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Project Report
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Bachelor of Engineering

in

Mechanical Engineering

Submitted by

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NEW HORIZON COLLEGE OF ENGINEERING

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DEPARTMENT OF MECHANICAL ENGINEERING

CERTIFICATE

Certified that **M N Sanath (1NH18ME062), Nihal C L (1NH18ME078), Prabhuling (1NH18ME087), Shivaprasad P M(1NH18ME103),** a bonafide student of **New Horizon College of Engineering**, **Bengaluru**, have successfully completed Project Work entitled **""** in partial fulfillment of the requirements for V semester Bachelor of Engineering in Mechanical Engineering of Visvesvaraya Technological University, Belagavi during academic year 2020-2021. It is certified that all Corrections/Suggestions indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The Project report has been approved as it satisfies the academic requirements in respect of Project Work prescribed for the Bachelor of Engineering degree.

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ABSTRACT

The need for test focusing on mechanical properties of sandwich materials has emerged during recent years as a consequence of the increased acceptance of structural concept in several weight critical applications. Sandwich composite is a special form of a laminated composite comprising a combination of different materials that are bonded to each other. The properties of each separate component is used to determine the structural advantage of the whole assembly. Usually a sandwich structure consists of two relatively thin, stiff and strong face plates separated by a relatively thick lightweight core. The purpose of sandwich structure is to achieve a stiff and simultaneously light component. The layers can have different structural shape or different material properties. The correct material content for the required application can be provided by the adequate determination of the types, properties, and portion of different components.

We are still collecting data from different resources to know this topic more in depth. In our project we are using carbon fiber as face plates and ThermoplasticPolyurethane (TPU) as core material.This paper reviews sandwich structures, various tests performed on it and their properties along with some studies on mechanical behavior. Major applications of the sandwich specimens are also highlighted in this work.

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CHAPTER 1
INTRODUCTION

1.1 Composite materials

A composite is a structural material that consists of two or more combined constituents that are combined at a macroscopic level and are not soluble in each other. One constituent is called the reinforcing phase and the one in which it is embedded is called the matrix. The reinforcing phase material may be in the form of fibers, particles, or flakes. The matrix phase materials are generally in continuous structure form. Examples of composite systems include concrete reinforced with steel and epoxy reinforced with graphite fibers, etc. Composites are also found naturally such as wood, where the lignin matrix is reinforced with cellulose fibers and bones in which the bone-salt plates made of calcium and phosphate ions reinforce soft collagen.The constituent materials play a key role in the development of the final material properties. Advanced composite materials used in structural applications are obtained by reinforcing a matrix material with continuous fibers having high strength and stiffness properties. The selection of a composite material for any application will involve selection of reinforcing fiber and matrix, and their fractional volume in the resulting material.Composites are classified based on matrix constituent and reinforcement constituents. There are different types of matrix materials and reinforcement materials too.

1.2 Sandwich structures

Sandwich structured composites are a special class of composite materials which have become very popular due to high specific strength and bending stiffness. Structural sandwich composite construction involves a number of layers of different materials, made of two identical thin and stiff face plates, separated by a thick, low-density core. The faces are adhesively bonded to the core to obtain a load transfer between the components. The adequate material selection results in a composite material with properties that are much more advantageous compared to other traditional materials.

In a practical point of view, these composite structures are worth to compare to metal structures, since the application of composite materials instead of metals provides a significant weight saving due to their low density. The main reason for choosing sandwich structures are their high strength-to-mass and stiffness-to-mass ratios compared to monolithic constructions. Composite sandwich structures are geometrically more complex than monolithic structures and have a very complicated behavior. We can create flat and curved elements from a sandwich structure. In addition to providing a very efficient load carrying structure this sandwich concept enables designing in multi-functional structures.

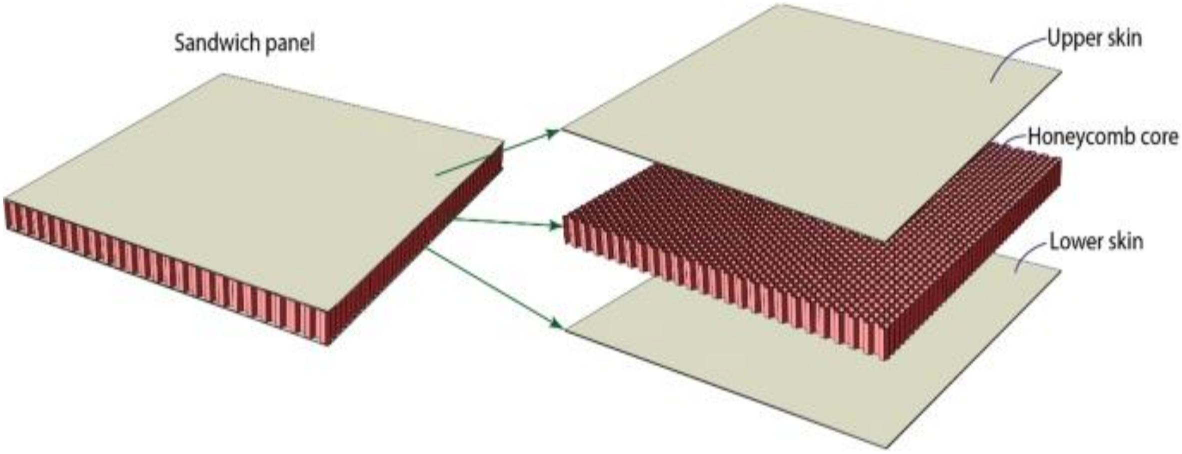


Fig 1.1 Schematic of a structural sandwich panel

The absorption of mechanical energy can in some deformation modes be multiplied compared with monocoque or unibody structures due to an imposed shorter modes of buckling waves. The use of cellular cores obviates the need to provide additional thermal insulation, ensuring low structural weight, since most cellular cores have a low thermal conductivity. Composites can be molded into almost any shape, which gives full design freedom. When building sandwich composite structures, the materials are shapeable until the last stage of production in which they get their final shape. This allows for non-linear and smooth designs, which can be done not only for esthetic but also aerodynamic reasons. Sandwich design enables lightweight construction and flexible, aerodynamic design that reduce fuel consumption and emission throughout the entire lifetime of the application. Composite materials are also very weather and corrosion-resistant, which means a minimum of maintenance and long life spans. Consequently, very little or no additional natural resources are needed to repair or renew the applications.An additional benefit is that sandwich solutions provide both thermal and acoustic insulation, thus increasing comfort and saving insulation materials.

CHAPTER 2
LITERATURE SURVEY

Literature survey is mainly carried out in order to analyse the background of the current project which helps to find out flaws in the existing system and guides on which unsolved problems we can work out. So, the following topics not only illustrate the background of the project but also uncover the problems and flaws which motivated to propose solutions and work on this project.

[1] Ireneusz Kreja, "Computational models for laminated composite and sandwich panels" in Gdansk University of Technology, Poland, 2011

Ireneusz Kreja surveyed on theoretical models for multi-layered plastics and shells and FEM implementation of various computational concepts. He used three layers of fiber reinforced composite laminate.

[2] A S Sayyad, YM Ghugal, "Vibration analysis of laminated composite and sandwich plates", 2017

A S Sayyadand Y M Ghugal researched on the free vibration analysis of multilayered laminated composite and sandwich plates using various methods available for the analysis of plates. Displacement fields of various displacement based shear deformation theories was compared and flexural mode frequencies of laminated composite and sandwich plates were researched and presented using a trigonometric shear and normal deformation theory.

[3] H Hu, S Belouettar, M Potier-Ferry, "assessment of various theories for modeling sandwich composites", 2008

H Hu, S Belouettar and M Potier-Ferry analyzed the various kinematics and theories used for the modeling of sandwich composites. Major classes of representative theories such as classical laminate theory (CLT), first-order shear deformation theory (FSDT) and high-order theories (HOTs) as well as Zig-Zag based theory models was considered and a unified kinematic formulation was proposed. Qualitative and quantitative assessments of displacement, stress fields and modal parameters was researched and discussed for several geometrical and mechanical sandwich beams configurations.

[4]Mallikarjuna, TKant, "refined theories of fiber-reinforced laminated composites and sandwich composites", 1993

Mallikarjuna and T.Kant**,** researched in transient dynamics, free vibrations and geometric nonlinear transient response in fiber reinforced laminated composites and sandwich composites.

[**5] AK Noor, WS Burton, CW Bert "Computational Models for Sandwich Panels and Shells", 1996**

A K Noor, W S Burton and CW Bert researched on the hierarchy of computational models for sandwich panels and shells, predictor-corrector procedures and sensitivity of the sandwich response to variations in the different geometric and material parameters. Their main application areas were heat transfer problems, thermal and mechanical stresses, free vibrations and damping, transient dynamic response, bifurcation buckling, local buckling, face sheet wrinkling, core crimping and post buckling problems.

CHAPTER 3
COMPOSITES AND TYPES

A composite material is a combination of two materials with different physical and chemical properties. When they are combined they create a material which is specialized to do a certain job, for instance to become stronger, lighter or resistant to electricity. They can also improve strength and stiffness. The reason for their use over traditional materials is because they improve the properties of their base materials and are applicable in many situations. Different types of composites are:

- **Ceramic matrix composite:** Ceramic spread out in a ceramic matrix. These are better than normal ceramics as they are thermal shock and fracture resistant.
- **Polymer matrix composite:** The matrix is made from polymer resin material like polyester, epoxy, polyurethane etc. These are light in weight, abrasion and chemical resistant.
- **Metal matrix composite:** The matrix is made from light metals like titanium, aluminium, magnesium etc. It has high fracture toughness, stiffness, etc.
- **Engineered wood:** Manufactured wood combined with other cheap materials. One example would be particle board. A speciality material like veneer can also be found in this composite.
- **Plywood:** Engineered wood by gluing many thin layers of wood together at different angles.
- **Carbon Fibre reinforced polymer:** Carbon fibre set in plastic. It produces rigid material with high strength-to-weight ratio. It is mainly used in body structures of automobiles and aeroplanes.
- **Sandwich panel:** A variety of composites that are layered on top of each other.
- **Composite honeycomb:** It is a mass of hexagonal cells inspired by the structure of honeycomb.
- **Syntactic foams:** Strong, light materials created by filling metals, ceramics or plastics with hollow spheres known as micro balloons. These balloons are made using either glass, carbon or plastic. This is used to create better buoyant materials for the use in marine applications.

CHAPTER 4
COMPOSITE SANDWICH PANELS:

Sandwich panels are composites which consist of two thin laminate outer skins and lightweight thick core structure. Owing to the core structure, such composites are distinguished by stiffness. Despite the thickness of the core, sandwich composites are light and have a relatively high flexural strength. The mechanical properties of these composites are directly dependent on the properties of sandwich components and method of manufacturing.

The two outer thin laminate outer skins are known as reinforcements or face plates. There are different types of reinforcements such as glass, aramid, carbon fiber, aluminium etc. They are selected based on type of core material selected and adhesive used. The inner core which of specific thickness and can be differentiated based on different structural organization such as homogeneously supported, locally supported, regionally supported, unidirectionally supported, bidirectionally supported.

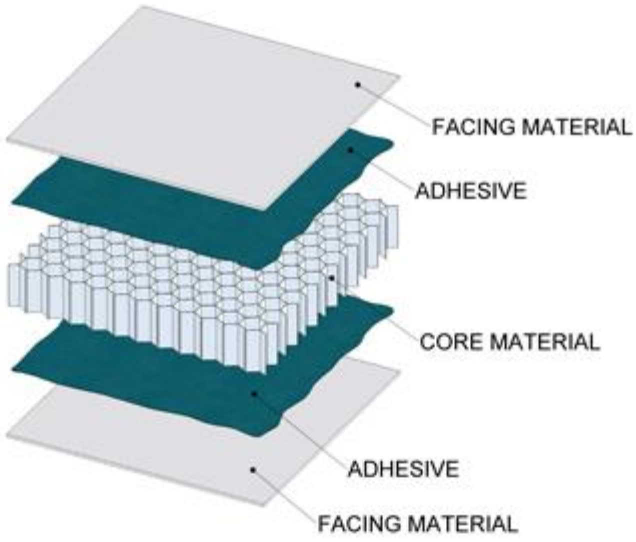


Fig 4.1: Schematic of Composite sandwich panel

Reinforcement materials can be in the form for fibers, sheets or panels. If they are in sheets they have to be fabricated first before using as face plates or reinforcements. Reinforcements such as carbon fibers are extremely used nowadays due to their high stiffness-to-weight ratio. Even metals such as aluminium and mild steel are also used. The composite made from these materials are used in automobile industries.

Core materials used are mainly in the form of honeycomb structures. A honeycomb shaped structure provides a material with minimal density and relative high out-of-plane compression properties and out-of-plane shear properties. These honeycomb structures are also made up of metals. Honeycomb materials are widely used where flat or slightly curved surfaces are needed and their high specific strength is valuable.

The strength of the composite material is dependent largely on two factors:

- **The outer skins:** If the sandwich is supported on both sides, and then stressed by means of a downward force in the middle of the beam, then the bending moment will introduce shear forces in the material. The shear forces result in the bottom skin in tension and the top skin in compression. The core material spaces these two skins apart. The thicker the core material the stronger the composite.
- **The interface between the core and the skin:** Because the shear stresses in the composite material change rapidly between the core and the skin, the adhesive layer also sees some degree of shear force. If the adhesive bond between the two layers is too weak, the most probable result will be delamination.

Fig 4.2: Carbon reinforcement with honeycomb core structure

CHAPTER 5
REINFORCEMENT MATERIALS

Reinforcement is a fundamental concept of operant conditioning, whose main purpose is to strengthen or increase the rate of behaviour. Reinforcement helps increase certain behaviour with the use of stimulus, which is called reinforcement. It provides structural performance required for the final part. Types of reinforcement materials are:

- **Carbon(Graphite):** Carbon Fibers are conductive, have an excellent combination of high modulus and high tensile strength and offers good resistance to high temperatures. Carbon fibre has the highest strength and highest price of all reinforcements fibers used in composites nowadays.

Fig 5.1: Carbon fibre

- **Fiberglass:** These are glasses spun into the form of fibers. These are not strong and stiff as carbon fibers but it has characteristics that make it desirable in many applications. Fiberglass is an insulator. There are different types of glassfibers such as alkali glass, chemical glass, electrical glass, structural glass and dielectric glass. When these are compared with each other they have different properties.

Fig 5.2: Fiberglass

- **Aramid:** Aramid fibers are a class of heat-resistant and strong synthetic fibers. They are used in aerospace and military applications, for ballisticrated body armor fabric and ballistic composites, in marine cordage, marine hull reinforcement, and as an asbestos substitute. These are low flammable, very high melting point.

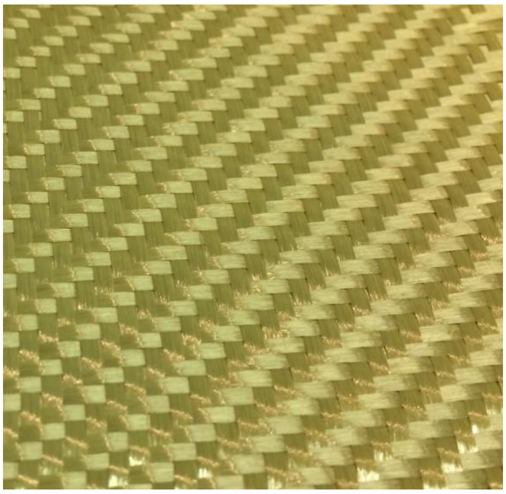


Fig 5.3: Aramid fiber

- **Metals:** Metals such as aluminium and mild steel can be used as reinforcement materials.Metal Matrix Composite (MMC) is a composite material consisting of at least two components, one of which must be metal, and the other material may be another metal or another material such as ceramic or organic compound. When there are at least three ingredients, it is called a hybrid compound. MMC is an addition to the certification.

CHAPTER 6
CORE MATERIALS

The sandwich structure composite consists of face skin laminate, the core material and the back skin laminate. The usage of core creates a thicker laminate with a minimum increase in weight. Face skin laminates can be any material. The most commonly used face sheets are glass and carbon. When using lightweight, thin skin laminate, the core must be capable of taking a compressive loading without premature failure. This helps to prevent the thin skins from wrinkling, and failing in a buckling mode.

Types of core materials are:

- **Plywood or Balsa wood:** It is a natural core. It is less expensive and simple to work with it has high strength, resistance to cracking and twisting. But these are sensitive to moisture. It is both a relatively high strength core and less expensive than vinyl or honeycomb. It achieves its high compression strength because on a microscopic level it has a honeycomb type of structure yet is quite dense.

Fig 6.1:Balsa wood

- **Polyisocyanurate Sheet Foam:** This sheet foam is a rigid, closed cell material with excellent thermal insulation that is bonded to facers on both sides and flotation properties.

Fig 6.2:Polyisocyanurate sheet foam

- **Honeycomb:** Honeycomb is a series of cells, nested together to form panels similar in appearance to the cross-sectional slice of a beehive. These are extensively used in aerospace and transportation industry. It offers the best strength to weight ratio. Honeycomb materials include paper, aluminium, polypropylene, etc.

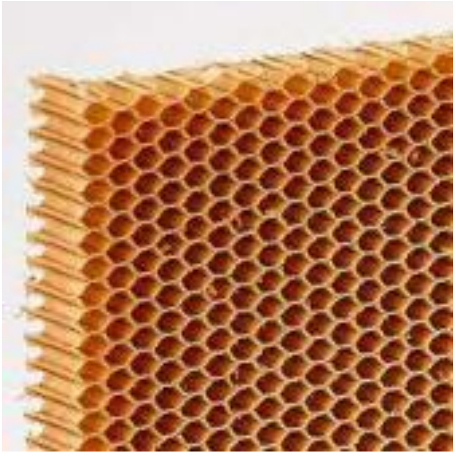


Fig 6.3:Honeycomb structure

- **Polyurethane foam:** Polyurethane is available either in sheet form or it can be foamed in place when used as an insulation material. This foam is a rigid, closed cell material with excellent thermal and floatation properties. There are Different types of polyurethane foams such as Flexible Polyurethane Foam, Rigid Polyurethane Foam, Thermoplastic polyurethane (TPU) etc.

Fig 6.4: 3D printed TPU

CHAPTER 7
CORE STRUCTURE PATTERN

Sandwich structures are important innovative multifunctional structures with the advantages of low density and high performance. Creative design for sandwich structures is a design process based on sandwich core structure evolution mechanisms, material design method, and panel (including core structure and facing sheets) performance prediction model. The multifunctional performance of sandwich structure greatly depends on the structure configuration and the choice of sandwich materials.
The different types of sandwich core structure patterns are:

- **Honeycomb core:** Honeycomb core structures are most common closed cell prismatic lattice structures. The typical geometries for honeycomb cores include square, triangle, chiral, circular, hexagonal, and auxetichoneycombs. Load carry and load transference are much greater in honeycomb than in any laminate. The core can be made of different materials.

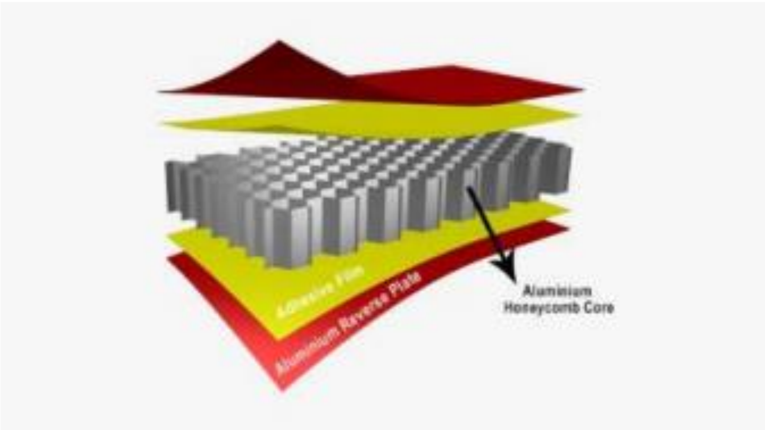


Fig 7.1:Sandwich composite structure made up of aluminium core and aluminium faceplate

- **Truss core:** Truss core sandwich structures are one of the oldest and most used sandwich structures. The traditional geometries for truss cores include pyramidal, tetrahedral, Kagome, and X-type configurations. However, several derivative patterns have been developed in the last few years. Based on the typical pyramidal truss core, a new type enhanced lattice structure called “Hourglass” truss sandwich structure was designed by a transition process. As shown in Figure, the Hourglass truss core is similar to the two-layer pyramidal truss core and has the same inter-node spacing.

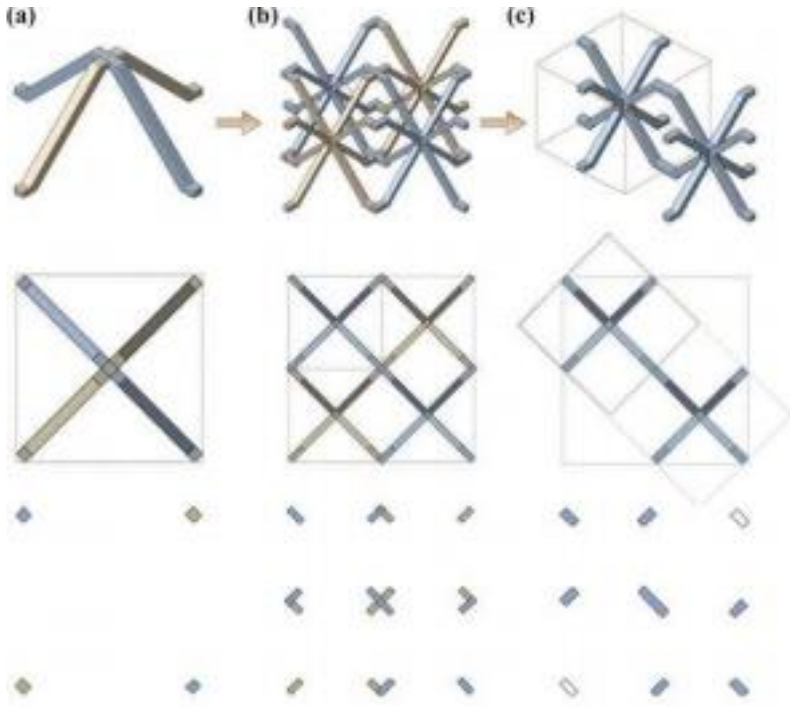


Fig 7.2:The process of transformation from a single-layer pyramidal truss lattice to an hourglass truss lattice: (a) single-layer pyramid, (b) two-layer pyramid, and (c) Hourglass truss.

- **Foam core:** Foam core sandwich structures are a major class oflightweight structure materials and widely used in engineering filed including aerospace, automotive, and marine structures. The figure shows different types of foam structures.

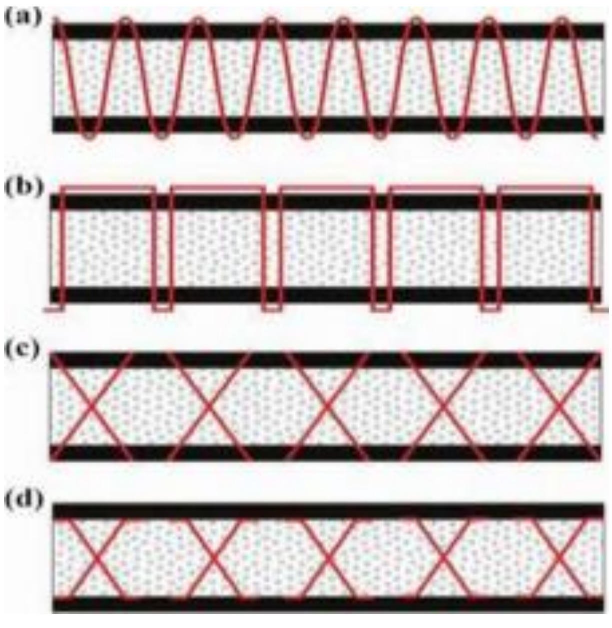


Fig 7.3: Schematic of stitched foam sandwich panels: (a) stitched foam core with oblique direction, (b) stitched foam core with vertical direction, (c) X-core foam core, and (d) K-core foam core

CHAPTER 8
THERMOPLASTIC POLYURETHANE (TPU) MATERIAL

Thermoplastic Polyurethane (TPU) is a material of polyurethane plastics which consists of many properties such as elasticity, transparency, resistance to oil and abrasion. These are thermoplastic elastomers consisting of linear segmented block copolymers composed of hard and soft segments. Thermoplastic Polyurethane or TPU is referred to as the bridge between rubbers and plastics. The material appears rubber-like, which means it can be extremely flexible, durable and smooth to the touch. All these properties and compound versatility makes TPU widely used in many industries for coatings, components and customer goods. It is often used for 3D printing.

TPU provides a large number of physical and chemical property combinations for the most demanding applications such as automotive, wires and cables, breathable films for leisure, sports and textile coatings, weather able, non-yellowing films etc.

It has properties between the characteristics of plastic and rubber. Thanks to its thermoplastic nature, it has several benefits over other elastomers are unable to match, such as:

- Excellent tensile strength.
- High elongation at break.
- Good load bearing capacity.

Fig 8.1: Thermoplastic Polyurethane produced by 3D printing

8.1 Production of TPU:

It is produced when a poly addition reaction occurs between a diisocyanate and one or more diols in a specific way. The three basic raw materials required to produce a TPU are:

- A polyol or long-chain diol
- A chain extender or short-chain diol
- A diisocyanate

It is a linear segmented block copolymer composed of hard and soft segments.

- **Soft Segment (polyether or polyester):** It is built out of a polyol and an isocyanate which provides flexibility and elastomeric character of a TPU.
- **Hard Segment (aromatic or aliphatic):** It is constructed from a chain extender and isocyanate giving TPU its toughness and physical performance properties.

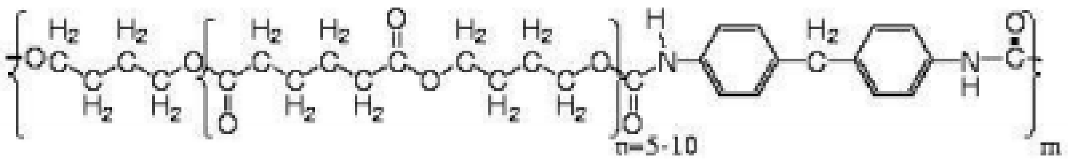


Fig 8.1.1:Molecular Structure of Thermoplastic Polyurethanes

Properties of TPU:

- Abrasion/Scratch Resistance: When abrasion and scratch resistance are critical for an application like automotive interior parts, sports and leisure applications or technical parts, as well as specialty cables, TPUs give excellent results compare to other thermoplastic materials. It has better abrasion resistant compared PVC, neoprene, nylon11.
- Optimum Comfortness: TPU design is in sportswear, footwear or building and construction products, highly breathable TPU are available to ensure optimum comfort.
- High elasticity across the entire hardness range.
- Excellent low-temperature and impact strength.
- Resilience to oils, greases and numerous solvents.
- Robust weather and high-energy radiation resistance.
- UV Resistance.
- Good flexibility over a wide temperature range.

Types of Thermoplastic polyurethane materials:

1. **Polyester TPU:** Usually recommended for parts subject to abrasion. This group has great chemical and oil resistance, and its properties are stable, which leads to many uses in material blends.
    - They are compatible with PVC and other polar plastics
    - Excellent abrasion resistance.
    - Good balance of physical properties.
2. **Polyether TPU:** Suitable for underwater applications. Characteristics include excellent hydrolysis resistance and can withstand microbes and tear stress, keeping flexibility in low temperatures.
    - They are slightly lower in specific gravity than polyester and polycaprolactone grades.
    - Good abrasion and tear resilience.
    - Excellent hydrolysis resistance.
    - Durable against microbial attack.
    - Low temperature flexibility.
3. **Polycaprolactone TPU:** It combines durability and toughness with great performance in cold and hydrolysis resistance. Successfully used in seals.
    - They have the inherent toughness and resistance of polyester based TPUs.
    - Low temperature performance and hydrolysis.
    - A relatively high resistance.

Applications of TPUs:

- Caster Wheels
- Agriculture and textile coating
- Drive Belts
- Film and Sheet
- Seal and gasket or fire hose liner
- Footwear—sport shoe soles
- Sporting Goods
- Swim Fins and Goggles
- TPU Coated Fabrics

CHAPTER 9
IMPLEMENTATION
9.1 Carbon Fiber:

Carbon fiber is used as reinforcement for the sandwich composite. The carbon fiber which is present in sheets is hardened using suitable resins. The steps used in processing a carbon fiber is mentioned below:

1. **Precursor:**To produce carbon fibre, an organic polymer precursor is needed.This raw materialis processed with heat and chemicalagents to convert it to carbon fiber. The first high-performance carbon fiber materials were made from a rayon precursor. Currently, approx 90% of carbon fiber is made from polyacrylonitrile, while the other 10% or so ismade from rayon or petroleum pitch.
2. **Manufacturing:**The carbon fibre manufacturing process begins with carbonization.To achieve high-quality carbon fiber, the precursor polymer needs to contain a high percentageof carbon atoms. The majority ofthe non-carbon atoms within the structurewill be removed in the process.

   First, the precursor is pulled into long fibers. These fibers are then heated to very high temperaturesin an anaerobic gas mixture (without the presence of oxygen) to ensure the material doesn’t burn.The heat energizes the atomic structure of the fibers and drives off most of the non-carbon atomsfrom the material.
3. **Treatment:** Following carbonization, the surface of the carbon fibers must be treated to improve bond ability with epoxies or other resins. Careful oxidation ofthe surface of the carbon fibers improves chemical bonding properties, while simultaneous rougheningof the surface provides improved mechanicalbonding. This oxidation can be accomplished in a number of different ways. The carbon fiber can be exposed to various gases such as carbon dioxide orozone, or liquids such as nitric acid, or even processed electrolytically.
4. **Sizing:**Prior to weaving, the carbon fibers must be sized, or coated,with a polymer to protect them duringthe weaving process. The sizing is selected forcompatibility with the laminating resin to be used. The fibers are then wound onto bobbins, spun, andprocessed into various weaves and other formats.

Fig 9.1.1: Carbon fiber inthe form offolding sheet

Fig 9.1.2: Resin used to harden the carbon fiber

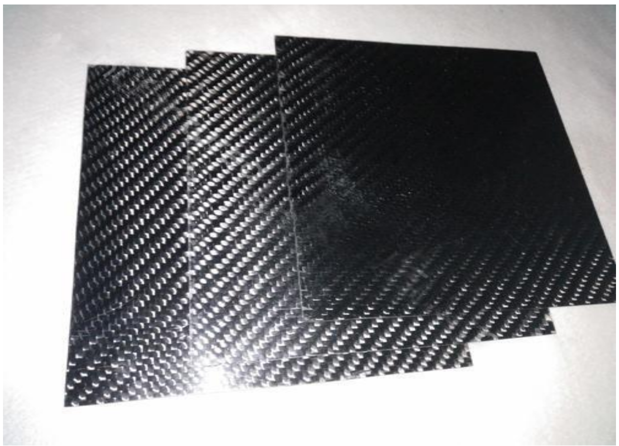
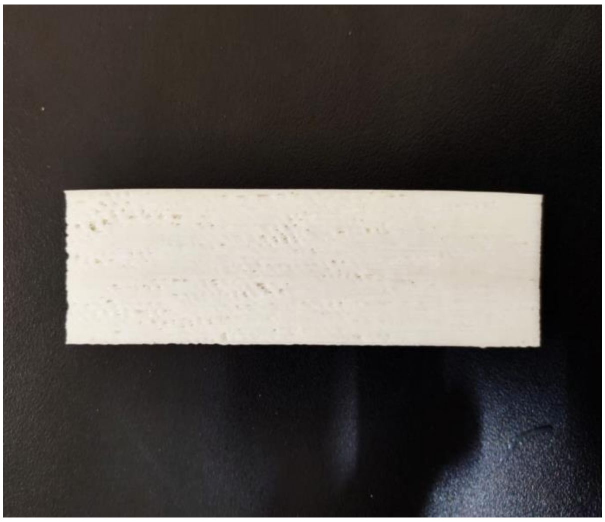


Fig 9.1.3: Final product of carbon fiber after application of epoxy resin

9.2 3D Thermoplastic Polyurethane (TPU):



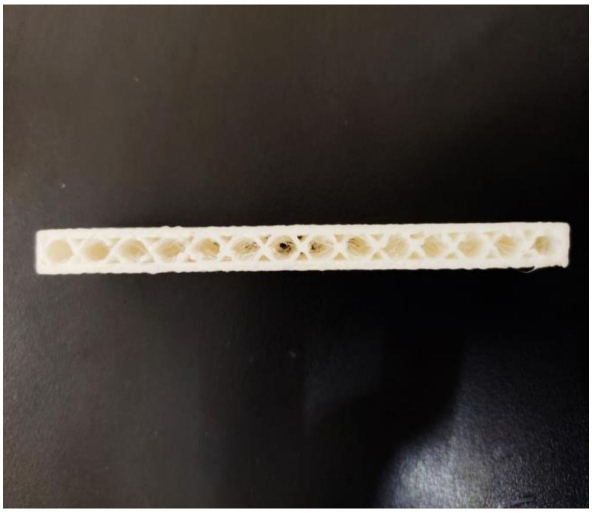


Fig 9.2.1: Section of TPU material used

Here precisely the construction of the proposed interior design that positions infill patterns in a specific way is done by using the pattern columns. The above TPU material is 3D printed of length 9.6cm, breadth 2.4cm and thickness of 0.5cm. The interior is of hexagonal structure.

The carbon fiber is then cut into required sections and glued together with the above 3D printed thermoplastic polyurethane material using appropriate adhesive.

9.3 Epoxy adhesive

Epoxy refers to the original composition or end product treated with epoxy resin, as well as the colloquial name of the epoxy-functional group. Epoxy resins are known as polyoxide and are a class of early materials and reactive polymers comprising epoxy groups. Epoxy resins can react with various amines, acids (and acid anhydrides), phenols, alcohols and thiols (commonly called mercaptans), including homogeneous catalytic polymerization. These reagents are commonly referred to as solids or therapeutic agents, and the cross linking reaction is called preconditioning.

The reactions of polyoxides or multifunctional hardening machines themselves lead to the formation of thermopolymers, which generally have good mechanical properties and high thermal and chemical resistance. Epoxy has a wide range of applications including metal coatings, electronic / electrical components / lamps, high voltage electrical insulation, brush making, fiberglass plastic and structural adhesives.

The epoxy adhesive used is fevicol fix 20mg. This adhesive is used to bond reinforcement and core material together.

Fig 9.3.1: Epoxy adhesive (fevicol)

When compared with other adhesives such as araldite and Epoxy adhesive (fevicol), exopy adhesive used is better. Adhesives are drawn from the class of materials known as ‘polymers’, ‘plastics’ or ‘synthetic resins’ and therefore have their inherent limitations. They are not as strong as metals however the difference is offset by the increased surface contact area provided by the bonded joints. With increasing temperature the bond strength decreases and the strain properties of the adhesive move from elastic to plastic. This transition is usually in the temperature range 70 – 220°C: the transition temperature depends on the particular adhesive.

9.4 Sandwich composite

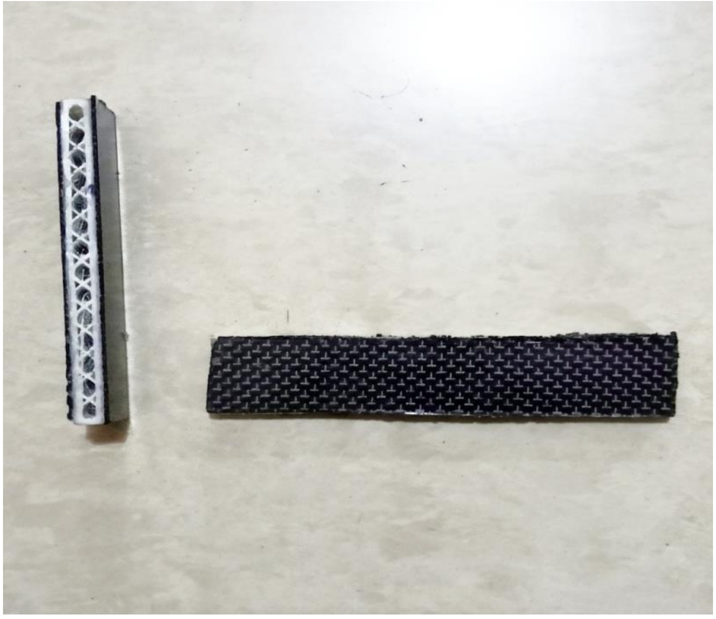


Fig 9.4.1: Final sandwich composite

The carbon fiber is cut to required dimension of length 9.6cm and breadth 2.4cm.The thermoplastic polyurethane material used as core structure is 3D printed of same dimension as carbon fiber. The adhesive is applied on the carbon fiber and core material (TPU) and bonded together. Load is applied on the sandwich composite to avoid air gaping or bubble formation in the composite. It is placed in room temperature for the duration of 4-5 hours for drying.

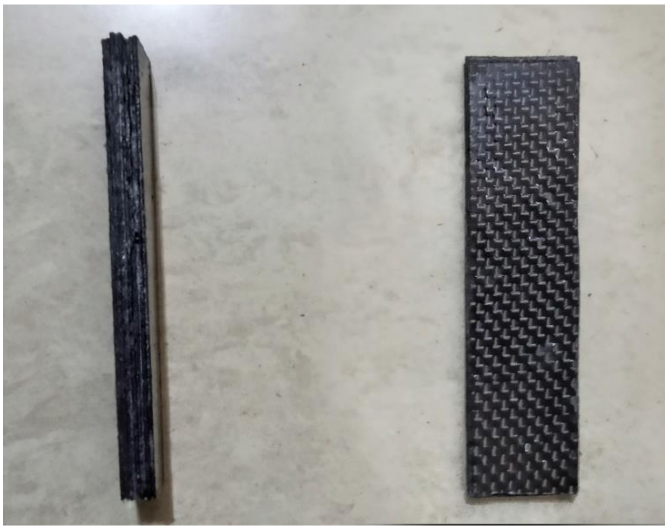


Fig 9.4.2: Final sandwich composite with only reinforcement material

Another composite is produced by only using carbon fiber as core and reinforcement. When compared to the above sandwich material this composite has high strength but does not resist more elasticity. The finished product is shown above.

CHAPTER 10

FUTURE SCOPE

The sandwich concept has more advantages and properties than semi-metal. Since half of them are in a continuous core, global and local hardness can be guaranteed. In addition, simple manipulation reduces the complexity, texture, and maintenance of the analyte, resulting in the cost of the entire life cycle of the structure. The introduction of sandwich structures into the hall skins reduces the amount of noise in the passenger compartment due to the high moisture content of the main material and improves passenger comfort. Thermal septic integration is also possible in this application. Unless we know what causes damages, what kinds of damage are induced, and how these damages affect the residual mechanical properties of structures, we cannot fruitfully utilize sensors and actuators to detect and suppress damages. Hence, detailed understanding of damages in composite sandwich structures is essential to develop smart sandwich structures.

TPU material can be replace with honeycomb structures of thickness 4mm. Honeycomb sandwich structures have long been utilized in aerospace structures, since honeycombs have excellent mechanical properties; very high stiffness perpendicular to the face sheets and highest shear stiffness and strength to weight ratio among all available core materials.

The composite material can undergo various tests such as three point bending, tensile, flexibility, compressibility and shear test.

CONCLUSION

The main aspect we need to keep in mind that strength and stiffness are major considerations for aircrafts whereas stiffness and low coefficient of thermal expansion are major consideration in this project. Regarding the influence of thicknesses, it is possible to observe an increase with increasing thicknesses of the coating. As concerns the core material type used in the composite, the highest impact strength occurs in the constructions with a polymer core as compared to all other core materials.

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