# EXPERIMENTAL TEST OF A NEW COMPOSITE MATERIAL

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***Abstract:*** *This paper presents extended researches regarding tensile and three-point bend tests accomplished on "SDV" composite material. The experimental tests have been carried out on LS100 Plus and LR5K Plus materials testing machines produced by Lloyd Instruments, UK. Load-extension and load-deflection distributions have been plotted during tensile and three-point bend tests. The tests put into evidence the significant anisotropy of this composite material.*
***Keywords:*** *SDV, composite material, tensile test, three-point bend test, load-extension distributions*

## 1. INTRODUCTION

A homogenization method and some averaging methods to predict the elastic properties of multiphase pre-impregnated composite materials like Sheet Molding Compounds (SMCs) are presented in reference [1]. The upper and lower limits of the homogenized coefficients for a 27% fibers volume fraction SMC have been computed. A comparison between the upper and lower limits of the homogenized elastic coefficients for a 27% fibers volume fraction SMC and the experimental data is presented. The estimation model used as a homogenization method of these heterogeneous composite materials, gave emphasis to a good agreement between this theoretical approach and experimental data. Hysteresis behaviors of three-phase randomly oriented glass fiber-ceramic particles-reinforced polyester resin composite material subjected to static cyclic tension-compression loadings have been carried out [2]. Various cyclic tests with different test speeds, load limits and number of cycles have been accomplished on a Lloyd Instruments LS100Plus materials testing machine with STGA/50/50 E85454 extensometer. The most important results regarding mechanical properties of three-phase chopped strand mat-$Al_2O_3$ particles-SYNOLITE 8388 P2 polyester resin laminates subjected to short time static cyclic tension-compression loadings are presented in reference [3]. Simulations regarding the elastic properties of glass, carbon and Kevlar49 fiber-reinforced composite laminates based on epoxy resin and subjected to off-axis loading system have been accomplished using an approach developed by Clyne and Withers within Cambridge University, UK [4]. Behavior simulations of various polymer matrix composite laminates subjected to three and four-point bending using the finite element method have been carried out. The models have been designed and analyzed with MSC Patran and MSC Nastran. Four types of composite laminates have been developed based especially on epoxy resin reinforced with Chopped Strand Mats of various specific weights and RT800 glass fabrics [5]. Three types of composite laminates have been subjected to four-point bend tests using the resistive stress analysis have been used in reference [6]. Between these layers, three strain gages have been applied and connected to a Spider8 device. Distributions of load versus time as well as specific deformation versus time for all three types of composite laminates have been experimental determined in four-point bend tests using the CATMAN software. Basic mechanical properties have been experimentally determined on twelve layers glass fabric-reinforced polyester resin specimens subjected to tensile loads on weft direction until break. Glass fabric of type RT300 has been used to reinforce Polylite 440-M888 polyester resin [7]. The most important mechanical properties determined in a simple tensile test on a 0.4 mm thickness 2/2 carbon twill weave fabric impregnated with epoxy resin, used as skins for an advanced ultralight sandwich composite structure with expanded polystyrene as core have been presented in reference [8]. To use composites in design of car components, their mechanical properties are for a great importance. A calculation of the stresses and loads of parts manufactured from composites can be carried out. To determine their mechanical properties, theoretical models can be used. Bearing in mind the differences in the charges of composite materials, even when the same manufacturer produces them, an experimental research is required on these materials [9]. Stratimat 300 glass fibers has been used to reinforce Heliopol 9431ATYX_LSE resin in hand lay-up process. A 6 mm thick composite laminate plate with five layers has been cured from which nine specimens have been cut using a diamond powder mill being under protection of a specific cooling system. Interesting mechanical properties have been also determined during three-point bend tests [10]. Other important mechanical characteristics of different composite materials have been presented in references [11-17].

## 2. THE EXPERIMENTAL SET-UP AND PROCEDURE

The tests in the Scientific Research Contract no. 178 / 8.06.2015 /7284/25.06.2015 "MECHANICAL TENSILE AND BENDING TESTS FOR STANDARD COMPOSITE MATERIAL SPECIMEN" were carried out in the Mechanical Testing Laboratory of the Mechanical Engineering Department within the Faculty of Mechanical Engineering of the Transilvania University of Brasov. The tensile test was performed on the Lloyd LS 100 machine (Fig. 1) with a maximum load of 98 kN. An Epsilon extensometer have been used to determine the strain (Fig. 2). The three-point bend tests have been performed on the Lloyd LR5k machine (Fig. 3) with a maximum load of 5 kN. Specimens provided for tensile testing from the SDV die material are shown in Fig. 4. For three-point bend tests, the SDV material samples are shown in Fig. 5. The dimensions of the specimens have been measured.

**Figure 1:** The LS100 Plus materials testing machine

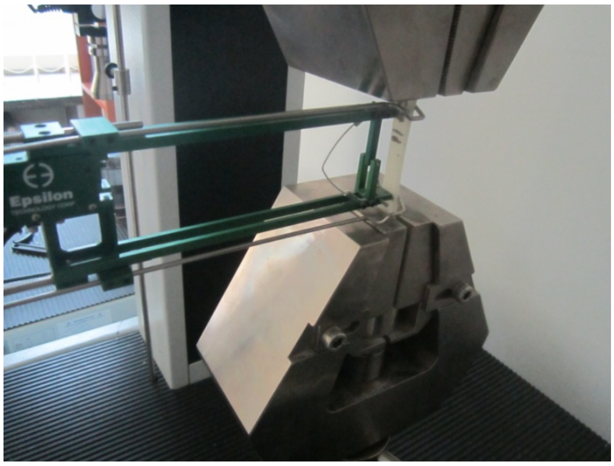


**Figure 2:** The Epsilon extensometer

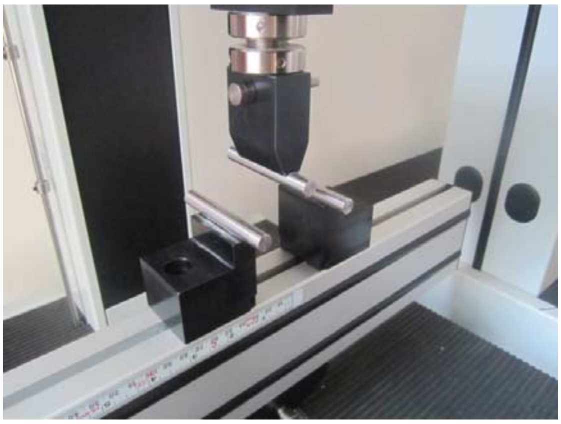

**Figure 3:** The LR5K Plus materials testing machine

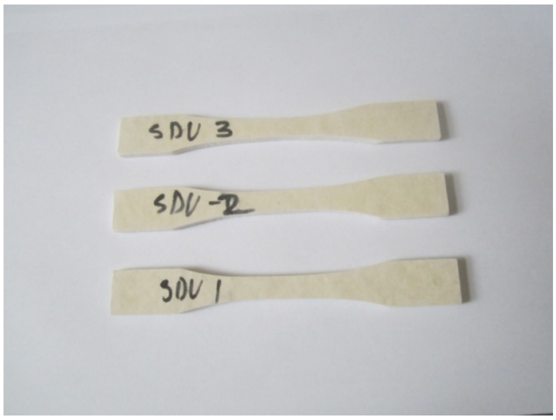

**Figure 4:** „SDV” composite specimens for tensile tests

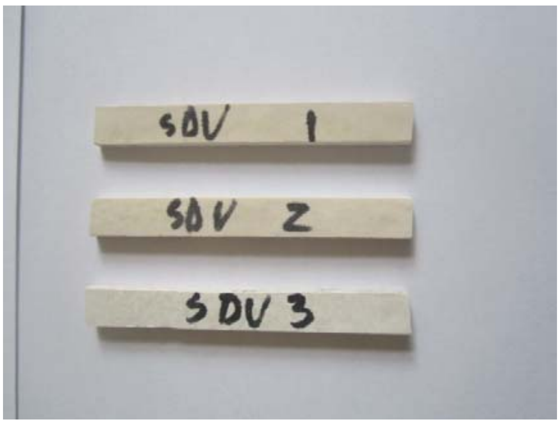

**Figure 5:** „SDV” composite specimens for three-point bend tests

## 3. RESULTS

For the SDV composite, load-extension distributions of all specimen, obtained in tensile tests are presented in Figs. 6-8. Figs. 9-11 shows the load-deflection distribution of the specimens, determined in three-point bend tests. Geometrical features of SDV composite specimens for tensile and three-point bend tests are shown in Tables 1 and 2. The tensile and three-point bend tests results are presented in Tables 3 and 4.

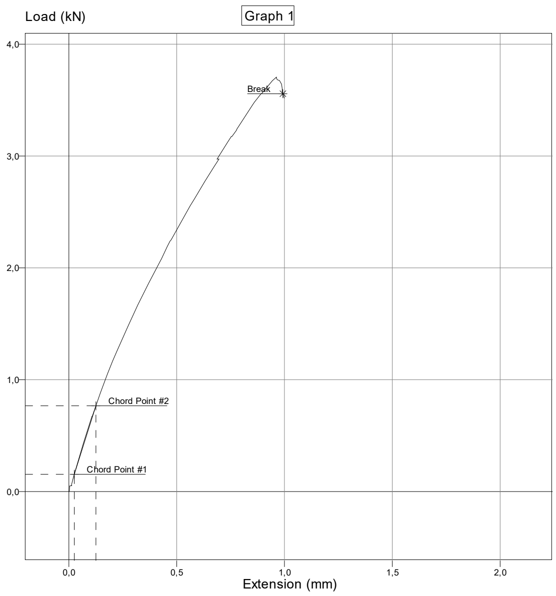


**Figure 6:** Load-extension distribution of SDV1 specimen in tensile test

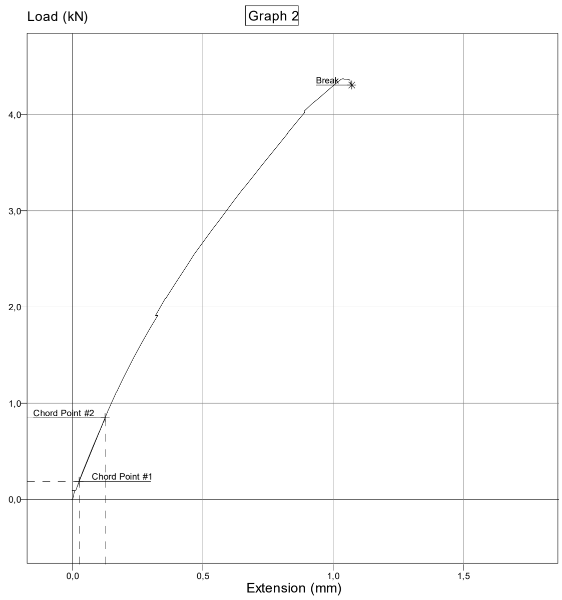


**Figure 7:** Load-deflection distribution of SDV2 specimen in tensile test

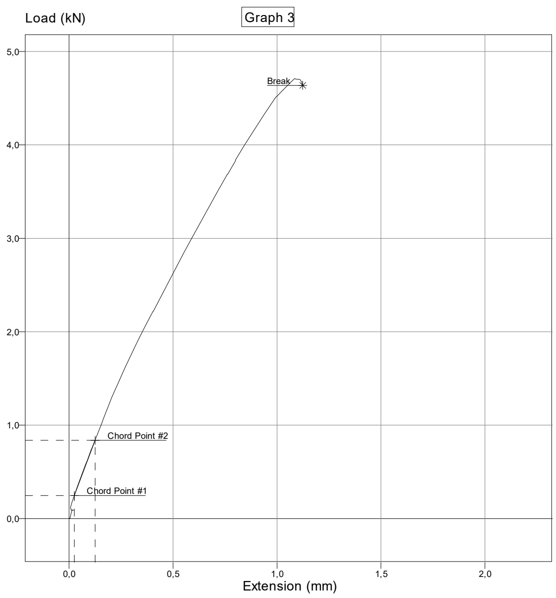


**Figure 8:** Load-extension distribution of SDV3 specimen in tensile test

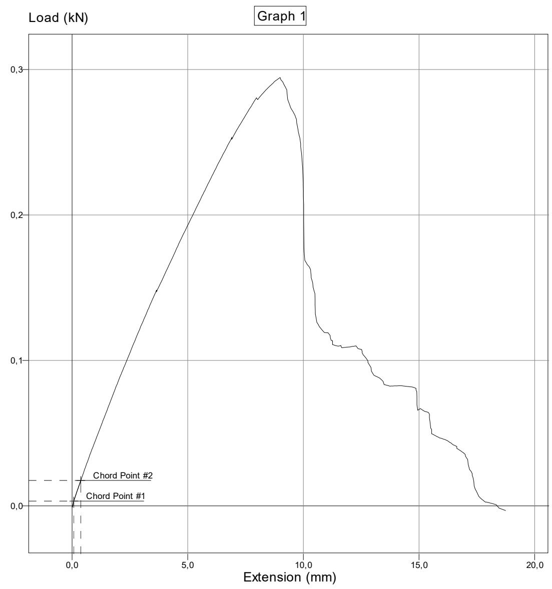


**Figure 9:** Load-deflection distribution of SDV1 specimen in three-point bend test

**Table 1:** Geometric features of SDV composite specimens for tensile tests

| Specimen | L (mm) | b (mm) | h (mm) | Area ($mm^2$) |
|---|---|---|---|---|
| SDV1 | 150 | 10 | 5 | 50 |
| SDV2 | 150 | 10 | 5 | 50 |
| SDV3 | 150 | 10 | 5 | 50 |

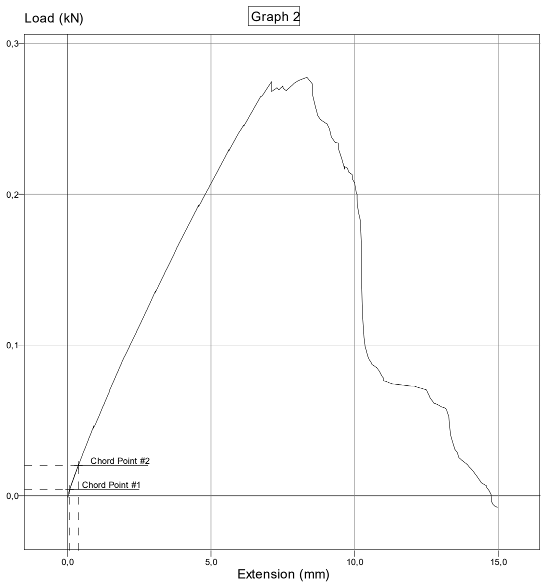


**Figure 10** Load-deflection distribution of SDV2 specimen in three-point bend test

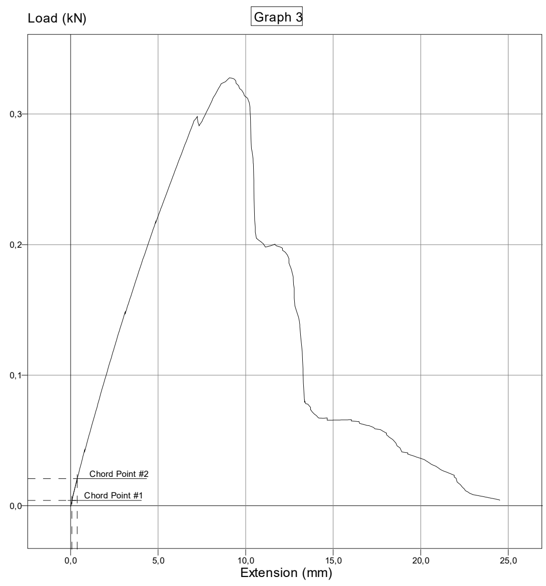


**Figure 11:** Load-deflection distribution of SDV3 specimen in three-point bend test

**Table 2:** Geometric features of SDV composite specimens for three-point bend tests

| Specimen | L (mm) | b (mm) | h (mm) | Span (mm) | Strength modulus ($mm^3$) |
|---|---|---|---|---|---|
| SDV1 | 80 | 10 | 4.5 | 64 | 33.75 |
| SDV2 | 80 | 10 | 4.5 | 64 | 33.75 |
| SDV3 | 80 | 10 | 4.5 | 64 | 33.75 |

**Table 3:** SDV composite tensile test results

| Specimen | SDV1 | SDV2 | SDV3 | Mean |
|---|---|---|---|---|
| Maximum load (N) | 3704.3 | 4382.9 | 4709.5 | 4265.6 |
| Maximum stress (MPa) | 74.087 | 87.657 | 94.190 | 85.311 |
| Deformation at max. load (mm) | 0.962 | 1.038 | 1.08 | 1.03 |
| Strain at max. load (%) | 1.9246 | 2.0764 | 2.1691 | 2.0567 |
| Work at max. load (Nmm) | 2075 | 2677 | 2929 | 2560 |
| Young's modulus (MPa) | 6111.4 | 6604.2 | 5921.2 | 6212.2 |
| Stiffness (N/m) | 6111390 | 6604151 | 5921200 | 6212200 |

**Table 4:** SDV composite three-point bend test results

| Specimen | SDV1 | SDV2 | SDV3 | Mean |
|---|---|---|---|---|
| Maximum load (N) | 294.55 | 277.57 | 328.14 | 300.09 |
| Maximum stress (MPa) | 139.64 | 131.59 | 155.56 | 142.26 |
| Deflection at max. load (mm) | 9.00 | 8.34 | 9.17 | 8.84 |
| Strain at max. load (%) | 5.9326 | 5.4968 | 6.0449 | 5.8248 |
| Work at max. load (Nmm) | 1516 | 1398 | 1778 | 1564 |
| Young's modulus of bending(MPa) | 3340.0 | 3793.1 | 3940.7 | 3691.3 |
| Stiffness (N/m) | 46441 | 52742 | 54794 | 51326 |
| Rigidity at bending ($Nm^2$) | 0.25363 | 0.28804 | 0.29925 | 0.28031 |

## 3. CONCLUSION

The tensile and three-point bend tests put into evidence the significant anisotropy of this composite material. The most important mechanical properties have been determined in the tensile test. Among these mechanical features, the Young's modulus determined in tensile tests is for a great importance for future modeling and loading simulations of this composite.

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