Characterization of Bending behavior of Welded Joint

Bhagyashree. P. Ingale[1] Prof. S. M. Jadhav[2]
[1]PG Student [2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]NBN Sinhgad School of Engineering Ambegaon (Bk), Pune-41 India

Abstract— In the use of aluminum alloys to structural applications, one challenge should be succeed may be that those diminishment about mechanical properties about welded joints as contrasted with parent material. In specific cases, the use of such composites is limited by a low quality in the warmth influenced zone (HAZ) because of softening reaction happening during welding, which have a tendency to reduce the general load-bearing limit of the component. Keeping in mind the end goal to use the properties of aluminum composites completely, a superior comprehension of the quality and malleability of welded joints is required. Proper modelling tools and concepts are required to meet the industrial need for rapid development and low cost of new products. In this paper bending behavior of on welded and virgin aluminum alloy 5052 plate subjected to static bending load is investigated and compared .The bending of aluminum plate is conducted using three point bend test experimentally and the validation is done on nonlinear finite element analysis. The experimentation done for destructive testing on Universal Testing Machine and static finite element analysis was performed. The experimental work includes tensile test,3 point bending test, TIG welding of aluminum plate .The finite element analysis and experimental results are compared.

Key words: Bending Test, FEA, Aluminum Alloy 5052, Welding

I. INTRODUCTION

Welding is a perpetual joining process used to join diverse materials like metals, compounds or plastics, together at their reaching surfaces by utilization of warmth as well as weight. At the time of welding, the work-pieces to be joined are liquefied at the interface and after cementing a changeless joint can be accomplished. Welded parts made of aluminum alloy are to an expanding degree utilized inside the vehicle and car ventures due to their high strength, good formability, low density, and good resistance to general corrosion.

The work concentrates on to characterize the stress strain analysis of aluminum alloy5052 plate subjected to bending and compare the results with welded aluminum alloy 5052 plate. The experimentation done for destructive testing on Universal Testing Machine and static nonlinear finite element analysis was performed. The experimental work includes tensile test, 3 point bending test, TIG welding of aluminum plate, micro hardness test .The finite element analysis and experimental results are compared.

A. Problem Statement

Stress Strain behavior of aluminum alloy 5052 weld joint subjected to bending is different than virgin alloy and is need to be characterized.

B. Objectives

– To analyse mechanical properties of aluminium alloy 5052.
– To determine bending behaviour of aluminium plate.
– To compare the results of virgin alloy and welded aluminium plate.

C. Scope of project

– Aluminium alloy of 5052 is considered in the present work. Analysis of mechanical properties of aluminium alloy 5052 is conducted by using ASTM8M standard Tensile testing
– The Bending behaviour of aluminum alloy 5052 was determined by using 3 point bend test.
– Validation is carried out using three point bending test.

II. LITERATURE SURVEY

Bowing Behavior of Aluminum Honey Comb Sandwich Panels.

[1] Aluminum sandwich development has been perceived as a promising idea for basic outline of light weight frameworks, for example, wings of air ship. This paper is hypothetically ascertain twisting conduct, of sandwich boards and to contrast the quality with weight proportions of Normal Aluminum rod (panel) and Aluminum Honey Comb Panel. Impact of welding parameters on 5052 aluminum compound weldments Using TIG welding [2]. The present work intends to assess the impact of Gas Tungsten Arc Welding process parameters on the profundity of entrance of the given example.

The welding parameters, for example, arc voltage, welding current, welding speed, gas stream rate and warmth info are considered which impact the profundity of infiltration measured after the welding. A trial examination of mechanical properties of Al 6106 t6 combination joined by Friction Stir Welding and TIG welding[3]. FSW is a strong state new joining process that is by and by drawing in significant intrigue. Characterization of mechanical properties by space tests and FE investigation – approval by application to a weld zone of DP590 steel[4]. In this work, the mechanical properties of the metal dynamic gas (MAG) weld zone and warmth influenced zone (HAZ) were described using the nonstop space technique together with its limited component (FEM) examination.

Finite Element Analysis Of Welding Residual Stress Of Aluminum Plates Under Different Butt Loint Parameters[4] A warm elastoplastic limited component strategy was worked to mimic the procedure of variable extremity plasma bend welding (VPPAW) for aluminum composite plates. The reproduced and exploratory outcomes were compared and they demonstrated that they are well steady with each other. Investigation of Micro Structure and Mechanical Properties of aluminum compound welded by MIG and TIG welding processes [5]. In this review, customary combination welding forms: MIG, TIG and strong state prepare grating mix welding (FSW) were connected to 6 mm thick plates of aluminum composite.

The weld metal microstructure of MIG welded example contains equiaxed dendrites subsequently of cementing procedure amid MIG welding while FSWed example have created microstructure On the impact of welding leftover weights on the dynamic conduct of structures [6] It is broadly realized that welding forms incite the era of lingering stresses, which, through the so-named stretch solidifying impact, can impact the static and dynamic conduct of the welded parts.

The outcomes show the significance of considering the impact of welding remaining worries in the forecast of the flexural dynamic conduct of plates and the possibility and productivity of the disentangled demonstrating approach, which can promptly be reached out to more mind boggling circumstances, for describing this impact.

A. Springback of grating STIR Welded Sheets[7]

The targets of the present work are, (i) to research the impact of hardware rotational speed and welding speed on the springback of Friction Stir Welded (FSW) sheets, and (ii) to predict the same at various welding conditions utilizing finite element simulation.

III. EXPERIMENTAL BENDING TEST

The experimental bending test is conducted by using three point bend test method of both welded and unwelded aluminum alloy 5052. The aluminum alloy 5052 plate of dimension 400mm long 250mm wide and 6mm thick is welded using TIG (tungsten inert gas welding)process .The two plates are joined by butt welded joint and the gap is filled using tig welding filler rod .The then after welding, the specimens for bending is cut into for parent material bending of dimension 150mm x 50mm x 6mm thick as per the bending parameters .The three point bending is performed on Universal testing machine by using static gradual loading the specimen is bend uptill post yielding of material. The flexural test technique measures behaviour of materials subjected to simple loading. The goal of the present review is to do an examination of stresses and strain on welded joint compared with virgin alloy plate under three-point twisting.

Fig. 1: The specimen for testing welded and un welded

The above figure shows the four specimen of aluminum alloy 5052 plate cut into dimensions for bend test and tensile test for welded and without welded plate of standard size 150 mm x 50mm x6 mm (length x wide x thickness)

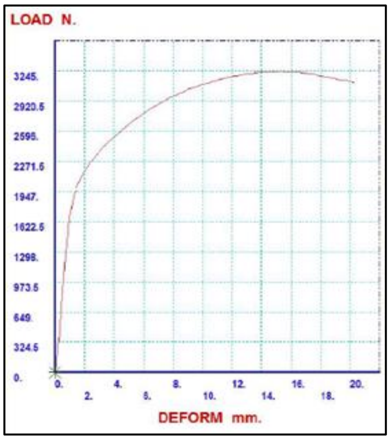

Fig. 2: Flexural Test performed without weld of AA5052

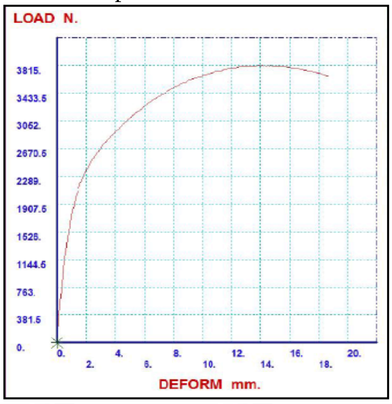

Fig. 3: The flexural test performed on welded AA5052

The above graphs shows the conclusion after the flexural test on both welded and virgin aluminum alloy is shown in the plotted graph. The graph shows that the result of reaction force obtained during welded is 3813 N and without welded plate the load is 3240 N.

IV. ALUMINIUM 5052 THREE POINT BENDING SIMULATION

Limited component examination (FEA) shapes a standout amongst the most adaptable classes of such techniques and were initially created in the field of auxiliary investigation; however now it has been stretched out as a general strategy for answer for some mind boggling designing and physical science issues. FEA as applied in engineering is a computational tool for performing engineering analysis. It includes the use of mesh generation techniques for dividing a complex problem into small elements, as well as the use of software program coded with FEM algorithm. In applying FEA, the complex problem is usually a physical system with the underlying physics , while the divided small elements of the complex problem represent different areas in the physical system. In this paper FEA is carried out by using the static nonlinear FEA analysis. A 3D solid 84 brick element with 8 nodes is used to mesh the geometry of the specimen. The Length of specimen is 150mm and the width of specimen is 50mm. The meshing type of Element is second order Hexahedron, the elements count is 5721, nodes count 24965.

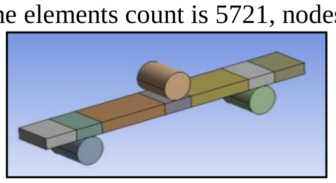

Fig. 4: Solid Model – Without Weld Aluminium 5052 Plate – 150*20*6 mm

Material Properties of Aluminum alloy 5052

Material properties	value	units
Youngs modulus	72450	MPa
Poissons ratio	0.33	
Shear modulus	2.7237E+10	Pa
Bulk modulus	7.1029E+ 10	Pa
Yield strength	200	MPa
Tangent modulus	3622.5	Mpa

Table 1: Aluminium Material Properties

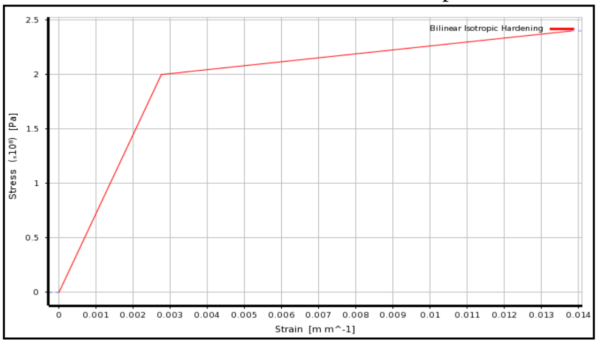

Fig. 5: Aluminium Nonlinear stress strain Material Curve

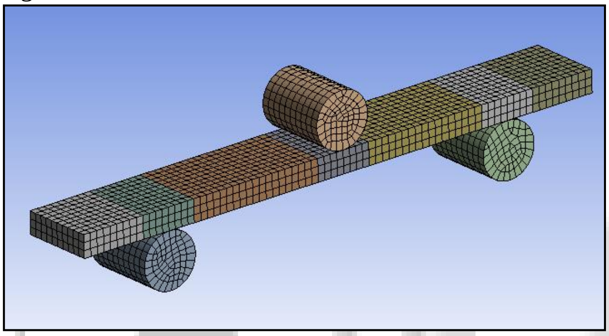

Fig. 6: Aluminium Meshing

- Element Type: Second order Hexahedron
- Elements count: 5721
- Nodes count: 24965

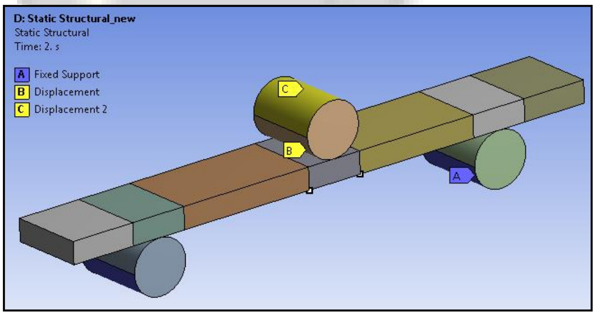

Fig. 7: Aluminium Boundary Condition

- Element Type: Static Structural

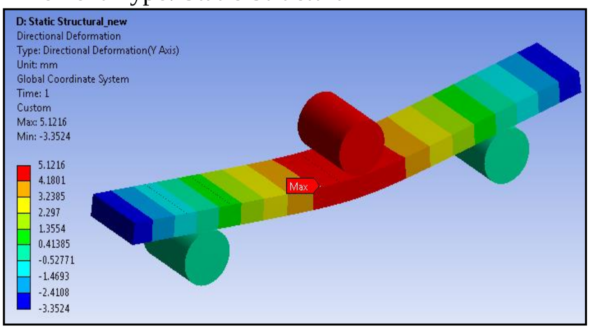

Fig. 8: Aluminium Deformation

- Element Type: Directional Deformation
- Elements count: 5.1216 mm

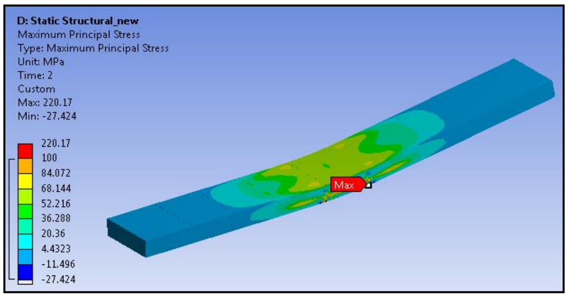

Fig. 9: Aluminium Max Principal Stress

- Element Type: Maximum Principal Stress
- Elements count: 220.17 MPa

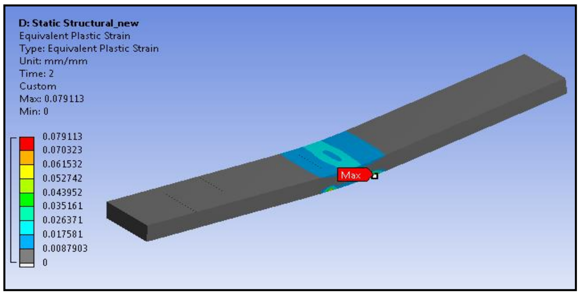

Fig. 10: Aluminium Equivalent Plastic Strain

- Element Type: Equivalent Plastic Strain
- Elements count: 0.079

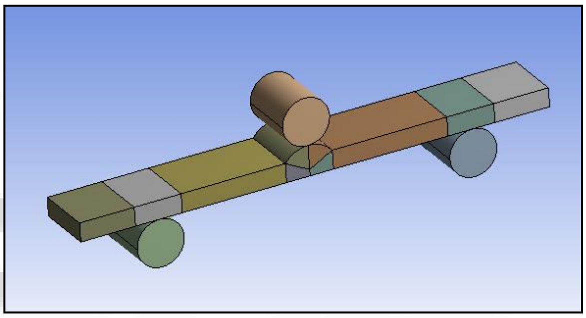

Fig. 11: Aluminium Solid Model–With ButtWeld

- Element Type: Aluminium 5052 PLATE with Butt Weld – 150*20*6 mm

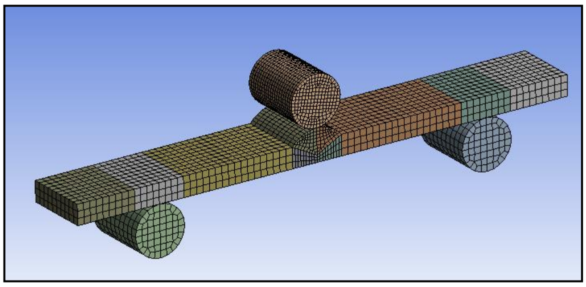

Fig. 12: Aluminium Meshing

- Element Type: Second order Hexahedron
- Elements count: 8680
- Nodes count: 11168

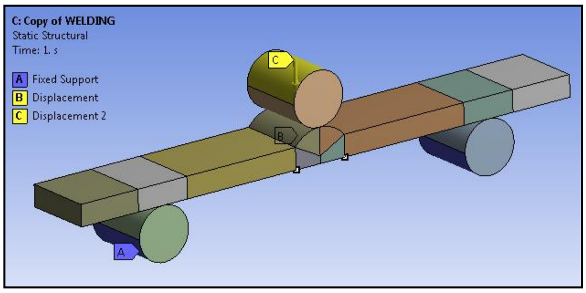

Fig. 13: Aluminium Boundary Condition

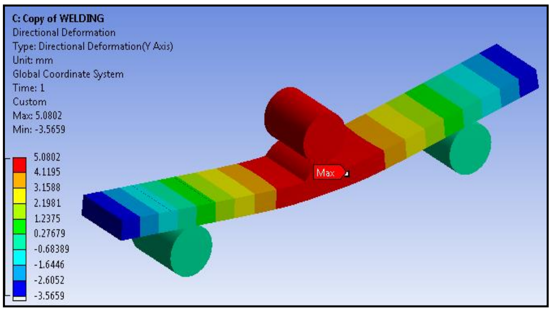

Fig. 14: Aluminium Deformation

- Element Type: Directional Deformation
- Element Count: 5.08mm

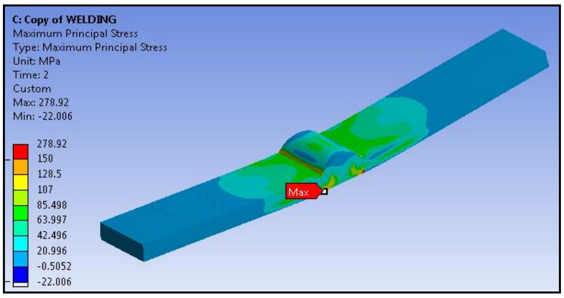

Fig. 15: Aluminium Max Principal Stress

- Element Type: Maximum Principal Stress
- Element Count: 278.92

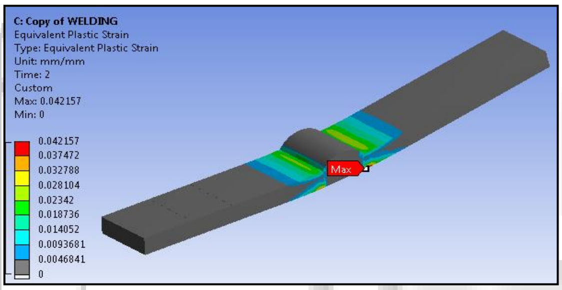

Fig. 16: Aluminium Equivalent Plastic Strain

- Element Type: Equivalent Plastic Strain
- Element Count: 0.042

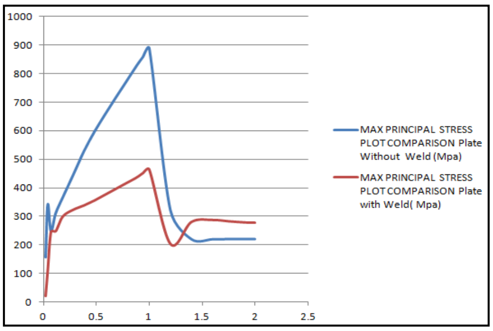

Fig. 17: Aluminium Max Principal Stress Comparison

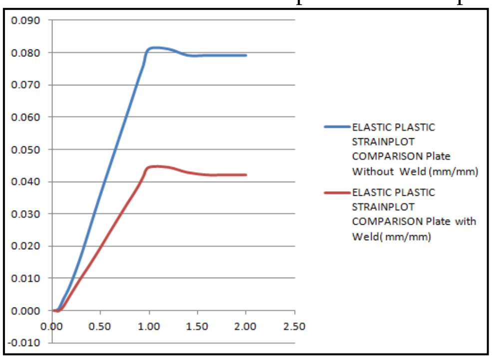

Fig. 18: Aluminium Equivalent Plastic Strain Comparison

The graph shows results of the comparison of welded and unwelded maximum principal stress ploted in excel it shows that maximum stress in welded plate is less than that of non-welded virgin plate. The value of max principal stress is 870 MPa in without weld and in welded is 460 MPa

This graph plotted shows the results of plastic strain obtained in the welded and non-welded plate comparison. This shows that the plastic strain in without welded plate is 0.081 and the plastic strain in welded plate is 0.044. This shows that the plastic strain obtained in without welded plate is more than that of welded plate.

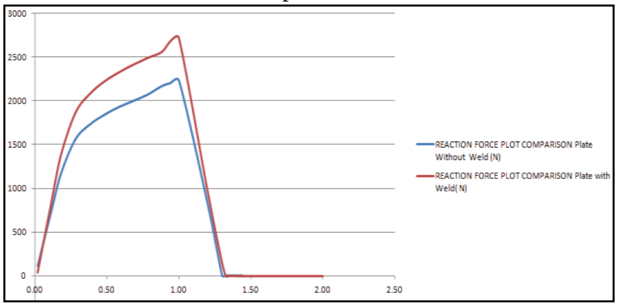

Fig. 19: Aluminium Reaction Force Plot

The graph shows that reaction force plot or the load in the comparison of welded and non-welded plate the plot shows that the reaction force developed in without weld plate is 2200 N and in welded plate is 2700N.

Reaction Force developed at non welded plate is less than that of welded plate

V. TENSILE TESTING AND ANALYSIS

Tensile tests are utilized to decide the mechanical conduct of material under statics, extend loading. In this paper the tensile testing is conducted on two samples of AA 5052 aluminum welded by TIG process and virgin AA5052 without welded. The elastic examples are set up according to ASTM E8. Tensile tests are directed utilizing 100KN computer controlled all-inclusive testing machine. Before testing, cross-sectional zone and gage length is measured for each specimen. The example is then stacked into a machine set up for ductile loads according to the ASME determination and put in the correct grippers so that the tractable examples experience disfigurement. Once stacked, the machine can then be utilized to apply a consistent, proceeds malleable load. With use of tensile load, examples experiences misshapening and bendable break happens at specific load and this esteem is recorded to compute extreme rigidity of segment load.

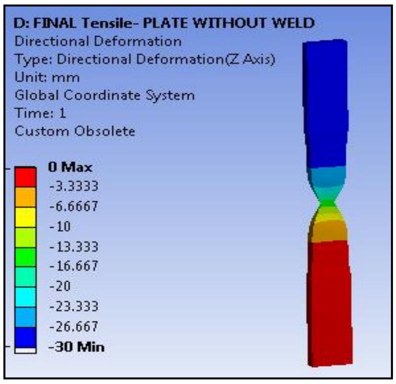

Fig. 20: Tensile test without weld deformation simulation result

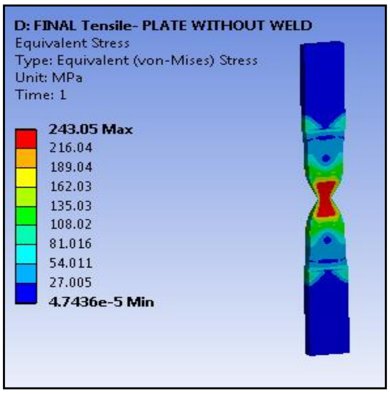

Fig. 21: Equivalent (von-mises) Stress result without weld

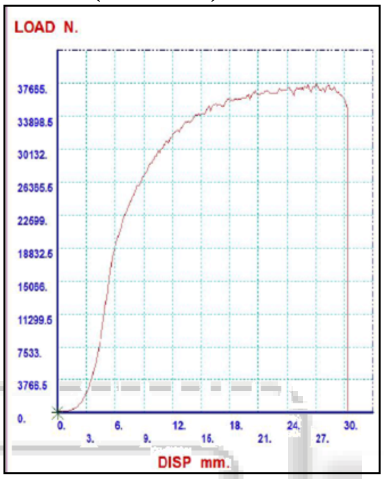

Fig. 22: Tensile test experimental result without weld testing result

Tensile Load =34760N

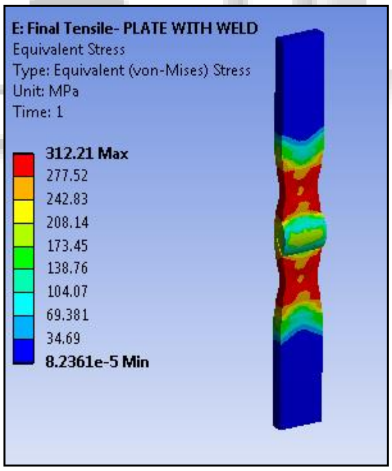

Fig. 23: Tensile test with weld simulation result

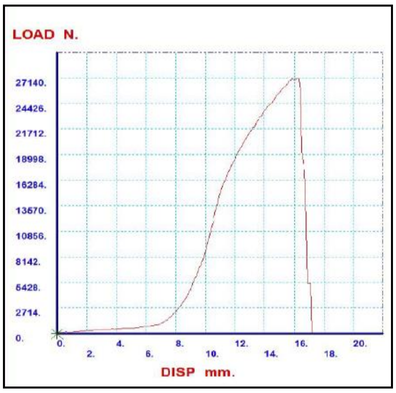

Fig. 24: Tensile test experimental result with weld Test

Tensile Load =27136N

The following table shows the results validated with the experimental and the FEA analysis .the results shows the Reaction force developed during bending and tensile test are showed in table.

Test conducted	FEA	Experimental
Three point bend test (without weld)	2718 N	3240 N
Three point bend test (with weld)	2236 N	3813 N
Tensile test without weld	29668 N	34760 N
Tensile test with weld	29684 N	27136N

Table 2: Results of Reaction force validation experimental and with FEA

VI. Conclusion

The bending test and tensile test conducted on welded and without weld virgin aluminium alloy 5052 plate of thickness 6mm concluded the following results

A. Bending test

The Flexural test conducted using three point bend test method on Universal testing machine experimentally. The results showed on both welded and virgin AA5052 are compared.

- The Max Principal Stress developed in non-welded plate is more than that of Welded Plate
- Equivalent Plastic Strain developed in non-welded plate is more than that of Welded Plate
- Reaction Force developed at non welded plate is less than that of welded plate

From all above results it proves that Butt welded plate is strong in Mechanical characteristics as compared to that of non-welded plate.

B. Tensile Testing

In tensile testing the welded plate of AA5052 plate breaks at the weld joint as the area gets smaller and thus welded specimen in tensile test is weaker than as compared to virgin AA5052 without weld specimen.

Acknowledgement

I am thankful to Prof. S.M.Jadhav for his helpful guidance, continuous encouragement and cooperation extended to me during this work.

References

[1] K.Kantha Rao, K. Jayathirtha Rao, A.G.Sarwade, B.Madhava Varma" Bending Behavior of Aluminum Honey Comb Sandwich Panels" International Journal of Engineering and Advanced Technology (IJEAT) ISSN: 2249 – 8958, Volume-1, Issue-4, April 2012.
[2] Sushil Kumar Kamat ,Ajay Kumar "An experimental investigation of mechanical properties of Al 6106 t6 alloy joined by Friction Stir Welding and TIG welding" International Journal of Innovations in Engineering and Technology (IJIET), Vol. 3 Issue 1 October 2013.
[3] A. Raveendra1,Dr. B. V. R. Ravi Kumar2 Dr.A.Sivakumar3 N.santhosh4 "Effect of welding parameters on 5052 aluminium alloy weldments Using TIG welding International Journal of Innovative

Research in Science, Engineering and Technology Vol. 3, Issue 3, March 2014”
[4] Kyung-Hwan Chung a, Wonoh Lee b, Ji Hoon Kim c, Chongmin Kim d, Sung Ho Park a,Dongil Kwone, Kwansoo Chung e, “Characterization of mechanical properties by indentation tests and FE analysis – validation by application to a weld zone of DP590 steel” International Journal of Solids and Structures 46 (2009) 344–363.
[5] Sunil M.Pawar,Prof.Vivek V.Kulkarni, “Mechanical Characterization of alluminium alloys for TIG welding-Experimental and Modeling studies,International Research journal of Engineering and Technology (IRJET),Volume :02 issue:02;May- 2015
[6] G. Mi1 – C. Li1 – Z. Gao1– D. Zhao1 – J. Niu1 “Finite Element Analysis Of Welding Residual Stress Of Aluminum Plates Under Different Butt Joint Parameters” Engineering Review, Vol. 34 Issue 3, 161-166, 2014.
[7] A.C. Bezerra, L.C. Vieira, D.A. Rade and A. Scotti “On the influence of welding residual stresses on the dynamic behavior of structures.” Shock and Vibration 15 (2008) 447–458
[8] SudhindraKatre, SiddharthaKaridi, R.Ganesh Narayanan, “Springback of Friction Stir Welded Sheets: Experimental and Prediction” 5th International & 26th All India Manufacturing Technology, Design and Research Conference (AIMTDR 2014) December 12th–14th 2014, IIT Guwahati, Assam, India