International Journal of Research in Engineering, Science and Management
Volume-3, Issue-3, March-2020
www.ijresm.com | ISSN (Online): 2581-5792

Impact Studies on Friction Stir Welding Process in AZ31B Magnesium Alloy

S. Divya[1], S. Sabari Dhinesh[2], P. Vijayaraj[3], M. Shanmugavel[4], M. Siddharthan[5]
[1]*Professor, Department of Mechanical Engineering, Sri Eshwar College of Engineering, Coimbatore, India*
[2,3,4,5]*Student, Department of Mechanical Engineering, Sri Eshwar College of Engineering, Coimbatore, India*

***Abstract*: An investigation on friction stir welded magnesium AZ31B rolled plate has been made and its ballistic performance was found. Two plates of 6mm thickness is welded, after which the numerical value was determined using ABAQUS software. The welded and non-welded plates are assessed with a ballistic performance. From the ballistic outcomes, it was found that both welded and non-welded plate targets effectively halted on the depth of penetration in middle layer. Finally, a comparison was made on both numerical and experimental value outcomes of AZ31B mg plates.**

***Keywords*: Ballistic test, Friction stir welding, Depth of penetration.**

1. Introduction

In recent years, magnesium alloy has made more impact in the field of research and development in various industrial application due to its properties like low density, light structural weight, excellent machinability and it is recyclable. To improve the property over the welded area of magnesium alloy, the solid welding process is recommended. It is one of the most convenient joining processes for magnesium alloy since it eliminates the loss of material and there is no requirement for filler material.

A. AZ31B magnesium alloy

Magnesium is one of the lightest metal with a density of 1.74 g/cm^3 in solid state. The main reason for considering magnesium alloy materials in engineering designs is due to their high strength to weight ratio. It is Highly stiff to weight, castable, machinable, and excellent damping are the desirable properties of magnesium alloys that make magnesium as the default material selection process. It is used as an alloying element for nonferrous alloys like aluminium, zinc, and lead. Magnesium can be used as desulfurizer in iron and steel production. It is 35% Lighter than Aluminium. It is Lesser in weight, more comfort and affordable. Magnesium parts are used in the field of Aerospace, Automotive, Defence and General machinery since they are less in weight and increase efficiency. Most magnesium alloys can't be heat treated like aluminium. AZ31B magnesium alloy is available in the form of Plate, Sheet, and Rod and bar.

B. ABAQUS software

It is testing software used in the field of automotive, aircraft industries and other mechanical industries. Abaqus is popular in research in the field of engineering because of the various material modelling capability, and the program iscustomized, for instance, the user can define the material models and the Abaqus software will simulate new materials. The Abaqus software gives us the progressive failure model analysis result for various composite materials that are used for finding the impact. Abaqus was first designed for addressing the non-linear physical behaviour. As a result, Abaqus software has extensive range of material models and capabilities to test the materials. The failure will mostly appear between the boundary of nugget and thermodynamically affected zone.

2. Literature survey

N. Afrin et al., [1] investigates the microstructural change over AZ31B-H24 magnesium alloys after the friction stir welding and reveals that friction stir welding can be done for magnesium alloys to eliminate various problems like crack, void and expulsion over the welded area. It also reveals us that lower rotational speed of 500rpm during the friction stir welding will end up with higher yield strength than the high rotational speed of 1000rpm.

S. Ugender et al., [2] reveals that friction stir welding over Mg AZ31B alloy is carried out at different speeds and with different tool materials at a constant welding speed of 40 mm/min with a tilt angle of 2.50 and an axial force of 5 KN. The rotational speed gives us the effect of tool material and microstructure.

W. Woo, et al., [3] gives us the variations of microstructure, chemical composition, texture, hardness and residual stress in AZ31B magnesium alloys after the friction stir welding and the residual stress is measured over the stir zone.

Inderjeet Singh et. al. [4] reveals that metallurgical properties of AZ31B-O Mg alloy joints were found using combination of different parameters such as tool rotational speed, welding speed and tool shoulder diameter and the fine grain structure were observed due to dynamic recrystallization at higher value of weld pitch.

Ugender Singarapu, et. al., [5] investigation gives us the opinion that the result depends on the rotational speed, traverse speed and the tool material in deciding the mechanical properties of friction stir processed magnesium alloy. In addition to this the mathematical models were developed to find the various mechanical properties.

G. Padmanaban et. al., [6] demonstrates us the influence of various welding processes like friction stir welding, laser beam welding and pulsed current gas tungsten arc welding to test the fatigue properties such as fatigue strength, fatigue notch factor and notch sensitivity factor. The main aim is to compare the fatigue properties

Wenya Li et al., [7] results gives us a bowl-shaped stir zone with the presence of fine equi axed grains and its grain size increases as increasing the tool rotational speed. The lowest Vickers hardness is found in the thermo-mechanically affected zone on the advancing side. If the rotational speed is increased, the ultimate tensile strength of joints will also increase.

S.M. Chowdhury et al., [8] explains the properties of AZ31B like microstructure, tensile property and hardening behavior of double side arc welding and friction stir welding on the AZ31B-H24 magnesium alloy. it is observed that at lower strain, a high-hardening is being obtained and at higher strains, the strain hardening rate becomes higher because of the recrystallized grains.

G. Venkateswarlu et. al., [9] reveals that weight reduction can be done on the automotive components which will result in the cost reduction of materials as well as reducing the overall weight of the vehicle. The total elongation is observed on the friction stir welded AZ31B magnesium alloy by varying the rotational speed and tilt angle.

A.H. Ammouri et al., [10] shows us that friction stir processing is an effective method to improve the material property by significant refining and homogeniation. The extruded AZ31B magnesium alloy limits the ductility because of the processing parameters such as cutting speed and shoulder diameter.

Hamed Seifiyan et al., [11] Investigate the effect on friction stir processing over the corrosive property of AZ31B magnesium alloy specimens that are processed under various conditions. The corrosive behavior was studied under potentiodynamic polarization, Electrochemical impedance spectroscopy and immersion test is conducted.

Motalleb-nejad P et. al. [12] investigates the microstructure and mechanical properties over the friction stir welded AZ31B magnesium alloy. Here, the pin geometry is considered to be simple cylinder, screw threaded cylinder and taper. The welding is done at different rotational speeds. Microstructures of the friction stir welded joint is examined using the optical electron microscopes and the tensile properties are measured. The rotational speed has a more significant role on the obtaining the fine microstructure

Cao X et. al. [13] reveals that the effect of welding speed rating overbutt joint quality of friction stir welded AZ31B-H24 magnesium alloy. The microstructure, defect, tensile and mechanical properties were examined. The main objective is to reduce the weight in ground vehicles and aircraft which will result in reduced fuel consumption as well as reduced economical expenditure.

Chowdhurya S. M. et. al [14] evaluvates the fatigue test over AZ32B-H24 magnesium butt joints. Here, the friction stir welding resulted in recrystallized grain structure in the stir zone and in the thermos-mechanically affected zone and the partially recrystallized grain structure is found in the heat-affected zone with the lowest hardness appeared in the Stir zone.

Seyed Behzad Behravesh et. al. [15] gives us the result of cyclic behaviour of spot welded AZ31B magnesium alloy. Fatigue strength obtained for magnesium spot weld was similar to aluminium and comparatively less than steel. The various available modes of fatigue tests were conducted by predicting the life of magnesium spot welds.

Amir Hossein Baghdadi et al. [16] Weight reduction is one among the major issue in the field of automotive and aircraft industry. Magnesium alloys are the lightest in weight and low density. It processes high strength to weight ratio. Magnesium alloys is limited to ductility and it is low workable at room temperature. Friction stir welding is a solid-state welding process that can be performed to make joints on the magnesium alloys.

Yu Sirong et. al. [17] AZ31B magnesium alloy sheet added with 0.5% weight of Cerium is welded by the friction stir welding. The microstructures and mechanical properties of the welded joint were examined. The results showed that the grain structure of the weld nugget zone is found to be uniform with the small equi axed grains. The fracture locations of Friction Stir Weld joint were found in the heat-affected zone and ductile fracture is the main fracture mode.

Zhihan Zhang et. al. [18] various materials ranging from low diffusive granite to high diffusive copper were welded by friction stir welding process to reveal the effect of back plate on its microstructure and properties. The results suggests us that the decreasing the back plate diffusivity will increase the recrystallized grain structure in the nugget zone.

Jian Chen et. al. [19] investigation says that both the cold rolling and welding techniques were combined for joining the AZ31B magnesium alloys. The static recrystalizatition of microstructure and the mechanical properties were examined and the results show that rolled weld sample has high tensile strength and strength coefficient.

S. Ramesh Babu et. al., [20] states that friction stir processing is an effective method for improving the material properties through significant refinement process. The extruded AZ31B magnesium alloy has limited ductility because of the hexagonal atomic structure and severe mechanical twinning. After friction stir welding, it is observed that they have improved ductility and process fine grain structure.

3. Conclusion

In this work, an attempt is made to study the mechanical properties and structural properties of friction stir welded AZ31B rolled magnesium alloy. The following are the conclusions observed in this study.

1. AZ31B magnesium alloy can be welded successfully with without any macro defect.
2. The various properties such as microstructure, hardness and chemical composition were examined in the friction stir welded AZ31B magnesium alloy.
3. Impact strength over the welded area is observed to be greater than the base metal.

References

[1] N. Afrin a, et al., "Microstructure and tensile properties of friction stir welded AZ31B magnesium alloy," 2008.
[2] S. Ugender, A. Kumar, A. Somi Reddy, "Microstructure and Mechanical Properties of AZ31B Magnesium alloy by Friction Stir Welding," 2014.
[3] W. Woo, H. Choo, "Microstructure, texture and residual stress in a friction-stir-processedAZ31B magnesium alloy," 2008.
[4] InderjeetSingha, et. al., "An experimental approach to study the effect of welding parameters on similar friction stir welded joints of AZ31B Mg alloy," 2014.
[5] Ugender Singarapu, Kumar Adepu, "Influence of tool material and rotational speed on mechanical properties of friction stir welded AZ31B magnesium alloy" 2015.
[6] G. Padmanaban, V. Balasubramanian, "Fatigue performance of pulsed current gas tungsten arc, friction stir and laser beam welded AZ31B magnesium alloy joints," 2010.
[7] WenyaLia, et. al., "Improving microstructural and tensile properties of AZ31B magnesium alloy joints by stationary shoulder friction stir welding," 2019.
[8] S. M. Chowdhurya, D. L. Chena, et. al., "Tensile properties and strain-hardening behavior of double-sided arc welded and friction stir welded AZ31B magnesium alloy," 2010.
[9] G. Venkateswarlu, D. Devaraju, M. J. Davidson, B. Kotiveerachari, G. R. N. Tagore, "Effect of overlapping ratio on mechanical properties and formability of friction stir processed Mg AZ31B alloy," 2013.
[10] A. H. Ammouri, R. F. Hamade, "On the selection of constitutive equation for modeling the friction stir processes of twin roll cast wrought AZ31B," 2014.
[11] Hamed Seifiyan, et. al., "Influence of friction stir processing conditions on corrosion behavior of AZ31B magnesium alloy," 2019.
[12] Motalleb-nejad P, et. al. "Effect of tool pin profile on microstructure and mechanical properties of friction stir welded AZ31B magnesium alloy," 2014.
[13] Cao X, Jahazi M. "Effect of welding speed on the quality of friction stir welded butt joints of a magnesium alloy," 2009.
[14] Chowdhurya S. M., Chena D. L, Bholea S. D, Caob X, "Effect of pin tool thread orientation on fatigue strength of friction stir welded AZ31B-H24 Mg butt joints," 2010.
[15] Seyed Behzad Behravesh, Hamid Jahed, Steve Lambert, "Fatigue characterization and modeling of AZ31B magnesium alloy spot-welds," 2014.
[16] Amir Hossein Baghdadi, et al. "Effect of travel speed on Quality and Welding Efficiency of Friction Stir welded AZ31B Magnesium alloy," 2018.
[17] Yu Sirong et. al. "Microstructure and mechanical properties of friction stir welding of AZ31B magnesium alloy added with cerium," 2010.
[18] Zhihan Zhang et. al. "Effect of backplate diffusivity on microstructure and mechanical properties of friction stir welded joints," 2013.
[19] Jian Chen, et. al. "Microstructure and mechanical property of rolled-weld magnesium alloy AZ31B," 2012.
[20] S. Ramesh Babu, et. al., "Microstructural changes and mechanical properties of friction stir processed extruded AZ31B alloy," 2012.