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An analytical investigation of ductile moment -resisting connections using cold-formed steel sections

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Abstract

This paper presents an investigation on the potential use of cold-formed steel sections (CFS sections) in moment-resisting frames (MRFs) for seismic applications. The main limitation of CFS sections is the low out-of-plane stiffeners of their thin-walled elements which leads to low ductility. In earthquake resistant MRFs, the beams are designed to provide considerable ductility, whereas the other elements are mainly limited to their elastic range. The proposed beam–column connections are used to connect innovative column which has box section and double back-to-back C-shape beam. In web bolted connections without out-of-plane stiffeners, premature web buckling results in early loss of strength, while some kinds of stiffeners can improve the performance of connections. The behaviour of CFS beam–column connections is studied by means of finite element analysis (FEA). The results of the analyses show optimum stiffeners which can postpone local buckling, and they increase dramatically the level of resistant moment.

Keywords: Cold-formed steel sections, Beam–column connections, Moment-resisting frames, FE analysis

1. INTRODUCTION

Thin-walled, cold-formed steel sections (CFS sections) are commonly used either as main structural elements in stud wall frames, mezzanine floors, storage racks, etc., or as secondary structural elements such as in roof purlins. Compared to hot-rolled steel sections, CFS are less expensive to manufacture and offer far greater flexibility in producing any desired shape. The most common structural system constructed from CFS sections is the shear/stud wall system mainly used for residential buildings [1–2]. Investigations on the seismic behaviour of CFS shear/stud walls [3–6] identified the need for serious improvement in the connections to achieve a more ductile behaviour. The use of very thin elements and the existence of semi-rigid connections in shear wall systems are the main deficiencies that can lead to premature local failures and as a consequence low ductility. Sheathing elements such as plasterboards and corrugated sheets attached on one or both sides of the stud walls can improve both the vertical and horizontal load resistances as well as the lateral stiffness of the wall panels. This has been investigated analytically and experimentally by numerous researchers [7–9]. An alternative is to use heavier CFS sections and more complicated connection details. However, this solution is not compatible with the fundamentals of this type of structural system, which is more efficient and economical for low span frames and light loads. For CFS sections there is a need to develop CFS frames in the same way as for hot-rolled steel frames. This will allow the use of heavier CFS sections in a more **ec**onomic manner to resist seismic forces and provide a more ductile response compared with that of conventional CFS shear walls.

In current CFS bolted beam–column moment-resisting connections, semi-rigid partial-strength connections do not satisfy the requirements of seismic moment-resisting frames [10,11]. Nevertheless some experimental studies show that CFS double face-to-face channel sections can achieve a ductile capacity which can be taken into account in seismic design [12,13]. In earthquake resistant design, the required ductility of MRFs is mainly provided by the beams, while columns and connection elements are expected to remain elastic. This means that for use in seismic regions the ductility of CFS beams needs to be considerably improved.