A STUDY OF MECHANICAL PROPERTIES OF HDPE REINFORCED WITH LIME STONE COMPOSITE MATERIAL

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***ABSTRACT*: A Composite is a structural materials with combine two or more constituents. The constituents are combined of a microscopic level and they are insoluble each other one phase is called "Reinforcing" phase. Which is hand and it is embedment in a soft and ductile phase called Matrix. Strong and hard phase is called reinforcing phase. Soft and ductile phase is called matrix phase. Fiber and particle reinforced composites usually consist of a phase which is more or less continuous. This continuous phase is also known as the matrix, and the material that is distributed through the matrix is known as the dispersed phase. Matrix phase provides support or base for the reinforcing and also it protecting the reinforcing force from the hot environment. It is soft and ductile. The matrix is the monolithic material into which the reinforcement is embedded, and is completely continuous. This means that there is a path through the matrix to any point in the material, unlike two materials sandwiched together. In structural applications, the matrix is usually a lighter metal such as aluminum, magnesium, or titanium, and provides a compliant support for the reinforcement. In high-temperature applications, cobalt and cobalt–nickel alloy matrices are common. The matrix binds fibers together by virtue of its cohesive and adhesive characteristics. Its purpose is to transfer load to and between fibers, and to protect the fibers from hostile environments and handling. The matrix is the weak link in the composite, so when the composite experiences loading, the matrix may crack, deboned from the fiber surface, or break down under far lower strains than are usually desired. But matrices keep the reinforcing fibers in their proper orientation and position so that they can carry loads, distribute loads evenly among fibers, and provide resistance to crack propagation and damage. Limitations in the matrix generally determine the overall service temperature limitations of the composite.**

***KEYWORDS*: Composite Material, Reinforcing phase, Matrix. Monolithic material, cohesive and adhesive characteristics.**

INTRODUCTION

Reinforcing phase provides sufficient structural properties to the composition. It has discontinuous particles. The reinforcement material is embedded into a matrix. The reinforcement does not always serve a purely structural task (reinforcing the compound), but is also used to change physical properties such as wear resistance, friction coefficient, or thermal conductivity. The reinforcement can be either continuous, or discontinuous. Discontinuous MMCs can be isotropic, and can be worked with standard metalworking techniques, such as extrusion, forging, or rolling. In addition, they may be machined using conventional techniques, but commonly would need the use of polycrystalline diamond tooling (PCD).Continuous reinforcement uses monofilament wires or fibers such as carbon fiber or silicon carbide. Because the fibers are embedded into the matrix in a certain direction, the result is an anisotropic structure in which the alignment of the material affects its strength. One of the first MMCs used boron filament as reinforcement. Discontinuous reinforcement uses "whiskers", short fibers, or particles. The most common reinforcing materials in this category are alumina and silicon carbide.

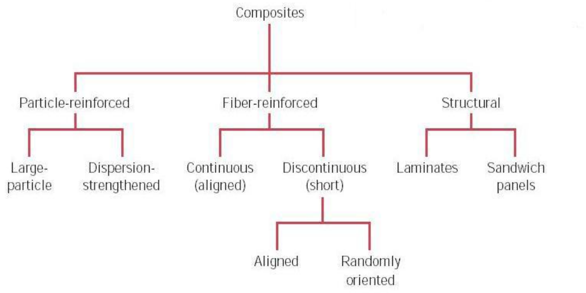
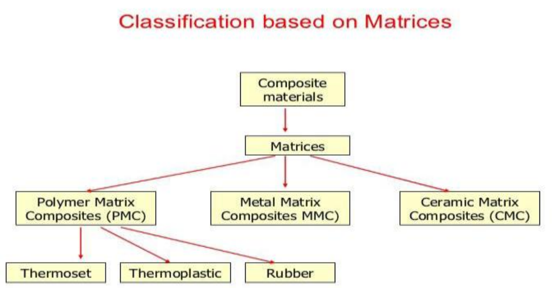


Fig1.1. composite material classification

Matrix materials:

- PMC : Polymer Metal Matrix Composite
- MMC's : Metal matrix composite[Aerospace, Automobile discs, Aeronautical]
- CMC's : Ceramic Matrix Composites

Polymer matrix composite:



The most advanced composites are polymer matrix composites. The composites consist of polymer a matrix material. PMCs are often divided into two categories: reinforced plastics, and so-called advanced composites. The distinction is based on the level of mechanical properties (usually strength and stiffness); however, there is no unambiguous line separating the two. Reinforced plastics, which are relatively inexpensive, typically consist of polyester resins reinforced with low-stiffness glass fibers (E-glass). They have been in use for 30 to40 years in applications such as boat hulls, corrugated sheet, pipe, automotive panels, and sporting goods. Advanced composites, which have been in use for only about 15 years, primarily in the aerospace industry, consist of fiber and matrix combinations that yield superior strength and stiffness. They are relatively expensive and typically contain a large percentage of high-performance continuous fibers, such as high-stiffness glass (S-glass), graphite, aramid, or other organic fibers. This assessment primarily focuses on market opportunities for advanced composites.

Ex : Epoxy, Polyester, and Urethane etc.

- Reinforced by thin diameter fiber

Ex**:** Graphite, Armed, Boron.

- The reason for most common composition material.
- Low cost high strength and simple manufacturing principles.
- The main drawback of PMC's for low operating temperature high Coefficient of thermal and moisture expansion and low elastic Properties in certain direction.

Polymers:

Poly- means "many" and - mer means "part" or "segment". Polymers are made up of many molecules all strung together to form really long chains (and sometimes more complicated structures, too). What makes polymers so UN is that how they act depends on what kinds of molecules they're made up of and how they're put together? The properties of anything made out of polymers really reflect what's going on at the ultra-tiny (molecular) level. So, things that are made of polymers look, feel, and act depending on how their atoms and molecules are connected, as well as which ones we use to begin with Some are rubbery, like a bouncy ball, some are sticky and gooey, and some are hard and tough, like a skateboard. Polymers are most widely used matrix material for fiber reinforced composite. Their advantages are

- Low cost
- Easy process ability
- Good chemical resistance

And on the other hand low strength, low modulus, low operating temperature limit their used, they are also degrade by for long explores to ultraviolet light and some solvents. According to their structure and behavior polymers can be classified as thermo plastics and thermo settings. The polymers soften or melt called thermoplastic polymers.

Thermo plastics consist of linear or branch chain molecules having the inert molecular bond. Melting and solidification of this molecular are reversible and they can be reshaping by the application re heat and pressure they are either semi-crystalline or amorphous in structure.

EX: Polyethylene, polystyrene, Polyether-ether-Ketene [PPEK]

Thermo settings:

A thermosetting resin is a pre polymer in a soft solid or viscous state that changes irreversibly into an infusible, insoluble polymer network by curing. Curing is induced by the action of heat or suitable radiation, often under high pressure. The curing process transforms the resin into a plastic or rubber by cross-linking individual chains of the polymer. The cross-linking is facilitated by energy and catalysts at chemically active sites, which may be unsaturated sites or epoxy sites, for example, linking into a rigid, three-dimensional structure. This yields molecules with a large molecular weight, resulting in a material that usually decomposes before melting. Therefore, a thermo set cannot be melted and re-shaped after it is cured. This implies that thermo sets cannot be recycled for the same purpose, except as filler material. A cured thermosetting resin is called a thermo set or a thermosetting plastic/ polymer. Thermo setting plastic consist of cross structure with covalent bond between all the molecules, they do not soften and decompose on heating. Once solidified by curing process, they cannot be reshaped. Thermosetting plastics are generally stronger than thermoplastic materials due to the three-dimensional network of bonds (cross-linking), and are also better suited to high-temperature applications up to the decomposition temperature. However, they are more brittle.

EX: Epoxy, Phenolic resin, and Polyamide etc.

Metal matrix composites:

Metal matrix composites (MMCs) are composite materials that contain at least two constituent parts – a metal and another material or a different metal. The metal matrix is reinforced with the other material to improve strength and wear. Where three or more constituent parts are present, it is called a hybrid composite. In structural applications, the matrix is usually composed of a lighter metal such as magnesium, titanium, or aluminum. In high temperature applications, cobalt and cobalt-nickel alloy matrices are common. Typical MMC's manufacturing is basically divided into three types: solid, liquid, and vapor. Continuous carbon, silicon carbide, or ceramic fibers are some of the materials that can be embedded in a metallic matrix material. MMCs are fire resistant, operate in a wide range of temperatures, do not absorb moisture, and possess better electrical and thermal conductivity. They have also found applications to be resistant to radiation damage, and to not suffer from out gassing. Most metals and alloys make good matrices for composite applications. If metal matrix composite the matrix is a soft and ductile material [Al, Mg, Titanium, Cu – etc…]. The typical fibers are used boron, carbon, silicon carbide etc… This material may be utilized at higher surface temperatures than the base metals. Reinforced by in metal matrix composites may be in the form of particles, fibers [continuous or discontinuous] and Wister's. [Wister's: **-** single crystal defective free].

The typical properties include high specific strength, stiffness and abrasion resistance, creep resistance, thermal conductivity and thermal stability. Metal matrix composition than PMC's and have several advantages over PMC's. This includes higher elastic properties, higher service temperatures, in sensitive to moisture, higher thermal stability etc…

Ceramic matrix composites [CMC's]:

The properties of metal and ceramic matrices are also likely to be improved (resistance to creep and wear, thermal or electrical behavior modified through the addition of nano -fillers, etc.) by adding a second phase. The use of metal and ceramic matrices can also be justified in light of the limitations inherent in polymer matrices, even though such limitations are constantly being resolved. It is mostly certain mechanical properties of the resins combined with the use of ceramic reinforcements that may cause doubts to arise. For each limitation, metal or ceramic matrix composites may represent an alternative. Although polymer matrices achieve satisfactory strength and ductility properties, and it is the reinforcement in the composite material that bears the external load, doubts may arise about the stiffness ratio between the matrix and the reinforcement. It has been proven that shear forces acting on the interfaces depend on this ratio. A very low or very high ratio is undesirable. This means that advanced work must be undertaken to ensure compatibility between the fibers and the matrix to produce a high level of binding energy at the interfaces. However, this improvement lowers the resilience of the materials, since fissures can spread more easily. The material tends towards the properties of the macroscopic ceramic material containing defects and then becomes more fragile. Using a metal matrix some 10 to 50 times more rigid provides a solution to this particular Problem. For example, in the case of structures, lightweight aluminum or magnesium matrices have been combined with carbon fibers. These materials involve complex fabrication methods and feature between 30 and 60% volume of fibers, with mechanical properties superior to equivalent polymer matrix composites, while offering high resilience.

Ceramic materials such as Alumina [Al2O3], calcium, aluminum silicate are the matrix materials and reinforced by fiber such as boron, carbon, silicon etc… The advantages of CMC's are included high strength, hardness, high temperature, low density and chemical stability. The combination of fiber and ceramic matrix make the CMC, more attractive for applications where as more mechanical properties and extensions temperatures are desired.

Reinforcements:

It is the reinforcements that are the solid part of the composites, which are reinforced into the matrix. They determine the strength and stiffness of the composites. Most common reinforcements are fibers, particles and whiskers. Fiber reinforcements are found in both natural and synthetic forms. Fiber composite was the very first form composites, particle reinforcements are cheaper and are usually used to reduce the cost of isotropic material. They are also isotropic but this type of reinforcement is very expensive. There are four kinds of fiber reinforcements, which are:

- Carbon fibers
- Glass fibers
- Natural fibers
- Plant fibers

The natural fiber compositions can be very cost effective material for following applications: Building and construction industry: Panels for patrician and false ceiling, portion boards, wall, floor, etc…

- Storage devices: post boxes, again storage silos, etc.
- Furniture: Chair, table, shower, bath units, etc.
- Electric devices: electrical appliances, pipes, etc.
- Every day applications: lampshades, suitcases, helmets, etc.
- Transportation: automobile and railway coach interior, boat, etc.

Advantages and disadvantages of composite materials:

Advantages:

Some of the advantages of composites materials are as follows.

- They have excellent fatigue strength.
- They are low cost.
- They have good tensile strength
- They have good resistance to fire.
- They generally increase mechanical damping.
- High resistance to impact damage.
- Improved friction and wear properties.

Disadvantages:

- Some of the disadvantages of composites materials are as follows.
- Matrix is weak, therefore, low toughness.
- Reuse and disposal may be difficult.
- Composites are more brittle than wrought metals and thus are more easily damaged.
- Transverse properties may be weak.

HDPE RESIN

Introduction about HDPE resin:

High-density polyethylene (HDPE) or polyethylene high-density (PEHD) is a polyethylene thermoplastic made from petroleum. It takes 1.75 kilograms of petroleum (in terms of energy and raw materials) to make one kilogram of HDPE. HDPE is commonly recycled, and has the number "2" as its recycling symbol. In 2007, the global HDPE market reached a volume of more than 30 million tons. HDPE is sometimes called polythene when used for pipes. It is one of the most commonly used plastics in the United States. It creates no harmful emissions during its production or during its use by the consumer. Also, HDPE leaks no toxic chemicals into the soil or water. Recycling contributes to reduction in resource consumption and pollution. Over 80% of U.S. households have access to a plastics recycling program. The physical properties of HDPE can vary depending on the molding process that is used to manufacture a specific sample; to some degree a determining factor are the international standardized testing methods employed to identify these properties for a specific process. High Density Polyethylene (HDPE) Pipes are manufactured all over the world by extrusion technique. Sizing methods still vary but the trend is the pressure sizing i.e. introducing air at the pressure of about 0.8kg/cm2 to 1 kg/cm2 through one of the spider legs of the dies. HDPE Pipes are generally manufactured on single screw extruder.

Properties of HDPE:

The mass density of high-density polyethylene can range from 0.93 to 0.97 g/cm3. Although the density of HDPE is only marginally higher than that of low-density polyethylene, HDPE has little branching, giving it stronger intermolecular forces and tensile strength than LDPE. The difference in strength exceeds the difference in density, giving HDPE a higher specific strength. It is also harder and more opaque and can withstand somewhat higher temperatures (120 °C/ 248 °F for short periods, 110 °C /230 °F continuously). High-density polyethylene, unlike polypropylene, cannot withstand normally-required autoclaving conditions. The lack of branching is ensured by an appropriate choice of catalyst (e.g., Ziegler-Natta catalysts) and reaction conditions. HDPE contains the chemical elements carbon and hydrogen. HDPE is also used for cell liners in subtitle D sanitary landfills, wherein large sheets of HDPE are either extrusion or wedge welded to form a homogeneous chemical-resistant barrier, with the intention of preventing the pollution of soil and groundwater by the liquid constituents of solid waste. One of the largest uses for HDPE is wood plastic composites and composite wood, with recycled polymers leading the way.

HDPE is also widely used in the pyrotechnics trade. HDPE mortars are preferred to steel or PVC tubes because they are more durable and more importantly they are much safer compared to steel or PVC. If a shell or salute were to malfunction (flowerpot) in the mortar, HDPE tends to rip or tear instead of shattering and becoming shrapnel like PVC, which can kill or maim onlookers. PVC and steel are particularly prone to this and their use is avoided where possible. Milk bottles and other hollow goods manufactured through blow molding are the most important application area for HDPE – More than 8 million tons, or nearly one third of worldwide production, was applied here. Above all, China, where beverage bottles made from HDPE were first imported in 2005, is a growing market for rigid HDPE packaging, as a result of its improving standard of living. In India and other highly populated, emerging nations, infrastructure expansion includes the deployment of pipes and cable insulation made from HDPE. The material has benefited from discussions about possible health and environmental problems caused by PVC and Polycarbonate associated Biphenyl A, as well as its advantages over glass, metal and cardboard.

- It is having large strength to density. The density of HDPE can range from 0.93 to 0.97 g/cm3.
- High specific strength.
- It is also harder and more opaque and can withstand somewhat higher temperatures [1200 C/2480 f for short periods]
- It is also stronger than LDPE
- High tensile strength-26.6 MPa
- Density– 0.958 g/cc
- Water absorption-0.111
- Elongation at yield 10.4%
- Modulus of elasticity 0.883 GPa
- Flexural strength 62.5 MPa

Applications:

Following are the some of the applications of HDPE. HDPE is resistant to many different solvents and has a wide variety of applications, including:

- Bottle caps
- Chemical–resistant piping
- Coax cable inner insulator
- Food storage containers
- Corrosion protection for steel pipelines
- Fire works
- Plastic bags
- Plastic lumber etc
- Backpacking frames
- Ballistic plates
- Bottle caps
- Bottles, suitable for use as refillable bottles
- Chemical resistant piping systems
- Coax cable inner insulators (dielectric insulating spacer)
- Containers
- Fuel tanks for vehicles
- Laundry detergent bottles
- Milk jugs
- Watering cans
- Corrosion protection for steel pipelines
- Folding chairs
- Folding table
- Geothermal heat transfer piping systems
- Heat-resistant fireworks display mortars
- Hula hoops
- Meter & Valve Boxes
- Natural gas distribution pipe systems
- Plastic bags
- Plastic lumber

LIMESTONE POWDER

Introduction about limestone:

Limestone is a sedimentary rock, composed mainly of skeletal fragments of marine organisms such as coral and mollusks. Its major materials are the minerals calcite and aragonite, which are different crystal forms of calcium carbonate ($CaCO_3$).About 10% of sedimentary rocks are lime stones. The solubility of limestone in water and weak acid solutions leads to karts landscapes, in which water erodes the limestone over thousands to millions of years. Most cave systems are through limestone bedrock. Limestone has numerous uses: as a building material, as aggregate for the base of roads, as white pigment or filler in products such as toothpaste or paints, as a chemical feedstock for the production of lime, or as a popular decorative addition to rock gardens. The first geologist to distinguish limestone from dolomite was BelsazarHacquet in 1778.Limestone often contains variable amounts of silica in the form of chart (chalcedony, flint, jasper, etc.) or siliceous skeletal fragment (sponge specula's, diatoms, radiolarians), and varying amounts of clay, silt and sand (terrestrial detritus) carried in by rivers. Most cement plants consume much energy and produce a large amount of undesirable products, which affect the environment. In order to reduce energy consumption and CO2emission and increase production, cement manufacturers are blending mineral additions such as slag, natural pozzolan, sand and limestone, limestone has been used in concrete production for the last 25 years, not only for the main purposes of lowering the costs and environmental load of cement production, but also to increase the concrete durability, more recently limestone is also used as a filler material to improve the workability and stability of fresh concrete and for a high flow able concrete. Limestone is a sedimentary rock composed primarily of calcium carbonate ($CaCO_3$) in the form of the mineral calcite. It most commonly forms in clear, warm, shallow marine waters. It is usually an organic sedimentary rock that forms from the accumulation of shell, coral, algal, and fecal debris. It can also be a chemical sedimentary rock formed by the precipitation of calcium carbonate from lake or ocean water.

Fig.3.1.Limestone

Fig.3.2.Microscopic structure of limestone

Limestone is by definition a rock that contains at least 50% calcium carbonate in the form of calcite by weight. All limestone contain at least a few percent other materials. These can be small particles of quartz, feldspar, clay minerals, pyrite, siderite, and other minerals. It can also contain large nodules of pyrite, or siderite. The calcium carbonate content of limestone gives it a property that is often used in rock identification - it effervesces in contact with a cold solution of 5% hydrochloric acid.

Table 3.1.1 Physical properties of limestone:

Hardness	3 to 4 on Mohr's scale
Density	2.5 to 2.7 kg/cm3
Compressive strength	60 – 170 N/mm2
Water absorption	Less than 1%
Porosity	Quite low
Weather impact	Resistant

Table3.1.2 Chemical properties of limestone:

Lime [cao]	38-42%
Silica [sio3]	15-18%
Alumina [al203]	3-5%
Mgo	0.5 to 3%
Feo + fe2o3	1-1.5%
Alkalies	1-1.5%

Applications:

Following are the applications of limestone

- Roads and railroads
- White lines
- Cleaning products
- Limestone is main component of glass
- Used in water treatment
- Wall coatings
- Used in themanufacturing of greases and lubricants etc.
- Powdered limestone is used as filler in paper, paint, rubber, and plastics.
- Crushed limestone is used as a filter stone in on-site sewage disposal systems.

HDPE REINFORCED WITH LIME STONE

Specimen preparation:

To prepare the composite material, the fibers in pre-determined weight proportion (5, 7.5, and 10%) are reinforced in random orientation into the HDPE. The natural fiber composite specimens were fabricated by the hydraulic compression molding machine. At first, switch on the heater of compression molding machine. Take two aluminum plates and apply wax o the plates so that the material does not stick inside the mold. Put aluminum square plates on the middle plate, put the mold on the square plate and fill the raw material in a manner that no bubbles are formed. Now put the second square plate over the mold. Apply pressure till the pressure gauge shows pressure of 120kg/mm^2 and let the pressure remains constant throughout the cooling process.

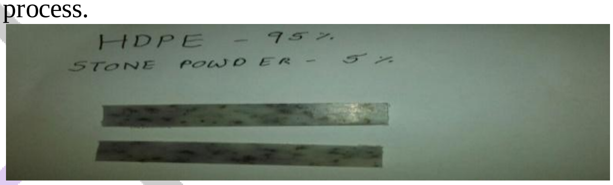


Fig (a): HDPE-95% & limestone-5%

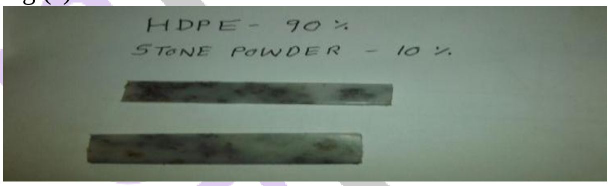


Fig (b): HDPE-90% & limestone-10%

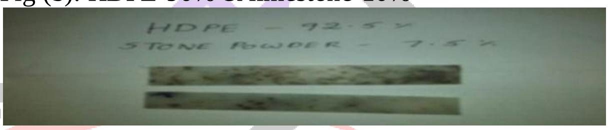


Fig (c): HDPE-92.5% & limestone-7.5%

Fig4.1: Composite material consisting HDPE reinforced with limestone

Curing:

The casting is put under load for about 3 hours for proper curing at temperature after this, molds are cured further a constant room temperature of up to 350C in order to treat the cast and also to remove it from hydraulic press machine. The composite specimen prepared with a size of 110 x 110 x 3 mm. The composite specimens are shown in the figure and the designations of composite specimens are shown in table.

Fig.4.2.Hydraulic pressing machine

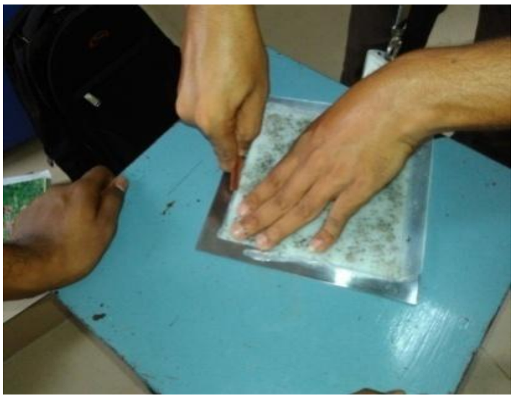


Fig.4.3.Material preparation

Table4.1.Designation of composites:

DESIGNATION		COMPOSITION
C1	Lime stone	HDPE (95%) + STONE POWDER (5%)
C2		HDPE (92.5%) + STONE POWDER (7.5%)
C3		HDPE (90%) + STONE POWDER (10%)

MECHANICAL CHARACTERIZATION TECHNIQUES

Introduction:

The Specimens of HDPE reinforced with stone powder composites are prepared as per the ASTM standards to evaluate various mechanical properties such as tensile strength, compression, flexural strength, and Izod impact strength.

Fig.5.1.Pure HDPE specimen

Tensile strength:

Tensile properties were evaluated as per ASTM D 538 using rectangle shaped samples and an INSTRON Universal testing machine model 3342 tensile tester with a cross head speed 5mm/min. The dimensions of the specimen were 160 mm in length, 12.5 mm in width and 3mm thickness. The UTM used for testing tensile properties is shown in fig., and the specimens for tensile test are shown in figure.

Fig.5.2.HDPE & limestone composite for tensile testing

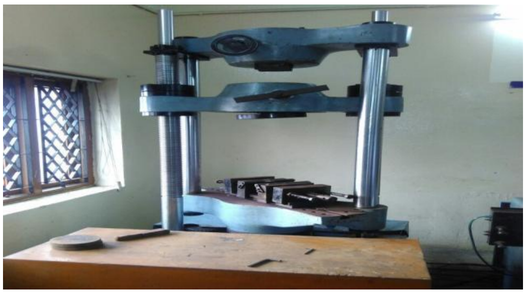


Fig.5.3 (a).Universal Tesing Machine

Fig.5.3 (b).HDPE& Limestone Composite material Specimen setting

Operation of machine is by hydraulic transmission of load from the test specimen to a separately housed load indicator. The hydraulic is ideal since it replaces transmission of load through levers & knife edges which are prone to wear and damage due to shock to rupture of test pieces. Load is applied by a historically lubricated ram. Main cylinder pressure is transmitted to the cylinder of 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 a lever system to a 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 a specimen.

Table.5.1 Tensile test results:

Test Results					
S. No	Sample identification	Width(mm)X Thk(mm)	Area,mm²	Ultimate Tensile Load (N)	Ultimate Tensile Strength (MPa)
1	HDPE 90% STONE POWDER 10%	26.55x2.60	69.03	840	12.17
2	HDPE 95% STONE POWDER 5%	24.84x2.59	64.33	1080	16.79
3	HDPE 92.5% STONE POWDER 7.5%	23.84x2.61	62.22	1320	21.22

Flexural strength:

Flexural properties are evaluated according to ASTM D 790-2003 using an INSTRON Universal Testing Machine model 3342 with a cross head speed of1.3 mm/min. The dimension of the specimen was 160 mm in length, 160mm in width and 3mm thickness. The UTM used for testing flexural properties is shown in fig.5.4, and the specimens for flexural test are shown in fig.

Fig.5.4.Flexural Testing Machine

Experimental procedure:

1. Measure the width and thickness of the specimen including the span length in the table provided for the calculation of the stress and elastic modulus. Mark on the locations where the load will be applied under three-point bending.
2. Bend testing is carried out using a universal testing machine until failure takes place. Construct the load-extension or load-deflection curve if the dial gauge is used.
3. Calculate the bend strength, yield strength and elastic modulus of the specimen.
4. Describe the failure under bending and sketch the fracture surfaces in the table provided.
5. Noted the obtained experimental results.

Fig.5.5.HDPE & limestone Composite Specimens for Flexural Test

Table 5.2 Flexural strength results:

Test Result									
Sl No	Sample ID No	Load,p (N)	l (mm)	3pl	b (mm)	d (mm)	d*d	2bd^2	Flexural Strength (3pl/2bd^2) (N/mm^2)
1	HDPE 90% STONE POWDER 10%	240	70	50400	22.70	2.60	6.76	306.90	164.22
2	HDPE 95% STONE POWDER 5%	240	70	50400	23.84	2.59	6.7081	319.84	157.58
3	HDPE 92.5% STONE POWDER 7.5%	260	70	54600	24.91	2.60	6.76	336.78	162.12

Izod impact test:

Izod impact properties were evaluated according to ASTM D256 using impact Kaiser Technique tester model impact KI 300 with a notch angle 450 and depth of 2.54 mm. The dimensions of the specimen are 60mm in length, 12.5mm in width and 3mm thickness. The impact testing machine used for test impact properties is shown in fig. and the specimens for impact test are shown in fig.

Fig.5.6.Impact Testing Machine

Experimental Procedure:

Note: Test one material with three specimens for each temperature,

1. Check the zero calibration of the impact tester.
2. First, test a specimen at room temperature.
3. Based on the room temperature result, decide whether to concentrate on higher or lower temperature.
4. Test specimens over a selected range of temperatures, attempting to establish a fully ductile test, a fully (or nearly) brittle test, and as many temperatures in between as possible. .

5, Note fracture energy and estimate the % brittleness from the appearances of fracture surfaces of the specimens.

Fig.5.7.HDPE& limestone composite specimen for impact test

Table.5.3 Izod strength results:

IZOD Impact V notch at Room Temperature		
Sl No	Sample Description	Observed Values (Joules)
1	HDPE 90% STONE POWDER 10%	2J
2	HDPE 95% STONE POWDER 5%	2J
3	HDPE 92.5% STONE POWDER 7.5%	2J

Hardness test:

Number is shown in According to ASTM D 785, the Shore hardness tester is used for testing hardness of the composite. For testing the hardness Ball indenter is used.

Fig.5.8.Shore hardness tester

The diameter of the ball indenter is 0.125 inches and maximum load applied is 60kgs. The Rockwell hardness tester is used for testing hardness figure. Easy to operate, allowing quick measurement. The depth of indentation is small so that it can be used for product inspection. A wide range of measurement is available from small specimens to large specimens, with more applications possible by using special accessories such as the swing arm or roll testing stand. The Shore hardness testing machine is designed for easy hardness measurement where test machine and test method must be in compliance with the JIS standard. It is suitable for hardness testing of large, heavy, and difficult to move items such as rolls and for hardness measurement of finish surfaces. It has a compact body that is easy to move. By removing the measurement tube, it can be used to directly measure the hardness of the specimen.

Table.5.4 Hardness test results:

Test Results

S.No	Sample Description	Shore 'D' Hardness
1	HDPE 90% STONE POWDER 10%	67,67,67
2	HDPE 95% STONE POWDER 5%	67,68,68
3	HDPE 92.5% STONE POWDER 7.5%	67,67,68

Water absorption test:

When an organic matrix composite is exposed to a humid environment or liquid, both the moisture content and material temperature may change with time. These changes usually degrade the mechanical properties of the laminate. The picture of Water absorption test is shown in figure.

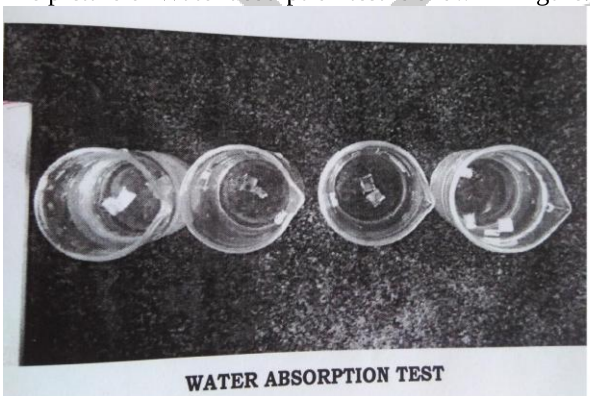


Fig.5.9.Water absorption test

The study of water absorption within the following composites is based on

- The temperature inside the material as a function of position.
- The moisture concentration inside the material.
- Thetotal amount of moisture inside the material.
- The dimensional changes of the material.
- The mechanical, chemical, thermal and electrical properties changes.

The water absorption test was performed as per the ASTM D5229/D5229M – 92, the specimens are immersed in distilled water for 24 hours under room temperature conditions. The initial and final weighs of the specimens were noted before placing the specimen into the beaker and after removing out of the beaker.

RESULTS AND DISCUSSIONS

The prepared Specimens of HDPE reinforced with limestone

Wt% of the limestone	5	7.5	10
Tensile strength (MPa)	16.79	14.56	12.17
Flexural strength (MPa)	157.58	162.12	164.22
Izod impact (J/mm2)	2.10	2.18	2.25
Hardnes	67.66	67.33	67

are subjected to various mechanical tests such as tensile strength, flexural strength, impact strength, hardness and Water Absorption chemical test. The Experimental results of HDPE reinforced with limestone are given in table.

Table.6.1.Mechanical Properties of HDPE reinforced with limestone composite

Variation of tensile strength with respect to fiber loading:

The variation of tensile strength of the composite material with respect to Wt% of fiber loading from the table,it is inferred that, as the wt% of fiber loading inreases the tensile strength of the composite material decreases . As the wt% of fiber loading increases the bonding between the resin and the reinforcing material decreases. The maximum tensile strength of 16.79Mpa was noticed at 5%Wt of fibre loading.

Variation of flexural strength with respect to fiber loading:

flexural strength results of control and different fiber loaded composites (with HDPE) were shown in Table. The mechanical property of the composites such as flexural strength is increasing with addition of fiber. When the fiber loading is increased from 5 to 10% for the HDPE reinforced with limestone composites the Flexural strength was increased from 157.58 N to 164.22 N.

Variation of impact strength with respect to fiber loading:

The Izod impact property is another key important characteristic of the composite structure, especially due to its significance in many applications such as automotive and architecture applications. Therefore the mechanical property of the composites such as Impact strength is increasing with addition of fiber. When the fiber loading is increased from 5 to 10% HDPE reinforced with limestone composites the impact strength was increased from 2.10 J/mm2 to 2.25J/mm2. **Variation of hardness with respect to fiber loading:**

The Hardness is predominant property in processing of composite materials. The influence on the hardness of HDPE resin reinforcement with limestone composite material is decreasing with the increase in fiber weight fraction. In the present investigation the maximum hardness value of 67.66 was noticed at the fiber weight fraction of 5% of limestone reinforced HDPE composite and minimum hardness value of 67 was noticed at the fiber weight fraction of 10% of the composite.

CONCLUSIONS

- The composite materials were prepared using the HDPE resin by varying the Weight Percentage of stone powder Fiber. The above said samples are subjected to Tensile strength, Flexural strength, Impact strength, and hardness.

- The different test samples with different fiber weight fraction were successfully fabricated by Hydraulic press.

- For stone powder reinforced HDPE composites as the fiber loading is increased from 5% to 10% the Tensile strength was decreased from 16.79 MPa to 12.17 MPa.

- The Flexural strength is also increased from 157.58 MPa To 164.22 MPa, when the Fiber loading increased from 5% to 10%.The Impact strength is increasing from 2.10 J/mm2 to 2.25 J/mm2 for increasing in fiber weight Percentage from 5 to 10%.

- Among the above resins the HDPE with 5% lime stone posses better Tensile strength, HDPE with 10% stone powder posses better Flexural strength, HDPE with 10% stone powder posses better Izod Impact strength, and HDPE with 10% stone powder posses better hardness.

- By comparing the HDPE resin reinforced with stone powder fiber composites shows better results than some other Reinforced composites.

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