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Exploration of mechanical properties of aluminium and epoxy filled with iron waste and coal ash composite material

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ABSTRACT

The composite materials are most important constitutions in aeronautical applications. Aluminum material act as vital role in aircraft, in which the present study involves aluminum and epoxy matrix filled with iron waste and coal ash used to fabricate a composite plate by hand lay-up method. The volume fraction of matrix is 60% and 40 % of fiber in which the change of filler materials of first sample 5% and second sample 15% of both iron waste and coal ash used. The fabricated composite plate were cut in to as per ASTM and tensile, impact, moisture test to be carried out. The results were compared between iron waste and coal ash to shown the best property of composite material.

INTRODUCTION

Composites materials is a material composed of two or more distinct phases (matrix phase and dispersed phase) which are chemically & physically different. The primary phases, having a continuous character, is called matrix. Matrix is usually more ductile and less hard phase. It holds the dispersed phase and shares a load with it. The second phase which is embedded in the matrix is called dispersed phase. Dispersed phase is usually stronger than the matrix, therefore it is called reinforcing phase.

Composites materials are widely used in the Aircraft Industry. It can be various shapes and, if desired, the fibres can be wound tightly to increase strength. A useful feature of composites is that they can be layered, with the fibres in each direction. This allows an engineer to design structures with unique properties. The development of light-weight, high-temperature resistant composite materials will allow the next generation of high-performance, economical aircraft designs to materialize. Usage of such materials will

reduce fuel consumption, improve efficiency and reduce direct operating costs of aircrafts.

Composites have good tensile strength and resistance to compression, making them suitable for use in aircraft part manufacture. The tensile strength of the material comes from its fibrous nature. When a tensile force is applied, the fibrous within the composite line up with the direction of the applied force, giving its tensile strength. The good resistance to compression can be attributed to the adhesive and stiffness properties of the base matrix system. It is the role of the resin to maintain the fibres as straight columns and to prevent them from buckling.

The main aim of the aircraft industries is to reduce weight keeping the same or more strength than the regular metals. Applications of composite in aerospace are fuselage (bulk head), wing flaps, rudder, elevators, radome, spoilers, floor beams and panels, Helicopter main and tail rotor blades, space vehicles: Satellites, Missiles, Rockets etc.,

METHODOLOGY

- The Composite is done by the combination of the Aluminum powder Iron waste and coal powder with epoxy resin.
- This procedure is done by the hand-layup method, with proper ration of the all the material are been mixed in the bowl.
- And with the actual measurement of the die set the mixture has been poured, and it has been spread all through the die set.

Table.1 Properties of materials

| Property | Aluminium powder | Epoxy resin | Coal powder | Iron waste |
|----------------------------|---------------------|-------------|-------------|------------|
| Tensile strength GPa | 47*10 ⁻³ | 0.11 | - | 0.35 |
| Elastic modulus GPa | 70 | 4.1 | - | 211 |
| Poisson's ratio | 0.33 | 0.35 | - | 0.26 |
| Density kg/cm ³ | 2700 | 1350 | 641 | 7874 |

- And it has been covered by the plate with some weigh on it.
- After 24hr time, the plate has been separated by the die set.
- And it has been cut to the ASTM Value of the following test,
- Tensile Test
- Moisture Test
- Impact Test
- Result and conclusion with graph has been obtained

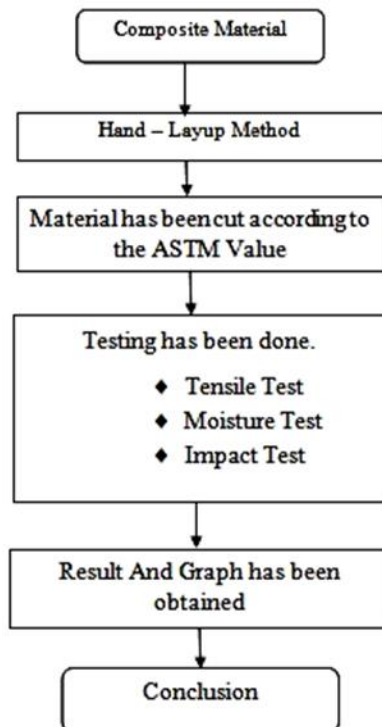


Fig.1. Flow Chart

MATERIAL SELECTION

Aluminum Powder

Aluminium powder is powdered aluminium. This was originally produced by mechanical means using a stamp mill to create flakes. The resulting powder might then be processed further in a ball mill to flatten it into flakes for use as a coating or pigment. The melting point of the aluminium powder is 660°C . Aluminium powder can be incorporated into explosives to raise the reaction temperature, enhance the heat of detonation, increase bubble energies in underwater weapons, improve air blast, and create an incendiary effect. Therefore, the aluminized explosive is usually called high explosive and has attracted much attention.

Epoxy Resin

Epoxy resin refers to a type of reactive pre-polymer and polymer containing epoxide groups. These resin react either with themselves in presence of catalysts, or with many co-reactants like amines, phenols, thiols, etc. Epoxy resin has many industrial application for a variety of purpose.

Iron Waste

The material of the chemical element. Its mass depends on the amount to be tested. It's magnetic in nature. Its gives the strength and proper dimension to the material has obtained.

Coal Powder

Coal is the combustible black powder, it is the sedimentation of the rock. Coal is the mostly carbon with variable amounts of the other element. It's theformation of the dead plant matter decays into peat and over millions of years the heat and pressure of deep burial converts the peat into coal.

FABRICATION PROCESS

Composites fabrication processes involve some form of molding, to shape the resin and reinforcement. A mold tool is required to give the unformed resin/fiber combination its shape prior to and during cure. For an overview of mold types and materials and methods used to make mold tools.

Preparing the Mould

Remove any dust and dirt from mould. Spray or brush with PVA, parting compound and allow it to dry.



Fig. 2 Preparing the Mould

Hand Lay-Up Process

The fibers are first put in place in the world. The fiber can be in form of woven, knitted, stitched or bonded fabrics. Then the resin is

impregnated. The impregnation of resin is done by using rollers, brushes or a nip-roller type impregnator. The impregnation helps in forcing the resin inside the fabric. The laminates fabricated by

this process are then cured under standard atmospheric conditions. The hand lay-up process is depicted. The materials that can be used have, in

general, no restrictions. One can use combination of resin like epoxy, polyester, vinyl ester, phenolic and any fiber material.



Fig. 3 Hand – Layup Method

TESTING

Impact Testing

The impact test is a method for evaluating the toughness and notch sensitivity of engineering materials. It is usually used to test the toughness of metals, but similar tests are used for polymers, ceramics and composites. Metal industry sectors include Oil and Gas, Aerospace, power generation, Automotive and Nuclear.

The notched test specimen is broken by the impact of a heavy pendulum or hammer, falling at a predetermined velocity through a fixed distance. The

measures the energy absorbed by the fractured specimen.

Charpy Impact Test

A test specimen is machined to a 10 mm x 10 mm (full size) cross section, with either a “V” or “U” notch. Sub-s es.

Izod Impact Test

Izod specimens are used where the material thickness is restricted. Specimens can be tested down to cryogenic temperature

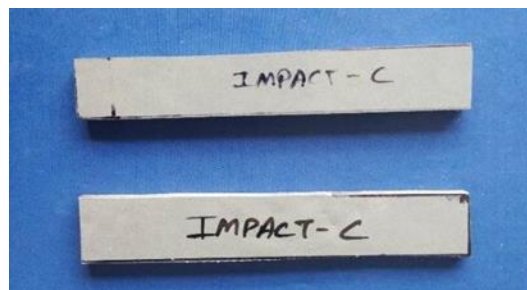


Fig. 4 Impact Test Material

The test specimen is machined to a square or round section with either one, two or three notches.

The specimen is clamped vertically on the anvil with the notch facing the hammer.



Fig. 5 After Test of the Impact Test

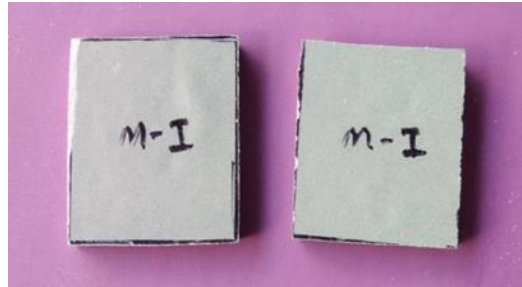


Fig. 6 Moisture Test Material

Moisture Meters

Moisture meters are used to measure the percentage of water that is present in the substance. If the material is ready for the calculation can be done. For further methodology, unexpectedly wet or dry, or otherwise in need of further inspection.

The problems caused by varying degrees of moisture content in material of aluminium, go beyond simple shrinkage in the dimensions of parts. Problems with distortions in the shape of the aluminium material, such as twisting, warping and cupping, occur because of the difference in the degree of dimensional change versus radially (perpendicular to the growth).

A moisture meter gives the approximate moisture content reading of material. The reading helps in determining whether the material is suitably for drying its intended purpose. The moisture content reading can also assist in planning a project design that will accommodate future changes in dimension. The caused that changes in relative humidity is in the material, in which the material shows. The amount of overall shrinkage lumber will undergo in the drying process varies from aluminium material species that has obtained. The difference between radial and tangential shrinkage also varies from material

to material. Aluminium and those mixture with a low ratio of tangential to radial shrinkage, are less prone to distortion due to changes in moisture content than the all the material that are obtained with a high ratio, such as eastern white pine and certain material of oak. Material with both low overall shrinkage and a low tangential/radial shrinkage ratio are more stable and will react better to changes in moisture content.

Universal Testing Machine

A universal testing machine, also known as a universal tester, materials testing machine, is used to test the tensile and compressive strength of materials. An earlier name for a tensile testing machine is a tenso-meter.

Working Principles

It is fully automatic operated universal testing machine. Which realized ease-of-operation? It consists of high precision electronic control panel. Which incorporating control, optics, sensors and information processing. This machine is very useful to test any material. This is subjected to tension and compression. The Extensometer is used to measure the elongation of different type of the materials and compression of the material that obtained.



Fig. 7 Tensile Test Material

Table. 2 ASTM standard values

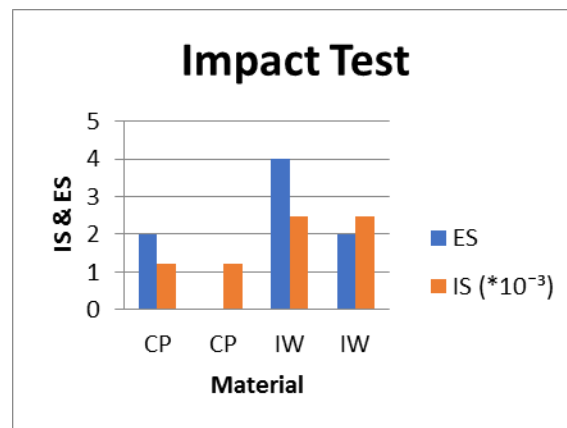
| Test Name | ASTM Standard | Specimen Size (mm) (l*b*h) |
|---------------|---------------|----------------------------|
| Tensile Test | D638 - 03 | 165*13*3 |
| Impact Test | D256 | 64*12.7*3 |
| Moisture Test | | 100*100*2 |

RESULT AND DISCUSSIONS

The mechanical properties of aluminium and epoxy filled with iron waste and coal ash composite material are studied. The relative effects of aluminium concentration on various mechanical properties of the composites are presented with respect to filler concentration.

Impact test result

Impact is considered as one of the most important factors. In present work, Impact values of iron waste and coal ash concentration are obtained. The test result (fig) shows that with iron waste concentration is higher than the coal ash concentration.

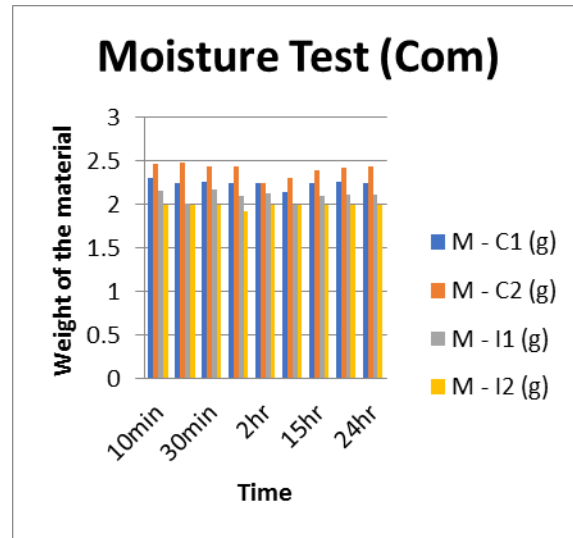


Graph. 1 Impact Test Results For Iron Waste and Coal Powder

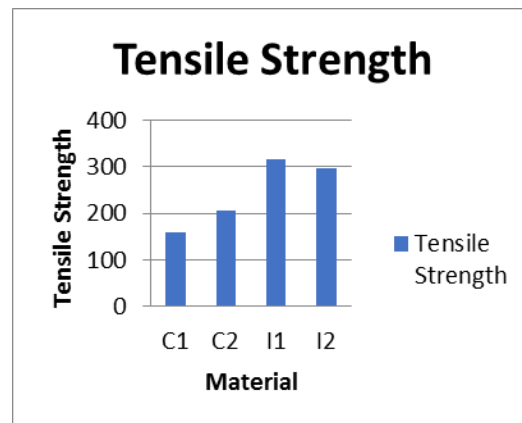
Moisture test result

In moisture test is most important to the polymer matrix composites. In this section, both of

the combination takes some amount of absorption takes place.



Graph. 2 Moisture Test of Iron Waste and Coal Powder



Graph. 3 Tensile Strength in the Materials

Tensile test result

The tensile strength of iron waste concentration and coal powder concentration is shown in figure. It is found that, there is a gradual increase in tensile strength. The tensile strength is 158.25 kg/cm², 205.61 kg/cm²(Coal Powder), 315.79 kg/cm², 296.84 kg/cm²(Iron Waste).

CONCLUSION

The aluminium, iron waste and aluminium, coal powder with epoxy resin composite specimens are prepared and subjected to tensile, impact and moisture test. From the experiment, the following conclusions are derived.

- The aluminum, iron waste and aluminum, coal powder with epoxy resin composite samples possess good tensile strength and can withstand the strength up to 205.61 kg/cm² (Coal powder) and 315.79 kg/cm² (iron Waste).
- The composite specimen is withstanding the maximum Impact strength of $2.62 * 10^{-2}$ J/mm² (Coal Powder) and $7.87 * 10^{-2}$ J/mm² (Iron Waste).
- The composite specimen is observing the water in less quantity, which gives the slight changes on the weight of the material.
- From the result, it can be conclude that aluminum with the combinations of the iron waste and coal powder mixture with epoxy resin, composite performing better for tensile loading.

- The performance of these iron waste and coal powder composites with aluminum can apply in the aero application which requires medium strength.

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