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Behaviour and Modelling of All-Steel Beam and Composite Steel Beam-Column Joints under Fire Conditions

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Summary

This paper presents the behaviour and modelling of two experimental programmes, viz. one on typical extended end-plate steel beam-to-column (conventionally deemed as "fully rigid" joints) and another on composite steel beam- to-column (conventionally deemed as "semi-rigid" joints) under fire conditions. The first programme comprised three beam-column cruciform joints tested at isothermal temperature of 400C, 550C and 700C, and another three specimens at 700C but subjected to different axial restraints. The second programme consisted of six ambient temperature tests (as control specimens) and eight elevated-temperature tests on composite top-and-seat-and-web (TSW) angle joints under vertical loading. It should be noted that the steel beams in the second programme supported profiled decking concrete slabs through shear studs, giving rise to composite-steel beam-column joints. From both test programmes, a summary of moment-rotation-temperature characteristics was obtained for both programmes of specimens. Detailed finite element simulations of the tests were also performed. Corresponding numerical and analytical investigations on the behaviour of all-steel joints and composite-steel TSW angle joints will be presented in this paper. The author proposed a "component-based" approach to analyze the mechanical response of both types of joints at elevated temperatures, incorporating various components of the joints as rows of discrete spring elements. It is found that the component-based analytical model can represent well the structural behaviour in the tests, including the effect of thermal restraint. Both the numerical predictions from finite element modelling and component-based approach provide acceptable correlations with the test behaviour. It should be noted that the component-based approach is much less computationally demanding as it can be programmed using excel spreadsheet. Besides, the joint characteristics in terms of initial stiffness, peak strength and rotation capacity, can be incorporated into self-developed finite element software based on fibre beam elements to capture the rotational characteristics of both types of joints.