# Taylor Retrofit Solutions for Non-Ductile Concrete Buildings

Taylor Devices is a world leader in the manufacturing of high quality seismic protection products. Our qualified team offers extensive experience with the design of damping systems for seismic upgrades of existing concrete buildings. Taylor Devices offers training and design tools to project stakeholders through technical presentations and project specific consulting at no cost.

## Non-Ductile Concrete: Cause for Concern

Before the 1980s the inclusion of seismic design requirements in building structures was minimal and based mainly on observations made during previous earthquakes. The concepts of a ductile concrete moment frame did not find their way into building codes until the 1967 UBC, yet these were still limited to structures above 160 feet. Seismic events like the 1964 Anchorage Alaska Earthquake and the 1971 San Fernando Earthquake laid bare the deficiencies of the existing building codes. Several concrete buildings collapsed, and many were damaged beyond repair. There were multiple reasons for the damage and collapses, but most can be attributed to non-ductile detailing of the columns, beams, and beam-column joints.

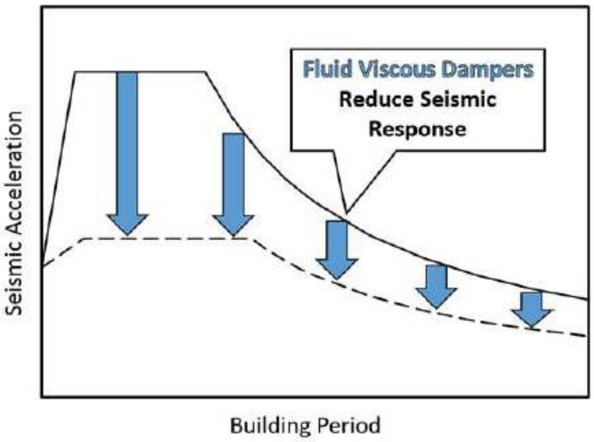
There are still thousands of pre-1980 non-ductile concrete buildings in high seismic regions in the U.S. and abroad. The California Seismic Safety Commission estimates that there are 40,000 in California. Several Southern California cities have recently adopted ordinances that require owners to assess the collapse potential of their older concrete buildings and retrofit these if the assessment deems this necessary. These cities include the City of Los Angeles, West Hollywood, and Santa Monica. San Francisco is currently deciding what to do about the non-ductile concrete building stock in the city.

*Olive View Hospital – failed tied column. (Source: NISEE-PEER, University of California, Berkeley)*

## FVD Solutions for Non-Ductile Concrete Structures

There is an economical way to retrofit these non-ductile concrete buildings before the next big one hits. Non-ductile concrete moment frame structures are ideal candidates for upgrades employing Fluid Viscous Dampers (FVDs) because they are inherently flexible structures permitting FVDs to dissipate large amounts of energy at relatively low force levels. As the building sways in an earthquake and one-floor moves relative to another, this drives the FVD, which dissipates the energy as heat, without any damage to the FVD. Conventional retrofit methods are more costly, architecturally restrictive, and disruptive to building occupants. The FVD is a velocity-dependent device uniquely capable of mitigating the structure's dynamic motion during an earthquake, without increasing demands on the structure and foundations.

Simplified procedures for retrofitting structures with Fluid Viscous Dampers have been developed and implemented in building code standards from the American Society of Civil Engineers (ASCE). With just a basic understanding of the building characteristic properties and an assumed configuration of the FVDs, Taylor Devices can provide a conceptual design and cost estimate for an upgrade solution.



### Building Specifics

- Located in Sacramento,CA
- Built in the early 1970s
- Two 14 Story RC Towers
- Roughly 175,00 SF Each
- Engineering Performed by Miyamoto International

# CS 555 Capitol Mall

case study

555 Capitol Mall in Sacramento California consists of two 14 story concrete office towers totaling over 380,000 square feet. It was constructed in the early 1970s to the 1967 version of the Universal Building Code. The facilities had several factors that enhanced its seismic performance such as its rectangular floor plan and its symmetrical design, however, there were concerns regarding several other structural deficiencies.

The biggest concern regarding the structure's seismic performance was due in part to the soft-story response of the first floor which was 50% taller than all of the other floors. These structures are more prone to collapse in the event of an earthquake. Additionally, the structure also experienced drift great than 2% in both orthogonal directions. These responses are deemed too high for non-ductile concrete buildings.

The buildings in their existing configuration had a Probable Maximum Loss (PML) value that exceeded 20% and it was determined that the structure was more than likely to experience moderate to significant damage in the event of a design-level earthquake. This combination of concerns led building management to consider and ultimately pursue a seismic upgrade of the structure.

Eight Fluid Viscous Dampers were added to the first floor of each tower, totaling 16 dampers. These devices were aesthetically integrated into the existing building structure and presented minimal disturbance to facility operations during installation.

Additionally, building management opted to cancel their earthquake insurance, roughly $145,000 a year, given the direct investment in a seismic improvement technology to protect the structure. With a project cost of roughly $800,000, building management was able to achieve a full return on investment in 6 years.


### RESULTS:

- Soft-story response at the first floor significantly reduced.
- Drift ratio at the floor reduced from >2% to 1.2%, essentially limiting damage to minor yielding or none at all.
- Fluid viscous damper solution dramatically reduced the total project cost.
- Minimal impact on the day-to-day operations of the facilities.

**www.taylordevices.com**

**90 Taylor Drive | North Tonawanda, NY 14120 | Phone: +1-716-694-0800 | sales@taylordevices.com**