SEISMIC VULNERABILTY OF DATA CENTERS

Frederick Tajirian

Chevron Energy Technology Company
Civil, Structural and Marine Engineering
6001 Bollinger Canyon Road
San Ramon, CA 94583
ftajirian@chevron.com

ABSTRACT

Large global energy companies rely on the safe operation of data centers that are scattered around the world. These data centers sometimes consist of a few server racks supported on raised access floors installed in various types of buildings located on various floors of the building. The data centers can also contain several thousands of square feet of raised computer floors housed in one or two stories of large commercial buildings, which are normally existing structures designed to meet the local building codes for office buildings, applicable at the time of construction. Often these centers are located in zones of moderate to high seismicity. Past earthquakes have demonstrated that data centers experience severe damage and loss of operations even in moderate, more frequently occurring earthquakes. This paper will describe several approaches used in Chevron to enhance the safety of data equipment.

In large data centers, the relative cost of the structure is around 7% of the total cost, when counting the cost of exterior components, architectural details and MEP. When compared to the cost of a fully equipped data center including furniture, fixtures and data equipment, the relative cost of the structure drops to 1%. Even though historically, the greatest contributor to earthquake losses has been damage to contents, the importance of good earthquake performance of non-structural components, equipment and systems required for facility function/operation, is often overshadowed by focus on controlling building structure damage. As a result, the structural engineer is not much involved in securing the contents. It is usually up to architects, suppliers and installers to meet code requirements. Equipment bracing, even for critical equipment is often nonexistent or second-rate.

In new buildings, nonstructural components have to be designed to resist loads that satisfy building code requirements. These loads have increased in code revisions since 1997. Code requirements usually provide design requirements for equipment anchors. These normally focus on preventing injuries and rarely do they consider the impact of high accelerations on the post earthquake functionality of data components. More recent codes, especially ones applicable to critical facilities, have required that all components satisfy seismic requirements by shake table testing, experience data or analysis.

The most effective solution for protecting equipment and ensuring continued operations with minimum business interruption, is to use seismic isolation. This is especially cost-effective when new buildings are constructed, and when the peak design ground acceleration exceeds 0.3 g. Currently a 10,000 ft^2 new data center for a Chevron refinery is being designed with base isolation. The details are described in the paper. The second case study examines a large data center being upgraded to house a 30,000 ft^2 raised floor system on the first floor of a three story steel moment frame with eccentric braces (EBF) built in 1982. Two alternate retrofit schemes are discussed: seismic isolation and viscous dampers. Although dampers can reduce seismic forces in the structure, the data equipment may still be subjected to high accelerations. An option for using computer floor isolation systems is considered. Although such systems are commonly used in Japan, they have not been used in such a large scale in the US because of the perceived cost. Another approach which has been used in existing Chevron data centers is to isolate the server racks from the raised floors. The advantages and disadvantages of these systems are also discussed in the paper.