

Structural Protection Products



taylor devices inc.

Since 1955



We're on top of structural control



250 West 55th Street

7 custom high capacity metal bellows dampers at the top of the building in an outrigger configuration.

Output Forces: 380,000 lbs.

Stroke Capacity: +/- 3.5 inches

Owner: Boston Properties

Architect: Skidmore, Owings & Merrill LLP

Engineer: ARUP Group

General Contractor: Turner

Steel Contractor: Owen Steel Company



As The World Churns: A New Level of Seismic Protection



Taylor Devices' Seismic Dampers and our President, Douglas Taylor, were inducted into the Space Technology Hall of Fame in 2015. Our Vice-President, Richard Hill, received the Corporate Award.

Originally developed for NASA in the 1960s, Taylor Fluid Viscous Dampers are now used by civil engineers worldwide to protect their work and the people who rely upon its safety. Over 600 buildings, bridges and other crucial structures around the world are now using Taylor dampers.

Taylor Devices - a 2015 inductee into the Space Technology Hall of Fame - has been recognized and certified by NASA for these space program innovations that now save lives on Earth.

Taylor Devices has established a track record for reliability and state-of-the-art performance. Our unshakeable reputation has been validated through rigorous research, full scale testing, and published work by organizations such as:

- The Multidisciplinary Center for Earthquake Engineering Research (MCEER) along with SEESL & NEES at the State University of New York at Buffalo
- Earthquake Engineering Research Center (EERC) at UC Berkeley
- The Highway Innovative Technology Evaluation Center (HITEC)
- The National Center for Research on Earthquake Engineering (NCREE) located in Taiwan
- The Caltrans Seismic Response Modification Device (SRMD) test facility at UCSD
- E-Defense test facility located in Japan

Why seismic dampers?

There are simply no disadvantages to using Taylor Seismic Dampers for structural control due to their viscous behavior. Building codes throughout the world now recognize and even encourage their use. A straightforward dynamic analysis of a structure using standard software demonstrates the significant benefit of seismic dampers, and the technology is now being widely used to optimize structures. Taylor Fluid Viscous Seismic Dampers provide a reliable, inexpensive, environmentally-friendly and easy-to-install solution.

How seismic dampers work

Taylor Seismic and Wind Dampers are available in output force ratings up to 2 million pounds and stroke (amplitude) capacities up to +/-42 inches. These highly efficient devices absorb a tremendous amount of energy during an earthquake in order to prevent that energy from ever reaching the structure itself. This earthquake energy is transferred to heat energy and is safely dissipated after the event is over. This allows designers to reduce the cost of the structure by utilizing smaller structural elements and less complex foundations while improving the dynamic performance of the structure.

Using seismic dampers

Taylor Seismic Dampers are easy to incorporate into a structure. Dampers can be placed between any two points where relative motion exists during a transient event such as an earthquake or wind event. Diagonal brace mounting is popular, as is the use of dampers in a chevron brace arrangement. Base-isolated structures are also optimized by using seismic dampers along the plane of motion in conjunction with base isolators/bearings. Special custom configurations are also available.

Dampers that produce a linear relationship with respect to velocity are available. Please note that standard damping exponents can be set anywhere between .3 and 2.0, as required by the specific application.

Seismic Dampers

Ready, Steady, Reliable.

Seismic dampers soak up earthquake-induced motion to prevent structural damage. Compact yet powerful, our fluid viscous dampers increase structural damping levels to as much as 50 percent of critical.

Our fluid viscous dampers are based on aerospace technology developed for the MX missile and B-2 Spirit "Stealth Bomber." These dampers have been proven in extensive tests at internationally accredited laboratories. Along with a standard 35 year warranty, these dampers utilize dependable machined fluid flow passages for ultimate reliability and longevity.

San Bernardino Justice Center

184 Seismic Dampers throughout structure

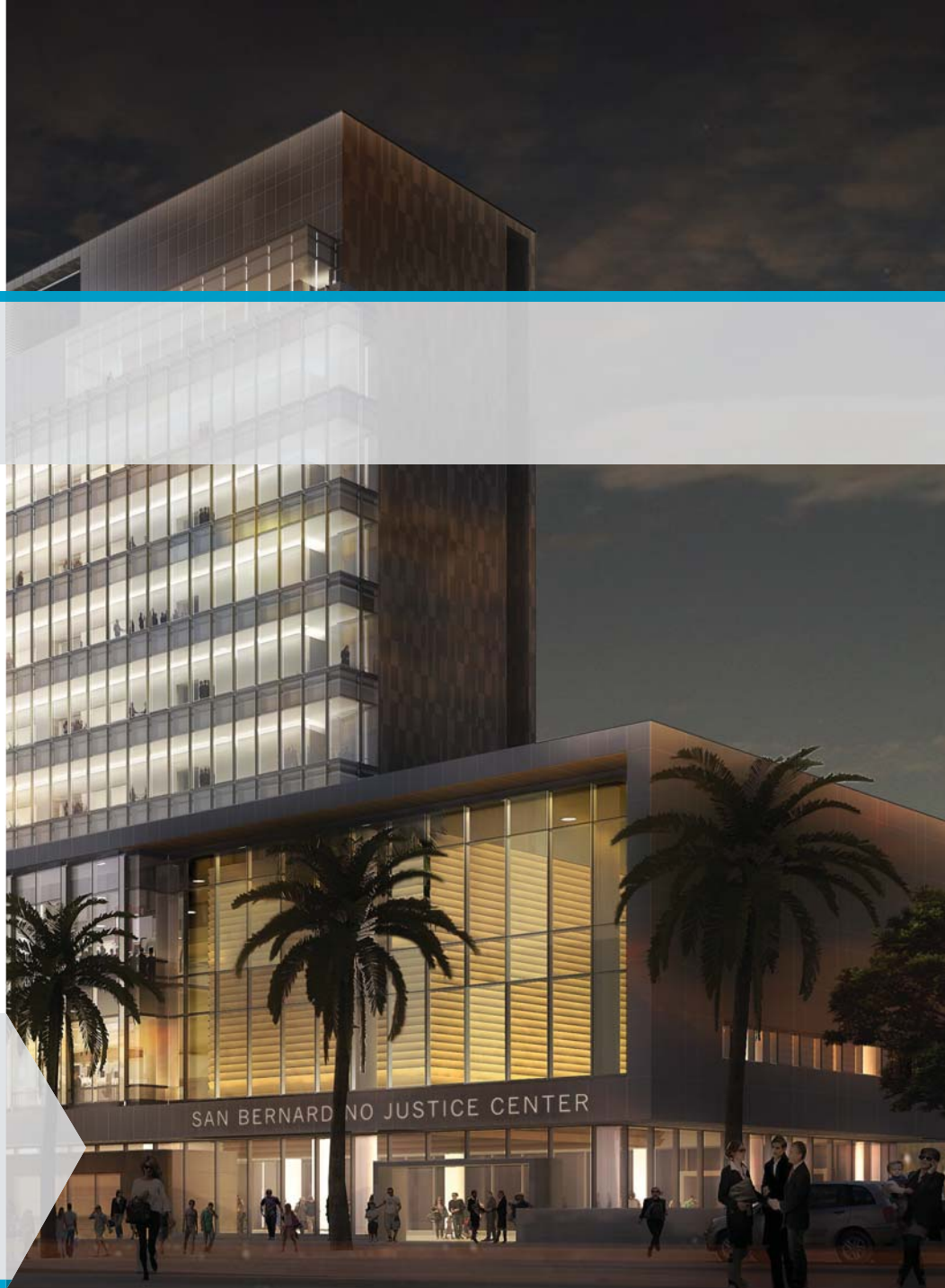
Output Force: 450,000 lbs

Stroke Capacity: +/- 5 inches

Engineer: Skidmore, Owings & Merrill LLP

General Contractor: Rudolph & Sletten

Steel Contractor: Schuff Steel



Protect new or existing structures against earthquakes simply and inexpensively. Taylor Devices' Fluid Viscous Dampers provide complete protection for buildings, bridges, towers, elevated freeways - virtually any structure that is subject to earthquake damage.

- Diagonal brace dampers are available in output levels up to 2 million pounds force with strokes of up to 20 inches.
- Base isolation dampers are available in output levels up to 2 million pounds force with strokes of up to 84 inches.

For unusual seismic applications, motion amplification devices and open space frames can be incorporated. These products also have non-seismic applications as wind dampers on tall buildings, bridges and other structures.

Taylor Seismic Dampers require no maintenance - ever. Our exclusive design uses a minimum number of moving parts and our patented dry seal has over 50 years of successful performance in some of the world's most demanding applications.

Tuned Mass Dampers

Against the Wind.

Tuned Mass Dampers (TMD) are often used in tall buildings and consist of a large, internally-lumped mass suspended from the uppermost floors. The mass is supported with cables, steel arms or springs combined with air/fluid/mechanical slider bearings. The mass is centered within the building on these lateral spring elements.

Fluid dampers (inset photo) which typically have long strokes in the 2 to 6 feet range, control the response of the tuned mass. When the building is subjected to wind inputs, the building sways from side to side. The tuned mass, due to its inertia and long period attachment, moves out of phase with the building. Energy is dissipated by the fluid dampers.

432 Park Ave. - New York City

16 Long Stroke Taylor Dampers for Tuned Mass Dampers at the top of the building

Damper Force: 30,000 lbs

Stroke Capacity: +/- 40 inches

Damper Power Capacity: Greater than 4.0 HP

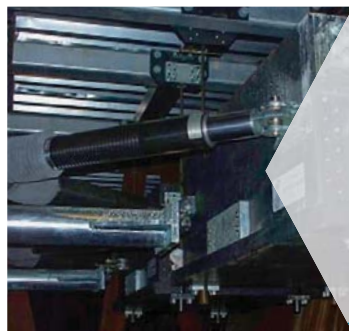
Wind Consultant and TMD Designer: RWDI/
Motioneering



The tuned mass damper reduces deflection of the building under wind inputs by essentially applying force to the building in a direction always opposite to the wind-induced motion.

Tuned mass dampers are not normally used to provide seismic protection.

TMDs are also in pedestrian bridges, ballrooms, stadiums and other structures to reduce vertical, lateral and/or torsional vibrations caused by human activities and/or wind.



This photograph shows a 7,600 lb TMD designed and manufactured by Taylor Devices used to mitigate lateral movements on a long pedestrian bridge. The mass is suspended by steel cables, tuned to the lateral frequency of the bridge, and is controlled by fluid dampers. One of these dampers is shown in the foreground with heat dissipating fins on its outside diameter.

Vertical vibrations on this bridge were mitigated by similar tuned mass dampers that were mounted on springs and designed to move out of phase in a vertical orientation.

Lock-Up Devices

Instant Protection.

Lock-up devices (LUD) and snubbers are dampers with extremely restrictive orifices that function much like a seatbelt. These products are used to limit relative motion between masses during a transient event while allowing free motion in the normal mode. This allows dynamic loads to be shared at multiple locations rather than concentrated at fixed locations.

LUDs can also be used to prevent two adjacent buildings from colliding or to tie multiple masses together during an earthquake.

Seattle Central Light Rail

146 Lock-Up Devices with various force and stroke capacity for seismic protection

Output Force: Up to 650,000 lbs

Stroke Capacity: +/- 6 inches

Engineer: International Bridge Technologies

Various Contractors: PCL, Mowat



In the 1990s, Taylor Devices began using snubbers, originally developed during the 1960's for protection of large steam pipes in nuclear power plants, as locking devices to limit the relative motion of highway bridge sections under various types of transient motion - usually seismic in origin. When used on civil engineering structures, the product is usually called a lock-up device (LUD) or shock transmission unit (STU).

Most applications have been in regions of low or moderate seismic risk. The devices allow essentially unrestricted motion when the bridge structure expands and contracts thermally, but locks the structural masses together under seismic or wind storm conditions.

Our lock-up devices have the same basic dimensions as our fluid viscous dampers. Available in force ranges of 10 kip to 2000 kip with thermal stroke capability of up to 84 inches.



Facilities



More than
600 buildings
and bridges
are now using
Taylor Dampers

Made in the USA

All Taylor products are made in the United States at our two manufacturing centers located in North Tonawanda, New York. Our facilities cover 15 total acres and over 105,000 square feet and are minutes from both the Buffalo Niagara International Airport and Niagara Falls International Airport.

Small Parts Manufacturing

The Small Parts Division includes a small machine shop and tool room with separate assembly and pre-test room. Assembly of space-qualified products is performed in a controlled atmosphere clean room with a laminar flow assembly bench certified to Class 100 requirements of U.S. Federal Standard 209E.

Large Parts Manufacturing

The Large Parts Division consists of a complete machine shop, using predominantly custom-built machinery for boring, deep hole drilling, gun drilling and turning of large parts. Two assembly zones are used - both are deep pit areas capable of assembling and pre-testing products up to 45 feet in length.

Common Facilities

Both Taylor manufacturing centers are capable of centerless and center grinding, honing, diamond lapping, bar and plate handling, in-house welding and heat treatments.

Quality Assurance

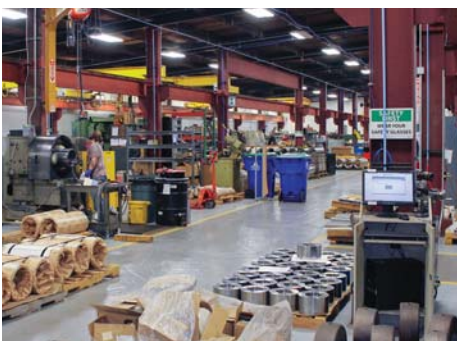
Taylor facilities and business management systems are registered to the following standards:

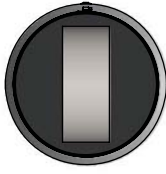
- ISO 9001 - audited and certified by NSF International Strategic Registrations for AS9104:2005
- AS9100 - audited and certified by NSF International Strategic Registrations for AS9104:2005
- ISO 14001 - environmental management standard audited and certified by NSF International Strategic Registrations
- NHB-5300.4 (1C) - NASA quality standard for spacecraft and satellite applications
- EN15129 - European standard for anti-seismic device

Testing Facilities

Taylor facilities set the world's standard for testing of shock absorber and shock isolation systems. Facilities include:

- | | |
|--|-------------------------|
| ■ Vertical drop rails | ■ Hydraulic multipliers |
| ■ Heavyweight vertical drop rail | ■ Static testing |
| ■ Super-heavyweight vertical drop rail | ■ Thermal testing |
| ■ Hydraulic vibration testing | ■ Velocity testing |
| ■ High frequency vibration testing | ■ Data acquisition |





Frequently asked questions

Q *What are the benefits of using Taylor Devices' Seismic Dampers in a structure?*

A Since dampers resist dynamic motion and remove energy from a structure during wind or seismic events, the resulting structural stress and deflection will always be mitigated in an efficient and reliable manner. This enables the structure to withstand the harsh input energy associated with these events and allows for a simple retrofit of existing structures without costly foundation work.

Q *Why do Taylor Dampers offer a better solution than other devices?*

A Since damping force in a Taylor Damper is dependent on velocity, this force is out-of-phase with the normal structural stresses during a dynamic event such as an earthquake.

When a structure moves, the maximum structural stress occurs at the point of maximum deflection. At this point the velocity is zero, and the damping force is therefore zero. Then, the maximum damping force occurs when the structural stress is lowest, because this is the precise instant in time that the velocity is the highest. This results in the ability of the damper to precisely remove energy from the structure at optimal points of deflection, while not needing any additional structural strength to withstand damping forces.

The result: forces and accelerations are reduced simultaneously with deflection reductions, thereby allowing the structure to protect not only the structural frame, but contents and occupants as well.

Q *How reliable are Taylor Dampers?*

A Taylor Devices has been manufacturing fluid dampers since 1955. We have extensive experience and a proven track record over many decades. Our structural dampers have been tested to provide completely leak-free operation for millions of cycles. We use our own proprietary seals manufactured from structural plastic combined with solid high strength stainless steel piston rods polished to a mirror-like finish of less than 4 micro-inches. These types of products have been successfully used in thousands of applications, benefiting buildings, bridges, steel mills, chemical plants, military ships, submarines, aircraft and missiles. Taylor Devices Dampers do not degrade with age, do not utilize any moving parts for fluid flow orifices and are completely maintenance-free. These units do not need service or even inspection after a seismic event and maintain their required characteristics for the life of the structure.

Q *What types of materials are used for dampers?*

A All materials used are corrosion-protected, usually with a combination of plating and paint. Special paints and colors are used if requested. Stainless steel is used exclusively in the piston rod. Stainless steel is also available for any external part if needed.

Taylor Devices does not use commercially available seals, but instead rely on our own proprietary machined seal design using high strength structural polymers rather than soft elastomers. This seal does not degrade with age and we have test units that date back to 1955 that operate perfectly today with zero leakage and no refilling or seal changes of any type needed. Our seals have been tested to provide completely leak-free operation for millions of cycles.

Q *Why are Taylor Fluid Dampers better than other solutions such as Buckling Restrained Braces (BRB's)?*

A Taylor Fluid Dampers are reliable, predictable, reusable and have been proven through decades of use. Our dampers allow perfect re-centering of the structure due to near-zero resistance force at near-zero velocities. In fact, they are instantly ready for the next aftershock. Automobile suspensions converged to viscous damping-type shock absorbers over 100 years ago for the same reason: to be instantly ready for the next bump.

There are several reasons our dampers are superior to BRBs:

- Taylor Dampers allow the relief of forces that could otherwise build up in BRB's as a result of creep and shrinkage as a building ages.
- BRB's are yielding members, and their characteristics and life are unpredictable after use.
- BRB's need to be replaced after a significant seismic event.
- BRB's cannot provide energy dissipation for low-level earthquakes. A BRB functions only as a brace until a larger earthquake strikes, when they may or may not yield.
- BRBs increase acceleration levels in the structure.

Q *What type of fluid is used in a damper?*

A Silicone fluid. It is non-toxic and is cosmetically and chemically inert. This fluid is thermally stable, does not experience viscosity breakdown and will not settle out. Its flashpoint is greater than 600°F and is non-flammable and non-combustible. The fluid is manufactured and certified in accordance with U.S. Federal standards.

Q *How much damping is usually needed to protect structures?*

A Structures have different requirements. Sometimes the structure calls for a reduction in deflection, stress, or acceleration (or a combination thereof). Typical structures can experience a dramatic improvement with 10 to 40 percent of critical damping added. A dynamic analysis demonstrates the best solution through a relatively simple iterative approach. However, due to the fact that the optimized solution requires non-linear damping performance, it is not accurate to quantify the required damping in terms of percent of critical. A dynamic analysis demonstrates the best solution through a relatively simple iterative approach.

Q *How can I be sure that Taylor Fluid Dampers will operate as required during an earthquake or wind event?*

A To ensure exact performance, prior to shipment, each and every Taylor Devices structural damper is dynamically tested to maximum rated force at maximum velocity using our world-class in-plant test machines with instrumentation certified to exact U.S. government standards. Each damper is proof-pressure-tested to ensure the integrity of its parts and assembly. A test report on each damper is provided with every shipment.

