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ASPECTS REGARDING TO THE STIFFNESS OF THE WOOD PANELS USED ON PRECAST WOODEN HOUSES

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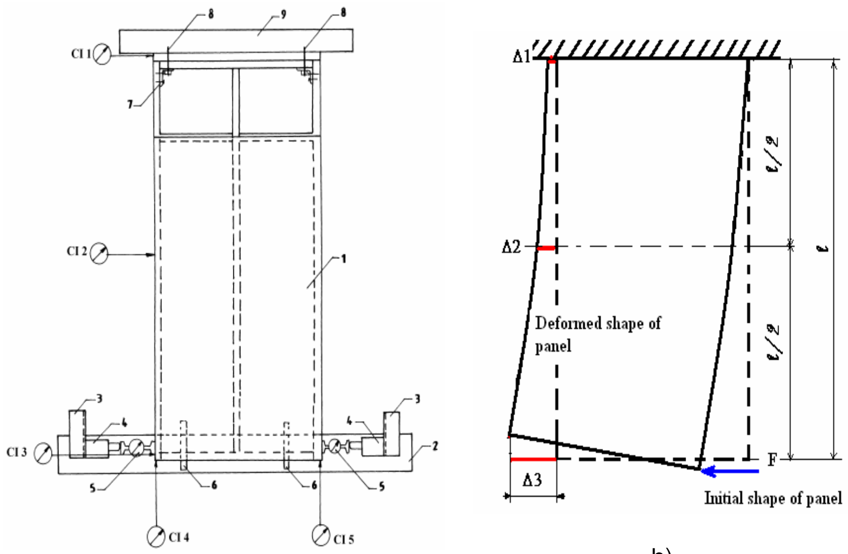
ABSTRACT
The aim of the paper is to research the stiffness of the wood panels used on prefabricated wooden houses structures as walls, roofs or ceilings. The first part of study presents different types of panelled boards structures namely single-faced frames, double-faced frames, partial double faced frames with various types of solid wood ribs and prefabricated pieces. In the second part, it is study the behaviour of panels to the loads applied in the plane of panel or transversal to the panel. This was study on the one hand with the finite element method (FEM) and on the other hand with experimental methods. As far as the experimental tests, it was evaluated the size of strains to the static loads applied on the plane of panels, taking into account the type of the frame's joint, the thickness of the upper and lower plates, the presents of the solid wood ribs. In the end, the paper presents the optimum structures with raised stiffness and small strains. The paper is illustrated with charts and pictures.
Keywords: paneled boards, solid wood rib, stiffness, the degradation of stiffness, strain

1. INTRODUCTION
In the prefabricated wooden houses are used wood panels as diaphragms or plates which are loaded with vertical forces in the panel's plane (bearing wall) or with horizontal forces [7]. The panel structures have different mechanical connections which allow a good dissipation of energy produced by vertical and/or horizontal forces such as structures with vertical diaphragms without mechanical connections, structure with vertical diaphragms strength to horizontal forces, structures with vertical diaphragms strength to horizontal forces [1],[2],[3].
The stresses produce bigger or smaller displacements depending on the structure of panels (with single-faced frames, double faced frames and with different types of solid wood ribs, shutters, diagonal ties), types of assemblages (nails, screws, rods – varying as position, number, dimensions), materials used (solid wood, chipboard, plywood, gyps-board), types and size of stresses [5],[6].
The research aims: to establish the correlations between forces and displacements (F-Δ) for different structures of panels, to relieve the plastic deformations, to notice the jointing elements behaviour (nails, screws, rods, diagonal ties, shutters, the panel faces, a. o.).

2. MATERIALS AND METHOD OF TESTING
In order to achieve the objectives, for experiments were used the next types of panels [8]: panel 1– made of vertical and central stiles, horizontal and intermediate frame legs with one face made of plywood (12 mm thickness) and the other one made of gyps-board (10 mm thickness); as fixing

elements were used steel screws, panel 2 – the same structure as the panel 1, with difference that the plywood face was replaced with chipboard, 12 mm thickness, panel 3 - the same structure as the first, but with both faces made of gyps-board 10 mm and hardened with diagonal tie and shutter, panel 4 - made of frame with diagonal ties, without faces.

It was used the pilot plant (figure 1) from UTC Bucharest which allow the fixing of panel (1) with elements (7, 8, 9).on the carrying system. The loads are assured by hydraulic sources (2,3,4) and the forces are measured with special devices (5). The installation is fitted with rollers bearing (6) which ensure the panel displacements during the stresses. The displacements are measured with comparing watches (CI1, CI2...CI5) [8].



a) b)

Figure1. The pilot plant scheme (a), deformed shape of panel (b)[8]

First, the structure was loaded with some force. For each value of force, was measured the values of displacements in three points Δ1, Δ2, Δ3. Then was increased the value of force and measured the displacements. After the gradually increasing the force, it was decreased the loads. For each tasted panel it was established the correlation between forces and displacements (F-Δ) and it was calculated the stiffness [4].

$$k = \frac{F}{\Delta} \quad (1)$$

k - the stiffness, [kN/mm];
F - the force, [kN];
Δ – the displacements, [mm].

An important phenomenon is the degradation of stiffness (Δk) which characterizes the quality of panel structure. This parameter was calculated with relation:

$$\Delta k = \left(1 - \frac{k_n}{k_i}\right) * 100 \quad (2)$$

Δk – the degradation of stiffness, [%];
k_n – the stiffness after stresses, [kN/mm];
k_i – the initial stiffness, [kN/mm].

3. RESULTS

The experimental results were figured in the next charts (Fig.2...6)

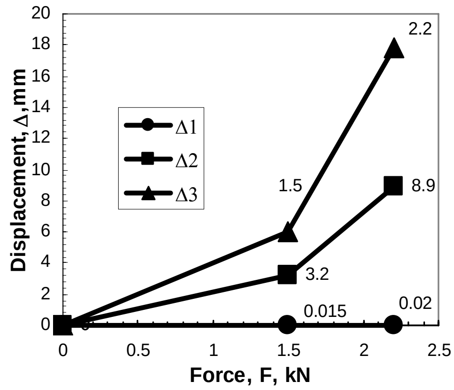


Figure 2. Panel 1 a) variation of forces versus displacements (F-Δ)

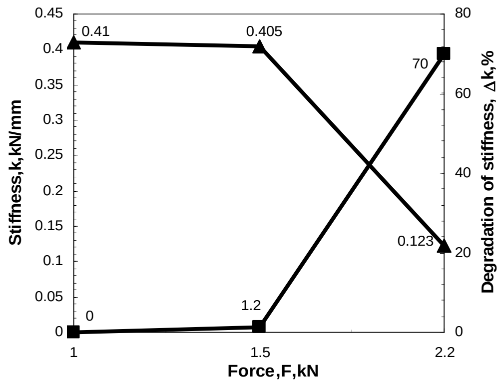


Figure 3. Variation of stiffness k and degradation of stiffness Δk *for different values of forces*

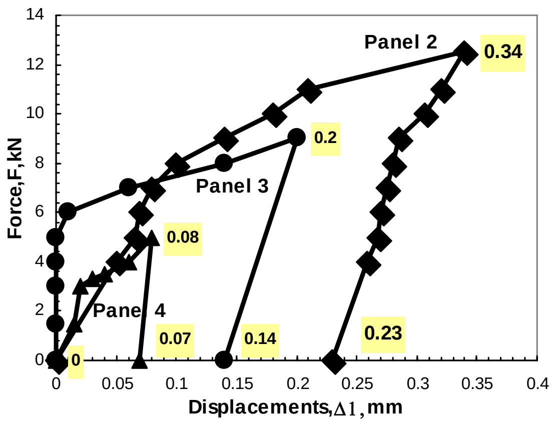


Figure 4. Variation of forces versus displacements (F-Δ) *in the* Δ*1 point of measurement for panels 2, 3, 4*

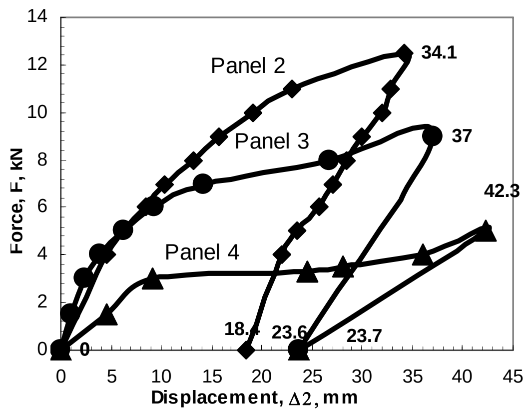


Figure 5. Variation of forces versus displacements (F-Δ) *in the* Δ*2 point of measurement for panels 2, 3, 4*

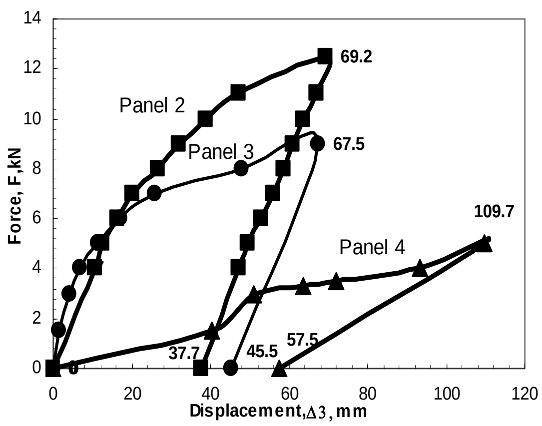


Figure 6. Variation of forces versus displacements (F-Δ) *in the* Δ*3 point of measurement for panels 2, 3;4*

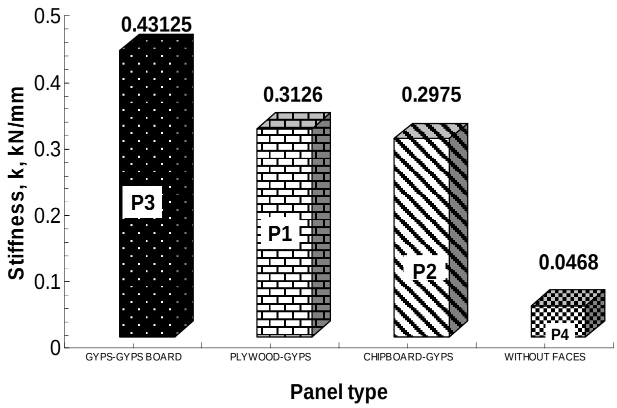


Figure 7. Comparison between the stiffness of different panels

Finally, it is displayed a comparison between the stiffness of each tested panels (figure 7). It is notice a decreasing of stiffness at the panel without faces of 9.2 times in contrast with panel with gyps-board faces.

4. DISCUSSION

It is remark the plastic deformations occurred after unloading of structures. These can be visible on hysteresis loops which is different on the three points of measurement (Figure 4, 5, 6).

The deformations of wood panels are depended on structures, materials, type of jointing. Thus, the panels with different structures can be order according to increasing the stiffness:

$$k_{0\text{-}0} - k_{chipboard\text{-}gyps} - k_{plywood\text{-}gyps} - k_{gyps\text{-}gyps} : 1 - 6.35 - 6.67 - 9.2 \quad (3)$$

$k_{0\text{-}0}$ – the stiffness of simple panel (without faces);
$k_{chipboard\text{-}gyps}$ – the stiffness of panel with one face made of chipboard and the other one made of gyps-board;
$k_{plywood\text{-}gyps}$ – the stiffness of panel with one face made of plywood and the other one made of gyps-board;
$k_{gyps\text{-}gyps}$ – the stiffness of panel with both faces made of gyps-board.

The optimum structure is the panel with both faces made of gyps-board and with diagonal ties inside the structure.

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