kpff Consulting Engineers

FIRE STATION / BLOCK A&N BUILDING

ASCE 31 SEISMIC EVALUATION

AUGUST 26, 2014

KPFF PROJECT NO. 214463

PREPARED BY:

KPFF CONSULTING ENGINEERS
111 SW FIFTH AVENUE, SUITE 2500
PORTLAND, OR 97204

SUBMITTED TO:

PORTLAND DEVELOPMENT COMMISSION
222 NW 5TH AVENUE
PORTLAND, OR 97209

STRUCTURAL
REGISTERED PROFESSIONAL ENGINEER
78836PE
OREGON
MARCH 13, 2007
MARK W. TOBIN
EXPIRES: 6-30-16

TABLE OF CONTENTS

This report is to summarize the findings of our seismic evaluation of the Fire Station / Block A&N Building. The evaluation was performed using the procedures of ASCE 31 "Seismic Evaluation of Existing Buildings." Please note that this evaluation only relates to the seismic performance of the structure. It does not address issues related to revising gravity framing or architectural layout.

SCOPE AND INTENT

KPFF Consulting Engineers was contracted to perform a seismic evaluation of the Fire Station / Block A&N Building, located at the corner of NW 3rd Avenue and NW Glisan Street in Portland, Oregon. This evaluation is based upon the procedures and guidelines of ASCE 31-03 "Seismic Evaluation of Existing Buildings." The intent is to determine if the structure meets the requirements for the Life Safety performance level, as defined by ASCE 31. Our scope was limited to evaluating the primary structure and therefore does not include the check lists for geologic hazards and non-structural hazards.

SITE AND BUILDING DATA

The Fire Station / Block A&N Building is an existing Unreinforced Masonry (URM) building located at the intersection of NW 3rd Avenue and NW Glisan Street in Portland, Oregon. We understand that the building was originally constructed in 1913 and was used as a fire station. The building is rectangular in plan, measuring approximately 85 feet in the east/west direction by 38 feet in the north/south direction. It consists of two stories above ground and a partial basement, resulting in approximately 7,200 total square feet (including the basement).

The ground floor suspended slab (over the basement) consists of a one-way concrete slab and concrete beams supported by concrete columns. The basement walls are also constructed of concrete.

The second floor framing consists of two rows of cast-iron columns supporting steel beams that run in the east/west direction. Wood joists with 1x wood sheathing span in the north/south direction between the exterior URM bearing walls and the interior steel beams.

The roof framing consists of large wood trusses that clear span in the north/south direction between the exterior URM bearing walls. Wood purlins with 1x wood sheathing span in the east/west direction between the exterior URM bearing walls and the interior wood trusses.

While not observed, it is assumed that the foundations consist of conventional concrete spread and strip footings.

The lateral force resisting system for the building consists of straight-sheathed wood diaphragms that transfer their seismic load to the perimeter URM walls (which act as shear walls). It should be noted that significant deterioration of the building, including large settlement cracks, deterioration of the mortar, missing/broken bricks, spalled concrete, etc., were observed during our site visit.

LIST OF ASSUMPTIONS USED FOR ANALYSIS

A geotechnical investigation was not performed for this evaluation. However, based on our experience with other buildings in the vicinity, we have assumed that the site would be classified as Site Class D. Due to its proximity to the river, it is possible that there is a risk of liquefaction at the site. We would recommend consulting a geotechnical engineer for additional information on this potential risk. The following ground motions were used for the analysis.

Parameter	Value	Comments
S_1	0.343 g	Spectral response acceleration parameter at one-second period for the Maximum Considered Earthquake (MCE).
S_S	1.045 g	Short period (0.2 second) response acceleration parameter for the Maximum Considered Earthquake (MCE).
F_v	1.71	Modification factor for S_1 to account for site class. Refer to Table 3-5.
F_a	1.08	Modification factor for S_S to account for site class. Refer to Table 3-6
S_{D1}	0.39 g	Design spectral response acceleration parameter at one-second period. $S_{D1} = (2/3)\ F_v\ S_1$
S_{DS}	0.75 g	Design short period (0.2 second) spectral response acceleration parameter. $S_{DS} = (2/3)\ F_a\ S_S$
T	0.25 s	Building period defined in Section 3.5.2.4.
S_a	0.75 g	Response spectral acceleration parameter. $S_a = S_{D1} / T$ but S_a need not exceed S_{DS}.

The Level of Seismicity for the structure is therefore considered to be "High" as defined by Section 2.5 of ASCE 31.

Existing drawings for the structure were not available for review. We therefore relied upon our site visit in conjunction with additional information and materials provided by the owner as the basis for this evaluation. It should also be noted that a material testing program was not performed for this evaluation.

FINDINGS

The building was evaluated in accordance with ASCE 31 "Seismic Evaluation of Existing Buildings. Our evaluation was limited to the Tier 1 procedure. However, given the nature and condition of the building, it is very unlikely that a more detailed Tier 2 evaluation would yield different results.

The building in its existing condition does not meet the requirements for the Life Safety performance level as defined by ASCE 31. The Basic Structural Checklist and the Supplemental Structural Checklist from ASCE 31 that denote the building's seismic deficiencies are included as an appendix to this letter. In general terms, the deficiencies consist of the following:

- Deterioration of Wood and Masonry Elements – The brick walls and wood framing are significantly deteriorated in many areas. This can compromise their ability to resist both gravity and lateral loads.

- Shear Walls Overstressed – There is an inadequate amount of shear walls in the building to safely resist the prescribed seismic forces.

- Connections of Floor/Roof Diaphragms to URM Walls – The floor and roof diaphragms lack a positive connection to the URM walls. In a seismic event, this can lead to the walls separating from the diaphragm and can result in a partial collapse of the structure.

- Out-Of-Plane Stability of URM Walls – The URM walls do not have sufficient strength to span vertically between the diaphragms. In a seismic event, this could lead to partial collapse of the URM walls and the floor/roof framing that the wall is supporting.

- Diaphragms Overstressed – The diaphragms lack adequate strength to tie the building together and distribute seismic loads to the URM shear walls.

- Beams and Trusses Lack Secondary Supports – The steel beams and wood roof trusses lack a secondary gravity support to prevent a collapse in the event that a portion of the URM wall fails during a seismic event.

In our opinion, the building would require significant seismic and structural upgrades to mitigate the above deficiencies and meet the Life Safety performance level. Based on our experience with similar buildings, we would estimate that the construction costs for the required seismic upgrade work would be approximately $45 to $50 per square foot with an additional allowance of $150,000 for re-pointing and repairing the masonry. If you have any questions or comments, please call me.

Sincerely,

Mark Tobin, P.E., S.E.
Associate

kpff Consulting Engineers

APPENDIX A

ASCE 31-03 CHECKLISTS

SEISMIC EVALUATION (PER ASCE-31)
BASIC STRUCTURAL
BUILDING TYPE URM: UNREINFORCED MASONRY BEARING WALLS WITH FLEXIBLE DIAPHRAGMS
BUILDING NAME: Fire Station / Block A&N Building
BUILDING LOCATION: NW 3rd Avenue & NW Glisan St., Portland, OR

Evaluation Statement	Evaluation (1)
BUILDING SYSTEM	
LOAD PATH: The structure shall contain a minimum of one complete load path for Life Safety and Immediate Occupancy for seismic force effects from any horizontal direction that serves to transfer the inertial forces from the mass to the foundation. (Tier 2: sec. 4.3.1.1)	C
ADJACENT BUILDINGS: The clear distance between the building being evaluated and any adjacent building shall be greater than 4 percent of the height of the shorter building for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.1.2)	C
MEZZANINES: Interior mezzanine levels shall be braced independently from the main structure, or shall be anchored to the lateral-force-resisting elements of the main structure. (Tier 2: Sec. 4.3.1.3)	N/A
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 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.1)	C
SOFT STORY: The stiffness of the lateral-force-resisting system in any story shall not be less than 70 percent of the lateral-force-resisting system stiffness in an adjacent story above or below, or less than 80 percent of the average lateral-force-resisting system stiffness of the three stories above or below for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.3.2.2)	C
GEOMETRY: There shall be no changes in horizontal dimension of the lateral-force-resisting system of more than 30 percent in a story relative to adjacent stories for Life Safety and Immediate Occupancy, excluding one-story penthouses and mezzanines. (Tier 2: Sec. 4.3.2.3)	C
VERTICAL DISCONTINUITIES: All vertical elements in the later-force-resisting systems shall be continuous to the foundation. (Tier 2: Sec. 4.3.2.4)	C

SEISMIC EVALUATION (PER ASCE-31)
BASIC STRUCTURAL
BUILDING TYPE URM: UNREINFORCED MASONRY BEARING WALLS WITH FLEXIBLE DIAPHRAGMS
BUILDING NAME: Fire Station / Block A&N Building
BUILDING LOCATION: NW 3rd Avenue & NW Glisan St., Portland, OR

Evaluation Statement	Evaluation (1)
MASS: There shall be no change in effective mass more than 50 percent from one story to the next for Life Safety and Immediate Occupancy. Light roofs, penthouses, and mezzanines need not be considered. (Tier 2: Sec. 4.3.2.5)	C
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 connection hardware shall be deteriorated, broken, or loose. (Tier 2: Sec. 4.3.3.1)	NC
MASONRY UNITS: There shall be no visible deterioration of masonry units. (Tier 2: Sec. 4.3.3.7)	NC
MASONRY JOINTS: The mortar shall not be easily scraped away from the joints by hand with a metal tool, and there shall be no areas of eroded mortar. (Tier 2: Sec. 4.3.3.8)	NC
UNREINFORCED MASONRY WALL CRACKS: There shall be no existing diagonal cracks in wall elements greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy or out-of-plane offsets in the bed joint greater than 1/8 inch for Life Safety and 1/16 inch for Immediate Occupancy, and shall not form an X pattern. (Tier 2: Sec. 4.3.3.11)	NC
LATERAL-FORCE-RESISTING SYSTEM	
REDUNDANCY: The number of lines of shear walls in each principal direction shall be greater than or equal to 2 for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.1.1)	C
SHEAR STRESS CHECK: The shear stress in the unreinforced masonry shear walls, calculated using the Quick Check procedure of Section 3.5.3.3, shall be less than 30 psi for clay units and 70 psi for concrete units for Life Safety and Immediate Occupancy. (Tier 2: Sec. 4.4.2.5.1)	NC

SEISMIC EVALUATION (PER ASCE-31)
BASIC STRUCTURAL
BUILDING TYPE URM: UNREINFORCED MASONRY BEARING WALLS WITH FLEXIBLE DIAPHRAGMS
BUILDING NAME: Fire Station / Block A&N Building
BUILDING LOCATION: NW 3rd Avenue & NW Glisan St., Portland, OR

Evaluation Statement	Evaluation (1)
CONNECTIONS	
WALL ANCHORAGE: Exterior concrete or masonry walls that are dependent on the diaphragm for lateral support shall be anchored for out-of-plane forces at each diaphragm level with steel anchors, reinforcing dowels, or straps that are developed into the diaphragm. Connections shall have adequate strength to resist the connection force calculated in the Quick Check procedure of Section 3.5.3.7. (Tier 2: Sec. 4.6.1.1)	NC
WOOD LEDGERS: The connection between the wall panels and the diaphragm shall not induce cross-grain bending or tension in the wood ledgers. (Tier 2: Sec. 4.6.1.2)	N/A
TRANSFER TO SHEAR WALLS: Diaphragms shall be connected for transfer of loads to the shear walls for Life Safety and the connections shall be able to develop the lesser of the shear strength of the walls or diaphragms for Immediate Occupancy. (Tier 2: Sec. 4.6.2.1)	NC
GIRDER/COLUMN CONNECTION: There shall be a positive connection utilizing plates, connection hardware, or straps between the girder and the column support. (Tier 2: Sec. 4.6.4.1)	U

FOOTNOTES:
(1) C = Compliant; NC = Non-compliant; N/A = Not Applicable; U = Unable to Determine or Not Investigated
(2) Quick Check refers to ASCE-31 Procedures

SEISMIC EVALUATION (PER ASCE-31)
SUPPLEMENTAL STRUCTURAL
BUILDING TYPE URM: UNREINFORCED MASONRY BEARING WALLS WITH FLEXIBLE DIAPHRAGMS
BUILDING NAME: Fire Station / Block A&N Building
BUILDING LOCATION: NW 3rd Avenue & NW Glisan St., Portland, OR

Evaluation Statement	Evaluation (1)
LATERAL-FORCE-RESISTING SYSTEM	
PROPORTIONS: The height-to-thickness ratio of the shear walls at each story shall be less than the following for Life Safety and Immediate Occupancy (Tier 2: Sec. 4.4.2.5.2): Top story of multi-story building: 9 First story of multi-story building: 15 All other conditions: 13	NC
MASONRY LAY-UP: Filled collar joints of multi-wythe masonry walls shall have negligible voids. (Tier 2: Sec. 4.4.2.5.3)	NC
DIAPHRAGMS	
CROSS TIES: There shall be continuous cross ties between diaphragm chords. (Tier 2: Sec. 4.5.1.2)	NC
OPENINGS AT SHEAR WALLS: Diaphragm openings immediately adjacent to the shear walls shall be less than 25 percent of the wall length for Life Safety and 15 percent of the wall length for Immediate Occupancy. (Tier 2: Sec. 4.5.1.4)	C
OPENINGS AT EXTERIOR MASONRY SHEAR WALLS: Diaphragm openings immediately adjacent to exterior masonry shear walls shall not be greater than 8 feet long for Life Safety and 4 feet long for Immediate Occupancy. (Tier 2: Sec. 4.5.1.6)	C
PLAN IRREGULARITIES: There shall be tensile capacity to develop the strength of the diaphragm at re-entrant corners or other locations of plan irregularities. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.7)	N/A

SEISMIC EVALUATION (PER ASCE-31)
SUPPLEMENTAL STRUCTURAL
BUILDING TYPE URM: UNREINFORCED MASONRY BEARING WALLS WITH FLEXIBLE DIAPHRAGMS
BUILDING NAME: Fire Station / Block A&N Building
BUILDING LOCATION: NW 3rd Avenue & NW Glisan St., Portland, OR

Evaluation Statement	Evaluation (1)
DIAPHRAGM REINFORCEMENT AT OPENINGS: There shall be reinforcing around all diaphragm openings larger than 50 percent of the building width in either major plan dimension. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.1.8)	N/A
STRAIGHT SHEATHING: All straight sheathed diaphragms shall have aspect ratios less than 2-to-1 for Life Safety and 1-to-1 for Immediate Occupancy in the direction being considered. (Tier 2: Sec. 4.5.2.1)	NC
SPANS: All wood diaphragms with spans greater than 24 feet for Life Safety and 12 feet for Immediate Occupancy shall consist of wood structural panels or diagonal sheathing. (Tier 2: Sec. 4.5.2.2)	NC
UNBLOCKED DIAPHRAGMS: All diagonally sheathed or unblocked wood structural panel diaphragms shall have horizontal spans less than 40 feet for Life Safety and 30 feet for Immediate Occupancy, and shall have aspect ratios less than or equal 4-to-1 for Life Safety and 3-to-1 for Immediate Occupancy. (Tier 2: Sec. 4.5.2.3)	N/A
NON-CONCRETE FILLED DIAPHRAGMS: Untopped metal deck diaphragms or metal deck diaphragms with fill other than concrete shall consist of horizontal spans of less than 40 feet and shall have span/depth ratios less than 4-to-1. This statement shall apply to the Immediate Occupancy Performance Level only. (Tier 2: Sec. 4.5.3.1)	N/A
OTHER DIAPHRAGMS: The diaphragm shall not consist of a system other than wood, metal deck, concrete, or horizontal bracing. (Tier 2: Sec. 4.5.7.1)	C

SEISMIC EVALUATION (PER ASCE-31)
SUPPLEMENTAL STRUCTURAL
BUILDING TYPE URM: UNREINFORCED MASONRY BEARING WALLS WITH FLEXIBLE DIAPHRAGMS
BUILDING NAME: Fire Station / Block A&N Building
BUILDING LOCATION: NW 3rd Avenue & NW Glisan St., Portland, OR

Evaluation Statement	Evaluation (1)
CONNECTIONS	
STIFFNESS OF WALL ANCHORS: Anchors of concrete or masonry walls to wood structural elements shall be installed taut and shall be stiff enough to limit the relative movement between the wall and the diaphragm to no greater than 1/8 inch prior to engagement of the anchors. (Tier 2: Sec. 4.6.1.4)	NC
BEAM, GIRDER, AND TRUSS SUPPORTS: Beams, girders, and trusses supported by unreinforced masonry walls or pilasters shall have independent secondary columns for support of vertical loads. (Tier 2: Sec. 4.6.4.5)	NC

FOOTNOTES:
(1) C = Compliant; NC = Non-compliant; N/A = Not Applicable; U = Unable to Determine or Not Investigated
(2) Quick Check refers to ASCE-31 Procedures