Numerical Analysis of HSS Endplate Connections at Ambient and Elevated Temperatures

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Introduction

In order to investigate the behaviour of high strength steel (HSS) endplate connections in fire conditions, a numerical modelling has been conducted and compared with that of mild steel. Validation against test results shows that the proposed model can reproduce the behaviour of mild steel endplate connections at elevated temperatures with reasonable accuracy. Using HSS instead of mild steel as endplate material, this model is also able to predict the performance of HSS endplate connections. By a parametric study on the effects of endplate thicknesses, it is found that a thinner HSS endplate possesses more ductility than mild steel endplate connection at ambient and elevated temperatures, and their load bearing capacities are almost the same.

Yu et al.'s Tests

The tests were performed by Yu et al. under steady-state conditions, as shown in Fig.1[1,2].

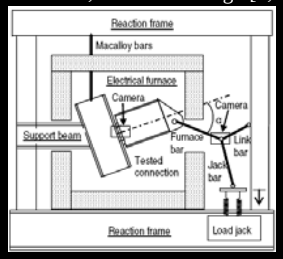


Fig.1 Test setup

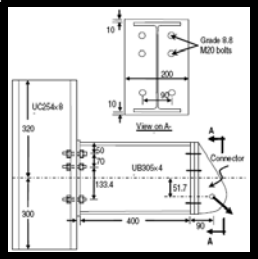


Fig.2 Connection specimen

Finite Element Analysis

ABAQUS is used to conduct the numerical modelling, considering material and geometric non-linear effects and contact interactions.

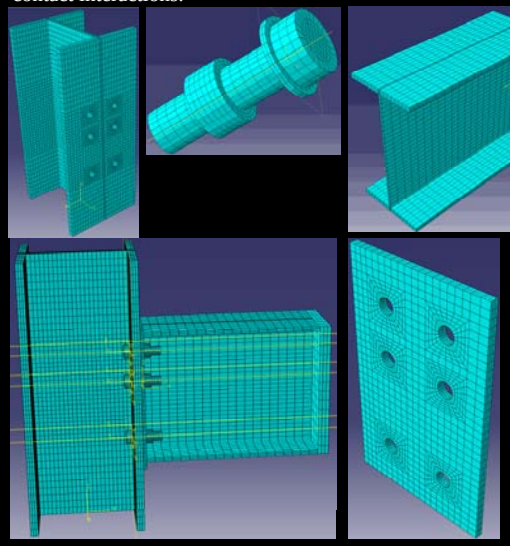
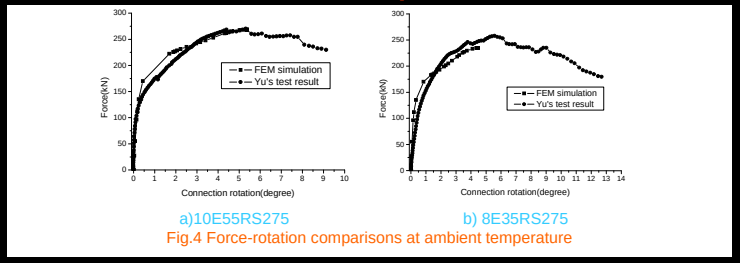


Fig.3 FE model and mesh generation

Validation against Tests on Mild Steel Connections

at Ambient Temperature



a)10E55RS275 b) 8E35RS275

Fig.4 Force-rotation comparisons at ambient temperature

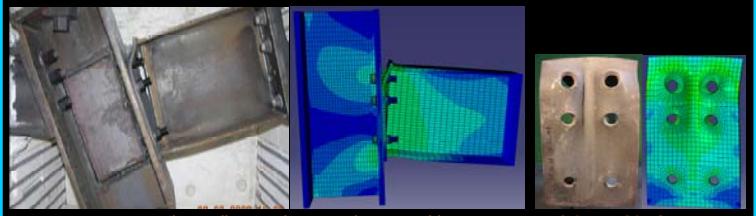
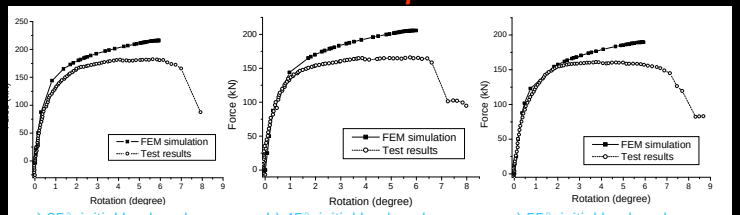


Fig.5 Failure mode comparison at ambient temperature (10E55RS275)

at Elevated Temperatures



a) 35° initial load angle b) 45° initial load angle c) 55° initial load angle

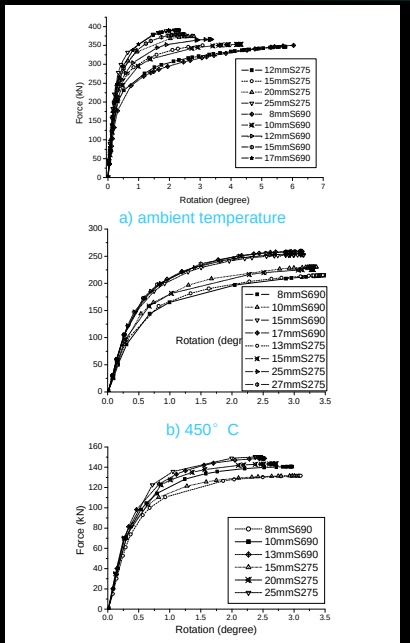
Fig.6 Force-rotation comparisons of 10mmS275 at 450° C

Conclusion and Further Improvement

★A thinner HSS endplate enhances ductility of the connection at ambient and elevated temperatures, and achieves the same load-bearing capacity as the one with a mild steel endplate.

★ Solid modelling of welds taking into account fracture feature is necessary to simulate the occurrence of component failure.

Parametric Study-Thickness



a) ambient temperature

b) 450° C

c) 550° C

Fig.7 Parametric study- endplate thicknesses

Reference

[1]Yu, H.X., Burgess, I.W. Davison, J.B., Plank, R.J. 2008. Experimental Investigation of the Behaviour of Flush Endplate Connections in Fire. Proc. Structures in Fire Workshop, Singapore: 150-157.

[2]Burgess I.W. 2009. The Robustness of Steel Connections in Fire. Proc. ASCCS 2009, Leeds: 103-114.

[3]AM Girao Coelho, FSK Bijlaard. 2007. Experimental behaviour of high strength steel end-plate connections. Journal of Constructional Steel Research 63:1228-1240.

[4]Ju Chen, Ben Young. 2006. Behaviour of High Strength Structural Steel at Elevated Temperatures. Journal of Structural Engineering: 1948-1954.