Seismic Isolation Design for Achieving Post-Earthquake Functionality

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Abstract

Functionality is an important consideration while designing critical buildings, bridges, and industrial structures in earthquake prone regions of the world. This is necessary for minimizing post-earthquake disruption to society. Major earthquakes that have occurred every year in the world are a constant reminder that critical structures must remain functional and operational post-earthquake, so that community needs are met. Hospitals need to remain functional and operational in order to treat injured people and save lives. Bridges classified as lifeline structures also need to remain functional so that rescue and recovery operations can be performed. Code provisions (ductility based) for seismic design of structures all over the world have focused primarily on achieving "Collapse Prevention" within acceptable limits, at the expense of inflicting damage to structural, non-structural, architectural elements, and contents, resulting in loss of function.

Keywords: functionality, seismic design, seismic isolation, earthquakes, seismic isolator standard.

1 Introduction

For over 60 years the code seismic performance objective has been to prevent structure collapse. Code compliance is the performance criteria used for 99% of structural component design. Building and bridge engineers typically implement prescriptive design procedures to comply with minimum building code requirements at the lowest construction cost. These prescriptive code design procedures based on "ductility" concept have allowed structures to get damaged during an earthquake, but largely intended to avoid "collapse" so that human lives would be protected. However, avoiding facility damage is not the intent of the building codes. Over the years this approach was refined with new design/analysis, construction materials and methods. However, till date the basic code objective for earthquake design all over the world has remain unchanged; i.e. "Collapse Prevention". The 2010 Mag. 8.8 earthquake in Chile and the 2011 Mag. 6.3 earthquake in New Zealand have demonstrated that Engineers have accomplished the basic objective of "Collapse Prevention" as only 22 buildings collapsed amongst thousands. Earthquake damage of over US $ 60 billion has nevertheless, left communities devastated.

The Building Code objectives should now change from "Collapse Prevention" to "Damage Prevention". The world of automotive industry has already started shifting from "Occupant Safety" to "Collision Prevention" with the integration of smart sensors and advanced braking technology.

In the US both the Building Code requirements and Building Industry practices are shifting towards resiliency in design and construction to minimize earthquake damage. The American Society of Civil Engineers (ASCE) latest Building Code Standard ASCE 7-22 Section 1.3.3 on Functionality requires Essential Facilities (Risk Category IV Structures) to remain functional and operational after a design level earthquake [1].

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