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SEISMIC RESPONSE OF PRE-CAST CONCRETE SHEAR WALLS WITH CONTROLLED ROCKING MOTION USING SELF-CENTERING FRICTION DEVICES

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Low damage structural systems are defined as systems in which the earthquake input energy is dissipated in sacrificial fuses. These fuses, if required, can be repaired or replaced after moderate to severe earthquakes. However, some of the low damage systems are expected to have residual displacements after earthquakes. This residual displacement results in problems in building occupation and imposes re-alignment costs. Therefore, a self-centering feature is a bonus when the designer is sure that residual displacement is a problem for the structure being designed.

Friction dampers have been used as passive energy dissipation devices for seismic protection of different types of structures. These dampers have shown repetitive cyclic performance when properly designed. This repetitive performance means that the device can resist many severe earthquake events when the input cycles are within its design slip displacement. However, residual displacement is expected after moderate and severe earthquakes.

Resilient slip-friction joint (RSFJ) and Resilient Slip-Friction Damper (RSFD) are two recently developed friction dampers with self-centering capability. In these devices, self-centering and energy dissipation is provided using the combination of pre-stressed disk springs and clamped friction surfaces. These devices can be specifically designed to achieve the desired flag-shaped load displacement performance. When the residual displacement is of concern or additional damping is required, these devices can be used to control the response of the system.

The use of pre-cast concrete improves the construction process with decreasing the required time and labor and provides higher quality compared to conventional cast-in-situ concrete. Besides, pre-cast concrete members can form low-damage structures when connected with properly designed low-damage connections. This potential makes pre-cast concrete a suitable choice for modular construction in countries such as New Zealand where development in seismic-prone areas is of high priority.

Amongst low damage systems, rocking concrete shear walls have been considered as an efficient system when their inherent self-centering capability is combined with an additional system to control the rocking motion and to add energy dissipation. Rocking walls with unbonded post-tensioning and additional yielding dampers are one of the examples of such systems.

In this paper, the performance of a pre-cast rocking concrete shear wall equipped with RSFJs and RSFDs is assessed experimentally and the results are compared to the analytical and numerical predictions. The input action is designed for the ultimate limit state demand defined in New Zealand code. The results have shown that the system is able to withstand the seismic input energy with a repetitive manner while self-centering is achieved at the same time.