THE EFFECT OF LOW ENERGY IMPACT LOADS ON THE FLEXURAL STRENGTH OF A SANDWICH-STRUCTURED COMPOSITE WITH HEREX CORE

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1. Introduction

Sandwich-type composites are usually made with two types of materials. The outer layers are made of materials with good mechanical properties, carry the load and determine the strength. The inner layer, called the core, is made of a material of lesser strength, stiffness and density in relation to the outer layers [1]. The middle layer separates the two covers (mostly in thin-walled structures) in order to increase the stiffness of the entire structure with a slight increase in weight.

The structures made up of core materials are characterized by much greater flexural strength in relation to materials made only with a solid material. The stresses caused by the bending moment are smaller in sandwich-type structures.

Due to a favourable weight ratio of the selected strength parameters, the core materials are used in the production of building walls, sports equipment and above all in the airline industry as a material for fuselages, beams, wing ribs, stabilizers.

However, composite structures may be exposed to mechanical damage caused by low energy loads acting perpendicular to the surface of the element. This type of damage adversely affects the strength of the layered composite [2]. The paper presents the results of research on the effect of low energy impact loads on the strength of the sandwich-structured composite. As a test to determine the change in the strength of the composite after impact, a three-support bending test was selected.

2. Experimental research

For testing, the authors prepared three sandwich-structured composite boards of different Herex density. The external layers consisted of one layer of a carbon fabric 160 g/m^2 in weight and one layer of glass fabric 250 g/m^2 in weight, while the core was Herex foam of the densities: 55 kg/m^3, 75 kg/m^3 and 90 kg/m^3 (Fig. 1). The matrix of the tested composites was epoxy resin LH385, with the hardener HG385.

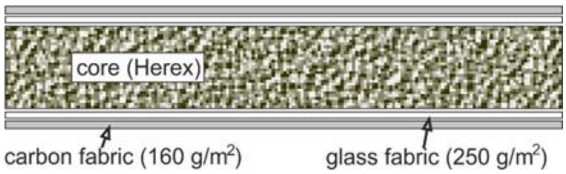

Fig. 1. Structure of the sandwich composite used in research.

The composite sheets were prepared by the contact method of manual lamination, using compression on both sides with glass plates at standard pressure. The fabrics in the layers were laid out with fibres parallel to one another. Next, they were cut down into samples square samples with dimensions 60x60 mm and the resulting thickness.

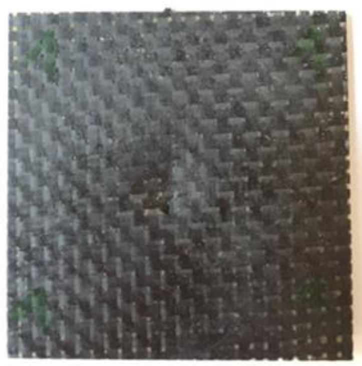

Fig. 2. Impact loaded surface of a sample loaded with 3 J energy.

The samples were divided into four parts. The first was intended for flexural strength tests. The remaining series of samples were subjected to impact loads with energies of 1, 3 and 5 J (Fig. 2).

Samples after impact loads were observed using a microscope, and next their flexural strength was tested, thus determining the residual strength.The bending strength test of the samples was performed using the three-support method on the Zwick / Roell Z100 machine, with the spacing of supports 50 mm. The results of the tests are presented in Figures 3 and 4.

The highest flexural strength for all impact loads characterized a composite with a Herex core of 90 kg/m3 density (Fig. 3).

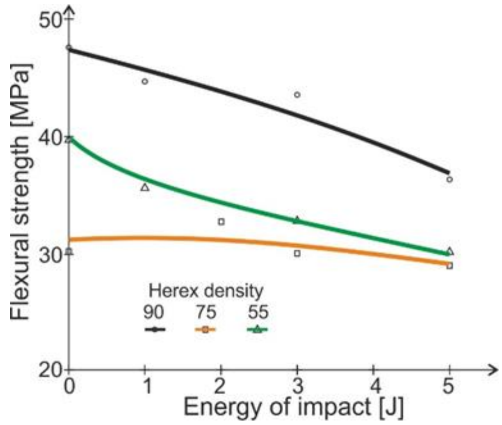

Fig. 3. Dependence of the composite's flexural strength on the energy of the impact load.

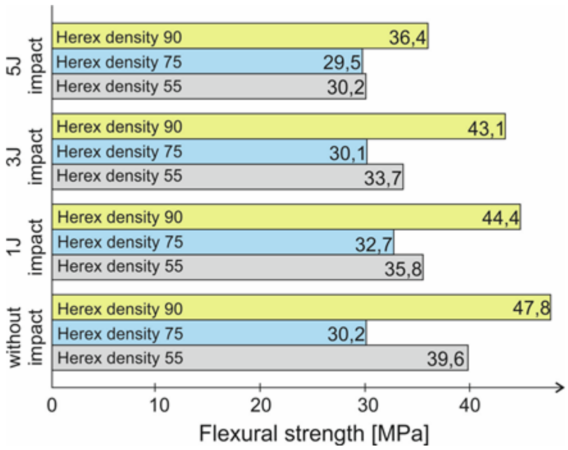

Fig. 4. Flexural strength of tested composites.

It was found that there is no correlation between the density of the core material of the composite and its flexural strength regardless of the value of impact loads (Fig. 4).

For all the impact loads used in the tests, similar damage to the samples was observed. Loads of 1 J caused a plastic deformation of the outer composite layer (approx. 0.2 mm) without matrix cracking and fiber damage. Loads of 3 J and 5 J caused cracks in the outer layer of the composite (Fig. 2), and at loads of 5 J additionally deformations of the lower layer of the composite were observed. We also tested samples of Herex foam, but they

breaks and splits into several parts when it was loaded with 1 J energy.

Observation of the top layer damage using an electron microscope allows perceiving broken reinforcement fibers (Fig. 5).

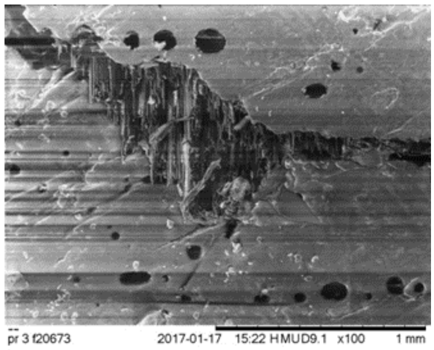

Fig. 5. Picture of damage in the composite loaded with 3 J energy (electron microscope - magnification x100).

3. Conclusions

Increasing energy resulted in an increase in the damage area of the top layer, and with 3 J energy, visual noticeable deformation of the backsheet of the composite was noticeable.

The flexural strength of a composite with a Herex core is dependent on the density of the core material, but higher density does not mean higher strength. Therefore, we are planning to conduct a series of additional tests with use of other Herex densities.

The Herex PVC foam core in the sandwich composite absorbs and dissipates the impactor's energy, which at low values of impact loads results in damage only the layer to which the load have been applied and Herex foam. The bottom layer of the composite remains intact, so repairing such an element is much easier than in classic layered composites without a core. It is worth considering using such materials (with a core) in structures exposed to low energy impact loads.

References

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