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Bending strength (modulus of rupture) and modulus of elasticity of MDF different density at various temperature

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Abstract: *Bending strength (modulus of rupture) and modulus of elasticity of MDF different density at various temperature* Bending strength and modulus of elasticity of MDF with thickness 10 and 16 mm and density 770…870 kg/m^3 were studied at temperature 20, 40, 60, 80 °C with different strain rate on the standard tensile testing machine. Bending strength and modulus of elasticity are significantly affect by temperature and strain rate. With increasing temperature reduction occurs MOE about 200 MPa, and MOR at 3…5 MPa for every 10 °C.

Keywords: Bending strength, modulus of elasticity, MDF, durability

INTRODUCTION

During service fiberboards can be exposed to a range an environmental conditions, sometimes at high or low temperatures. As a result fiberboards can change their strength properties with the change of the surrounding temperature. Therefore, the relationship between temperature and strength properties is very important if fiberboards are to be used as structural members subjected to temperature changes. However, there is not enough information available in the literature (Bekhta and Marutzky 2007, Bekhta at al. 2003, Suzuki and Saito 1987, Yu DeXin ant Ostman 1983) about the effects of temperature on the strength properties of fiberboards. Therefore, such knowledge is very important from practical point of view.

Because MOR and MOE according to the current technical conditions of their production to MDF normalized not only on their density, but also on their thickness, as objects of study were taken MDF producer of two thicknesses of the various parties.

The objective of this study is the determination of effect of various temperatures on the strength properties of fiberboards while varying densities in this group of materials within 770 ... 870 kg / m^3.

MATERIALS

Two different commercial fiberboards from Ukraine manufacturer Korosten plant MDF according GOST were selected for the study (Table 1). Eight specimens from each type of fiberboard for each temperature series were prepared (with dimensions 450 x 50 x 10 and 450 x 50 x 16 mm). All test samples were cut in the same direction of the board. The moisture content of the boards was 9,5 %. Investigated temperature were 20, 40, 60, 80 °C and 65 % relative humidity. Samples thickness and weight were measured before testing. Bending strength (modulus of rupture (MOR)) and modulus of elasticity (MOE) were determined according to EN 310. Measurements of the fracture load was carried out on a standard tensile testing machine with a hard load constant strain rate. Investigated speeds of deformations were 2, 7, 12 mm/min. Specimens were conditioned at 65 % RH condition in a climate-controlled chamber to equilibrium under each of the 4 investigated temperatures 20, 40, 60, 80 °C. The temperature kept constant at ± 1 °C during tested.

Table 1. Properties of MDF used in study

Thickness *, mm	Density**, kg/m^3	Dimensions (length x width), mm
10	730 … 750	450 x 50
16	750 … 880	450 x 50

* Thickness was measured after specimens reached equilibrium at 65 % RH, and temperature 20, 40, 60, 80 °C.

** Density was based on over-dry weight and volume at 65 % RH and temperature 20, 40, 60, 80 °C.

RESULTS

Histogram density of the samples is shown in Fig. 1. As you can see the density is sufficiently wide range of variation, even for plates of the same thickness.

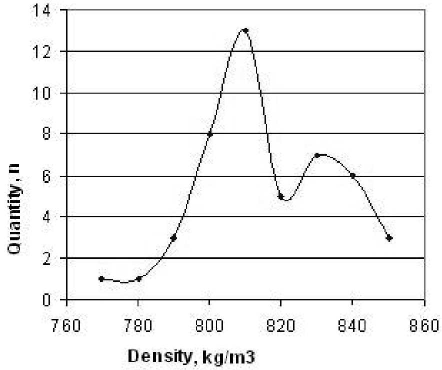

Figure 1. Histogram of the density distribution of samples of MDF thickness 10 and 16 mm

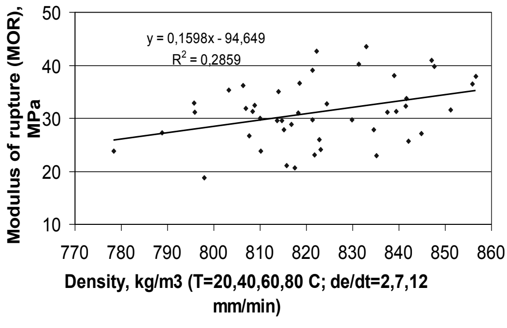

Figure 2. MOR values for each of the tests

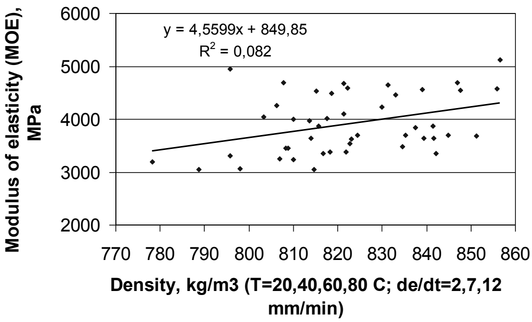

Figure 3. MOE values for each of the tests

Generalized dependence on density the MOE and MOR at different temperatures and strain rates is shown in Fig. 2, Fig. 3. Dependence MOE and MOR from density has a very weak correlation and practically normally distributed about their mean values equal to MOE = 4000 MPa and MOR = 32 MPa. It is known such a normal distribution is the result of simultaneous influence of a random amount of several variables. In this case, in addition to varying the density, the change in temperature and strain rate.

So, if do not take into account the change in the MOE and MOR separately from temperature and strain rate, that is, if we summarize the impact of individual variables in the tests, their impact separately would be very difficult to determine. Therefore, in Fig. 4 and Fig. 5 shows combinations depending MOR and MOR from density at constant temperatures and different strain rate.

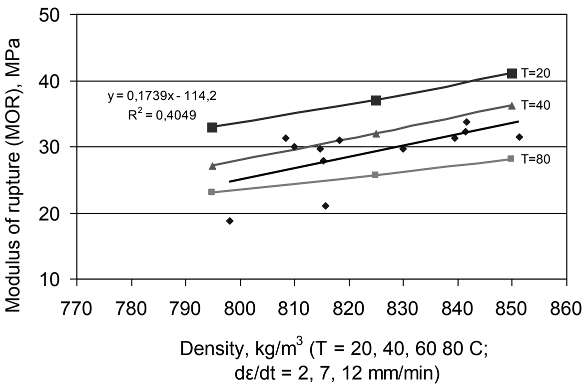

Figure 4. MOR combination depending on the density at constant temperatures and different strain rate

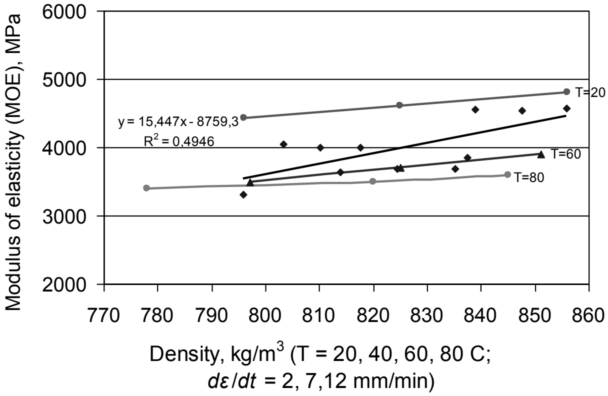

Figure 5. MOE combination depending on the density at constant temperatures and different strain rate

As follows from Fig. 4, 5 dependence on the density to MOR and MOE is now more correlated with the influence of temperature, the effect of substantially higher density and determines the overall downward trend in MOE and MOR with increasing temperature. Moreover, the effect of temperature increases with increasing density, as evidenced by a diverging fan of the regression lines.

In Fig. 6 and 7 shows the dependence of MOR and MOE from the temperature at different strain rates. Here, the correlation of MOR and MOE at temperature even higher. With increasing temperature reduction occurs MOE about 200 MPa, and MOR at 3 ... 5 MPa for every 10 °C.

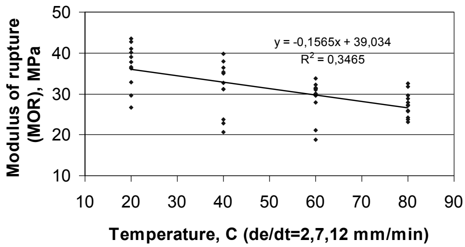

Figure 6. MOR dependence on temperature at different densities and strain rate

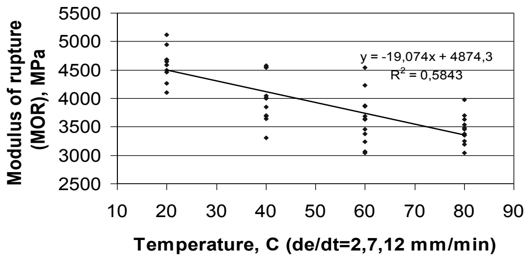

Figure 7. MOE dependence on temperature at different densities and strain rate

A further allocation of the effect of individual variables on the value of the MOD and MOE, leads to the conclusion that the largest is the correlation between the MOE, MOD and the temperature. This conclusion is confirmed by the regression curves Fig. 8 and 9. Moreover, this correlation is particularly evident at a constant strain rate.

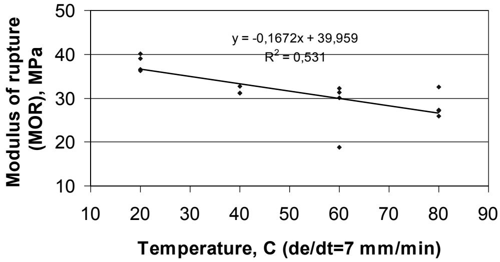

Figure 8. MOR dependence on the temperature at a constant strain rate and different densities

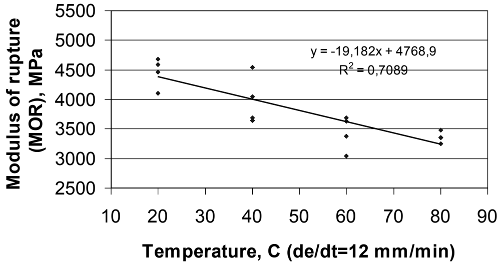

Figure 9. MOE dependence on the temperature at a constant strain rate and different densities

MOR and MOE depends on the temperature during their MDF service. The effect of temperature on the strength of higher density MDF stronger than the same MDF lower density. Because thickness increases MDF m decreases, the influence of temperature on MDF greater thickness less than the thickness of the lower plate.

Because mechanical properties of MDF are strongly dependent on the temperature of their operation, the process of deformation and fracture can be described as thermally activated, that allows to use in predicting the durability of all the provisions of the kinetic theory of strength of solids.

Because carrying out of experiments revealed that the strength properties of MDF are dependent in their deformation not only on temperature but also on the strain rate, it can be the basis of methodology for assessing thermal activation parameters in the short-term tests on rigid tensile testing machine at different strain rate.

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Streszczenie: *Wytrzymałość na zginanie i moduł sprężystości MDF o zmiennej gęstości I zmiennej temperaturze.* Badano wytrzymałość na zginanie MDF o grubości 10 I 16 mm oraz gęstości 770…870 kg/m^3 w temperaturach 20, 40, 60, 80 °C przy różnych obciążeniach na standardowej maszynie wytrzymałościowej. Obydwa badane parametry wykazywały zależność od zarówno temperatury jak i obciążeń. Wraz ze wzrostem temperatury zarówno MOR wynoszący około 200 MPa, i MOR spadają o 3…5 MPa na każde 10 °C.

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