Experimental Study on Sections Made using Glass Fibers

Author: Assit.Prof. Srinath T. Rafik Mohamed PrinceCheladurai

Department of civil engineering, SNS College of Engineering, Coimbatore.

Abstract

Composite materials are materials with two or more constituents combined to form a material with different properties than those of the individual constituents. Fiber reinforced plastic (FRP) is a composite material that consists of two constituents: a series of fibers surrounded by a solid matrix. As with many other composite materials such as reinforced concrete, the two materials act together, each overcoming the deficits of the other. Whereas the plastic resins are strong in compressive loading and relatively weak in tensile strength, the fibers are very strong in tension but tend not to resist compression. The study was carried out for the type of short column with the proportionate of fibre glass material and Epoxy Resin. The strength of the column depended on the material usage. Different size of the columns are identified and the test was performed as theoretical and numerical analysis. The standard strength was selected for doing the experimental analysis. EFC-100-75-3-500 of the fiber glass epoxy material attained more strength as 32 kN.

Key words: Fiber reinforced plastic (FRP), EFC, Epoxy resin, Polyester, Analysis of column.

1.INTRODUCTION

FRP has been used for many years in the aerospace and automotive industries and has recently been used in Civil Engineering structures. Civil Engineers are exploiting the advantages of using FRP, advantages such as light weight, corrosion resistance, low thermal and electrical conductivity, high strength to weight and stiffness to weight ratios, and the ability to vary the properties over a wide range of values. Fiberglass or glass-fiber reinforced plastic (GFRP) is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers of glass. The plastic matrix may be, a thermo-setting plastic or thermoplastic. Glass Fibers are among the most versatile industrial materials known today. Fiberglass is much more sustainable than aluminium, steel or timber. Fiberglass is recyclable and can be ground down and is commonly used as a filler in concrete. Two types of materials were used for the compressive strength testing such as Thermo setting resin and thermo plastic resin. A thermo setting plastic, also known as a thermosetpolymer material that irreversibly cures. Once hardened a thermoset resin cannot be reheated and melted to be shaped differently. Most thermoplastics have a high molecular weight. The polymer chains associate through intermolecular forces, which permits thermoplastics to be remolded because the shoreline applications, generaloutdoor applications, and wastewater treatment plants.

3. Materials and Methodology

Material properties are mainly depends on type and composition of materials. Material properties such as Young’s modulus, Ultimate Tensile stress, Yield stress are determined using Universal testing machine of 40 tonne capacity. Two types of materials are used for the fibre glass reinforcement. The following results were obtained for Epoxy resin and Polyester with the finer glass ;

Table 1 Properties of Polyester Resin and Epoxy Resin

Properties	Polyester Resin	Epoxy Resin
Young’s Modulus (N/mm^2)	0.05 x 10^5	0.13 x 10^5
Yield stress (N/mm^2)	51.38	64

Fig 1 Failure of Coupon Specimen (Epoxy Resin)

Experimental Study

The experimental setup for testing the Columns under axial compression is shown in Fig 2. The data acquisition system is used to record the load, deflection and strain measurements. The experimental results and numerical results are compared with results of Theoretical Analytical study and the findings are presented. From the experimental results load deflection curve is plotted. The detailed study of the graphs gives the type of failure of the specimen and the critical load. The experimental result also gives the stress strain relationship of the member.

Fig 2. Specimen EFC 100-75-3 -500 reaches the ultimate load of 32 kN by UTM test.

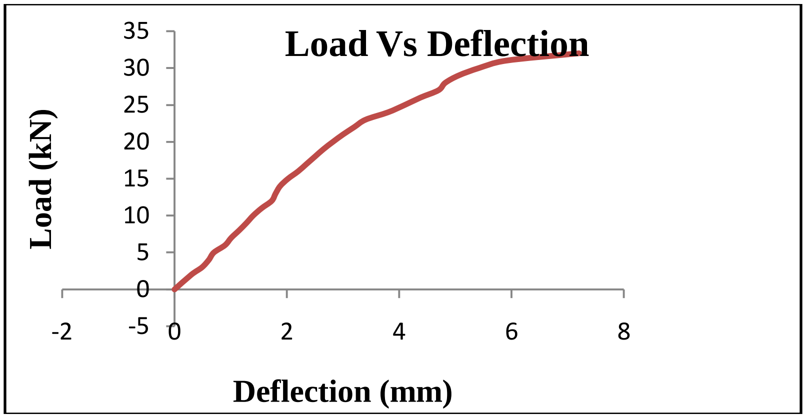

Fig 3 Load – Deflection curve for Specimen EFC-100 – 75 - 3 -500

4. RESULTS AND DISCUSSION

From the Experimental and Theoretical study the following conclusions are made; For long composite columns, overall (Euler) buckling occurs before any other instability failure and short columns, local buckling occurs first, leading either to large deflections and finally to overall buckling or to material degradation due to large strains (crippling). The intermediate lengths, interaction between local and global buckling may occur and possibly material degradation may occur. Hence the buckling strength of column can be increased by using different types of resin, Fibers and its orientation and also increased by providing stiffeners.

Table 2. Results of the ultimate load for different size of the columns

Specimen	Experimental (kN)	Numerical(kN)	Theoretical(kN)
EFC-75-50-3-500	22.5	23.22	21.851
EFC-75-50-4-500	24.6	24.76	28.61
EFC-100-75-3-500	32	32.97	38.74

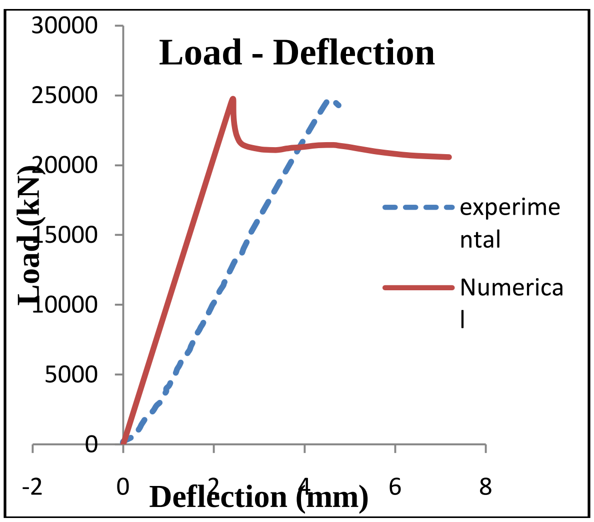

Fig.4 Comparison of results for specimen EFC 100 – 75 - 3 – 500

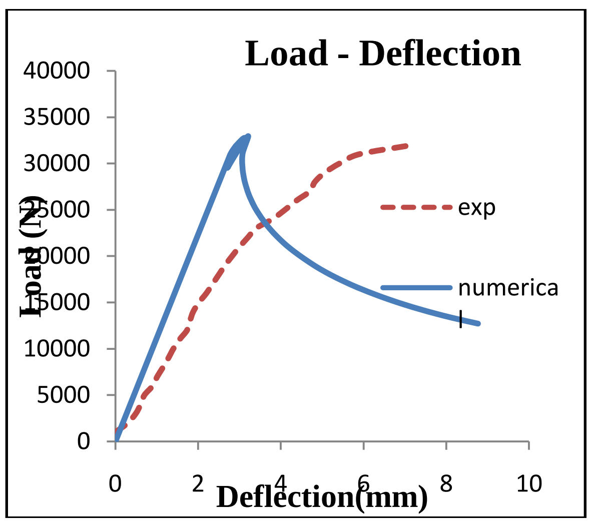

Fig.5 Comparison of results for specimen EFC 100 – 75 - 3 – 500

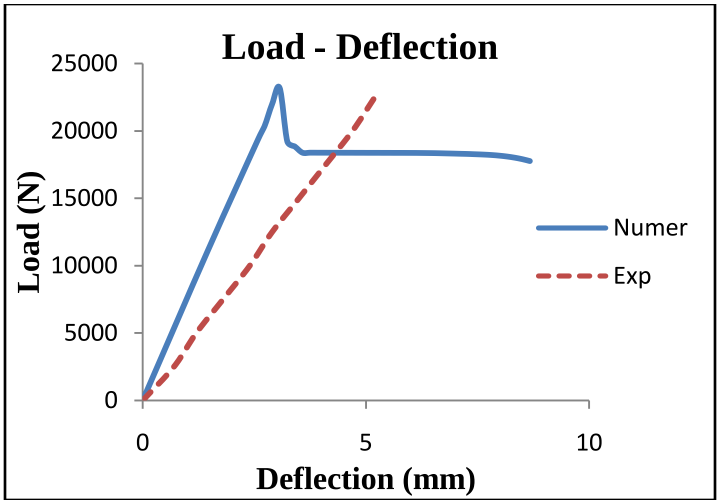

Fig.6 Comparison of results for specimen EFC 75 – 50 – 3– 500

REFERENCES

1. Barbero E J, Raftoyiannis I G, "Euler buckling of pultruded composite columns". Composite Structures, 1993, 24(2): 139–147.
2. Correia,M.M , Correia,J. ,Nunes.F., Silvestre,N. , ,"Experimental and numerical study on the structural behavior of eccentrically loaded GFRP columns." Thin-Walled Structures, 2013,72, 175-187.
3. Ever Barbero and John Tomblin , "Local Buckling Experiments on FRP Columns", Thin-Walled Structures , 1994 (18): 97-116.
4. Ever J. Barbero and Malek Turk, "Experimental Investigation of Beam-Column Behavior ofPultruded Structural Shapes",Journalof Reinforced Plastics and Composites, 2000,vol. 19.
5. FerdinandoLaudiero,FabioMinghiniandNerioTullini,"Buckling andPostbuckling Finite-Element Analysis of FRP Profiles under Pure Compression". Journal of Composites for Construction,2013.
6. PizhongQiao, Julio F. Davalos, and Jialai Wang, "Local Buckling of Composite FRP shapesby Discrete Plate Analysis", Journal of StructuralEngineering, March, 2001,Vol. 127, No. 3,.
7. Sang KyoonJeong and Soon Jong Yoon, "Elastic Buckling of Orthotropic Open Section Compression Members with Edge Stiffeners".KSCE Journal of Civil Engineering,1998,Vol.2,377-386.
8. Shao-Yun Fu & Bernd, "Effects of Fiber Length and Fiber Orientation and Distributions on the tensile strength ofshort-fiber-reinforced polymers",Composite science and Technology ,1996,1179-1190.
9. Zureick A, Scott D., "Short-term behavior and design of fiber-reinforced polymeric slender members under axial compression". Journal of Composites for Construction, 1997, 1(4): 140–149.