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Experimental Analysis of Composite material Specimen

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Abstract

Composite material are one of the most important material on which extensive research is going on. Cast aluminium alloy is widely used in automotive and aircraft industries because of their excellent properties like high strength to weight ratio, low density, high corrosion rates etc. Aluminium alloy leads to a need for deeper understanding of their mechanical properties and the impacts of combining different light metal alloys within one component without additional joining Processes provide the possibility to implement specific properties at the points needed. Depending on the desired product, specific material combinations can be used. Ms-Al, Ms-Cu-Al- and Al based compounds can contribute to lightweight designs to create an optimum of adapted strength and low density. In this work focus is made on the analysis of two different specimen collected from industry in Ghaziabad, these casted aluminium specimen are of different shapes and geometry. These samples have tested to check the mechanical properties like tensile strength, elongation, reduction area and yield strength the analysis also presents the comparative results of the different specimens. A sound metallic bonding between both aluminium alloys develops due to diffusion and reaction zones. Mechanical tests confirm a sound metallic bonding. Depending on the integrated alloy, enhanced mechanical properties of the compound structure can be achieved. The observations will be beneficial for designer to select the best material with a specified geometry.

Keywords: : Mild steel, ultimate strength, microstructure, impact strength, hardness

1. Introduction

Composite material is widely used in automotive and aircraft industries because of their excellent properties like high strength to weight ratio, low density, high corrosion rates etc. This increased use of aluminium alloy leads to a need for deeper understanding of their mechanical properties and the impacts of processing factors. The mechanical properties can determine by controlling the microstructures of the alloys. For designing any part we should have a thorough understanding of solidifications at different cross sections of the cast part and its influence on the mechanical properties. Most applications of composite material dependent on mechanical properties, so the performance of this alloy has been the subject of many micro-mechanical investigations. Mechanical properties were improved with grain refinement. Since the mechanical properties are mainly dependent on their microstructure, a lot of efforts have been done for refining microstructure of casting to improve the mechanical properties of mild steel with aluminium. Refinement can achieve by using power ultrasound and electromagnetic stirring and equal channel angular pressing, or accumulative roll bonding. As-cast composite material are made up of coarse primary α-Ms-Al-Co dendrites and acicular-shaped eutectic silicon, which lowers the mechanical properties and limits its industry application. Heat treatment and aging are important to homogenize α- Ms- Al-Co dendrites in composite material so we can achieve better mechanical properties. Cooling rate of mould is measured by introducing a thermocouple inside the mould. Heat treatment and aging processes are the most important processes determining casting microstructure and mechanical properties. As-cast alloys are made up of coarse primary α-Ms-Al dendrites and acicular-shaped eutectic silicon, which lowers the mechanical properties and limits its industry application. The mechanical properties can determine by controlling the microstructures of the alloys. Heat treatment and aging are important processes to homogenize α-Ms-Al-Cu dendrites in aluminium alloys. In this work focus is made on the analysis of two different specimen collected from industry in Faridabad, these casted aluminium specimen are of different shapes and geometry these samples were tested to check the mechanical properties like tensile strength, elongation and yield strength the analysis also presents the comparative results of the different specimens. A sound metallic bonding between both alloys develops due to diffusion and reaction zones. Mechanical tests confirm a sound metallic bonding.

2. Methodology

The analysis consists of two different specimen of casted mild steel with aluminium28 mm, 30 mm, diameters (section sizes) which are casted in different shapes namely Casted rod mild steel with aluminium and Casted rod mild steel, copper with aluminium respectively as shown in Fig.1 and Fig.2 . Aluminium alloy is melted using muffle furnace and poured to the moulds. Thermocouple tip is placed 1mm apart from mould cavity in order to avoid damage of contact tip and temperature is monitored till there is a decrease in temperature after an initial increment. Temperature is measured using a K type thermocouple. Temperature-Time graph were plotted for all experiments and cooling rate for each sections were measured. Cast specimens were heat treated to ASTM standard B917-01 at a temperature of 1550°C for 12 hours and followed by anaging of 5 hours.

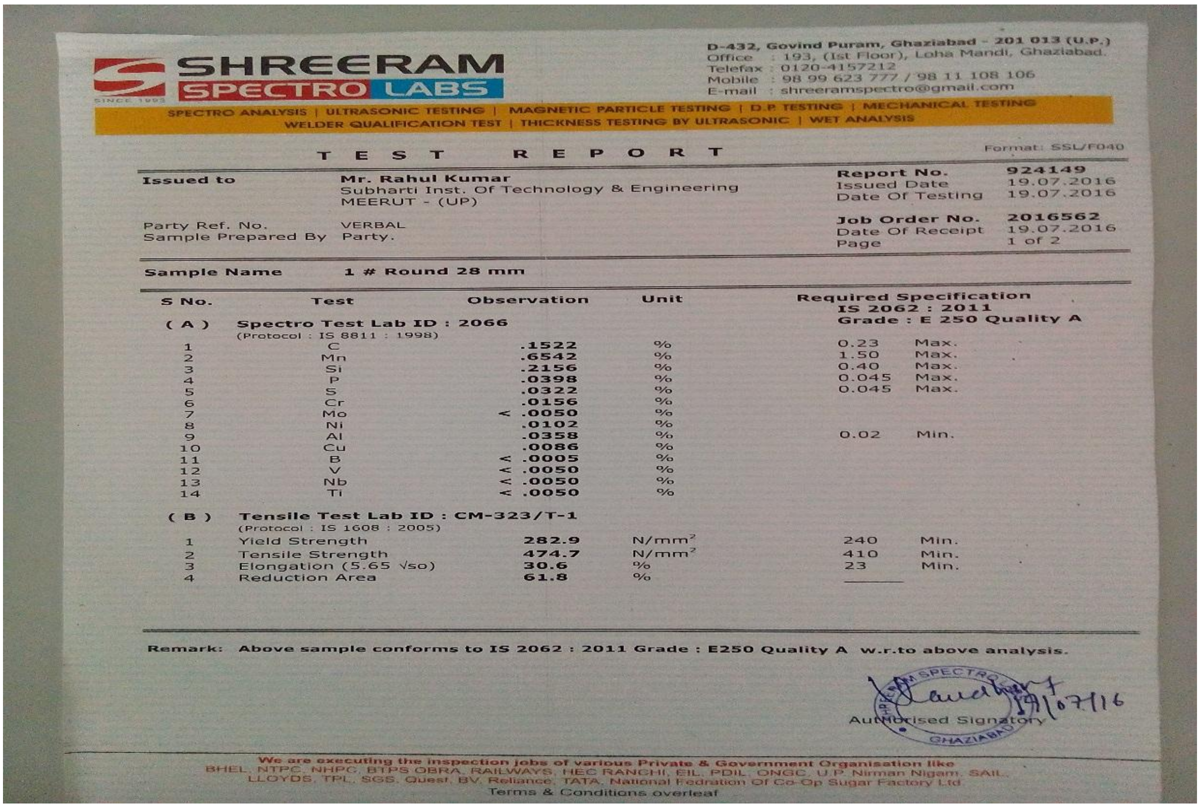
Fig.1 Casted Mild steel with Aluminium

Fig 2 – Casted mild steel with Copper and Aluminium

3. Testing Criteria

In order to investigate the effect of heat treatment and aging process on microstructure and mechanical properties, impact strength, hardness and tensile strength were measured for as-cast condition, heat treated and aged condition. Specimens were prepared for microstructure analysis by polishing on disc polisher followed etching with diluted hydrofluoric acid. Microstructure analysis was performed by an inverted metallurgical microscope and the microstructures were compared. Average grain size is measured using Metal Vision software. Cast specimens were machined to ASTM standard E23-12C, 10 mm*10 mm*75 mm for Izod test and 10 mm*10 mm*55 mm for Charpy test. Using an impact testing machine model IT30 both impact tests Izod test and Charpy test were performed for as cast condition and heat treated and aged condition. Cast specimens were machined to ASTM standard E8M with a gauge length of 45mm and gauge diameter of 9mm for tensile test. Tensile test were performed on universal tensile testing equipment and ultimate tensile stress value for as-cast condition and after heat treated and aged condition were compared. Hardness test were performed with Vickers hardness tester by applying a load of 100kgf for 20 second both as cast condition and after heat treated condition. All tests were repeated 5 times in both as-cast and aged and heat treated condition. We have tested the above mentioned two specimen at SRI RAM SPECTRO LABS, GHAZIABAD and the concerned reports are attached herewith for related discussions and calculations. These reports are being used to analyse and synthesized the various related parameters of the concerned specimens.

Report 1



SHREERAM SPECTRO LABS

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SPECTRO ANALYSIS | ULTRASONIC TESTING | MAGNETIC PARTICLE TESTING | D.P. TESTING | MECHANICAL TESTING
WELDER QUALIFICATION TEST | THICKNESS TESTING BY ULTRASONIC | WET ANALYSIS

Format: SSL/F040

T E S T R E P O R T

Issued to: Mr. Rahul Kumar, Subharti Inst. Of Technology & Engineering, MEERUT - (UP)
Party Ref. No.: VERBAL
Sample Prepared By: Party.

Report No.: 924149
Issued Date: 19.07.2016
Date Of Testing: 19.07.2016
Job Order No.: 2016562
Date Of Receipt: 19.07.2016
Page: 1 of 2

Sample Name: 1 # Round 28 mm

S No.	Test	Observation	Unit	Required Specification IS 2062 : 2011 Grade : E 250 Quality A	
(A)	Spectro Test Lab ID : 2066 (Protocol : IS 8811 : 1998)				
1	C	.1522	%	0.23	Max.
2	Mn	.6542	%	1.50	Max.
3	Si	.2156	%	0.40	Max.
4	P	.0398	%	0.045	Max.
5	S	.0322	%	0.045	Max.
6	Cr	.0156	%		
7	Mo	< .0050	%		
8	Ni	.0102	%		
9	Al	.0358	%	0.02	Min.
10	Cu	.0086	%		
11	B	< .0005	%		
12	V	< .0050	%		
13	Nb	< .0050	%		
14	Ti	< .0050	%		
(B)	Tensile Test Lab ID : CM-323/T-1 (Protocol : IS 1608 : 2005)				
1	Yield Strength	282.9	N/mm^2	240	Min.
2	Tensile Strength	474.7	N/mm^2	410	Min.
3	Elongation (5.65 √so)	30.6	%	23	Min.
4	Reduction Area	61.8	%		

Remark: Above sample conforms to IS 2062 : 2011 Grade : E250 Quality A w.r.to above analysis.

Authorised Signatory

We are executing the inspection jobs of various Private & Government Organisation like
BHEL, NTPC, NHPC, BTPS OBRA, RAILWAYS, HEC RANCHI, EIL, PDIL, ONGC, U.P. Nirman Nigam, SAIL,
LLOYDS, TPL, SGS, Quest, BV, Reliance, TATA, National Fedration Of Co-Op Sugar Factory Ltd.
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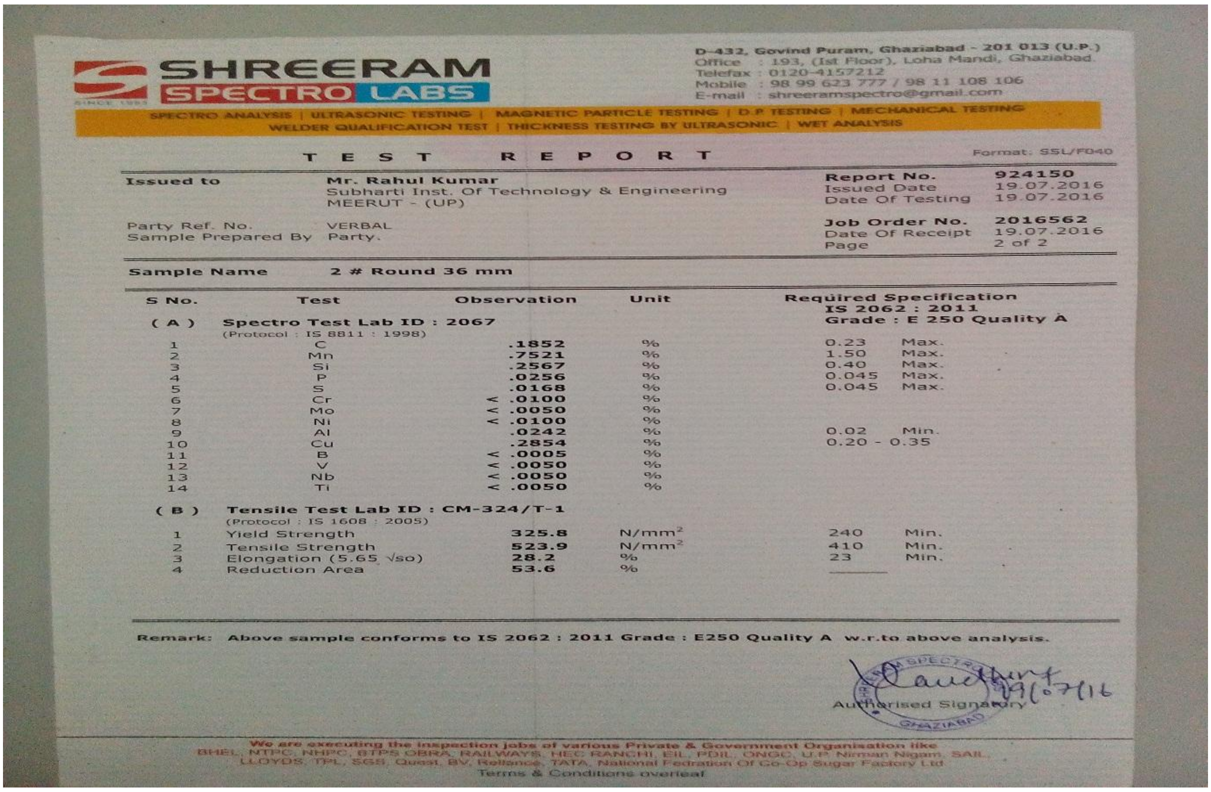
Report 2



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WELDER QUALIFICATION TEST | THICKNESS TESTING BY ULTRASONIC | WET ANALYSIS

Format: SSL/F040

T E S T R E P O R T

Issued to: Mr. Rahul Kumar, Subharti Inst. Of Technology & Engineering, MEERUT - (UP)
Party Ref. No.: VERBAL
Sample Prepared By: Party.

Report No.: 924150
Issued Date: 19.07.2016
Date Of Testing: 19.07.2016
Job Order No.: 2016562
Date Of Receipt: 19.07.2016
Page: 2 of 2

Sample Name: 2 # Round 36 mm

S No.	Test	Observation	Unit	Required Specification IS 2062 : 2011 Grade : E 250 Quality A	
(A)	Spectro Test Lab ID : 2067 (Protocol : IS 8811 : 1998)				
1	C	.1852	%	0.23	Max.
2	Mn	.7521	%	1.50	Max.
3	Si	.2567	%	0.40	Max.
4	P	.0256	%	0.045	Max.
5	S	.0168	%	0.045	Max.
6	Cr	< .0100	%		
7	Mo	< .0050	%		
8	Ni	< .0100	%		
9	Al	.0242	%	0.02	Min.
10	Cu	.2854	%	0.20 - 0.35	
11	B	< .0005	%		
12	V	< .0050	%		
13	Nb	< .0050	%		
14	Ti	< .0050	%		
(B)	Tensile Test Lab ID : CM-324/T-1 (Protocol : IS 1608 : 2005)				
1	Yield Strength	325.8	N/mm^2	240	Min.
2	Tensile Strength	523.9	N/mm^2	410	Min.
3	Elongation (5.65 √so)	28.2	%	23	Min.
4	Reduction Area	53.6	%		

Remark: Above sample conforms to IS 2062 : 2011 Grade : E250 Quality A w.r.to above analysis.

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LLOYDS, TPL, SGS, Quest, BV, Reliance, TATA, National Fedration Of Co-Op Sugar Factory Ltd.
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4. Results & Discussion

Cast specimens were machined to ASTM standard E23-12C, 10 mm*10 mm*75 mm for Izod test and 10 mm*10 mm*55 mm for Charpy test. Using an impact testing machine model IT30 both impact tests Izod test and Charpy test were performed. Table 1 shows the complete details of the testing results.

S. No.	**Properties**	**Method**	**Casted rod with M.S and aluminium**	**Casted rod M.S CU And aluminium**
1	Tensile strength	IS:2062-2011	474.7N/mm^2	523.9N/mm^2
2	Elongation	IS:2062-2011	30.6%	28.2%
3	Yield Strength	IS:2062-2011	282.9N/mm^2	325.8N/mm^2
4	Reduction area	IS:2062-2011	61.8%	53.6%

Table-1 Detailed test report of Different Specimen

Based on the different tests the results obtained are categorized into three different parameters.

4.1 Tensile Strength

Following calculations can be made:

Before testing

$D_{1=}$ 10.06mm, C.A= 79.52mm^2, gauge length= 50.00mm, yield load= 22.50KN, UL= 37.75KN, elongation gauge length= 65.3, mm

After testing

$D_{2=}$ 6.8mm, C.A= 49.98mm^2, gauge length= 50.00mm, yield load= 25.50KN, UL= 41.0KN, elongation gauge length= 64.1, mm

% of Tensile Strength = UL/C.A*1000

Where UL- ultimate load, C.A- cross sectional area

Casted mild steel with aluminum

Tensile Strength = UL/C.A*1000 = 37.75/79.52*1000= **474.7N/mm^2**

Casted mild steel with copper and aluminum

Tensile Strength = UL/C.A*1000

= 41.0/78.26*1000= **523.9N/mm^2**

The computed values are shown in Fig 4 respectively,

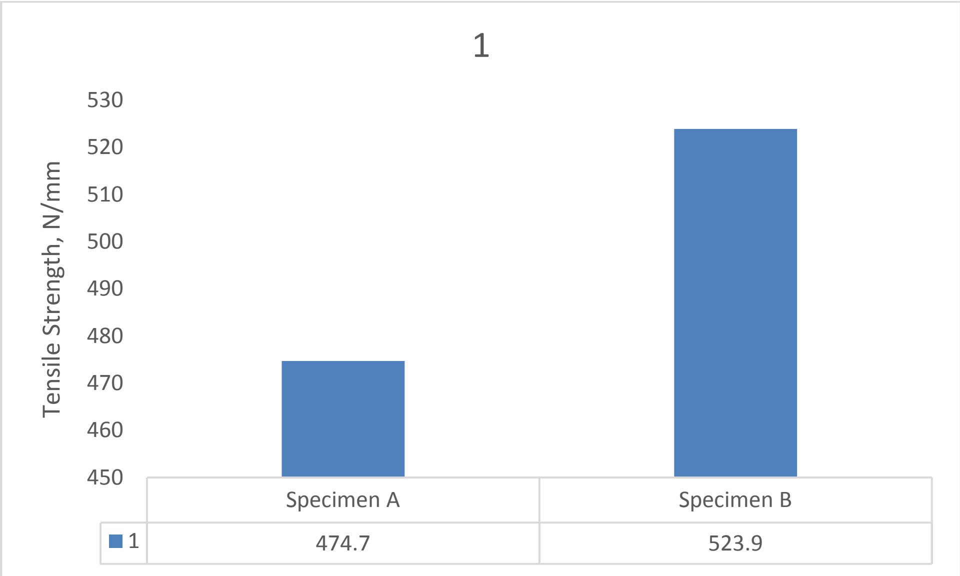

Fig 4 Variation of Tensile strength as a function of two specimens

4.2 Yield Strength

Following calculations can be made:

Before testing both Ms with Al and Ms with Co and Al

$D_{1=}$ 10.06mm, C.A= 79.52mm^2, C.A= 78.26 gauge length= 50.00mm, yield load= 22.50KN, UL= 37.75KN, elongation gauge length= 65.3, mm

After testing both Ms with Al and Ms with Co and Al

$D_{2=}$ 6.22mm, C.A= 36.32mm^2, C.A= 6.8 gauge length= 50.00mm, yield load= 25.50KN, UL= 41.0KN, elongation gauge length= 64.1, mm

Yield Strength= yield load/C.A*1000

Where C.A- cross sectional area

Casted mild steel with aluminum

Yield Strength yield load/C.A*1000 = 22.50/79.52*1000= **282.9N/mm^2**

Casted mild steel with copper and aluminum

Yield Strength = yield load/C.A*1000

= 25.50/78.26*1000= **325.8N/mm^2**

The final computed results are shown in Fig 5 respectively.

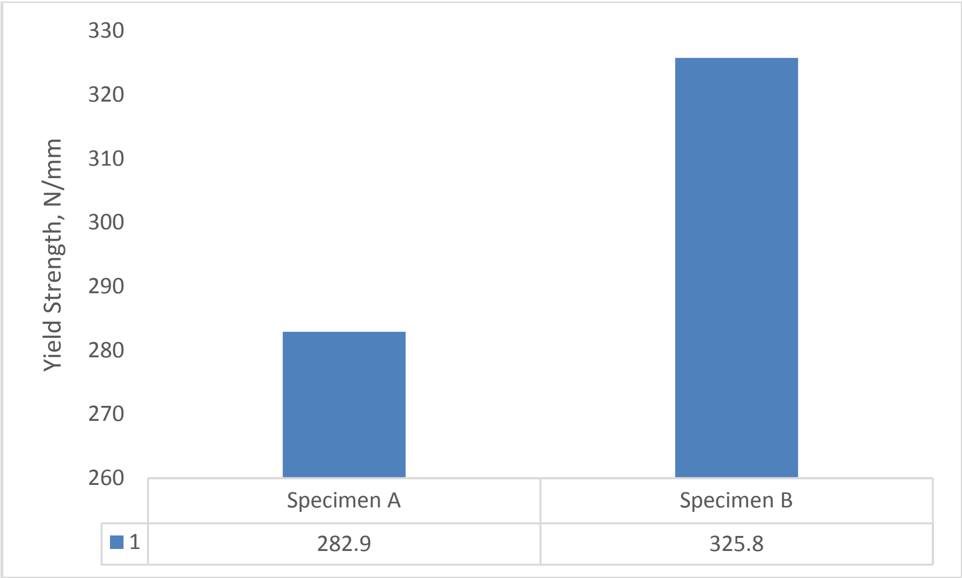

Fig-5 Variation of compressive strength as a function of different specimen

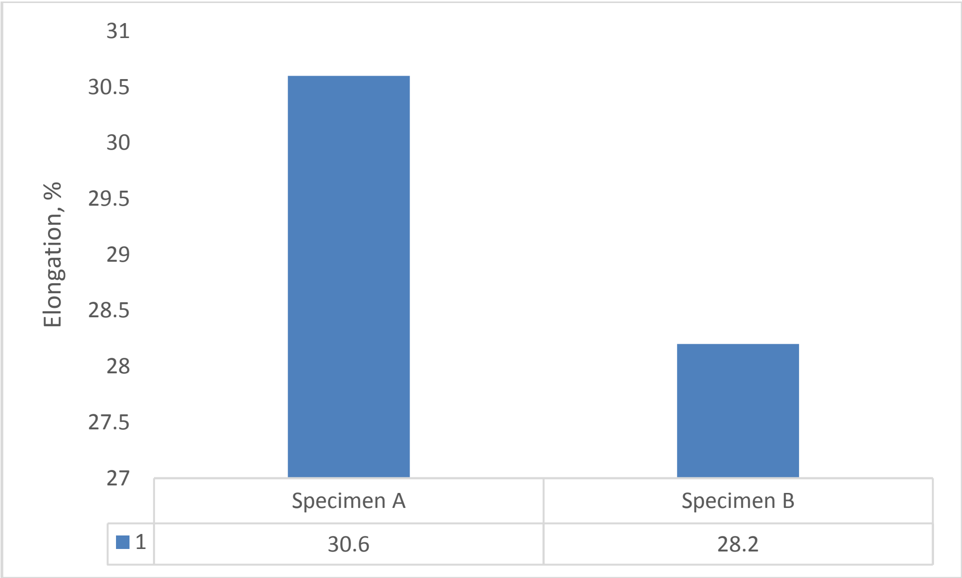

Fig-6 Variation of % Elongation as a function of different specimen

4.3 % Elongation

Following calculations can be made:

% of elongation (References values – obtain value / reference value) x 100

% of elongation = [(l_c– l_a)/l_c] x 100

Where l_c – final gauge length

L_a – Initial gauge length

Casted mild steel with aluminum

% of elongation = $[(l_c - l_a)/l_c] \times 100$

(65.3-50 / 50) x 100 = **30.6 %**

Casted mild steel with copper and aluminum

% of elongation = $[(l_c - l_a)/l_c] \times 100$

(64.1-50/50) x 100 = **28.2 %**

The final obtained comparative results are shown in Fig-6 respectively.

4.4 Reduction Area % of 02 specimen

% of Reduction area= (References values – obtain value / reference value)x 100

% of Reduction area = $[(a_c - a_a)/l_c] \times 100$

Where a_c – final cross sectional area

a_a – Initial cross sectional area

Casted mild steel with aluminum

Reduction area = $[(a_c - a_a)/a_a] \times 100$

(79.52-30.40/79.52) x 100 = **61.8%**

Casted mild steel with copper and aluminum

Reduction area = $[(a_c - a_a)/a_a] \times 100$

(78.26-50/78.26) x 100 = **53.6%**

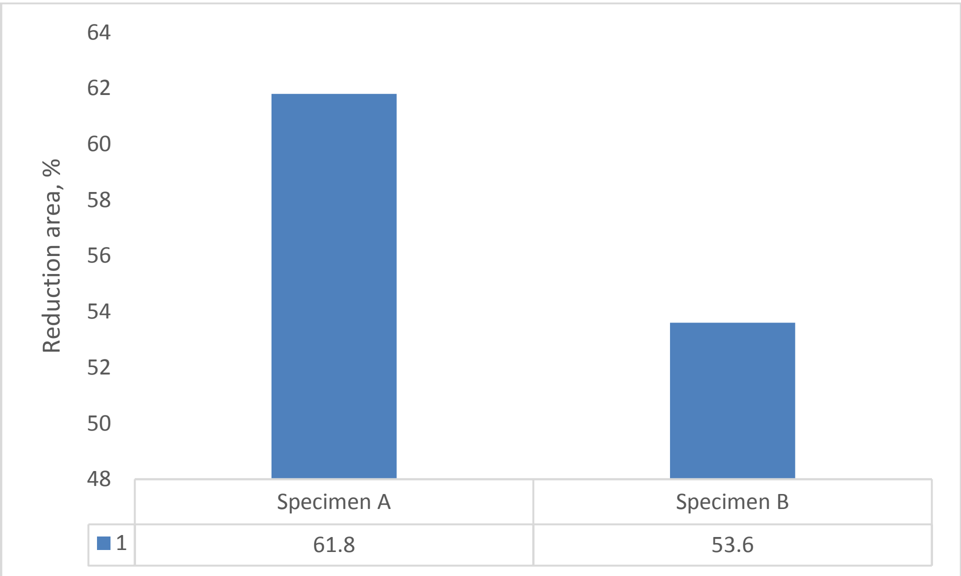

Fig 7 Variation of % Reduction area

5. Conclusions

These specimens were tested and the final reports obtained were compared with the standard reference values following observations were made.

Major conclusions achieved from the analysis are,

1. In all the test conditions for all the two specimen material properties plays an important role.
2. As all the two specimen were tested uniformly the four essential properties were analysed those are , Tensile strength , Elongation , Yield strength and Reduction area the standard values of these properties were referred and compared with the test results obtained.
3. Mild steel with Aluminium and copper is using to decrease the value of elongation and reduction in area then the Mild steel with Aluminium. However under some different requirements casted composite material may also be selected.

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