ISET Journal of Earthquake Technology, Paper No. 538, Vol. 55, No. 1-4, March-Dec. 2018, pp. 1-20

SEISMIC PERFORMANCE OF OPEN GROUND STOREY REINFORCED CONCRETE BUILDING WITH CHEVRON STEEL BRACING INCORPORATING X-PLATE DAMPER

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ABSTRACT

A three-storey half scale Reinforced Concrete (RC) open ground storey building is fixed with yielding type X-shaped metallic (elasto-plastic) damper at the ground storey level, to study the seismic response characteristics. Experimental studies are carried out using the 4m x 4m triaxial shake table facility to evaluate the seismic performance. Initially the reinforced concrete building is tested for different earthquake inputs in the shake table. During the test, the cracks and hinges are formed in various locations of beams, columns, beam-column joints and infill walls. During the seismic testing, the plastic failure cracks (plastic hinges) are formed in the columns and beam-column joints of the ground storey. The seismically damaged RC building is retrofitted. Two types of retrofitting techniques have been developed. Type 1 is the local retrofitting of columns and beam-column joints in the ground storey using Geopolymer concretes. Type 2 is the global retrofitting of RC building with Chevron type steel bracing incorporating X-plate damper in the ground storey. The dual functioning of X-plate damper is to improve the global stiffness of building thereby protecting the building during earthquake. In general, earthquake loading induces large displacements in an Open Ground Storey (OGS) structure. During such large displacements, a yielding type elasto-plastic device made of X-shaped metallic dampers performs better. The supporting steel frame of Added Damping and Added Stiffness (ADAS) is of chevron type, serially contributing stiffness to the system. Free vibration tests on OGS RC building with and without yielding type X-shaped metallic damper is carried out. The natural frequencies and mode shapes of the model with and without yielding type X-shaped metallic damper are evaluated.

KEYWORDS: Earthquake Response, Dynamic Characteristics, RC Building, Yielding Type X Shaped Metallic Damper, Natural Frequencies and Mode Shapes

INTRODUCTION

Reinforced concrete frame buildings are built in India which has open ground storey. Owing to the high cost of land and small sizes of plots, parking is often accommodated in the ground floor area of the building. Open ground storey buildings have consistently shown poor performance during past earthquakes across the world. For example during 1999 Turkey, and 2003 Algeria earthquakes, a significant number of them have collapsed. In India, during Gujarat earthquake (2001) many buildings have been damaged that are seismically deficient. It is found from that the Reconnaissance Report of January 26, (2001) Bhuj India Earthquake that large number of open ground storey buildings in Ahmedabad, Bhuj, and other towns in Gujarat suffered severe damage or dramatic collapse. Out of the 130 buildings that collapsed in Ahmedabad, most were of open ground storey configuration. Among those that did not collapse, the damage was confined mostly to the open ground storey columns. The entire lateral deformation is concentrated in the ground storey columns, and the upper stories moved laterally as a rigid block. The reinforced concrete columns at the bottom storey have suffered the maximum damage and the brick in-fill at the top stories has developed sliding cum separation failure. These buildings are normally not designed as per the earthquake resistant design proposed in the Bureau of Indian Standard