2013/14 Undergraduate Research Grant Scheme – Executive Summary

Project title:
Optimisation of column-beam connections using beam web perforation

University:
University of Leeds

Supervisor:
Konstantinos Tsavdaridis

Contact details:
University of Leeds, School of Civil Engineering, Woodhouse Lane, Room 2.06, Leeds, West Yorkshire, LS2 9JT
Telephone: 0113 343 2299
Email: k.tsavdaridis@leeds.ac.uk

Student: Theodore Papadopoulos

Project summary:
The use of RBS is well established nowadays and effectively dissipates the seismic energy and controls the location of the plastic hinge formation by reducing the beam section locally with flange cut-outs at a close distance from the face of the column. This concept of weak beam-strong column mechanism is also known as a ductile seismic "fuse" in Civil Engineering. The last five years, researchers focus on alternative fuse designs promoting the perception within the performance based design while reducing the beam section in different ways including that of creating a hole in its web. The same practice is applied in the fabrication of perforated (i.e. cellular and castellated) beams mostly used to support the service integration as well as the significant weight reduction of the entire frame.

This study presents a finite element (FE) computational analysis of a partially restrained extended end-plate connection found in the literature, with both single and multiple circular web perforations introduced along the length of the beam while subjected to the cyclic loading SAC protocol from FEMA-350. The 3D solid model was validated against FE and experimental results; the chosen configuration was determined capable of representing the "real" structural behaviour of the connection by being partially restrained and not idealised as fully fixed. The parameters introduced in the parametric study were the distance from the face of the column, S, and the web opening spacing, So. The potential of adding periodical web openings along the entire length of the beam was also examined.

It was concluded that when large circular beam web openings are introduced in beam-to-column connections, an enhanced hysteretic performance in terms of stress distribution is demonstrated. The design of such reduced web section (RWS) connections should be based on the articulate decision of the first opening's distance from the face of the column.