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Composite Material

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ABSTRACT- Composite materials are substances manufactured by two or more different material.Composite consist of a matrix(continuous phase) and reinforcrments(fibers,particles).Composite material use in aerospace(aircraft wings,fuselage components and rocket structural parts),automotive(engine components,body panels and chassis for weight reduction),construction(reinforced concrete,plywood),consumer goods(tennis rackets,wind turbine blades).composite material is a combination of two materials with different physical and chemical properties.

KEYWORD- lamina, matrix, reinforcement,fiber,delamination etc.

INTRODUCTION- There are four types of composite materials-

(1) POLYMER MATRIX COMPOSITE
(2) METAL MATRIX COMPOSITE
(3) CERAMIC MATRIX COMPOSITE
(4) CARBON MATRIX COMPOSITE

(1) **POLYMER MATRIX COMPOSITE-** Polymer Matrix Composites are advanced materials consisting of high strength fiber embedded in an organic polymer matrix.They offer high strength to weigth ratio,superior corrosion resistance and high stiffness,making them crucial for lightweight applications in aerospace,automotive and sports equipment.

(2) **METAL MATRIX COMPOSITE**- Metal matrix composites are engineered materials combining a metal matrix (aluminium,magnesium,titanium)with reinforced material(silicon,carbide,carban fiber) to achieve superior strength,high temperature stability,low density and high wear resistance.It is widely in aerospace,automotive and defence application.

(3) **CERAMIC MATRIX COMPOSITE**- Ceramic matrix composites are advanced high temperature materials consisting of ceramic fibers embedded within a ceramkc matrix,designed to overcome the brittleness of traditional ceramics. It is lightweight extremely heat resistant and corrosion resistant.They are useful for aerospace, defence and energy application such as high efficiency jet engines.

(4) **CARBON MATRIX COMPOSITE-** Carbon matrix composite are high performance materials consisting of carbon fiber reinforcement in a carbon matrix. They are lightweight possess high strength to weight ratios and maintain structural integrity where conventional material fail. It is used in aerospace,defence and automotive industry.

COMPOSITE= MATRIX + REINFORCEMENT

MATRIX= In composite materials,the matrix is the continuous phase that surrounds and binds the reinforcing fibers or particles together.It provide material its physical shape, protects the reinforcement from environmental damage, and transfers mechanical loads to the stronger reinforcing phase.

REINFORCEMENT= Composite reinforcement refers to the high strength materials(fibers,particles,flakes) embedded within a softer matrix to enhance structural strength,stiffness and durability.It is the primary load bearing component of a composite material,determining its directional properties and resistance to environmental factors.

TYPES OF REINFORCEMENT-

(1) CONTINUOUS FIBERS
(2) SHORT FIBERS/WHISKERS
(3) PARTICULATES
(4) PLATES/FLAKES

(1) CONTINUOUS FIBER- A continuous fiber is a highly long,unbroken strand of material(such as carbon,glass or aramid) used to reinforce composite materials.Common types of continuous fibers are Carbon fiber,Glass fiber,Aramid(Kevlar).

(2) SHORT FIBER / WHISKERS- Short fibers are discontinuous,chopped fibers(typically less than 5 mm long) randomly dispersed into a matrix like plastic or resin,widely used in injection molding,they enhance polymer strength,stiffness and thermal resistance.

(3) PARTICULATE- Particulate reinforced composites are engineered materials made by embedding solid particles(the reinforcing phase) into a continuous binding material(the matrix) to enhance overall stiffness,wear resistance and thermal stability.

(4) PLATES/FLAKES- A composite plate is a structural material made by embedding high strength fibers(like carbon or glass) into a supportive resin matrix or bonding multiple layers together.

DEFECTS IN COMPOSITES-

(1) VOIDS AND POROSITY- Small gas or air pockets trapped within the matrix. They act as stress concentrators and significantly reduce the material's fatigue life.

(2) DELAMINATION- Separation of the individual composite layers.This is usually caused by trapped air,improper consolidation or resin shrinkage during curing.

(3) FIBER MISALINGNMENT AND WRINKLING- Fibers that are laid incorrectly,bent or wavy rather than straight.This drastically lowers compressive strength.

(4) RESIN-RICH/ RESIN-LEAN AREAS- Uneven distribution of resin leading to brittle or weak zones where the fiber to matrix ratio is suboptimal.

(5) INCLUSIONS AND CONTAMINATION- Foreign objects,backing paper or moisture accidentally left between plies during the layup process.

DETECTION AND ANALYSIS OF DEFECTS IN COMPOSITE MATERIAL-

(1) **ULTRASONIC TESTING-** Uses high frequency sound waves to map internal voids or delaminations.

(2) **THERMOGRAPHY-** Detects internal flaws by analyzing the varying thermal conductivity of the material.

(3) **X-RAY COMPUTED TOMOGRAPHY(CT)-** Provides 3D imaging of the internal structure to check for fiber alignment and porosity.

CONCLUSION - Composite materials are manufactured by combining two or more distinct materials to create a new material with superior properties. They are revolutionizing industries by providing exceptional strength-to-weight ratios,high corrosion resistance,and structural adaptability that traditional metals and plastics can not acieve.

INDUSTRIAL IMPACT AND FUTURE OF COMPOSITE- Composites are rapidly replacing conventional materials across multiple sectors.

AEROSPACE AND AUTOMOTIVE- Dramatically reduces overall vehicle weight,improving fuel efficiency and performance.

CONSTRUCTION AND INFRASTRUCTURE- Utilized for their high durability,weather resistance and ability to be molded into complex shapes.

BIOMEDICAL AND SPORTS- Offers unique combinations of flexibility,toughness and lightweight handling.

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BIOGRAPHY- Er. SAURABH KUMAR SINGH HAS ABOVE FIFTEEN YEAR VAST TEACHING EXPERIENCE. HE IS WORKING IN MECHANICAL ENGG. DEPATRTMENT . HE HAS COMPLETED HIS B.TECH. IN ME DEPARTMENT IN 2009.