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Building the Bay Area, How Bay Area Companies are Preparing for a Seismic Event, Kurt R. Lindorfer, S.E., Principal Engineer for PARADIGM Structural Engineers, San Francisco based professional services structural engineering firm.

There are a multitude of reasons why individuals want to live in the San Francisco Bay Area—perhaps best evidenced by the 66,000 people the Association of Bay Area Governments projects will move to the nine-county Bay Area each year for the next quarter of a century. Apart from the accessible lifestyle, appealing weather and spectacular vistas, the Bay Area enjoys the distinction of being the birthplace of a large number of forward-thinking and internationally renowned companies, especially in the technology and science sectors.

Still, when any company considers establishing the foundations of its business here, or decides to relocate to the Bay Area, it must consider one of the Western United States' other most famous distinctions; the potential of a large-scale earthquake in the region.

HISTORY AND BACKGROUND

Widely distributed photographs depicting the destruction caused by the 1906 earthquake—images of devastation, irrecoverable structures and lost lives—remind Bay Area residents of the looming threat of a large-scale seismic event. It was formerly believed that the Great 1906 San Francisco Earthquake had a Richter magnitude of approximately M 8.3, however, recent modifications to the magnitude gage it closer to a Moment Magnitude M 7.9; 40 times less than originally thought, and of a magnitude that could more likely occur again.

The San Andreas fault, which caused the troubles in 1906, isn't the only fault affecting us. The area could also see activity from the Hayward fault, which runs roughly parallel to the San Andreas and along the east side of the San Francisco Bay, extending from South San Jose up to Vallejo (where it becomes the Rogers Creek fault), and the Calaveras fault, extending from Hollister in the South Bay to the San Ramon Valley just West of Mount Diablo.

San Francisco building code adjustments since the late 1930's have greatly advanced building and fire safety codes, but much of the city's business district is built on areas of reclaimed land where liquefaction will occur in a seismic event. More recently, there has been a greater recognition of ground motion and its impact on structures, which are essentially designed to protect the health and safety of building occupants during an earthquake. Previous code incorporated a "prescriptive" design approach, which considered inelastic or permanent deformations for the dissipation of energy.

New codes use a performance-based approach, which allows for the determination of a specific performance objective, i.e., immediate occupancy, operational, life safety, or collapse prevention, and then requires that the engineer design the structure to attain the selected performance objective. The performance objective can be achieved through the use of energy dissipation devices—isolators or dampers, or through traditional structural yielding of the elements thereby allowing for permanent deformations.

Most experts agree that from a health and safety standpoint, the new code is much more appropriate. Similarly, from a building performance standpoint—how well a building performs during an earthquake—the owner can select how much damage he or she is willing to accept to his or her building, understanding the potential of business interruption.

BAY AREA INDUSTRY

Technology

San Francisco's southern neighbor, the Silicon Valley, is still the epicenter of technology growth in California—and by many measures the United States—with companies like Intel, Hewlett-Packard and Applied Materials anchoring the growth, and startups filling in the remaining square footage.

While the brunt of damage will most likely occur near the quake's origin, or epicenter, businesses would have to be hundreds of miles away from a 1906-type quake to avoid the effects the ground motion will have on their buildings. Many area technology companies have buildings in the mission critical category—those built to house hundreds of millions of dollars worth of computer manufacturing, chip manufacturing and computer servers.

These technology companies have a heightened need to have their equipment housed within buildings that would be fully accessible and functioning after a major event—so building owners are more acutely aware of and concerned with how their buildings will perform in the next seismic event. It is vital the processes of manufacturing and distribution of data be uninterrupted, as such disruption could lead to product loss and resulting loss of market share, truly a catastrophe for any business.

Life Science

In addition to attracting technology companies, the Bay Area is the birthplace of biotech in the United States and has become a world recognized leader in the life science industries. Supported by aggressive venture capitalist-backed funding—and the close proximity of some of the finest research institutions in the country—the life science industry has been growing rapidly in the Bay Area since the late 70s, with companies such as Genentech, Bayer Healthcare and Novartis leading the way. Many of these companies have special needs—lab space and sensitive inventory. Often in the life science industry, and specifically in biopharmaceutical production, upon completion of the manufacturing process, the product is stored in an inert environment such as a large, minus 35-degree freezer—hundreds of millions of dollars of product, essentially the life blood of the company, making these companies susceptible to catastrophic losses in the event of building or content damage.

SOLUTIONS

There are three common solutions for buildings that are vulnerable including a number of retrofitting technologies—devices that can be implanted in existing or new buildings at relatively low cost, which greatly improve the structural integrity and post-earthquake performance.

Base Isolation

Most of the highest performing buildings use a technology called base isolation; it is expensive, but by far the most advanced and successful system to limit building damage during a seismic event. While this technology is widely used in Japan, even on homes, there are only around 100 base isolated buildings in the United States—a substantial percentage of them in California. In its simplest form, base isolation involves the insertion of isolation bearing pads into the major load-carrying elements, under the columns and in the base of a structure. These “isolators” allow the building to move as a unit relative to the ground, rather than have the building experience large inter-story displacement. Generally, these elements will continue to perform adequately for the life of the building without requiring replacement after a seismic event.

Fluid Viscous Dampers

Another solution frequently used to retrofit Bay Area buildings is fluid viscous dampers (FVDs), which are an effective and relatively inexpensive option to help reduce building displacement. Simply put, FVDs are “shock absorbers” for buildings. They reduce building drifts and decrease both structural and non-structural damage to the building and its contents during a seismic event. Although not as elegant as base isolation, this system is substantially more cost-effective when considering upfront building costs.

Buckling Restrained Braced Frames (BRBFs)

The least expensive of the three solutions are buckling restrained braced frames (BRBFs), which take the place of the traditional diagonal or “X” braces often observed along the inside face of the exterior walls of buildings; a site common in seismic country. Traditional “X” bracing requires the diagonal brace buckle in order to dissipate earthquake energy. In the BRBF system, discrete steel elements, surrounded by concrete encased in a steel housing, compress or lengthen to absorb earthquake energy. Unlike base isolation and FVDs, BRBFs do little to reduce damage to the building contents and often require replacement after a significant seismic event.

BAY AREA COMPANIES TAKE ACTION TO PROTECT ASSETS

The leaders of these Bay Area mission critical companies—with buildings housing laboratories, biotech, pharmaceutical and chip manufacturing—are taking the risk of earthquake damage seriously and in turn planning smarter. Bay Area risk and facilities managers, architects and others associated with the construction and maintenance of commercial properties are some of the most well-informed and vigilant individuals when it comes to reducing the vulnerability of their facilities and the structures they are constructing. They realize the potential for loss of life, property and business from low-performing buildings present a real threat, and many are making tough economic decisions to protect their personnel and facilities now.

While all companies don't have the same performance objectives for their buildings, many mission critical and 24-hour operation companies have considered the detrimental losses associated with the alternatives, and have elected to build beyond current codes minimums. By investing in the structure of their buildings, these companies are assuring the physical safety of their employees in a seismic event, as well as the financial stability of their company assets after a large seismic event. In some ways, retrofitting serves as an extra insurance policy. By implementing retrofitting solutions or building new construction beyond code minimums, these companies will be able to quickly restart operations after a large seismic event.

Bay Area Companies How Are Preparing for a SEISMIC Event

By Ben F. Lashley

Photocourtesy of Knowledge-Based Systems

There are a multitude of factors that contribute to how the San Francisco Bay Area—specifically San Francisco—will fare in the event of a major earthquake. One of the most significant factors is the seismic resilience of the region's infrastructure. In the wake of a major quake, the Bay Area's ability to maintain critical services and infrastructure is paramount. This includes the resilience of the region's infrastructure, particularly in the technology and service sectors. While many companies consider reinforcing the foundations of their business, it is also critical to ensure that the region's infrastructure is resilient to the effects of a major seismic event.

History and Background

Highly developed geotechnical engineering practices have been used by the 19th-century—through the 20th-century—through the 21st-century. The history of the Bay Area's infrastructure is a testament to the region's resilience. In the wake of the 1906 San Francisco earthquake, the region's infrastructure was significantly damaged. However, the region's resilience was demonstrated by the fact that the region's infrastructure was able to be rebuilt and improved upon. This includes the region's infrastructure, particularly in the technology and service sectors.



Construction workers are preparing for the Bay Area's seismic event.

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San Francisco has been originally thought of as a region that could be built on. The fact that the region's infrastructure was able to be rebuilt and improved upon is a testament to the region's resilience. In the wake of the 1906 San Francisco earthquake, the region's infrastructure was significantly damaged. However, the region's resilience was demonstrated by the fact that the region's infrastructure was able to be rebuilt and improved upon. This includes the region's infrastructure, particularly in the technology and service sectors.

San Francisco's position as a global hub is a testament to the region's resilience. In the wake of the 1906 San Francisco earthquake, the region's infrastructure was significantly damaged. However, the region's resilience was demonstrated by the fact that the region's infrastructure was able to be rebuilt and improved upon. This includes the region's infrastructure, particularly in the technology and service sectors.

Bay Area Industry Technology

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Building Resilient Infrastructure

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Bay Area Companies Take Action to Protect Assets

Bay Area companies are taking action to protect their assets. This includes the use of advanced engineering practices, particularly in the technology and service sectors. The region's infrastructure is a testament to the region's resilience. In the wake of the 1906 San Francisco earthquake, the region's infrastructure was significantly damaged. However, the region's resilience was demonstrated by the fact that the region's infrastructure was able to be rebuilt and improved upon. This includes the region's infrastructure, particularly in the technology and service sectors.

Protecting Critical Infrastructure

Protecting critical infrastructure is a top priority for Bay Area companies. This includes the use of advanced engineering practices, particularly in the technology and service sectors. The region's infrastructure is a testament to the region's resilience. In the wake of the 1906 San Francisco earthquake, the region's infrastructure was significantly damaged. However, the region's resilience was demonstrated by the fact that the region's infrastructure was able to be rebuilt and improved upon. This includes the region's infrastructure, particularly in the technology and service sectors.



A server room in a data center.



A person working at a computer workstation.



A modern office interior.



A modern building with a distinctive facade.

BUILDING THE BAY AREA

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