Experimental Investigation of Structural Steel Welds at High Temperature

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Background

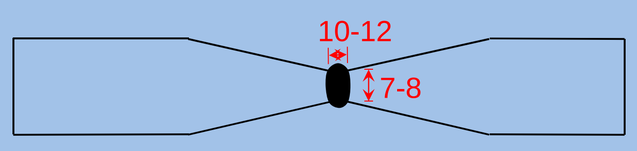
1. Behaviour of connections in fire is becoming a major concern for steel constructions.
2. Structural weld failures are commonly observed in high temperature connection tests.
3. Structural weld failures are also observed for other welded structural members, such as steel tube.

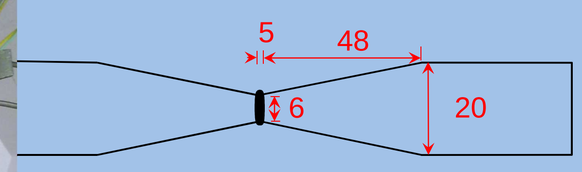
Weld failure was observed to be temperature dependent. Therefore, it is necessary to perform research on the following issues:
1) Failure mode: weld metal failure or heat affected zone failure
2) Strength: the reduction of the weld strength with temperature

Test Arrangement

Q235 steel with E43 electrode： 27 tests
Q345 steel with E50 electrode： 27 tests

For each group, 3 specimens for each temperature.
Temperatures tested: 20, 100, 200, 300, 400, 500, 600, 700, 800



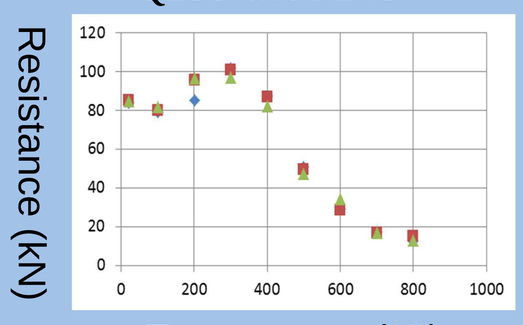


Furnace fixed to the loading machine

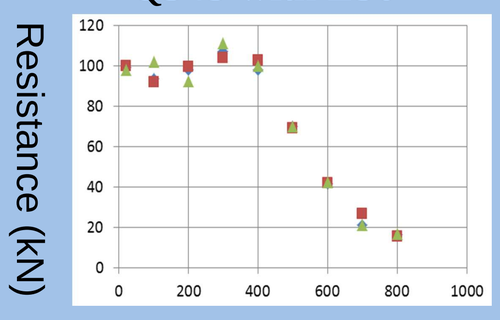
Fractured specimen being removed from the furnace

Test Results

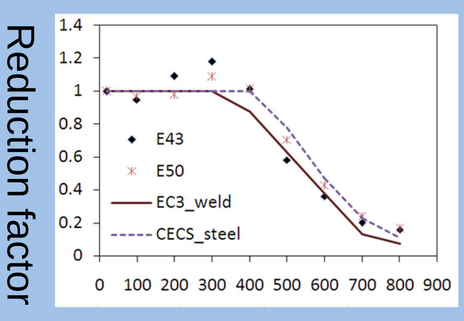
•Q235 with E43



•Q345 with E50



Weld strength reduction with temperature



Four Typical Failure Modes Identified

shear fracture within the weld

irregular fracture within the weld

shear fracture at the interface

tensile failure at the interface

When the temperature is below 500ºC, failure mode can be any of these three.

Failure mode when the temperature is above 500ºC.

Conclusions

1) The ultimate resistances of the welds reduce with the increase of temperature after 400ºC. The resistance degradation rate is similar to that of hot-rolled steel.
2) When the temperature is from 20ºC to 400ºC, the welds show brittle fracture at small deformations, which could have explained the observation of weld cracks in connection fire tests.
3) At temperatures above that, welded region behaves extremely well in terms of both strength and ductility