Moment-Rotation Characteristic of Joints of Steel-Concrete Composite Frame under Exceptional Events

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Summary

The paper presents studies on experimental investigation of beam-to-column joint behaviour in standard and exceptional events situations. This assessment is done to form a picture of the general the behavior of full scale frameworks at both the level of the global behavior of the framework, in terms of its load-displacement characteristic, and of the local behavior of joints in terms of their moment-rotation characteristics, and evaluates details about the interaction of the joint elements and how they work together in a balanced manner, during exceptional events, this study concerns the joints which are subject to the collapse and also includes the behavior of joints in the neighborhood of the collapse. The intricacy of such investigations appear from nonlinear effects associated with the outlook of joint behavior or functioning, such as structural shortcomings, large displacements and rotations, inelastic properties of steel and concrete materials, the effects between steel and concrete, and slip between concrete and structural steel, through others. The paper addresses these problems using two types of joints flush and extended end-plate with four and eight bolts and provides recommendations and reasoning for the behavioral techniques for the evaluation of joint moment-rotation response when exposed to negative and positive moments together.

Keywords: joint; robustness; composite; redundancy; steel joint; composite joint; sub-frame test; column loss; catenary action; joint ductility.

1. Introduction

Building frameworks are usually designed for service loads only [1, 2] despite the fact that they are vulnerable to a certain degree to progressive collapse phenomenon caused by local damage as a result of a column loss due to a vehicle impact, explosion, fire or earthquake. The objective was to investigate the behaviour of steel and steel-concrete composite joints of building frameworks under typical load combinations and exceptional loading due to accidental loss of a column. The review of literature concluded that there is a broad evidence of the global and local behaviours of frameworks in standard situations of load combinations but rather a limited knowledge on the local behaviour of joints in frames during such an extreme event like the column loss. Thus, the experimental investigations on building frame joints are carried out following the joint behaviour under service action effects and after step-by-step joint destruction in course of the progressive column loss scenario [7, 8]. Four full scale tests were conducted on two steel and two composite frame specimens, one steel and one composite with flush end-plate and the similar arrangements of two specimens with extended end-plate joints. Test specimens were two-bay plane frames with beam extensions to model the influence of neighboring bays up to the points of beam contraflexure under gravity loads. Local damage caused by column loss may not lead to a progressive collapse of the entire framework if it is prevented by robust design. Taking advantage of the inherent ductile behaviour of steel joint components and reinforcement of concrete slab, the requirements for robust