Taylor Retrofit Solutions for Non-Ductile Steel Buildings

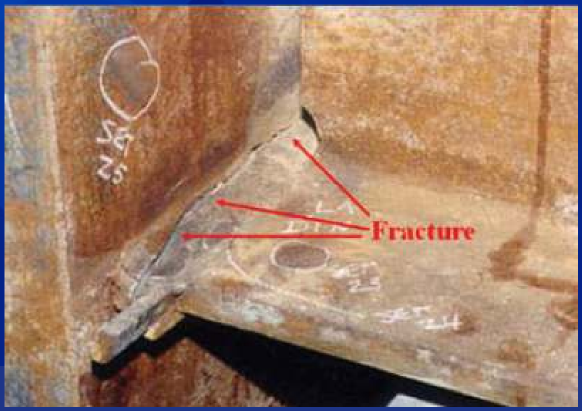
Taylor Devices is a world leader in the manufacturing of high quality seismic protection products. Our qualified team offers extensive experience with the design of damping systems for seismic upgrades of existing steel buildings. Taylor Devices offers training and design tools to project stakeholders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

taylor devices inc.

Non-Ductile Steel: A Cause for Concern

From one side of the Pacific Ocean to the other, major seismic events have shown the vulnerability of improperly detailed steel buildings. Many welded, steel, moment-frame buildings sustained significant damage in both Los Angeles, California and Kobe, Japan during the 1994 Northridge earthquake and the 1995 Kobe earthquake, respectively. This damage consisted of a brittle fracturing of the steel frames at the welded joints between the beams and columns due to the lack of suitable energy dissipation.

A few of the most severely damaged buildings could readily be observed to be out-of-plumb; however, many of the damaged buildings exhibited no outward signs of these fractures. The observed damage raised questions as to whether buildings in cities affected by other past earthquakes had also sustained similar undetected damage and were now weakened and potentially hazardous. In fact, some structures in the San Francisco Bay area have been discovered to have similar fracture damage most probably dating back to the 1989 Loma Prieta earthquake.

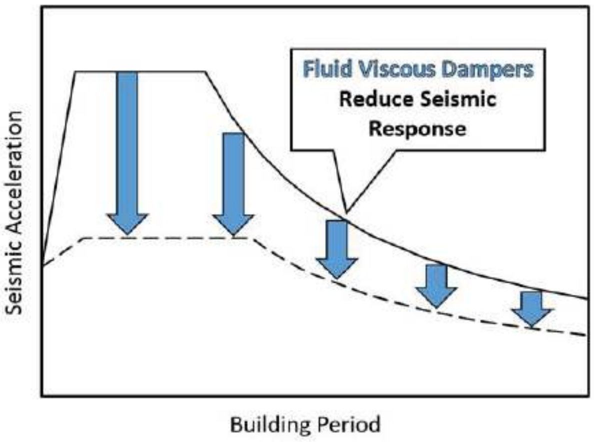


Fracturing of welded connections can lead to damage to the bolted connections that hold the beams onto the columns, creating potential for localized collapse.

FVD Solutions for Non-Ductile Steel Structures

Welded steel 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 Bremerton, WA
- Built in the late 1970s
- 9 Stories Tall
- 250,000 sq/ft
- Engineering Performed by Reid Middleton

CS case study

Bremerton Naval Hospital

The Naval Hospital at Bremerton (NHB) is a fully accredited, community-based hospital that serves over 60,000 military families in the Puget Sound region. Given its proximity to Seattle, in the event of a major earthquake, the medical campus could anticipate the need to serve over 250,000 people.

In 2001, the hospital shook for 45 seconds as the 6.8 magnitude Nisqually Earthquake struck the Pacific Northwest. Occupants on the upper floors recalled seeing the building sway as they watched the tree line below and feared for its collapse. The hospital structure experienced significant lateral drifts during the relatively small, “less than design level” earthquake, particularly on the upper floors of the tower of the main building. Calculated peak roof displacements from this modest earthquake shaking were over 6”.

Since the main building was constructed in the late 1960s with “Pre-Northridge Steel Moment Frames,” a detailed inspection in accordance with FEMA 350 standards was performed and the building was evaluated. During the evaluation of the structure, it was determined that a conventional seismic retrofit by strengthening or stiffening would have been too costly and disruptive to hospital operations, therefore alternative retrofit solutions had to be considered.

The use of Taylor Fluid Viscous Dampers proved to be the best design scheme to improve the seismic performance of the building while minimizing the disruption to hospital operations. In total, 88 Fluid Viscous Dampers were strategically installed in the existing structure. These dampers reduced the demands on the existing structure by reducing the lateral displacement of the structure and no retrofitting of the foundation was required.

RESULTS:

- Story drifts and floor accelerations reduced by over 40%.
- Diaphragm rotations reduced by 30-70% on all floors.
- Fluid Viscous Damper solution dramatically reduced the total project cost.
- Minimal impact on the day-to-day operations of the hospital.

www.taylordevices.com

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