The 2025 World Congress on
Advances in Structural Engineering and Mechanics (ASEM25)
BEXCO, Busan, Korea, August 11-14, 2025

Investigation of orthotropic engineering constants of CFRP laminate with and without delamination pre-crack

Eva Kormanikova*[1a], Hugo Sol[2,3b], Jun Gu[3,4c], Kamila Kotrasova [1d], Lenka Kabosova[5e], Viktória Bajzecerová[1f]

[1]*Technical University of Košice, Faculty of Civil Engineering, Institute of Structural Engineering and Transportation Structures, Košice, Slovakia*
[2]*Vrije Universiteit Brussel, Mechanics of Materials and Structures, Brussels, Belgium*
[3]*BYTEC BV, Merksplas, Belgium*
[4]*Vrije Universiteit Brussel, Physical Chemistry and Polymer Science, Department MACH, Brussels Belgium*
[5]*Technical University of Košice, Faculty of Arts, Department of Architecture, Košice, Slovakia*

ABSTRACT

The experimental method used in this paper is based on the Impulse Excitation Technique by Resonalyser procedure and focusses on the characterization of elastic and damping properties of carbon/epoxy material. The Resonalyser procedure is used for the non-destructive evaluation of the UD CFRP composite, that shows transverse isotropy behavior. The Resonalyser procedure is based on a mixed numerical experimental inverse method with measurements of resonance frequencies and damping ratios of thin plates and beams. The goal of the investigation is to determinate the complete orthotropic engineering constants of CFRP composites needed for 3D numerical modelling of structural elements and structures made of this material.

We thank the Scientific Grant Agencies of the Ministry of Education, Research, Development and Youth of the Slovak Republic for financially supporting this work under Projects VEGA 1/0365/25, VEGA 1/0307/23 and APVV-23-0204. We would like to thank the BYTEC BV Belgium for collaboration.

REFERENCES

[*] Corresponding author, Professor, E-mail: eva.kormanikova@tuke.sk
[a] Professor, E-mail: eva.kormanikova@tuke.sk
[b] Professor, E-mail: Hugo.Sol@vub.be
[c] Ph.D., E-mail: bytec.bv2330@gmail.com
[d] Assoc. Professor, E-mail: kamila.kotrasova@tuke.sk
[e] Assoc. Professor, E-mail: lenka.kabosova@tuke.sk
[f] Assoc. Professor, E-mail: viktoria.bajzecerova@tuke.sk

V. M. Cuartas, M. Perrin, M.L. Pastor, H. Welemane, A. Cantarel, et al. Determination of the elastic properties in CFRP composites: comparison of different approaches based on tensile tests and ultrasonic characterization. Advances in Aircraft and Spacecraft Science, Techno-Press, 2(3), 249-260, 2014.

R. Vodička, E. Kormaníková, F., Kšiňan. Interfacial debonds of layered anisotropic materials using a quasi-static interface damage model with Coulomb friction. International Journal of Fracture, 211(1-2):163-182, 2018.

T. Nakamura, S. Suresh. Effect of thermal residual stress and fiber packing on deformation of metal-matrix composites. Acta Metall Mater, 41(6):1665-1681, 1993.

O. Van der Sluis, Homogenisation of structured elastoviscoplastic solids. PhD thesis, Eindhoven University of Technology, Eindhoven, The Netherlands, 2001.

B. J. Lazan. Damping of Materials and Members in Structural Mechanics, Pergamon Press 1968.

C. W. Bert. Material damping: an introductory review of mathematical models, measures and experimental techniques, Journal of Sound and Vibrations, 29(2):129-153, 1973.

R. D. Adams. Damping properties analysis of composites, Engineered materials handbook, Volume 1, Composites, ASM, 206-217, 1973.

A. Treviso, B. Van Genechten, D. Mundo, and M. Tournour. Damping in composite materials: Properties and models, Composites part B, 78:144-152, 2015.

H. Sol, H. Rahier, and J. Gu. Prediction and measurement of the damping ratios of laminated polymer composite plates. Materials, 13(15):1-25, 2020.

E. Kormanikova, K. Kotrasova, S. Harabinova, E. Panulinova. Elastic mechanical properties of random oriented short fiber composites. ICNAAM 2019. Melville (USA), AIP Publishing, 4, 2020.

ASTM C1259-15: Standard Test Method for Dynamic Young’s Modulus, Shear Modulus, and Poisson’s Ratio for Advanced Ceramics by Impulse Excitation of Vibration

ASTM C1548-02: Standard Test Method for Dynamic Young's Modulus, Shear Modulus, and Poisson's Ratio of Refractory Materials by Impulse Excitation of Vibration, 2012.

ISO 12680-1: Methods of test for refractory products - Part 1: Determination of dynamic Young's modulus (MOE) by impulse excitation of vibration, 2005.

ISO 20343: Fine ceramics (advanced ceramics, advanced technical ceramics) - Test method for determining elastic modulus of thick ceramic coatings at elevated temperature, 2017.

EN 843-2:2006: Advanced technical ceramics - Mechanical properties of monolithic ceramics at room temperature - Part 2: Determination of Young's modulus, shear modulus and Poisson's ratio, 2006.

EN 820-5: Advanced technical ceramics - Thermomechanical properties of monolithic ceramics - Part 5: Determination of elastic moduli at elevated temperatures, 2009.

ASTM-E111: Standard Test Method for Young’s Modulus, Tangent Modulus, and Chord Modulus, 2017.

H. Sol, Identification of anisotropic plate rigidities using free vibration data, PhD. Thesis, Vrije Universiteit Brussel, October 1986.

H. Sol, J. De Visscher, W.P. De Wilde, A mixed numerical/experimental technique for the nondestructive identification of the stiffness properties of fibre reinforced composite materials. NDT & E International, 30(2):85-91, 1997.