RECTIFICATION OF MINOR DEFECTS OF LM25 Al ALLOY CASTING PARTS USING TIG WELDING

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Abstract: In recent years LM25 (Al-Si7Mg) Al Alloy is widely used in various automobile parts. During solidification of LM25 Aluminium alloy some of the casting defects may be produced and these defects are repaired with the TIG welding process. Finally, the required Mechanical properties like tensile test, wear and micro – macro scope analysis were conducted on weld metal and compared with the same base metal.

Index Terms - LM25 Aluminum, TIG welding, casting defects.

I. INTRODUCTION

This project work was done in autoparts Ltd. Industry in Tirupathi. Mainly in this industry LM25 aluminium alloy parts were doing casting and finishing. In this company auto parts are cast and sent to the inspection department to inspect any defects present in a casting. In this department it found some of the minor and major defect components like blow holes, pin holes, cracks, wet holes, allowances and scars etc.

(a) (b) (c)

Fig.1: above (a), (b) & (c) figures shows the cast defective components

In this work pin hole, blow holes and wet hole defective parts were elected to minimize of defects. One of the wonderful ideas gets to do rectifying these defects by using welding process. During this investigation, Tungsten Inert Gas (TIG) welding process is used to rectify the minor defects in casting. In this welding process, ER4043 types of filler rod used for weld the defective region of a component. This welded component marked machined around the weld region with satiable dimensions for different testing purposes. Finally, surface levelling of welded portion done with grinding machine.

II. LITERATURE REVIEW

Bhushan Shankar Kamble, et al [1] experimentally investigated on the TIG welding of aluminium plates at welding cracks. It had been done the studied on the different casting defects like blow holes, pin holes, broken casting, axial shrinkage, casting chilling defects, cold shunts, corner shrinkage, hot tears, flash/fin, micro porosity, scars etc. and their occurrences cause was identified. Finally, they investigated that the welding strength and welding properties by changing different current conditions. Prakash Mohan, et al [2] studied the effects of welding parameters on TIG welding of aluminium plate. They described that the welding strength or tensile force of the weld joint depends on the welding parameters like welding speed and welding current. Hardness values of the weld zone change with the distance from weld center due to variety of microstructure. It investigated by using variable current TIG welding process. Siddanna Awarasan Prof. N.S. Devour, et al [3] the Microstructure study shows clear indication about good bonding between LM 25 Al alloy and steel wire as the material is spread out along the limit and there will be no defects like voids and porosity in the boundary area. From the Izod and Charpy test it is clear that the impact strength is likewise increased by 45% as compared to base LM 25 Al alloy which shows better impact absorbing capacity of composite. Suyitno, et al [4] it studied with the impression of copper content in micro porosity, microstructure and macrostructure in the casting of Al-Cu alloys. In this research find the porosity propertied of the composition by changing of copper percentages in chemical composition of alloys. S. Nallusamy, et al [5] this investigates a study on the effects of heat treatment on the microstructure, quality of casting and mechanical properties of Al-7Si-0.3Mg (LM25) alloy. Dang Thien Ngon, Phan Van Toan, et al [6] Proposed on the basic mechanism of TIG welding of aluminium plates and experimentally studied on the optical microscopy images, micro hardness and tensile strength of the welded zone at the cross section. Narender Bansal, et al [7] has been investigated to the welding aspects like weld bead geometry, bulk hardness, surface cracks, using dry penetrate test, impact strength, micro hardness, joint quality and chemical composition of strain less steel (ss202 & ss304) using the GTAM process.

Radhika N., Balaji T. V., et al [8] studied of mechanical properties and wear characteristics of LM25/SiC/Al2O3 hybrid metal matrix composites. It was found that, the mechanical properties and wear resistance at different weight percentage of reinforcement.

It is concluded from the literature survey that few studies have been taken out for the investigation of the dissimilar types of casting flaws and their remedy in the moulding process with pictures. Also less data about the material matrix composition of LM25 alloys and its characteristics, and some reports gave good information, how to usage of TIG welding process for joining of aluminium alloy plates. Nevertheless, there is no information regarding to optimization of minor cast defects by using TIG welding process and there is no comparison of mechanical properties and wear analysis and micro- macro structure analysis of the base and weld metal of LM25 alloys after minimization of defects.

III. TIG Welding Process

In arc welding processes, Tungsten Inert Gas (TIG) welding is best for welding of ferrous materials like aluminium, nickel, copper, titanium and magnesium alloys. In this welding process non-consumable tungsten electrode used to furnish heat, with the filler rod added manually. Clamp the earth cable to work piece, non consumable electrode connects to the power supply, heat generates and melt to filler rod metals for joining.

Fig.2: Defected component

Fig.3: During the welding at defect

Fig.4: Defected component after welding

IV. Results and Discussion

4.1 Tensile Test

Tensile Tests are performed for several reasons; the results of tensile tests are used in selecting materials for engineering applications. Tensile properties are frequently included in material specifications to ensure quality. Tensile properties often are measured during development of new materials and processes, so that different materials and processes can be compared. Finally, tensile properties often are used to predict the behaviour of a material under forms of loading other than un-axial tension

The shape and dimensions of the tensile specimen are shown in Fig. The work sample must be designed in American Associations dimensions for the welded specimen in ASME SEC IX and non welded specimen in ASME A8. The standard dimension of welded sample is 50mm×19mm×5mm and non welded sample is 50mm×12mm×5mm.The UTM (universal testing machine) was used for the tensile test. The specimens were loaded hydraulically, when the loads reach maximum at which the specimen has reached the yield point and all this value are noted and tabulated.

Fig.5: UTM machine

Fig.6: Samples after Tensile test

Table.1: Tensile Test Results

Samples No.	Base Samples			Welded Samples		
	UTS (MPa)	UYS (Mpa)	Elongation (%)	UTS (Mpa)	UYS (Mpa)	Elongation (%)
1	152.52	120.29	3.92	146.92	114.48	2.68
2	170.19	117.15	6.80	127.11	103.71	3.60
3	169.50	146.50	2.62	119.37	95.53	3.84

4	165.00	165.00	5.36	163.70	117.35	3.40
5	147.56	147.56	1.32	137.84	94.54	0.68
Average	160.95	139.30	4.00	138.99	105.12	2.8

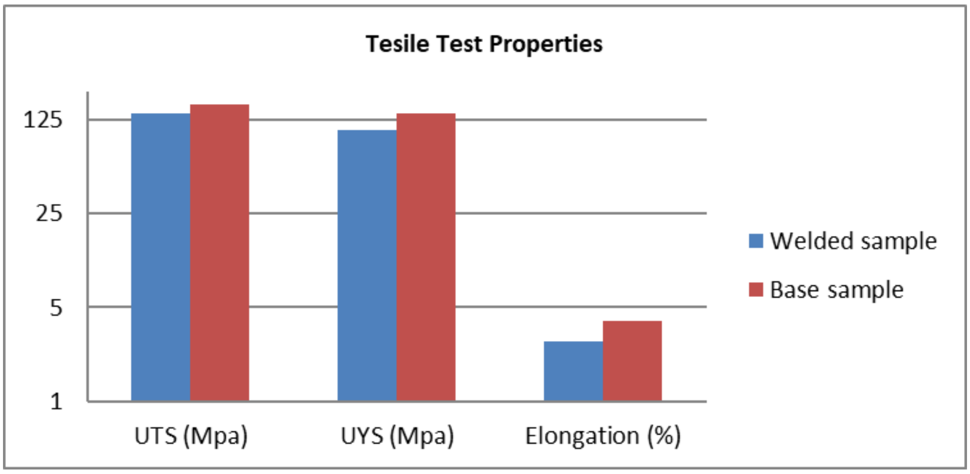


Fig.7: Comparison of Ultimate tensile stress for each sample

From the graph it was observed that tensile strength properties in base metal and weld metals are having negligible changes occurred (i.e. 21.96MPa, 34.18MPa in Absolute deviation). Also ductility in base metal is more as compared with the base samples. So, the brittleness in a weld metal little bit increased (i.e.1.2%).

4.2 Wear Test Analysis

Wear is related to interaction between surfaces and specific the removal and deformation of material on a surface as a result of mechanical action on the opposite surface.

Rotary Drum Type Abrasion testing machine:

The rotary drum Type abrasion tester is really easy to the weight loss a material. Design the dimension of a test specimen is 20mm diameter and 7 mm thickness. The test specimen is fixed in a quick clamp sample holder and precisely guided - either with or without rotation - over a predefined distance of either 20 or 40 Meters and with a defined load on a sheet of abrasive paper mounted on a stainless steel rotary drum of 150 mm diameter. The drum rotates with a speed of 40±1 rpm. Finally the frictional loss is calculated by comparing the sample weight before and after testing. This setup annually connected to the power switch board. Contact pressure of for specimens expandable up to 20N and number of revolutions of roller is 40 /min, the Equivalent revolution of the roller is 84 and Dimensions of abrasion sheet is 470mm,5(+2)x400.

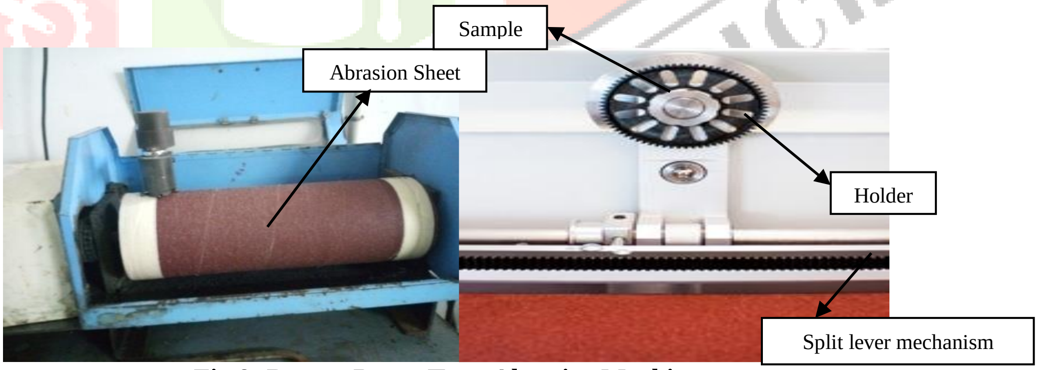


Fig.8: Rotary Drum Type Abrasive Machine

The abrasion, the mass loss (average value of 3 to5 single values) and % of mass loss calculated and tabulated of weld and base metal sample as shown below.

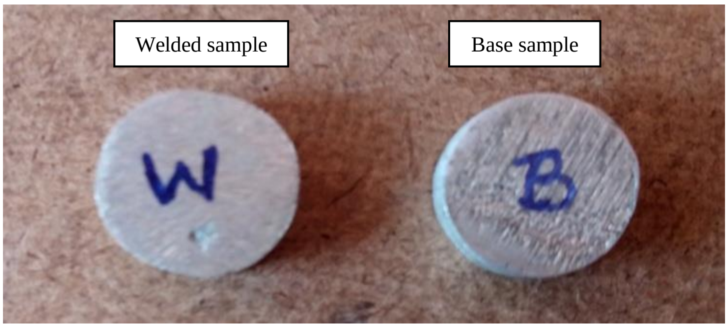


Fig.9: Wear test samples

Formula:

$$\text{Percentage (\%) of Wear} = \frac{M_i - M_f}{M_i} \times 100$$

Where,

M_i = Initial mass of specimen in grams

M_f = Final mass of specimen in grams.

The samples of the base metal and welded metal were taken, continues process applied up to 5 reading taken from each sample at a constant speed and force. These values are tabulated in table 4.1.

Table 4.1: Wear test results

Sample no.	Percentage of Weight loss	
	Welded sample	Base sample
1	10.55	13.70
2	8.59	11.38
3	9.01	10.38
4	10.69	11.47
5	11.05	13.81
Average	9.98	12.15

Absolute deviation of percentage = |base metal – welded metal |.

From the table 4.1 takes the average percentage of weight loss in abrasion and drawn a graph between the welded sample and base sample for LM25 Aluminium.

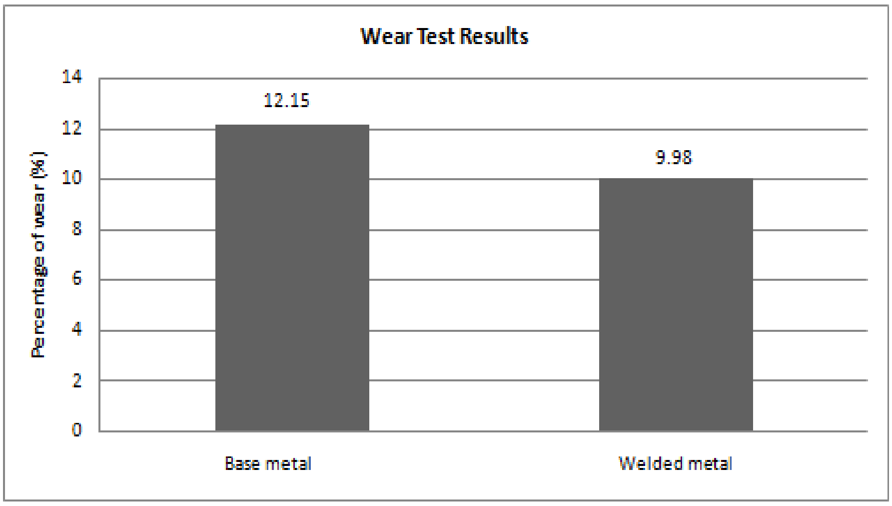
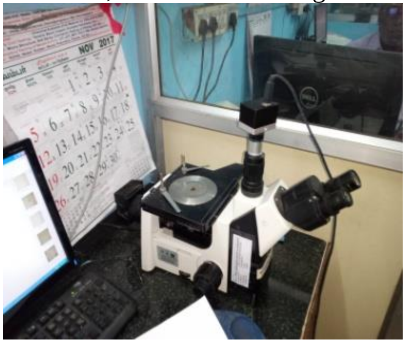


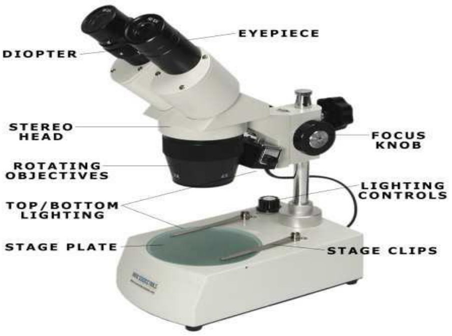
Fig.10: Average percentages of wear for base and weld metal

The average absolute deviation in percentage of wear is 2.20%. Average wear at the welded zone is less when compared to base sample. So welding is better to minimize the casting defects.

4.3 Micro Structure Analysis

The microscope is a major tool used by biologists, which was invented about 350 years ago. It is a device that allows observation of minute organisms and various cell types too small to be seen by the unaided eye. Since an unaided eye cannot detect anything smaller than 0.1 mm, a light microscope can extend our view a thousand times so that objects as small as 0.2 micrometers (2×10^{-7} m) can be seen. The electron microscope can further extend our viewing capability down to one nanometer (1×10^{-9} m). A good microscopy involves three main factors: resolution, magnification and contrast. The resolution and resolving power of a microscope will increase, when the wavelength of the light source is reduced.





(a) **(b)**

Fig.11: (a) & (b) are the XTD-229 stereo microscope

E-ray type diffraction (XTD) series stereo microscopes are a king of positive microscope. They have long working distance, light and still image quality, extensive field, convenience operating etc. It can be used for culture and education, scientific research, agriculture and forestry electronics and precision machine industries widely. Optical tube 45º in inclination, can be rotated 360º. In eyepiece tube different types magnification lances can be adjusted.

(a) Base Zone (b) Heat affected zone (c) Welded zone

Fig.12: Microstructure observation of Aluminium welded sample

From the Fig.11 micro structural observation was revealed that,

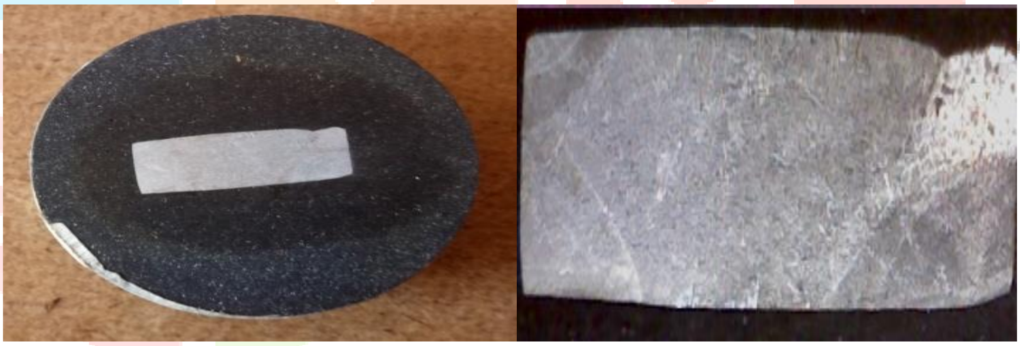
1. The thickness of inter-metallic layer of new joint geometry and regular joint geometry were examined. The microstructure shows complete fusion between weld and base metal, and some of the base metal composition is mixed with the welded metal composition.

2. A very fine grain size is observed in the base sample near the weld joint and grain size decreases as the distance from the weld line decreases. There were observed coarse grain dendrite particles in the microstructure of welded sample.

4.4 Macro Structure Analysis

In regular welding joint geometry there was uniformly welding joint formed around the entire weld circumference. The formation of the weld interface of new joint geometry facilitates in the destruction and removal of oxides and other contamination at the weld interface is observed in the macro scope analysis.

Now, take (XTD) -229 series stereo microscopes change the eyepiece lens is 10X magnification. It is clearly shown that the penetrations base metal and porosities in welded zone.



(a) Sample fixed in a Bakelite solution (b) Sample examined by microscope

Fig.13: Welded macro etched sample for testing

From the Fig.12 macro structural observation was revealed that the,

1. The macro etched sample examined visually and followed by stereo microscope under 10X magnification and it reveals that the complete fusion and weld defected area. Porosity was observed in base metal zone.

2. It absorbed that the removal of oxides and other impurities from the weld interface, including from the inner region.

V. CONCLUSION

In this present work, tensile test, wear and micro and macro scope analysis test were conducted on the base metal samples and weld metal samples of LM25 aluminium alloy. Based on the present experimental work the following conclusions can be drawn:

- From the engineering stress- engineering strain curve, the absolute deviation of the tensile strength, yield strength and the percentage of elongation is 4.5MPa, 7.8MPa and 3.6%.
- From the wear test, the percentage of mass loss is less for welding material when compared with the base metal.
- From the micro and macro scope analysis, grain formation, porosity and weld quality were observed behind the welded area.
- From the experimental observations, it state that the TIG welding process, a method to do rectify the casting defects. Because, negligible change had in welded metal properties compare with the base metal properties.

From this investigation, it should be suggested that the there is no changes occurs in mechanical properties like tensile strength and wear and micro – macro scope analysis of base metal and weld metal as same. This paper suggested to, the TIG welding process is a best method to rectify the casting defects as compared with other welding processes.

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