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FEA Simulation For Analyzing The Effect of Submerged Arc Welding Process Parameters On Distortion

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ABSTRACT: In welding process material is heated and melted to give permanent joint using a heat source such as electric arc laser etc..In welding material is subjected to high temperature and further cooled cause expansion and contraction result in distortion and warping of metallic structures. It has also been found that temperature distribution in work piece effects the mechanical properties and further cause distortion. In this article effect of process parameter(thickness, welding speed and current) was simulated and analyzed using ANSYS. Finite element analysis using ANSYS was used to compare the result of varying the process parameter . Study of thermal analysis has been done using ANSYS and to simulate the behavior of butt welding in SAW. The main objective of the present work is to simulate and describe the general behavior of the butt joint weld under different parameters (geometric parameters and process parameters). Distortion was calculated by FEM and experimentally by varying process parameter and found closely matched.

Key words: ANSYS, Submerged Arc Welding, FEM, Welding speed, current, thickness

Introduction: Welding process parameters such as electrode, welding thickness and current greatly affect the mechanical properties and hence produces warping and distortions[1]. The main parameters in SAW welding are arc travel speed[2], heat input, temperature dependent material properties [3]. In all welding process heat is required to accomplish the joint depending upon heating and cooling different microstructure were obtained in weld bead and heat effected zone. It produces a different mechanical properties thus to obtain welding of desire specification

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it is essential to know the heat flow in welding, temperature distribution during welding so as to determine the cooling rates in different directions with respect to weld axis. Application of SAW was found in Cover Pressure Vessel, Line Pipe, Storage Tank, Heavy structural ships, railway wagon and coaches [4]. Main welding Parameters of SAW are electrode polarity, Welding current[5] electrode diameter, Arc Voltage, welding speed. Unwanted physical change or departure from specification in fabricated structure or component as a consequence of welding is called welding distortion after lot of experiment it has been found out that departure not only complicate the fabrication but also effect the purpose for which it is design. Table [1]shows the composition of work piece used for experimentation

Table 1: Material Composition

Element	Carbon	Manganese	Sulphur	Phosphorus	Ferrous
Percentage	0.20	1.60	0.045	0.045	Rest

Chen and Kovacevic [6] performs thermal and thermo-mechanical analysis was performed on friction stir welding. investigated the HAZ using ABAQUS software[7]. Effect of phase transformation was observed on carbon steel[8]. used a double ellipsoid heat source model for predicting the temperature distribution[9]. investigated the affect of welding current, electrode polarity and wire diameter on welding[10].. Effect of process parameter was analyzed using 8 mm plate and author calculated distortion of 8 mm plate[11]. In this present mainly comparison was done between geometric parameters same parameter used by author [11]was taken and plate thickness was increased and effect was studied.

Results and discussion:

Other then material properties distortion also effected by welding sequence ,current voltage clamping method welding speed etc. welding distortion depends upon the heated material. ,Distribution of heated material(bead shape) effects the type of distortion if heat is evenly distributed then shrinkage will be uniform but if the heat is not uniformly distributed then it cause angular distortion. Volume of heated material depends upon:

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(a)**Welding Processes**: it has been found that concentrated heat source gives less distortion as compared to spread heat source and also single pass welding gives less distortion then multi pass welding.

(b) **Welding Speed**: Welding Speed also effects the distortion high speed reduces heat spread as heat spread is less distortion will be less as compare to low speed

Plate Thickness(mm)	welding speed(m/min)	Current(Amp)	Maximum distortion
10	0.45	450	1.080mm

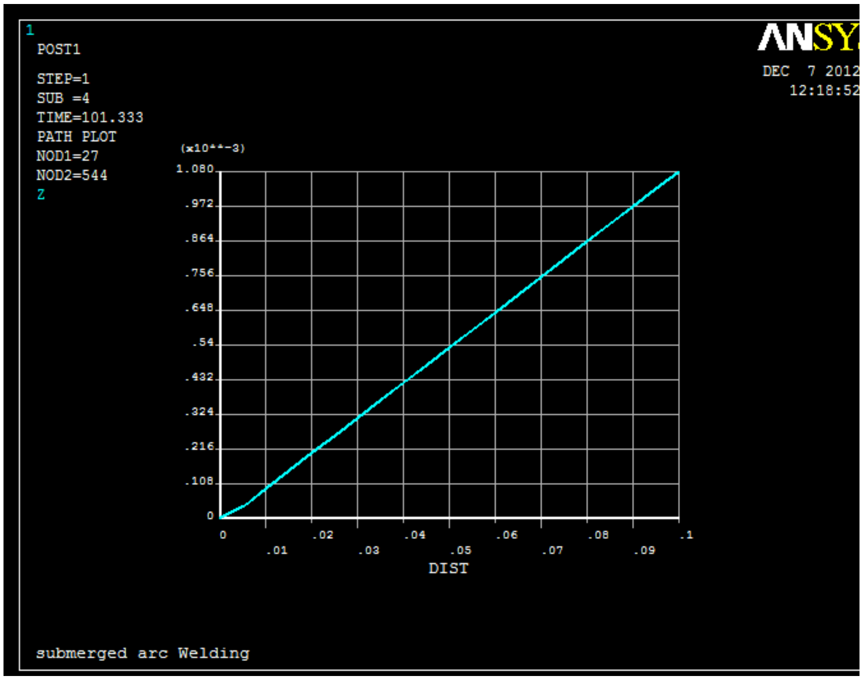

Plate Thickness(mm)	Welding Speed(m/min)	Current(Amp)	Maximum distortion
10	0.50	450	0.6 mm

Figure.[1]Distortion along the nodes of process parameter(10 mm thickness, welding speed 0.45m/min, current 450A)

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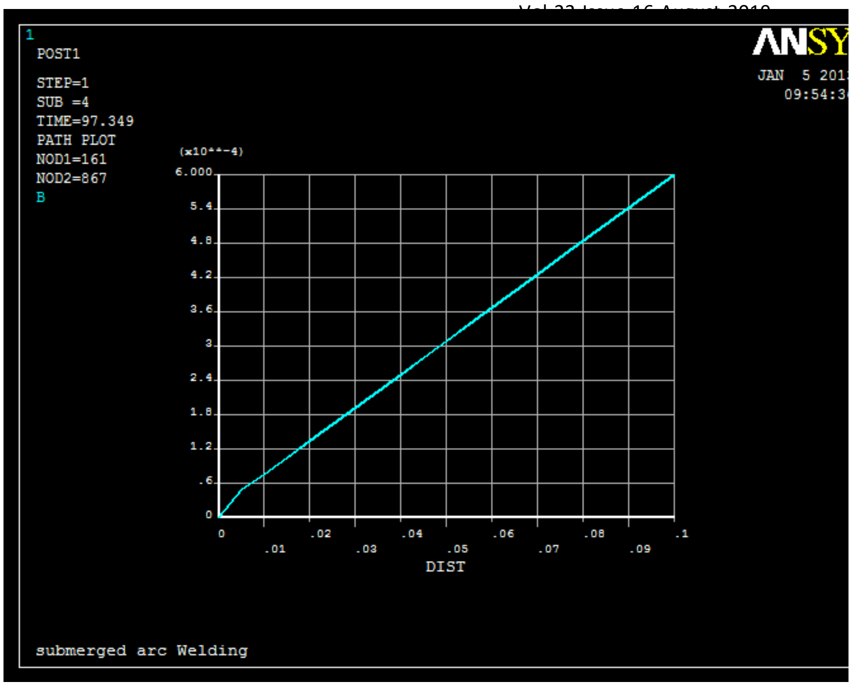

Figure[2] Distortion along the nodes of process parameter(10 mm thickness, welding speed 0.50m/min, current 450A)

Plate Thickness(mm)	Welding Speed(m/min)	Current(Amp)	Maximum distortion
10	0.45	500	2.478 mm

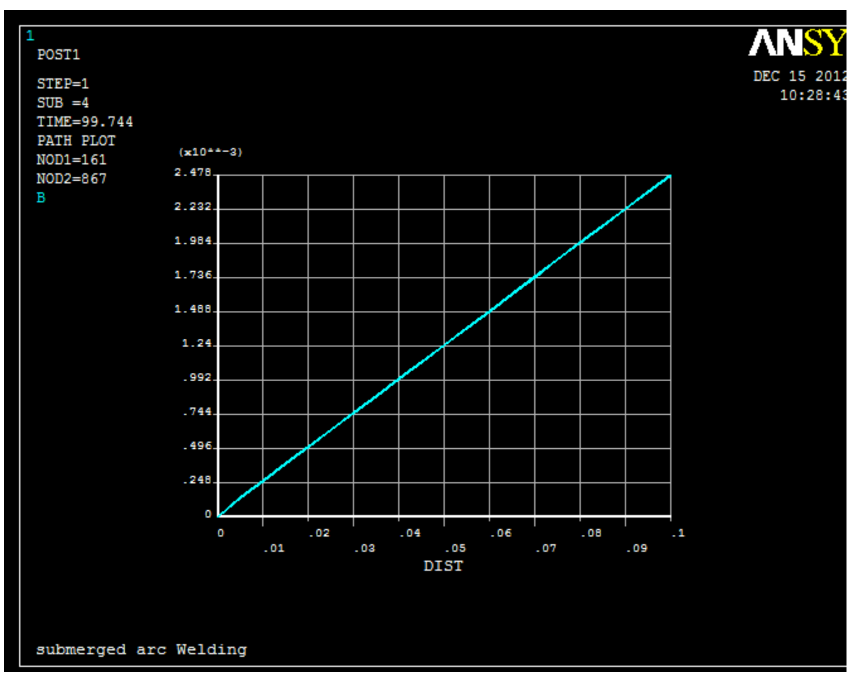

Figure.3 Distortion along the nodes of process parameter(10 mm thickness, welding speed 0.45m/min, current 500A)

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Plate Thickness(mm)	Welding Speed(m/min)	Current(Amp)	Maximum distortion
10	0.50	500	1.082 mm

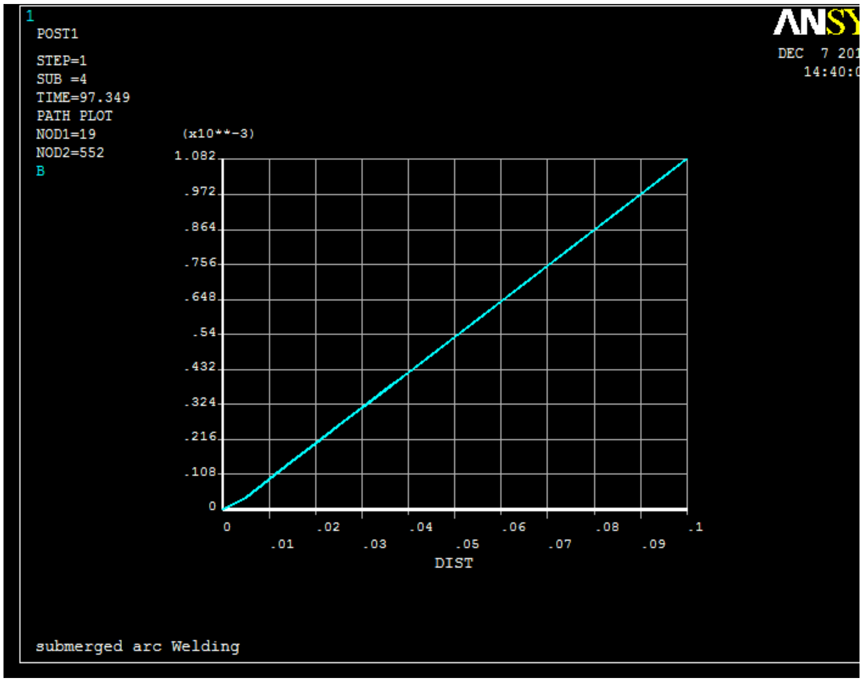

Figure.4 Distortion along the nodes of process parameter(10 mm thickness, welding speed 0.50m/min, current 500A)

In this present study three dimensional model was built using ANSYS and heat transfer analysis was conducted using element type SOLID70 (Brick 8 node 70). This element type has a capability of three dimensional thermal analysis. The element is applicable to a steady state or transient state analysis. For Structural analysis element SOLID70 was replaced by a 3-D structural element Quad 4 node 42. Effect of thermal was utilized for calculating the distortion by selecting rth file generated during thermal analysis.

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For thermal analysis following path used:

Pre-processor>Add/Edit>Delete>Thermal mass solid>Brick 8 node 70

For Thermo mechanical analysis:

Pre-processor>Add/Edit>Delete>Thermal mass solid>Quad 4 node 70

As shown the distortion depends upon the welding process parameters. When the current is increased the distortion is also found to be increased. Even it has been found out that when parameter such as current and thickness is kept constant and welding speed is increased then distortion decreases due to less time for heat to travel. Maximum value of distortion was found to be 2.478 mm when parameter selected was plate thickness 10 mm, welding speed 0.45m/min and current was 500 Amp. If plate thickness was 8 mm welding speed 0.45 m/min and current was 500 A distortion calculated was 3.01 mm[11]. Distortion depends upon the thickness of plate. FEA can be used for selecting optimal parameter which reduces distortion and distortion calculated experimentally using dial indicator was found closely matched.

Conclusion:

In this study geometric and welding parameter are varied and results are compared with ANSYS. It has been found that distortion is also directly proportional to the welding and geometric parameter. The results showed in graph that the welding current, welding speed and plate thickness have significant effect on the distortion. The result shows that as expected, low welding current, high welding speed and thicker plates reduce distortion. Maximum value of distortion was found to be 2.478 mm when parameter selected was plate thickness 10 mm, welding speed 0.45m/min and current was 500 Amp

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