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Analysis & Validation of Properties of Weld Zone Using FEA

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ABSTRACT*:-* *Joining of dissimilar metals has found its use extensively in power generation, electronic, nuclear reactaors, petrochemical and chemical industries mainly to get tailor-made properties in a component and reduction in weight. However efficient welding of dissimilar metals has posed a major challenge due to difference in thermomechanical and chemical properties of the materials to be joined under a common welding condition.*

Weld residual stress and thermal stress have been analyzed for dissimilar metal welding of 304 stainless steel and 1024 mild steel. Similarly taking strain developed as an index the susceptibility of the welded joint to stress corrosion cracking have been studied. It is found that when the filler metal is replaced by material itself for significant improvement is obtained in the welded joint in terms of reduction in stress developed and stress corrosion cracking.

The relationships between the input laser-welding parameters (i.e. laser power, welding speed and focal point position) and the process responses (i.e. welded zone width, heat affected zone width, welded zone area, heat affected zone area and penetration depth) are investigated. The optimum welding conditions are identified in order to increase the productivity and minimize the total operating cost

Keywords:- *Keywords- dissimilar welding; deformation; thermal stress; residual stress, temperature distribution.*

I. INTRODUCTION

The laser beam focuses on a small area and creates high-power density to the material surface, thus its beam can be used as a welding process. To decrease cost and time, it is comfortable to predict laser welding parameters based on process modeling

Aim is to find the optimal welding combination that would maximize the penetration depth while minimizing other bead geometry (welded zone width, heat affected zone width, welded zone area and heat affected zone area). The laser-welding parameters used in this study were parameters that can be controlled on the welding machine

Welding is a manufacturing process of creating a permanent joint obtained by the fusion of the surface of the parts to be joined together, with or without the Application of pressure and a filler material. The materials to be joined may be similar or dissimilar to each other. The heat required for the fusion of the material may be obtained by burning of gas or by an electric arc. The latter method is more extensively used because of greater welding speed

Tensile Testing

Ultimate Tensile Strength of the welded samples was carried on a 400KN (40T) UTM, Manufactured by M/S. Fuel Instruments and Engineers

Features of tensile testing machine

- Loading Accuracy as high as ± 1%
- Straining at variable speed to suit a wide range of materials
- Continuous roll autographic recorder supplied as standard to enable study of the behavior of materials.
- Motor driven threaded columns for quick effortless adjustment of lower cross-head-to facilities rapid fixing of test specimen.
- High reading accuracy due to large size and design of dial.
- Wide range of standard and special accessories, including load stabilizer.
- Easy change from plain to threaded and screwed specimens.
- Large effective clearance between columns enables testing of standards specimens.

Fig: experimental model of tensile testing

Experimental setup & jig and fixture:

Clamping is done at the end surface to avoid distortions while welding of plates. As effect of clamping at both end surfaces, vertical displacement of plates due to welding force is constrained. Further load is applied on test specimen to evaluate experimental results. The results evaluated from testing were used determined stress values and failure point

II. NUMERICAL APPROACH

Step 1: Modelling geometry by using creo parametric 3.0 modelling software

Step2: Meshing of geometry using hyper mesh meshing software

- Meshing model using hex elements.

Step3: Input parameter

- temperature dependent properties
- material properties
- boundary conditions
- mechanical properties

step4: Heat input

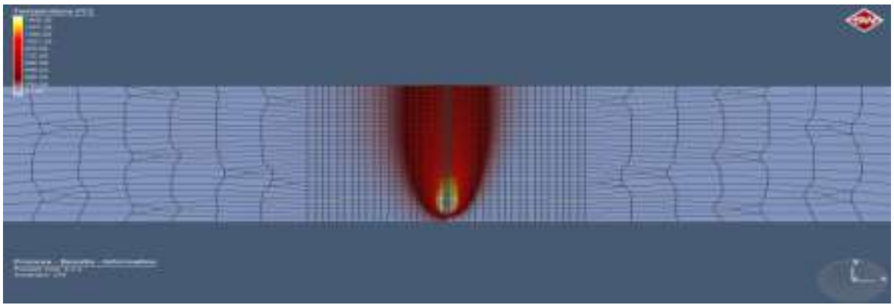
- constant heat input with moving heat source

step5: Results

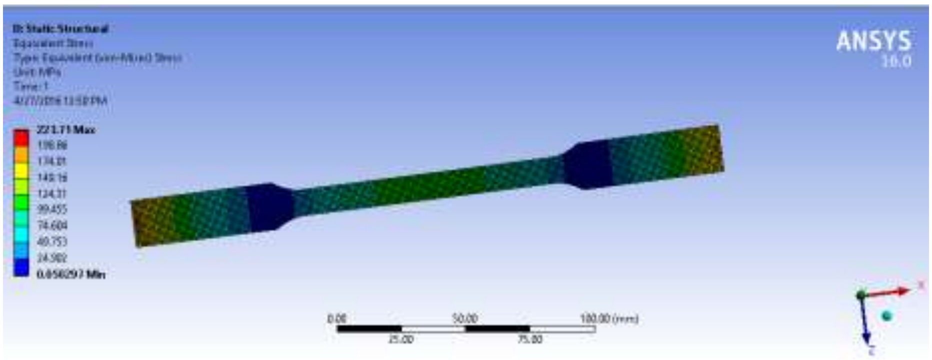
- temperature contour
- heat flux
- thermal stresses
- deformation

Experimental approach

- Yield point
- Ultimate point
- Failure point



Mesh model with constrained boundary condition with Gaussian heat flux source analysis



Equivalence Stress Distribution

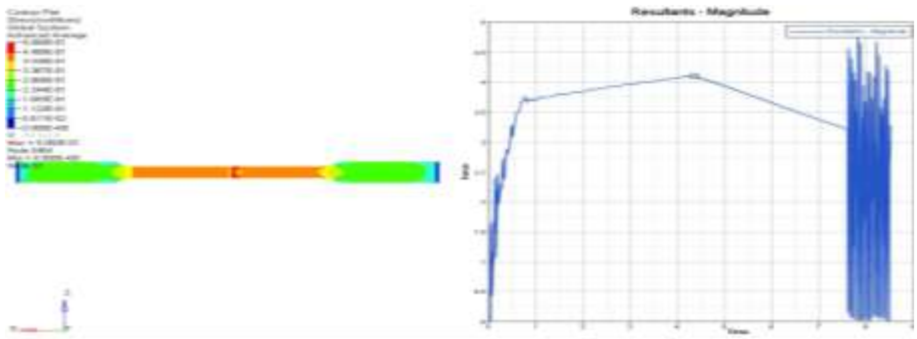


Fig: force vs time on Ls Dyna and corresponding stresses

III. RESULT ANALYSIS

Above figure shows the force vs time graph, it shows the yield load, ultimate load, and failure load. We can calculate the stress at which exact failure occur and corresponding failure point on the sample. Also we can select the specific application for specific load and stress.

Validation test results

sr.no	power source	optimized numerical result(stress)	actual experimental results (stress)
Sample1	900	506	546
Sample2	1200	576	648

Above parameters are calculated at constant velocity of 20 m/s and with increase in power source with increasing power input source.

IV. CONCLUSION

- Heat input increases corresponding stresses increases
- As Velocity increases depth of penetration, heat affected zone area and weld zone width decreases.
- It is more accurate method than other welding processes
- There is a close agreement between the numerical and experimental testing model. As the numerical testing model are nearly matching with experimental results, it can be predict that stress profiles got by numerical must match with experimental profile.

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