International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 02 - Issue 08 || August 2016 || PP. 57-63

Optimization & Verification Of Drive Shaft Parameters Of Wind Mill

Mayuri U. Waghmare[1], S.M.Jadhav[2]
(Mechanical Department, JSPM's Rajarshi Shahu College of Engineering, Tathwade ,Pune/ Savitribai Phule Pune University,India)
(Mechanical Department, JSPM's Rajarshi Shahu College of Engineering, Tathwade ,Pune/ Savitribai Phule Pune University,India)

ABSTRACT: Optimization & verification of drive shaft using composite material deals with the possibility of simulation of complex parts made from polymer-composit**e.** The main objective of this paper is to review different papers related to material optimization. By reviewing these papers the material optimization & various parameters of drive shaft can be analyzed under static conditions. First part of the contribution is aimed on describing the basis of fiber composites & its behavior under load. Second part will lead to different studies performed in simulations & describes the stress & weight comparisons made from steel, carbon fiber, glass fiber composites. Thus this review help for optimization of material.

KEYWORDS: Fibre composites, carbon fibre

I. INTRODUCTION

The Carbon fiber composites, particularly those with polymeric matrices, have become the dominant advanced composite materials for aerospace, auto-mobile, sporting goods, and other applications due to their high strength, high modulus, low density, and reasonable cost. For applications requiring high temperature resistance, as required by spacecraft, carbon fiber carbon-matrix composites (or carbon-carbon composites) have become dominant. As the price of carbon fibers decreases, their applications have even broadened to the construction industry, which uses carbon fibers to reinforce concrete.

Design of composite parts in the past consisted of many trials, prototyping and testing, resulting in increased production costs. With the advances of technology and performance of personal computers came on the analytical range of 3D CAD software to enable the design and analysis in a virtual environment. This eliminates the tedious and expensive, often limiting the design process: test - mistake. Often the designer neglects the preparatory phase in order to reduce costs and propose over equipped components, which today is highly inappropriate.

1.1 Composite Materials

Composite materials (composites for short, distribution shown on Figure 1) are made simultaneously by two or more materials with vastly different mechanical and / or chemical properties which remain separate and are clearly observable in macroscopic or microscopic scale inside the finished part. There are two categories of materials involved: reinforce and filler. At least one piece from each category must necessarily be present. Filler surrounds and supports the reinforcement to maintain mutual relative position. Reinforcement is adding its special mechanical properties in order to improve the mechanical properties of filler. Synergy produces mechanical properties unattainable by individual participating materials and a wide range of fillers and reinforcement allows the designer to select the most appropriate product mix.

II .DETAIL REVIEW OF LITERATURE STUDY

Chris J. Burgoyne, [1] studied the different applications of composite materials in the area of construction. Where the materials used for structures are all characterized by low creep, as would be expected when the structures must resist significant permanent loads. For most applications, the higher stiffness fiber, i.e. carbon, glass and polyester, are used. The use of GFRP composites for complete structures is proving to be economic when there are access difficulties for building conventional heavy structures. The use of polyesters as soil reinforcement is also commercially successful, due to their resistance to corrosion in potentially aggressive soil conditions. Other applications have not yet taken off commercially. It also concluded that there is some scope for the use of composite reinforcement, but only in areas where rapid corrosion of steel is to be expected and only when deflections are not the limiting factor.

Fully Composite Structures : Structures made entirely from composites need to be thought about from a completely fresh viewpoint. The production processes are different from conventional structures, and the governing material properties are unfamiliar non-familiar to many engineers. The two most sensible production techniques, pultrusion and filament winding, yield products with considerable anisotropy in their properties. This results in considerable difficulties in making joints. Drilling for bolts tends to sever the load-carrying fibres, and the lack of isotropy precludes other load paths. Welding is impossible, and although adhesives can be used, the design of efficient and durable adhesive joints is not trivial. The Aberfeldy Footbridg in the UK, The main structure consists of a cable-stayed GFRP deck, suspended by Parafil aramid ropes from GFRP towers. Although originally designed only for pedestrians, it has recently been strengthened locally by the addition at some highly stressed locations of CFRP. the flexibility of GFRP structures due to the low Young's modulus of glass, which can result in unacceptably low natural frequencies. The very light weight allowed mass to be added locally to the structure (by filling some of the tubes with concrete) so that the flexural and torsional natural frequencies could be separated. The light weight of composites offers advantages when moveable bridges are required, since significant savings in the machinery can be realised.

Bonds Mill Lifting Bridg near Gloucester, UK, provides access for heavy trucks to an industrial estate, across a recently reopened canal. The deck is made from GFRP pultrusions, similar to those used in Aberfeldy. The upper layer of cells is filled with structural grade foam to resist local bending under wheel loads.

Aberfeldy Bridge

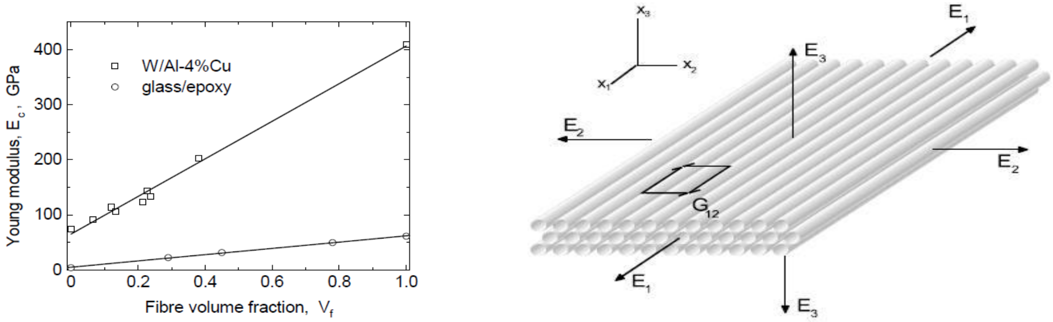
Bonds Mill Lifting Bridge

The use of CFRP as externally bonded passive flexural reinforcement is a commercial success, due to the light weight of the material and the consequential savings in construction time. Similarly, the use of GFRP composites for complete structures is proving to be economic when there are access difficulties for building conventional heavy structures. The use of polyesters as soil reinforcement is also commercially successful, due to their resistance to corrosion in potentially aggressive soil conditions. Other applications have not yet taken off commercially. There is some scope for the use of composite reinforcement, but only in areas where rapid corrosion of steel is to be expected and only when deflections are not the limiting factor. Post tensioned concrete with external cables should be economic provided that whole-life costs and proper alternative designs are evaluated. Internal pre-tensioning tendons are unlikely to be economic, primarily because there are few problems with steel tendons, unless some form of automated production process can be developed that uses machines to fabricate the shear reinforcement. What remains to the industry, at the moment, is niche applications, where novel solutions are found to existing problems by making use of the combination of properties that composites possess. The successful applications all make use of more than one benefit of using composites, which makes the cost problem less acute.

Branislav Duleba et. al. [2], in his paper describes the possibilities of use of carbon fiber composite in wide range of application. Carbon fiber composites, particularly those with polymeric matrices, have become the dominant advanced composite material for many industries due to their high strength and low density. He First tested model was design of rear upper arm from complex model of roadster, made with cooperation with students. This study shows, that use of normal carbon fiber composite at this part is not advisable, because possible faults of material can occur at area connected to bushings and chassis. As the goal of his whole study was to make the chassis as light as possible, simulation shows that there is the need of changing the material of composite or apply more layers of composite. At the end of paper the technique of production of test model was described. Technique called core wrapping was used by him, where the core made of Styrofoam was wrapped by layers of carbon fibre and epoxy resin.

ELASTIC PROPERTIES OF FIBER COMPOSITES: For estimating the stiffness of composite material in which fibres are aligned in the direction of applied load, is to assume that the structure is simple beam. In this, two composites are bonded together so that they can deform together. Here, we should ignore the time dependent deformation. The polymer matrix can exhibit time-dependent deformation. The elastic (Young) module of the matrix and reinforcement are Em and Ef, respectively. The cross section area of fibre „component□ be Af and that of the matrix component be Am. If the length of the beam is L, then we can represent the quantities of the two components in terms of their volume fractions, Vf and Vm , which is more usual, and we know that their sum Vf + Vm = 1. The fibre volume fraction, Vf, is the critical material parameter for most purposes. The load on the composite, Pc, is shared between the two phases, so that Pc = Pf + Pm, and the strain in the two phases is the same as that in the composite, $\varepsilon c = \varepsilon f = \varepsilon m$ (ie. this is an „iso-strain□ condition). Since stress = load/area,

we can write: $\sigma_c A_c = \sigma_f A_f + \sigma_m A_m$ (1) and from the iso-strain condition, dividing through by the relevant strains, we have $E_c = E_f V_f + E_m(1 - V_f)$ (2). This equation is referred to as the Voigt estimate, but is more familiarly known as the rule of mixtures. It makes the implicit assumption that the Poisson ratios of the two components are equal ($\nu_f = \nu_m$), thus ignoring elastic constraints caused by differential lateral contractions.



Rule-Of-Mixtures Relationship for the Young Moduli

Using the selected model surfaces its necessary to define the orientation of layers and composite structures. One layer consists of unidirectional fabric and suitable thermosetting resin. The layer has three main axes: are; X-axis- fibre direction, Y axis- normal to direction, Z axis- normal to fibre.

For complete characterization of orthotropic materials is necessary to define the following five parameters:

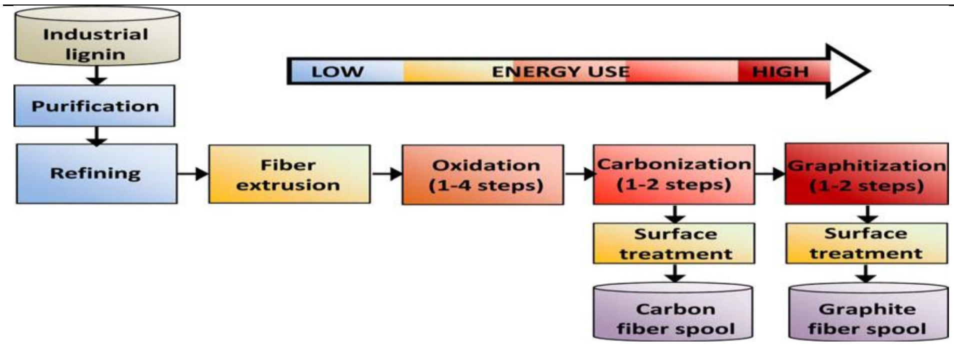
- Tensile strength in the X direction, Fxt ,,
- Tensile strength in the direction Y, Fyt,
- The compressive strength in the direction X, Fxc,
- The compressive strength in the direction Y, Fyc,
- Shear strength in the XY plane, Fxy.

This paper describes use of carbon fibre in wide range of applications. Carbon fibre composite have become advanced dominant composite material for many industries due high strength & low density.

The paper of **Darren A. Baker et. al. [3]** discusses about recent advancements in carbon fiber materials. Review of the authors provide the context of subject matter importance, a cost comparison of potential low-cost carbon fibers, a brief review of historical work, a review of more recent work, and a limited technical discussion followed by recommendations for future directions. As the available material for review is limited, the author includes many references to publicly available government documents and reviewed proceedings that are generally difficult to locate.

LIGNIN CARBON FIBER MANUFACTURE: The currently preferred method for the manufacture of carbon

Fibre from lignin which involves the preparation of a suitable lignin that is melt-spun into fibre under an inert atmosphere. The lignin fibre is then oxidatively thermo stabilized and carbonized. The integrity of the lignin fibre during oxidative thermo stabilization depends on its ability to crosslink, so that the glass transition (T_g) of the material is maintained above the process temperature, ultimately rendering it infusible.



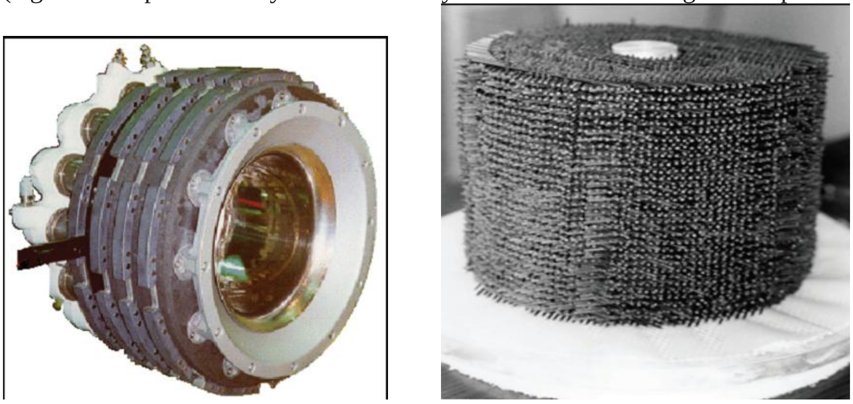
Schematic of carbon fibre production from an industrial (technical) lignin

Extrusion and Oxidative Thermo-stabilization : By necessity, have used single filament devices to melt-spin lignin fiber, which is then oxidatively thermo stabilized and carbonized. A potential problem therefore arises in transition to larger scale extrusion operations which will operate at high pressure, with high shear (at the die) and with much longer residence times at the melt temperatures used; some material might even remain in the extruder for longer times due to admixing. The reason for this is undoubtedly the reactive chemistry of lignin which will cause some level of polymerization during thermal extrusion and this becomes more critical as the T_g, T_s, and therefore melt extrusion temperature is increased. However, because a higher T_g is needed to efficiently oxidatively thermo-stabilize lignin fibres prior to carbonization, low residence times are preferable.

Lignin required to manufacture carbon fibre of greater strengths should not only be of high purity, but it should also have a narrow molecular weight distribution (small difference between T_g and T_s). There are many difficulties in providing lignins suitable for carbon fibre manufacture, in fact, no demonstration has yet been made of suitable lignins being processed into carbon fibre that satisfy both strength requirements and cost objectives. This is due to the unavailability of lignins with suitable properties so that they are: (A) able to be melt spun into fibre; (B) converted rapidly to carbon fibre; and (C) at low cost. Unfortunately, (A) requires a low Tg lignin to be melt spun, (B) requires a high Tg lignin to assure low cost, and (C) requires minimal processing cost of the lignin prior to fibre spinning; for a melt spinning process, (D) may therefore be high.

Luiz Claudio Pardini and Maria Luisa Gregori [4] in their work present ab-initio predictions of elastic constants and thermal properties for 2.5D carbon fiber reinforced carbon-silicon carbide hybrid matrix composites, by using the homogenization technique. The homogenization technique takes properties of individual components of the composites (fiber and matrix) and characteristics of the geometrical architecture of the perform to perform calculations. Ab-initio modeling of mechanical and thermal properties is very attractive, especially during the material development stage, when larger samples may be prohibitively expensive or impossible to fabricate. The modeling of properties by this simple method allows avoiding costly testing and reducing time consuming specimen preparation.

Composites have outstanding thermo-mechanical properties overcome the shortcomings of ceramic or metal components. These materials have been largely developed on an empirical basis. Examples of thermo-structural composites can be seen in Fig. 1. Carbon fiber reinforced carbon/silicon carbide hybrid matrix composites (CRFC-SiC) are considered to be one of the most potential thermo-structural materials for aerospace components (e.g. thermal protection systems of reentry vehicles or rocket engine components).



Aircraft Brakes preform for a rocket nozzle

The traditional 2D preforms have high performance in-plane but they are susceptible to delamination.

RESULTS FOR AVERAGE STIFFNESS 2.5D CARBON FIBER REINFORCED C/SIC HYBRID MATRIX COMPOSITES : For the prediction of the mechanical properties of 2.5D CFRC-SiC composites through the micromechanics method, it is necessary initially to establish representative properties of the carbon fiber, the carbon matrix and the silicon carbide matrix. The thermal properties depend on the axis of measurement and are mainly influenced by the carbon fibre. Calculation for thermal conductivity of CRFC-SiC composites are in the range from 32 to 46 W/m.K.

This work described a simple method for estimation of the elastic and thermal properties of 2.5D carbon fibre reinforced carbon-SiC hybrid matrix composites. These materials are the state-of–the-art composites for use in thermal protection systems. The Z-direction reinforcement allows higher delamination resistance and endurance on thermal stresses generated by heat treatment processing, and also the inter-laminar fracture toughness is improved. Mechanical and thermal properties of 2.5D CRFC-SiC composites were calculated based on composite average stiffness micromechanics. The modelling of properties by this simple method allows avoiding costly testing and reducing time consuming specimen preparation.

Mechanical properties of composites are fibre dominated. Calculations were done by considering the total carbon fibre volume fraction in the range of 40 to 50%, which are commonly found in carbon and ceramic composites reinforced with carbon fibres. The addition of only 2% of fibres out of the main plane of reinforcement increases the elastic modulus in the out-of-plane direction by about 20%.

An increase in the carbon fibre volume fraction from 40 to 50%, results in higher elastic properties, but nevertheless decreases the thermal conductivity.

The aim of this work was to investigate the development and mechanical characterization of new polymer composites consisting of glass fiber reinforcement, epoxy resin and filler materials such as TiO2 and ZnS. The newly developed composites are characterized for their mechanical properties. Experiments like tensile test, three point bending and impact test were conducted to find the significant influence of filler material on mechanical characteristics of GFRP composites. The tests result have shown that higher the filler material volume percentage greater the strength for both TiO2 and ZnS filled glass epoxy composites, ZnS filled composite show more sustaining values than TiO2.

Tensile, Bending and Impact strength increases with addition of filler material, ZnS filled composite shows significantly good results than TiO2 filled composites, Impact toughness value for unfilled glass composite is more than filled composite is concluded in the paper **by Patil Deogonda et. al. [5]**

Following tests were conducted ;

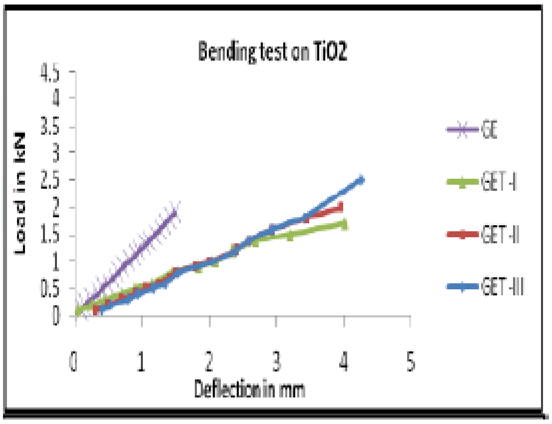
☐ Three Point Bending test

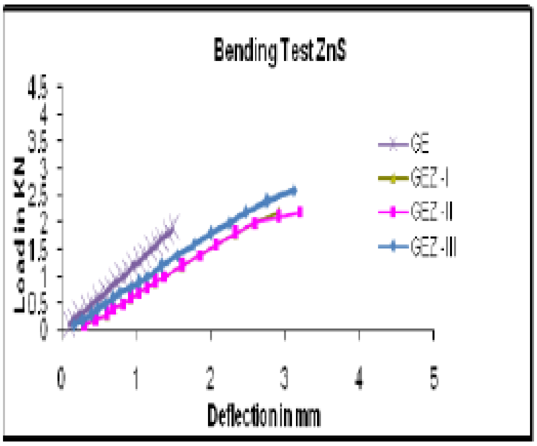
☐ Tensile Test

☐ Impact Test (Charpy)

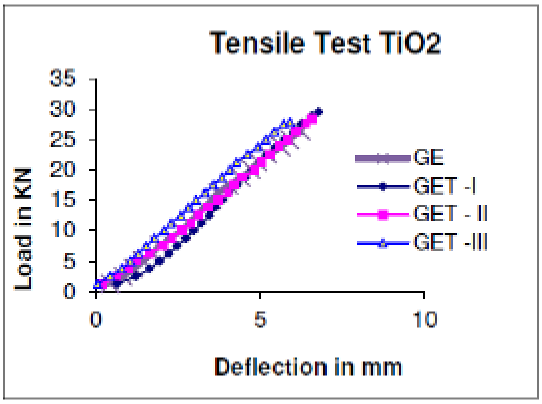
Results and Discussion :

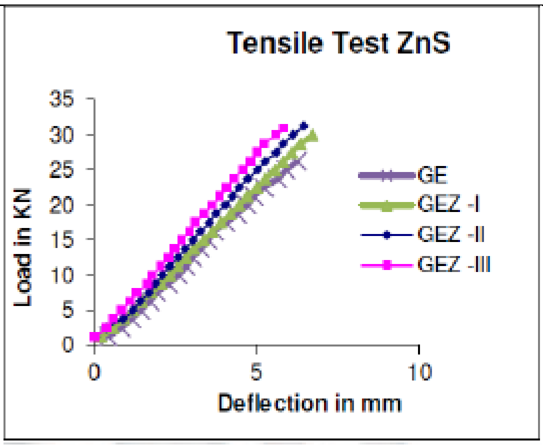
Effect of Filler on Bending Characteristics :





Effect of filler on Tensile Characteristics :





- Tensile, Bending and Impact strength increases with addition of filler material.
- ZnS filled composite shows significantly good results than TiO2 filled composites.
- ZnS filled composite shows more tensile load in comparison with unfilled and TiO2 filled composites.
- Impact toughness notch across the laminates is higher than that of along the notch.
- Impact toughness value for unfilled glass composite is more than filled composite.
- TiO2 and ZnS filler material makes material harder and brittle which is the reason for reduction in impact toughness value.
- ZnS filled composite shows significantly higher values than TiO2 filled composites.

H. Kim et. al. [6] proposed that the out-of-plane properties can still be increased further by using CNMs via effective processing techniques. It is also time to consider scale-up processing more seriously 20 years after the first discovery of CNTs. So far, aligned CNTs on carbon fibers have shown most promising results in mechanical property enhancement for carbon fiber composites, but this may be the most expensive method to incorporate CNTs into carbon fiber composites and has a limitation for scale-up processing. Hence, economical and effective processing methods should be devised further to see more real life applications of CNMs for carbon fiber composites.

Properties :

Mechanical properties : It is not effective to improve fibre dominant properties of carbon fibre composites such as the tensile properties by using CNMs since the mechanical properties of carbon fibres are usually two orders of magnitude higher than those of polymer matrices even after reinforced with CNMs. For an example, the mode I fracture toughness of carbon fibre composites was 2.5 times increased by inserting vertically aligned multi-walled carbon nanotube (MWCNT) forests between carbon fibre prepreg layers. However, due to the long and stiff MWCNT layers, the thickness resin-rich region of the CNT samples was much larger than that of the control samples. This is a reason why processing – microstructure – property relationship is critical to verify the real reinforcement mechanism of carbon nanotubes in the fibre composites. In another study, a very large increase in the mode-I fracture toughness by growing CNTs perpendicularly onto SiC fibres was shown. However, only the initiating part of the crack propagation was used for the fracture toughness calculation.

In an authors' work, MWCNTs were grown onto carbon fibres and the composites were processed using a VARTM method. From the results of this study, as long as the adhesion between CNTs and carbon fibres is not good, the presence of CNTs did not increase the mode-I fracture toughness of the carbon fibre composites even though CNTs were aligned perpendicularly to the carbon fibres (crack propagation direction). Despite of several studies that showed increased interfacial shear strength (IFSS) for CNT-grafted carbon fibres by pull-out test of single fibre/epoxy samples, we have not seen any reinforcement effect by using aligned CNTs on carbon fibres at least for the mode-I fracture toughness.

Electrical conductivities: The electrical conductivities of carbon fibre composites can be increased by using CNMs particularly for the out-of-plane direction, whereas the electrical conductivities in the in-plane direction are not much affected by CNMs since the in-plane electrical conductivity is mainly controlled by highly conductive carbon fibres. It should be noted that carbon fibre volume fractions can be more critical factor than CNMs for the out-of-plane electrical conductivity. By this token, keeping consistent processing quality for each case of samples is really essential and fibre volume fractions or equivalent information should be reported for each case to discern the effect of CNMs on the out of- plane electrical conductivities of carbon fibre composites. Reasonably good dispersion of CNMs is generally required to increase the electrical conductivities of the composites. However, poor dispersion of CNTs in the carbon fibre composites still lead to increased the out-of-plane electrical conductivities.

III .CONCLUSION

- The results we got for hollow shaft with composite materials are showing good improvement compare to Solid/hollow steel shaft.
- From orientations 90/0/90/0 shows safe results and is selected for further work.
- Material Carbon epoxy- woven shows less stress (6.80 %) compare to Carbon Epoxy-UD and hence finally suggested for hollow composite Shaft.
- Overall reduction using Composite layers (Compare to existing hollow shaft) in Von-misses stress is 41.29 %, 2.98 % in Shear Stress and 12.25% in deformation.

REFERENCES

[1]. Chris J. Burgoyne, Cambridge, UK “Advanced Composites in Civil Engineering in Europe” at Structural Engineering International report 4/99.

[2]. Branislav Duleba, Frantisek Greskovic “Simulation of Loading the Polymer/Carbon Fibre Composites and Prediction of Safety Factors” at International Journal of Engineering and Innovative Technology (IJEIT) ISSN: 2277-3754, Volume 2, Issue 8, February 2013.

[3]. Darren A. Baker, Timothy G. Rials “Recent Advances in Low-Cost Carbon Fibre Manufacture from Lignin” at Journal of Applied Polymer Science DOI: 10.1002/APP.39273, 2013.

[4]. Luiz Claudio Pardini, Maria Luisa Gregori “Modelling elastic and thermal properties of 2.5D carbon fibre and carbon/SiC hybrid matrix composites by homogenization method” at International Journal of Aerospace Technology Management, Sao Jose dos Campos, Vol.2, No.2, pp. 183-194, May-Aug., 2010.

[5]. Patil Deogonda, Vijaykumar N Chalwa “Mechanical Property of Glass Fibre Reinforcement Epoxy Composites” at International Journal of Scientific Engineering and Research (IJSER) ISSN (Online): 2347-3878 Volume 1 Issue 4, December 2013.

[6]. H. Kim, H. T. Hahn, E. Bekyarova, E. Oh, G. Lee “Carbon Fibre Composites Reinforced With Carbon Nano materials” at 18th International Conference On Composite Materials.