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EFFECT OF WELDING HEAT ON MICROSTRUCTURAL AND TENSILE PROPERTIES OF FERRITIC STAINLESS STEEL AND MILD STEEL

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Abstract: In the present work, welding heat effect of arc welding processes such as shielded metal arc welding on tensile properties and microstructure of the Ferritic Stainless steel and mild steel is studied at constant current of 100 A and voltage of 24V. In this work, the plates of 6 mm thickness were used as the base material for preparing single pass v butt welded joints Tensile properties, microstructure of the welded joints have been evaluated and results are compared From this investigation it is found that, the tensile properties of FSS is more as compare to MS after welding. This is mainly due to grain coursing occur in heat effected zone.

Keywords: FSS, MILD STEEL, SMAW

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INTRODUCTION

Welding is a precise, dependable, economical method of joining materials. Most widely used by manufacturers to join metals and alloys efficiently and to add value to their products. Unfortunately the welding process induces also few problems that need to be more accurately identified and after that minimized as much as possible. Among the welding typical problems and most important are the residual stress/strain and the induced distortions in structures

Ferritic Stainless Steels (FSS) constitute approximately one-half of the AISI type 400 series stainless steels. These steels contain 10.5% to 30% of Cr along with other alloying elements, notably molybdenum. These steels exhibit good ductility, formability, and moderately better yield strength relative to those of the austenitic grades, but the high temperature strength is somewhat poor. Due to the crystal structure, the toughness is low at cryogenic temperature. These grades provide a saving of approximately 1.5 percent over the austenitic grades in material cost and are, as such, attractive alternative to the austenitic variety .Ferritic stainless steel is a candidate material in less severe corrosion atmosphere for chemical processing equipment, furnace parts, heat exchangers, petroleum refining equipment, recuperates, storage vessels, electrical appliances, solar water heaters, and household appliances . They are particularly more appropriate in caustic and chloride environments

Mild/low carbon steel has excellent weld ability and produces a uniform and harder case and it is considered as the best steel for carburized parts. Mild/low carbon steel offers a good balance of toughness, strength and ductility. Provided with higher mechanical properties, hot rolled steel also includes improved machining characteristics and Brinell hardness .Specific manufacturing controls are used for surface preparation, chemical composition, rolling and heating processes. All these processes develop a supreme quality product that are suited to fabrication processes such as welding, forging, drilling, machining, cold drawing and heat treating.

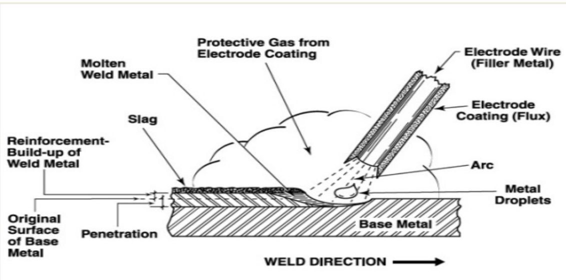

Fig. 1 SMAW welding

Shielded metal arc welding (SMAW) is the most commonly used welding process for Steels as they are easily available. SMAW uses a consumable electrode coated in flux to place a weld. An AC/DC electric current is used to form an electric arc between the electrode and the metals to be joined. As the weld is placed, the flux coating of the electrode break down, giving off vapors that help in forming a shielding gas which protect the weld area from atmospheric adulteration as shown in Fig. 1. Because of the flexibility of the SMAW it dominates other welding processes

EXPERIMENTAL WORK:-

The chemical composition of the base metal was obtained using spectrometer (ASTM-E-415-2005) at various locations of the samples and their spectrum was analyzed for the estimation of different alloying elements. The chemical composition of the base metal in weight percent is given below in Table 1 & 2. From the observation table it has confirmed that the plate is low chromium Ferritic stainless steel having chromium 11.107%.

Table 1:- chemical composition of FSS

Sr. No	Sample Identify	C %	Si %	Mg%	P %	S %	Cr %	Ni %	Mo%	Al%	Cu %	Nb %	Ti %
1	SS Sample	0.032	0.467	0.548	0.027	0.001	11.010	0.178	0.056	0.008	0.186	0.001	0.001

Table 2:- chemical composition of MS

sample	% c	% si	% Mn	% S	% p
MS sample	0.17	0.13	0.69	0.0085	0.021

In order to analyze the effect of heat on metal joining by shielded metal arc welding techniques were adopted welding 409M ferritic stainless steel and mild steel plate. In this investigation, the sheet of 6mm thickness AISI 409M grade ferritic stainless steel were cut into the required plate of dimensions (130mm X 75mm) by hydraulic shearing machine. The plate dimensions after cut are shown in the Fig

The plates were prepared for the welding by providing the V-groove between both plates for V-butt joints. V-groove prepare on the grinder machine with maintaining root gap of 1.5 mm, root face of 1 mm and 30^o-60^o were made on each plate for welding V-groove butt joint. As the dimension were checked by vernier caliper. The dimensions of the plates are shown in the Fig. 4 and the images of the actual plates prepared for welding are shown in Fig

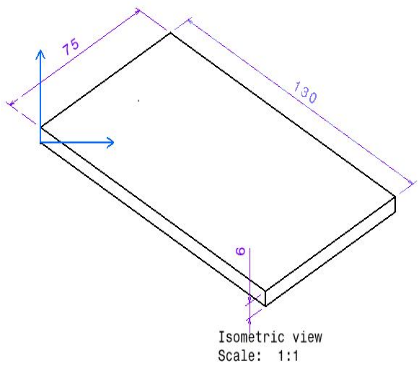

Figure2: FSS & MS Cut Sample for Welding

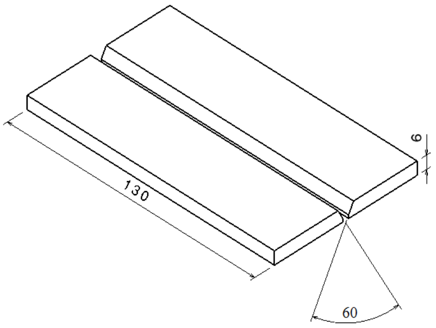

Figure3:-preparation of v butt

The various welding processes & welding parameters which are used to fabricate the joints are given in the Table 3.

Table 3: Welding Processes & Welding Parameters

PARAMETERS	SMAW M.S	SMAW FSS
Polarity	DCEN	DCEN
Arc Voltage	22V	22V
Welding Current	95A	95A
Welding Speed	2.13 mm/sec	2.43 mm/s
Efficiency [5]	0.75	0.75
Heat Input	788.53 J/mm	680.16 J/mm
Electrode Dia.	3.15 mm	3.15 mm
Ele. Material	7018	308L

The welded joints were sliced using power hack saw and then machined to the required dimensions for preparing tensile specimens.

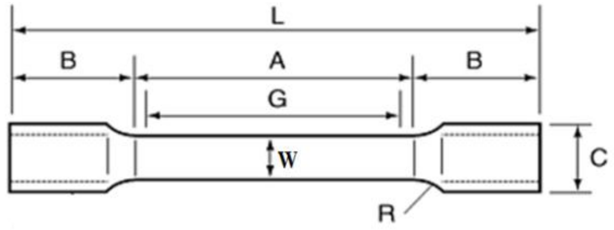

Figure 4:- Tensile Specimen

Table 4:- tensile results

Joint	Yield strength mpa	Tensile strength mpa	% Elongation
Base metal FSS	328.35	500	11.43
Base metal MS	271	404	9.6
Fss Joint With Ass Filler	318	457	9.0
MS JOINT With Ms Filler Rod	219	393	7.56

I. RESULT & DISCUSSION :-

Transverse tensile properties such as yield strength, tensile strength and percentage of elongation, of the joints were evaluated. In each condition, two specimens were tested, and the average of results is presented in Table The yield strength and tensile strength of fss unwelded base metal are 328.35 and 500.9 MPa, respectively. But the yield strength and tensile strength of SMAASS (fabricated using ASS filler metal) joints are 318 and 457.62 MPa, respectively. This indicates that there is 63% reduction in strength compared to base metal strength.

The yield strength and tensile strength of ms unwelded base metal are 271 and 404 MPa, respectively. But the yield strength and tensile strength of SMAASS (fabricated using MS filler metal) joints are 219 and 393 MPa, respectively. This indicates that there is 47% reduction in strength compared to base metal strength.

1) It can be seen that there is a significant reduction in tensile strength because of welding

2) The microstructure obtained showed that the true HAZ includes the region where microstructures have been altered due to both grain coarsening and carbide precipitation.

3) The accumulated heat has been distributed between the welding structure and the heat released into the surroundings due to convective heat transfer.

4) Tensile strength of fss metal after welding is more as compare to ms metal because ms electrode generate more heat and due to this HAZ area is more there for tensile strength is less

II. MICROSTRUCTURE:-

Microstructural examination was carried out using a light optical microscope with image processing software. The specimens of size 50 mm × 10 mm × 3 mm were sectioned using wire-cut electrical discharge machine (WEDM) to the required size comprising of weld bead metal, heat affected zone (HAZ) and base metal regions. The open surface of sample was polished on emery papers of grade 180, 320, 600, 800 and 1200. Using the diamond compound of particle size 0.75 µm final polishing was done in the disc polishing machine as shown in Fig. 3. The fss specimens were electro etched using solution of 95 ml hydrochloric acid and 5 ml methanol for 10-15 seconds and ms specimen were etched with 2% nital . The structures then are viewed in computer software.

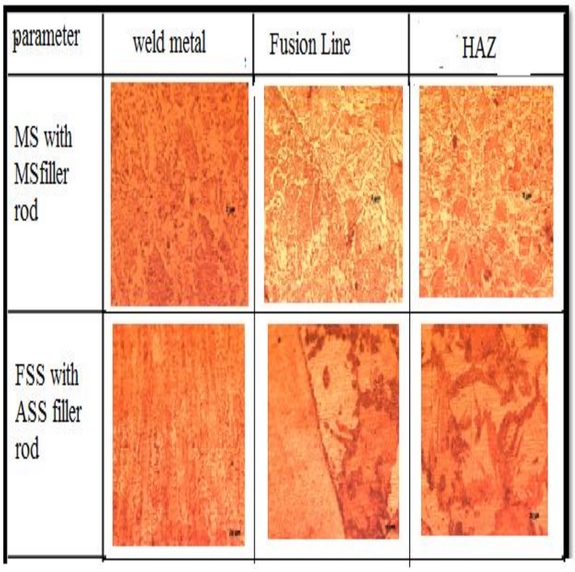

Figure 4:-Microstructure Of MS & FSS Plate After Weld

III. RESULT AND DISCUSSION:-

1) Heat Affected Zone - HAZ will exhibit a heat-treated structure involving phase transformation, recrystallization and grain growth. The amount of change in microstructure in HAZ depends on the amount of heat input, peak temp reached, time at the elevated temp, and the rate of cooling. Also this zone is the weakest section in a weldment.

2) HAZ area is more in MS plate as compare to FSS plate.

IV. CONCLUSION:-

1) the tensile strength of ms plate after welding is less as compare to fss plate

2) haz area is more in ms as compare to fss

3) More heat more decrease in tensile strength

4) Heat due to welding causes grain growth

and softening; this decreases the tensile strength Heat Affected Zone will exhibit a heat-treated structure involving phase transformation, recrystallization and grain growth. The amount of change in microstructure in HAZ depends on the amount of heat input, peak temp reached, time at the elevated temp, and the rate of cooling. Also this zone is the weakest section in a weldment.

5) HAZ area is more in MS plate as compare to FSS plate.

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