PORTLAND STATE UNIVERSITY
SCIENCE TWO

PRELIMINARY
SEISMIC EVALUATION

Prepared for:
SRG Partnership, P.C.
Portland State University
Portland, Oregon

Prepared by:
DEGENKOLB ENGINEERS

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Reference: Portland State University, Science Two  
Preliminary Seismic Evaluation  
Portland, Oregon  
[Degenkolb Job Number 98502.00]

Dear Roz:

At your request, we have performed a preliminary evaluation of the Science Two building at Portland State University in Portland, Oregon, to determine its expected performance during a design basis earthquake. This letter-report serves to summarize our findings and includes a possible seismic strengthening scheme, a discussion of typical costs for seismic rehabilitation, and a discussion of the City of Portland requirements regarding the seismic upgrade of this facility. Also included are figures and photographs of the building in Appendix A, copies of the structural checklists in Appendix B, and project calculations in Appendix C.

Our work is based on the following:

1. A review of available architectural and structural design drawings for the original building, prepared by Campbell, Yost & Partners Architects, dated March 1969.

2. A site visit on December 18, 1998, to verify original construction details, perform a nonstructural survey, and investigate feasibility of proposed strengthening techniques.

Building Description

Science Two was constructed in 1970 and is located near the northwest corner of Portland State University in Portland, Oregon (see Figure 1). The building houses classrooms, offices, and laboratory spaces, and includes lab spaces on the first two floors for Department of Environmental Quality and Public Health Labs. The structure sits on a level site, and is bordered by SW Mill on the north and SW 10th on the east.
Science Two is four stories above grade, with two lower levels, and a mechanical floor level below grade. The building is rectangular in plan, and has dimensions of 280 feet by 146 feet at most of the levels. At the fourth and roof levels, the plan steps back to 208 feet by 146 feet in plan. Story heights are approximately 18 feet for the mechanical level, 12 feet for the two lower levels, and 13 feet and 9 inches for the remaining levels. When the building was constructed, the two lower levels were used for parking. These levels have since been converted to lab and office spaces.

The gravity load-resisting system consists primarily of precast and cast-in-place concrete elements. The roof consists of metal deck with gypsum concrete over rigid insulation board supported by open-web steel joists. The joists span to steel girders that frame to reinforced concrete bearing walls at the building centerline and at the cores. The floors above grade all consist of precast tee sections, with a three-inch reinforced topping slab spanning to cast-in-place and precast girders. When the lower levels were converted to lab space, an additional topping slab between one-half inch and six inches was added to level the floor that originally sloped for drainage. The girders span to concrete bearing walls at the building centerline and at the cores. At the east and west edges of each floor are one-way concrete slabs spanning between the precast girders and edge beams. There are eight stair and elevator cores in the building (four on both the east and west sides) that all consist of reinforced concrete bearing walls. Below the first level, reinforced concrete retaining walls extend to the mechanical level. The stair towers are founded on four-foot-thick concrete footings, and the centerline walls are founded on a seven-foot-thick strip footing. The foundation walls do not have a strip footing but span between adjacent wall footings. The mechanical level is a concrete slab-on-grade.

The lateral force-resisting system of the building consists of the metal deck diaphragm of the roof, reinforced concrete topping slabs of the floors, and reinforced concrete shear walls around the eight stair and elevator cores, as well as down the centerline of the building (see Figure 2). The core walls are eight inches thick at all levels. The walls in the east-west direction are mostly solid. The walls in the north-south direction have many openings for doorways and are also often separated from the diaphragm by openings. The centerline walls are eighteen inches thick at all levels. Below the first level, the perimeter retaining walls substantially increase the amount of shear wall in both directions (see Figure 3).
Performance Objective

In accordance with the requirements of the City of Portland for existing buildings, we have evaluated the Science Two building for a Life-Safety performance objective for the design earthquake. This objective is defined in FEMA 178, the National Earthquake Hazard Reduction Program (NEHRP) Handbook for the Evaluation of Existing Buildings, published by the Federal Emergency Management Agency. This performance objective is meant to ensure that a building will not collapse, and that exit paths from the building will not be blocked, but that the building may be heavily damaged and may be unable to be occupied after a major earthquake. The design earthquake hazard is defined as an earthquake with a 10% chance of exceedance in 50 years as defined by the mean spectral amplification factors included in the 1988 NEHRP Recommended Provisions. The City of Portland requires that the seismic hazard in Portland be defined, as an effective peak velocity-related acceleration ($A_v$) of 0.3 and an effective peak acceleration ($A_0$) of 0.3 in place of those values specified in FEMA.

Discussion of Building Deficiencies

Based on the checklist procedures of FEMA 178, a number of possible deficiencies in Science Two’s lateral force-resisting system have been identified:

- The concrete shear walls in the north-south direction do not appear to have sufficient in-plane shear strength to resist design earthquake forces above the first level. Based on the quick check procedures, the walls have a demand to capacity ratio of 1.8.

- Many of the existing walls are slender and have large openings for doorways, with spandrels over the openings that act as coupling beams. These coupling beams have inadequate strength and ductility to enable the walls to work together.

- At the ends of a number of walls, boundary elements are not provided. At other locations where boundary elements are provided, they have inadequate strength and ductility to resist design earthquake forces. This is especially critical just above the first floor as the walls transition into the basement levels.
Based on the procedures of FEMA 178, a number of deficiencies in the Science Two's nonstructural components have been identified:

- Partitions and fixed glass do not appear to be detailed to accommodate the expected interstory drift.
- Suspended ceiling systems do not appear to be adequately braced to the structure, and ceiling tiles do not appear to be secured with clips over exit routes. The edges of the suspended ceiling do not appear to be separated from the enclosing walls, which may make them subject to distortion and damage under the expected building drifts.
- We did not observe any independent support of the light fixtures in the suspended ceilings or bracing of emergency lighting equipment.
- The building contains a substantial number of storage cabinets and other heavy furniture that do not appear to be anchored to the structure to resist overturning.
- Breakable items stored on shelves, including some chemicals, do not appear to be restrained from falling.
- A number of pieces of mechanical and electrical equipment do not appear to be adequately anchored or braced to the building. Systems including gas, fire suppression, and HVAC do not appear to be braced and lack flexible couplings.
- Compressed gas cylinders do not appear to be properly restrained.

Expected Building Performance

Based on the checklist procedures of FEMA 178, Science Two does not appear to meet Life-Safety for the design level earthquake. We believe a detailed evaluation as well as some seismic strengthening will be required to obtain a Life-Safety performance objective for Science Two.

Note that the FEMA 178 procedures used for this evaluation are screening tools and, by nature, are quite conservative for a building of this type and size. For example, the quick check of shear ignores any reinforcing steel in the wall and any contribution of perpendicular walls to the overall strength of the core. A detailed evaluation may show that the performance of this building is better than we have concluded.
Possible Seismic Strengthening Scheme

The key to strengthening Science Two at this stage is addressing the lack of shear strength in the north-south direction. Multiple seismic strengthening schemes may be appropriate for this structure. These should be explored in more detail in a detailed seismic study. One possible strengthening scheme may include all of the following elements:

- Strengthen the existing north shear walls with a new reinforced concrete shear wall down the centerline of the building. The new wall should be attached to the diaphragms and existing walls at each level, and should extend all the way to the foundation. We believe that the new wall when combined with the existing walls may be long enough to prevent the need for new boundary elements.
- Add new steel or concrete collectors at the new shear wall location below the diaphragm and bottom of the precast tees. Dowel into the side of the girders and into the far walls on the east and west ends.
- All nonstructural components and building contents that pose a hazard, as described above, should be corrected.

Typical Costs for Seismic Rehabilitation

To estimate the potential cost of seismic strengthening without doing a detailed analysis of the structure, the historic cost data contained in FEMA 156, Typical Costs for Seismic Rehabilitation of Existing Buildings - Second Edition, can be used. The cost data covers only the structural costs of the strengthening work and does not include costs for extensive architectural remodel, nonstructural strengthening, or collateral hazards such as asbestos mitigation or ADA compliance. As the data was developed for use on large inventories of buildings, the range of cost developed for single buildings can be quite large.

For Science Two, the estimate of seismic strengthening costs using FEMA 156 range from a low of $7.57 per square foot to a high of $31.81 per square foot based on a moderate confidence range. We would estimate, based on our experience with this type of structure, the actual cost would be in the lower half of this range. Based on an estimate of a 219,000 square foot building, the low estimate structural cost to retrofit Science Two would be about $1.7 million. The middle estimate structural cost to retrofit Science Two would be $3.4 million.
City of Portland Requirements

Current City of Portland requirements do not require existing buildings to be structurally upgraded when undergoing an extensive architectural renovation (except for unreinforced masonry buildings which undergo renovation of greater than $15 per square foot over a two-year period). However, when an alteration for which a building permit is required has a value more than $100,000, the City of Portland requires a FEMA 178 evaluation to be submitted to the City for review. The evaluation we have completed on Science Two satisfies this City requirement.

In some cases, the City has required additional measures beyond the FEMA 178 investigation on certain structures. These projects usually involve some removal, addition, or alteration to a building's lateral force-resisting system. With regards to the renovation of the first two levels proposed for this project, we do not currently believe that a full upgrade will be required.

Summary

The Science Two building at Portland State University is a four-story precast and cast-in-place concrete building located in Portland, Oregon. We have evaluated the building's seismic performance using FEMA 178 in accordance with the City of Portland requirements. Based on our evaluation, the building lacks adequate walls in the north-south direction to adequately resist the design lateral forces. Without further analysis or seismic strengthening, the building does not meet the Life-Safety performance objective of FEMA 178 for the design level earthquake. A strengthening scheme involving adding a new reinforced concrete wall at the building centerline, adding collector elements, and addressing the nonstructural hazards could bring the building up to a Life-Safety performance level. This type of strengthening work may cost between $7.57 and $31.81 per square foot based on FEMA 156.
Degenkolb

Mr. Roz Estimé, SRG Partnership, P.C.
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We appreciate the opportunity to evaluate Science Two at the PSU campus. If you have any comments or questions regarding this evaluation, please do not hesitate to call.

Very truly yours,

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Attachments
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