

Design and Fabrication of Die for Composite Materials

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ABSTRACT

Several molding techniques fall under die making process. Commonly there are two methods in die making process. They are two methods in die making process. There are hand layup method and compression molding method. The common features in all these technique is that the mould consist of two parts (upper and lower) that form a intermediate in between them. The shape of the cavity corresponds to that of the parts to be moulded. The moulds are fabricated with steel, because the steel has high strength and low cost. Fiber reinforced (natural fiber) are also used in moulding process. Compression moulding is commonly used method. It is employed in fabrication of automobile body panels, housing for electrical appliances and machines, covers, sinks and several other products. In this project the mould material used in resin coated fabrics- polyester. Polyester is less expensive and it is suitable for researchers.

Keywords: PMC's, Compression Molding Method, Natural fiber (Coconut Sheath), Polyester Resin.

INTRODUCTION

Manufacturing is the backbone of any industrialized nation. Manufacturing and technical staff in industry must know the various manufacturing processes, materials being processed, tools and equipments for manufacturing different components or products with optimal process plan using proper precautions and specified safety rules to avoid accidents. Beside above, all kinds of the future engineers must know the basic requirements of workshop activities in term of man, machine, material, methods, money and other infrastructure facilities needed to be positioned properly for optimal shop layouts or plant layout and other support services effectively adjusted or located in the industry or plant within a well planned manufacturing organization. The study deals with several aspects of workshops practices also for imparting the basic working knowledge of the different engineering materials, tools, equipments, manufacturing processes, basic concepts of electromechanical controls of machine tools, production criteria's, characteristics and uses of various testing instruments and measuring or inspecting devices for checking components or products manufactured in various manufacturing shops in an industrial environment. It also describes and demonstrates the use of different process (welding, drilling, grinding and cutting etc.), equipments, machinery and various methods of manufacturing that facilitate shaping or forming the different existing raw materials into suitable usable forms. It deals with the study of industrial environment which involves the practical knowledge in the area of composite materials, their properties and uses. It should provide the knowledge of basic workshop processes namely pattern making, mould making, foundry,

smithy, forging, metal working and heat treatment, welding, fastening, machine shop, surface finishing and coatings, assembling inspection and quality control. It emphasizes on basic knowledge regarding composition, properties and uses of different raw materials, various production processes, replacement of or improvement over a large number of old processes, new and compact designs, better accuracy in dimensions, quicker methods of production, better surface finishes, more alternatives to the existing materials and greater output.

SCOPE OF THE STUDY

From the title that has been given, the development of this project must include how to make a die for composite materials using advance software like cad and solid works and how to fabricate the system of the fiber piece. It also needs some knowledge and skill to finish the project. There is some other guide must followed to finish this project. The main objective of our mini project is to make a die for composite materials by using universal testing machine. For a developing industry the operation performed and the parts (or) components produced should have it minimum possible production cost for it to run profitability. It is employed in fabrication of automobile body panels, housing for electrical appliances and machines, covers, sinks and several other products. In this project the mould material used in resin coated fabrics- polyester. Polyester is less

COMPRESSION MOULDING AND UNIVERSAL TESTING MACHINE

Compression molding is the most commonly used matched-die molding method. It is employed in fabrication of automobile body panels, housings for electrical appliances and machines, covers, sinks and several other parts. The moulds can have a single cavity or multiple cavities with complex curved shapes. Provision may exist to heat either or both the moulds. The pressure is applied by mounting the moulds in a mechanical or hydraulic press or by some external means. The precise application of pressure and temperature and their duration and cycles can be controlled. The process can also be easily automated. On application of pressure and temperature, the mould material softens and then flows and fills the mould cavity. Further, continuation of heat and pressure accelerates curing. The dimensions close to those of the desired finished part can be obtained in compression molding. This reduces, to a great extent, subsequent trimming and machining. The molding material may be a predetermined quantity of BMC, SMC, resin coated performs (or) fabrics or prepregs. It is laid on the mould and then the moulds are closed. A barrier along the edge prevents the resin to flow out. The depth of the barrier also controls the thickness of the part. Heat and pressure are applied during curing. Once the curing is complete, the mould is opened and the part is removed. Some resins like polyesters and epoxies are highly exothermic and may not require external input of heat during curing. The molding material with these resins can be cold pressed.



Figure 1: Compression Molding Machine

In this study a universal testing machine is used to test the tensile 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. The compression molding method is more expensive one. In our campus there is no separate machine for compressing the material. Instead of using the compression molding machine we are using UTM machine which are suitable for researches.

COMPOSITE MATERIALS

A composite material is a material system composed of a suitably arranged mixture or combination of two or more micro- or macro- constituents with an interface separating them that differ in form and chemical composition and are essentially insoluble in each other. At the atomic level materials such as some metal alloys and polymeric materials could be called composite materials since they consist of different and distinct atomic groupings. Material property combinations and ranges have been, and are yet being, extended by the development of composite materials. Generally speaking, a composite is considered to be any multiphase material that exhibits a significant proportion of the properties of both constituent phases such that a better combination of properties is realized. According to the principle of combined action, better property combinations are fashioned by the judicious combination of two or more distinct materials. Many composite materials are composed of two phases; one is termed the matrix, which is continuous and surrounds the other phase, other called the dispersed phase. "Dispersed phase geometry" in this context means the shape of the particles and the particle size, distribution, and orientation. One simple scheme for the classification of composite materials consists of three main divisions: particle-reinforced, fiber-reinforced, and structural composites; also, at least two subdivisions exist for each. The dispersed phase for particle-reinforced composites is equiaxed (i.e., particle dimensions are approximately the same in all directions); for fiber-reinforced composites, the dispersed phase has the geometry of a fiber (i.e., a large length-to-diameter ratio). Structural composites are combinations of composites and homogeneous materials. Generally composites materials can be classified as polymer matrix composites, metal matrix composites and ceramic matrix composites. They can be further classified by reinforcement as particulate composites, flake composites and fiber composites.

Polymer Matrix Composites

It comprises of a matrix from thermosetting (unsaturated polyester) or thermoplastic (nylon, polystyrene) and embedded glass carbon, steel or Kevlar fibers (dispersed phase). They are not able to withstand high temperature and it may insensitive to moisture. This is the major disadvantages of polymer matrix composite

Advantages

They have improved high strength to weight ratio, high stiffness to weight ratio. better fatigue resistance. high impact resistance. corrosion resistance, good thermal conductivity and high damping capacity

Applications

In automotive industry drive shafts, clutch plates, engine blocks, push rods, frames, valve guides, automotive racing brakes, filament-wound fuel tanks were used. In aircraft drive shafts, rudders, elevators, bearings, landing gear doors,

panels and floorings of airplanes are used. In space payload bay doors, remote manipulator arm, high gain antenna, antenna ribs and struts. In marine propeller vanes, fans and blowers, gear cases, valves and strainers, condenser shells. In chemical Industries composites vessels for liquid natural gas for alternative fuel vehicle, racked bottles or fire service, mountain climbing, underground storage tanks, ducts and stacks, etc.

COMPONENTS USED

Metal Plate Totally there are three metal plates used in this work. The metal plate is made up of mild steel material. It is brought in Theni. The metal plate weighs about 13.5 kg. The purpose of using mild steel material is it is one of the most common of all metals and one of the least expensive steels used.

Fiber (Coir Sheath) Coconut sheath fiber is one of the base materials of our project which is collected from the local resource. The naturally woven coconut coir sheath fiber was collected.

Resin is the most specific use of the term is a hydrocarbon secretion of many plants, particularly coniferous trees. Resins are valued for their chemical properties and associated uses, such as the production of varnishes, adhesives and food glazing agents. They are also prized as an important source of raw materials for organic synthesis, and as constituents of incense and perfume. In our project we are using polyester resin.

Polyester Resin is a synthetic material manufactured through the reaction between organic acids and alcohols. It can take several forms, including liquid, gel, and film, and has different properties that make it a useful material in many industries. Architects, builders, engineers, and designers all take advantage of the light weight, weatherproof strength of polyester resin in a variety of applications.

Pin a short, straight, stiff piece of wire with a blunt head and a sharp point, used especially for fastening. Something, such as a safety pin, that resembles such a piece of wire in shape or use.

DIMENSION DETAILS

Table 1: Dimensions of Material

SI NO	MATERIALS	DIMENSIONS
1	MS Plate (Upper & Lower)	Length : 300mm Breadth : 300mm Thickness: 6mm Hole dia : 10mm
2	Inner Plate	Length : 220mm Breadth : 220mm Thickness: 6mm Hole dia : 10mm
3	Pin	Dia : 10mm Thickness: 22mm

DESIGN DETAILS

This drawing will explain about the design and sketching that had been chosen to be as the final idea to be produce or fabricate.

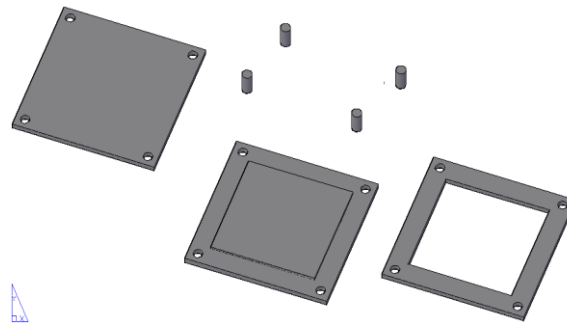


Figure 2: Design Drawing

FABRICATION PROCESS

This chapter is present the fabrication process such as welding, drilling, grinding and others. Before fabrication process, the material selection is crucial. The selection of joining is also important to get a product with better strength and durability.

- ❖ The welding process is used to combine many part of material in welding surface cleaning machine fabrication.
- ❖ The drilling process is used to make hole on the material
- ❖ The grinding process is used to make a better surface

CONSTRUCTION

The various components used in our project are ms-steel plate, fiber, resin, pin are collected. The coconut sheath was collected and cut in to required shape (22.5mm * 22mm). At first wax is applied at all sides of the plate. And then the required amount of resin is taken in the beaker. It is mixed with the catalyst and the oxidizer. The catalyst is used for inducing the chemical reaction at a faster rate. The whole mixture is stirred well using the stirrer. The stirring is done continuously because if it is not stirred the mixture may get clotted. After that the resin is applied along the surface of the bottom plate. And then the second plate, where the inner cut was done which is in the shape of frame is placed over the bottom plate. The mixture is applied on the both sides of the coconut sheath. It is placed inside the metal frame. Another piece of coconut sheath is taken and is placed over the previous sheath with resin applied on the both sides. The third plate which has the extruded thickness of 6 mm is placed.

The constructions are schematically represented below which consists of coir sheath, applying wax, mixing the resins and proper placement of upper plate.



Figure 3: Cutting Coir Sheath



Figure 4: Applying of Wax



Figure 5: Mixing of Resin



Figure 6: Placing the Plate

WORKING PRINCIPLE

The whole set up is placed in the UTM machine for compression. Adjust the whole set up which is fitted into the UTM. To compress load is provided to the metal plate. The range of load for compressing the metal plate is 60 kg. Leave the experimental set up undisturbed for 4 to 6 hours. After few hours the experimental setup is removed from the UTM.



Figure 7: Placing the material in UTM

Then by exerting the pin from the whole, the metal plate is removed gradually. Due to wax applied, the fiber piece can be easily removed between the metal plates.

CONCLUSIONS

Thus the composite piece was created by using various machining operation such as cutting, grinding, welding, drilling, etc. Commonly there are two methods for making a die using composite materials. They are hand layup molding method and compression molding method. Among these two methods, the compression molding method is most suited one. But in our campus, there is no machine to compress and also its cost is high. So we had chosen the universal testing machine (UTM). From this the mechanical (tensile, impact) strength and vibration (damping, frequency) can be easily evaluated for composite materials. In other materials the qualities such as visual attractiveness, wear resistance, fatigue life, high strength, stiffness, etc are not good. To overcome these properties composite materials are used. It is employed in fabrication of automobile body panels, housing for electrical appliances and machines, covers, sinks and several other products. At present and in future research would be focused on composite. Our faculties are also giving importance and doing research on composite.

REFERENCES

- [1] Alavudeen, A., Thiruchitrambalam, M., Venkateshwaran, N., and Athijayamani, A. (2011). Review of Natural Fiber Reinforced woven Composite. *Reviews on Advanced Materials Science*, 27: 146-150.
- [2] Bisoyi D.k., (2012). Fabrication And Characterization Of Alkali Treated Natural Fiber Reinforced Polymer Composites: Department of physics, National Institute Of Technology Rourkela.
- [3] Winowlin Jappes, J.T., Siva, I., and Rajini N. (2012). Fractography Analysis of Naturally Woven Coconut Sheath Reinforced Polyester Composite: A Novel Reinforcement. *Polymer-Plastics Technology and Engineering*, 51: 419-424.
- [4] Velmurugan, R Mohan, T.P., Ramesh Kumar, M., and. (2006). Thermal, mechanical and vibration characteristics of epoxy-clay nanocomposites. *Journal of Materials Science*, 41: 5915-5925.
- [5] Tara Sen., Jagannatha Reddy, H.N. (2011). Application of Sisal, Bamboo, Coir and Jute Natural Composites in Structural Upgradation. *International Journal of Innovation, Management and Technology*, 2(3): 186-191.