Fluid viscous damping technology can be an ideal solution for seismic energy protection in steel structures.

product focus

SEISMIC SENSIBILITY

BY JEFF WEISBECK

THE RECENT MAGNITUDE 6.0 earthquake in Napa, Calif., was yet another reminder of the importance of earthquake protection for buildings and bridges.

According to the U.S. Geological Service, more than half-a-million earthquakes occur around the world each year, of which 100,000 can be felt by people. In the U.S. and across the globe, concerns about deficiencies in bridges and buildings are growing.

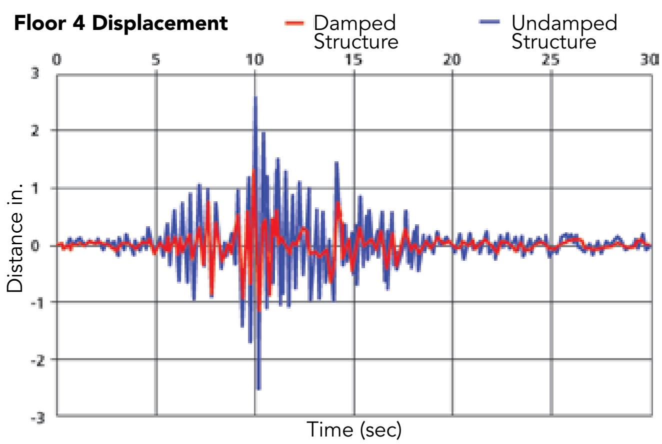
Every four years, the Earthquake Engineering Research Institute sponsors a national conference that attracts a broad range of professionals from throughout the earthquake engineering industry. This year's 10th U.S. National Conference on Earthquake Engineering (10NCEE) was hosted in Anchorage, Alaska, and featured technical presentations and seminars from some of the industry's most respected experts.

At 10NCEE, industry professionals discussed new developments in the world of seismic engineering, including the growing market need for more reliable, customized energy dissipation and isolation technologies. In modern construction, methods are constantly evolving and today's structures are experiencing improved performance with the addition of dissipation devices, such as fluid viscous dampers (FVDs), which can provide energy dissipation during earthquakes.

FVD Basics

An FVD is a device whose resultant force is proportional to its relative velocity (linear FVD) or summed power of velocity (non-linear FVD). FVDs operate by converting kinetic energy into heat—typically over multiple cycles (tension and compression). This technology uses flow of internal fluids and custom orifice geometry to obtain linear and non-linear damping properties. Using them as an energy dissipation device, a structure will increase its critical damping ratio and reduce the dynamic magnification factor, thereby reducing the dynamic response of a structural system in the event of an earthquake.

When examining the total cost of system ownership, adding FVDs for energy dissipation can often be a more cost-effective solution, especially when coupled with a supplier that represents reduced risk for any associated elements and integration into a project. Because FVDs have the ability to reduce the stress and displacement of a structure, they require less material, reducing the customer's total cost. FVDs are available in two basic technologies: low-pressure and high-pressure. Selecting the proper technology is critical to protecting structures from such seismic events. Following are three general applications and the benefits of using the proper FVD type.



	Damped	Undamped	Reduction
4th	1.35	2.59	47.78%
3rd	1.20	2.27	46.85%
2nd	0.91	1.69	46.19%
1st	0.49	0.91	45.73%

A structural system incorporating FVDs will increase its critical damping ratio and reduce the dynamic magnification factor, thereby reducing the dynamic response of a structural system in the event of an earthquake or other external excitation.

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Bridges and base isolation. Because bridges and related infrastructure components are often exposed to wind, thermal and traffic excitation on a daily basis, FVDs for these applications must be able to withstand harsh conditions and sustain a long lifespan often over many miles of total seal travel. Modern low-pressure FVD designs feature an internal reservoir allowing for extended seal and damper life as well as the ability to visually monitor internal fluid levels. Using a low-pressure design in bridge applications is beneficial because:

- It helps to reduce seal friction, which reduces seal wear therefore extending seal life.
- It allows use of a fluid reservoir. As any static seal wears, a microfilm of fluid is able to escape the damper as the piston travels in and out. A fluid reservoir contains a calculated amount of supplemental fluid based on expected seal travel to replace the fluid lost over time to ensure the damper performs as required throughout the entire design life.
- It allows for use of a fluid level indicator. Because the internal charge pressure is relatively low, a "window" can be safely added without compromising the pressure containment of the unit.

Buildings. Considering that excitation frequency in buildings is significantly less than bridges, FVDs for building applications should be designed to endure long periods of static installation, with features that promote an extended life span. These dampers are typically a building's main defense against seismic activity. Using a high-pressure design in these applications is beneficial because:

- Expected seal travel is minimal, with long periods of static installation and short stroke requirements being common.
- It allows for a compact design, which promotes relatively high damping force capabilities in a small installation envelope. This benefit can be extremely helpful in retrofit scenarios where space is limited.
- It is an economical choice when compared to other supplementary damping technologies.

Tuned mass damping systems. A linear damper is often recommended for tuned mass damping systems or applications requiring high energy dissipation demand in tight spaces and often a relatively high amount of expected seal travel over the design life. Using a linear damper in these applications has many of the same benefits as a low-pressure reservoir damper with the additional capability of being able to continuously dissipate energy within a tight installation envelope.

Whatever the application, a high level of design, technology, engineering support and testing, along with the associated higher quality levels of the products, are essential to seismic protection and sustained performance and are key attributes to FVD technology.

ITT Enidine's TYPE-B and TYPE-H fluid viscous dampers are designed for a long life span, with customized features that provide the expected design performance during a seismic event.

Early and Often

FVDs can incorporate new and innovative design features that ensure increased safety for structure users, improved lifecycle economics and optimal performance throughout a structure's life. As technology evolves, it is becoming imperative that structural engineers consult FVD manufacturers early and often to ensure achievement of the best available solution for any application. In addition, here are a few FVD considerations:

- The capability of computer-aided design to model non-linear elements has been evolving, and structural engineers are becoming more familiar and comfortable with using non-linear FVDs in their structures.
- Fluid indicators, cycle counting and remote monitoring capabilities are a part of a comprehensive health-assessment program that can help to ensure adequate damper life and reduce the risk of leaving a structure unprotected without the required damping in the case of a seismic event.
- Design features such as internal fluid reservoirs and innovative sealing technologies extend damper design life. Thru-rod designs provide reliable symmetric performance in tension and compression. Single-rod designs allow for high energy dissipation capabilities in tight installation envelopes.

FVDs are one method by which to address seismic concerns in steel buildings, bridges or other structures. By following these suggestions, working closely with FVD makers and choosing the right type of FVD for a specific application, your projects will be better equipped to whatever vibrations the earth throws at it. ■

Fluid Viscous Damper (FVD) Producers

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