NUMERICAL MODELS FOR STEEL AND COMPOSITE ECCENTRICALLY BRACED FRAMES UNDER SEISMIC ACTIONS

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ABSTRACT

In order to investigate the influence of interaction between the concrete slab and steel beam in the potential plastic zones of eccentrically braced frames, an experimental program was conducted. Six specimens were constructed and tested, with beams designed either as pure steel or composite steel-concrete elements. Numerical models were validated against experimental data. The aim was to develop hysteretic models for cyclic behavior of steel and composite links.

Keywords: Steel frame building, composite beams, experimental program, plastic zones.

INTRODUCTION

Steel frames are heavily used for seismic resistant building, due to their large dissipation capacity. For drift limitation under lateral loads, different types of brace systems, e.g. concentrically braces, eccentrically braces, are traditionally employed. The structural response of eccentrically braced frames relies primarily on the part of the beam called link, which must be able to dissipate energy by development of plastic bending mechanism and/or plastic shear mechanism. The links should be designed to dissipate seismic energy without significant reduction of their resistance, provided that the forces transferred to columns, beams and braces. Steel beams can be designed either as structural steel or composite steel-concrete elements. When steel beams are designed to behave as composite elements, the dissipation capacity of the links reduces. To be used in design, simple but reliable models are necessary in order to take into account the concrete slab - steel beam interaction.

In order to investigate the influence of interaction between the concrete slab and steel beam in the potential plastic zones of eccentrically braced frames, an experimental program was conducted. Six specimens were constructed and tested, with beams designed either as pure steel or composite steel-concrete elements. Numerical models were validated against experimental data. The aim was to develop hysteretic models for cyclic behavior of steel and composite links.

RESULTS AND CONCLUSIONS

The beam frame has been carried out in three solutions (Fig. 1): Pure steel beam, composite steel-concrete beam with with shear studs on dissipative zones, composite steel-concrete beam without shear studs on dissipative zone. Due to the influence of the concrete slab (with or without shear studs present in dissipative areas) and the friction between concrete slabs
and steel beams, plastic hinges did not have a symmetrical behavior. Plastic deformation was more pronounced in the area of negative bending moment. The rotational stiffness was lower due to the tensile stresses that appeared in the concrete slab and free flange of steel section of composite beam was subjected to compression and without the stabilizing effect of connection with the concrete slab.

Fig. 1 - Experimental specimens: Pure steel beam (l); composite steel-concrete beam(r)

Fig. 2 - Force-displacement curve experiment/Abaqus/SAP2000

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