EVALUATION OF MECHANICAL PROPERTIES OF Al5052 REINFORCED WITH CHOPPED BASALT FIBER AND BORON CARBIDE.

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Abstract-Among the MMCs, Aluminum Matrix composites have extensive regards in automotive industries, air transportation and concealing applications. Substantially because of higher level and durable properties for example cut down in weight, lessen density, greater hardness, towering temperature of operation an. Metal matrix composites are formed by fusing of two to three materials of diverging properties. Ongoing experimentation deals with Al 5052 as matrix medium, Boron carbide (B_4C) and Short basalt fiber as reinforcing phase. Stir casting is used for manufacturing AMCs. Chopped Basalt fibers added 4% of total mass and particulate reinforcement as Boron carbide with amount as 2%,4%,6% and 8%.UTM brought in action for computing supreme strength in Tension and Compression also. Hardness values are commissioned by Brinell Hardness testing machine.Superlative Tensile, compressive and Hardness were portrayed by MMC with 4% of Basalt fiber, 6% of Boron carbide in Al5052 in both unprocessed and heat treated case.

Keywords- Short Basalt, Al5052,Boron carbide, Mechanical Properties, Ultimate Strength, Brinell hardness, Stir Casting Method.

I. INTRODUCTION

Composite materials are the class of materials that have prominent importance over the science fiefdom, engineering firmament and also sector of manufacturing in response to unparallel technological stipulations owing to meteoric boosting in space technology, aircraft, automotive, naval and sporting goods manufactories. They have NETHER relative density that enhances its characteristics, notably provides comparatively higher modulus and strength of numerous conventional materials of engineering alike metals. This new material comprises of enhanced output composites essentially reinforced composites. Constant progress in world of composite resulted in vast applications. The enhancement in mechanical properties of materials due to addition of reinforcing materials [1].

II. LITERATURESURVEY

Bharath gowda et. al [2] investigated the tribological and mechanical properties of Al 5052 with SiC by powdered Metallurgical technique. From the research it was found that ideal conditions for production are at 500ºC temperature with load compaction equal to 0.2MN and a time equal to 1hour 30minutes.Following results were obtained such as prime hardness is at percentage of reinforcement SiC equals to 5% but further escalation in addition of SiC decreases hardness where as compression of specimen shows that for 5% to 10% of Silicon carbide has nearly same strength but for 15% it declines, in case of two body wear test specimen with 15% emerges as best one.

The consequence additions of Silicon Carbide to Al 5052 on the supreme characters were studied by Ranganathan S et al [3]. A numbers for specimens were fabricated by stir casting as well as by fluctuating the percentage of weight of reinforcing medium such 2%,4% and 5%.Then samples are tested on UTM ,the one with towering value is the one with 4% of addition of carbide of silicon the former also provides peak hardness value. The examination of microstructure reveals that up to identical above composition shows beneficial dissolving of reinforcement particles in matrix but beyond this it is opposite. The impact strength is directly proportional to weight % of harder.

Further study by Syed Junaid Ali, Assistant Pofessor Babu Reddy and Ambadas [4] They have concentrated on examining the tensile properties Mg alloy AZ91 with chopped Basalt fibers. Stir Casting Technique was economical and flourished method for this combination of MMCs. By differing the percentage of rock fibers on weight basis from 2 to 10%.The upcoming results were elasticity modulus calculated from stress vs strain graph shows upward trend from lower to higher percentage of additive, the Ultimate Tensile Strength and maximum load also approaches the crest value at fraction of volume of fiber equal.

Gopal Krishna U B et al [5] - reviewed on the consequences of Boron carbide on composites with matrix as Aluminum alloy. AMCs gainful produced by Stir Casting. Reinforcing particles are dispersed equivalent through microstructure analysis. Vicker's hardness approaches to peak if 250 microns is size of particle but in terms of measure of weight it is for 12% with particles having size of 105µm.Same size also gives more resistance against tensile load but for 8%.

III. MATERIALS USED FOR MANUFACTURING METAL MATRIX COMPOSITE Al ALLOY 5052 ASMATRIX

Aluminum and its alloys have phenomenal application as consequence of one step ahead in terms of properties like lower density, higher strength per unit mass, better welding properties, good machining, good conductor of heat as well as electricity. They are employed whenever application is of lighter in weight and also good strength. for example, car panels, aircrafts parts, whether satellite and many more.

Table 1.1 Mechanical Properties of Al Alloy 5052.

Property	value
Ultimate Tensile Strength(UTS)	193 MPa
Compressive Yield Strength	89.6 MPa
Tensile Yield Strength	89.6 MPa
Elastic Modulus, Shear	25.9GPa
Elastic Modulus	70.3GPa
Liquidus Temperature	649°C
Brinell Hardness	47
Density	2.68 g/cc
Thermal Conductivity	138 W/k*m

BASALT FIBER AS REINFORCEMENT

Basalt fiber is also known as Rock Fiber. It is produced from rocks which are equipped with unique chemicals which are heated to a temperature of about 1550°C. This melt consist of compound of nearly 205 basic strands which are bound together with noteworthy liquid oil and it then extended across a gadget which is at the base of the furnace. Finally polymerization of it, which forms the Rock fibers.

Fig. 1 Chopped Basalt Fiber

Table 1.2 Basalt Fiber Mechanical properties [6]

Property	Value
Density	2.64 g/cc
Elastic Modulus	89 GPa
Tensile Strength	3200 MPa
Thermal Conductivity	0.031 W/m.k

BORON CARBIDE AS ANOTHER REINFORCEMENT

Boron carbide hard material whose hardness is ranked on third number as Diamond occupies first and Boron nitride as second. Because of its hardness it having military application such as vest that can resist bullets, shields of tank and in industries, in nozzles, cutters of jet of water.

Table 1.3 Mechanical Properties of Boron carbide

Property	Value
Density	2.52g/cm^3
Melting point	3036 K (2763°C)
Vickers Hardness	30GPa
Elasticity modulus	460GPa

IV. METHODOLOGY

The details of methodology are as follows

- Acquiring of raw materials.
- Casting of samples.
- Machining the specimens.
- Testing the specimens.

PROCUREMENT OF RAW MATERIALS

Aluminum alloy 5052 is selected as Matrix where as short Basalt fibers (length= 3millimeter) and Boron carbide powder (105μm) as Reinforcing phase are acquired. The five weight fractions are carried out in steps of 2 units from zero units.

CASTING THE SAMPLES

➢ Firstly Aluminum alloy 5052 chosen as Matrix material. Then Ingots of Al5052 are weighed as per calculations which is now placed Graphite crucible of furnace whose temperature is maintained above melting point nearly 750°C.Basalt and B_4C also preheated to 400°C.

➢ At this point heated Basalt fibers and Boron carbide powder are introduced into melt of matrix. Finally it is stirred for roughly 17min at 3000 rpm for through mixing of .Red hot liquid which is now poured into permanent Mild steel die of size

22mm diameter and 170mm length. Heat treated specimens are designated as H.

- It allow cool until it attains room temperature. Then it is removed from die .Specimens are ready for machining.

Fig. 2 Pouring Hot Mixture in Mould

Fig.3 Casted Specimens

MACHINING THE SPECIMENS

Once casting of Samples are completed then it is machined as ASTM E8 standard for tensile test and ASTM E10 for hardness test and compression test. On the Lathe machine cylindrical sample is machine by using Harder tool. The specification diagram is drawn in fig 4.

Table 1.4 Designations of Specimens

Sl. No	**Material compositions**	**Alloy Designation for Tensile, Compressive, Hardness respectively**	**Wt.% of Basalt fibers**	**Wt.% of B_4C**
1	Al5052 as cast	T1,C1,H1	0.0	0
2	Al5052+4% Basalt Fiber +2%B_4C	T2,C2,H2	4.0	2
3	Al5052+4% Basalt Fiber +4%B_4C	T3,C3,H3	4.0	4
4	Al5052+4% Basalt Fiber +6%B_4C	T4,C4,H4	4.0	6
5	Al5052+4% Basalt Fiber +8%B_4C	T5,C5,H5	4.0	8
6	Al5052 as cast (Heat treated-H)	TH1,CH1,HR-H1	0.0	0
7	Al5052+4% Basalt Fiber +2%B_4C (H)	TH2,CH2,HR-H2	4.0	2
8	Al5052+4% Basalt Fiber +4%B_4C (H)	TH3,CH3,HR-H3	4.0	4
9	Al5052+4% Basalt Fiber +6%B_4C (H)	TH4,CH4,HR-H4	4.0	6
10	Al5052+4% Basalt Fiber +8%B_4C (H)	TH5,CH5,HR-H5	4.0	8

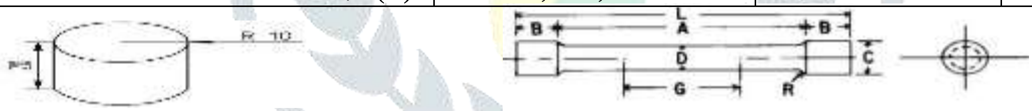

Fig. 4 ASTM E10 and ASTM E8 [7] Specimens respectively.

Table 1.5 ASTM E8 Dimensions [7]

Symbol	Dimension (mm)	Description
G	50 (+,-0.1)	Gage Length
D	12.5	Diameter
B	20	Length of End Section
A	100	Length of Reduced Section
R	002	Radius of Fillet
L	155	Overall Length
C	20	Diameter of End Section

TESTING THE SPECIMENS

HARDNESS TEST: This test is accomplished and completed if specimens both faces lie in planes such that they a angle equal zero then Brinell tester with diameter of 5mm and by applying 250kgs of load for time duration of 1/6 of a minute. Three indentations were made then and each of them is noticed under optical lens for procuring diameter of indent, average of that values hardness of that trial.

Fig.5 Before hardness Testing

Fig.6 During Testing

Fig.7 After hardness Testing

TENSILE TEST*:* Considerably extreme portion lengths must be higher than the actual one because this will provide better grip whenever UTM applies load on it. Firstly load is equated to zero then clamp the specimen in the machine, start to put in load from zero that intensify in a steadily manner. The axial pull up to which it can oppose is the Yield stress where as the maximum load that it can bear is Ultimate tensile strength, Finally it fails. Results displayed includes UTS, Percentage elongation and Load vs displacement graph.

Fig.8 Before Tensile Testing

Fig.9 During Testing

Fig.10 After Tensile Testing

COMPRESSIVE TEST: ASTM E10 specimen is necessitate for testing which is similar to those of Hardness ones. On utm Load are induced in opposite direction along axis of specimen which makes reduction in its height but increment in cross sectional area. The peak at which specimen fails per unit cross sectional area is compressive strength.

Fig.11 Before Compressive Testing

Fig.12 After Compressive Testing.

V. RESULTS ANDDISCUSSION

HARDNESS TEST RESULTS:

Table 1.6 Hardness of Al5052/Basalt/B_4C untreated and treated:

Sl No	Alloy/Composites	Hardness	
		Untreated	Treated
1	Al5052(100%)	50.07	52.8
2	Al5052+ Basalt 4%+B_4C 2%	45.83	44.43
3	Al5052+ Basalt 4%+B_4C 4%	46.01	51.20
4	Al5052+ Basalt 4%+B_4C 6%	54.80	57.17
5	Al5052+ Basalt 4%+B_4C 8%	45.43	48.17

An increment of 5.45% in value of BHN from H1 to HR-H1 but in between H2 and HR-H2, H2 value specimen is slightly higher. Similarly contrast between H3,H4,H5 and HR-H3,HR-H4,HR-H5 yields enhancements of 11.20%,4.32% and 6.03% in respectively values. Heat treated specimens slightly more hardness than unprocessed ones.

TENSILE TEST RESULTS:

Table 1.7 UTS of Al5052/Basalt/B_4C untreated and treated.

Sl No	Alloy/Composites	UTS(N/mm^2)	
		Untreated	Treated
1	Al5052(100%)	141.775	135.263
2	Al5052+ Basalt 4%+B_4C 2%	113.605	105.221
3	Al5052+ Basalt 4%+B_4C 4%	135.697	163.873
4	Al5052+ Basalt 4%+B_4C 6%	155.850	147.327
5	Al5052+ Basalt 4%+B_4C 8%	129.827	122.103

Form unprocessed to processed trial in the sequence of listing the variability in percentage of UTS are as -4.5%,+8.05%,+20.76%,-5.46% and -5.94%.This bent indicates that only TH3 sample >T3 sample but all other unrefined samples are superior than refined ones.

RESULTS OF COMPRESSION TEST: Table 1.8 Compressive load of Al5052/Basalt/B_4C untreated and treated.

Sl .No	Alloy/Composites	Compressive load(KN)	
		Untreated	Treated
1	Al5052(100%)	206.7	217.60
2	Al5052+ Basalt 4%+B_4C 2%	237.16	220.66
3	Al5052+ Basalt 4%+B_4C 4%	249.64	231.60
4	Al5052+ Basalt 4%+B_4C 6%	245.64	357.96
5	Al5052+ Basalt 4%+B_4C 8%	220.700	225.660

Refined samples shows raises their value with respective specimen of same constituent. Pinnacle value is attained for CH4 sample(Al5052+ Basalt 4%+B_4C 6%) that is 358 KN and 100% Al5052 with 218KN as downtick.Whenever Compressive load of processed and unprocessed specimens juxtaposition, then C1 to C1H depicts +5.27% enlargement, similarly -

6.96%,7.26%,+45.72% and +2.25% are the mutations in strength respectively.

Graphs of Results:

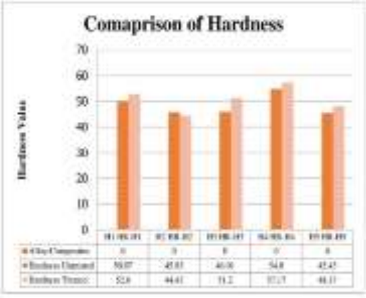

Fig.13 Comparison of Hardness

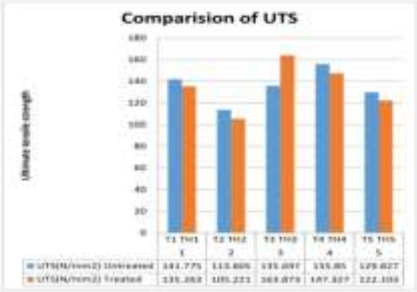

Fig.14 Comparison of UTS

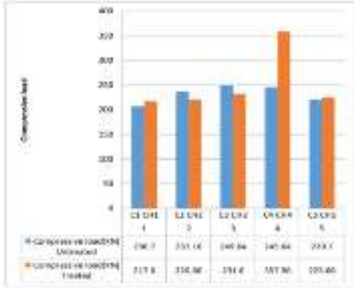
Fig.15 Comparison of compressive load.

VI. CONCLUSIONS

The prime focus of this thesis toil is to have insight of the consequences of mechanical properties Aluminum Alloy reinforced with different weight fractions of 2%, 4%, 6% and 8% of Boron carbide powder and also unchanging 4% weight fraction of short Basalt fibers. As per ASTM methodology mechanical tests conducted on it. This leads conclusion such as.

- Stir casting process is economical and successful method for manufacturing this composite.
- Boron carbide proportions have commutative pay off mechanical properties.
- Upper most value of Extension before failure is at 6% of B_4C.
- Hardness and Ultimate tensile strength upsurges when 6% of B_4C and 4% of Basalt fibers added to Al5052,but for compressive strength it is 4% B_4C with 4% of Basalt with alloy. Heat treated specimens have better compressive and hardness properties than untreated.

FUTURE SCOPE

- Other than the mechanical properties, Tribological properties can be investigated on this composite.
- Use methods for fabricating MMC other than Stir casting then weigh up with this one.
- Study the characteristics by using other length and diameter of Basalt.
- Use other carbides instead of Boron carbide and compute outcomes.
- Investigate the properties by keeping weight % of B_4C constant and alter proportion of fibers.

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