Computer Aided Modeling and Analysis of Dissimilar Metal Welded Joint using Ansys

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Abstract -*Welding process is one of the oldest and strongest manufacturing method, welding of similar metals are being done in past decades but the welding of material with different composition is a new era of interest and in present work we are about to analyze the effect of joining the two different material work pieces using some kind of filler material and to find the induced thermal stresses, normal stresses and induced stain at the joint and over the whole product. The whole work is divided into two parts i.e., computer aided modeling and assembly of different work pieces along with the filler material and computer aided analysis of the same providing different materials. Here in the present analysis we are using CATIA software for modeling part and ANSYS software for its further analysis.*

***Key Words*: Dissimilar metal, welded joint, CATIA, ANSYS, Thermal Analysis.**

1. INTRODUCTION

In modern industry it is extremely important to use a number of different elements for the different components or parts which lead to reduce cost, enhance material properties, reduces weight and to optimize the performance of machine elements etc. A schematic representation of the same is shown in figure

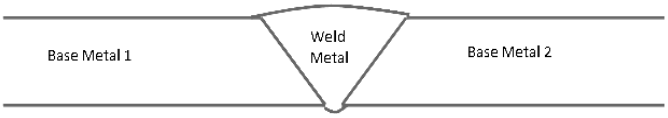

Fig -1: Schematic picture of a dissimilar metal weld

In present work we are choosing Nickel and copper welding is focused. The nickel-base family of alloys was developed within the early 1900s, and important amounts of nickel began to be employed in engineering materials within the 1920s. Though nickel was discovered by a swedish scientist in 1751, they found no useful applications of the element till the late 1800s.

Nickel copper welding are employed from past 50 years successfully for the fabrication of piping industry working under sea water as it is corrosion resistant. It is not difficult to weld copper and nickel together as they can be welded by conventional processes without any obstacles by a normal welder but it needs cleanliness a beat more as the surface after weld is not as fine as in case of steel weldments. One more advantage of using copper to be weld with nickel is they are ductile in nature and hence they are machinable which means the surface roughness can be easily removed by choosing some machining operations like filling etc.

2. LITERATURE REVIEW

A lot of researches are being carried out in this field and we are discussing a few here as a mechanical testing in fabrication of titanium alloy and 304 stainless steel joints with silver interlayer is performed and the results from mechanical testing showed that shear strength values have an instantaneous relationship with bonding time[1]. A dissimilar metal weld between ferritic/martensitic modified 9Cr-1Mo steel (P91) and solid solution AISI 316LN stainless-steel used self-generated electron beam(EB) welding was also analysed [2]. A friction welding method is tried to affix Ti to 304L SS. Direct friction welding of Ti to 304L SS ends up in a stronger weld during which failure happens within the Ti base metal throughout tensile testing.[3]. The material combination Al-Cu crack-free welds were carried out and tensile tests show, that the optical device welded Al-Cu joints failing directly at the fusion zone on the copper part[4]. The factors affect the joint performance of friction-welded joint of austenitic SS to copper and also the numerous tests were meted out to judge the joint performance [5]. The dissimilar joint of metallic element and metal alloys by friction stir welding method is also mentioned [6].

3. METHODOLOGY

The detailed description of various steps being involved in modeling and simulation of welded joint is represented in the following flow chart.

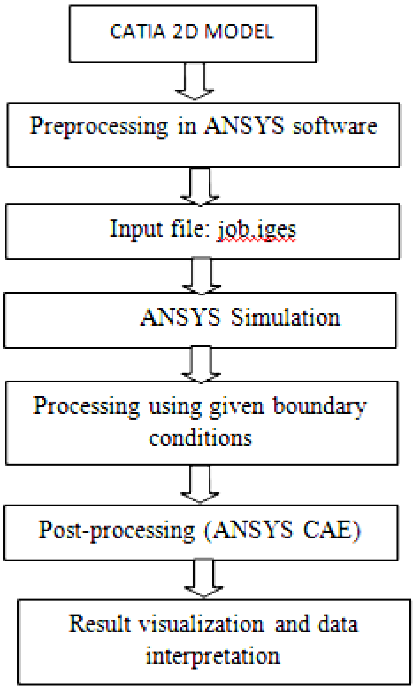

Fig-2: Flowchart of welding process.

Analytical calculation

Calculation for leg size

S= t (cosθ + Sinθ)

Where s = Leg size

t = Throat thickness

θ= Angle of plane of maximum shear stress

Shear stress calculation

$$\tau = \frac{p(\cos\theta + \sin\theta)}{2s \times l}$$

Where

τ= Shear stress

P = Applied load parallel to weld

l = length of weld

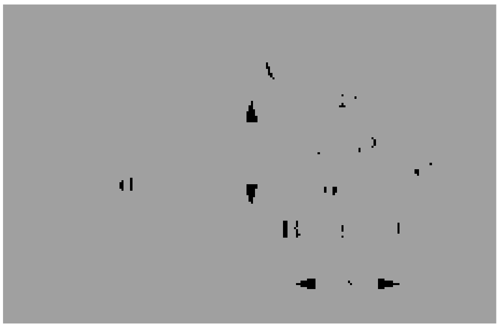

Fig-3: Line diagram of welding process

This stress will be maximum when we differentiate the shear stress with respect to angle of plane of maximum shear stress and put it equal to zero.

After calculation it is observed that for maximum shear stress will be at $\theta = 45^{\circ}$

For maximum shear stress so the relation becomes

$$\tau_{max} = \frac{1.414P}{2s \times l}$$

4. Modeling and Simulation:

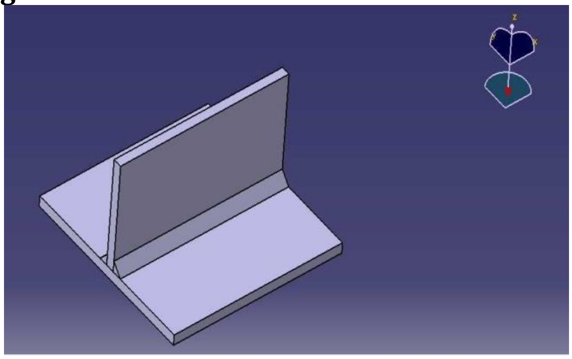

Fig-4: Assembly of T joint in CATIA assembly workbench

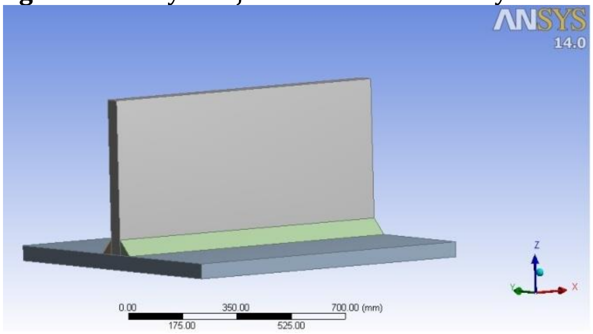

Fig-5: Import of T joint in ANSYS workbench

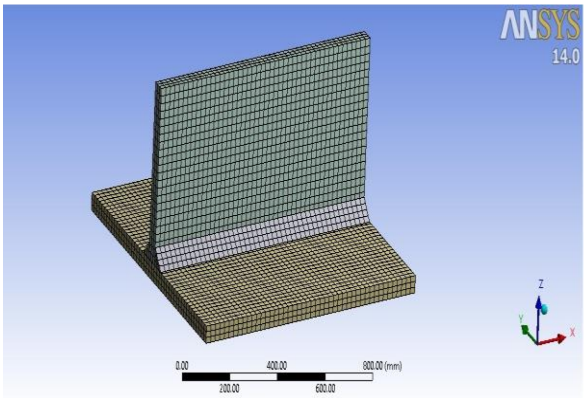

Fig-6: Meshing of T Joint

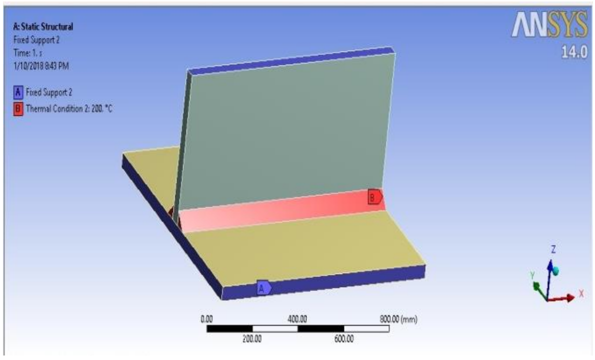

Fig-7: Boundary Conditions of T Joint

In present work the modeling is done using CATIA V5R12 software and then the product is imported in Ansys 14.0 Workbench to carry out the analysis the above figures represent the Assembly, imported Ansys model, meshing and boundary conditions of T Joint.

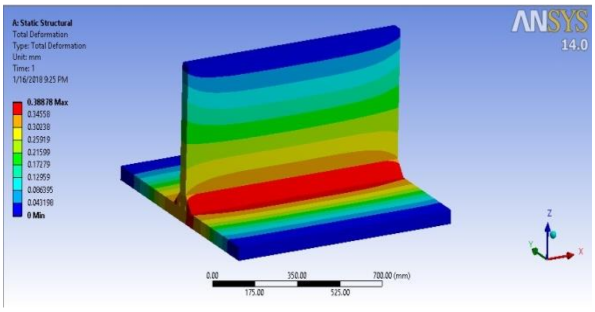

Fig-8: Total deformation occurred in Cu-Ni welding process

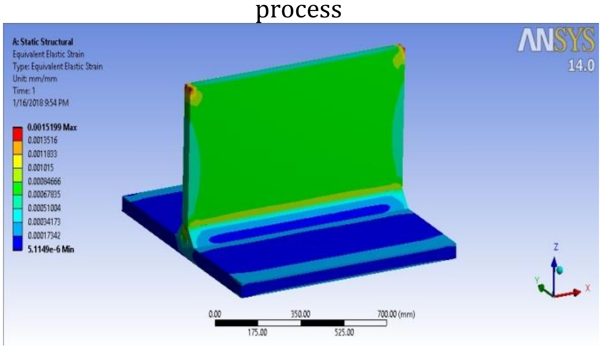

Fig-9: Elastic strains in Cu-Ni T Joint

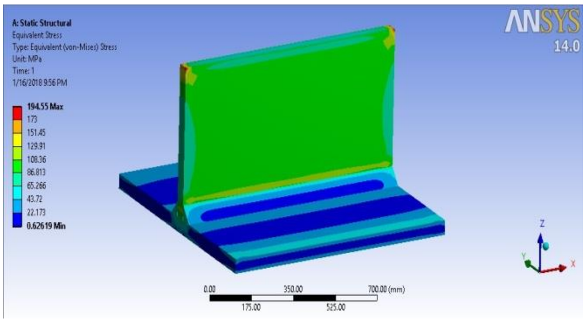

Fig-10: Equivalent Von Mises strain in Cu-Ni

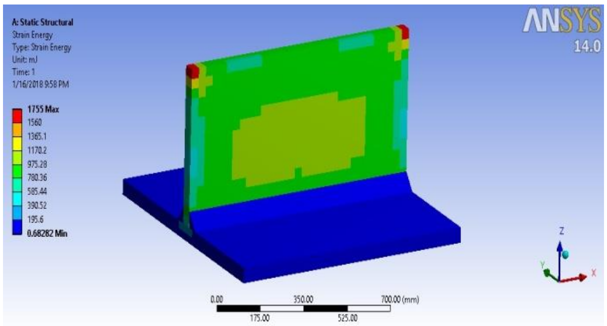

Fig-11: strain Energy in Cu-Ni welding of T Joint

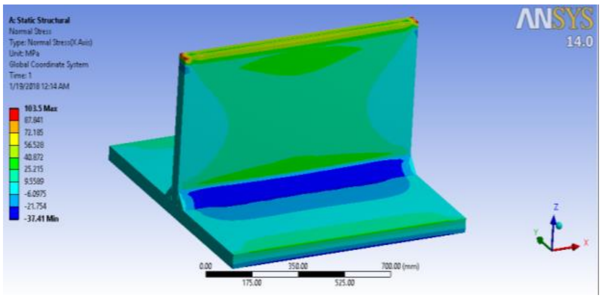

Fig-12: Normal stress in Cu-Ni welding of T Joint

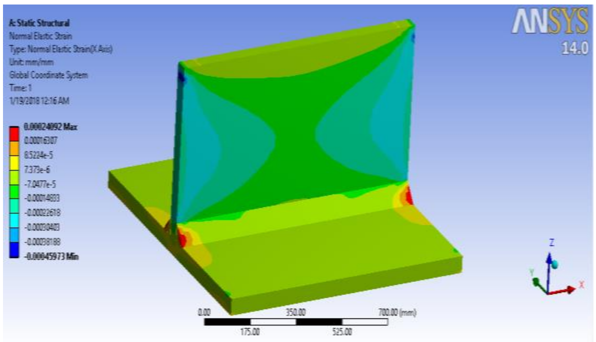

Fig-13: Normal elastic strain in Cu-Ni welding of T Joint

The above figure represents the deformation, elastic strain, von mises strain, strain energy, normal stress and normal elastic strain in T joint as a result from Ansys workbench.

5. CONCLUSION AND FUTURE SCOPE

Following table represents the values obtained for deformation, elastic strain, von mises strain, strain energy, normal stress and normal elastic strain in T joint from Ansys workbench.

Table -1: Result Table

Sr. No.	*Parameter*	*Unit*	*Cu-Ni Welding*	*Pb-Ni Welding*	*Ni-Sn Welding*
1	Total Deformation	mm	0.38878	9.571	5.7614

2	Elastic strains	mm/mm	0.0015	0.1314	0.0728
3	Von Mises strain	mm/mm	194.55	9006.4	9082.6
4	Normal Stress	MPa	103.5	5163.6	4926.2
5	Normal Strain	mm/mm	0.0002	0.0301	0.0221

Based on the results obtained from table 1, graphs have been plotted for various output parameters versus the dissimilar welding joints type.

As shown in fig.14, the graph has been plotted for values of Deformation (measured in mm) for different dissimilar welded joints (Cu-Ni, Pb-Ni and Sn-Ni). It can be clearly seen that for the Pb-Ni welding, the Deformation is maximum (0.13), whereas it is minimum for Cu-Ni (0.02).

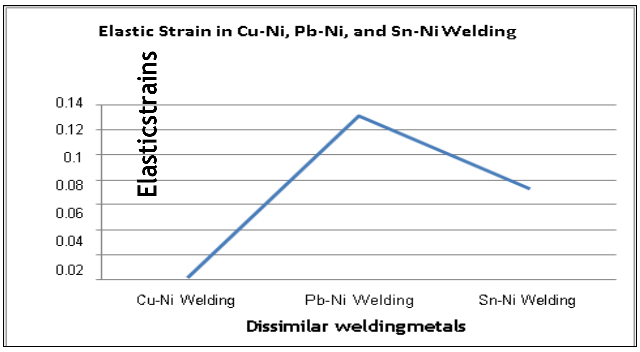

Fig-14: Main Effects Plot for UTS (Elastic strain)

As shown in fig. 15, the graph has been plotted for values of Von Mises strain for different dissimilar welded joints (Cu-Ni, Pb-Ni and Sn-Ni). It can be clearly seen that for the Pb-Ni welding, the Von Mises Strain is maximum (0.13), whereas it is minimum for Cu-Ni (0.02).

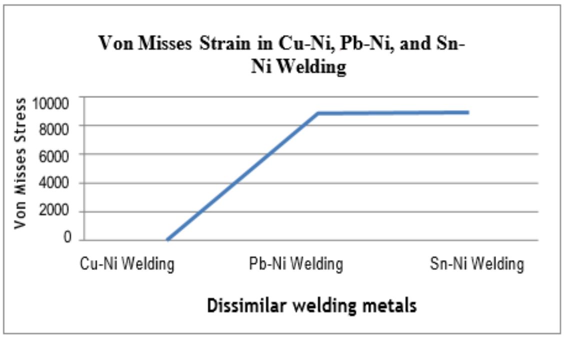

Fig-15: Main Effects Plot for UTS

As shown in fig. 16, the graph has been plotted for values of Normal Stress (measured in MPa) for different dissimilar welded joints (Cu-Ni, Pb-Ni and Sn-Ni). It can be clearly seen that for the Pb-Ni welding, the Normal Stress is maximum (0.13), whereas it is minimum for Cu-Ni (0.02).

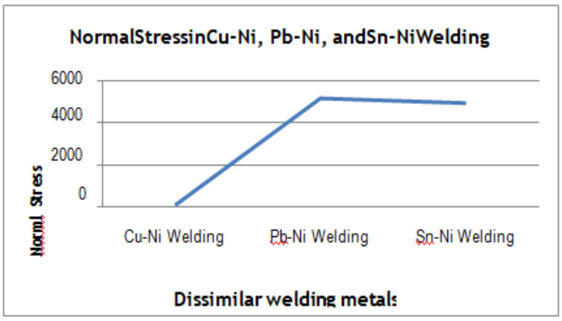

Fig-16: Main Effects Plot for UTS (Normal stress)

As shown in fig. 17, the graph has been plotted for values of Deformation (measured in mm) for different dissimilar welded joints (Cu-Ni, Pb-Ni and Sn-Ni). It can be clearly seen that for the Pb-Ni welding, the Deformation is maximum (0.13), whereas it is minimum for Cu-Ni (0.02).

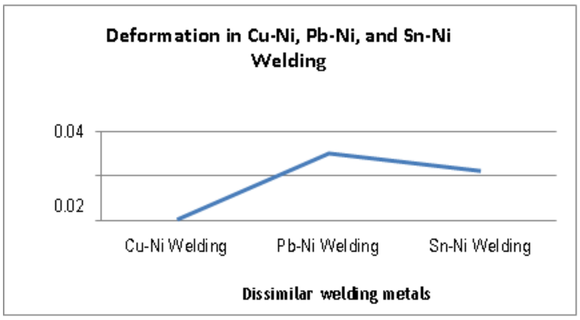

Fig-17: Main Effects Plot for UTS (Deformation)

As shown in fig. 18, the graph has been plotted for values of Normal strain for different dissimilar welded joints

(Cu-Ni, Pb-Ni and Sn-Ni). It can be clearly seen that for the Pb-Ni welding, the Normal Strain is maximum (0.13), whereas it is minimum for Cu-Ni (0.02).

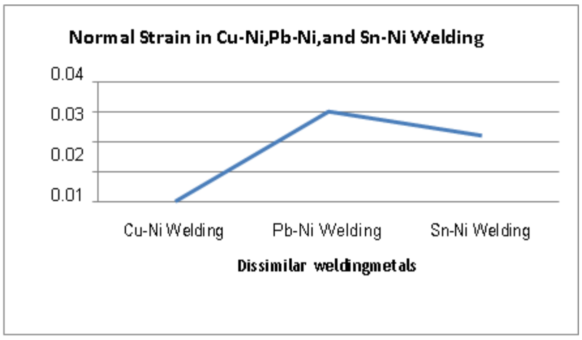

Fig-18: Main Effects Plot for UTS (Normal strain)

From the above results it can be seen that all the values are within the permissible range and hence the copper and nickel welding can be performed within the working temperature and pressure.So, we may conclude that the computer based results are good evidence with respect to the research review we have done earlier which states in most of the cases people use Copper and Nickel for welding together.

Future Scope: Welding analysis of some other materials can also be performed to see that they are feasible or not. Some other kind of geometry like pipe joint etc can also take to see the stress induced in different cases. A verity of software can be used and then the validity of software for said application can be proven for the same kind of material and welding conditions. In last a comparative study of different welding materials can be performed by fixing any one of the base material so that the material which best suits the base material can be obtained through software without actually being welded.

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