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**Experimental observation and microstructure-based simulation**

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**Abstract:** The instrumented indentation test and the microstructure-based finite element analysis were used to study the effect of post weld heat treatment (PWHT) on the mechanical properties of C-Mn weld metal, i.e. the individual microstructures, the heterogeneous deformation distribution and the plastic strain localization under tensile loading. It is found that the PWHT significantly influences the strength of weld metal by changing the strength of individual microstructures: the grain boundary ferrite is softened after PWHT regardless of the holding temperatures; the acicular ferrite is softened after treating at 400 °C and 700 °C, whereas hardened after treating at 600 °C; the variation of the mechanical properties is due to the reduction of dislocation and the precipitation of carbonitride. As a result, the strength variation between grain boundary ferrite and acicular ferrite after the PWHT leads to the distinct distribution of plastic strain localization in weld metal and the critical fracture strain of weld metal.

**Keywords:** Post weld heat treatment; Mechanical properties; Finite element analysis; Weld metal;

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