Study of Mechanical Properties of Glass Fiber and Flyash Particulate Reinforced Al 2219 Hybrid Composites

Ramakrishnaiah,
M.E.Student, Department of Mechanical Engineering, UVCE
Bangalore-560 001

Md Atiqur Rahman,
Department of Mechanical Engineering, BTLITM, Bangalore

Dr. H. K. Shivanand,
Associate Professor,Department of Mechanical Engineering, UVCE,
Bangalore-560 001

***ABSTRACT*- Composite material is a material composed of two or more distinct phases (matrix phase and reinforcing phase) and having bulk properties significantly different from those of any of the constituents. Many of common materials (metals, alloys, doped ceramics and polymers mixed with additives) also have a small amount of dispersed phases in their structures, however they are not considered as composite materials since their properties are similar to those of their base constituents (physical property of steel are similar to those of pure iron). Favorable properties of composites materials are high stiffness and high strength, low density, high temperature stability, high electrical and thermal conductivity, adjustable coefficient of thermal expansion, corrosion resistance, improved wear resistance etc**

THE PRESENT PAPER DEALS WITH-

- **To produce Hybrid Composite by heating Al 2219 in electrical resistance furnace at a temperature of 700^0 C.**
- **E Glass fiber & Fly ash will be added to the molten metal with varying weight fractions i.e., Al 2219 and stirred well. Then the resulting mixture will poured into the mould to get hybrid composite casting.**
- **The obtained Castings will be machined in order to get the specimens of required dimensions as per the ASTM Standards.**
- **To study various Mechanical properties like tension, compression & hardness.**
- **The results of various weight fractions will compare to select the material of best mechanical properties.**

***KEYWORDS*-Composite material, Hybrid Composite ,E Glass fiber & Fly ash ,Castings , ASTM Standards Mechanical properties**

INTRODUCTION

Conventional monolithic materials have limitations in achieving good combination of strength, stiffness, toughness and density. To overcome these shortcomings and to meet the ever increasing demand of modern day technology, composites are most promising materials of recent interest. Metal matrix composites (MMCs) possess significantly improved properties including high specific strength; specific modulus, damping capacity and good wear resistance compared to unreinforced alloys. There has been an increasing interest in composites containing low density and low cost reinforcements. Among various discontinuous dispersoids used, fly ash is one of the most inexpensive and low density reinforcement available in large quantities as solid waste by-product during combustion of coal in thermal power plants. Hence, composites with fly ash as reinforcement are likely to over come the cost barrier for wide spread applications in automotive and small engine applications. It is therefore expected that the incorporation of fly ash particles in aluminium alloy will promote yet another use of this low-cost waste by-product and, at the same time, has the potential for conserving energy intensive aluminium and thereby, reducing the cost of aluminium products.Now a days the particulate reinforced aluminium matrix composite are gaining importance because of their low cost with advantages like isotropic properties and the possibility of secondary processing facilitating fabrication of secondary components. Cast aluminium matrix particle reinforced composites have higher specific strength, specific modulus and good wear resistance as compared to unreinforced alloys .While investigating the opportunity of using fly-ash as reinforcing element in the aluminium melt, R.Q.Guo and P.K.Rohatagi observed that the high electrical resistivity, low thermal conductivity and low density of fly-ash may be helpful for making a light weight insulating composites. The particulate composite can be prepared by injecting the reinforcing particles into liquid matrix through liquid metallurgy route by casting. Casting route is preferred as it is less expensive and amenable to mass production. Among the entire liquid state production routes, stir casting is the simplest and cheapest one. The only problem associated with this process is the non uniform distribution of the particulate due to poor wet ability and gravity regulated segregation

LITERATURE SURVEY

2.1Aluminium Matrix Composite's (AMC)

Aluminium based metal matrix composites are well known for their high specific strength, stiffness & hardness. Al-alloy composites are extensively used in practice due to ease of fabricated, easy availability with high strength to weight ratio. Aluminum composites are materials in which reinforcement, typically a ceramic-based material, is added with the purpose of improving the material's properties. Of the variety of ceramic materials that can be used as reinforcements, silicon carbide (SiC) and aluminum oxide (Al_2O_3) are the two that have seen the greatest use as a result of their favorable combination of density, price, and property improvement potential. Reinforcements also come in a variety of forms: continuous fibers, whiskers, and particulates. When these reinforcements are combined with an aluminum matrix, the resulting material has significant increases in elastic modulus (stiffness), wear resistance, and, in some cases, strength and fatigue resistance. In addition, the coefficient of thermal expansion of aluminum is reduced by the addition of the reinforcement, while the material retains the high thermal conductivity and low density inherent in the aluminum alloy. These types of property changes, not generally possible through conventional alloying methods, have been the source of the excitement about aluminum composites.The main reason why aluminium composites are profitable in aerospace compared to conventional materials such as Aluminium and steel, is that fuel can be saved due to its light weight. When looking at propellers and compressed blades, in addition to weight, the creep properties, high elastic modulus and high strength are important. The improved properties compared to common aluminium alloys can be achieved by choosing the orientation of continuous fibers in radial direction of the component. A different formulation of boron/Aluminium is used in jet engine fan blades. Aluminium alloys reinforced with continuous graphite has good height temperature capability, which makes them interesting for tactical missile skin, stiffness and launch tubes.

2.3 Previous investigations in aluminium 2219 alloy composite

- **Fretting behavior of glass-fiber reinforced polypropylene composite against 2219 Al alloy**

Composite materials, mainly fibre type ones, are used to respond to crucial demands in engineering applications. Various limitations mean that it is usually impossible to produce structures without mechanical joints. Fretting is an important failure mode for such joints, especially for dynamic loads. This paper sets out to assess the influence of this failure mode—fretting—in association with the effect of displacement, surface treatment with aluminium (anodisation) and the effect of environment, temperature and relative humidity. A series of experiments was carried out, changing each of the variables. To analyse the influence of each parameter, tangential force and displacement were used to establish the fretting cycles for every condition tested. Variations in the shape of the cycles revealed three regimes typical of fretting; stick, slip and partial slip, but the most effective way to characterize the transition between regimes was based on energy dissipation by friction. Surface treatment by anodisation leads to lower wear values, for small amplitude displacements, while for higher displacement amplitudes the wear volume was larger, for the case of room temperature and humidity. Increased temperature resulted in a rise in wear volumes, especially for non-anodised aluminium. Variation in humidity did not greatly influence the behaviour of the specimens studied.

- **Damage tolerance assessment by bend and shear tests of two Multilayer composites: Glass fiber reinforced metal laminate and aluminium roll-bonded laminate**

The damage tolerance of an aluminium roll-bonded laminate (ALH19) and a glass fibre reinforced laminate (GLARE) (both based on Al 2219-T3) has been studied. The composite laminates have been tested under 3-point bend and shear tests on the interfaces to analyze their fracture behaviour. During the bend tests different fracture mechanisms were activated for both laminates, which depend on the constituent materials and their interfaces. The high intrinsic toughness of the pure Al 1050 layers present in the aluminium roll-bonded laminate (ALH19), together with extrinsic toughening mechanisms such as crack bridging and interface delamination were responsible for the enhanced toughness of this composite laminate. On the other hand, crack deflection by debonding between the glass fibres and the plastic resin in GLARE was the main extrinsic toughening mechanism present in this composite laminate

From a study of previous work, it appears that very few investigations have been carried out on aluminium alloy-fly ash-glass fiber composites. Further, no investigation appears to have been made to study the effect of adding E-glass fiber to aluminium alloy on mechanical properties. Therefore experiments were planned to study the effects of varying percentages of E-glass fiber and fly ash on the mechanical properties and surface finish of aluminium alloy.

It is hoped from these experiments that one can get a picture of the effect of varying volume of E-glass fiber, Fly ash on the mechanical properties and surface finish of aluminium- fly ash- E-glass fiber composite

Cui Y Geng [1] investigated that, an aluminium matrix composite was successfully obtained using the self propagating high temperature SiC particulates as reinforcement material. The composite was found to be superior in mechanical performances to those of the composite reinforce with the conventional abrasive grade Sic particulates. High interfacial bond strength was observed between siC and aluminium matrix. The interfacial bond strength was attributed the effective mechanical keying role and the atom match bonding with an crystallographic orientation relationship.

Shyong J.H et al [2] reported, the deformation characteristics of aluminium alloy 6061 reinforced wuth particulate SiC particulate 3, 10 and 30 micro meter size by varying the SiC vol percentage(0.5, 10 and 20 %) using experimental numerical methods. They measured tensile strength and stiffness of the composite subjecting the matrix to dispersoid content. They observed that the tensile strength and stiffness of the composites were found to increase with the increasing particle content (volume fraction) for heat treatment provided that it was over a limiting value. The highest tensile strength, but the NA specimens had the greatest elongation to failure and largest ratio of tension to yield strength. Good arrangement was observed between experimental results and predictions of mechanical properties.

Choon Weng wong, Manoj, Lilu[3], studied aluminium based metallic matrices having varying weight fractions of copper(1 wt% Cu and 4.5 wt% Cu) were reinforced with SiC particulates using a partial liquid phase casting casting technique. The results of their investigation showed smaller sized and higher weight percent of copper in the matrix.

Davies C.H.J[4] mentioned, the optimized age hardening treatments are vital if aluminuium based particle reinforced metal matrix composites (PR-MMCs) are to zcieve widespread use as an engineering material . For some PRMMCs ageing may not be optimized and suggests why this is the case. Composites of a 7xxx- series aluminium alloy containing a number of volume fractions of Sic were investigated.

Gomes E.G. and Rossi[5] investigated heat treatment of 7475 Aluminium alloy, specimens are heated in a solution at 520 deg for two hours was ineffective for homogenizing the matrix microstructure. At higher solution temperature 570 deg for 2 hours most of precipitates dissolved. The peak hardness was achieved only after ageing at 150deg for ten hours. These observations indicated that the composite precipitation kinetics was slower. The tensile specimens rupture occurred mainly through the A1/SiC interface.

Scolians [6] produced SiC/p-reinforced Al-4.5%, Cu-1.5% Mg composites and which were processed by vigorous stirring of the carbide in a semi –solid alloy slurry followed by remelting and casting (stir casting). The tensile and fatigue characteristics were evaluated in the as-cast and heat treated conditions. They reported yield strength and ultimate tensile strength and the elastic modulus of the composite, increased for heat treated and followed the same trend with the increase of volume fraction of carbide. However ductility was found to decrease.

Metal matrix composites (MMC) comprising powder aluminium alloys reinforced by particulate ceramic were developed by shakesheff A.J. [7] for widespread aerospace structural applications ranging from fuselage and missile components to undercarriage parts. These MMCs posses high levels of specific stiffness with high specific strength but can exhibit ductility and toughness than conventional un-reinforced aluminium alloy. Al-Cu-Mg MMCs gave higher strength and modulli than unreinforced sheet. They reported lowering the copper magnesium content resulted in reduced strength but did not affect the rate of age hardening. The Al-Cu MMCs showed the lowest strength but the absence of natural ageing may prove advantageous, enabling sheet to be formed and subsequently heat treated to peak strength condition.

Zhou W.[8] devised a process that, comprises based on two aluminium alloys (A536 and 6061) reinforced with 10% or 20% volume fraction of SiC particles were produced by gravity casting and a novel two step mixing method was applied successfully to improve the wettability and distribution of particles. The SiC particles were observed to be located predominantly in the interdentric regions, and a thermal lag model proposed to explain the concentration of particles . It may be due to the SiC particles acted as substrates for heterogeneous nucleation of Si crystals in one of the cast composites.

K.H.W. Seah, S.C Sharma[9], analysed the oxidation behaviour of 6061 Al and 6061 Al based composites with 1,2,3 and 4% by weight of albite particles in the temperature range from 500-800 K. The composites were fabricated by the compo casting technique. Oxidation of the matrix material was observed to very rapid during the initial stages of exposure to high temperatures but subsequently slowed down due to the formation of a protective surface layer of oxide. Addition of reinforced albite particles enhanced this oxidation because they provided sites for oxidation initiation. The oxidation was especially severe above 600 K

METHODOLOGY

4.1 PROCUREMENT OF MATERIALS:

Al 2219 alloy

11 Kgs of ALUMINIUM 2219 was collected at FENFE METALLURGICALS located at Uttarahalli, Bangalore

E-glass fiber

1 Kg E-Glass Fiber was being collected at SUNTECH FIBER PVT. LTD, Vasanth Nagar, Bangalore.

Fly Ash

1 Kg Fly Ash was collected at KPCL, Kudithini located near to Bellary

STEPS INVOLVED IN PROCESS:

Aluminium 2219 is taken in the Electrical resistance furnace and heated up to 750^0c to red hot liquid condition. Then the E-glass fiber, fly ash mixture is added in to this red hot liquid and is well stirred by metal steer cast method.

Later the red hot liquid mixture is poured in to ASTM casting dies and allowed for solidification for 30 to 45 minutes. Then the casting dies are separated and the castings are machined to prepare specimens for Tension, Compression and Hardness tests as per ASTM standards.

And these specimens are studied for different mechanical properties like Tension, Compression and Hardness. And the results are tabulated and studied for using in aerospace engineering, automobile and marine industry.

4.3 WORKS DONE:

1. Commercially pure Al was melted and casted.
2. Al-fly ash-E glass fibre composite was fabricated by stir casting method.
3. The mechanical characteristics of Al-fly ash-E glass fibre composite samples were evaluated and compared.
4. Tensile test were carried out for different casting composition and compared and maximum break load was obtained.

5. Compression test were carried out for different casting composition and compared and maximum compressive strength was obtained.
6. Hardness test were carried out for different casting composition and compared and maximum Hardness was obtained.

STEPS INVOLVED IN CASTING PROCESS:

1. First of all, 1500 gm of commercially aluminium 2219 was melted in a resistance heated muffle furnace and casted in a clay graphite crucible. For this the melt temperature was raised to 1023K.

Figure 4.1: Al 2219 melting in the electrical resistance furnace.

2. It was degassed by purging hexachloro ethane tablets in the clay graphite crucible. Degasification is the removal of dissolved gases from liquids, especially water or aqueous solutions, in the fields of science and engineering.

Figure 4.2: Degassifier Hexachloro ethane
Figure 4.3: Degasifier is mixed in crucible.

3. Fly ash and E-glass fibre are mixed in the red hot liquid Al 2219 kept in the crucible in the required composition. By stir casting method all the composites are well stirred such all the constituent material get mixed properly with the base metal that is Al 2219.

Figure. 4.4 Constituent materials are mixing.
Figure. 4.5 stirring is getting done.

4. Later the red hot liquid mixture is poured in to ASTM casting dies and allowed it for solidification for ½ hour.

Figure 4.6 ASTM Casting Dies.
Figure 4.7: Hot liquid molten metal is poured in ASTM Dies.

5. Then the casting dies are separated and the casting is sent for machining for required dimension.

Figure 4.8: Final Castings

4.5 COMPOSITION OF TEST SPECIMENS PREPARED BY CASTING:CASTING 1 is obtained by mixing E-glass fibre in composition of 1% and Fly ash of 2% in red hot liquid condition of Al 2219 in composition of 97%.Similarly all different casting are obtained as the data provided in the table.NOTE- All the figures are given in percentage

Table 4.1 Different casting composition

Casting	Fly ash	E fibre	Al 2219
Casting 1	2	1	97
Casting 2	2	3	95
Casting 3	2	5	93
Casting 4	4	1	95
Casting 5	4	3	93
Casting 6	4	5	91
Casting 7	6	1	93
Casting 8	6	3	91
Casting 9	6	5	89
Casting 10	8	1	91
Casting 11	8	3	89
Casting 12	8	5	87

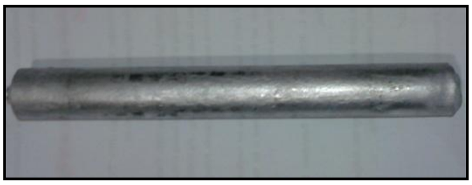


Figure 4.9: Casted product after solidification.

4.6 TESTS CONDUCTED

1. **Tensile test**
2. **Compression test**
3. **Hardness test**

4.6.1 TENSILE TEST:

Apparatus used: Tensometer

Figure 4.10: Tensometer Apparatus

A tensometer is a device used to determine a material's response to varying strains, called loads. The amount of stretch that a material has when it is under strain provides important information about the material’s tensile strength and fatigue strength. Tensometer devices are routinely used in the manufacturing industry to ensure that parts meet necessary strength and endurance requirements.

Tensometer devices consist of two grips that hold a section of test material in place. These grips are then used to apply a tensile or compression force, called a load, to the test piece. Tensometer instruments can create the force through the use of either a screw or a hydraulic ram, which are powered by mechanical or electrical means

Sealed chambers can be used to house a tensometer. This configuration allows for the testing of a material’s strain characteristics under specific temperatures and pressures. This is critical for testing metals used in aircraft and submarines, which can experience drastic changes in atmospheric pressure. Chambers are also useful for testing materials that will be exposed to high temperature ranges

Accurate results from tensometer devices depend upon the quality of the test piece. Any defect that is created during the cutting process can skew test results and lead to premature failure under strain. Even the tiniest surface inconsistency can rapidly enlarge and spread under strain, leading to early fractures and metal fatigue. This is the same process that causes poorly produced rivets and metal sheeting to fatigue and fail on aircraft when repeatedly exposed to the stresses of atmospheric pressure

Results produced by tensometer instruments provide load as a function of extension. From this data, along with the cross-sectional area of the test piece, a stress-strain curve can be plotted. This curve is unique for every material and provides key measures. These measures include the material’s elastic limit, proportionality limit, yield strength and ultimate strength.

Tensometers enable engineers to determine the Young’s modulus for the material being tested. Young’s modulus represents the initial linear slope of a material’s stress-strain curve, defined as the tensile strength divided by the tensile strain. The tensile strength is determined by dividing the force applied by the cross-sectional area of the test piece. Tensile strain represents the amount of stretch produced, divided by the original length of the test piece. Materials exposed to a force within Young’s modulus, the initial linear portion of the stress-strain curve, will return to their original condition after the load is removed

The point at which a material’s stress-strain line begins to curve represents the material’s elastic limit. Strain caused by loads greater than this limit will result in permanent deformation of the material, preventing it from returning to its original condition when the load is removed. The maximum force, or strain, absorbed by the material represents its ultimate strength. This might or might not be equal to the material’s fracture strength.

Figure 4.11: Experimental setup for Tensile Test

PROCEDURE:

1. The specimen of the required dimensions is located between the tensile grips in the tensometer.
2. A constant increasing load on to the specimen which is being monitored continuously
3. The load at which fracture occurs is noted down

Ultimate tensile strength and percentage of elongation are calculated

TENSILE SPECIMENS

(a) Before testing
(b) After testing

Figure 4.12: Tensile Specimens

4.6.2 COMPRESSION TEST:

Apparatus used: Universal Testing Machine (UTM)

Figure 4.13: Universal Testing Machine

Specifications of UTM

- Hydraulic Pump Motor 2HP
  Maximum Load 400kN

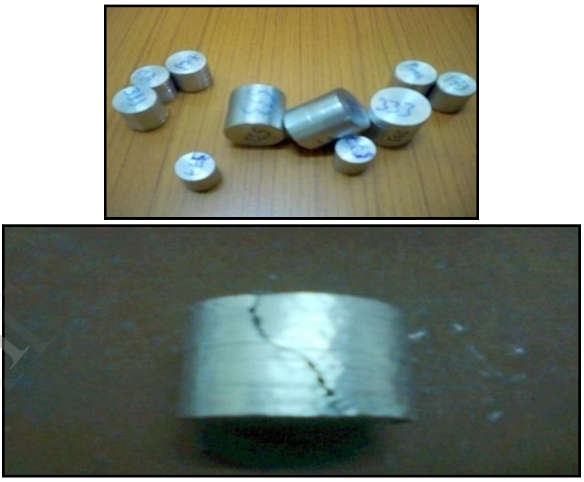
A Universal Testing machine, also known as a universal tester, materials testing machine is used to test the tensile strength and compressive strength of materials. It is named after the fact that it can perform many standard tensile and compression tests on materials, components, and structures.

Operation of the universal testing machine is by hydraulic transmission of load from the test specimen to a separately housed load indicator. The system is ideal since it replaces transmission of load: through levers and knife edges, which are prone to wear and damage due to shock on rupture of test pieces. Load is applied by a hydrostatically lubricated ram. Main cylinder pressure is transmitted to the cylinder of the pendulum dynamometer system housed in the control panel. The cylinder of the dynamometer is also of self - lubricating design. The load transmitted to the cylinder of the dynamometer is transferred through leverage to the pendulum. Displacement of the pendulum actuates the rack and pinion mechanism which operates the load indicator pointer and the autographic recorder. The deflection of the pendulum represents the absolute load applied on the test specimen. Return movement of the pendulum is effectively damped to absorb energy in the event of sudden breakage of the specimen

PROCEDURE:

1. The specimen of standard dimensions is located between the compression grips that are adjusted manually
2. Constantly increasing load is applied to the specimen which is being constantly monitored
3. The load at which fracture occurs is noted down
4. Calculate percentage increase in area.
5. Calculate percentage decrease in length

Compression specimens



(a) Before testing
(b) After testing

Figure 4.14: Compression Test Specimens

4.6.3 HARDNESS TEST

Figure 4.15: Brinell's Hardness Testing Machine

PROCEDURE:

- The specimen is placed on the table. Hand wheel rotated so that the specimen along with the table moves up and just touches the ball indenter, applying an initial load of 10kgs.
- A Load of 100kg is applied on the specimen for a period of 30 seconds, during which the indenter presses onto the specimen.
- The diameter of the indentation made in the specimen is recorded by the use of the micrometer microscope. The

diameter of various indentations are taken and the average diameter is calculated.
Brinell Hardness Number is calculated as follows:

$$\mathrm{BHN} = \frac{2P}{\pi D(D - \sqrt{(D^2 - d^2)})}$$

Where,
P=Load applied in kg=100kg
D=Diameter of ball indenter
d=Average diameter indentation made on the specimen

Figure 4.16: Hardness testing specimens

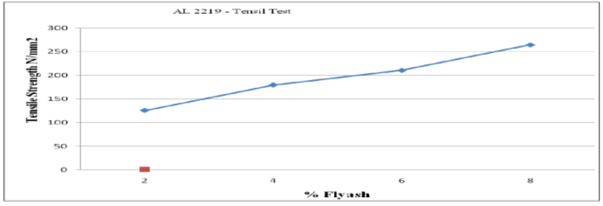
5.0 RESULTS & DISCUSSION

5.1 TENSILE TEST RESULTS

5.1.1 Tensile Strength of AL 2219+ 1% E-Glass+ Varying % of Fly ash

1.0 Table: 5.1: Tensile Results for 1% E-glass

Tensile Strength (N/mm^2)	% E-Glass	%Flyash
126.2	1	2
180.1	1	4
209.4	1	6
263.7	1	8



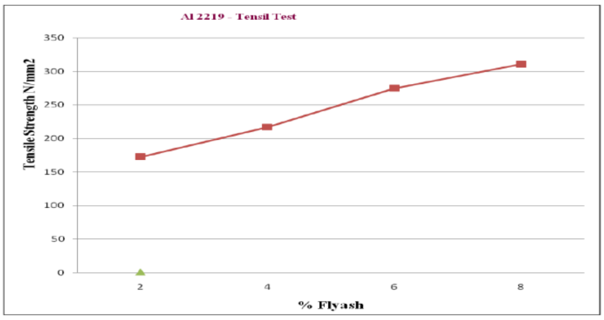
Graph 5.1: Tensile Strength v/s Flyash with 1% E-Glass

It is observed that with varying Percentage of Flyash Tensile Strength increases from 126.2 N/mm2to 263.7 N/mm2

5.1.2 Tensile Strength of AL 2219+ 3% E-Glass+ Varying % of Fly ash

Table: 5.2: Tensile Results for 3% E-glass

Tensile Strength	% E-Glass	%Flyash
171.4	3	2
215.8	3	4
273.7	3	6
311.6	3	8



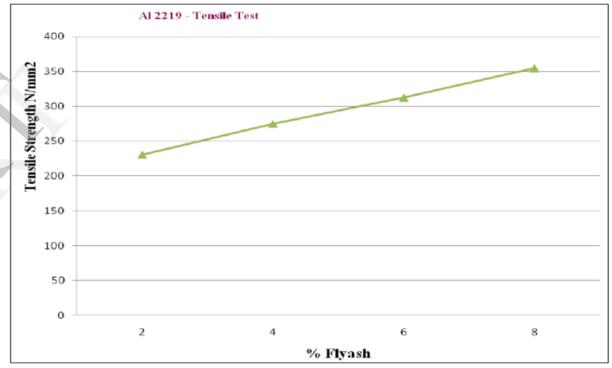
Graph 5.2: Tensile Strength v/s Flyash with 3% E-Glass

It is observed that with varying Percentage of Flyash Tensile Strength increases from 171.4 N/mm2 to 311.6 N/mm2

5.1.3 Tensile Strength of AL 2219+ 5% E-Glass+ Varying % of Fly ash

Table: 5.3: Tensile Results for 5% E-glass

Tensile Strength	% E-Glass	%Flyash
230.6	5	2
274.8	5	4
312.7	5	6
351.3	5	8



Graph 5.3: Tensile Strength v/s Flyash with 5% E-Glass

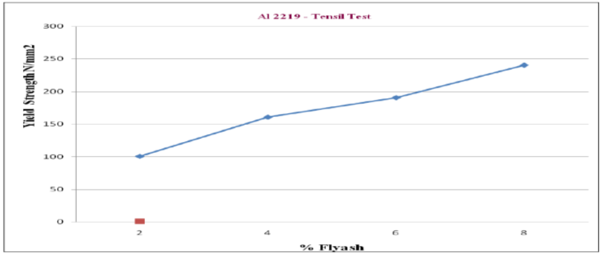
Its is observed that with varying Percentage of Flyash Tensile Strength increases from 230.6 N/mm2 to 351.3 N/mm2

5.2 YIELD STRENGTH RESULTS

5.2.1 Yield Strength of AL 2219+ 1% E-Glass+ Varying % of Fly ash

Table: 5.4: Yield Strength Results for 1% E-glass

Yield Strength	% E-Glass	%Flyash
100.1	1	2
155.6	1	4
190.6	1	6
247.5	1	8



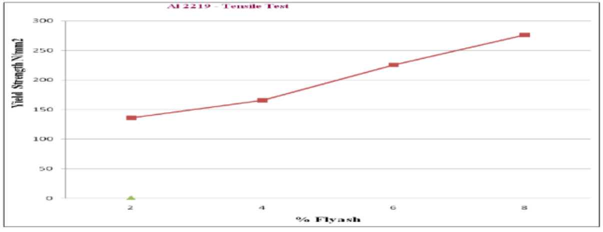
Graph 5.4: Yield Strength v/s Flyash with 1% E-Glass

Its is observed that with varying Percentage of Flyash Yield Strength increases from 100.1 N/mm2 to 247.5 N/mm2

5.2.2 Yield Strength of AL 2219+ 3% E-Glass+ Varying % of Fly ash

Table: 5.5: Yield Strength Results for 3% E-glass

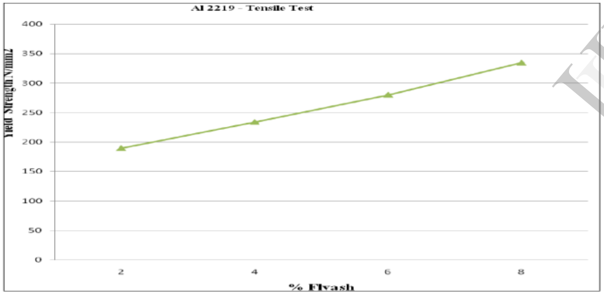
Yield Strength	% E-Glass	%Flyash
140.9	3	2
166.7	3	4
229.6	3	6
274.3	3	8



Graph 5.5: Yield Strength v/s Flyash with 3% E-Glass

Its is observed that with varying Percentage of Flyash Tensile Strength increases from 140.9 N/mm2 to 274.3 N/mm2

Yield Strength	% E-Glass	%Flyash
190.7	5	2
235.2	5	4
281.3	5	6
336.8	5	8



Graph 5.6: Yield Strength v/s Flyash with 5% E-Glass

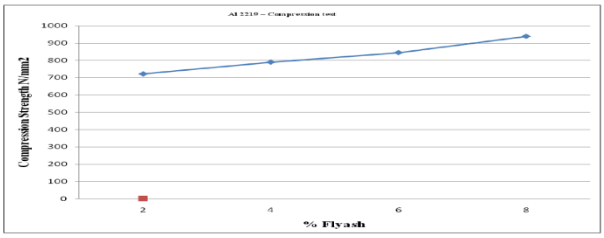
Its is observed that with varying Percentage of Flyash Tensile Strength increases from 190.7 N/mm2 to 336.8 N/mm2

5.3 COMPRESSIVE STRENGTH RESULTS

5.3.1 Compressive Strength of AL 2219+ 1% E-Glass+ Varying % of Flyash

Table: 5.7: Compression Strength Results for 1% E-glass

Compression Strength (N/mm^2)	% E-Glass	%Flyash
715.8	1	2
793.5	1	4
843.3	1	6
941.7	1	8



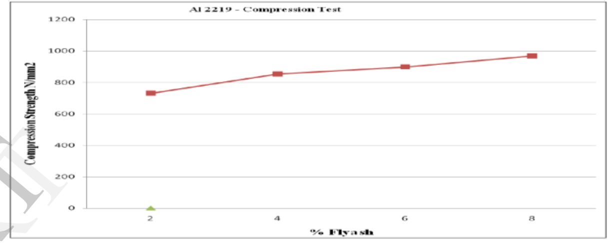
Graph 5.7: Compressive Strength v/s Flyash with 1% E-Glass

Its is observed that with varying Percentage of Flyash Compression Strength increases from 715.8 N/mm2 to 941.7 N/mm2

5.3.2 Compressive Strength of AL 2219+ 3% E-Glass+ varying % of Fly ash

Table: 5.8: Compression Strength Results for 3% E-glass

Compression Strength	% E-Glass	%Flyash
729.9	3	2
853.5	3	4
895.7	3	6
980.6	3	8



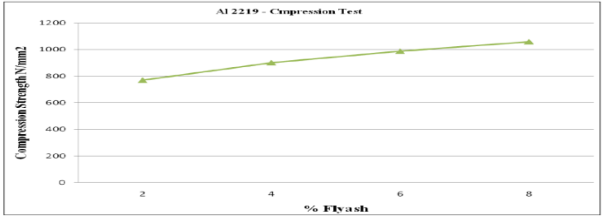
Graph 5.8: Compressive Strength v/s Flyash with 3% E-Glass

Its is observed that with varying Percentage of Flyash Compression Strength increases from 729.9 N/mm2 to 980.6 N/mm2

5.3.3 Compressive Strength of AL 2219+ 5% E-Glass+ varying % of Fly ash

Table: 5.9: Compression Strength Results for 5% E-glass

Compression Strength	% E-Glass	%Flyash
775. 7	5	2
905. 7	5	4
989.8	5	6
1051.6	5	8



Graph 5.9: Compressive Strength v/s Flyash with 5% E-Glass

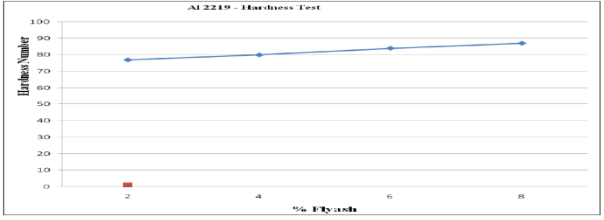
Its is observed that with varying Percentage of Flyash Compression Strength increases from 775. 7 N/mm2 to 1051.6 N/mm2

5.4 HARDNESS TEST RESULTS:

5.4.1 Hardness of AL 2219+ 1% E-Glass+ Varying % of Fly ash

Table: 5.10: Hardness Results for 1% E-glass

Hardness	% E-Glass	%Flyash
78	1	2
80	1	4
83	1	6
88	1	8



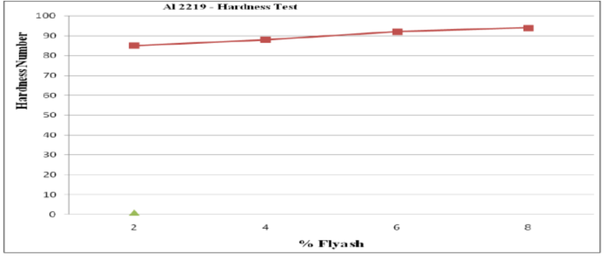
Graph 5.10: BHN v/s Flyash with 1% E-Glass

Its is observed that with varying Percentage of Flyash Hardness increases from 78 to 88 BHN.

5.4.2 Hardness of AL 2219+ 3% E-Glass+ Varying % of Fly ash

Table: 5.11: Hardness Results for 3% E-glass

Hardness	% E-Glass	%Flyash
86	3	2
89	3	4
91	3	6
93	3	8



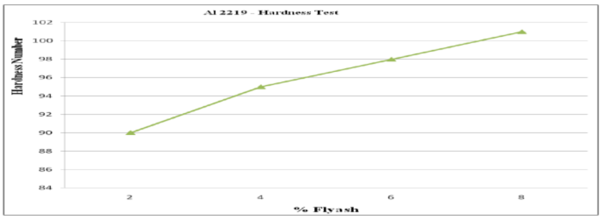
Graph 5.11: BHN v/s Flyash with 3% E-Glass

Its is observed that with varying Percentage of Flyash Hardness increases from 86 to 93 BHN.

5.4.3 Hardness of AL 2219+ 5% E-Glass+ Varying % of Fly ash

Table: 5.12: Hardness Results for 5% E-glass

Hardness	% E-Glass	%Flyash
89	5	2
94	5	4
98	5	6
103	5	8



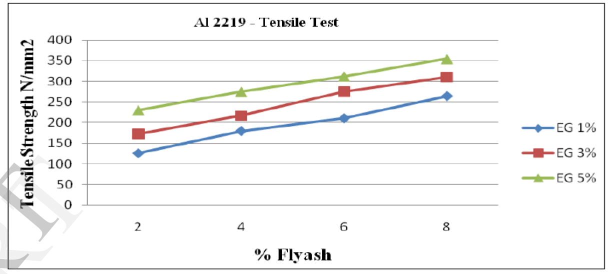
Graph 5.12: BHN v/s Flyash with 5% E-Glass

Its is observed that with varying Percentage of Flyash Hardness increases from 89 to 103BHN.

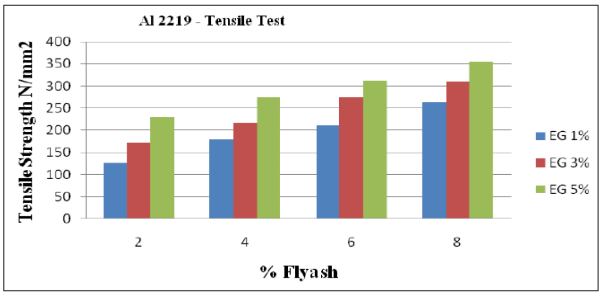
5.5 COMPARISION OF TENSILE STRENGTH:

5.13: Comparative Results of Tensile Strength in N/mm2

EG 1%	EG 3%	EG 5%	%Flyash
126.2	171.4	230.6	2
180.1	215.8	274.8	4
209.4	273.7	312.7	6
263.7	311.6	351.3	8



Graph 5.13: Comparative Line Chart of Tensile Strength

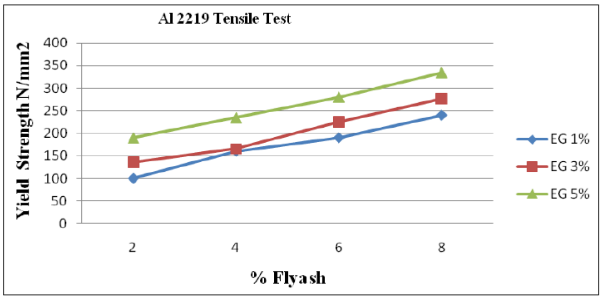


Graph 5.14: Comparative Bar Chart of Tensile Strength

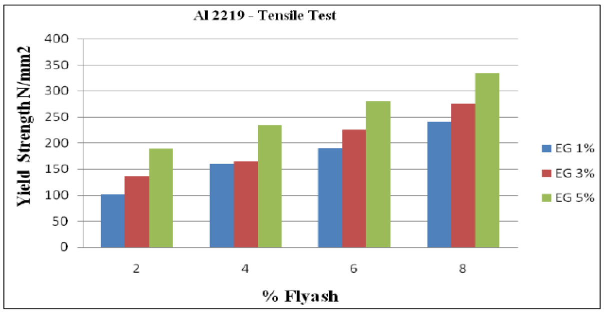
5.6 COMPARISION OF YIELD STRENGTH

5.14: Comparative Results of Yield Strength in N/mm2

EG 1%	EG 3%	EG 5%	%Flyash
100.1	140.9	190.7	2
155.6	166.7	235.2	4
190.6	229.6	281.3	6
247.5	274.3	336.8	8



Graph 5.15: Comparative Line Chart of Yield Strength

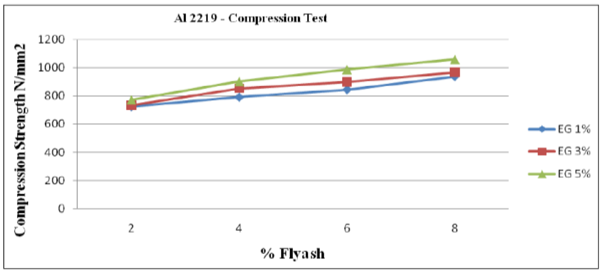


Graph 5.16: Comparative Bar Chart of Tensile Strength

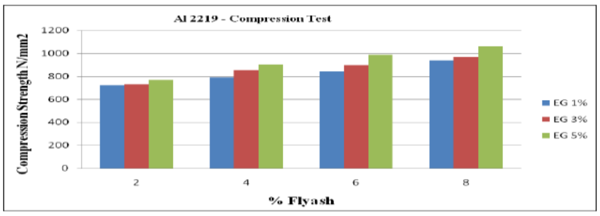
5.7 COMPARISION OF COMPRESSION STRENGTH

5.15: Comparative Results of Compression Strength in N/mm2

EG 1%	EG 3%	EG 5%	%Flyash
715.8	729.9	775. 7	2
793.5	853.5	905. 7	4
843.3	895.7	989.8	6
941.7	980.6	1051.6	8



Graph 5.17: Comparative Line Chart of Compression Strength

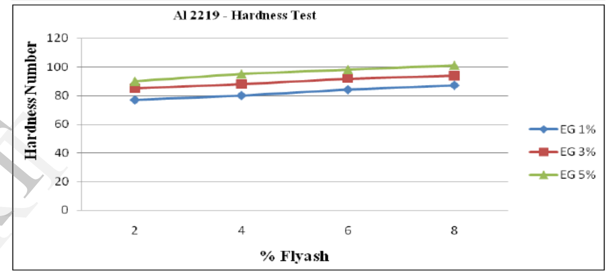


Graph 5.18: Comparative Bar Chart of Compression Strength

5.8 COMPARISION OF HARDNESS

5.16: Comparative Results of Hardness Strength

EG 1%	EG 3%	EG 5%	%Flyash
78	86	89	2
80	89	94	4
83	91	98	6
88	93	103	8



Graph 5.19: Comparative Line Chart of BHN

Graph 5.20: Comparative Bar Chart of BHN

CONCLUSION

- New MMC's can be synthesized by liquid metallurgy technique successfully with enhanced properties using low cost E glass and Flyash particulate reinforcement.
- Stir and permanent mould castings can be obtained with microscopically uniform distribution of particles
- It is clear that ultimate tensile strength increases with increase in percentage composition of constituent material with Aluminium 2219. The increase in ultimate tensile strength is due to the addition of E-glass fibre which gives strength to the matrix alloy there by enhanced resistance to tensile stresses, there is a reduction in the inter-spatial distance between the particles this leads to restriction to plastic flow due to the random distribution of the particulate in the matrix.
- The yield strength of the hybrid composite material increases monotonically up to 8% of fly ash. The increase in yield strength may be due to the addition of e-glass fibre acting as barriers to dislocations in the microstructure.
- It is seen that the compressive strength of the hybrid composites increases monotonically as reinforcement contents are increased. The increase in compressive strength is mainly due to the decrease in the inter-particle spacing between the particulates since fly ash powder and E-glass fibre are much harder than Al 2219 alloy. The presence of E-glass fibre and fly ash resists deforming stresses and thus enhancing the compressive strength of the composite material.
- It is seen that the Hardness of the hybrid composites increases by about 20% monotonically as reinforcement contents are increased

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