

Advantages and Disadvantages of Using Composite Laminates in The Industries

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Received: 📅 July 05, 2020

Published: 📅 August 20, 2020

Abstract

With today's growing interest toward composite materials and their augmentation as part of integrated business from aerospace engineering, medical applications and others, which are getting increasing dependency on composite materials in recent operations. However, the most sophisticated composite materials still need to rely on the other integrated sub-sets of components. On the other hand, there certain limitation and flaws that exist within composite materials' component that can cause and error to grow way beyond control and can impact its main master component. These sorts of limitation and flaws also would impact the engineering targets from perspective of resiliency built into the daily operations that is also pointed it out in current article.

Keyword: Composite material; laminate; carbon nanotubes; carbon fibre reinforced composites (CFRP)

Introduction

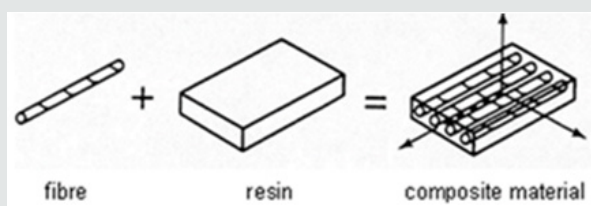


Figure 1: Composition of a composite material.

The composite materials are produced when two or more different materials are laminated together. These laminae were found to have numerous uses due their high strength to weight ratio and resistance to corrosion and surface degradation.(Figure 1)briefly explains the composition of a composite material. Optimizing the construction of composites, multiple adjusted layers (laminae) use to form a laminate. (Figure 2) illustrates layers of individual laminates having different fibre directions combined to form a laminate. By changing the direction of the fibres in the resin, the material properties can be tailored to fit the required properties in a structure.The fibre reinforcement plays a major role in determining the structural properties in a composite material.

Since the fibre is held together with the matrix resin, it optimizes the properties in the final part such as strength and stiffness, while still minimizing weight. The primary function of the fibers is to carry the loads along their longitudinal directions. Common fiber reinforcing agents include:

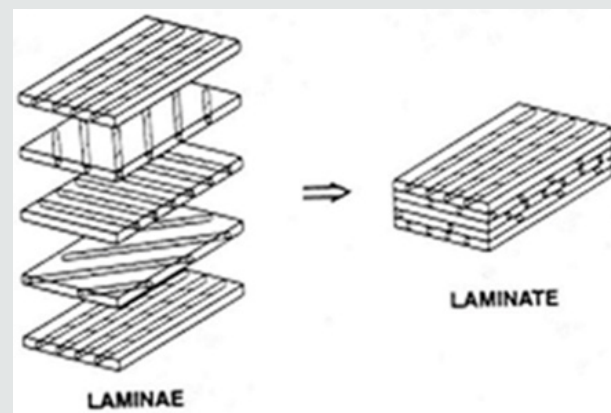


Figure 2: Tailored composites.

a. Carbon (Graphite)

- b. Glass (E-glass, S-glass, D-glass)
- c. Polyamide (Aromatic polyamide, Aramid), e.g., Kevlar 29
- d. Quartz (Fused silica)
- e. Titanium
- c. Polyester
- d. Polyurethane
- e. Vinyl Ester

Resins have a wide variation in properties, and they are relatively low cost. Due to this, most composite matrices are made of resins. Aside from protecting the fibres from mechanical and/or environmental damages, the matrix also serves to transfer stresses between the reinforcing fibres. Common resin material includes:

- a. Epoxy
- b. Phenolic

Table 1: Advantages and disadvantages of composites.

Benefits	Drawbacks
i. High impact damage resistance.	i. Composites are more brittle than wrought metals, making them much easier damaged.
ii. Resistant to fatigue and corrosion degradation.	ii. Matrix is susceptible to environmental degradation.
iii. High strength-to-weight ratio.	iii. Transverse properties may be weak.
iv. The fibre pattern can be tailored to efficiently sustain the applied loads. This directional tailoring capabilities allow products to meet the design requirements.	iv. Costs of raw materials and fabrication are expensive.

Composites have been incorporated in many fields. This includes from household items to construction parts. Several household items which incorporated composites are window frames, bathtubs and doors.[1] Sporting goods such as rackets and bicycles also implemented the use of carbon nanotubes and carbon fibre reinforced composites (CFRP) respectively. In public infrastructures, several bridges and utility poles have been using composites in its construction. Among the composites implemented were carbon composites and glass composites(Figure 3). Due to its

Benefits and Drawbacks of Using Composites

Polyesters are the most widely used resin systems. Epoxies comes in second for their higher cost, with advantages of having higher adhesion and less shrinkage than polyesters. Using composites has their own pros and cons. Depending on their purposes, trade-offs should be considered when implementing composites in a design. (Table 1)summarizes the advantages and disadvantages of composites.

high strength-to-weight ratio, composites are highly demanded in the aerospace industry. Weight is a critical parameter in aerospace. It affects the flying capabilities of an aircraft. Previously, aircraft structures consisted of only metal, which results in a heavy overall structure. Once composites were introduced, they were found to be able to significantly reduce the weight of the aircraft while providing comparable or even higher structural integrity than that of metals at the same time.

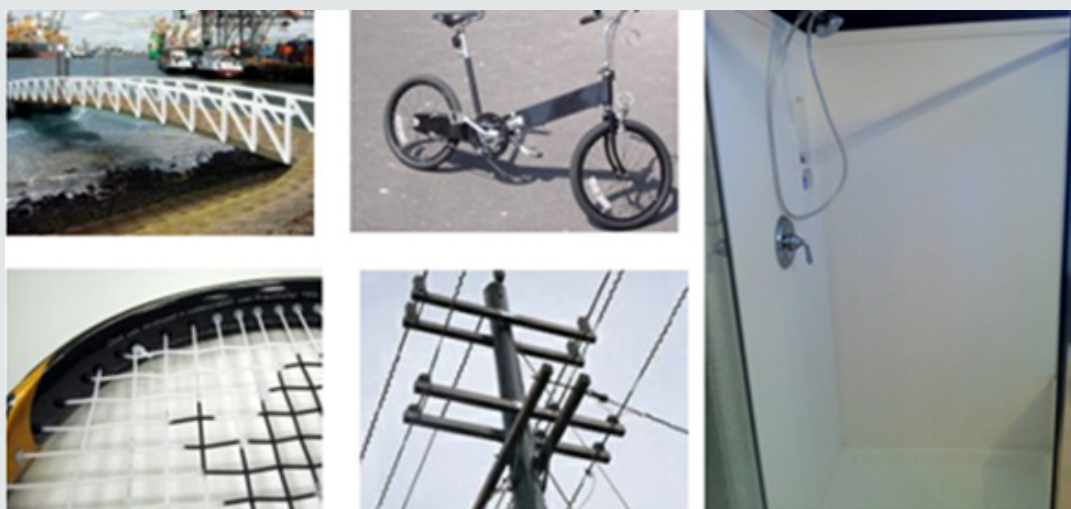


Figure 3: Applications of composites in daily life.

Nowadays, more and more aircrafts are incorporating composites in its design to make it lighter. A lighter aircraft also means less fuel consumption and therefore allows lower emission of greenhouse gasses. Among commercial aircrafts which incorporated composites in its design are the Airbus A380 and Boeing 787 Dreamliner. The A380 contains about 25-30 tons

of composites, 85% of which is CFRP. On the other hand, 50% of the B787 Dreamliner is comprised of composites, with the remainder being 20% aluminum and 30% titanium.(Figures 4&5) show the composition of composites implemented in the aircrafts respectively.

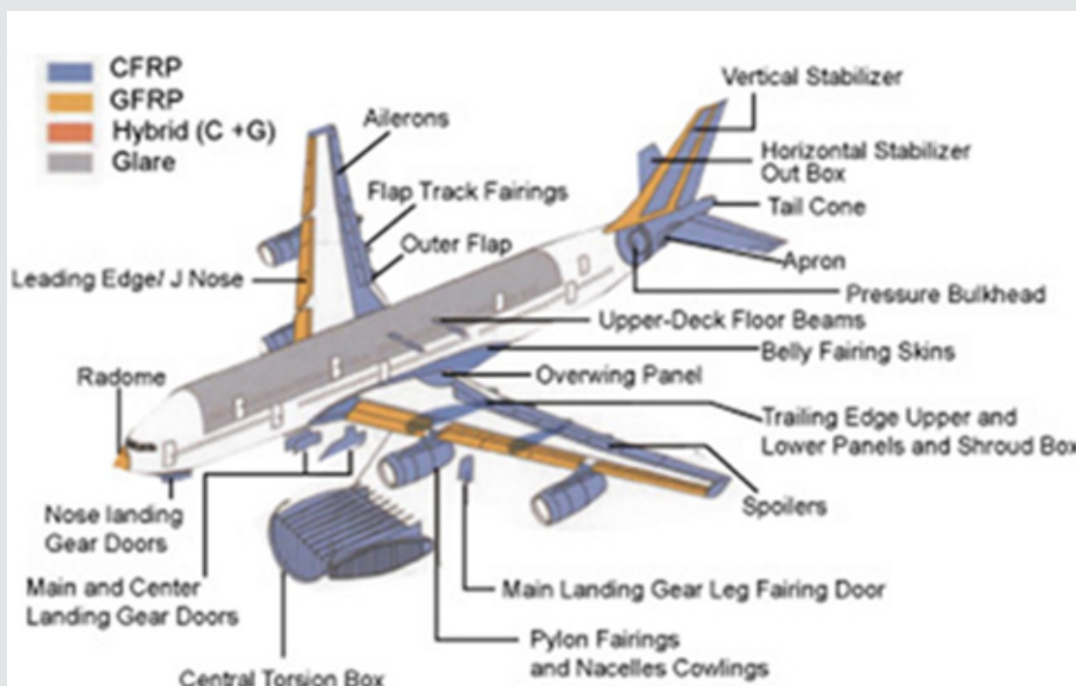


Figure 4: Composition of composites in A380.



Figure 5: Composition of composites in B787 Dreamliner.

Fibre-reinforced composite materials own various functions in most industries, especially the aerospace industry, due to the high specific stiffness. Nonetheless, the expense of conventional composites is also noticeable. Ordinarily, Haphazard divided fibre reinforced composite materials appeared as affirming the most outstanding alternative materials for unique manufacturing challenges, joining the methods and the basic material selection

considerations for multi-material lightweight structures due to the mass production capabilities and low cost [2]. For instance, the possible use in the automotive industry was recorded. In contemplation of expanding the application, meticulous material characterisation is needed. Subsequently, the major complication in the quite exploring models of the geometry at the micro-level of 35-40% fibre volume ratios, which is even more appeared at the highest aspect ratio among the different types of reinforcements [3].

Glass-fibre reinforced composite materials showed limited applications in terms of construction and building industry for several years. Recently, well potential for the applications of fibre-reinforced composite materials for the numerous applications due to expeditiously retrofit and repair deteriorating infrastructure is being achieved [4]. Moreover, mechanical properties of fibre-reinforced composite materials closely depend upon the properties of the component materials such as void content, type, orientation, fibre distribution and quantity. On the other hand, the main concept of the interfacial bonds and the mechanism of load transfer at inter laminar also play a vital role [5].Accordingly, varied researchers

discuss about the design process of short fibres reinforced composite materials. Therefore, they are ready for using to aim attention at the strength properties of the composite materials that reported the effects of them on shapes of the fibres in short-fibres glass composite materials [6]. The flexural strength, vertical stress generated by bending moment of avoided short-fibres reinforced composites were studied by considering the effects of fibre orientation and length on mechanical properties. In addition, a short while ago, efforts to reduce the weight of automobiles by the increased use of plastics and their composites, have led to a growing penetration of short-fibre reinforced injection moulding thermoplastics into fatigue-sensitive applications [7]. Mainly, short-fibre-resin matrix composite materials are minor fatigue resistance than the correspondingly continuous fibre reinforced composites, which is extensively applied in the piping and pipeline systems and the pressure vessels for all major chemical industries [8].

Summary

The flexural strength, vertical stress generated by bending moment of avoided short-fibres reinforced composites were studied by considering the effects of fibre orientation and length on mechanical properties. In addition, a short while ago, efforts to reduce the weight of automobiles by the increased use of plastics and their composites, have led to a growing penetration of short-fibre reinforced injection moulding thermoplastics into fatigue-sensitive applications. Mainly, short-fibre-resin matrix composite materials are minor fatigue resistance than the correspondingly continuous fibre reinforced composites, which is extensively applied in the piping and pipeline systems and the pressure vessels for all major chemical industries[9-15].

Conflict of Interest

There is no conflict of interest to declare.

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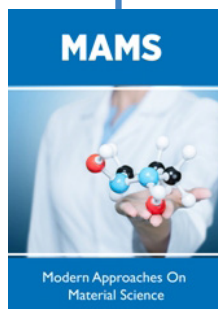


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DOI: [10.32474/MAMS.2020.03.000158](https://doi.org/10.32474/MAMS.2020.03.000158)



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