Effect of Mig Welding Process on The Mechanical Characteristics of Cold Rolled Sheets

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Abstract- *Welding is one of the most commonly used techniques which can give strength comparable with the parent material. The welded sections are more prone to fatigue failures. In this study, the responses of welded structures using MIG process were investigated. Experiment was conducted on butt welded joints with square edge preparation of different combinations of current, welding speed. Tensile test, micro hardness and penetration were conducted on the specimen and the results were tabulated. Welded joints contain metallurgical and compositional differences result from welding process. This effects change in mechanical properties. Tension test is performed to evaluate the breaking strength of the metal. Hardness test is performed at different zones of welded specimens to investigate the reason for the behaviour of weldment. Microstructure of the weld is examined for the weld bead quality. Most of the welded structures are subjected to fluctuating loads over their lifetimes. In designing the welded joints to sustain changing loads over their lifetime these parameters are useful in improving the fatigue life of the structures using proper fatigue improvement techniques for weld.*

Keywords- Welding, fatigue failure, tension, hardness, penetration

I. INTRODUCTION

The welding bead width and depth of the T-joint increase with increasing the average current. As the current difference increases, the differences of weld pool temperature and stress between thermal pulse and thermal base increase accordingly [1].Welding consumables and welding processes have significant effects on the integrity of welded structures and their performance in service. This is because the chemistry of the filler material and the employed deposition mechanics control the phase trans-formation and thermal distribution in the weld metal respectively [2].The important parametric welding setups are the mechanical design of the joint) and the applied heat input. These are the key factors for the evolution of microstructure and residual stress distribution of the weldments as well as the extent of heat affected zone [3].When the welded parts of steels that are used as structural components are subjected to dynamic loading, the fatigue properties of such components also become very important. The fatigue strength of the base metals increases with increasing strength. However, the welded joints exhibit inferior strength due to both geometry effects and weld defects [4]. Gas metal arc welding (GMAW) is one of the most popular processes commonly employed for DP steels, especially in the automotive industry. An experiment is conducted on DP780 steel to evaluate the effect of the weld geometry on GMAW lap joints. It was discovered that improving the weld geometry of the steel enhanced its fatigue life [5]. For MSAW, the smaller bead size provides a higher energy density with having less spread of the fusion zone and HAZ along with a comparatively faster cooling rate At the same time using a combination of MSAW and FCAW processes is reported to provide excellent results including ensuring high deposition rate, i.e. improved productivity rates, low distortion and adaptability and ease of use of equipment [6].Two factors, the welding process and the filler consumables controls the mechanics of thermal distribution and the chemistry of the welded join, which in turn affect weld integrity through the resulting microstructure and residual stresses[7].

As briefly mentioned it is clear that the welding parameters such as current, voltage, wire feed rate have significant effect on the output parameters such as ultimate tensile strength, hardness which needs to be optimized. There is sufficient gap to investigate the response of MIG weldments with change in process parameters for improving its performances.

II. EXPERIMENTAL ANALYSIS OF WELDEDSPECIMEN

The experimental analysis is carried out on the specimens and the experimental analysis is discussed as follows

2.1 EXPERIMENTAL PROCEDURE

The surface of the cold rolled sheets is cleaned and the marking is made on it. The cold rolled sheets is cut into 9 pieces with the proper dimensions

2.3 PREPARATION OF JOINT

The cold rolled sheets have been cut into the required size (250×25mm) by power hacksaw cutting, butt joint was configured. Before welding the plates, side and edge preparation done to fabricate MIG welded joints. The square edge preparation is chosen for the weld specimens.

2.3 FACTORS AND LEVELS

The experiment was conducted on butt welded joints with square edge preparation of nine different combinations of current (amps), wire feed rate (IPM). Three level of current 80, 90,100 amps and three level of Wire feed rate 125,250,375 IPM were choosen.

Table 1 Welding parameters and levels

Parameters	Level1	Level2	Level3
Current(amps)	80	90	100
Wire feed rate(IPM)	125	250	375

Table 2 Design of experiments

Ex. No.	Current(amps)	Wire feed rate(IPM)
1	80	125
2	80	250
3	80	375
4	90	125
5	90	250
6	90	375
7	100	125
8	100	250
9	100	375

Table 4.1 and 4.2 shows the levels of welding parameters and design of experiments respectively.

2.4 PRODUCTION OF JOINTS

The sheets used in the present study were cold rolled sheets having thickness of 3mm which are joined. Nine joints has been produced according to design factorial of experiment

Figure 1 Welded Specimens

2.5 TENSILE TEST

The welded joints are sliced using power hacksaw and then machined to required dimension to prepare tensile specimen as per ASTM standards E8. The dimension of the specimen is shown in figure 3.2. These specimens are taken in the normal direction of the weld. The specimen is loaded and tensile specimen undergoes deformation. The tensile test of butt joint was conducted by using a universal testing machine of 1000KN capacity. The tensile test result were recorded and tabulated.

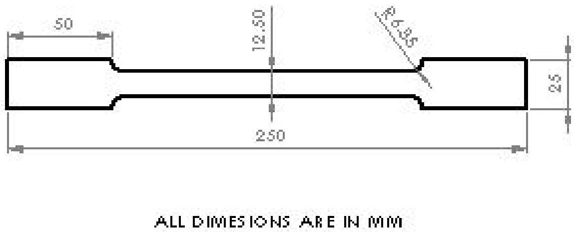


Figure 2 Tensile testing specimens

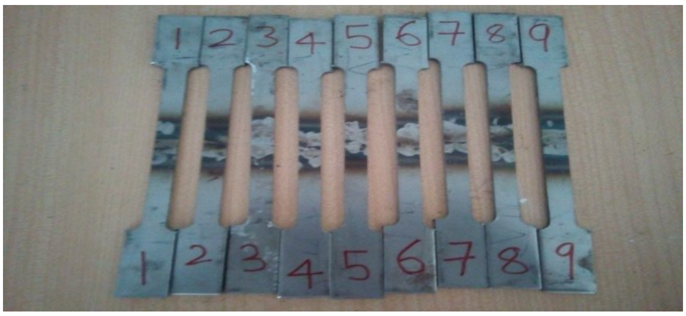


Figure 3 Specimens for tensile test

III. RESULTS AND DISCUSSION

The results of the tensile testing were recorded and tabulated in table 4.1 theresults were discussed as below.

3.1 TENSILE STRENGTH ANALYSIS

From the table 5.1, it is identified that the minimum ultimate tensile strength value MPa is obtained at the value of 80 amps current, 2 inching wire feed rate. The maximum ultimate tensile strength value MPa is obtained at the value of 100 amps current, 3 inching wire feed rate.

Table 3 Experimental value of tensile strength

Exp no.	Current (amps)	Wire feed rate	Ultimate Tensile Strength (N/mm^2)
1	80	125	268
2	80	250	256
3	80	375	291
4	90	125	295
5	90	250	239
6	90	375	292
7	100	125	275
8	100	250	296
9	100	375	313

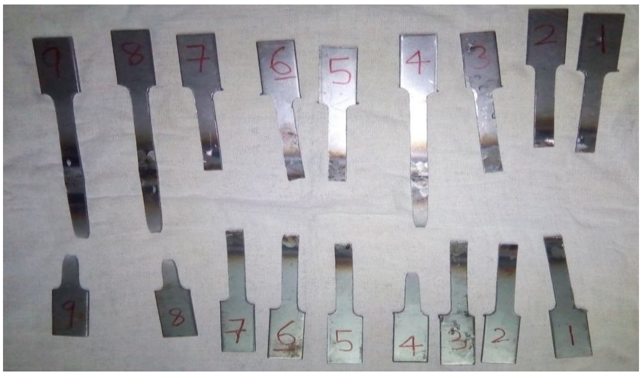


Figure 4 Tensile tested specimens

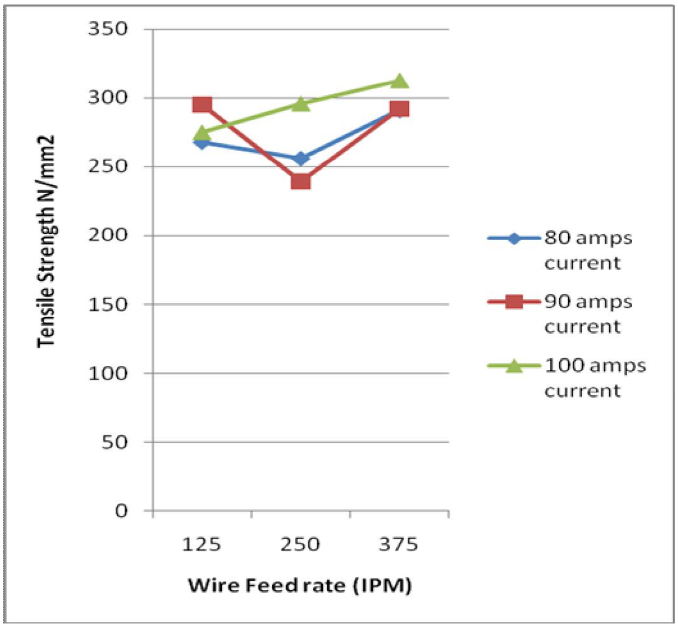


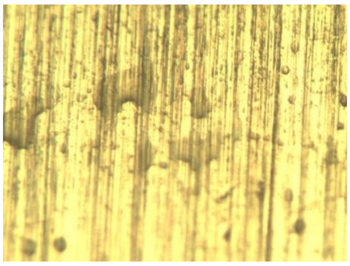
Figure 5 Relationship between Tensile Strength vs Wire feed rate vs current

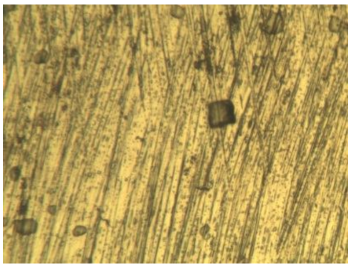
The graph figure number 5 shows the relationship between Tensile strength, Wire feed rate and Current. It can be clearly seen that at 80 and 90 amps of current, the tensile strength decreases and it increases respective to the increase in wire feed rate. The tensile strength increases linearly at 100 amps of current to the respective increase in feed rate.

3.2 MICROSTRUCTURE ANALYSIS

Metallurgical characterization was performed with the use of optical microscope and inverted microscope on the weldment, compromising of base metal and fusion zone. Standard metallographic procedure was adopted to prepare the sample for examination.

The microstructures of cold rolled steel weldments are shown in Fig. 6. In samples the presence of black spots is due to formation of slag during welding. In samples 2,4,8,9 formation of slag is minimum due to less ferrite content. In the HAZ, on either side of the weld, there were no noticeable changes in the grain structure compared to the respective unaffected base material


Sample 1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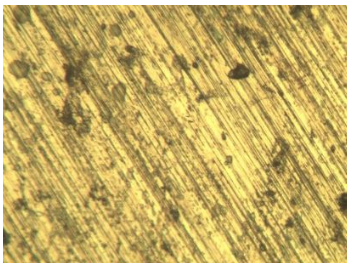
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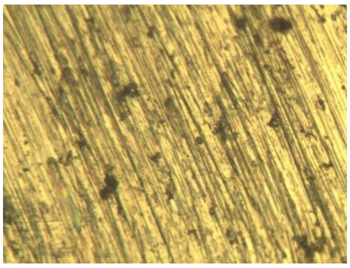
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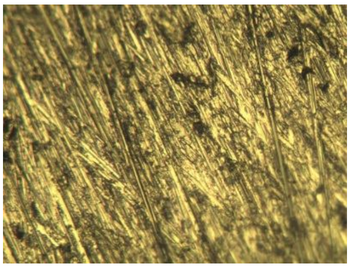
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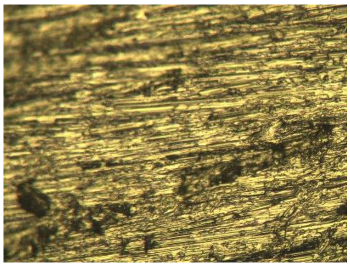
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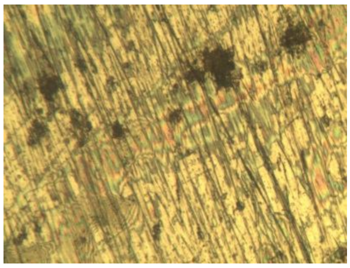
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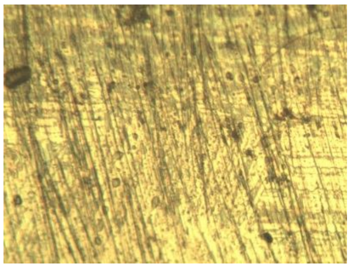
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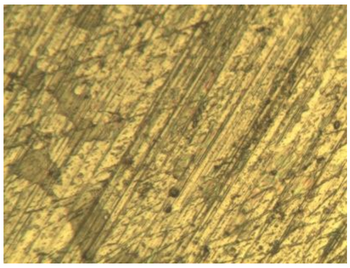
Sample 9

Figure 6 Microstructures of the weldments

3.3 MICRO HARDNESS TEST

Vickers micro hardness tests were conducted across the weld (mid-section, 0.25 mm spacing) to ascertain possible microstructure/property variations among the various regions of the weldment.

From the table 5.1, it is identified that the minimum hardness value 76.10 HV is obtained at the value of amps current, IPM wire feed rate. The maximum hardness value

103.85 HV is obtained at the value of amps current, IPM wire feed rate.

Table 4 Experimental value of Vicker's Hardness

Distance from the weld centre	Experiment No								
	1	2	3	4	5	6	7	8	9
-12	138.7	156.7	163.5	147.4	158.4	141.3	156.7	168.1	150.2
-9	140.3	180.1	174	151.6	169.3	169.7	166.1	174.3	156.7
-6	170.3	199.7	172.6	154.2	187.1	211.1	172.7	205.4	178.1
-3	187.6	225	225.8	167.2	192	243	181	225.8	219.6
0	197.7	228	226.5	169.3	248.6	254.4	198.8	229.4	222.3
3	185	209	214.7	168.4	202.4	237.6	184	220.4	190.9
6	151.6	207	189.7	157.2	183.2	199	180.2	213	189.3
9	143.4	189.7	180	147	171.4	175.9	160	187.1	161.7
12	131.6	179.8	171.4	139.6	154.7	139.7	149.7	154.8	151.7

The Table 4 shows the experimental values of harness of the tested specimens

The table shows the hardness value of the each specimen at different points from the weld centre. From the hardness test it is seen that for the specimen 100A current with high wire feed rate may give sound weldment. The hardness values increases from butt weld area to heat affected zone. The reason for increase in hardness is due to high welding temperature the precipitation of dissolved carbon occurs during the welding. For specimen Number 7 the hardness values lies in the range of 180 in the weld region which indicates that meltdown of weld has happened. For Specimen Number 8 the hardness values lies in the range of 220 where the heat affected zone area is affected with high welding temperature. For Specimen Number 9 the hardness values lies in the range of 200 where fusion and penetration is maximum.

V. CONCLUSION

The analysis presents effect of current, wire feed rate on weld quality. Tensile strength of MIG welded cold rolled sheets have been found under different conditions. The specimens welded with varying parameters shown distinct strength regimes. The specimen welded with 100 amps shows an increase in strength with increase in wire feed rate. This may be due to higher welding speed which caused lower thermal effects on the parent material; whereas the specimens welded with 80 amps and 90 amps shows mixed values with strength dipping at middle level of speed. This may be due to improper fusion of the joint. Moreover in some specimens the failure happened away from fusion zone indicating sound weldment.

It is concluded that for this specimen 100A current with high wire feed rate may give sound weldment. The microstructure and hardness of these specimens were examined. The results of each specimen were studied, examined and compared with each other, the specimen with 100A current and 125 IPM wire feed rate were found to be better than the other specimens. The parameter obtained from the analysis has to be studied further to get a better parameter which gives a sound which is good both in static and dynamic loading condition.

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