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Multi-story truss moment frames equipped with friction dampers and self-centering system for enhanced seismic performance

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1 Abstract

In this article, two new truss moment frame (TMF) systems exhibiting enhanced seismic performance are examined: truss moment frames with friction energy dissipation dampers between the truss bottom chord and the columns (F-TMFs) and F-TMFs with tendons added to achieve self-centering response (FT-TMFs). In both cases, all steel components of the systems are expected to behave essentially elastically to eliminate structural damage. The second system is also expected to have negligible residual lateral deformations. To compare and investigate the seismic performance of the proposed TMF systems, a 5-story commercial steel building located in Vancouver, BC, is designed in accordance with the National Building Code of Canada 2015 (NBCC) and it is subjected to a series of nonlinear static and dynamic time history analyses. The earthquake records, employed in non-linear time history analyses, are scaled for a hazard level corresponding to a probability of 2% in 50 years. The analytical results show that structural damage does not occur in neither of the two proposed systems . Meanwhile, FT-TMF system showed notably better seismic response and negligible residual deformations due to its self-centering capacity provided by the tendons.

Keywords: Truss moment frames, Friction damper, Tendon, Self-centering.

2 Introduction

Truss moment frame is an excellent system to construct single and multi-story long span structures, covering large areas such as sport facilities, shopping centers, office buildings and industrial buildings.

The structural system can be fabricated and installed simply and rapidly. Moreover, the installation of the piping, ductworks, and other electrical and mechanical equipment in truss moment frames is more convenient compared to moment frames with solid web beams. In addition, since the structural elements in such systems are mostly exposed, structural inspection, repair and retrofit can be easily conducted.

Seismic design requirements for Special TMFs have been in force in the AISC seismic provisions since 1997. These provisions have been developed to provide ductile inelastic deformations in the chord and web members within central special segments of the trusses. Other truss members and columns are designed to remain essentially in the elastic range [1-4].

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