THE EFFECT OF WELD POSITION ON MECHANICAL PROPERTIES OF TMT ROD JOINED BY ARC WELDING

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Abstract

There are various welding processes for joining the materials. Arc welding is a prominent joining process in which two steel parts are joined by heat generated due to arc. Many researches have been carried out in joining of different materials by different welding techniques. Our research has been emphasized on TMT bars. A Thermo Mechanical Treated (TMT) bar is commonly used for making reinforced roofs and column of building. They are also used in for industrial purpose such as rock bolting in underground mines etc. Most of TMT bar's joining process took place with arc welding. In this paper a study has been made for the effect of welding position on strength of joined rods. In this study four Nos. of samples were taken having different locations of welding. They were allowed to cool under ambient condition. The chemical composition of parent material and weld zone were checked and observed that weld zone have different chemical composition compared with parent material. The variations of hardness with respect to distance were also checked using Brinell hardness testing machine and it was found that firstly hardness decreases and then increases with increase in distance from weld centre. From microstructural examination it has been seen that weld zone, HAZ and parent material all have different grain size as well as phase composition. Such change has been due to differential heating during welding. This increase and decrease in hardness has been justified with microstructural changes. Smaller grains have high hardness. Higher the pearlite phase higher is the hardness. There is decrease in hardness and strength in weld zone compared to parent zone and this was justified by lower percentage of carbon in weld zone as well as the microstructure of weld zone.

Keywords: *TMT, Tensile strength, HAZ, Hardness, Microstructure.*

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1. INTRODUCTION

TMT bar is used in making roof and column because of its high tensile strength and hardness. High Tensile strength of a material to allows a material to withstand large axial loads. While high hardness resists wear and tear of the material. Welding is very old technique to joining steel. It is considered as an extension of hot forging [1]. Arc welding use filler material for coalescence to take place. TMT bars are often welded by arc welding. The filler material has different composition thus the weld joint will have different properties from the base material. Also the Heat Affected Zone (HAZ) being heated during welding suffers micostructural changes. So both these zone will differ in hardness from the base metal. Although the failure of the material will depend on which section is the weakest as stated by strain energy theorem. Various researches have been done in welding of steel using different welding methods. A research done on torr rod showed that the weld zones have same tensile strength as parent i.e. 524 MPa [2]. In High strength low carbon alloy showed that tensile strength of weld zone was 1230MPa and 1260 MPa when filler material E309 L and 18-8-6 were used respectively while the base material have tensile strength 1720 MPa and showing joint efficiency of 72% [3]. Ferrite presence in the weld zone increases the tensile strength of weld zone [4].

2. EXPERIMENTATION

Tensile test specimens were prepared from a sample rod having gauge dimension 200 mm length and 16 mm diameter. The gripping for holding in machine was made of 18 mm diameter and 5 mm length. The weld joint were made at centre and at a distance of 20 mm, 40mm and 60 mm from centre. The groove was made of 35^0 on both cut pieces. The specimens are shown in figure 1. The specimens were joined using arc welding keeping the welding parameter same for all the specimens i.e. current 240 A and voltage 100 V. Hardness test was done using brinell hardness testing machine using load of 720 kg and steel ball of 5mm diameter. For hardness test the sample was prepared by making surface flat & smooth reflective surface by grinding & using emery papers respectively (figure 2). The microstructures of weld region, HAZ and parent zone were seen using optical microscope. The grinded and polished surfaces were etched with 2% nital solution for micro examination. Etching affects the grain boundaries and makes them visible. The chemical composition of parent material by weight was C= 0.21 %, Mn =0.746% Cr = 0.03 and Ni= 0.0143 and of weld zone is C= 0.09%, Mn= 0.43 Cr =0.02, Ni=0.01


Fig -1: Specimens used for tensile test


Fig -2: Hardness test specimen

3. RESULT

3.1 Tensile Test

The results of tensile test done on universal tensile testing machine is shown in table 1 and fracture samples in figure 3 and 4.


Fig -3: Fracture specimens


Fig -4: fracture surfaces

Table -1: Tensile test result

Sl no	Weld position from centre; mm	Dia ;mm (area; mm^2)	Ultimate tensile load; kg	Failure load; kg	Failure position
1	Parent material	16 (201.06)	13300	9900	Around 20 mm from centre
2	0	16 (201.06)	9450	9000	Welded joint
3	20	16 (201.06)	9350	8800	Welded joint
4	40	16 (201.06)	9450	8950	Welded joint
5	60	16 (201.06)	9300	8950	Welded joint

3.2 Hardness

The hardness of the weld centre is greater than weld root. There is initial drop in the hardness value at HAZ but again it increases towards the parent zone and maximum at parent zone. The variation of hardness is shown in table 2. Such variation occurs due to differential heating in the weld specimen. The drop in hardness value in root of weldment is due to softening of grains near faying surface. In others words the Initial drop in the hardness is due to large grains at the starting of the heat affected zone as we move towards parent zone the grain size decrease. Small grains have more tendencies to resist the load thus they have higher hardness.

Table -2 hardness variation toward left of weld centre

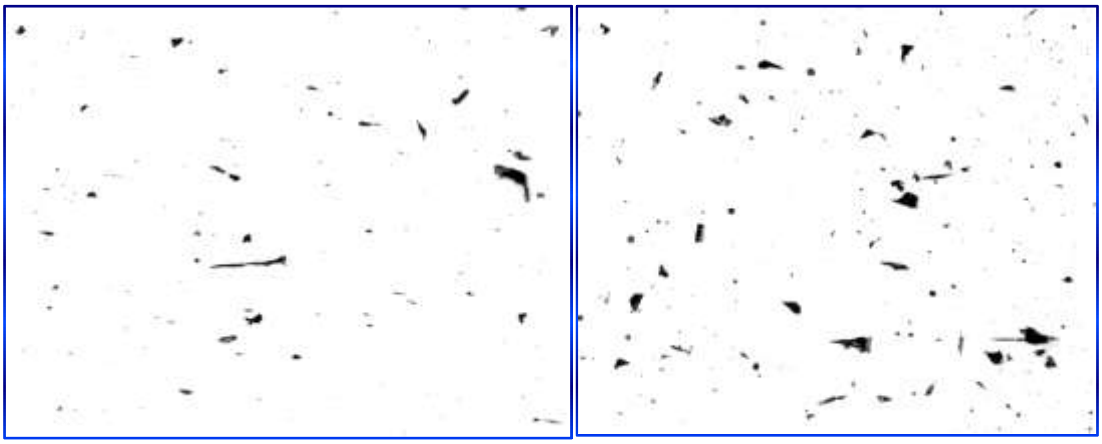
Distance from centre of specimen; mm	Ball diameter	BHN
0	2.30	170
3	2.36	161
7	2.36	161
14	2.20	187
17	2.00	229
21	2.00	229
28	1.96	239
35	1.86	266
42	1.86	266

Table -3 hardness variation towards right of weld centre

Distance from centre of specimen; mm	Ball diameter	BHN
0	2.30	170
7	2.36	161
14	2.46	148
21	2.16	195
23	2.10	207
28	1.96	239
35	1.86	266
42	1.86	266

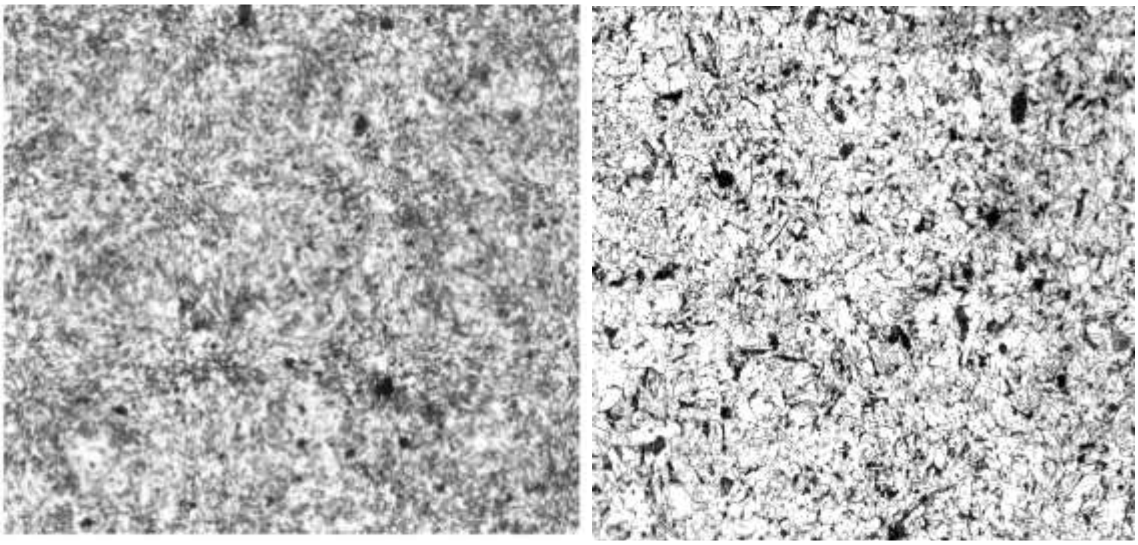
3.3 Micro Analysis

Micro analysis without etching (figure 5) shows that in the weld region there is more inclusion compared to parent material. After etching the microstructure of parent zone, weld zone, HAZ and transition from HAZ to weld is shown in figure 6 and 7. The black zones are pearlite and white ones are ferrite. The phase analysis showed that parent material has 63.18 % pearlite and 36.82 % ferrite while HAZ has 65.31% pearlite and 34.69 % ferrite. The weld zone has 46.69 % pearlite and 53.31 % ferrite. The phase composition in HAZ will vary from different places in HAZ.



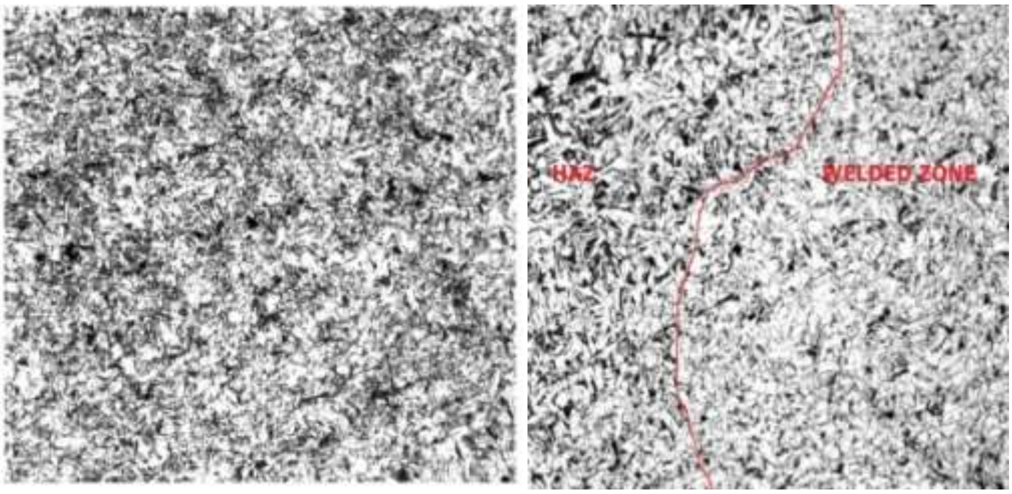
a) parent zone b) weld zone

Fig -5: Inclusion examination a) parent b) weld zone at 10 X



a) Parent zone b) Weld zone

Fig -6: Micro exam result of a) Parent zone b) Weld Zone



a) HAZ b) HAZ+ Weld zone

Figu-7: Micro Analysis of a) HAZ (10X) b) transition from HAZ to weld zone (10X)

3.4 Fractography

The tensile fracture surface was seen under scanning electron microscope (SEM) and fine dimples were seen for welded joint having good ductility but parent specimens showed much finer dimples (figure 8).

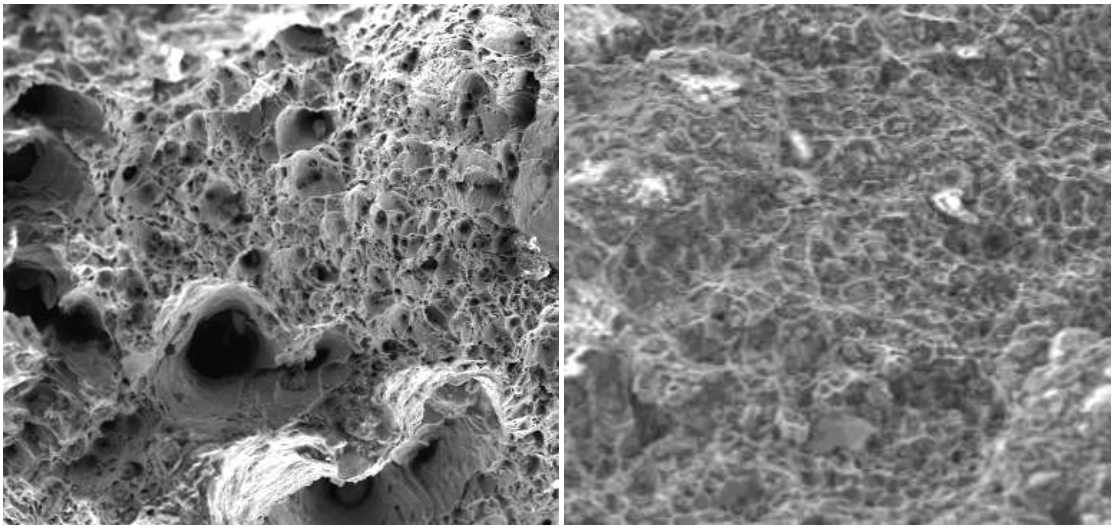


Fig -8: SEM image of fracture surface of a) parent b) weld surface at 2.00KX

4. CONCLUSION

From the tensile test we can conclude that all the specimens irrespective of their weld position failed at the weld joint. This shows that the weld joint is the weakest joint in case of arc welding of TMT bar. The microstructure of weld joint show there is less pearlite than the base material. The parent zone has very fine pearlite and due to heating the ferrite and pearlite in the HAZ has grown. The weld zone contains large no of inclusions which decreases the hardness and tensile strength. Apart from that the carbon percentage in the weld region is less than parent i.e. 0.9 % which may also be the reason for less tensile strength in the weld region.

ACKNOWLEDGEMENT

Authors are highly thankful to CSIR- CIMFR Dhanbad for proving lab facility for our project work.

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