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1.Horaţiu TEODORESCU-DRĂGHICESCU, 2.Sorin VLASE,
3.Ioan SZÁVA, 4.Imre KISS, 5.Renata Ildikó SZÁVA

# EXPERIMENTAL CHARACTERIZATION OF FIVE PLIES HELIOPOL/STRATIMAT 300 COMPOSITE LAMINATE

1-3,5. University Transylvania of Brasov, Brasov, ROMANIA
2. University Politehnica Timişoara, Faculty of Engineering Hunedoara, ROMANIA

**Abstract:** Five plies of Heliopol 9431ATYX_LSE/Stratimat300 glass fabric (300 g/m² specific weight), 6 mm thick laminate has been considered for experimental characterization using the three-point bend tests. Following distributions have been experimentally determined on five layers of Heliopol 9431ATYX_LSE/Stratimat300 glass fabric specimens using data recorded by the materials testing machine: Load (N)-deflection (mm), Stiffness (N/m) of each specimen, Young's Modulus of Bending (MPa) of each specimen, Flexural Rigidity (Nm²) according to each specimen, Maximum Bending Stress at Maximum Load (MPa)-Maximum Bending Strain at Maximum Load, Work to Maximum Load (Nmm) of each specimen, Load at Break (kN)-Deflection at Break (mm), Maximum Bending Stress at Break (MPa)- Maximum Bending Strain at Break and Work to Break (Nmm) of each specimen.
**Keywords:** Heliopol 9431ATYX_LSE, Stratimat300, Three-point bend tests, Composite laminate, Glass fibers

## INTRODUCTION

There is a wide range of fiber formats that together with the process used, provide useful information of different classes of composite materials. The fibers lengths can vary from discontinuous fibers (milled, short and long) to continuous fibers in swirled mats, fabrics, non-crimped fabrics and so on. The major use of glass fibers is still represented by chopped strand mats (CSM). In general, a composite structure is manufactured of various plies of discontinuous or unidirectional fibers with different orientations, stacked together to form so called laminates [1],[6],[11],[16]. The E-glass fibers mat of 300 g/m² specific weight, also known as Stratimat by its trading name, represents the most common reinforcing material used in polyester, vinylester and epoxy based hand lay-up composite laminates. This mat can be used in a wide variety of composite laminates as well as to repair damaged polymer matrix composite structures such as spoilers, hubs, doors, subwoofer boxes and so on, mainly in the automotive industry. It is also recommended for gelcoat applications that require high quality surfaces even for complex shape structures. Various researches have been carried out in the Department of Mechanical Engineering within Transilvania University of Brasov including simulations and experiments of different composites. Some of these are presented in references [2]-[5], [7]-[10], [12]-[15] and [17]-[21].

## MATERIALS AND EXPERIMENTAL PROCEDURE

Following polyester/glass fibers composite laminate has been manufactured at Compozite Ltd., Brasov and cured in specific dimensional panels from which specimens have been cut using a diamond mill and water as cooling agent to avoid introduce internal stresses in composite: five layers of Heliopol 9431ATYX_LSE/ Stratimat300 glass fabric (300 g/m² specific weight), 6 mm thick laminate. Specific compounds have been used to manufacture in the hand lay-up process the 6 mm thick laminate. These compounds are: Resin - Heliopol 9431ATYX_LSE; Hardener - Butanox M50; Glass fibers - Stratimat300 with 300 g/m² specific weight.

From cured plate, nine specimens have been cut using a diamond powder mill and a suitable cooling system to avoid introduce internal stresses in the composite laminate. The specimens have been subjected to three-point bend tests until break on a LR5K Plus Lloyd Instruments' materials testing machine using maximum 5kN load cell.

## EXPERIMENTAL RESULTS

Following distributions have been experimentally determined on five layers of Heliopol 9431ATYX_LSE/ Stratimat300 glass fabric specimens using data recorded by the materials testing machine:

- Load (N)-deflection (mm) plotted in Figure 1;
- Stiffness (N/m) of each specimen, presented in Figure 2;
- Young's Modulus of Bending (MPa) of each specimen, shown in Figure 3;
- Flexural Rigidity ($Nm^2$) according to each specimen, plotted in Figure 4;
- Maximum Bending Stress at Maximum Load (MPa)-Maximum Bending Strain at Maximum Load (Figure 5);
- Work to Maximum Load (Nmm) of each specimen, presented in Figure 6;

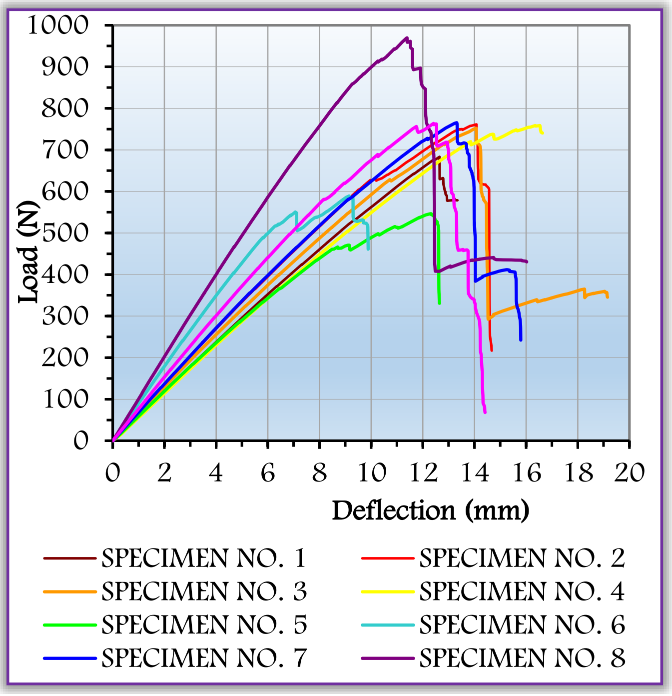


Figure 1: Load-Deflection distribution of five layers Heliopol/Stratimat300 composite laminate

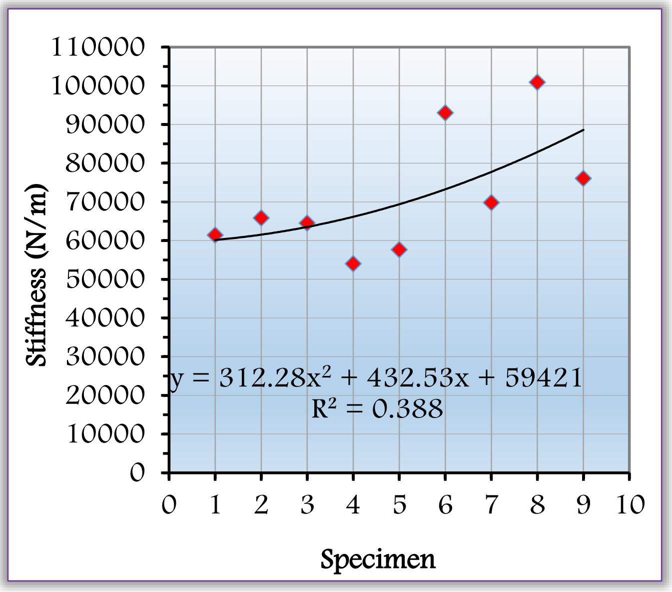


Figure 2: Stiffness distribution of five layers Heliopol/Stratimat300 composite laminate

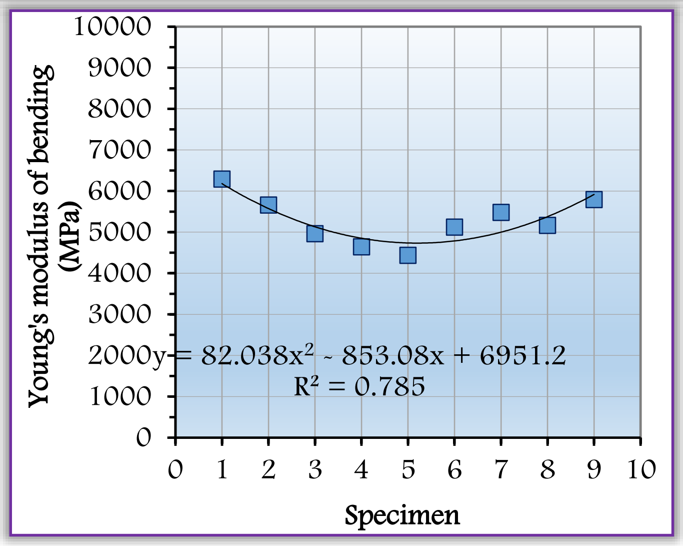


Figure 3: Young's modulus of bending distribution of five layers Heliopol/Stratimat300 composite laminate

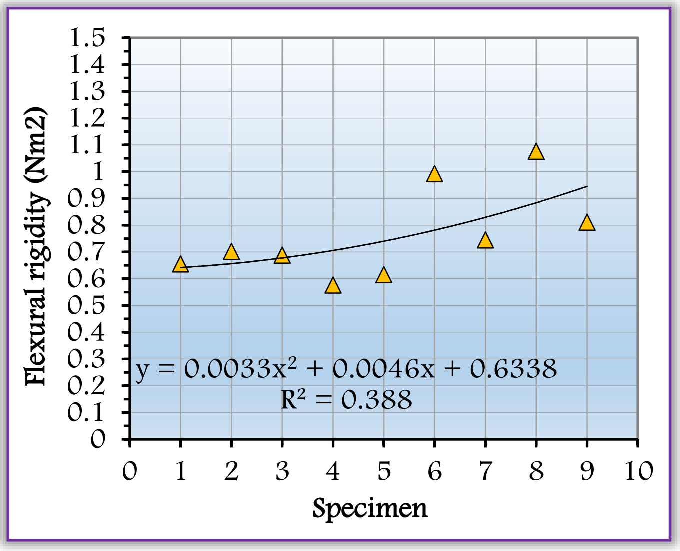


Figure 4: Flexural rigidity distribution of five layers Heliopol/Stratimat300 composite laminate

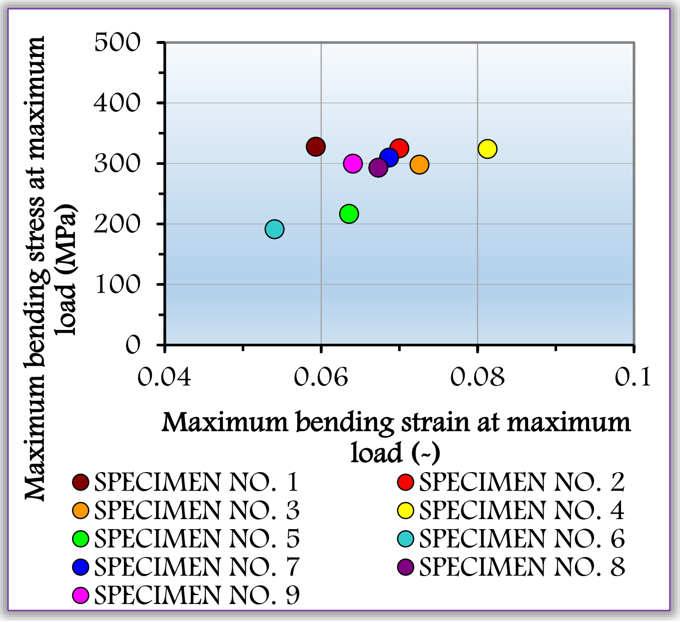


Figure 5: Maximum bending stress at maximum load distribution of five layers Heliopol/Stratimat300

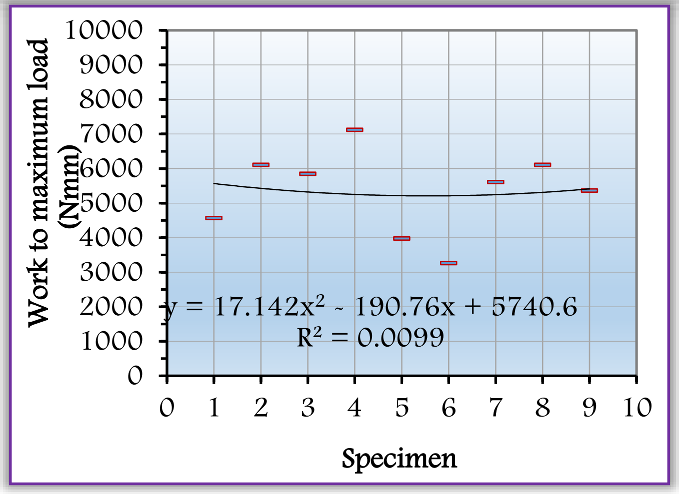


Figure 6: Work to maximum load distribution of five layers Heliopol/Stratimat300 composite laminate

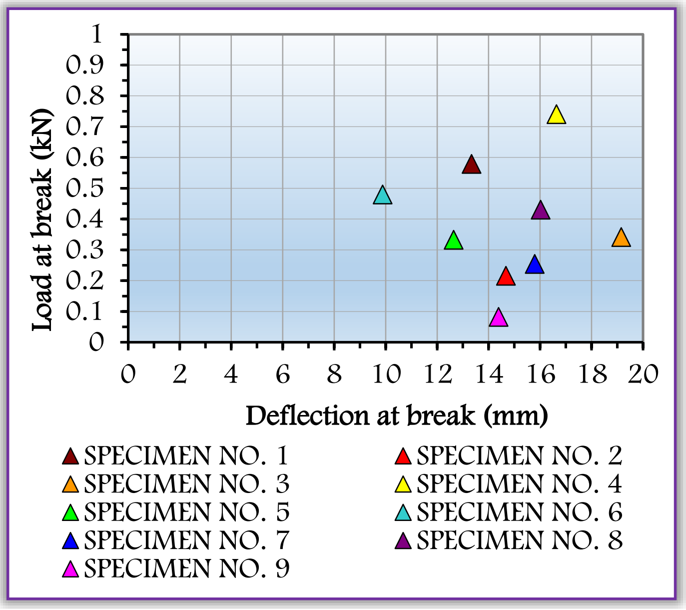


Figure 7: Load-deflection at break distribution of five layers Heliopol/Stratimat300 composite laminate

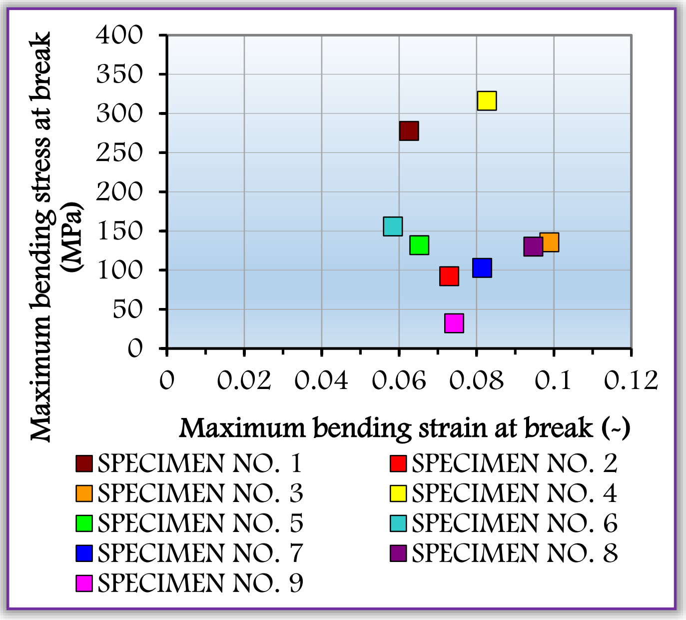


Figure 8: Maximum bending stress at break distribution of five layers Heliopol/Stratimat300

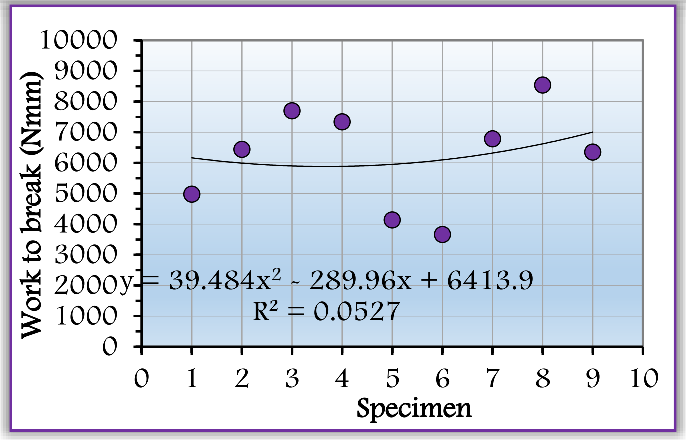


Figure 9: Work to break distribution of five layers Heliopol/Stratimat300 composite laminate

Also, the following distributions have been experimentally determined:

- Load at Break (kN)-Deflection at Break (mm), shown in Figure 7;
- Maximum Bending Stress at Break (MPa)-Maximum Bending Strain at Break (Figure 8);
- Work to Break (Nmm) of each specimen, presented in Figure 9.

## CONCLUSION

Regarding the load-deflection distribution of nine Heliopol/Stratimat300 specimens subjected to three-point bend tests, maximum load of 942.12 N has been reached at specimen number eight and a maximum deflection of 18.8 mm presents specimens number three (Figure 1). Specimen number eight presents also maximum stiffness of 100911 N/m and specimens number four exhibits minimum stiffness of 54009.42 N/m (Figure 2).

Young's modulus of bending distribution is situated between a maximum value of 6.29 GPa at specimen number one and a minimum one of 4.43 GPa at specimen number five (Figure 3). The maximum value of Young's modulus of bending represents an outstanding value for this kind of composite laminate subjected to three-point bend tests. The flexural rigidity distribution follows the stiffness distribution and exhibits a maximum flexural rigidity of 1.07 $Nm^2$ in case of specimen number eight and a minimum value of 0.57 $Nm^2$ reached by specimen number four (Figure 4). Maximum bending stress at maximum load of 327.99 MPa has been obtained at specimen number one and maximum bending strain at maximum load of 0.08 presents specimen number four (Figure 5). Regarding the work to maximum load distribution of nine Heliopol/Stratimat300 specimens subjected to three-point bend tests, maximum value of 7121.64 Nmm exhibits specimen number four and a minimum value of 3264.84 Nmm has been experimentally determined at specimen number six (Figure 6). Specimen number four exhibits the greatest load at break of 0.74 kN and the greatest deflection at break of 19.15 mm has been reached by specimen number three (Figure 7). Maximum bending stress at break follows the same distribution as the load at break distribution, the maximum value of 316.27 MPa being noted at specimen number four and the maximum bending strain at break of 0.098 exhibits specimen number three (Figure 8). The work to break distribution of nine Heliopol/Stratimat300 specimens subjected to three-point bend tests present a maximum value of 8541.08 Nmm in case of specimen number eight and a minimum value of 3660.39 Nmm has been reached by specimen number six (Figure 9).

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