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**Appendix A. FEMA 178 Checklists**
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**Appendix B. Site Visit Photographs**
HELEN GORDON CHILD DEVELOPMENT CENTER

FEMA-178 EVALUATION

I. INTRODUCTION

A. KPFF Consulting Engineers has been retained by Portland State University to perform a seismic evaluation, based on the FEMA-178 handbook, of the Helen Gordon Child Development Center located at 1609 SW 12th Avenue in Portland, Oregon.

Built in 1928, the Helen Gordon Child Development Center is an approximately 14,000-sf, three-story wood-framed building with unreinforced concrete walls. The building has an approximately 1,750-sf partial basement. The primary program space for the facility is on the first and second floors. The attic floor, originally a dormitory, is now used for light storage. The perimeter concrete walls are clad with brick veneer. The building has a pitched full-hip roof with a flat top. The pitched areas have slate roof tiles and the flat top has a composition roof.

Our evaluation of the Helen Gordon Child Development Center is based on the Federal Emergency Management Agency publication FEMA-178, "NEHRP Handbook for the Seismic Evaluation of Existing Buildings", published in June 1992. The FEMA-178 evaluation is intended to reveal deficiencies in the lateral force resisting system of existing buildings that could potentially pose a life-safety hazard in the event of a major earthquake. These deficiencies are outlined in this report, along with suggested seismic strengthening schemes.

The FEMA-178 evaluation does not specifically address compliance with the Uniform Building Code. In fact, the FEMA-178 evaluation criteria specifies seismic forces that are typically lower than those used for the design of new buildings under current code. According to FEMA-178, this concept is generally acceptable because it is believed that a building should be substantially below current code before triggering the requirement for costly seismic upgrade, and because a higher level of earthquake damage is acceptable in an existing building.

II. SCOPE OF SERVICES

A. The purpose of this report is to provide a preliminary evaluation of the lateral load resistance capacity of the structure relative to the criteria of FEMA-178. The review efforts consisted of the following:

1. Conducting a walk-through of the building to observe its general condition and to look for signs of distress in areas readily accessible to view.
2. Performing a preliminary lateral load analysis of the building structure according to FEMA-178 guidelines to check the adequacy of the existing lateral force resisting system.
B. FEMA-178 indicates that Oregon is in Seismic Zone 1. However, our review is based on the classification of Western Oregon as Zone 3, according to the 1997 edition of the Oregon Structural Specialty Code.

C. Observations, analysis, conclusions, and recommendations contained in this report reflect our best engineering judgment. Concealed problems with the construction of the buildings may exist that cannot be revealed through our review. KPFF therefore, can in no way guarantee the condition of the existing construction of the building and the building site.

D. No demolition was performed to confirm the type of structure. The evaluation relies on the accuracy of record drawings consisting of sheets 1 through 12, dated April 1928. If any further work to upgrade any or parts of this building is considered, verification of the building materials used should precede any design work.

III. BUILDING DESCRIPTION

A. Building Age

1. The building was constructed in 1928.

B. Building Configuration

1. The building has three stories, including an attic floor. There is approximately 14,000-sf of program space with an approximately 1,750-sf partial basement. The building footprint is approximately 5,200-sf.

2. There are three (3) small ancillary structures on the south and west sides of the building to provide covered outdoor play areas for children.

C. Structural System

1. Foundation

a. The basement has a 4" thick slab-on-grade.

b. Spread footings support the interior timber columns.

c. 12" thick by 16" wide strip footings support the exterior walls and the basement retaining walls.

d. The design allowable bearing pressure was assumed to be 3,000 psf in our analysis of the foundation.

2. Floors

a. The first and second floors and the attic are framed with 2x12 joists at 12" oc and sheathed with 1x tongue-and-groove diagonal sheathing.

b. The roof is framed with 2x8 joists at 16" oc and is also sheathed with 1x tongue-and-groove diagonal sheathing. The roof is a pitched, full-hip roof with a flat top. The pitched portion of the roof has slate tiles, while the flat center section has a composition roof.
3. Walls
   a. Building perimeter walls are 11' thick concrete at the basement, and 6" thick concrete
      above grade. The walls are clad with brick veneer above the ground level.
4. Lateral System
   a. The lateral force resisting system consists of concrete shear walls around the building
      perimeter. The wood-framed roof and floors act as diaphragms to transfer lateral forces to
      the shear walls.

IV. VISUAL OBSERVATIONS

A. Visual observations conducted on March 13, 2001 revealed the following:
   1. The building appeared to be constructed as detailed on the drawings.
   2. There are no signs of significant deterioration in any of the structural elements.
   3. There are no indications of significant settlement or excessive deflections.
   4. Some cracking was observed in basement walls.
   5. The retaining wall at the south end of the courtyard under the covered play area appeared to
      be bowed out slightly.
   6. The retaining wall at the southwest corner of the courtyard adjacent to the parking lot had
      significant brick deterioration (spalling) and vegetation was growing in and through the mortar
      joints above the parking lot grade.

V. SPECIFIC BUILDING DEFICIENCIES

A. The following list of deficiencies are the result of a structural review and site observations when
   compared with the checklists provided in the FEMA-178 Handbook. This list provided a series of
   true and false questions regarding the adequacy of the structure and its various components to
   resist seismic loading. The particular items noted below are a summary of the false responses to
   the questions. The numbers are provided as a reference in this report and do not relate to numbers
   in FEMA-178. In addition, FEMA-178 indicates Oregon is in seismic Zone 1. This is contrary to our
   latest understanding of Oregon's seismicity. Therefore, our review is based on Western Oregon
   being classified as Seismic Zone 3 according to the 2000 edition of the Oregon Structural Specialty
   Code.
Structural Items

1. The building shear walls fail the 'quick check' for shearing stress. A lateral analysis of the building determined that the maximum shear strength Demand to Capacity Ratio (DCR) is 2.7. The DCR for a given element must be less than 1 to be acceptable.

2. The area of reinforcing steel in the concrete shear walls was less than 0.0025 times the gross area of the wall in the horizontal and vertical directions. The 6" shear walls are unreinforced. FEMA 178 requires a 25 percent amplification of analysis forces when walls have a reinforcement ratio less than 0.0025. As stated in item 1 above, the lateral analysis of the building determined that the maximum shear strength DCR is 2.7.

3. The structural drawings do not indicate that there is edge reinforcement around all of the opening edges. Analysis of the lintels above the openings and the wall piers between the openings revealed that the walls have a maximum flexural strength DCR of 1.3.

4. The 1" nominal tongue-and-groove diagonal sheathing has insufficient shear capacity at all floors to resist FEMA-178 forces. At the roof, the diaphragm shear capacity DCR is 3.3. At the attic floor, the DCR is 4.9. Finally, at the second floor, the DCR is 5.4.

5. The details do not reveal a substantial connection between the concrete walls and the structural diaphragms. Continuity between the walls and diaphragms is critical to the stability of the building, especially for support of out-of-plane forces from the walls.

6. The details do not indicate that the perimeter walls are doweled to the foundation. Dowels between the walls and footings provide a mechanical connection that helps to transfer building lateral forces to the foundation.

7. The bearing pressure on the soil supporting shear wall footings appears to exceed the soil capacity when shear walls are subjected to FEMA-178 forces. Bearing pressure failure could increase building deflections under lateral forces.

Nonstructural Items

1. An unreinforced masonry chimney extends above the roof surface more than twice the least dimension of the chimney, presenting a possible falling hazard should the unreinforced masonry fail during an earthquake event.

2. Uniform Building Code masonry veneer detailing requirements are intended to help prevent masonry panel failure and resulting falling hazards from earthquake motion. We assume that there are insufficient ties between the veneer and the perimeter walls that could present a possible falling hazard during an earthquake event.

3. Storage cabinets, book shelves, filing cabinets, computers, and other items did not appear to be anchored to the structure to prevent falling or spilling of contents during an earthquake.
4. Pipes viewed in the basement were not braced for seismic forces. Unbraced pipes could rupture when they undergo swaying due to seismic forces.

VI. SEISMIC UPGRADE ITEMS

A. The following is a preliminary upgrade scheme that may address the deficiencies listed in the section above. We estimate that items listed below would range in cost between $9 and $12 per square foot based on a building program space of approximately 14,000-sf. This cost estimate does not include costs associated with removing and replacing finishes for the construction.

1. Add shotcrete walls from the basement to the roof with enough strength to support full building lateral forces. Connect existing walls to the new walls with epoxy-anchored dowel grids. Provide drag struts between walls with sufficient strength to transfer floor forces into the walls. Support overturning forces on the new walls by connection to the existing basement walls or with new strip footings, pin piles or helical anchors.

One benefit of adding reinforced concrete shear walls is that the force levels required by FEMA-178 for analysis and by the Uniform Building Code for design would be reduced from the forces used for analysis of the unreinforced concrete shear walls.

Adding shotcrete walls would require removal of interior finishes, demolition of portions of the floors to allow the walls to “pass through” the various structural levels, and a possible decrease in interior space in the vicinity of the walls.

2. Add plywood sheathing to the existing diagonal tongue-and-groove sheathing at the roof, attic and second floor if the existing framing is sufficient to carry the additional weight; strip existing sheathing and re-sheath with new plywood if the framing is not sufficient.

Adding sheathing would require removal and eventual replacement of existing floor finishes. In addition, the slate tile roof would need to be removed and replaced, as would the composition roof.

3. Anchor the existing walls to the second floor and attic diaphragms with Simpson-type straps that connect the purlins to the walls. Connect the straps to the concrete with all-thread bolts anchored to the wall with epoxy in pre-drilled holes. Reinforce floor girders across their end connections with Simpson-type strap anchors to provide continuous chords for floor and roof sub-diaphragms.

All anchorage and sub-diaphragm work would require removal and replacement of portions of the wall finishes, floor finishes and possibly lath and plaster finishes below the joists if work must be done from above.

4. Anchor existing masonry veneer to existing and new concrete with expansion anchor assemblies or helical repair anchors.

5. Provide bracing for the existing unreinforced masonry chimney, or strengthen the chimney with concrete.
6. Provide bracing, latches, anchors, etc. for interior components that may move, fall, or be knocked open during an earthquake event.

7. Provide bracing for pipes and equipment supported by the building frame.

VII. CONCLUSIONS

This building was evaluated to determine its lateral capacity to resist earthquake ground motions using FEMA-178. The building is classified as a concrete shear wall building, and has wood-framed floors and a wood-framed roof.

Based on this evaluation, the exterior shear walls and the floor and roof diaphragms appear to be inadequate to resist FEMA-178 lateral forces. In addition, the soil supporting the shear wall footings does not appear to have capacity to support shear wall overturning from FEMA-178 forces.

The floor and roof diaphragms were found to be the most overstressed elements in the lateral force resisting system under FEMA-178 forces. The maximum Demand-to-Capacity Ratio (DCR) for the diaphragm shear strength was 5.4. By comparison, the unreinforced concrete walls had a maximum DCR of 2.7.

A possible seismic strengthening scheme would focus on strengthening the walls and diaphragms. In addition, nonstructural components such as the unreinforced chimney and the brick veneer could be strengthened to mitigate potential failing hazards. We estimate that the cost for the structural components of the seismic strengthening would range between $9 and $12 per square foot based on a program space of 14,000-sf. Our estimate would not include removal of finishes for construction and replacement of finishes following construction, which would comprise a substantial part if not the majority of any seismic strengthening work.