Effect of Welding Parameters on the Mechanical Properties and Microstructure of BQ Plateastm SA 516 – 60 Grade

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Abstract: A detailed study on the microstructure, phase analysis and mechanical properties, HAZ width of BQ PLATE ASME SA 516 – 60 GRADE weld metal V- joint and heat-affected zone of 10 mm thick BQ plate was carried out using metallurgical microscopy, with olimpus inverted metallurgical microscope projection system including mega pixel camera and image analysis software. The various sub-zones in the microstructure were observed in the HAZ of weld, base metal and weld pool are spheroidized, partially transformed, grain refined and grain coarsened. The main purpose of present work is to investigation and correlate the relationship between the various parameters; mechanical properties and microstructure of single "V" butt joint of Boiler Quality plate.

***Keywords**: BQ PLATE ASTM SA 516 – 60 GRADE, stringer welding, hardness, microstructure Heat treatment process.*

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1. INTRODUCTION

Welding is a fabricated or sculptural process that joints material usually metals or thermoplastics by causing fusion. In welding base metals gets melt by application of heat and a filler material is typically added to the joints to form a pool of molten material that cools to form a joint that is usually stronger than the base material. Some best known welding methods which are widely used in industries are oxi fuel welding, shield metal arc welding, TIG welding, MIG welding, and submerged welding. Though we are using heat for joining of metal it causes some good and bad effect on the properties of metal
which we have to weld, also good quality of weld depends upon type of welding material, electrode, welding technique, etc. In this project we are using SMAW with different welding technique on mild steel plate (BQ ASTM-SA 516) with V-grove on it check and analyze the changes in mechanical properties and microstructure of plate.
The analysis of mechanical properties of two different test specimen having different welding techniques is done by performing the following test: Tensile test. Hardness test chemical test micro structural test.

2. EXPERIMENTAL WORK

On the basis of the literature review, following parameters were finalized

- Type of Welding
- Electric Arc Welding - Stringer Welding
- Type of welding joint - Single-V butt joint
- Type of heat treatment
  - Stress Relieving Heat treatment process
  - Green Refining

The analysis was performed varying one parameter at a time and keeping the other constant.
Step 1: BQ plate of dimension 300x300x10 mm are cut using Gas cutting. Gas cutting is used to cut the plate(dimensions 19x300x10) .Buffing is done on the plate. Buffing is a process in which the intermediate layer made from a relatively tough material. After buffing, an initial tests are done on the MS-BQ plate that are
- Hardness test
-Tensile strength test
-Chemical test
These tests are done before welding.
Step 2: New plate of dimension 19x300x10 mm are taken and single v-butt joint is made
on the plate with angle of groove 60˚ as shown in figure.

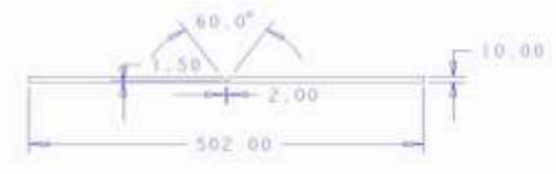

Fig. 2.1 **V-Groove**

Stinger welding is done on the plate. The Electrode operated was AWS/SFAS 1 E 7018. Electrode was pre-heated up to 200˚C (approx. 1 hour time consumed) for removing the moisture content in it. The Inter pass temperature recorded was 480˚C. Speed of weld is:

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- Stringer weld =120 mm/min

Fig.**Stringer weld**

Step 3: Pre-heating was done on both the plate (up to 210˚ C) for removing moisture present in it. DPT (Dye Penetrant Test) was done in order to check the pores and cracks formation after welding.

- Penetrant used is AMS 2644 ASM EB PU code, sec V IS 3658

- Developer used is SKD-52 ASM 2644 ASM EB & PV code, sec V IS 3658After Welding on both the plates, Radiography is done in Neco. A Radiography method is used to inspect the material for hidden flaws. In radiography, the parts to be inspected is placed between the radiation source and a piece of radiation sensitive film. The radiation that passes through the part, exposes the film and forms a shadowgraph of the part. After radiography, both sample

plates are cut into pieces for tests :

- 2 specimen for face bend test and root bend test each (38x300x10 mm each)
- 2 specimen for tensile test (19x300x10 mm each)
- 1 for Microstructure.

Sample ID	Observed (%)									
	C	Si	Mn	P	S	Cr	Ni	Mo	Cu	Al
Plate Sample	0.16	0.085	0.38	0.0129	0.0077	0.311	0.014	<0.005	0.020	0.034

Sr. No.	Sample Identification	Yield Stress (N/mm²)	Tensile Strength (N/mm²)	(%) Elongation
1	Plate Sample	319.948	447.644	30.750

3. CONCLUSIONS AND RESULT

RESULTS OF TENSILE TEST OF STRINGER WELD

Sr. No.	Sample Identification	Sample No.	Test	Tensile Strength (N/mm²)	Observations	Remarks
1	Stringer Welding weld coupon 10 x 300 mm (Without heat treatment)	T1	Tensile	446.489	Broken at Base Metal	Ok
		R1	Root Bend 180˚, 4T	---	No crack	Satisfactory
		F1	Face Bend 180°, 4T	---	No crack	Satisfactory
2	Stringer Welding weld coupon 10 x 300 mm (With heat treatment)	T2	Tensile	434.127	Broken at Base Metal	Ok
		R2	Root Bend 180˚, 4T	---	No crack	Satisfactory
		F2	Face Bend 180°, 4T	---	No crack	Satisfactory

Table 3.1

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STINGER WELDING

Without heat treatment

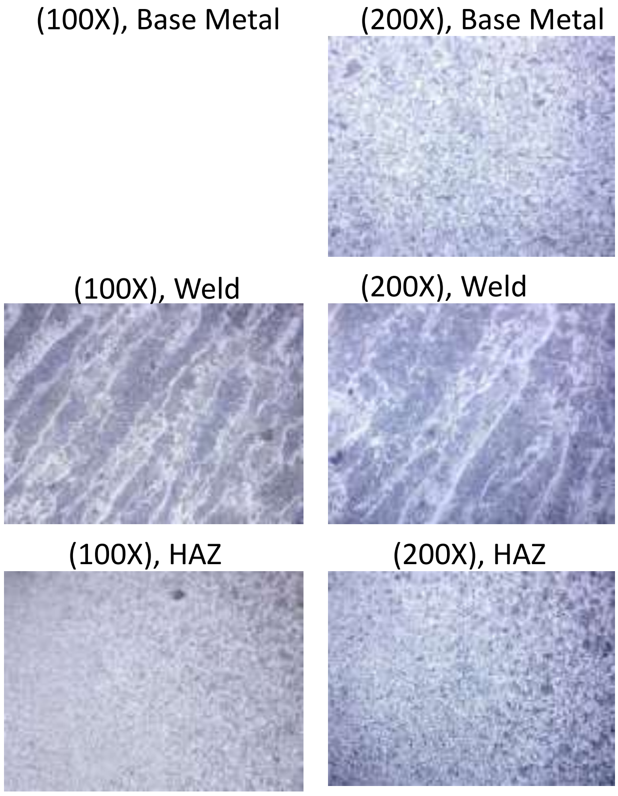

Fig. 3.1

With heat treatment

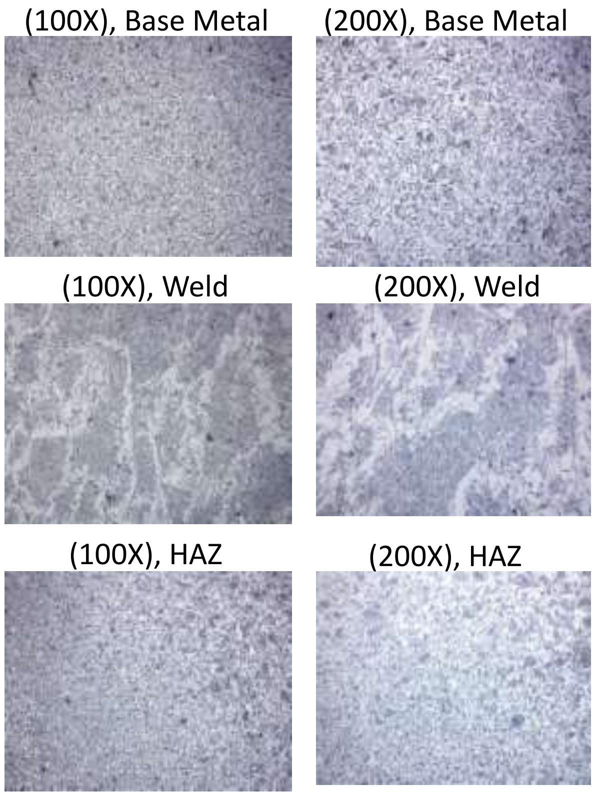

Fig. 3.2

Observations for figure 3.1:

- **Base Metal at 30 mm apart from weld pool**
  Angular pearlite ferrite grains observed, ASTM ferrite grain size no. observed to be 8
- **Weld Metal**
  ferrite pearlite observed, also ferrite observed along the grain boundries.
- **HAZ**
  In HAZ course dense pearlite structure observed. Pearlite ferrite grain structure smoothly migrates from coarse to fine from HAZ towards Base metal.

Observations for figure 3.2:

- **Base Metal at 30 mm apart from weld pool**
  Angular pearlite ferrite grains observed, ASTM ferrite grain size no. observed to be 8
- **Weld Metal**
  Acicular ferrite pearlite observed, also ferrite observed along the grain boundries.
- **HAZ**
  In HAZ course dense pearlite structure observed. Pearlite ferrite grain structure smoothly migrates from coarse to fine from HAZ towards Base metal.

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