ANALYSIS OF EPOXY, MWCNT and ALUMINIUM MATERIAL FOR COMPOSITE CONNECTING ROD

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ABSTRACT

This paper focused on a composite material made up of E-Glass Fibre, Epoxy Resin, Fly Ash, and MWCNT. Every of these materials are selected to obtain desired properties as per the applications. As the composite materials have wide range of classification. On the basis of structure composites are classified as Matrix and Reinforcement composite. The composite focused in this paper is fibre reinforcement composite. The main reason for fabrication of this composite material is to obtain an alternative material for connecting rod. Basically, Connecting rod is a mechanical element used to transfer energy from piston to camshaft. It also helps to convert reciprocating motion of piston to rotating motion of camshaft. Connecting rod has two major elements known as ends. It has large end which connects to camshaft and small end is used to connect piston by means of gudgeon pin. During each rotation of the connecting rod, there are number forces acts on it. Also connecting rod has a working in the high temperature applications so temperature is also one of the most important factors to be considered during its design. Composite material is a homogeneous mixture of more than one material generally done to improve the properties of material or to obtain new material having better and improved properties. The composite material is mainly divided in to two major categories namely matrix material and Reinforced composite. Basically manufacturing of composite material consist of number of phase changes during the operation. In this project epoxy resin is used as a casting material in liquid form with hardener. And E-Glass fibre, Fly Ash, and very little amount of MWCNT are used as additives.

Keywords:- *E-glass, reinforced composite material, Solid Works,*

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1. INTRODUCTION

There are many scientists and engineers are working on composite materials and they are doing well day by day. This paper also focused on a composite material made up of E-Glass Fibre, Epoxy Resin, Fly Ash, and MWCNT. Every of these materials are selected to obtain desired properties as per the applications. As the composite materials have wide range of classification. On the basis of structure composites are classified as Matrix and Reinforcement composite. The composite focused in this paper is fibre reinforcement composite.

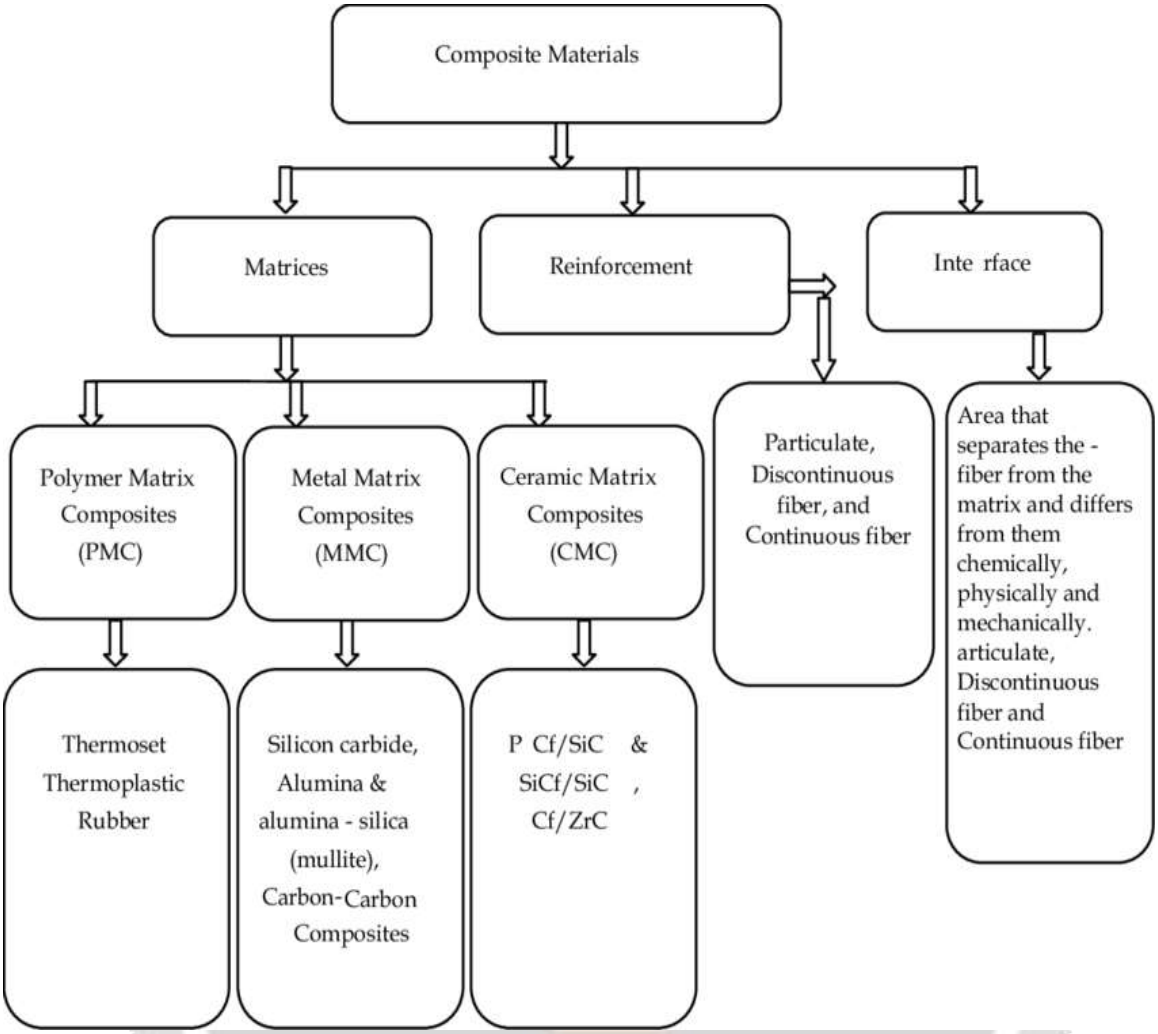

Fig-1: Classification of Composite Material

The main reason for fabrication of this composite material is to obtain an alternative material for connecting rod. Basically, Connecting rod is a mechanical element used to transfer energy from piston to camshaft. It also helps to convert reciprocating motion of piston to rotating motion of camshaft. Connecting rod has two major elements known as ends. It has large end which connects to camshaft and small end is used to connect piston by means of gudgeon pin. During each rotation of the connecting rod, there are number forces acts on it. Also connecting rod has a working in the high temperature applications so temperature is also one of the most important factors to be considered during its design. Composite material is a homogeneous mixture of more than one material generally done to improve the properties of material or to obtain new material having better and improved properties. The composite material is mainly divided in to two major categories namely matrix material and Reinforced composite. Basically manufacturing of composite material consist of number of phase changes during the operation. In this project epoxy resin is used as a casting material in liquid form with hardener. And E-Glass fibre, Fly Ash, and very little amount of MWCNT are used as additives.

2. LITERATURE REVIEW

Table 1: Literature Review

Sr. No.	Author	Paper Title	Remark / Outcome
01	Suraj Pal	Design Evaluation & Optimization of Connecting Rod Parameters Using FEM	FEM, Analysis by Static Method
02	G. Naga Malleshwara Rao	Design Optimization & Analysis of a Connecting Rod using ANSYS	Reduction of Weight of Connecting Rod, Detailed Analysis for Loads
03	K. Sudershan Kumar	Modeling and Analysis of Two Wheeler Connecting Rod	Composite of Aluminium and Boron Carbide, Analysis by Software like ANSYS
04	B. Anusha, C. Vijayabhaskar Reddy	Modeling and Analysis of Two-wheeler Connecting Rod by Using ANSYS	Solid Modeling, Composite Material Development, Comparison of Composite Materials, Comparative Analysis
05	H. B. Ramani	Analysis of Connecting Rod under Different Loading Condition Using ANSYS Software	Behavior of Material under different loading conditions, Determination of Maximum Stresses, Determination of Maximum pressure.
06	Leela Krishna Vegi Vennu Gopal Vegi	Design And Analysis of Connecting Rod Using Forged steel	Properties of Forged Steel in Comparison to Carbon Steel
07	Kuldeep B.	Analysis and optimization of Connecting rod using AlFASiC Composites	Change in weight of Connecting rod can be possible with change in material.
08	Vivek Patade	Stress Analysis of I.C.Engine Connecting Rod by FEM and Photoelasticity	Relation between stress at small end and big end.
09	N. P. Doshi	Analysis of connecting rod using analytical and finite element method	Steel and Aluminum composite have a chance to reduce weight of component.
10	Ram Bansal	Dynamic simulation of connecting rod made of aluminum alloy using finite element analysis approach	Analysis with the help of Dynamic Simulation.

3. METHODODLOGY

3.1 Material Selection:

3.1.1 Material: Epoxy Resin: Role in composition: Casting Element
Additives: 66 % Clear Casting Epoxy + 34 % Hardener

Fig-2: Epoxy Resin with Hardener

Major Properties:

- Shrinkage is minimum
- High Strength
- It has very good adhesion ability to any substance
- Less toxic and Cheap in price
- Chemical resistance
- Excellent thermal and electrical insulation

3.1.2 Material: E-Glass Fibre

Fig-3: E Glass

Composition: 54% SiO_2 – 15% Al_2O_3 – 12% CaO
Role in Composition: Additive, Strengthener
Major Properties:

- Excellent Strength
- Light in Weight
- High temperature range sustainability
- Higher Hardness

3.1.3 Material: Fly Ash

Role in Composition: Additive

Fig-4: Fly Ash

Major Properties:

- Good thermal resistance
- Higher strength
- Less weight
- Good stability at high temperature ranges
- Good Bonding Properties

3.1.4 Material: MWCNT

Role in Composition: Additive

Major Properties:

- Excellent Tensile Strength
- Improve dispersibility of composite
- Thermal stability above 600^0C

Fig-5: MWCNT Powder

3.2 Fabrication Procedure

Fabrication process consists of three basic steps such as,

a) Mould/Cavity Making
b) Composition and Pouring of Material
c) Solidification and Polishing

Here, the process has been explained with respective steps used to model making in brief. The steps are as follows,

- Prepare the mould as per the design with considering factors such as shrinkage allowance and distortion effect.

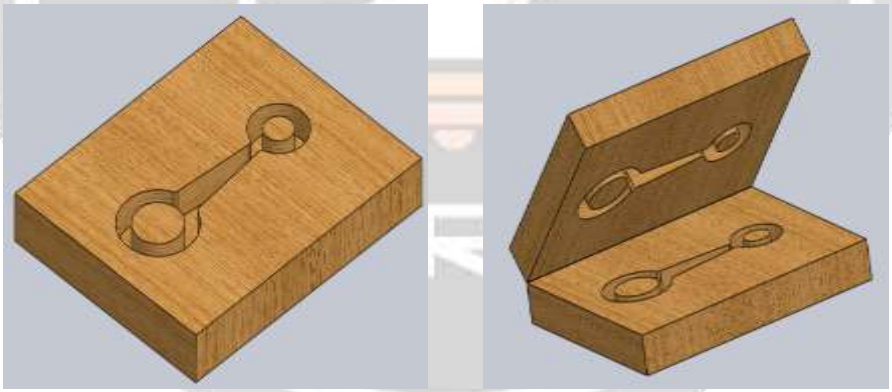

Fig-6: Wooden mould

- Take the liquid epoxy in required amount as per mentioned in composition.
- Then add hardener in the proportion as 1:3 to epoxy resin i.e. if epoxy is in 30gram then add 10 gram of hardener to it.
- Then stir it well as a result the white viscous liquid forms as a homogeneous product.
- Take E-Glass, Fly Ash, and MWCNT in proper amount as per the requirement in each composition.
- Mix well to become a proper mixture of these three materials.
- Put this mixture of each composition in the die or mold. [Compositions are C1 (Epoxy- 70%, E-Glass - 21%, Fly Ash - 8%, MWCNT- 1%); C2 (Epoxy 52%, E-Glass- 32%, Fly Ash-15%, MWCNT-1%); and C3 (Epoxy- 42%, E-Glass – 42 %, Fly Ash – 15%, MWCNT- 1%).]
- Fill the die or mold completely with these materials.
- Pour the homogeneous mixture of epoxy and hardener in the mold cavity very carefully to avoid bubble formation.
- Press the mixture in die cavity well to fulfill the die or mold completely.
- Set the material and keep it for solidify for minimum 24 hrs.

- After solidification, break the mold and take out the product from it.
- It need to be polished due to allowances may cause some variation in digestions, so it is necessary to maintain it.
- After 24 hours, the components are ready for use.

4. Result and Discussion

4.1.1 Result by Solid works Simulation and Static Testing:

Table 2: Result by Solidworks Simulation and Static Testing

Sr. No.	Parameter	Forged Steel		Composite	
		Min	Max	Min	Max
1	Von Mises Stress (N/m^2)	1815.22	8.30E+05	3824.58	1.87E+06
2	Equivalent Strain	9.67802E-09	2.70364E-06	9.45275E-07	4.38E-04
3	Displacement (m)	0	0.0057437	0	0.00385557
4	Factor of Safety	554.417	253413	2401.7	1.18E+06
5	Section Strain	7.58554E-09	3.4672E-06	8.76E-07	5.87E-04

Table 3: Result by Experimental Analysis

Sr. No	Parameter	Composition C1	Composition C2	Composition C3
01	Epoxy	70%	52 %	42 %
02	E-Glass	21 %	32 %	42 %
03	Fly Ash	8 %	15 %	15 %
04	MWCNT	1 %	1 %	1 %
05	Weight (grams)	110.24	125.6	142.23
06	Static Strain	25900	48700	51740
07	Flexural Shear Strength (MPa)	7.5	13.04	19.56
08	Ultimate Compressive Strength (MPa)	425.93	740.74	1111.11
09	Ultimate Tensile Strength (MPa)	766.67	1333.33	2000

As result indicates, the prepared materials with the composition C1, C2, & C3; it has been found that the properties of Composition C3 are much better than other two (C1 & C2).

a. Simultaneously, all of these compositions have higher strengths than that of conventional materials used for manufacturing of connecting rod.
b. Also the weight of the component using composite material almost equal to the forged steel so it won't matters the design of engine.

c. Also as compared to properties of Forges Steel, Powder metal and C-70 Alloy the composition C3 has more enhanced properties, which indicates the prepared composite can be a better alternative as a connecting rod material.

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