285. Testing system for composite wood based strips

V. Augutis[1, a], D. Gailius[1, b], G. Balčiūnas[2, c]
[1]Kaunas University of Technology
Faculty of Telecomunications and Electronics
Measurement Technologies Laboratory
Studentų 50-445, 51368 Kaunas, LITHUANIA

[2]Kaunas University of Technology
Institute of Metrology
Studentų 50-257, 51368 Kaunas, LITHUANIA

E-mail: [a] *vygau@ktu.lt,* [b] *dagail@ktu.lt,* [c] *gintautasbalc@gmail.com*

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Abstract. Wood based composite products are widely used. Wood based composite strips, where wood peel layers are oriented in the same direction, are relatively new product in furniture industry. They are usually used as spring elements. Mechanical properties of such elements are characterised by the bending strength, static and dynamic stiffness.

Beside standardized and well known testing methods, characteristics of wood based products may be determined using acoustic emission, ultrasonic, and multicycle load testing techniques. These testing means are realised in the presented developed system for composite wood based strips.

Keywords: Composite strips, acoustic emission, force, defects, delamination.

Introduction

Composite materials are more and more used in various areas because of their good properties. Composite strips may be used as fixing (fastening) elements or as bending stiff elements (springs). Its characteristics depend from many factors. Thus, reaching for high quality, it is important to control such strips parameters in production line (online).

One of the most important parameters of the controlled strips is the homogeneity – delamination and other defects absence. This determines strength and durability of the strips.

The main task of the work, was development of the fast composite plywood strips testing system, which may be used for online (in production line) testing of the manufactured strips, keeping in mind, that the main such strips strength properties limiting factor is delaminations between strip layers.

Measuring System

The structure of the composite strips quality evaluation system is shown in the Fig. 1. Informative signals (force, deformation, acoustic emission, etc.) are transformed by corresponding measurement transducers, amplified if required and fed into digital measurement – control system.

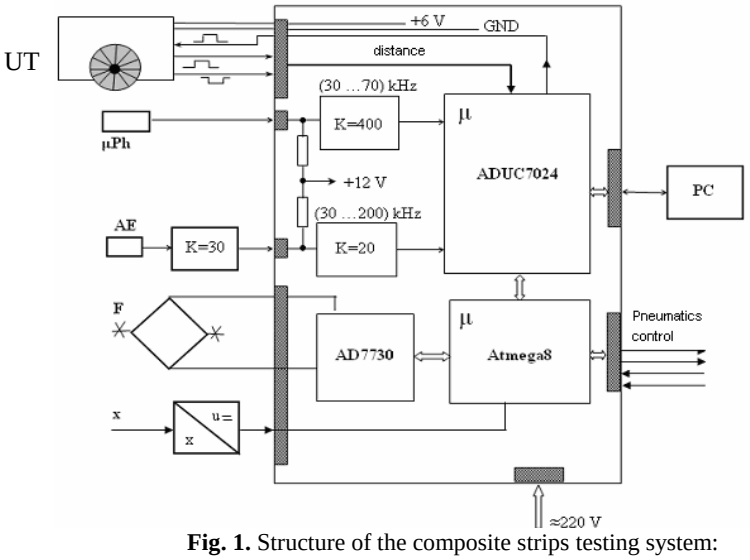

Fig. 1. Structure of the composite strips testing system:
UT – ultrasonic pulses exciting transducer; μPh – ultrasonic microphone; AE – acoustic emission transducer; F – force measurement transducer; x – displacement meter; K=20 (30;400) – amplifiers; ADUC7024 and Atmega8 – microcontrollers

Bending strength measurement mode of the system

Information about elastic properties of composite strips is acquired measuring force during and after deformation bending tests. The developed measuring system structure for similar tests is shown in figure 2. Beside dynamic force and deformation measurement channels, the acoustic emission registration channel is implemented.

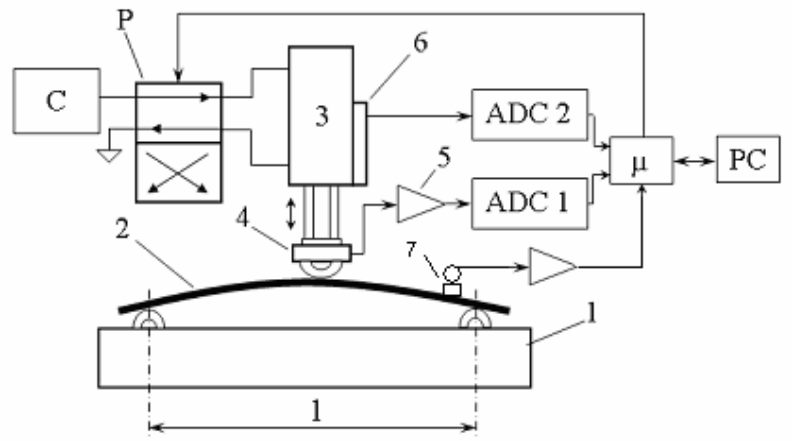

Fig. 2. Composite strips stiffness measurement system:
1 – stand, 2 – sample, 3 – pneumatic cylinder, 4 – force measurement transducer, 5 – amplifier, 6 – displacement (deformation) measurement transducer, 7 – acoustic emission transducer, ADC – analog to digital converter, V – controller, PC – computer, P – pneumatic valve

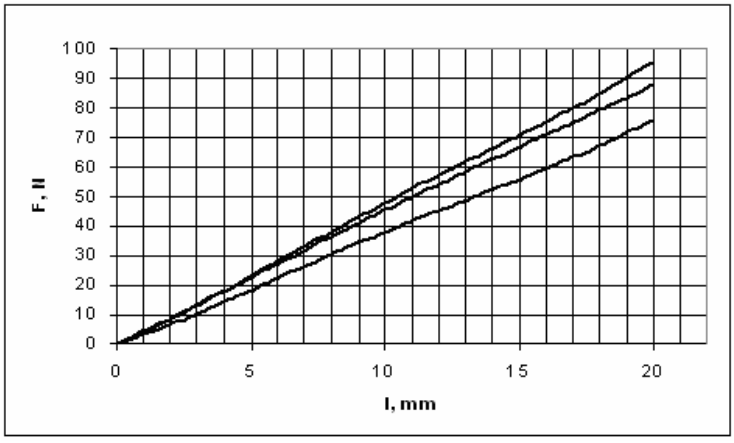

Fig. 3. Deformation - force graphs of different same kind samples

There was calculated correlation between the composite strip breaking force and measured stiffness. The determined correlation coefficient R = 0,91. We can assert, that there is a big correlation, between strip breaking force and stiffness of the strip.

Information about disintegration processes, when increasing force is applied or during multicycle load tests may be acquired measuring acoustic emission signals. Sample data of rupture test with parallel measured acoustic emission signals is presented in the Fig. 4.

Registered acoustic emission signals show structure changes of the tested sample such as delaminations of separate wood layers and wood fiber ruptures.

Strip homogeneity evaluation mode of the system

One kind of wood based materials is plywood boards and strips. These may be isotropic, when different wood layers are put in orthogonal directions, and anisotropic, when layers are oriented in same direction and ply strands usually are oriented along strip.

One of the main properties of such strips is their homogeneity, i.e. absence of delaminations between layers and various defects in layers. Such defects mainly determine strength and longelivity of composite wood strips.

Ultrasonic techniques allow locate defects precisely enough. Frequency range, wave type (longitudinal or Lamb) and testing technique is usually determined by the sample dimensions, material properties, defects types and size, testing speed and reliability.

A pass through ultrasonic testing technique is most suitable for wood based composite strips homogeneitiy testing. High frequency (up to 100 kHz) acoustic waves excitation, propagation and reception research was carried

out. Measured acoustic field sample when wave front passes through the small defect is shown in Fig. 5.

The main problem implementing such technique in industrial applications is development of suitable ultrasonic transducers, because strips usually move with high speeds in production line.

Proposed excitation transducer is made of 60 mm diameter and 4 mm width aluminium wheel, with both sides glued piezoceramic discs and rubber protector. Electrical pulses are fed from the programmable pulse generator through the rotating transformer. For the achievement of good signal to noise ratio, the developed transducer is relatively narrowband with central frequency around 40 kHz. This allowed to use contactless reception transducer of informative signals in the opposite surface of the tested strip.

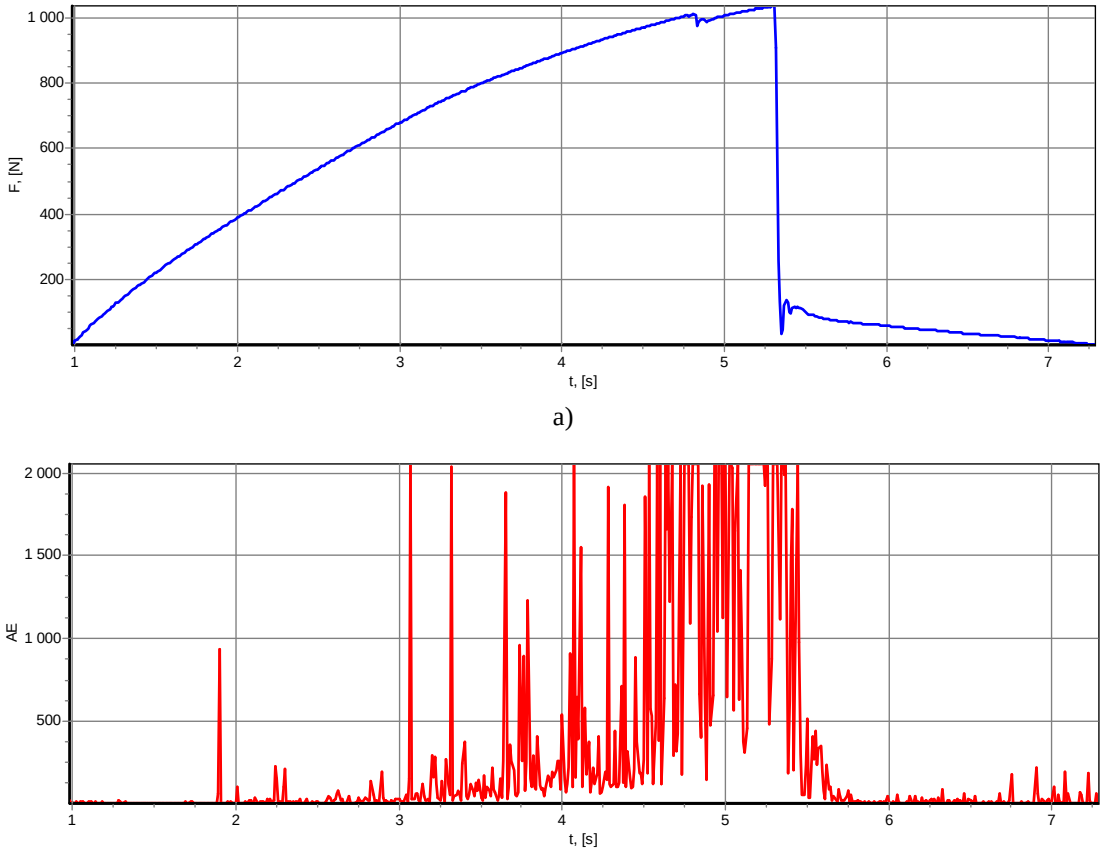

Fig. 4. Rupture test of a sample strip. Force - time graph (max force 1036 N) and corresponding acoustic emission signals

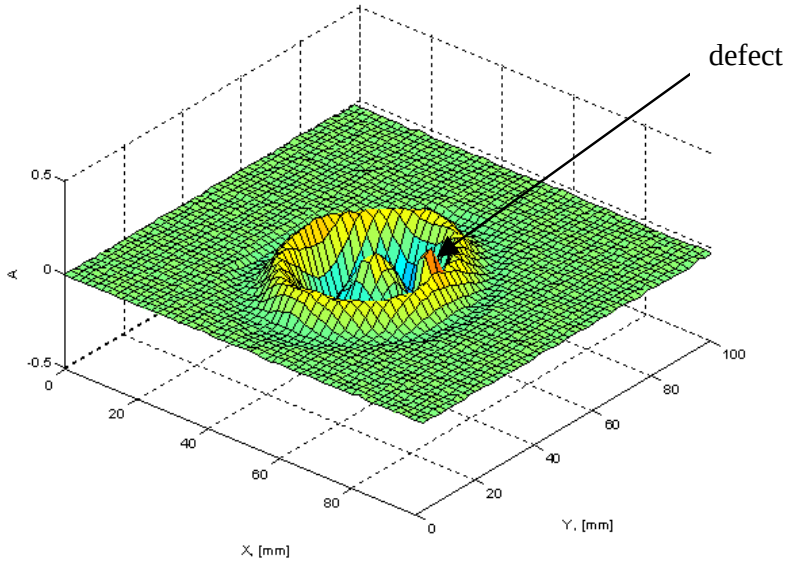

Fig. 5. Acoustic field near plywood board with 2 mm defect (small hole)

Delamination or other serious defects are registered when received signal amplitude is less than experimentally determined threshold level (red line in Fig. 6).

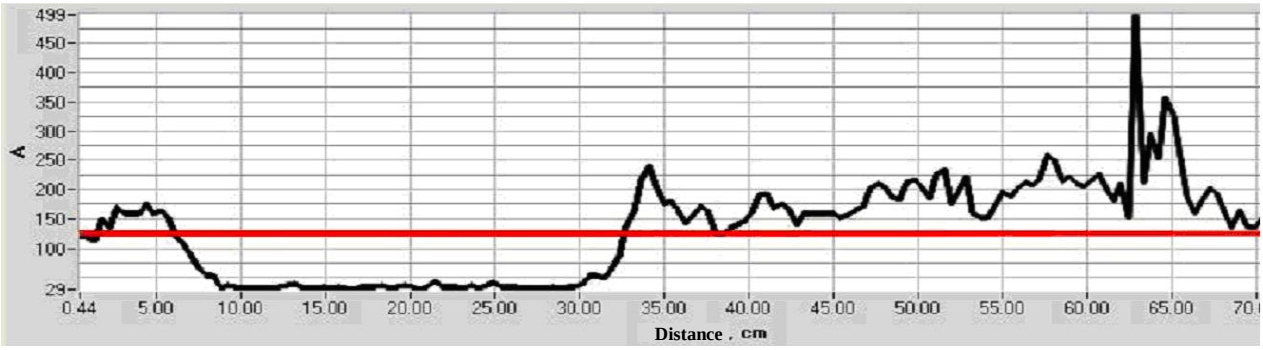

Fig. 6. Homogeneity test graph during composite strip test searching for possible delaminations

Metrological characteristics of the system:

Deformation measurement range during bending tests: 0 – 160 mm.
Deformation measurement resolution: 0,2 mm.
Force measurement range during bending tests: 0 – 2000 N.
Force measurement resolution: 0,1 N.
Ultrasonic homogeneity tester resolution (between defects): 4,4 mm.

Summary

The developed testing system is suitable for the composite wood based strips mechanical properties determination, homogeneity evaluation of the strips (detection of delaminations and other similar defects). This system is potentially suitable for implementation in the production line of such strips.

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