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EXPERIMENTAL SIMULATION AND STRUCTURAL ANALYSIS OF WELDED AND WELD-REPAIRED STRUCTURES OF AL, MS, CI

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ABSTRACT

Welding is a widely used fabrication technique in which the joining of the two metals takes place with the propagation of weld bead which assures the weld metal with properties better than base metal. Now a days the role of welding is extended to the fields of automotive, aerospace, missile, power, electronic, steel, machine tools etc. The present work is based on the research of structural analysis of welded and weld-repaired joints. The study includes both experimentation and simulation analysis of Al (AL 356A), MS and CI based butt joints to identify their behavior at varying loads and also with that of the base metals. The application of experimental simulation is made to find the yield strength, ultimate tensile strength, compression strength, thermal conductivity, specific heat etc. These results are compared with those of experimentation results of both base and weld metal of AL, MS and CI.

Keywords: *Welding techniques, engineering materials of AL, MS & CI, Autodesk inventor professional 2014*

1. Introduction

Materials science commonly known as materials engineering, is an interdisciplinary field applying the properties of matter to various areas of science and engineering. This relatively new scientific field investigates the relationship between the structure of materials at atomic or molecular scales and their macroscopic properties. It incorporates elements of applied physics and chemistry.

Almost every substance known to man has found its own way into the engineering shop at some time or other. The most convenient method way to study the properties and uses of engineering materials is to classify them into 'families' as shown in figure.

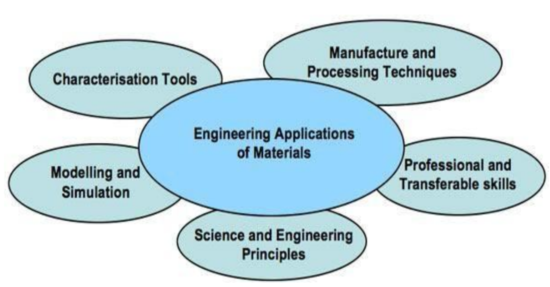

Fig. 1 Classification of properties and uses of engineering materials as 'Families'.

1.1 Classification of engineering materials

The classification of engineering materials is shown in the fig. 2.

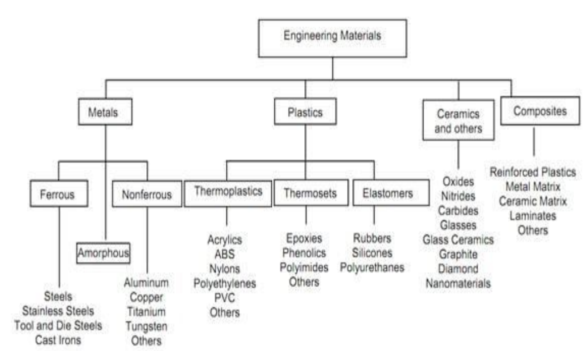

Fig 2. Classifications of Engineering Materials

2. Metals

2.1. Ferrous metals

Iron based alloys are referred as Ferrous metals. It possesses high strength, easily available and cheaper. Hence, they are identified as common engineering materials used in Bridge building, structures of large building and Railway lines, etc.

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2.2. Non-Ferrous Metals

Non iron based metals are referred as Non-ferrous metals. The pure metals are rarely used as structural materials as they lack mechanical strength. They are used as where special properties such as corrosion resistance, electric conductivity and thermal conductivity are required. They are mainly used with other metals to improve their strength.

3. Role of Autodesk Inventor Professional 2014

Autodesk inventor**,** developed by US-based Software Company, is 3D mechanical CAD design software for creating 3D digital prototypes used in the design (modeling), visualization and simulation. It competes directly with Solid Works and Solid Edge. Modelling of butt joint weld plates (Eg: aluminum, mild steel and cast iron).

The weld joints are modeled using Autodesk Inventor for the different materials. Modeled but joint is shown in Fig 3.1. After meshing the elements simulation has been performed for the butt joint of different materials such as aluminum, mild steel and cast iron. Fig 3.2 represents the Simulation of butt joint plate of Aluminum materials.

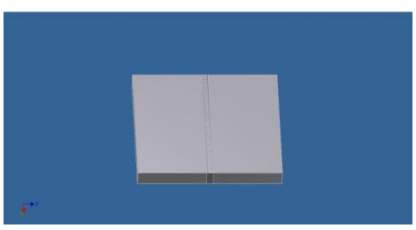

Fig 3.1 Modelling of butt joint weld plates (Eg: aluminum, mild steel and cast iron)

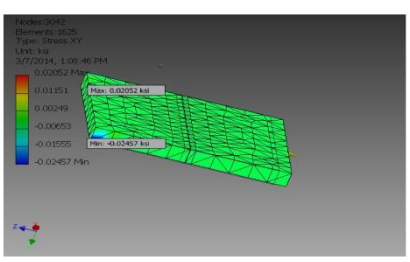

Fig 3.2 Meshing & Simulation of butt joint plate of Aluminum material

From this analysis, it is found that the yield strength and the Ultimate tensile strength of the aluminum butt joint plate have been 56.480 MPa and 79.6008 MPa respectively. This result is shown in Fig. 3.3.

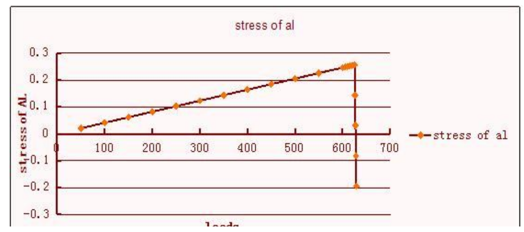

Fig. 3.3 Simulated results for Aluminum butt joint plate

All the simulated results were presented in Table 1.

Table 1. Simulated results

S.no	Material used for butt joint	Yields Strength (MPa)	Ultimate tensile Strength (MPa)
1.	Aluminum	56.480	79.6008
2.	Mild Steel	91.458	109.416
3.	Cast Iron	403.566	705.447

It is observed from Table 1, that the Aluminum joint possess lower strength amid the mild steel and cast Iron joints. The reason for this has been the AL possesses higher ductility compared to the MS and CI.

4. Comparison of stresses on both weld and base plates

The simulated results for stress, strain and displacement for butt joint has been presented in Fig 4.1, 4.2 and 4.3. Fig 4.1 shows the stress in welded and base metal of MS material. It shows that both weld plate and base plate is approximately following the same path. The stress bearing capacity of the base plate has been high compared to weld plate.

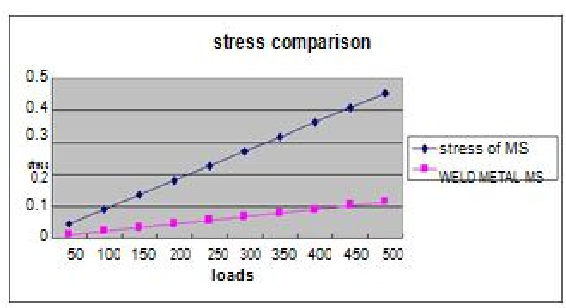

Fig. 4.1 Stress comparison for MS

The comparisons of strain and displacement for both the weld and base pales are presented in Fig. 4.2 and 4.3. The strain in the welded region has been higher than the base metal owing to the more thermal load in the weld region as shown in Fig. 4.2. The displacement in the welded region has been lower than the base metal as shown in Fig 4.3.

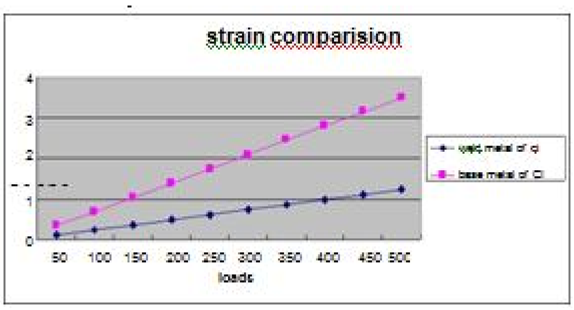

Fig 4.2 Strain Comparison

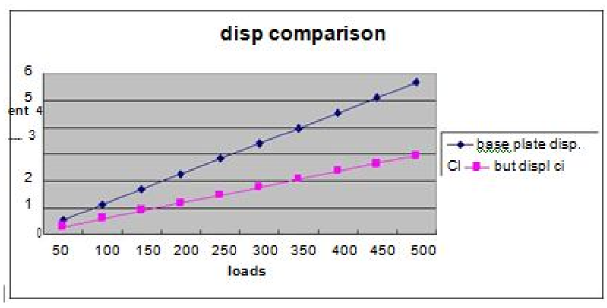

Fig. 4.3 Displacement Comparison

The stress, strain and displacement induced in the butt joint for the considered AL, MS and CI materials were presented in Fig. 4.4, 4.5 and 4.6 respectively.

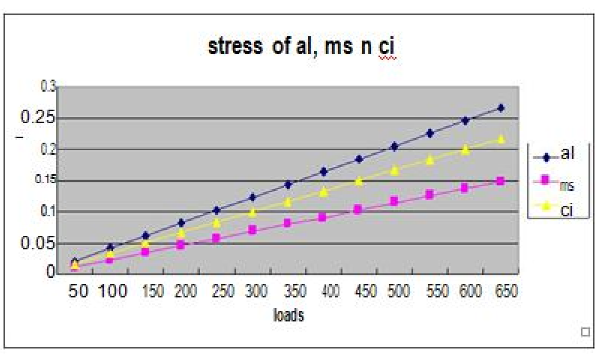

Fig. 4.4 Comparison of Butt joint Stress.

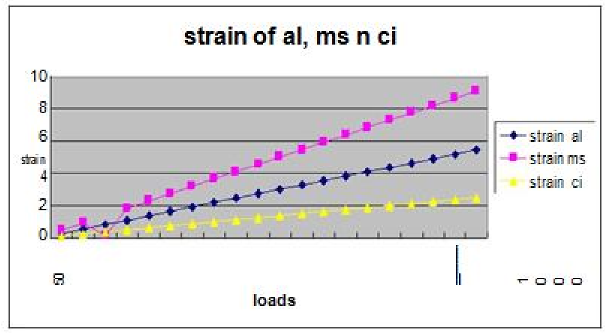

Fig. 4.5 Comparison of butt strain

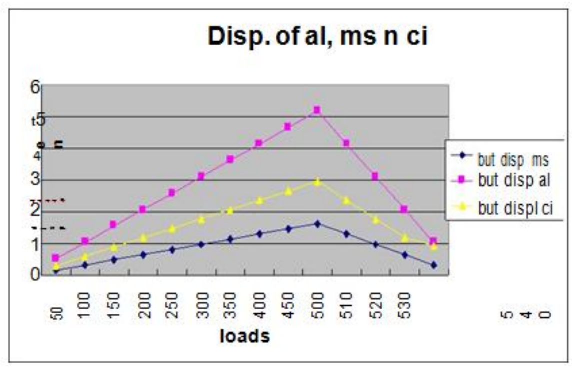

Fig. 4.6 Comparison of butt joint of displacements

From Fig 4.4, It is learnt that the Al joint exhibits higher stress for a particular load compared to MS and CI joints. Strain in the MS join has been higher compared to CI and Al. Higher displacement has been exhibited in Al joints as shown in Fig 4.6.

Stress, strain and displacement in the base metal plates has been analyzed and presented in Fig. 4.7, 4.8 and 4.9 respectively. For a particular load, the stress and strain induced in Al base plate has been higher compared to MS and CI plates. MS base plate exhibits higher displacement than MS and CI plates.

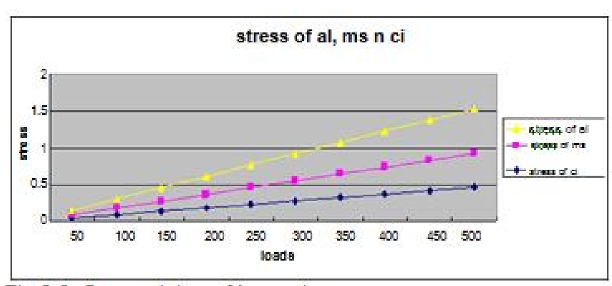

Fig. 4.7 Comparison of base plate stresses.

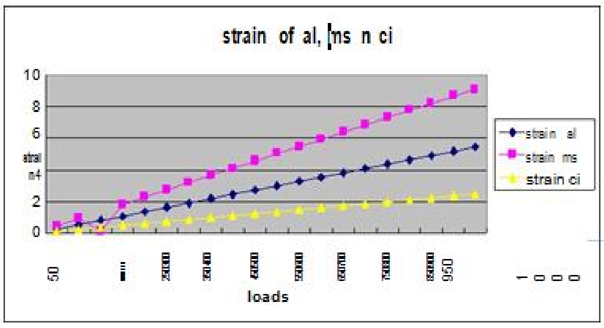

Fig. 4.8 Comparison of base plate strain

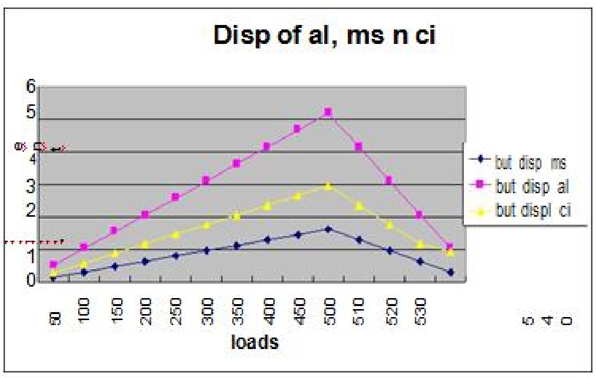

Fig. 4.9 Comparison of base plate displacement

5. Conclusions

From this study the following conclusions can be drawn.

The Aluminum butt joint exhibits lower strength compared to the mild steel and cast Iron joints at the Aluminum possesses higher ductility.

The Stress, strain and displacement in the weld region and the base metal has following the similar path.

For a particular load, Aluminum joint exhibits higher stress and displacement compared to MS and CI joints. Strain in the MS join has been higher compared to CI and Al.

For a particular load, the stress and strain induced in Al base plate has been higher compared to MS and CI plates. MS base plate exhibits higher displacement than MS and CI plates.

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