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Marble Dust Reinforced Composites: A Review

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Abstract- It is important to have a proper management of any waste and it can be efficiently achieved by using waste's potential in the development of some value added products. Marble processing units generate huge quantities of waste during different maneuvers such as cutting and polishing processes.About 16 million tons of this waste has been created in India alone annually. This dust adversely affects the environment; it decreases productivity of land by water absorption, decreases porosity, water percolation and also leads to air pollution.The effective use of marble waste particulates in the development of innovative advanced materials will serve the purpose of protecting the earth and becoming clean and green. Use of mineral fillers like marble waste particulates in the manufacturing of polymer composites is generally cost-effective.

Keywords- composite materials, epoxy, marble dust

I. INTRODUCTION

Composite materials have played an important role throughout human history, from housing early civilizations to enabling future innovations. Composites offermany benefits; the key among them are corrosion resistance, design flexibility, durability, light weight, and strength.

Composites have permeated our everyday lives such as products that are used in constructions, medical applications, oil and gas, transportation, sports, aerospace, and many more. In general, a composite consists of three components: (i) the matrix as the continuous phase; (ii) the reinforcements as the discontinuous or dispersed phase, including fiber and particles; and (iii) the fine interphase region, also known as the interface.

By carefully choosing the matrix, the reinforcement, and the manufacturing process that brings them together, the engineers can tailor the properties to meet specific requirements. Over the recent decades, many new composites have been developed, some with very valuable properties. [1]

Epoxy is a common thermoset resin used to make composite materials. Epoxy resins are used in a wide range of composites parts, structures and concrete repairs. Major benefits of using epoxy include it ability to be tailored to different products, their low shrinkage, strong mechanical properties, resistance to corrosive liquids and environments, superior electrical properties, good performance at elevated temperatures, and good adhesion to substrates. [5]

Several researches are being done on particulate filled polymers. Since the conventional fillers like metal and ceramic powders are quiet expensive, it is important to replace them with cheap and abundantly available filler materials. One such material is marble dust, which is a waste produce from marble industry.

II. LITERATURE REVIEW

[T Naveen et al] In this research marble powder reinforced epoxy composite was prepared and tested, with various wt% ratios of epoxy and marble powder composition. Results showed that the mechanical properties like hardness and impact strength of marble powder reinforced epoxy were enhanced. It concluded that marble powder epoxy composite can be used as an effective replacement for natural marble because of its lower density.

[Mahavir Choudhary et al] this research was focused on the study of the erosive wear response of epoxy based marble dust filled aramid bidirectional fabric-reinforced polymer composite. Steady state erosion test is performed on different impingement angle to investigate the erosion behavior of composites. The results reveal that erosive resistance of the composites is increasing with incorporation of marble dust and exhibit semi brittle erosion behavior.

[Sandip Kumar Nayak et al] This study shows the successful fabrication of polyester-based composites filled with micro-sized waste marble dustthrough solution casting technique.A Fourier transform infrared spectroscopy study is done to get an insight into the chemistry of composite formation. Scanning electron microscopy reveals the surface features of the filler as well as the composites. X-Ray diffraction tests are carried out on the raw filler and on the composites to ascertain the presence of hard phases. This research concluded that-While the tensile and flexural strengths decrease with the increase in marble dustcontent, improvements are noticed in the values of compressive and impact strength of the composites. Both the content and the mean particle size of the filler are found to be significantly affecting the strength properties of the composites. It reveals that the composite Shore hardness improves with the incorporation of marble dust. The presence of hard ceramic phases as identified by X-ray diffraction tests attribute to the improvement in the hardness of the composites. With lightweight, improved hardness, and good impact strength, these polyester–marble composites are expected to find potential use in wear-related engineering applications.

[Subhrajit Ray et al] this research investigates the improvement in the thermal conductivity of marble filled epoxy composites. The proposed model found to be the alternative to use the industrial by-product for successful manufacturing of new class of composites in view of heat conductivity capacity.Numerical Analysis-Numerically, the effective thermal conductivities of marble filled (6.5 wt %) epoxy composites are evaluated using ANSYS. Experimental determination of thermal conductivity- To measure the thermal conductivity of polymers Untherm TM 2022 model is used. The test was carried out as per ASTM E-1530 standards.Finite element method- Finite element method (FEM) was used as a computational technique. The study concluded that the incorporation of waste marble powder results in improvement of the thermal conductivity of the epoxy-based composite. With the addition of 1.4 vol. % of marble powder thermal conductivities increases by 4.9% and with 6.5 vol. % it improves by 20.1 % with respect to neat epoxy, and these developed epoxy-marble composites can be used for die (chip) attach, heat interface material, aerodynamic rotor blade, encapsulation, electrical cable insulation, electronic package, etc.

[Juana Abenojar et al] this research aimed to manufacture a composite material based on marble with acceptable mechanical properties and fire resistance, to be used in construction industry. To achieve this objective, polyester matrix composites with 50 wt. % of marble and 3 wt. % of glass fiber (short fiber or mesh) were prepared. Samples were characterized mechanically through flexural test, Charpy impact test, compression test and wear resistance by pin-on-disk test. Fracture surfaces were analyzed by scanning electron microscope (SEM), and wear tracks were studied by SEM and 3D optical profilometer. Besides, samples were

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subjected to fire test using a Bunsen burner at 900 Celsius for 20 min. Results show that marble improves mechanical properties of polyester and the effect of the glass fiber depends on its morphology (fiber or mesh). Fire resistance is high, and the fire goes out when the flame is turned off. Furthermore, the mesh maintains the integrity of the sample.

III. MARBLE DUST

Marble is a metamorphic rock formed from limestone by heat and pressure in the earth’s crust due to geological processes. Marble powder is extensively used with cement in constructions and sculpture industries. Marble has a very less content of; density is 2.7 g/cm3 quartz (0.2%), and relative porosity being 0.4%. It is used in architecture as a building material, in the arts for sculpture and in many other applications. The word ‘marble’ is used to refer to many other stones that are efficient of taking a high polish exhibiting different composition, origin and commercial properties. Marble results from metamorphism of sedimentary carbonate rocks. This metamorphic process causes a complete recrystallization of the original rock into an interlocking mosaic of dolomite crystals or calcite. The temperatures and pressures necessary to form marble commonly eradicate any fossils and sedimentary textures commenced in the original rock. During processing, 30% of the Marble stone is discarded to scrap because of its irregular shape and/or being smaller in size. Millions of tons of marble powder is extracted and processed every year around the Globe. As a result, significant environmental damage occurs due to the large quantities of marble dust produced from these industries. In Rajasthan, a large quantity of marble dust is produced during machining of stones. This marble dust when left unattended affects the productivity of land by water absorption decreased porosity, water percolationand also leads to air pollution.[2] Waste product of marble (marble dust) being dumped on the river beds or on roadsides and on undulated open land is a major environmental concern and has become a major threat to surrounding ecosystem .In dry conditions, the marble waste particulate dangle in the air around us and have the tendency to be deposited on vegetation, crops and significantly affects the ecology. Also, it results indecrease in porosity/permeability of the topsoil contributing to the water-logging followed by decreasing the soil fertility, crop yield as a result of increase in soil alkalinity. [7]

IV. HYBRID COMPOSITES

Hybrid composites are materials that are fabricated by combining two or more different types of fibers within a common matrix. There are several definitions of hybrid composites given by various researchers. Thwe and Liao defined hybrid composites as a reinforcing material incorporated in a mixture of different matrices. On the other hand, Fu et al. explained that these composites are a reinforcing material that is incorporated into two or more reinforcing and filling materials that are present in a single matrix. Hybrid composites are more advanced than other fiber-supported composites, and have a wider range of potential applications. Previous studies on natural–synthetic fiber hybrid composites have primarily focused on reducing the use of synthetic fibers. Furthermore, a previous study described the potential advantages associated with natural–synthetic fiber hybridization [8].

[Sandip K. Nayak et al] this research has explored the use of marble dust, an industrial/construction waste as secondary filler in the glass-polyester material system to prepare wear-resistant hybrid composites. Hybrid composites are fabricated through a simple hand layup route.Dry sliding wear trials are conducted under different test conditions using a pin-on-disc test rig as per ASTM G 99-05 following Taguchi's L 25 orthogonal array. Scanning electron microscopy of the worn composite surfaces is done to ascertain the possible wear mechanisms. Analysis revealed that the incorporation of filler helps in reducing the wear rate of the composites. Thus, the wear resistance of glass-polyester composites is improved significantly by the incorporation of marble dust.

V. CONCLUSION

It can be concluded through the study that using marble dust as filler material in composites is a very effective way of reducing the environmental pollution.Use of marble dust is also very cost effective as it is quite cheap as compared to conventional filler materials.Use of marble dust in composites also increase their mechanical properties, thus it can be said that marble dust can be a potential filler and reinforcement material to obtain high strength and low thermally conductive composites for multiple applications.

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