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**Section C**

**301/C**

**An investigation of hydrogen assisted cold cracking in steel fabrication**

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For many years, high strength steels have been used in several welded steel structure applications, which involve in failures of hydrogen assisted cold cracking (HACC) during fabrication and service. HACC occurs as a result of the critical combination of hydrogen being present in a susceptible microstructure under the influence of a stress field. In welding, hydrogen ions are easily absorbed by the molten weld pool, where it diffuses through weld metal (WM) and heat affected zone, thus interacting by various microstructures. This diffusible hydrogen is responsible for hydrogen cracking in welds known as HACC. The objective of this study is to investigate the root causes of HACC, methods used to evaluate the hydrogen content and susceptibility of welds to HACC, and discussing possible controlling methods.

A variety of methods is used to determine the diffusible hydrogen content in the WM, such as mercury method, vacuum method, glycerine replacement method, silicone oil replacement method and gas chromatography method. Among these, the mercury method is considered more reliable and the amount of hydrogen released measured by the volumetric method with the aid of diffusible hydrogen measuring meter. Further, in order to determine susceptibility of steels and filler materials to HACC during welding, implant test, LTP test, TRC test, Bead bend test, Tekken test, U-groove weld cracking test, Lehigh test, CTS test, Cruciform test, WIC test, RGW test, GBOP test, SCCT test and IRC test can be used.

Susceptibility to HACC in arc welding can be controlled by the welding parameters such as, preheating, interpass temperatures, controlled interpass times and increased arc energy heat input, with the additional two parameters of Contact tip to work piece distance (CTWD) and shielding gas. These parameters promote the cooling rate of WM, thus allowing the hydrogen to be effused away from the weld zone. Further, the maximum local hydrogen concentration must be less than 10 ml/100g for minimizing HACC during cooling to room temperature. The diffusible hydrogen content decreases with the increase of CTWD in flux-cored arc welding with rutile wires, and also related with residence time of wire in the resistive heating zone. The seamless flux-cored wires are regarded successful in minimizing the hydrogen contents in weld deposit. In addition, preheating and postheating are considered at weld joints to minimize the hydrogen concentration for avoiding HACC. Increasing temperature up to 300 °C soon after welding and maintaining for 2 hours is recommended to accelerate the hydrogen release to avoid cold cracking.

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