

EXPERIMENTAL STUDY OF A COMPOSITE BEAM LOADED IN FOUR POINTS BENDING TEST

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1. Introduction

In this paper the authors presents an analytical and experimental study for determine the Young's modulus in case of a composite beam (aluminum and wood- spruce) fig.1 and fig.2, loaded to pure bending. For the experimental study of displacements are used displacements transducers (WA20MM - HBM) and Digital Image Correlation (DIC) method. For spruce beam, displacements had determined for two cases: first, when the load is applied perpendicular on fibers, and the second, when the load is applied along the fibers.

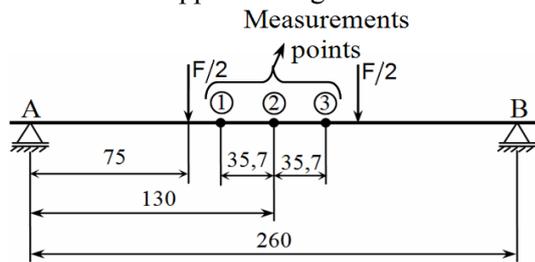


Fig.1: The representation of supported and loading beam

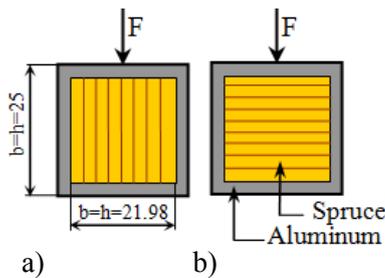


Fig.2: Section of the beam and the loading force: a) along to fibers; b) perpendicular on fibers

2. Experimental analysis and the obtained results

The beam is simply supported, being subjected to four points bending, with variable forces (fig.1).

In fig.3 is presented the experimental setup, with the following elements: 1- force transducer U2B 10kN-HBM; 2- loading system; 3- beam; 4- displacement transducers WA20mm-HBM; 5- supports; 6- illumination system (DIC); 7- video cameras (DIC); CATMAN EASY-HBM software; 9- data acquisition system Spider8 (HBM).

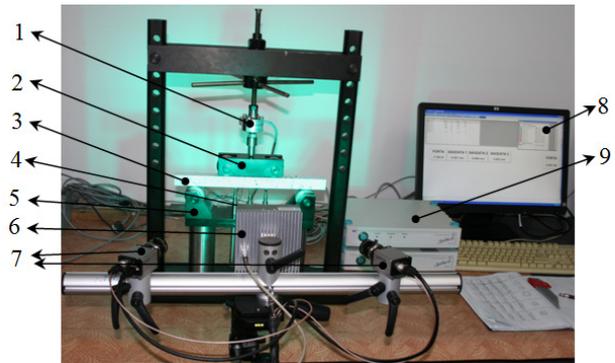


Fig.3: Experimental setup to determine the displacements in vertical plane

For the analytic calculus of the Young's modulus, has used the following relations:

a) spruce and aluminum beam:

$$E = \frac{F \cdot a \cdot (3 \cdot l^2 - 4 \cdot a^2)}{24 \cdot v_1 \cdot I_z} \quad (1)$$

where: E- Young's modulus, a- distance between the support and the load F/2; l- distance between supports; v_1 - the value of displacements in points 1, 2 and 3, determined by transducers and DIC method (fig.1); I_z - the inertia axial moment which depends by the beam section ($I_{z_Al}=13101\text{mm}^2$; $I_{z_spruce}=19450,443\text{mm}^2$).

b) composite beam:

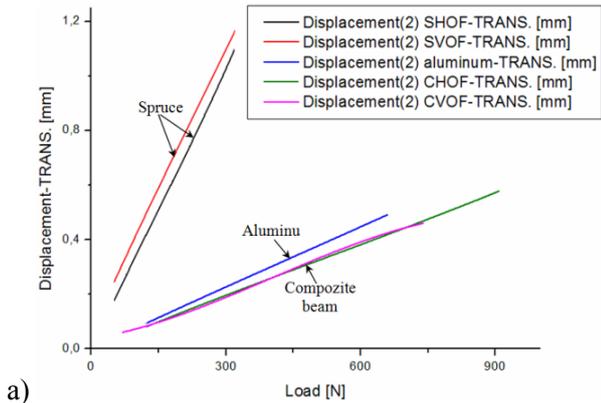
$$\varepsilon = \frac{v_2 \cdot H}{\frac{l^2}{4} - \frac{a^2}{3}} \quad (2)$$

where, ε - strain, v_2 - the value of displacements determined by two experimental methods, in point 2 (fig.1); H- beam section height.

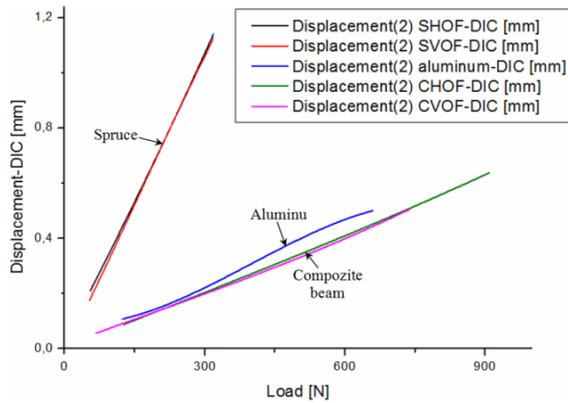
The Young's modulus had determined by Hook's equation, thus:

$$E = \frac{\sigma_{\max}}{\varepsilon} \quad (3)$$

Having in view the obtained results, had realised the diagrams from fig.4 and fig.5, which represents the variation of displacements, respectively of Young's modulus, obtained by the two experimental methods, according to the applied forces. Also, in the figures are given the average values of the Young's modules.



a)



b)

Fig. 4: The variation of displacements obtained by a) transducers and b) DIC, where: SHOF, SVOF- Spruce Horizontally and Vertically Oriented Fibres; CHOF, CVOF- Composite Horizontally and Vertically Oriented Fibres.

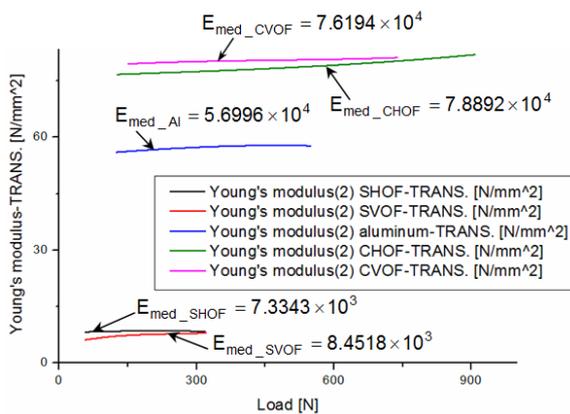


Fig. 5: The variations of the Young's modulus obtained by transducers

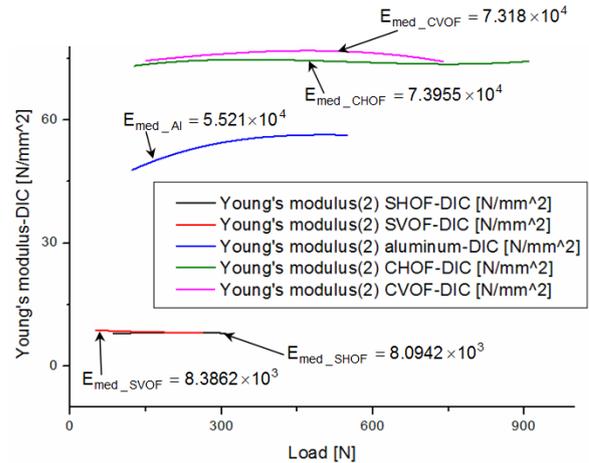


Fig. 6: The variations of the Young's modulus obtained by DIC

3. Conclusion

In this paper had presented the experimental study of a composite beam loaded to bending in four points, and had determined the displacements on Y axis, then analytic, the Young's modulus.

Having in view the diagrams from fig.4 and fig.5 can conclude the following:

- experimentally, had obtained an approximate linear representation, in elastic domain, of displacements and of Young's modulus;
- the composite beam presents a rigid behavior when the load is applied along the fibers.

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