Friction Pendulum™ Seismic Isolation Bearings protect buildings, bridges, and industrial facilities from earthquake damage. They are structural supports that use an innovative way to achieve a pendulum motion of the supported structure. By placing these concave spherical bearings at each support point, the structure sways with a gentle pendulum motion during earthquake ground shaking. This allows the ground to shake without damaging the structure. Friction Pendulum™ seismic isolation provides structures with a higher level of seismic protection than conventional structural strength and ductility design. Compared to elastomeric bearings, Friction Pendulum™ bearings can be used for a wider range of applications, have simpler and more predictable properties, and are less expensive to install.

Simple in design but with versatile properties, Friction Pendulum™ bearings have been used in some of the world's largest seismically isolated buildings, bridges and industrial tanks. Friction Pendulum™ bearings have also been effective and economical for small buildings, bridges, and chemical tanks. Since their conceptual development in 1985 by Dr. Victor Zayas, Friction Pendulum™ bearings have been used as the primary seismic protection for 1.6 billion dollars worth of civil engineering construction. Application highlights include:

U.S. Court of Appeals: The seismic retrofit of the historic U.S. Court of Appeals building in San Francisco, upon its completion in 1994, was the largest building in the world to have been retrofitted with seismic isolators, and the first federal government project to use seismic isolation. In awarding the isolation system design and supply contract to EPS, the U.S. Comptroller General stated that, "the advantages of the Frictio - its novel technical approach, supported by test results and other analysis, was found by the Technical Evaluation Board to more effectively enhance the building's survivability in the event of an earthquake". The project's Architects and Engineers, Skidmore, Owings & Merrill, stated that, "use of the Friction Pendulum™ base isolation system saved $7.6 million in construction costs and more than 80,000 sq. ft. of usable space". The project was sign Award for Engineering, Technology & Innovation.

San Francisco Airport International Terminal: The San Francisco Airport International Terminal was designed by Skidmore, Owings and Merrill with Dr. Anoop Mokha as Project Engineer. The seismic design used Friction Pendulum™ seismic isolation to resist a magnitude 8 earthquake occurring on the San Andreas fault, with no structural damage and minimal architectural damage. The building has dramatic architectural features, including:

expansive interior spaces, 80 feet tall columns, 700 feet long roof trusses, and glass exterior walls. Since falling glass posed a serious hazard during an earthquake, minimizing drift in the glass exterior walls was the critical seismic design criteria. Conventional structural frames, with or without added viscous dampers, could not satisfy the seismic performance requirements. Seismic isolation could achieve the desired seismic performance and provided the lowest construction cost. Moreover, the use of Friction Pendulum™ bearings, as compared to rubber bearings, allowed for a further reduction in column and beam sizes and saved an additional 680 tons of structural steel. With over 22 million cubic feet of interior space, it is the largest isolated building in the world.

Liquefied Natural Gas Tanks, Greece: Greece's centralized liquefied natural gas (LNG) storage tanks are located just outside of Athens. These tanks contain 38 million gallons of flammable LNG, and are situated within a region of high seismicity. Maximizing safety was a priority for this project. The isolation bearings were designed to protect the tank structures and contents, thus ensuring tank safety and operation after an earthquake. Friction Pendulum™ bearings were selected over elastomeric bearings after extensive tests of full size bearings showed that they were best able to withstand exposure to extreme cold temperatures and fire hazards, and maintain the desired design properties over a 35 year life. Isolation with Friction Pendulum™ bearings achieved the safest tank performance.

Benicia-Martinez Bridge: The Benicia-Martinez bridge is one of the largest bridges to date to undertake a seismic isolation retrofit, and uses the largest seismic isolation bearings ever manufactured. The Caltrans specifications state that, "Friction Pendulum™ bearings are the only bearings known to the State that can meet the requirements and time constraints of this contract." Retrofit of the bridge using a conventional strengthening approach would have resulted in unacceptably high construction costs, and a multi-year construction time with major disruption to traffic flow. By using Friction Pendulum™ bearings, the State was able to minimize project delivery time, reduce construction costs, and maintain traffic flow during the retrofit.

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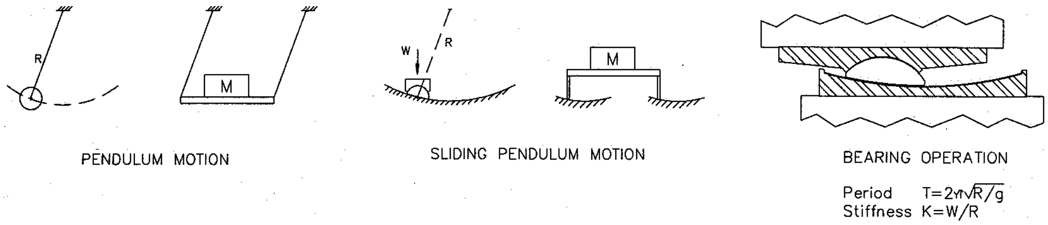
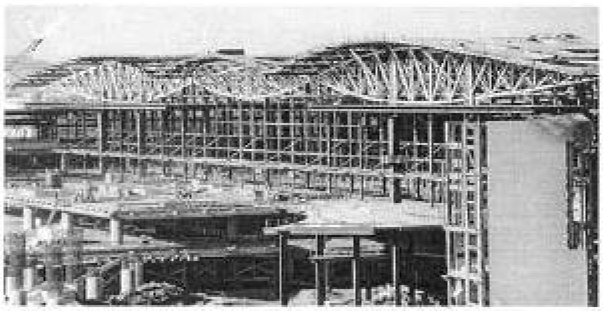
Friction Pendulum™ Seismic Isolation Bearings

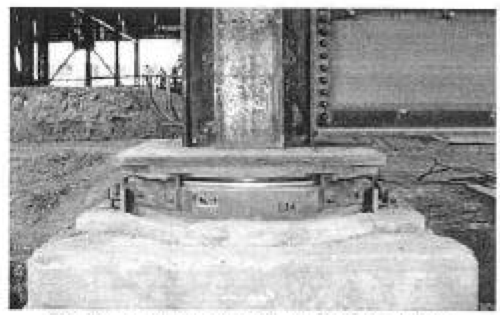


Basic Principles of the Friction Pendulum™ Bearing

Application Examples:



San Francisco Airport International Terminal



SF Airport Terminal Installed Bearing

Hayward City Hall

Hayward City Hall Installed Bearing

Benicia-Martinez Toll Bridge

Concave for Benicia-Martinez Bridge Bearing