EFFECT OF THE WELDING PROCEDURE AND P.W.H.T. ON THE 50 mm THICK WELDED JOINTS OF AN H.S.L.A. STEEL

L.M.Plaza(*),M.A.Roman(**) and A.M.Irisarri(*)

The effect of two different procedures and three postwelding heat treatment conditions on the fracture toughness of a H.S.L.A. steel welded joints have been studied. S.M.A.W. specimens tested at low temperatures exhibit a marked decrease in toughness compared with the room temperature ones. Semiautomatic G.M.A.W. weld metal specimens possess a relatively high level of toughness which is scarcely affected by testing temperature or heat treatment condition.

INTRODUCTION

High strength low alloy (H.S.L.A.) steels were developed to achieve high yield strength and, at the same time, maintain a reasonable level of toughness with a minimum of alloying. Appropiate composition and thermomechanical processing control allow to develope yield strengths typically in the range of 350 to 700 MPa (1). Most applications of these steels involve structures where welding is used. In the fusion zone, the weld metal composition, heat input and cooling rate, solidification characteristics, and reheating thermal cycles contribute to the properties of the weld joint (2). Moreover, post weld heat treatment (P.W.H.T.) given to the weldments to relievethe residual stresses introduce more microstructural changes and, obviously, have an influence on the mechanical properties of the joint.

* INASMET. Cº Portuetxe 12. San Sebastián. SPAIN.

** BABCOCK WILCOX ESPAÑOLA. Alameda Recalde 27. Bilbao. SPAIN.

The aim of the present work is to investigate the effect of two different welding procedures and three P.W.H.T. conditions of the fracture toughness of a H.S.L.A. steel weldments.

EXPERIMENTAL PROCEDURE

The study was carried out using a 50 mm thick plate of a H.S.L.A. steel, whose chemical composition is given in Table 1. Weldments were performed in the transverse direction of the plate, using shielded metal arc welding (S.M.A.W.) and semiautomatic gas metal arc (G.M.A.W.) processes. Three different heat treatment conditions were considered: as welded (A.W.) stress relieved 30 min at 580ºC (S.R.) and heat treated at 580ºC for 3 h (H.T.).

Fracture toughness characterization was performed by means of CTOD tests of specimens with the notch located in the weld metal and Charpy impact testing of specimens with the notch position in the weld metal or heat affected zone. The CTOD specimens which were in the as-welded condition were locally compressed to achieve a more homogeneous fatigue crack front using the two platens sequence A technique as described by Leggatt and Kamath (3). After fracture the specimens were examined in an scanning electron microscope.

RESULTS

Figure 1 shows the influence of the welding procedure, heat treatment condition and testing temperature on the values obtained in the CTOD tests of weld metal specimens S.M.A.W. samples tested at low temperatures exhibit a decrease in toughness compared with the room temperature values. This decrease in toughness is even more marked when the specimens have been stress relieved or heat treated. These results, supported by those obtained in impact tests (figure 2), are in good agreement with most of the observations reported in a previous revision (4). S.E.M. examination of these low temperature specimens reveals wide regions of cleavage which could explain this loss of toughness. A more detailed description on the fracture topography of the different broken specimens is given in another work (5).

G.M.A.W. samples possess a relatively high toughness but lower than this obtained in S.A.W. specimens (6), which is scarcely affected by both testing temperature or heat treatment. Fracture topography of all these specimens is very similar pointing to the action of the same fracture mechanism in all conditions (5). Although, a slight decrease in toughness is observed in Charpy specimens tested at the lowest temperatures, the results can be consider consistent with those of CTOD tests.

A negative effect of the heat treatment on the toughness is also seen in S.M.A.W. specimens with the notch in the heat affected zone. As figure 3 exhibits this loss of toughness is more marked as the heat treatment time increases. However, HAZ specimens corresponding to the G.M.A.W. weldments show a certain decrease when are stress relieved but the toughness is recovered, even at higher values, after 3 h. treatment.

TABLE 1. Chemical Composition of the Plate

C	Si	Mn	P	S
0.152	0.32	1.41	0.007	0.002
Ni	Cr	Mo	V	Al
0.49	0.25	0.096	0.076	0.012

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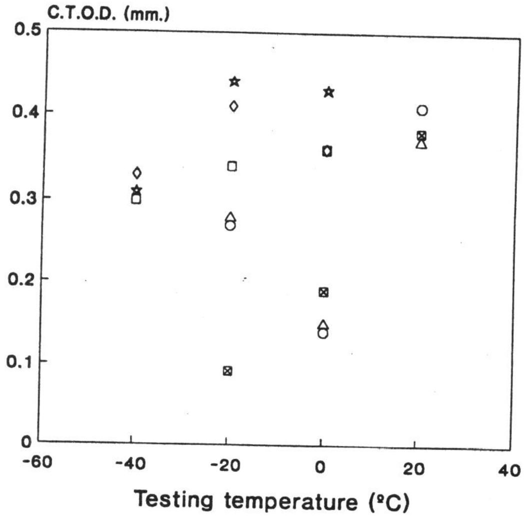
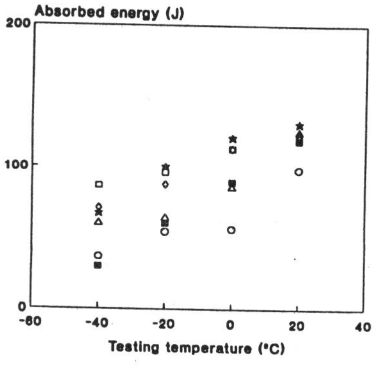


FIG.1. Effect of the testing temperature on C.T.O.D. WELD METAL VALUES.



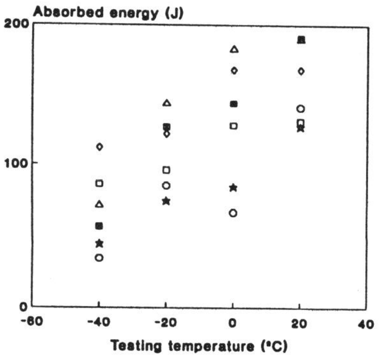


FIG.2. Absorbed Energy versus testing temperature (WM).

FIG.3.Absorbed energy versus testing temperature (HAZ).

△ **SMAW-AW** ☒ **SMAW-SR** ○ **SMAW-HT**
□ **GMAW-AW** ✮ **GMAW-SR** ◇ **GMAW-HT**