

Snell Hall Administration Building, Seismic Rehabilitation Project at the Oregon Institute of Technology

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Snell Hall at Oregon Institute of Technology (OIT), Oregon, was seismically upgraded as a demonstration project to increase its earthquake safety and community awareness (Figure 1). Snell Hall is a 2-story plus basement administration building constructed in 1964, which posed a life safety threat to OIT employees and students.



Figure 1. Snell Hall: demonstration tour of the completed seismic rehabilitation. David Ebsen (left side), Facilities Director, is holding a Certificate of Appreciation.

The university campus is situated in an area of high seismicity due to the immediate proximity to active faults associated with the Klamath Graben Fault System. Significant earthquakes in September of 1993 damaged this building and caused disruption in the student enrollment.

In 2002, this building was evaluated (using the FEMA 154 methodology) and it was concluded that the building may contain some serious seismic deficiencies. Snell has two predominant structure types, including a lower story concrete moment frame and an upper story steel moment frame that is very flexible and weak. The lower floor connections are weak and no shear walls are apparent on the second floor. Furthermore, it was estimated that the building contains a weak 1st story in the transverse (short) direction.

In April 2004, the Oregon Department of Geology and Mineral Industries was funded by the DHS- Federal Emergency Management Agency (FEMA) Predisaster Mitigation Program to conduct a complete seismic upgrade, including structural, nonstructural and contents.

The seismic rehabilitation of this rectangular-shaped building, which cost \$673,000, includes five structural mitigation measures:

- Foundation improvements including soil anchors to a 60 ft depth
- Steel tube bracing on the ground floor (for short/east-west direction)
- Steel moment frame on the ground floor (for long/north-south direction)
- Existing moment frame improvement on the second story (for short direction)
- Diagonal rod bracing on the second story (for long direction)

Seismic mitigation of the non structural components and contents was also conducted to improve the building to an operational level so that this building remains functional immediately after a major earthquake. To preserve the visual integrity of the campus architecture, Snell Hall was mitigated with the larger structural elements hidden from obvious view.

The most significant surprise during the initial seismic design phase was that the foundation soils and existing foundation were discovered to be critically inadequate. As a result of weak soils, a geotechnical study was conducted by excavating soil to expose the column at the basement level to assess the severity and extent of the problem. However, during the excavation, it was observed that the columns were actually two separate pieces. The above grade portion appeared to be precast concrete, and the below grade portion appeared to be cast-in-place concrete. It was then necessary to reanalyze the two separate pieces rather than one continuous piece as previously assumed.

The results of the new analysis indicated that this two piece column arrangement had little-to-no lateral support at its interface with the soil. Consequently, the final foundation design included a deep foundation system with helical soil anchors to a maximum depth of 60 ft combined with robust concrete foundation system. Figure 2 shows some of the foundation construction in progress for the soil anchors and rebar reinforcement in the foundation excavation.

The seismic work provided the opportunity to initiate additional building improvements. Due to additional non-seismic work on energy efficiency, deferred maintenance and modernization, the total project upgrade was \$1.8 million.

As part of the demonstration project, several tours were organized both during and after construction. The campus administration including the university President, elected officials, high profile community members and local press were involved. In addition, a commemorative plaque is mounted in the building's front hallway to remind the public of the pre-disaster mitigation measures taken and express gratitude to FEMA, Oregon Emergency Management, Oregon University System, and others involved in making this rehabilitation project a success.



Figure 2. Construction process used for installation of helical soil anchors (A) surrounding soil excavated around the column (B) helical soil anchor installation (C) proof testing helical soil anchor (D) compaction of soil surrounding the column (E) drilled holes for installation of epoxy coated anchors, and (F) rebar reinforcement before concrete is poured.



Figure 3. New steel tube bracing to the existing structure on the ground floor to strengthen the building's short direction.



Figure 4. New steel rod diagonal bracing on the 2nd story to help in the building's long direction