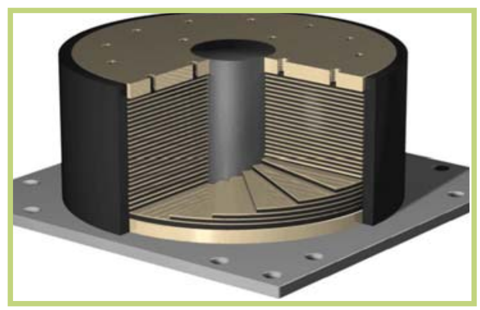
CHINA BASIN ADDITION



BASE ISOLATION
EARTHQUAKE PROTECTION TECHNOLOGY

The Addition at China Basin

The addition structure at China Basin utilizes an innovative application of seismic isolation technology. Under the ownership of RREEF & McCarthy Cook the two level, 175,000 square foot isolated addition has been built upon the 1991 vintage three level post tension concrete Berry Street Building at China Basin. This isolation technology is well suited for this application given the areas susceptibility to earthquake activity and meeting the current building code requirements under the performance based design criteria. The seismic isolation system provides lateral flexibility for the addition structure, and during an earthquake dampens the ground motion energy being transferred into the structure. The isolation system utilizes a combination of 87 DIS lead rubber bearings and sliding isolators. This sophisticated seismic isolation system is being used in high-value structures and offers the building occupants and operations with a high level of safety and protection.

According to the U.S. Geological survey, scientists put the odds at **99 percent** for California to experience a 6.7 magnitude earthquake or greater within the next 30 years. It is not a matter of “if” a major earthquake will strike California but “when”. For your reference further information on the earthquake potential is included in Section I and the details of this innovative isolation system is described in the following sections herein.

CHINA BASIN ADDITION

BASE ISOLATION

EARTHQUAKE PROTECTION TECHNOLOGY

I. CALIFORNIA EARTHQUAKE RISK

NOT IF.... BUT WHEN

II. BASE ISOLATION TECHNOLOGY

III. CHINA BASIN ADDITION

IV. ISOLATION APPLICATIONS

V. ISOLATION BENEFITS

VI. APPENDIX

CHINABASIN

MCCARTHY • COOK
A RELATIONSHIP DRIVEN EXPERIENCE

RREEF

I. CALIFORNIA EARTHQUAKE RISK

NOT IF.... BUT WHEN

SFGate.com

Huge state quake predicted within 30 years

David Perlman, Chronicle Science Editor
Tuesday, April 15, 2008

A strong and deadly earthquake is virtually certain to strike on one of California's major seismic faults within the next 30 years, scientists said Monday in the first official forecast of statewide earthquake probabilities.

They calculated the probability at more than 99 percent that one or more of the major faults in the state will rupture and trigger a quake with a magnitude of at least 6.7.

An even more damaging quake with a magnitude of 7.5 or larger, the earthquake scientists said, is at least 46 percent likely to hit on one of California's active fault systems within the next three decades. It probably would strike in the southern part of the state, the scientists warned.

The report by the team of federal and state geologists, seismologists and geophysicists does not significantly change the probability estimates for future large quakes on the Bay Area's major faults that were calculated five years ago, but it does provide the first detailed forecasts for quakes in the Los Angeles area, specifically on the southern San Andreas Fault, the San Jacinto Fault and the Elsinore Fault.

Quakes like those would be similar in magnitude to such deadly temblors as the Loma Prieta, which claimed 63 lives and caused at least $10 billion in damage in 1989, and the Northridge quake in the San Fernando Valley in 1994, which killed 57 people and caused more than $12.5 billion in damage.

"If you divide the state into its northern and southern regions, it's inevitable that we'll see large quakes on at least one or more of our major faults within the next three decades," said geophysicist Tom Parsons of the U.S. Geological Survey in Menlo Park, a member of the group that produced the report.

The work of tectonic plates

California, riven by thousands of faults that extend many miles deep into the Earth's crust, is one of the world's most seismically active regions. Two huge tectonic segments of the Earth's crust - the Pacific Plate and the North American Plate - move constantly past each other at about 40 millimeters, or 1 1/2 inches, each year, forming a great clashing boundary where stresses build up along all the state's faults.

That buildup of stress on any single fault after its most recent rupture and the average time between the fault's past quakes help scientists forecast the probability that stress will rupture the fault again and release an earthquake's power.

"The further you are in time from the last quake on a fault, the higher the probability is for the next one," said earthquake geologist David Schwartz of the Geological Survey.

The probability forecasts released Monday are only the first new ones in a series of more refined estimates that the working group will produce and make public for highly practical purposes.

"The report's details should prove invaluable for city planners, building code designers, and home and business owners who can use the information to improve public safety and mitigate damage before the next destructive earthquake occurs," said geophysicist Ned Field of the Geological Survey, who headed the Working Group on California Earthquake Probabilities, which developed the forecasts.

The analysis was requested by the California Earthquake Authority, a public agency created by the state Legislature in 1996 and funded by companies throughout the state that offer limited quake insurance to all comers.

Scientists from the Geological Survey, the Southern California Earthquake Center and the California State Geological Survey participated in the report, and its conclusions were evaluated and approved by two other expert groups known as the California and National Earthquake Prediction Councils.

Tweaking their forecasts

While predicting the precise time, location and magnitude of future quakes is impossible, scientists have been refining their forecasts for the odds of large quakes rupturing known faults since 1987.

To arrive at their latest forecasts, the scientists in the group used complex analytical tools developed over many years and powerful new computer programs. "Computer power played a large part in developing the new probability models," Parsons said.

By their calculations, the probability that a magnitude 6.7 quake will hit on any one of the Bay Area faults is 63 percent, only a tiny bit higher than the 62 percent estimated by a similar group in 2003. But the probability for that kind of severely damaging quake on the Hayward-Rodgers Creek Fault was increased in the new forecast from 27 to 31 percent.

The analysis was the first to assess the probabilities for quakes on several Southern California faults. It calculated the odds of a magnitude 6.7 quake striking within 30 years in greater Los Angeles at 2 to 1, a probability of 67 percent, according to the report.

The single fault in all of California with the highest probability for a large quake occurring within the next 30 years is the Southern San Andreas, and the seismic oddsmakers set the number there at 59 percent - a lot more than even money.

Looking at California's most northern region - actually the southern end of the 750-mile-long Cascadia Subduction Zone, which stretches far up the Pacific Coast into British Columbia - the quake experts set the probability for a large quake there within 30 years at only 10 percent. They concluded, however, that it could be a truly big one, what seismologists term a Great Earthquake - with a magnitude of 8 or even 9. Quakes that powerful occur once every 500 years on average.

But the report's primary focus was on the Bay Area and Los Angeles area.

"In our two major metropolitan areas where odds are highest that a large quake is coming, people think a lot about quakes whenever even a smaller one shakes ... but 10 days later most folks forget them, and they shouldn't," said Schwartz, who served on the scientific review panel that evaluated the new probability estimates.

Online resource

California's quake probability map: *links.sfgate.com/ZDAS*

Remembering 1906

The 102nd anniversary of the San Francisco earthquake and fire will be observed at 5:12 a.m. Friday at Lotta's Fountain on Market Street. The tradition was started years ago by the South of Market Boys to honor the survivors of the disaster. The time of the event is set to coincide with the precise moment the ground began to shake. At left is a view of Market Street as the fire consumed the downtown area.

Quake forecasts over the years

Scientists have refined their forecasts over time as they've been able to learn more about the nature of quakes. Here are some of the forecasts - a few seemingly based on flights of fancy, but most on solid science - since 1970:

September 1970: Nathan Newmark, a nationally known earthquake researcher, tells a Stanford audience that the ability to reasonably predict an earthquake is 10 to 15 years away. But, barring some scientific breakthrough, we won't be able to modify or control temblors before 2000, he says.

September 1974: Two British astronomers predict a great earthquake - magnitude 8 or greater - on the San Andreas Fault in 1982, the result of a rare alignment of the planets that will trigger violent radiation storms on the sun that, in turn, will disrupt Earth's weather patterns. The prediction is quickly rejected by earthquake experts. The quake never happens.

December 1979: UC seismologist Bruce Bolt and Stanford geology Professor Richard Jahns say there is a 50-50 chance for a major earthquake - at least a magnitude 7 - somewhere in California within 10 years. The warning is based on measurements of strain along California faults and historical records of earthquake occurrence. Ten years later, Loma Prieta hit with a magnitude of 6.9.

October 1991: Scientists at the U.S. Geological Survey set the odds at 2 to 1 that another large quake like Loma Prieta - magnitude 6.7 or larger - will strike the Bay Area within the next 30 years.

June 1994: New studies of the Bay Area's major earthquake faults convince government scientists that the chances are now 90 percent that a major quake will strike somewhere in the region within the next three decades. The estimate sharply raises the odds set only four years before, when a panel of the nation's leading seismic experts set the likelihood of a major quake in the Bay Area at 67 percent.

October 1999: USGS scientists calculate a 70 percent chance that a major earthquake will strike somewhere in the Bay Area before 2030.

September 2002: Scientists say they were probably wrong in trying to forecast the next big quake on the San Andreas Fault based on the frequency of previous tremors beneath Parkfield in Monterey County. The concession could cast doubt on many other quake forecasts, including the warning that there's a 70 percent chance of a dangerous temblor hitting the Bay Area by 2030.

April 2003: In the most detailed investigation of earthquake hazards throughout the Bay Area, scientists warn of a 62 percent probability that a major quake with a magnitude greater than 6.7 will strike in the Bay Area before 2032. They agree that the likelihood is more than 80 percent that a smaller but still damaging temblor of magnitude 6 to 6.6 will strike the region during the same time period.

April 2006: Scientists say the odds are 2 to 1 that a quake with a magnitude of 6.7 or greater will strike somewhere on one of the Bay Area's seven major seismic faults between now and 2031.

March 2008: The next major earthquake on the Hayward Fault - inevitable anytime now, experts say - will be the Bay Area's own Hurricane Katrina. The prediction comes from new estimates of losses resulting from a magnitude 7 temblor on the fault.

April 2008: Scientists put the odds of a strong and potentially deadly earthquake striking one of California's major seismic faults with a magnitude of at least 6.7 within the next 30 years at more than 99 percent.

E-mail David Perlman at dperlman@sfchronicle.com.

http://sfgate.com/cgi-bin/article.cgi?f=/c/a/2008/04/15/MNGC104TGE.DTL

This article appeared on page **A - 1** of the San Francisco Chronicle

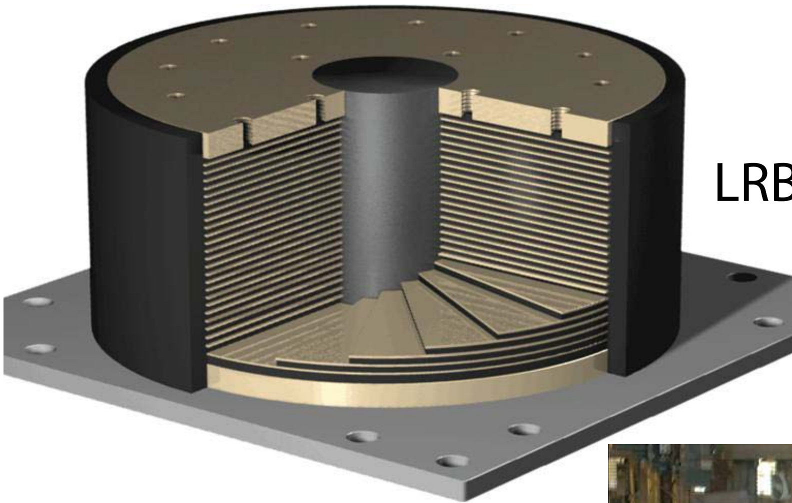
II. BASE ISOLATION TECHNOLOGY

ISOLATION ADVANTAGES

* Use base isolation technology to utilize the structure addition into a mass damper

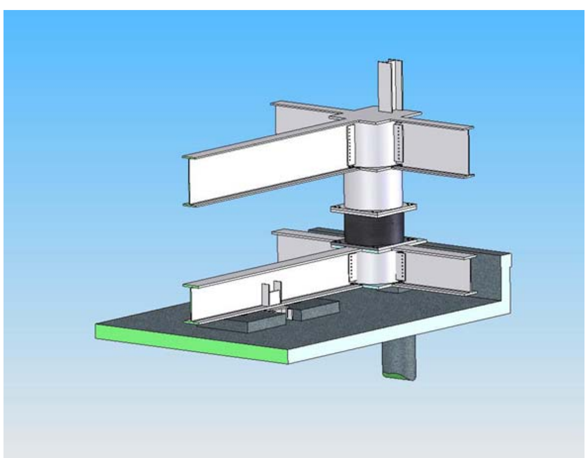
* Isolation Benefits
    * 95,000 additional square feet
    * Higher structural seismic performance
    * Significantly reduces risk of damage
    * Lower PML rating

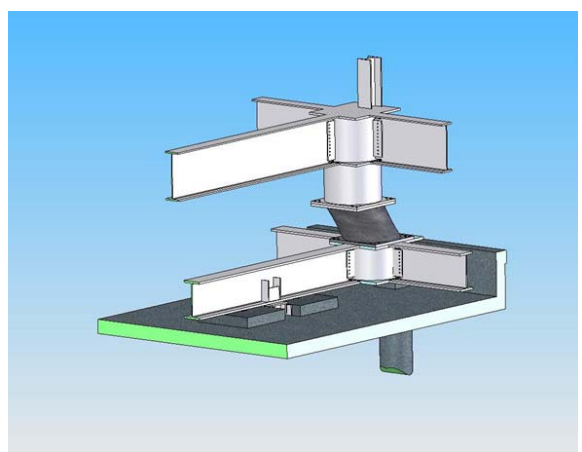
STRUCTURAL & SEISMIC SYSTEMS



LRB - 45.5" Diameter - 14.1" Rubber

Isolator bearings at Interstitial





III. CHINA BASIN ADDITION

PEER REVIEW

John Sumnicht
Simpson, Gumpertz & Heger

The SGH structural design contemplated constructing the two new stories on seismic isolation bearings over the roof of the existing structure, essentially deploying the addition as a mass damper. This was a unique and innovative concept that had never previously been implemented in any building in the United States.

When faced with unique structural solutions that are not adequately addressed by the prescriptive provisions of the building code, such as this, the City of San Francisco Department of Building Inspection requires a peer review to oversee the design process on behalf of the city. The peer review team for this project consisted of a practicing structural engineer, experienced in the design of base-isolated projects, Bret Lizundia, SE, a structural engineering researcher, Dr. Stephen Mahin from the University of California, Berkeley, and a geotechnical engineer, Dr. John Egan. Each of the three members on the peer review team is recognized as a distinguished professional in their respective fields.

The first issue tackled during the peer review was the seismic isolation provision contained in the 2001 CBC that require that the structure below the plane of isolation remain essentially elastic under design earthquake shaking. The existing structure had insufficient strength to ensure elastic behavior. Upgrade of the structure to provide such strength was impractical due to the cost and disruption of existing tenants. Therefore, SGH used a performance-based approach to demonstrate that although the substructure would not remain elastic, it would perform to acceptable standards. The agreed-upon performance objective has the existing building and addition providing a similar level of reliability against collapse or life safety endangerment as a new building designed to the current code.

A typical peer review process has a duration of between 3 and 5 months. Because of the complexity of this project and the rigor of the peer review our peer review process took 12 months from the start to final acceptance of the structural design. The breadth and depth of the review resulted in approximately 320 individual comments. Subjects ranged from broad issues such as site specific ground motions and consideration of soil-structure interaction to small detailing issues. By the end of the process the structural design has been well-vetted and confirmed to be sound engineered solution.

The Addition at China Basin
185 Berry Street, San Francisco

In December 2007, construction reached substantial completion on an unusual and innovative application of seismic isolation in a building expansion at 185 Berry Street in San Francisco's Mission Bay district. Backed by a team of dedicated building design professionals, including contractor Hathaway Dinwiddie Construction Company (HDCC), architects Helmuth Obata and Kassabaum (HOK) and engineers Simpson Gumpertz & Heger Inc. (SGH), the owner RREEF/McCarthy Cook, successfully expanded the existing three-story, 225,000 sq ft building by 175,000 sq ft adding two new stories, on budget and on time with minimal disruption to the existing tenants. The project team accomplished this complex, challenging project by going far beyond standard practices from initial design and permitting all the way through to final construction.

Building History

"Background and Tenancy"

The 185 Berry Street building at China Basin was originally designed in the mid-1980s and opened in 1991. With the construction of Pac Bell Park just to the east, and the new University of California at San Francisco (UCSF) Mission Bay campus to the west, office space and life science space in this portion of the City became highly desirable.

The existing building is a three-story, concrete frame structure with post-tensioned flat slabs. Development manager McCarthy Cook & Co wanted to expand this structure adding as much new rentable space as possible. In its existing condition, approximately 80,000 sq ft of additional space could be added on top of the existing building with light-weight steel framing without implementing a seismic upgrade to the existing structure. In order to add the desired two new floors conventional upgrade approaches involved building new reinforced concrete shear walls within the existing occupied structure. This would have been highly disruptive to the bio-science laboratories operated by UCSF, a major existing tenant in the building. Despite the fact that the University desired to expand its presence at China Basin, it could not tolerate the disruption of its existing operations that seismic retrofit construction would have entailed.

Designing a Solution

"The Advantage of an Isolation System"

The San Francisco office of SGH proposed that the two new stories be constructed on seismic isolation bearings placed on top of the existing structure. This mid-level isolation concept had never previously been implemented in any building in the United States. In initial feasibility studies, SGH demonstrated that using this technique, the new construction atop the isolation bearings would act like a giant tuned, 800 foot long mass damper. During strong earthquake shaking, the new stories addition would move laterally to counteract and dampen the motions of the existing building and actually reduce the amount of earthquake force and displacement demand on the existing structure. This not only permitted the new space to be constructed without requiring a structural upgrade but also improved the seismic performance capability of the existing building. Most importantly, it eliminated the need for an intrusive and disruptive seismic retrofit of the nearly, fully occupied building below.

The project employs 87 seismic isolation bearings, including 33 lead-rubber bearings and 54 elastomeric slider bearings, all supplied by Dynamic Isolation Systems (DIS) of Sparks, Nevada. The new superstructure uses approximately 3,000 tons of structural steel. The design of the isolation system presented a significant challenge: isolating a relatively light superstructure while keeping the isolators stable at a displacement of +/- 45 inches, which was 1.5 times the code required maximum displacement of +/- 30 inches (average of seven maximum credible earthquakes). This required an isolation system consisting of 45 inch diameter lead-rubber bearings and a new elastomeric based sliding system where the PTFE sliders provided +/- 30 inches of displacement and the additional +/- 15 inches of displacement was accommodated in the 24 inch diameter elastomeric bearing. Prototype testing demonstrated the stability of both bearings.

Performance-based Design

"Code Compliance"

Following preliminary study of the isolation concept, RREEF/McCarthy Cook retained SGH to complete structural design while the San Francisco office of HOK provided architecture for the expansion. Because the structural system is so unique, it falls outside of any defined system in the building code. SGH proposed to use a performance-based design approach to demonstrate that acceptable performance could be obtained.

An Intense Peer Review

"Validation by an Independent Panel"

The City of San Francisco Building Inspection department agreed to accept a performance-based design approach for the project, subject to an independent peer review by a team comprised of another independent structural engineer, a geotechnical engineer, and a prominent engineering researcher from the University of California at Berkeley. All parties agreed that the approach would be acceptable if SGH could demonstrate that the existing structure would perform as well as would be expected of a new code-conforming building of similar size and occupancy. The peer review process for this project was so intense that it lasted about 12 months; a typical peer review takes up to six months.

SGH developed a highly detailed analytical model of the structure that represented the nonlinear characteristics of the existing structure, the seismic isolators, the new addition, and even the existing foundation piles beneath the structure. Analyses were further complicated by the fact that the existing building is actually three separate structures, formed by the presence of two expansion joints located at approximately the 1/3 points of the 825-foot long structure. SGH modeled the structure so that the effects of pounding between the three separate structures could be explored. Eventually, SGH decided to place viscous dampers at the joints between the separate structures, to dissipate some of the energy transferred between the separate pieces as they collide, much as such devices are used to cushion the forces associated with berthing large ships at marine terminals.

From start to finish, this project and the process it entailed came with a significant level of risk for the owner. In order for the project to achieve its time and budget goals, RREEF/McCarthy Cook needed to stay committed to project, even while in peer review. This was a crucial element of the team's ability to stay on schedule. For example, the project team was relying on a specific window of time for its steel delivery, which, due to the schedule of steel fabricators on the West Coast, needed to be locked down 10-12 months in advance. In June 2006, with approval from ownership, McCarthy Cook gave the green light for the project to proceed and steel to go up – in March 2007.

Keeping to schedule became even more important because of one powerful, external influence: the San Francisco Giants. China Basin is located directly across the street from the Giants baseball stadium; they share streets, sidewalks, and traffic. The crane the project used to hoist steel and materials needed to be removed from the street by the middle of June in order to avoid significant traffic obstacles and conflicts during the height of the sports season. In addition to regular season games the Giants hosted the 2007 MLB All-Star Game!

Complete Collaboration

"Full Team Effort"

From initial design concept through construction, the full project team including the owner RREEF/McCarthy Cook, McCarthy Cook project manager, structural engineer, contractor, owner, architect, and other subconsultants, closely collaborated together. Hathaway Dinwiddie provided input on cost, schedule, and constructability from the very start, and as a result of the open communication, the design team was better able to incorporate these ideas into the process. Building the Addition over three levels of occupied space and maintaining the tenants use and occupancy through out the construction process was a major consideration. Detailed advanced planning was done with each tenant and during the construction phase, weekly coordination meetings were held with representatives from the building's current tenants, including CHW,UCSF and state agencies, to ensure tenant concerns were addressed.

During the design phase, the team encountered a number of what could have been project-ending design issues that required creative solutions. One representative issue dealt with the stair and elevator cores. The structure at 185 Berry Street had four main "cores" for the elevator and stairwells. Since the elevators could not accommodate any offset at the plane of isolation, the elevators and stairs were built inside of a tower that penetrated the isolated structure above. To accommodate the movement of the isolated structure, a moat was built around the cores. Access to the upper floors from the cores required special "tunnels" that would allow up to 36 inches of movement in all directions while maintaining a fire rating. HOK found only one supplier, Construction Services, Inc., which offered ICBO rated units that would allow the building to meet code. Through collaboration, the firms revised the original designs, which required 40 units, to a final design that required only 18, thereby keeping the project on budget. This is just one of many design iterations that occurred to meet the owner's project timing and cost objectives. Without the input from all of the team members, the changes would not have happened early enough to keep the project on schedule and on budget.

The close collaboration continued through construction. SGH worked very closely with the contractor to resolve any conflicts that came up as the project progressed. During one phase of construction, the design required workers to core five inches into and existing slab – in some cases, immediately above post-tensioning tendons. The design needed 780 cores. In addition, about 2,000 three-quarter inch diameter dowels were drilled into the slab. The building design conflicts are inevitable. Using ground penetrating radar with software upgrades enabling operator to create a real time 3D image in the field, the contractor, Hathaway Dinwiddie located all of the tendons and reinforcement in the areas that were to be drilled. Numerous locations showed a conflict; SGH worked closely with the contractor to redesign core locations to accommodate existing conditions. As a result of this collaborative effort, revisions occurred in real time, keeping the project on schedule.

Collaboration between Hathaway Dinwiddie and SGH also played a significant role during welding of steel beams on the roof. These beams were placed above concrete pads; large steel lugs were welded to the bottom of each beam, between each concrete pad. It was less expensive to shop-weld these lugs to the beams than to field-weld them. However, due to large amounts of pre-existing mechanical equipment on the roof – needed for the building to still operate for its current tenants – all of the steel beams could not be installed with the lugs pre-welded. SGH developed a second series of details so that the contractor could choose between shop-welded and field-welded details, keeping costs as low as possible without disrupting the tenants.

Subconsultants also contributed to the collaborative efforts. SGH, Hathaway Dinwiddie, and the steel subcontractor, Herrick, met regularly to ensure the project proceeded smoothly. The close "give and take" relationship allowed Herrick to perform certain details that adhered to their standard practice while at the same time figuring out the best practical and efficient way to bring the engineer's designs to reality.

Most of the structure's existing building columns needed to be reinforced; they were wrapped with fiber reinforced polymer. Using this material and working afterhours on the weekend, the contractor was able to minimize tenant disruption and in doing so, meet the owner's objectives. In addition, collaboration with the subconsultants and the seamless implementation of the interim mechanical plant enabled UCSF and the mechanical support systems to remain fully operational, twenty-four hours a day, seven days a week, while the team project moved the building's primary mechanical equipment.

Summary

"A Successful Development Project"

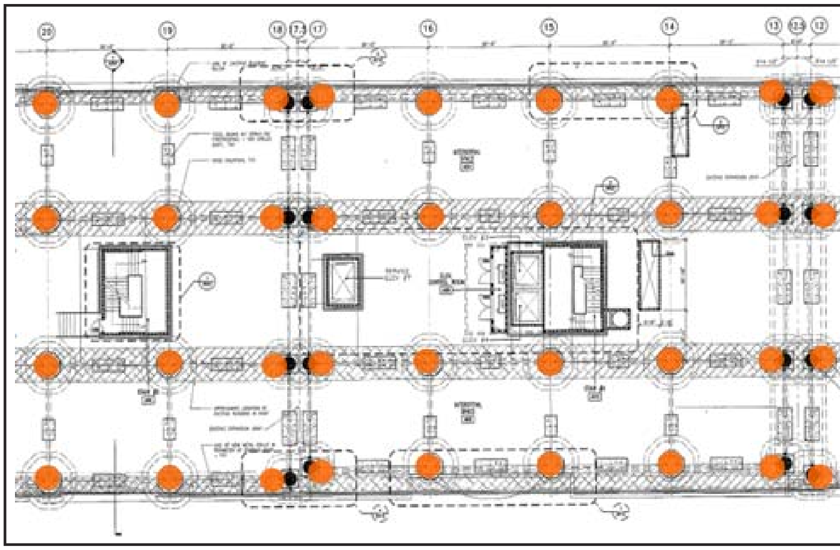
Many factors contributed to the success of this project: the owner's project management foresight and confidence, the positive working relationship among the team members including the contractor and all the consultants, a thorough peer review process, and an environment that encouraged input from all parties. In testament to their success and close collaboration, during the construction of a project of this size and complexity one can expect between 1,000 and 2,000 requests for information (RFIs) from the contractor. The project is now complete, and there were less than 150 RFIs in total.

STEEL BEAM INSTALLATION

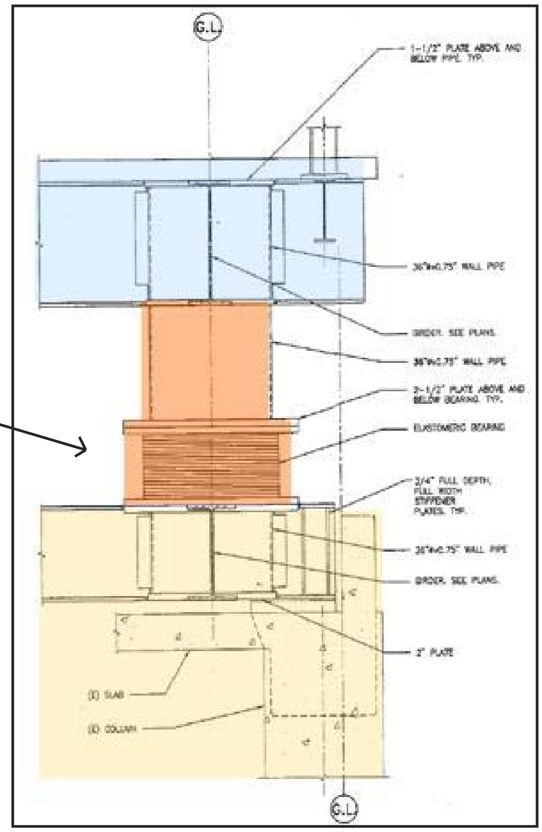
Structural & Seismic Systems
Steel: 60' long 6' Plate Girder

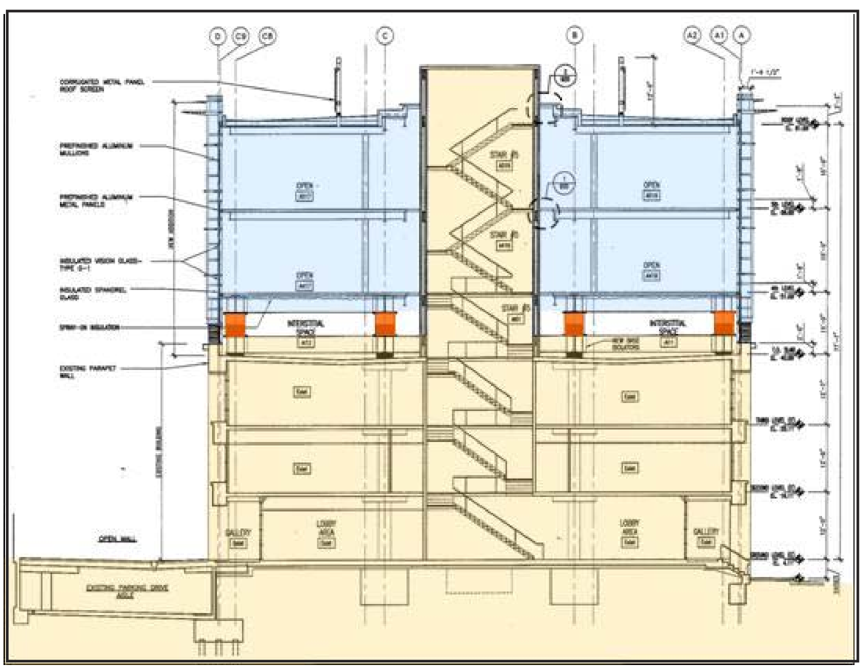
SEISMIC JOINT

ISOLATION DETAIL

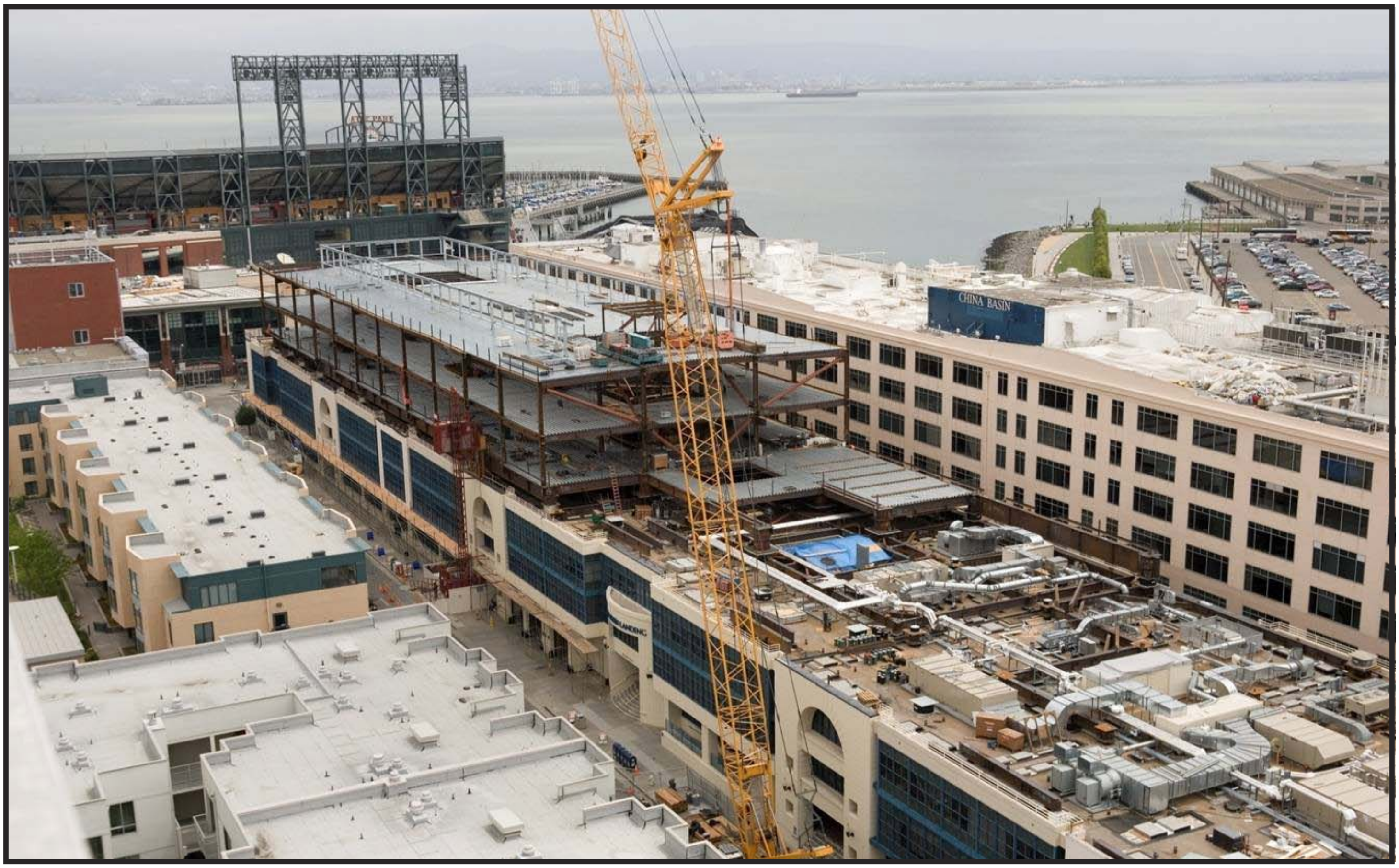


Seismic Base Isolation System





ADDITION STEEL ERECTION



IV. ISOLATION APPLICATIONS

ISOLATED BUILDINGS

Amgen Campus in Seattle

Kaiser Data Center in California

ISOLATION APPLICATIONS

Immunex Campus, Seattle, WA

"This Reasearch and Technology Center whish islocated on Seattle's industrial waterfront hosts immune system studies and drug therapy development. It also houses $50 million of state-of-th-art equipment. The owner was also concerned that an earthquake could prevent the center from working for several months which would be costly for the corporation."

- Dynamic Isolation Systems
  Seismic Isolation for Buildings and Bridges

V. ISOLATION BENEFITS

UNMATCHED STRUCTURAL SYSTEM
The China Basin Advantage

Life Safety Advantage and Operating Risk Reduction

* Base isolation reduces force levels during a cataclysmic 8.0 earthquake to a manageable 5.0 magnitude earthquake level
* Probable Maximum Loss (PML) of +/- 4% and Importance Factor of 125% equals a 'Mission Critical Data Center' standard

Long Term Preventative Insurance Value

* Major reduction in potential loss damage, business interruption, repair and restoration costs

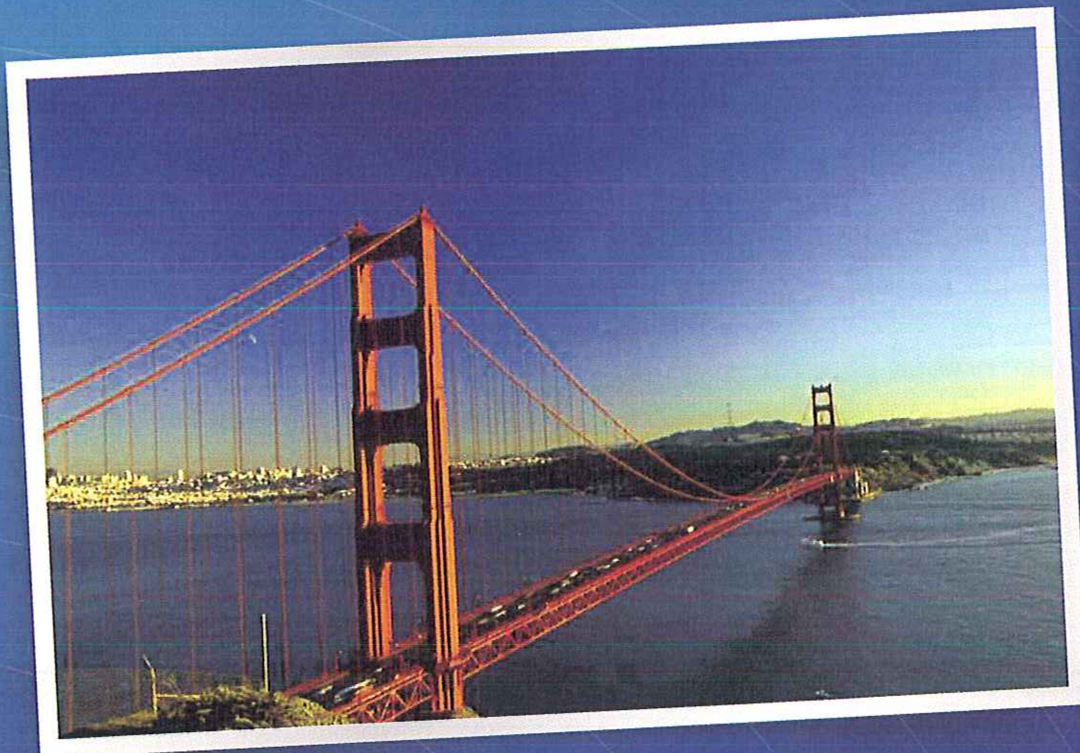
Reduced Insurance Risk and Rate

* Reduced cost for business interruption and earthquake insurance and/or radically reduced corporate self-insurance exposure

Green/Sustainable Benefits

* Base Isolation accepted by the US Green Building Counsel for LEED certification points
* Major reduction in damage potential and therefore points granted for meeting sustainable building goals

VI. APPENDIX



Seismic Isolation
For Buildings and Bridges

The Best Earthquake Protection Technology In The World.

Dynamic Isolation Systems

Seismic Isolation Should Be Your Design Solution Because It Provides:

- Superior Performance
- Improved Personal Safety
- Structural Protection
- Continuous Operation
- Content Protection
- Cost Savings

DYNAMIC ISOLATION SYSTEMS

Table of Contents

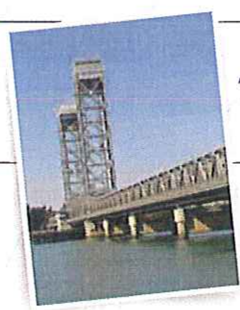
Section 1: Seismic Isolation

Seismic isolation is a technology that protects the structure from the destructive effects of an earthquake - it decouples the structure from the ground and provides it with damping.

This decoupling allows the building to behave more flexibly which improves its response to an earthquake. The added damping allows the earthquake energy to be absorbed by the isolation system and therefore reduces the energy transferred to the structure.

Left: Utah State Capitol Building, Salt Lake City. **Above:** Golden Gate Bridge, San Francisco, California.

Seismic isolation is physically achieved by placing the structure on isolators. The isolators are laterally flexible elements, yet they are able to carry the vertical loads of the structure. Since the isolators are more flexible than the structure, most of the lateral movements occur in the isolators. As a result the isolated structure experiences less motion and reduced forces.



DUE TO THE SMALLER MOTIONS AND LOWER FORCES IN THE SUPERSTRUCTURE, LIVES ARE PROTECTED, CONTENTS ARE PRESERVED AND BUILDINGS REMAIN OPERATIONAL.

The **Design Earthquake** has a 10% probability of occurring during the lifetime of the structure. It will measure from 6.0 to 8.0 on the Richter scale.

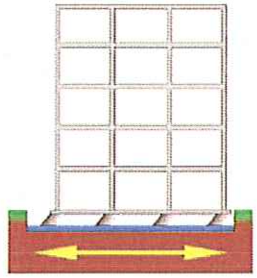
What types of structures are isolation candidates?

- Hospitals, Bridges and Emergency Centers that require operation during and immediately after an earthquake.
- Structures with valuable contents or operations such as data centers, communications facilities, high-tech manufacturing facilities and museums.
- Buildings with high occupancy such as low to medium-rise residences and office buildings.
- Historic structures.

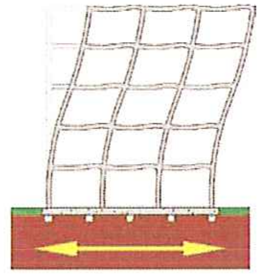
Seismic Isolation

What performance can be expected from isolation?

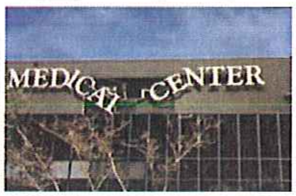
Seismic isolation provides superior performance compared to a traditional structural design. It reduces the forces and displacements in the structure by up to 75%. The isolation system accomplishes this by deforming laterally during the earthquake. After the earthquake this results in a functional structure with little or no damage.



Seismically Isolated Structure: The deformation pattern of an isolated structure during an earthquake. Movement takes place at the level of the isolators. Floor accelerations are low. The building, its occupants and contents are safe.



Conventional Structure: The deformation pattern of a conventional structure during an earthquake. Accelerations of the ground are amplified on the higher floors and the contents are damaged.



What performance can be expected from a conventional structure?

Traditional structural design is intended to prevent major failures and loss of life. This design approach does not consider immediate occupation, the maintenance of operation, nor does it provide for easy repair. Traditional design relies on damage to the structure, such as yielding and plastic deformation to dissipate an earthquake's energy. Ductile design of the yielding members helps prevent collapse of the structure. Inherent to this design is the possibility of significant damage to the structure, contents and an inoperable, unusable structure after an earthquake.

Isolated structures have demonstrated a record of excellent performance during earthquakes.

How have isolation systems performed in earthquakes?

The **USC Hospital** was isolated using Dynamic Isolation Systems isolators. The building remained operational throughout the 1994 Northridge Earthquake. There was no damage to the USC Hospital. In contrast the Los Angeles County Medical Center located less than a mile away suffered $400 million of damage and was not operational after the earthquake.

USC Hospital, Los Angeles, California.

The **Stanford Linear Accelerator** in Palo Alto, California was unscathed by the 1989 Loma Prieta Earthquake. Elsewhere on campus, damage was reported to be approximately $160 million.

The **Eel River Bridge** in Humboldt County, California was isolatd using DIS isolators in 1988. It experienced accelerations of 0.55g in the 1992 Petrolia Earthquake. The bridge displaced 9 inches laterally and sustained no damage.

How does isolation provide cost savings?

In bridges, the foundation design is based on elastic forces. Isolation reduces elastic forces by up to 75%. This translates into direct cost savings in the foundation. In buildings, isolation provides cost savings over the life of the structure. An isolated building will be essentially undamaged in an earthquake. By comparison, a conventional building's structure and contents will be damaged. The occupants will also experience interruption of their businesses, sometimes for weeks or even months.

Dynamic Isolation Systems

Dynamic Isolation Systems played a key role in the development of Seismic Isolation Technology including its commercialization in the 1980's.

DIS helped to develop codes and provided design and analysis support to engineers and government agencies. Over the past 20 years design earthquakes have increased considerably. DIS has continued to develop its isolators to perform well at large lateral displacements accompanied with high axial loads.

Isolated Projects

Dynamic Isolation Systems has provided over 12,000 isolators for more than 250 bridges and buildings worldwide. Some prominent projects isolated by DIS include the iconic Golden Gate Bridge, San Francisco City Hall (*left*) that was damaged in the 1989 Loma Prieta Earthquake and Tan Tzu Medical Center in Taiwan. At 1.7 million square feet, it is the largest isolated structure in the world.

Project Support

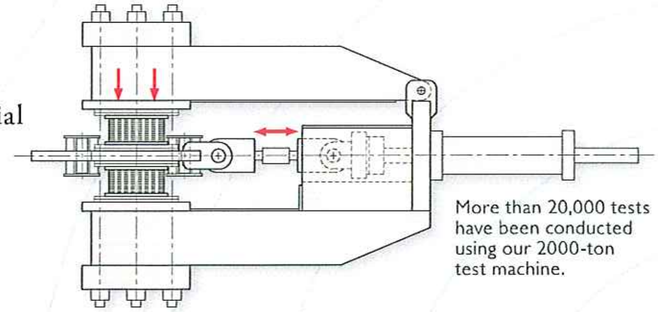
Dynamic Isolation Systems can assist you with your feasibility study, budget development and value engineering. We have been able to reduce the cost of the isolation system by up to 30% on projects where we can lend our expertise to the isolator layout and product mix. Our engineers can provide technical support and parameters for structural modeling.

Manufacturing Capabilities

Over 12,000 isolators have been fabricated by DIS.

- **Facility**
  Dynamic Isolation Systems' 60,000 square-foot manufacturing facility is located in Sparks, Nevada, USA. It is adjacent to Interstate 80 which allows for ease of freight throughout the United States and worldwide via the Port of Oakland in California.
- **Press Capacities**
  Dynamic Isolation Systems molds in custom-designed and built presses ranging from 200 to 4400 tons. In response to increased demand for larger-sized isolators DIS now has four presses of over 2000 ton capacity. The largest isolators we have manufactured were 60 inches in diameter and weighed 10 tons each.
- **Machining**
  Steel processing is a major part of manufacturing our isolators. Two large Computer Numeric Controlled (CNC) machining centers process the bulk of our steel plate. They have a capacity to machine up to 80-inch wide plates.
- **Testing**
  Our main test rig has a shear displacement of ± 31 inches, a shear force capacity of 700 tons and an axial force capacity of 2000 tons.

  Testing is also conducted in a smaller machine that has a shear displacement capacity of ± 12 inches, a shear force capacity of 100 tons and an axial force capacity of 600 tons.

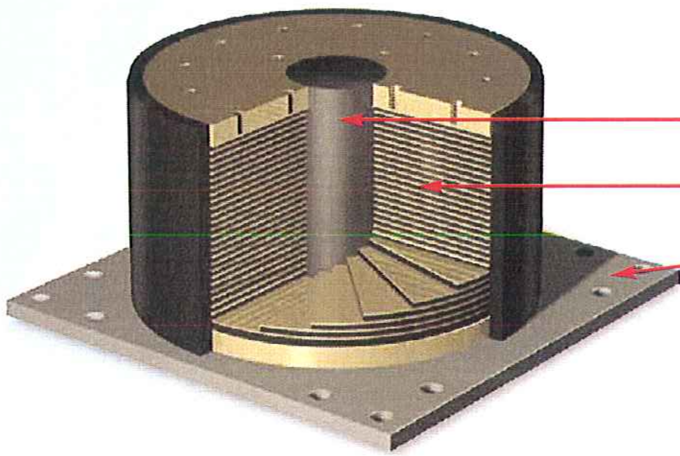


More than 20,000 tests have been conducted using our 2000-ton test machine.

DYNAMIC ISOLATION SYSTEMS

Seismic Isolator

Isolators consist of a laminated rubber and steel bearing with steel plates which connect to the structure. 90% of our isolators have an energy-dissipating lead core.



This is a DIS Lead Rubber Bearing (LRB). Vulcanized rubber layers are laminated between steel plates to form a flexible structural support. (The top mounting plate is not shown.)

Isolator Function

The rubber in the isolator acts as a spring. It is very soft laterally but very stiff vertically. The high vertical stiffness is achieved by having thin layers of rubber reinforced by steel shims. These two characteristics allow the isolator to move laterally with relatively low stiffness yet carry significant axial load due to their high vertical stiffness. The lead core provides damping by deforming plastically when the isolator moves laterally in an earthquake.

Size Ranges

Isolators from 12 to 60 inches in diameter and capacities of up to 4000 tons are manufactured. Custom dimensions are available for special applications.

Fabrication

The shims for isolators are cut to exacting tolerances by laser. The steel mounting plates are machined by computer-controlled milling machines that give high production throughput and accuracy. Molding each bearing takes 8 to 48 hours depending on the size of the bearing. The curing phase is continuously monitored to ensure that the rubber is uniformly cured throughout the bearing.

New construction or retrofits: For more than two decades Dynamic Isolation Systems has been helping architects, engineers, businesses and institutions match the right earthquake protection technology to the specific needs and requirements of their individual structures.

Sliding Isolator

A sliding isolator consists of a PTFE (Teflon) disc that slides on a stainless steel plate. A slider may be manufactured with or without an elastomeric backing. The most common slider has the same construction as an isolator with a Teflon disc substituted for the flange plate.

Slider Function

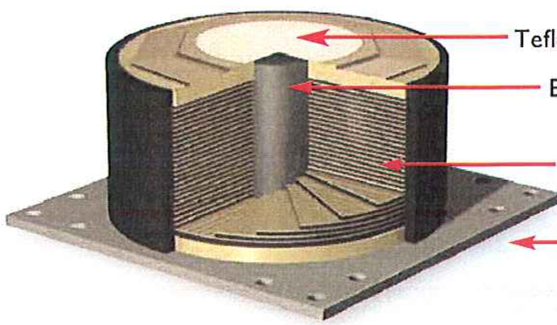
Sliders support vertical loads and have low lateral resistance. They are typically used in conjunction with isolators and enable the designer to optimize the performance of the isolation system. In some applications they are placed under lighter parts of the structure such as stairs and lightly-loaded columns. The elastomeric backing is used to accommodate rotations in the structure. An added benefit of sliders is that they provide damping from sliding friction.

Size Range

Sliding isolators have been made from 12 to 41 inches in diameter.

Slider Manufacturing

Sliders are fabricated with a Teflon disc that mates with a stainless steel sliding surface.



This slider was designed specifically for the Berry Street Project in San Francisco. It was designed to slide for 30 inches, then deform in shear a further 15 inches once it engages a restrainer plate. DIS fabricates and welds all parts of the slider assembly in-house.

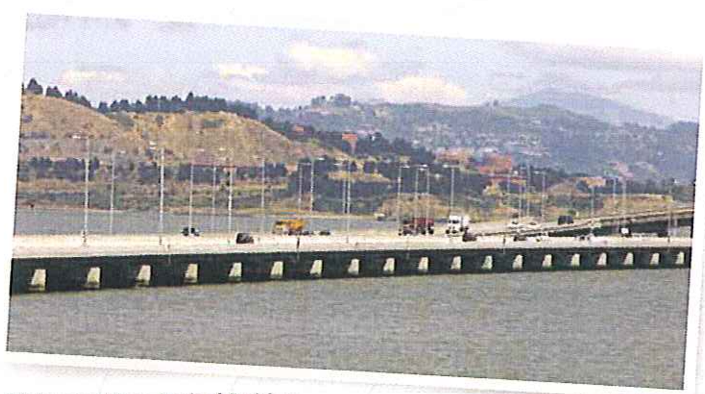
Other Products

Steelwork and Fasteners

Dynamic Isolation Systems processes over 2000 tons of steel a year. Steel mounting plates, sole plates, anchor bolts and fasteners are often fabricated and supplied with DIS isolators.

Specialty Bearings

Dynamic Isolation Systems designs and builds bearings for non-seismic applications such as ship loaders. The purpose of the bearings is to control forces within the structure during the off-loading of oil from tankers.



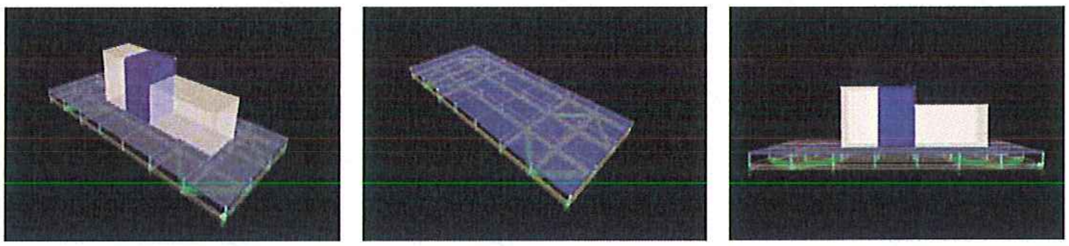
Richmond San Rafael Bridge:
Dynamic Isolation Systems developed and fabricated bridge bearings for Caltrans with increased corrosion resistance. The bearings are located six feet above the waterline and were fabricated with low permeability rubber and stainless steel construction.

Dynamic Isolation Systems

Floor Isolation

The DIS Floor Isolation System is a newly-developed product. The floor features a recently-invented, multi-directional spring unit that has a very low spring stiffness compared to a building isolator.

Spring stiffness up to 30 lbs/inch is available. The system is modular and can be used as an isolated floor platform or as a whole floor system.



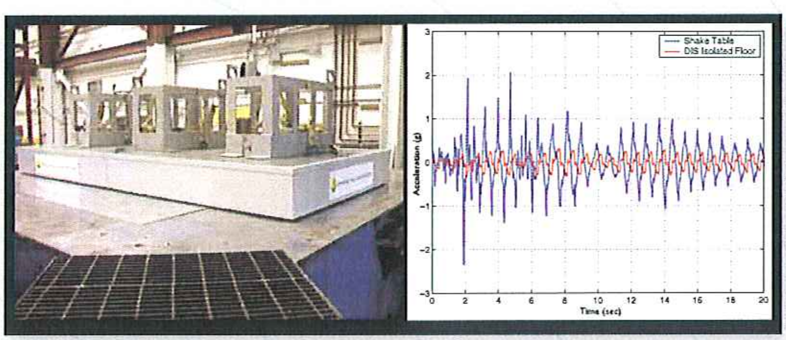
These schematics show the SAP 2000 computer model of a floor that that was tested at the University of Nevada, Reno. The floor unit is 14 feet wide by 6 feet deep. There are standard 4 foot by 6 foot modules at each end that are joined by 6 foot long stringers. The modules connect to multi-directional spring units and contain roller and sliding supports. Computer floor tiles make up the top surface of the isolated floor.

How does floor isolation differ from regular structural isolation?

A Floor Isolation System is installed inside the building and is not part of the structure. Traditional isolation is installed under columns and is an integral part of the superstructure. The same level of earthquake protection can be achieved by both systems.

When is floor isolation a good design solution?

Floor isolation is a good alternative when isolation of the whole building is not practical or economical. If you are a tenant, the superior performance of isolation can be achieved with floor isolation within the building. Data centers, medical equipment, high-tech manufacturing processes, artwork and valuable products such as vaccines require more seismic protection than a conventionally-designed structure provides.



The DIS Isolated Floor System was tested on the shake table at the University of Nevada, Reno. It gave excellent performance that matched our analytical models. For this test, the peak acceleration was reduced from 2g to 0.4g. The spectral accelerations were also reduced by as much as a factor of five.

What was our first floor isolation project?

The first floor isolation project was the King County Emergency Center in Seattle, Washington. The floor system protected communications equipment and involved isolating a concrete slab with lead rubber isolators and rollers. The new DIS Floor Isolation System is a lightweight solution that will allow its use on any floor of a building.

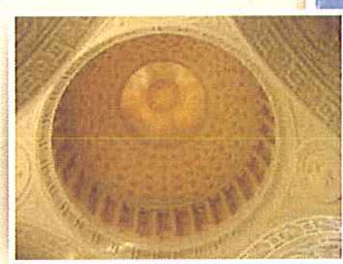
Section 2: DIS Portfolio

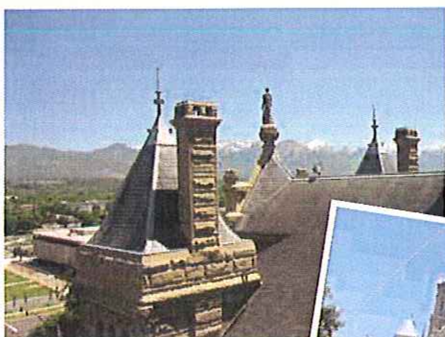
Notable Projects

Dynamic Isolation Systems has been at the forefront of seismic isolation for over 25 years. We have supplied isolators for the majority of prominent isolation projects around the world.

San Francisco City Hall

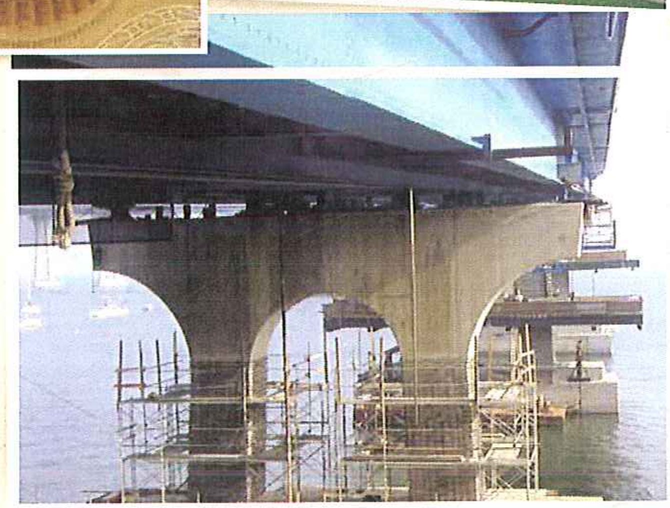
This West Coast landmark was damaged by the 1989 Loma Prieta Earthquake and has been restored and protected from future seismic activity. 530 DIS seismic isolators were installed, making it the largest seismic retrofitting project in the world.





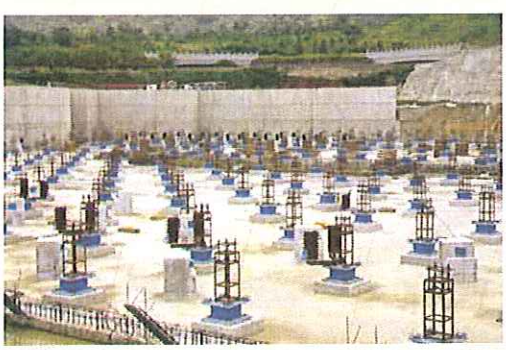
Salt Lake City and County Building

The City and County Building was the first seismic isolation retrofit in the world. The retrofitted building is designed to withstand earthquakes up to 7.0 on the Richter scale. It is a bearing wall structure constructed of unreinforced brick and sandstone. It was completed in 1894 in the Richardson Romanesque style.



San Diego Coronado Bay Bridge

This prominent project was the first to feature high-speed testing of isolators. Caltrans built a state-of-the-art test facility at the University of San Diego, California for its toll bridge retrofit program. The test rig was the first to be able to test bearings at actual earthquake velocities. The bearings are designed to accommodate a 1.2 meter fault rupture beneath the bridge.

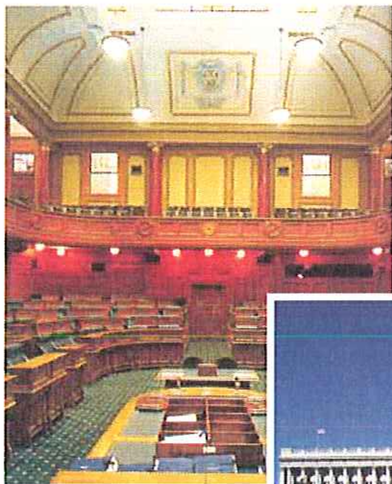


Tan Tzu Medical Center

The Tan Tzu Medical Center in Taiwan is currently under construction and at 1.7 million square feet is the largest isolated structure in the world. It is the third hospital in Taiwan for which DIS has provided isolators. Base isolation was chosen so that the hospital would be operational immediately after an earthquake.

Historic Building Retrofits

Seismic isolation is the best method for upgrading historic buildings to current earthquake design standards. As isolation reduces the forces in the structure, the original architectural fabric of the building can be retained.



New Zealand Parliament Buildings

Base isolation was chosen to meet conservation objectives. It allowed the maximum retention of original materials and workmanship within the buildings and avoided any changes to the exterior appearance.

Other historic retrofits using DIS isolators include Oakland City Hall, Kerckhoff Hall at UCLA and Campbell Hall at Western Oregon State College.

Utah State Capitol Building

The Utah State Capitol Building features Corinthian Architecture and integrates design concepts borrowed from other National Capitols. It was built in 1915. Local materials and custom-designed ornamental features give the building its unique character.

Hospitals

It is essential that hospitals remain operational after an earthquake. Isolation eliminates damage to the hospital, its operation and protects staff and patients.

Xindian General Hospital

Testing for this hospital in Taiwan was performed at the University of San Diego to one meter lateral displacement. The shear strain in the isolator was 400% which is well in excess of the demand of the design earthquake. Such testing demonstrates the high performance of DIS isolators. DIS also provided isolators for Hualin and Tan Tzu Hospitals in Taiwan.

Top: Yuzawa Hospital, Japan. **Bottom:** A slider installed at Takasu Hospital, Japan.

Erzurum Hospital

Workmen install isolators for Erzurum Hospital in Eastern Turkey. The Turkish Ministry of Health plans to build many new hospitals over the next ten years and is a proponent of superior-performing technology such as base isolation.

USC Hospital, Arrowhead Medical Center and Long Beach Veterans Administration Hospital

These hospitals are all located in California and fall under the oversight of OSHPD (Office of Statewide Health Planning and Development) with whom we have worked for over 15 years.

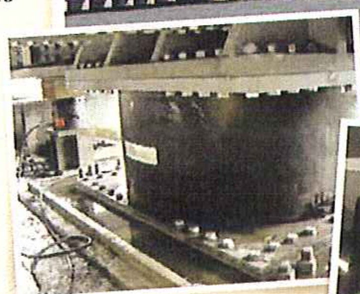
Bridge Retrofits

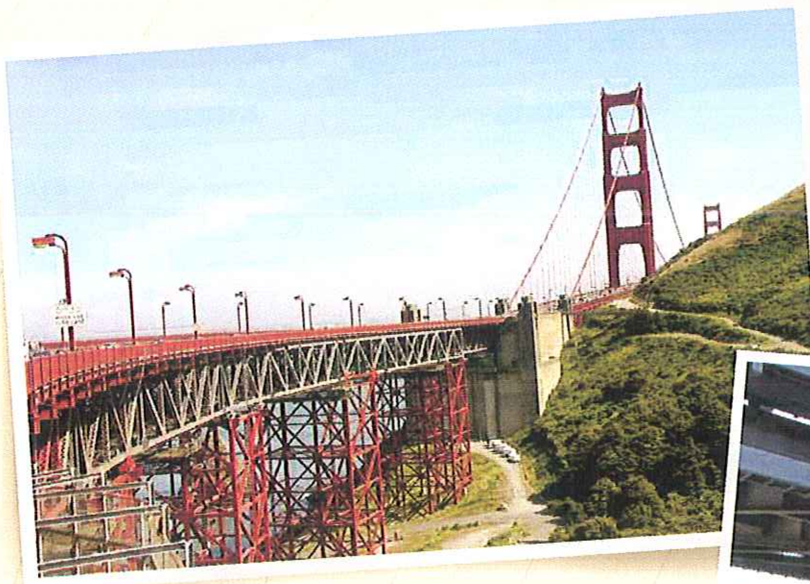
Bridges benefit from isolation as strengthening of the existing piers and foundations can be avoided. Isolation reduces the seismic forces in the structure and allows the designer to redistribute forces throughout the structure. DIS isolators have been used in more than fifty bridge retrofit projects.

Richmond San Rafael Bridge

The Richmond San Rafael Bridge benefits from isolation as forces can be redistributed throughout the structure. Without isolation the significant height differences of the piers would cause the shorter, stiffer piers to attract the majority of the lateral force. The structure required a higher than normal level of initial strength because of high wind loads. DIS designed and built 55-inch diameter isolators with three 11-inch diameter lead cores.

At the west end of the bridge, bridge pads are located in the splash zone only six feet above sea level. DIS and Caltrans designed these bearings to provide superior corrosion resistance. The bearings were fabricated with a low permeability rubber, stainless steel shims and sole plate.





Golden Gate Bridge

The North Approach of the Golden Gate Bridge is retrofitted with DIS isolators. Isolation ensures that the bridge will withstand an earthquake of magnitude 8.3.

Rio Vista Bridge

Typical location of an isolator in the retrofitted Rio Vista Bridge in California.

New Bridges

Patria Acueducto

Reduced substructure forces in isolated condition allow for aesthetic expression with sleek members in this bridge in Guadalajara, Mexico. The reduced foundation forces resulted in 50% fewer piles.

Woodrow Wilson Bridge

This bascule bridge spans the Potomac River near Washington, D.C. This critical bridge which carries over 250,000 vehicles each day, is in a low seismic zone. However, the redistribution of forces and performance under service-load conditions made seismic isolation an appealing option for the designers.

JFK Light Rail

The elevated JFK Light Rail System connects JFK Airport to the New York subway system. The bridge is ten miles long and is supported by 1,364 DIS isolators. The design-build contractor chose isolation to save foundation costs. As the foundations were smaller, significant other cost savings were realized by minimizing the relocation of underground services at the airport and along the Van Wyck Freeway.

Mexicalli Bridge

Isolation halved the foundation cost on this bridge in Mexicalli. The foundations required only two-thirds of the concrete and one-third of the reinforcing steel that would have been required with a conventional design.

Unique Applications

Berry Street Project

The Berry Street Project in San Francisco features isolation at the roof level of an existing three-story building. Isolation enabled the owner to add two extra stories with minimal strengthening of the existing structure.

As the application is quite unique, testing was conducted to 45 inches of lateral displacement. This is well in excess of the 30-inch design displacement.

Retrofitted water tank in Seattle, Washington.

The **Stanford Linear Accelerator** in Palo Alto, California is protected by DIS isolators.

Buildings With High Content Value

Isolation also prevents damage to the building contents in the event of an earthquake.

Hughes S-12 Building

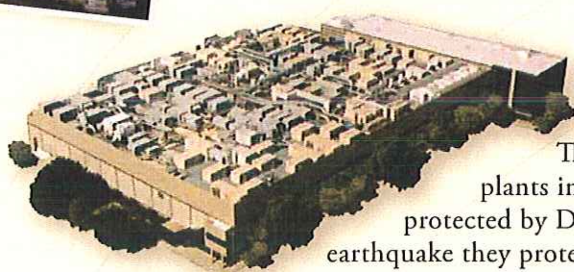
The Hughes S-12 building in Los Angeles is critical to Hughes' satellite operation. The 12-story building remained operational during the retrofit. The likelihood of damage or downtime in the design earthquake has virtually been eliminated.

Immunex Campus

This Research and Technology Center which is located on Seattle's industrial waterfront hosts immune system studies and drug therapy development. It also houses $50 million of state-of-the-art equipment. The owner was also concerned that an earthquake could prevent the center from working for several months which would be costly for the corporation.

Television studios and Telecommunications buildings, such as these in Japan, have been isolated for the purpose of avoiding business interruption.

DIS has also isolated Data Centers for Kaiser Permanente, Mountain Fuel and Evans & Sutherland



Conexant Semiconductor Plants

Three Conexant Semiconductor plants in Mexico and California are protected by DIS isolators. In the event of an earthquake they protect assets in the billions and prevent the loss of millions in sales and market share.

Emergency Centers

Berkeley Public Safety Building

The Berkeley Public Safety Building is one of many emergency centers built throughout the United States recently. The state-of-the-art building is designed to withstand a magnitude 7.0 earthquake on the Richter scale and remain operational. It houses the city's 911 Emergency Communication Center which is a vital hub in the city's Emergency Response Plan.

Long Beach 911 Center

San Diego Emergency Center

MASS DAMPED ADDITION

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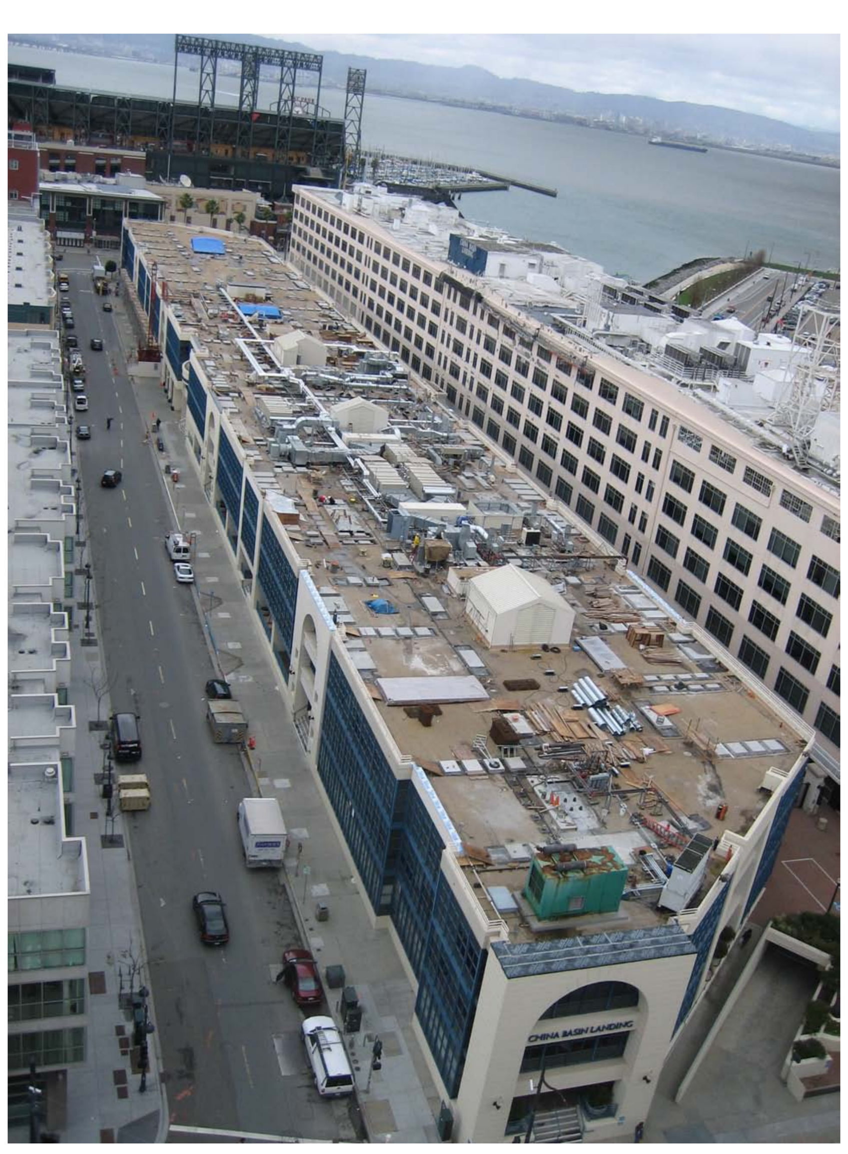

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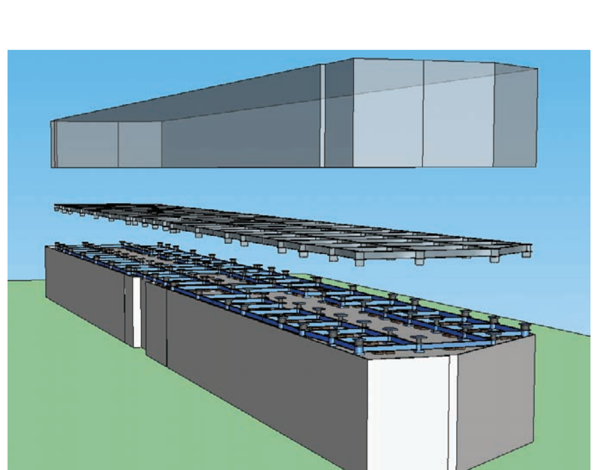

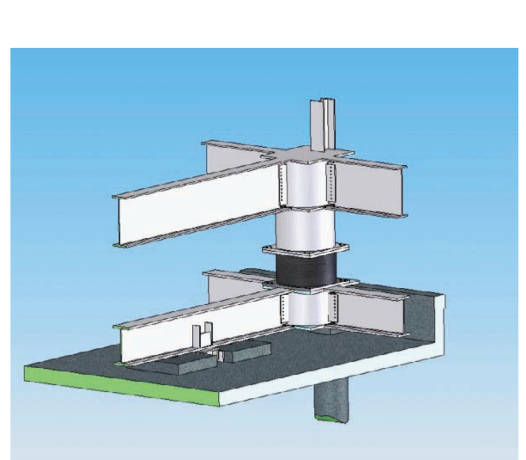

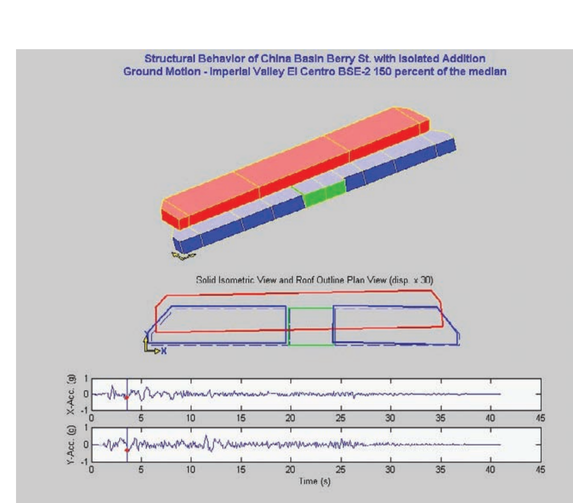

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