained. Include the documentation of destructive and material investigation in Appendix B. Reasonable assumptions shall be made as to the foundation configurations and their impact on the strength and stiffness of the lateral system they support.

## **3. STRENGTHENING**

### **3.1. Strengthening Required**

If the structure does not meet the requirements of section 2.1.1 and/or 2.2.1 and some deficiencies are found based upon the evaluation of section 2.1.3 and/or 2.2.2, create a strengthening program to remedy the deficiencies determined in section 2.1.3 and/or 2.2.2. At a minimum this section is to contain a description of the proposed strengthening of the lateral resisting system and a plan (1/8 or 1/4 inch per foot), in PDF format, to show the strengthening program. This plan shall include any new shear wall types and locations, new holdowns and miscellaneous hardware, new steel frames, new framing, existing bearing walls and any other information required to show the strengthening program. Details and general notes are not required for this report. If the structure includes a podium that is in need of strengthening, include the existing slab thickness, the column locations and size, the bearing/shear walls, new walls or frames, and any other information required to show the strengthening program.

Additionally, report the approximate quantity of new or re-nailed plywood (to the nearest 50 square foot increment), the amount of new holdowns and miscellaneous hardware, the size and length of members of new steel frames, or other similar information for other repairs that are to be added based upon the strengthening program.

#### **4. CONCLUSION**

##### **4.1. Conclusion**

This section of the report shall include a brief summary of the building description, the investigation performed, and the strengthening that would be required to eliminate the soft, weak, or open front wall line concern.

If the requirements of section 2.1.1 are met and/or the requirements of section 2.2.1 are met (or the podium is found to have no deficiencies based upon section 2.2.2), then the conclusion should include a request that the building be removed from the City of Berkeley Inventory of soft, weak, or open front wall line structures.

#### **ADDITIONAL RESOURCES**

*ICBO (1997). 1997 Uniform Building Code, International Conference of Building Officials, Whittier, CA.*

*ICC (2002). 2003 International Building Code, International Code Council, Country Club Hills, IL.*

*ICC (2003). 2003 International Existing Building Code, International Code Council, Country Club Hills, IL.*

*ICC (2005). 2003 International Existing Building Code Commentary, International Code Council, Country Club Hills, IL.*