ROCKING WALLS WITH LEAD EXTRUSION DAMPERS, PROTECT FORMERLY HOMELESS SENIORS FROM EQ RISKS

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ABSTRACT

1296 Shotwell St. is a new nine-story residential building in San Francisco that will provide affordable housing for low income people with 25\% of the units reserved for formerly homeless seniors. The design goal is to create a structurally resilient building and enable shelter-in-place for an economically vulnerable population in the event of a major earthquake.

The structure has post-tensioned concrete flat plates and concrete walls on a mat foundation. The walls rock during an EQ, remaining elastic and inducing non-linear flexural responses in the slabs and mat. The gravity loads enable re-centering.

The building was designed using non-linear response-history analysis using ground motions at the MCE hazard level. Resistance to overturning is obtained from superimposed gravity loads, the slab and mat footing self-weight, as well as from the slab and mat hogging effects at the ends of the shear walls that result from rocking and foundation uplift. Where the ends of the shear wall did not have enough strength from the slabs at the building edge, supplemental dampers were provided at the foundation level for additional overturning resistance. These lead extrusion dampers were developed by Prof. Geoff Rodgers from the University of Canterbury in New Zealand. They consist of a bulb ended metal shaft set in lead, encased in metal. During an earthquake, the foundation uplift forces the movement of the bulb in the damper. The bulb displaces through the lead by plastifying it, thereby resulting in energy dissipation. All the energy dissipation occurred

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in the dampers and the mild steel reinforcement in the slab and mat. The shear walls were designed to stay elastic under the Maximum Considered Earthquake. Gravity loads provided the primary restoring mechanism and eliminated any significant residual drifts.

The modeling of the rocking shear walls on the foundation and the wall-slab hogging interaction was done in Perform 3D. The inelastic yielding of the slab mild steel reinforcement at the ends of the shear wall was modeled and the restoring couple provided by the post-tensioning was captured.

Damage and loss estimation was done for the high-performance design and compared to a conventional structure. Modeling was with the Seismic Performance Prediction Program (SP3) tool following the FEMA P-58 methodology with input from the response-history analysis. Five different seismic hazard levels ranging from 50% in 50 years to 2% in 50 years were simulated to capture range of damage potential during the lifetime of the building.