Stress Analysis of Hybrid Spot Welded Joint

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Abstract

Spot Welding is a process in which contacting metal surfaces joined by heat obtained from resistance to electric current. This is a pressure welding technique using high current and low voltage .Some joining are permanent, semi-permanent or temporary category. Now days due to enormous advantages, the adhesive joining technique becomes popular. The present work aimed at predicting stress distribution& deformation of weld bonded joints to address role of adhesive layer. Comparison of adhesive bonded joint and spot welded joint were included in study. The material of the base metal used in this work is MildSteel (Fe275) sheet of 1.00 mm thickness and Epoxy adhesive Araldite used for bonding to fabricate both weld-bonded and adhesive bonded lap joint specimens.The 3D model drawn with the help of CATIA V5 software. The structural analysis and validation carried out with the help of ANSYS 19.2software and UTM respectively. The work demonstrated the effective role played by the adhesive layer in strengthening weldbonded joints.

Keywords- *Spot-Welded joint, adhesive, finite element Stress Analysis***.**

I. INTRODUCTION

Weld bonding is an advanced hybrid technology that has the advantages of spot welding and adhesive bonding combined[1].In weld-bonded lap joints, both the spot weld and the adhesive layer contribute to the joint strength. The loadbearing capability of the two constituents and the stress distribution in weld-bonded joints determined by many factors, such as the shape and size of the joints and the mechanical properties of the adhesive and base metal. In the last few years, vast amount of experimental, theoretical and numerical research works conducted and reported particularly for spot welded and adhesive bonded joints.[2]Many experimental results showed the properties of adhesives used in weld-bonded technology have important effects on load-bearing capability andfracture mode of the joints. In the present investigation, a three-dimensional finite element method used to study the stress distribution on adhesive/ weld-bonded joints[1].Very much challenging problem faced by a design engineer is the possible weakness of the adhesive bond and the poor through- thickness strength of the adherents.

Some of the advantages of using adhesives include the following:

- Invisible bonding;
- Even distribution of the bond stress;
- Ability to join dissimilar substrates and surfaces;
- Ability to fill gaps;
- Elimination of vibration failure;
- Corrosion protection;
- Reduced manufacturing/assembly costs;
- Bond strength. [3]

In the modern years, FEA has provided a powerful tool in studying these interactions and many related works have been carried out on the FEM modeling of SW. Input parameters of Welding play a very important role in find out the highest quality of a weld joint. Compassionate of physical mechanisms for easily manipulating and controlling weld qualities in advance is important. Finite Element Model developed for the analysis of transient thermal behavior of process using ANSYS 19.2 software to simulate the mechanical characteristics of SW process.

Spot weld subjected to various axial and non-axial loadings. Strengthening joints without changing dimensional is purpose of this study. Hence, Adhesive Hybrid spot weld investigated.There is limited scope of adding additional spot-welds due to design constraints. Hence, adhesive used to enhance strength of spot welded location.

II.MATERIAL ANDMETHODOLOGY

The material of the base metal used in this work is mild steel (Fe 275)sheet with 1.00 mm thickness. Epoxy adhesive Aralditeused for bonding to fabricate adhesive bonded joint specimens.Carbon contain in mild steel is 0.15% to 0.30% of carbon. Mild steel has the ferromagnetic properties. Mild steel is the most usedcarbon steel in the world and also the cheapest one.

The finite element method (FEM) used to obtain stresses.The spot welding machine used in this research, for the preparation of spot welded specimen joints, is Resistance Spot Welding Machine. Followings Steps were involved in methodology-

Step I – work started of this project with reference of literature survey. From that, I came to know about adhesive welded joints. I gathered many research paper related with this topic.

Step II – After component, which required for project are decided.

Step III – For the analysis purpose, three-dimensional model done with help of CATIA.

Step IV – Stress distribution & deformation analysis done with help of ANSYS software.

Step V- Experimental testing carried out on UTM.

Step VI – From the experimental and FEA analysis Comparative analysis done. Finally, result and conclusion obtained from this process.

V. STATIC STRUCTURAL ANALYSIS

For weld-bondedjoints, mild steel sheetsused in test. Araldite Epoxy Resin used asAdhesive. Factors that affect the joint- 1. Adherent material combination

2. Type of adhesive used.

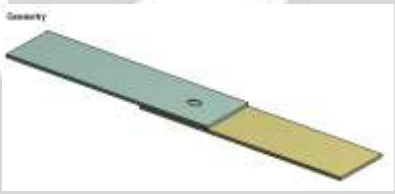


Fig. 1Geometry ofSpot Weld Specimen

Mesh

ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. It produces the most appropriate mesh for accurate, efficient Multiphasic solutions. A mesh well suited for a specific analysis generated with a single mouse click for all parts in a model. Full controls over the options used to generate the mesh are available for the expert user who wants to fine-tune it. The power of parallel processing automatically used to reduce the time you have to wait for mesh generation**.**

Fig. 2 Meshing of Spot Weld Specimen

Statistics	
Nodes	43073
Elements	7512

Fig. 2 Meshing Of Spot Weld 50mm Lap With Out Adhesive Specimen

Boundary Conditions:

A boundary condition for the model is the setting of a known

Value foran associated load or displacement. For a particular Node, we can set either the load or the displacement but notboth. The main types of loading available in FEA include pressure, force,and temperature. These applied to points**,**surfaces, edges, nodes and elements or remotely offset from a feature**.**

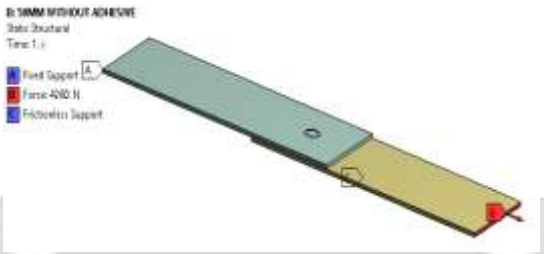
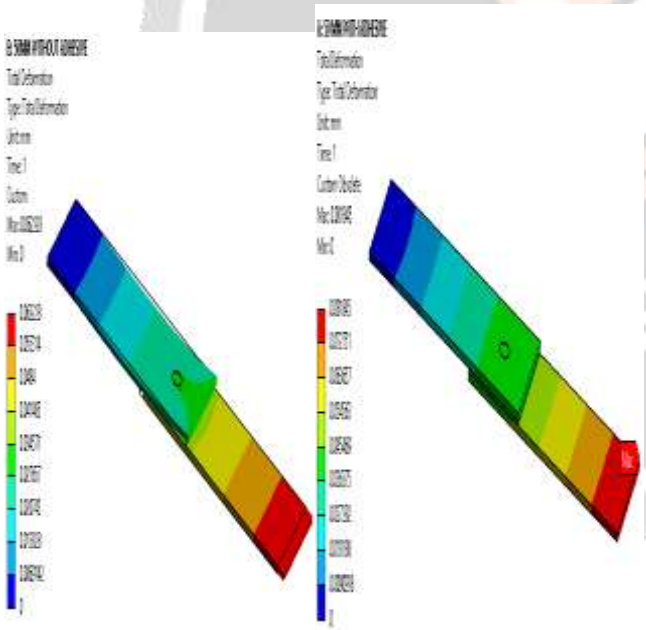


Fig. 3Boundary ConditionsOf Spot Weld Specimen

a. SPOT WELD 50MM LAP WITH OUT ADHESIVE AND WITH ADHESIVE-

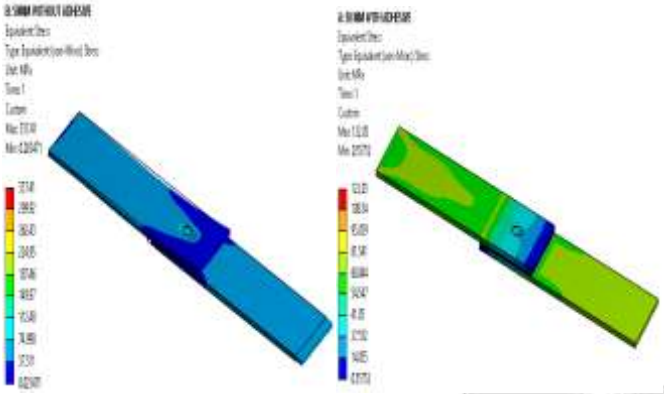
Total Deformation



(a) (b)

Fig. 4 (a) & (b) Total DeformationofSpot Weld 50mm Lap With Out Adhesive Specimen &With Adhesive Specimen.

Equivalent stress



(a) (b)

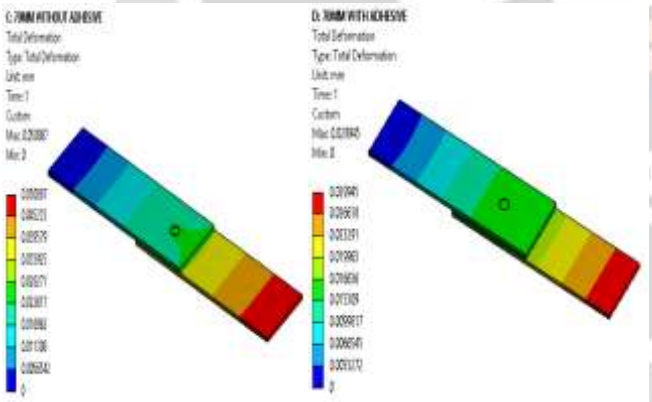
Fig. 5 (a) & (b) Equivalent stressOf Spot Weld 50mm Lap without Adhesive Specimen & withAdhesive Specimen.

Reaction force

Reaction Force on Spot Weld 50mm Lap without adhesiveobtained2420N (FEA)andReaction Force on Spot Weld 50mm Lap with adhesiveobtained 4280 N (FEA).

a. b.SPOT WELD 70MM LAP WITH OUT ADHESIVE AND WITH ADHESIVE-

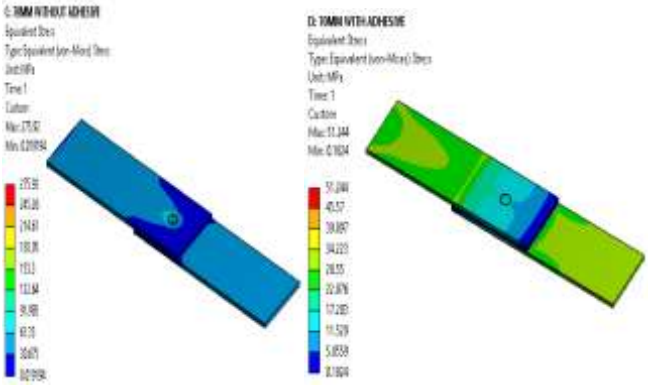
Total Deformation



(a) (b)

Fig. 6 (a) & (b) Total Deformationof Spot Weld 70mm Lap With Out Adhesive Specimen &With Adhesive Specimen

Equivalent stress



(a) (b)

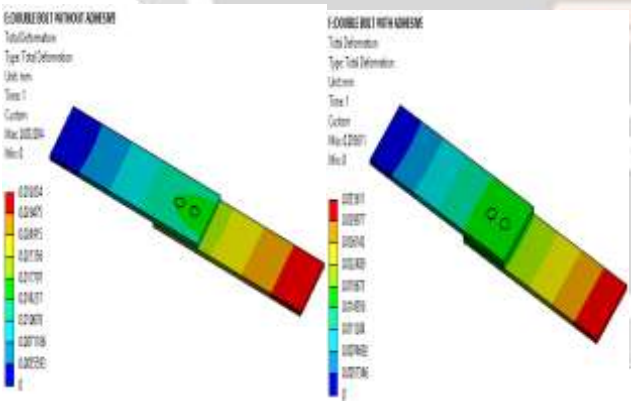
Fig. 7 (a) & (b) Equivalent stressOf Spot Weld 70mm Lap without Adhesive Specimen & withAdhesive Specimen

Reaction force

Reaction Force on Spot Weld 70mm Lap without adhesiveobtained3500 N (FEA)andReaction Force on Spot Weld 70mm Lap with adhesiveobtained3660 N (FEA)**.**

a. DOUBLE SPOT WELD WITHOUT ADHESIVEAND WITH ADHESIVE–

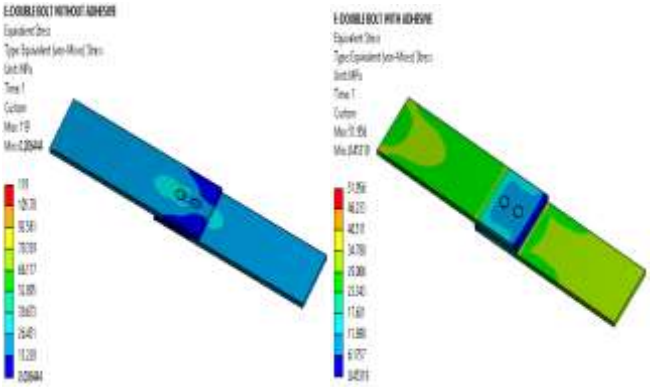
Total Deformation



(a) (b)

Fig. 8 (a) & (b) Total Deformationof Spot Weld 70mm Lap With Out Adhesive Specimen &With Adhesive Specimen

Equivalent stress



(a) (b)

Fig. 9 (a) & (b) Equivalent stressOf Spot Weld 70mm Lap without Adhesive Specimen & withAdhesive Specimen

Reaction force

Reaction Force on Double Spot Weld Lapwithout adhesiveobtained2300N (FEA)andReaction Force on Spot Weld Double Lap with adhesiveobtained2920N (FEA).

VI.EXPERIMENTAL TESTING

A universal testing machine (UTM), it is also known as a universal tester, Materials testing machine or materials test frame, it is used to test the strength i.e. compressive strength and tensile strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" name itself indicates that it can perform many standard compression andtensile tests on materials, components, and structures.

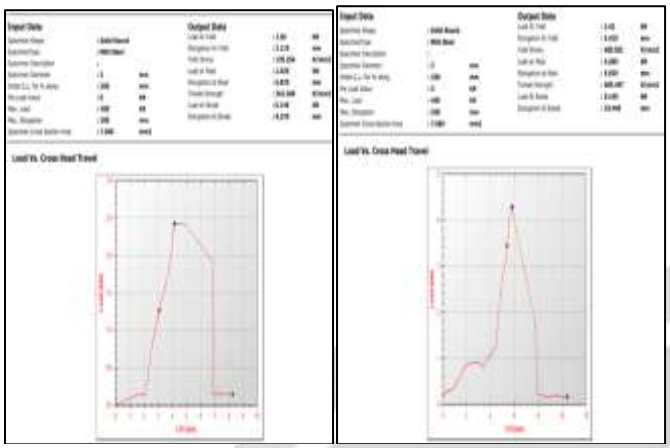
Specification:

Specification of UTM

1	Max Capacity	400KN
2	Measuring range	0-400KN
3	Least Count	0.04KN
4	Clearance for Tensile Test	50-700 mm
5	Clearance for Compression Test	0- 700 mm
6	Clearance Between column	500 mm
7	Ram stroke	200 mm
8	Power supply	3 Phase , 440Volts , 50 cycle. A.C
9	Overall dimension of machine (L*W*H)	2100*800*2060
10	Weight	2300Kg

TEST PLOTS

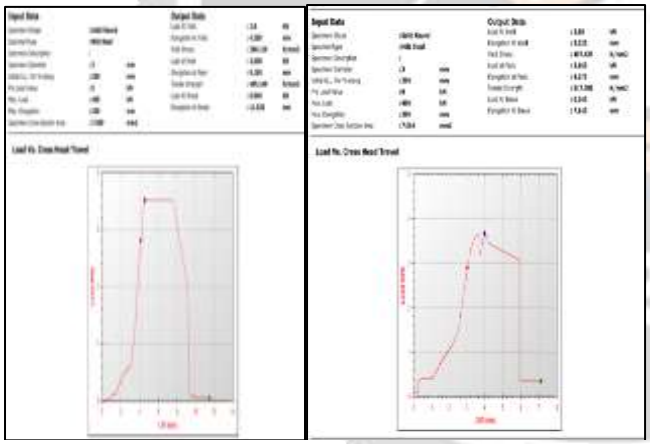
a. SPOT WELD 50MM LAP WITHOUT /WITH ADHESIVE-



REACTION FORCE

From UTM testing we gotReaction Force on Spot Weld 50mm Lap without adhesive 2420 N (FEA)andReaction Force on Spot Weld 50mm Lap with adhesive 4280 N (FEA)**.**

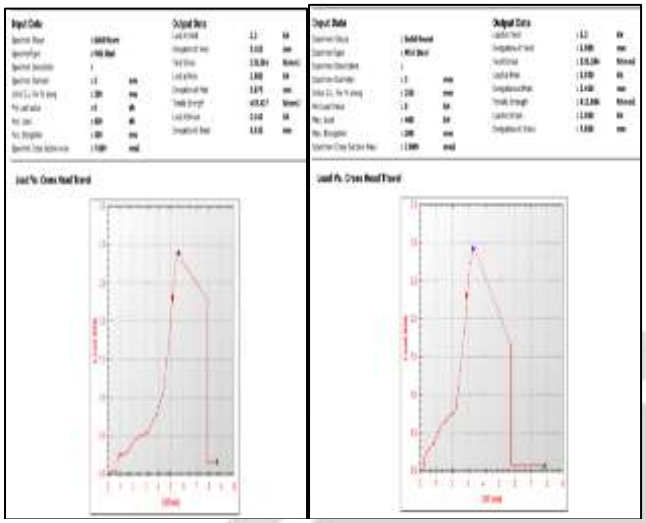
b. SPOT WELD 70MM LAP WITHOUT / WITH ADHESIVE-



REACTION FORCE =

From UTM testing we gotReaction Force on Spot Weld 70mm Lap without adhesive3500 N (FEA)andReaction Force on Spot Weld 70mm Lap with adhesive3660 N (FEA)**.**

DOUBLE SPOT WELD LAP WITHOUT / WITH ADHESIVE-



REACTION FORCE 2800 N (TEST)

From UTM testing, we gotReaction Force on Double Spot Weld without adhesive2800 N (FEA)andReaction Force on Double Spot Weld with adhesive2920 N (FEA)**.**

VII.RESULT

Specimen	**Total Deformation**	**Reaction Force from FEA**	**Reaction Force from test**
SPOT WELD 50MM LAP WITHOUT ADHESIVE	0.0622mm	2420	2420
SPOT WELD 50MM LAP WITH ADHESIVE	0.0818mm	4280	4280
SPOT WELD 70MM LAP WITHOUT ADHESIVE	0.0506mm	3500	3500
SPOT WELD 70MM LAP WITH ADHESIVE	0.0299mm	3660	3660
DOUBLE SPOT WELD WITHOUT ADHESIVE	0.0320mm	2800	2800

DOUBLE SPOT WELD WITH ADHESIVE	0.033mm	2920	2920

VIII. CONCLUSION

1. From above result it conclude that specimen of Spot Weld 50mm Lap With Adhesive has maximum deformation comparatively other spot weld specimen which was 0.0818mm.

2. Reaction Force from FEA are in good relationship with Reaction Force from UTM testing.

3. Reaction force of Spot Weld 50mm Lap with Adhesive has maximum force, which is 4280 N, which means it has more strength than other welded specimen does.

4. With use of adhesivematerial in spot weld specimen stiffness of weld is increases with force reaction

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