# To Study the effect of various parameter on Distortion in M.S Flat Sheet in Shielded Metal arc Welding

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## ABSTRACT

The aim of the study or analysis is modeling and verification effects of the various parameters on Shielded Metal Arc Welding process on mild steel with the focus on stress and temperature distribution prediction of welded plates. The report has mainly three parts namely; the literature survey on FEM modeling of welding processes, welding process modeling and verification of the experimental results with modeling.

Welding model was developed using finite element analysis software which has the capabilities to model welding processes. The three dimensional welding model was developed from 2-D welding model with the help of the analysis software. All the heat input parameter measured from the experiment were used in analysis software and actual structural restraints data used in developing the model.

Temperature distribution within the welded mild steel plate and its displacements were measured in this Welding process. The temperature of the plate was measured at various locations by using the thermocouples (K type) and these thermocouple were spot welded on to the MS plates for measuring the temperature at different location on the plate. At different stage of the manufacturing process the deformation of the plate were measured. The FEM was verified and found good correlation, for the temperature distribution in the welded plates.

**Keyword:** Manufacturing, arc welding, shield, distortion, FEM.

### LITERATURE REVIEW

The weld and bead geometry plays an important role determining the mechanical
Properties of the weld. Hence the input welding process variables which influence the bead geometry must therefore be properly selected to obtain an acceptable high quality joint. (Mostafa and Khajavi, 2006). Predicting weld bead penetration as a function of welding process parameters. They optimized process parameters for maximizing weld penetration. (Rayes et al, 2004) studied the influence of various hybrid welding parameters on bead geometry. They conducted experiments on
316L austenitic stainless steel work piece. They varied power to study their influence on various bead dimensions. They found that arc power has a great influence on bead width. (Thao and Kim, 2009)predicting bead geometry for lab joint ingas metal arc welding (GMAW) process. They conducted experiments based on five process parameters to obtain bead geometry using GMAW process. From the study it was inferred that welding voltage, arc current, welding speed and welding angle have large significant effects on
bead geometry. (Farhad Kolahan and Mehdi Heidari, 2010) developed an approach to
predict and optimize weld bead geometry in GMAW.They developed mathematical models for weld bead height, width and penetration. (S.P.Gadewar,2010) Investigated the effect of process parameters of TIG welding like weld current, gas flow rate, work piece thickness on the bead geometry of SS304.During experimentation it is found that, increase in the welding current result in increase in heat input. This increased heat is utilized to melt the base metal. Similarly as thickness of the work piece increases rate of gas flow need to be increased to increase the heat diffusion rate. Increase in gas flow avoids the vaporization of the molten metal. It also increases the penetration. The increase in weld current and gas flow results in change in Bead Geometry of the welded joint which dominates the weld characteristics. The variations in the process parameters affect the mechanical properties with great extent.

## Experimental Set Up

In this experiment there is different welding parameters used such as clamping device on plates, thickness of metal plate and the welding current. The below table shows that there is three values given to the welding parameters like low, medium and high values with the settings used in the standard experiment specified as the medium values. The welding of flat mild steel plate with 3 mm thickness at 90 A current used in standard experiments with four clamps .

| Factors | Low | Medium | High |
|---|---|---|---|
| Restraints [Amount ofClamps] | 2 | 4 | 8 |
| Plate Thickness [mm] | 2 | 3 | 4 |
| Welding Current [A] | 70 | 90 | 110 |

**Values of the welding parameters used in the experiments**

Clamping device are used because mild steel flat plate require rigid support and experimental set up is on welding jig because it is not influenced by welding process and allowed uniform cooling on the top and bottom of the plates. The contact surface in between the plates and the jig to be minimum to bound contact heat losses, but rigid support are stll allowed for clamping. The jig used in this experiment were act as heat sink and the surface near the jig/plate cooled faster than in the middle of the plate. From the modeling the contact heat transfer coefficient was determined.
A linear displacement transducer was used to measure the transient displacement of plate a linear displacement transducer was used during the welding and cooling of the plates. The transducer was placed In the middle of the plate transducer was placed which is far from the edge of the weld it is indicated by black dot. The transient displacement results were insignificantly small and not repeatable during welding and cooling of the plate. The results out from the experiment were not used for comparison with the finite element analysis results. The dial displacement guage were used for the static displacement measurements for the first and last measurements were done on a high precision measuring table. The surface of the table was taken as the reference plane and all displacements were taken relative to the reference plane. The measurements were taken on an equally spaced 25-point grid marked on the plates (Figure 5-4)Static displacement measurements were done at five stages of the experiment:

(a) Plate before clamped to the jig,

(b) Plate after clamped to the jig on the plates,

(d) After welding with one clamp on the plates and

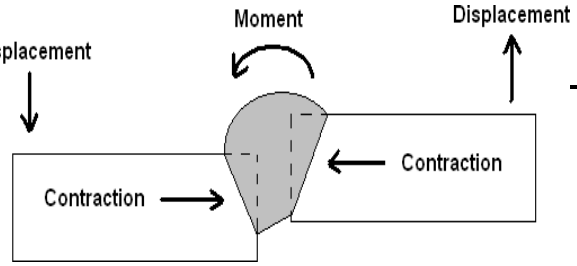
(e ) After the plates was removed from the jig.

The surface of the table which is used as a reference plane, the displacement of the point on the plates on the welding jig was measured by using reference point. The point nearest to the last clamp on the measuring grid was selected as the reference point. This clamp was referred as the reference clamp.The removal of other clamp during experiment effect on displacement of reference point which can be obtained from measurements. This proved that the reference point was rigid and was assumed absolute zero throughout the experiment.

Data logger is used for recording of voltage measured over the welding cable in welding Process. Current clap is used for measuring the welding current in welding cable. These measurements are helpful in finding the power and heat input of the welding process.

## RESULTS

During welding of plate start from the end without clamp towards the edge of plate with clamp,When there is arrangement of only two clap in experiment(#1 in Figure 5-3) .In begning plate were free to move and in end movement of plate is prevented due to this reason different causes induced such as misalignment of the

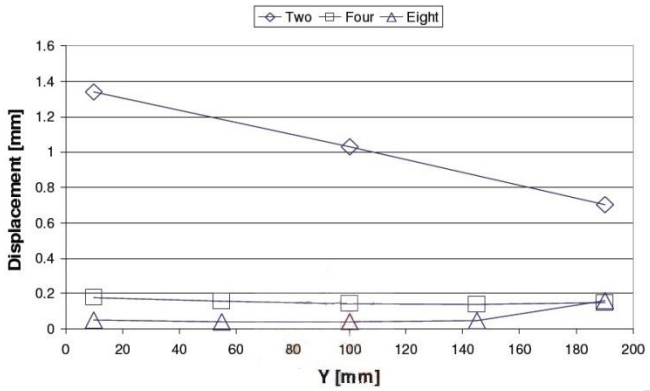



plates and extreme distortion in one plate during welding

The large welding distortions that occurred with the plate misalignment could be explained as the contraction forces that formed a couple-moment during contraction. In this welding process one metal plate deposited more filler metal than other, resulting in a larger contraction force in the one plate and created a moment around the weld.

The displacement magnitudes for the two-clamp experience on metal plate were significantly random but the trends observed were similar. The plates deflected upwards away from the clamps and weldment. The randomness in magnitude of displacement could create difficulty in controlling the welding with the plate movement. In case of four- and eight-clamp experiments, the misalignment and movement of the plates were controlled.

The displacement measurements of the plates after welding but before the removal of the clamps had shown that the two-clamp experiment deflected the most, while the distortion in the four-clamp and eight-clamp experiments were insignificant (Figure 5-6). The abscissa in Figure 5-6 shows transverse distance with the origin of the graph being the edge furthest from the weld and the 200 mm on the graph axis, the weld centreline. The plates in the four- and eight-clamp experiments distorted significantly and to a similar extent after the removal of all the clamps with the maximum deflections at the weld (Figure 5-7). The two-clamp experiment was slightly bended upwards away from the weld. The large distortion of the plates in the four- and eight-clamp experiments showed that high residual stresses were present after welding. With the removal of the clamps there was no resistance to the residual stresses and the plates distorted.




**Transverse displacement in middle of plate after welding but before the removal of the clamping for different clamp settings.**

The difference in distortion between the four- and eight-clamp experiments were insignificant and suggested that the use of more than four clamps on the plates were not necessary for this experiment. The restraints controlled the distortion of the plates during welding but could not control the final distortion after the removal of the clamps

| **No. of clamps** | **Y IN MM** | | | | |
|---|---|---|---|---|---|
| | **10** | **55** | **100** | **148** | **190** |
| 2 | 1.35 | ***** | 1.15 | **** | 0.7 |

| | | | | | |
|---|---|---|---|---|---|
| 4 | 0.189 | 0.180 | 0.180 | 0.180 | 0.180 |
| 8 | 0.1 | 0.1 | 0.1 | 0.1 | 0. 175 |

**Transverse displacement in the middle of the Plate after welding but before removal of clamps**

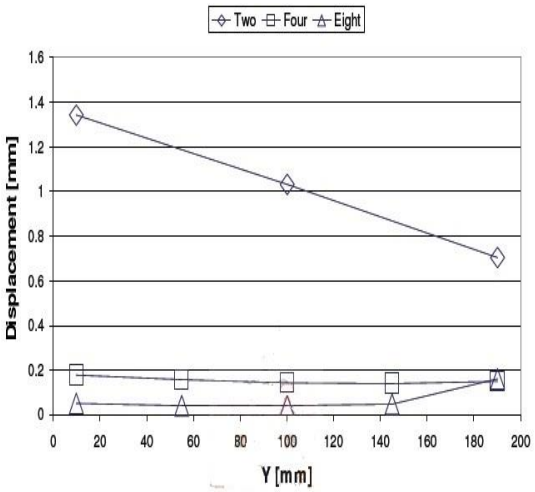
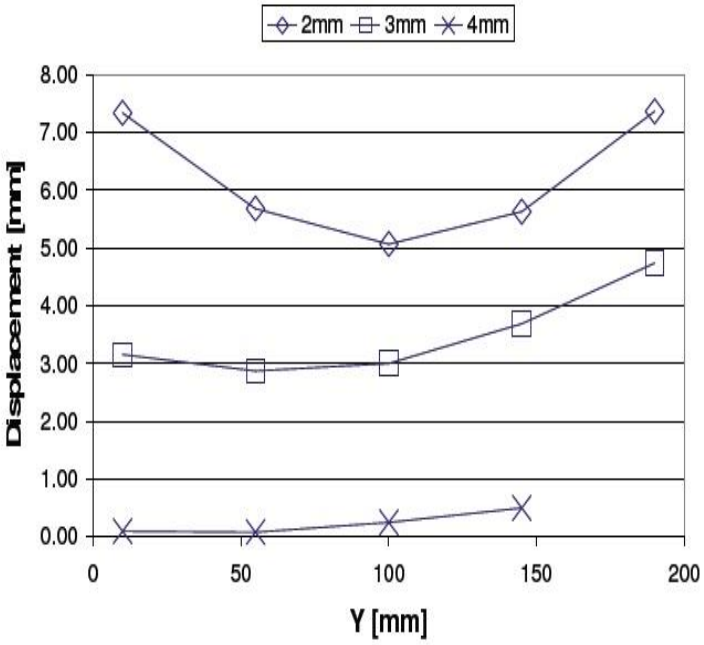



**FIG NO. 5.7: Transverse displacement in the middle of the Plate after welding but without removal of clamps**




**Final Longitudinal Displacement after removal of all the Clamps**

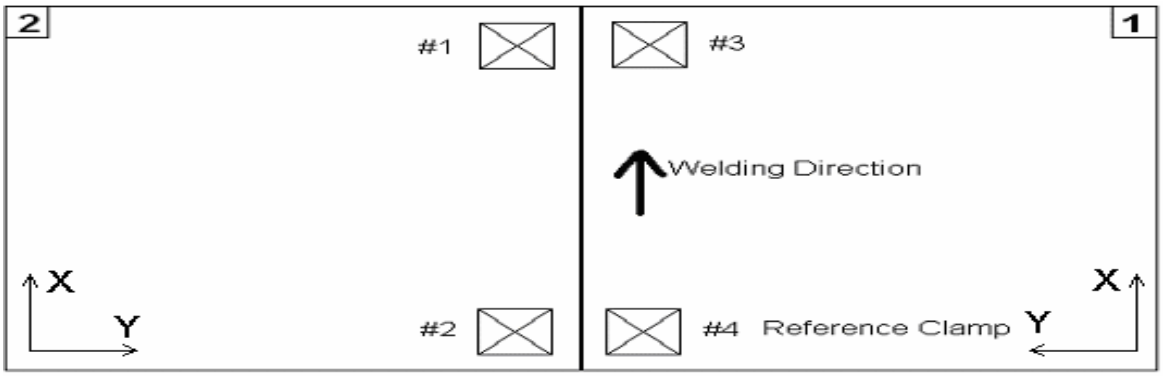
## Result and Discussion

1. There is no effect on the current and voltage with increase in the speed of the welding so power output remains same in the experiment which is around 2.157 KW (Table 4-2).

2. By increasing the welding speed in case of thinner plates, burning of plates can be avoided.

3. The average voltage and current in the experiments were 25.25 V and 85.76 A and respectively. Error for a current setting of 90 A 4.7% was. The accurate voltage assumption is 25 V for the accurate current setting of 90 A.

4. Before end of the plates the electrode was consumed so the overall length for 4mm plate was shorter.
5. The average welding speed for the 2 mm thick plate was faster than 3mm and 4mm plates. And the welding speed was 5.53, 3.74 and 3.20 mm/s for 2mm, 3 and 4 mm thick plates respectively.




6. 115A gave the least deflection and 100A current gave the maximum deflection. At high current the welder increased the welding speed and there is lowest heat input.

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