International Conference on Engineering Research and Practice for Steel Construction 2018 (ICSC2018)
5 to 7 September 2018, Hong Kong

EFFECTS OF WELDING ONTO MECHANICAL PROPERTIES OF S690 STEELS

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ABSTRACT

High strength steels are modern steel products with excellent strength-to-self-weight ratios manufactured by quenching-and-tempering (QT) production. However, they have not been widely adopted in construction owing to adverse effects of welding onto their microstructures. In order to tackle this problem, a series of investigations into mechanical properties of high strength S690 welded sections under different heat input energy have been conducted. A series of standard tensile tests were conducted on coupons of welded S690-QT steel to quantify strength reductions under the effects of welding. Both GMAW and SAW were employed to carry out perfectly-matched welding with various heat input energy, and high resolution Scan Transmission Electron Microscope was employed for identification of microstructures inside the heat affected zones (HAZ). It was also evident that only coupons from welded sections with a heat input energy not larger than 1.0 kJ/mm were able to meet various ductility requirements stipulated in EN1993-1-12. Moreover, experimental investigations into various mechanical properties of HAZ under different temperature history during practical welding have also been carried out. Thermal mechanical physical simulations onto high strength S690 steels have been carried out to obtain test coupons of HAZ with highly consistent microstructures according to specific temperature history. Tensile tests on these test coupons were then carried out to obtain their mechanical properties. It is interesting to find that fully recrystallized HAZ near the fusion zone of the welding possesses a tensile strength of 1185 N/mm^2 and an elongation limit of 18%, while partially recrystallized HAZ away from the fusion line possesses a relatively low tensile strengths of 760 N/mm^2 and an elongation limit of 22%. This study provides an in-depth understanding on both the microstructure evolution of HAZ under different heat input energy and their corresponding mechanical properties. More importantly, it provides valuable test data for formulation of constitutive models of various specific HAZ under monotonic actions.