Carbon Fiber Reinenforced Plastic – The End of Metal Age

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Abstract

Carbon fiber reinforced plastic is a material that will define a substantial scope of our future. CFRP is used in the aviation industry, Inflatable antenna for space applications, the wind energy, Car industry as well as shipbuilding industry. The end of metal age is here – the age of carbon fiber reinforced composites has just begun. Carbon fiber reinforced plastic (CFRP) is the advanced material innovation of 20th century.

Keywords: Carbon Fiber Reinenforced Plastic (CFRP)

I. SCOPE OF CARBON FIBER REINFORCED PLASTIC MATERIAL

Wherever a mass needs to be accelerated or slowed down light weight design is required to reach high energy efficiency. This has become basic need in aviation industry. If an airplane is lightened by 1 kg, its fuel consumption is reduced by approximately 3 kg over life time. The giant Airbus A380 has a take – off weight of about 500,000 kg. A lot of this weight can still save within the plane structure with the application of CFRP.

CFRP is made of two components; the single filaments are being embedded within a matrix, which can be made of resins of thermo plastics. This compound can be converted into many shapes.

The high-tech material is characterized by extraordinary mechanical properties. Those are extreme tensile strenght, stiffness of the composite and enormous elasticity, which is important during the manufacturing process. Furthermore, CFRP offers excellent fatigue behaviour and is corrosion resistant. The very low dilatation as well as brilliant damping capacities combined with a low density (2/3 of aluminum, 1/5 of steel) offer a wide range of applications in various industry branches. Therefore CFRP is of high interest to designing and constructing engineers.

Fibre composites containning CFRP can be tailor made for every intended use. The fibes are being places precisely within the structural part. Compared to steel design about 50%, compared to aluminum design about 20% of structural weight can be saved. Despite the weight savings, CFRP has a four times higher stiffness and an eight times higher strength compared to steel. In case of an accident CFRP absorbs about eight times more energy than steel or aluminum.

These properties of CFRP have brought high safety to motor sports and have also made the vehicles more powerful. Moreover, vehicles with less weight consume less fuel, which is a benefit for everyone‘s budget as well as the environment, since less CO2 is exhausted.

The lightweight potential of CFRP can be used for many applications. CFRP allows the building of very light and therefore energy-efficient aircrafts, vehicles and ships as well as larger rotor blades for more powerful wind turbines. Even longer bridges, higher buildings or self –supporting roofs with wider spans can be made of CFRP.

II. CARBON FIBER SPECIFICATIONS

Significance of different Carbon Fibers available in Market

K CARBON	*TEX*	*DENIER*
1	*70*	*630*
3	*200*	*1800*
6	*400*	*3600*
12	*800*	*7200*
24	*1600*	*14400*
50	*3300*	*29700*

A. Carbon Fiber Fabric Manufacturing on Rapier Looms (Broad & Narrow Weaving Machines)


B. Carbon Fiber Fabric Construction Particular

S.N0.	*WARP CARBON*	*WEFT CARBON*	*ENDS PER CM*	*PICKS PER CM*	*FABRIC WIDTH*	*TYPE OF FABRIC*
1	*3K*	*3K*	*9.44*	*9.44*	*100 CM*	*8 SATIN –BD CARBON*
2	*3K*	*3K*	*4*	*5*	*100*	*PLAIN BD CARBON*
3	*12K*	*12K*	*9.44*	*9.44*	*100*	*2/2 TWILL BD CARBON*
4	*12K*	*68 TEX GLASS*	*9.44*	*2.5*	*100*	*PLAIN UD CARBON*
5	*50K*	*6K*	*2.5*	*1.18*	*15*	*UD FOR CONSTRUCTION ON NARROW LOOM*

C. Use of Carbon Fiber for Car / Aeroplane / Ship Industry:

Carbon fiber is a flexible fabric-like material that, when combined with a polymer, can be moulded into the shape of a car part that is stronger and lighter than today's steel and aluminium parts. ... Carbon fiber makes more economic sense for electric cars, because it is cost effective compared to lithium-ion batteries are more expensive.

This is well proven fact that carbon fiber is just as safe as steel. Computer crash simulations show that carbon fiber cars perform just as well as steel cars.

D. CFRP-Material with Unique Properties

1) Fibre composites containing CFRP can be tailor made for every intended use. The fibes are being places precisely within the structural part. Compared to steel design about 50%, compared to aluminum design about 20% of structural weight can be saved. Despite the weight savings, CFRP has a four times higher stiffness and an eight times higher strength compared to steel
2) In case of an accident CFRP absorbs about eight times more energy than steel or aluminum. This becomes especially obvious in the aviation industry. If an airplane is lightened by 1 kg, its fuel consumption is reduced by approximately 3,000 kg over lifetime.

E. Carbon narrow width fabric (24 K UD Carbon) for Construction Industry


Cutting of Carbon fabric


CF for Axial Beams in Construction

24K TO 50K Carbon Fiber fabric can repair very old multi storied buildings without removing entire infrastructure if extremities of square pillar are being damaged. This repairing concept in Construction Industry has been utilized.

Research was carried out by author in NIRMA UNVERSITY, Ahmedabad with 24 K Carbon fiber extra heavy duty belt which was developed for Flexural strengthening of small scale reinforced concrete beams was conducted using this material in the laboratory. Axial strengthening of reinforced concrete columns was further explored using the said material. Overall, the 24 K carbon was able to enhance the performance of the specimens tested in the laboratory.

III. CONCLUSION

Carbon weaving is still a new concept to make technical fabrics. Many types of equipment and auxiliary attachments are available in advanced countries but these are very expensive investment. In India rare manufacturers are involved in Carbon fibre fabric manufacturing. There are lot of scope in various area for Carbon fiber fabric and CFRP but to make it cost effective in India, manufacturing of Carbon fabric must be increased by Entrepreneurs instead of outsourcing (Import).

More than that users mind set must be motivated from conventional metals to technical fibers composite applications.

Research is being carried out on technical textile composites but its adoptability and commercialization needs to boost in public sectors.