Investigation on Eccentrically Braced Frames with Tubular Links Using Non-Linear Time History Analysis

Soheil Soroushnia
Islamic Azad University, Takestan Branch, Takestan, Iran

N. Fanaie
Department of Civil Eng., Khajeh Nasirodin Toosi University of Technology, Tehran, Iran

M. H. Mamaghani
Islamic Azad University, Central Tehran Branch, Tehran, Iran

Sajad Soroushnia
Iranian Construction Engineers Organization, Tehran, Iran

SUMMARY:
Eccentrically Braced Frames (EBFs) have been shown to exhibit excellent seismic performance. Recently, interest in the use of EBFs and also energy dissipation systems with Wide Flange (WF) or I-shaped links has been increased in bridge piers or towers. Typically the links have had a wide-flange or I-shaped cross-section that requires lateral bracings to prevent lateral torsional buckling. The link is self-stabilizing and does not require lateral bracing, making it suitable for using in steel bridge piers where lateral bracing can be difficult to provide. This subject has limited the use of EBFs in bridge piers, since lateral bracings are difficult to provide in those situations. This paper describes an analytical investigation into the use of members with hollow rectangular cross-sections as EBF links which do not require lateral bracings. Finally, a finite element model of the frame is developed using shell elements. Time history analysis has been done to show the good behaviour under three specified earthquakes. To show the good seismic behaviour of the frames non-linear time history analysis has been performed and the results show the expected good behaviour of this new bracing under earthquake.

Keywords: Eccentrically Braced Frame, energy dissipation, buckling, ductility.

1. GENERAL INSTRUCTIONS

EBFs have been primarily used as seismic load resisting systems in buildings for more than a decade. Typically the links have had a wide-flange or I-shaped cross-section that requires lateral bracings to prevent lateral torsional buckling. The link is self-stabilizing and does not require lateral bracing, making it suitable for using in steel bridge piers where lateral bracing can be difficult to provide (building applications are possible as well). This subject has limited the use of EBFs in bridge piers, since lateral bracings are difficult to provide in those situations. Links of this type would also be useful in situations in buildings or other structures where lateral bracing may not be feasible or easily provided. The link beam which has a hybrid tubular cross-section composed of webs and flanges of different thicknesses. Experimental results indicate that the link beam reach a rotation of 0.15 radian, almost twice the current limit of 0.08 radian for wide-flange links and prior to suffering flange fracture (Almost twice the maximum allowed in building codes for I-shaped links). Providing a laterally stable link for using in bridge piers which prevent lateral torsional buckling, has been developed hollow rectangular cross sections such a tubular link which are able to achieve the maximum rotation level presented in the AISC Seismic Provisions for links with WF cross sections. The achieved large rotations are more than the required rotation in a seismic event, indicating that hybrid rectangular links without lateral bracing can indeed be a viable alternative for using in steel footbridges placed in seismic regions. This paper describes an analytical investigation into the use of members with hollow rectangular cross-sections as EBF links which do not require lateral bracings (Berman J.W, et al. 2007; Berman J.W, et al. 2008; Berman J. W., et al. 2006), . Finally, a finite element model of the frame is developed using shell elements, and reasonable agreement with the experimental results is observed. Time history analysis has been done to show the good behaviour under specified earthquakes.