MECHANICAL ANALYSIS OF THE BEHAVIOR UNDER ACTION OF DIFFERENTS TYPES OF WOODEN STRUCTURES SUBJECTED TO COMPOUND LOADS

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Abstract

The problems related to the way of behavior of the frame-type structures made of wood are a topical problem in the case of practical applications. The way of loading the structures with external forces highlights the countless problems related to their resistance and rigidity..

The present paper deals with a work situation often encountered in frame-type structures, namely a first situation being their simple loading on the horizontal crossbar, followed by the loading composed of a horizontal force distributed on one of the frame pillars and the same vertical force on the crossbar.

The analysis follows the maximum percentage deviations recorded both in the case of the kinematic parameters and in the case of the static parameters, which define the characteristics related to the strength and rigidity of the structures. Therefore, the author does not perform a classical static analysis using the analytical methods used, but only pursues the determination of the maximum percentage deviations for the parameters determined in the case of the two types of loads.

Keywords: frame, kinematics, static, parameters, load.

INTRODUCTION

The author considers for the study and analysis the case of a frame with two vertical pillars with a length of 2 [m] and a horizontal beam with a length of 1 [m]. Between the left vertical pillar and the horizontal crossbar, the connection is made by means of an internal joint. Ground support is considered to be by means of two articulated supports. Considering the external way of fixing the frame, the structure is statically indeterminate. From the point of view of the way of loading the structure, two cases are considered, namely with a force concentrated on the cross member, respectively in the second case with the same force concentrated in the same way located and a force distributed on the pillar on the left side of the frame. The distributed force can be considered from a practical point of view as the loading force of the structure from the action of the wind.

MATERIAL AND METHOD

The problem was treated in the work from a static point of view through a numerical analysis carried out with the help of the LISA 8 calculation program. The author did not resort to an analytical study in order to analyze the results, because the analytical methods were extensively treated for static structures undetermined by many authors (Ille 1977), (Ille, Bia , Soare 1977).

. Through the obtained results, the author aims to present from a statistical point of view the percentage deviations between the kinematic and static parameters obtained in each of the two loading modes. The structure is considered to have a diameter of 0.15 [m] both on the horizontal beam and on the pillars. Young's modulus is 100000 [N/mm2], Poisson's ratio is 0.2, and the density is 700 [Kg/m3] for the oak species from which the structure is made.

The force acting on the horizontal crossbar is 10 [KN] in both loading cases, and the uniformly distributed force on the left pillar of the structure - wind force, is 10 [KN/m].

In the case of the analytical study of the structure by other authors, the efforts method was applied in order to determine the static parameters for both loading cases (axial tension forces, shear forces and bending moments) (Bârsan, 2003), (Martian 1999).

To determine the kinematic parameters in order to evaluate the stiffness of the structure, other authors applied the direct integration method, Mohr's method or the method of initial parameters (Bors 2005).

The study and analysis carried out by the author considered the isotropy of the material as a simplifying hypothesis. The study followed by the numerical analysis was based on the application of the finite element methodGhinea (Fireteanu2004), (Soare, 1999).

RESULTS AND DISCUSSIONS

After running the LISA 8 program for the two loading cases of the structure, the following kinematic parameters were determined: the displacements along the X reference axis, the

vertical displacements along the plane Y reference axis, as well as the rotations of the cross sections of the main sections around Z axis. The determined static parameters are: axial stretching force, cutting force and bending moment. The analysis of the values obtained by the author is based only on the extreme values obtained for both the kinematic and static parameters. The extreme values of these parameters are presented in two tables. Table 1 includes the extreme values of the kinematic parameters. Table 2 shows the extreme values of the axial force, the cutting force and the bending momen.
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Table 1

The kinematic parameters considered in the module

Minimum displacements	Maximum displacements	Min Rotation	Max Rotation
Concentrated force			
0.005 (X Axes)	0.0365 (XAxes)	0.009	0.13
0 (Y Axes)	0/055 (Y Axes)		
Concentrated force and distributed forces			
0 (X Axes)	0.19 (X Axes)	-0.099	0.27
0.099 (Y Axes)	0.28 (Y Axes)		

Table 2

The static parameters considered in the module

Tensile force	Shear forces	Bending moments	
Concentrated force	0.51	0.085	1.87
0			
4.905	5.043		
Concentrated force and distributed forces			
0	0.43	0.20	3.39
2.63	7.93		

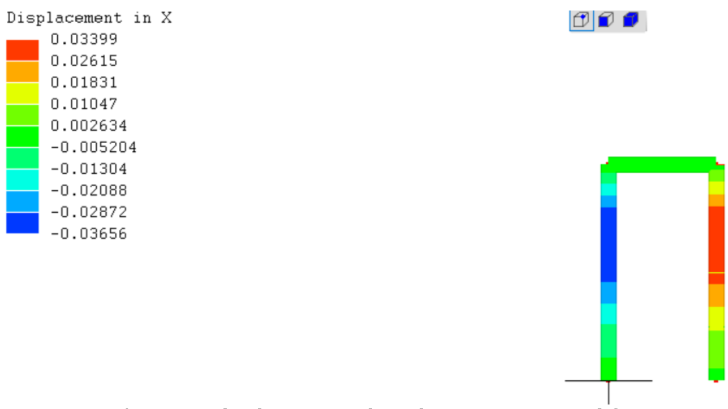

Figure 1 **Displacement in X by concentrated force**

Figure 2 **Displacement in X by concentrated force and distributed force**

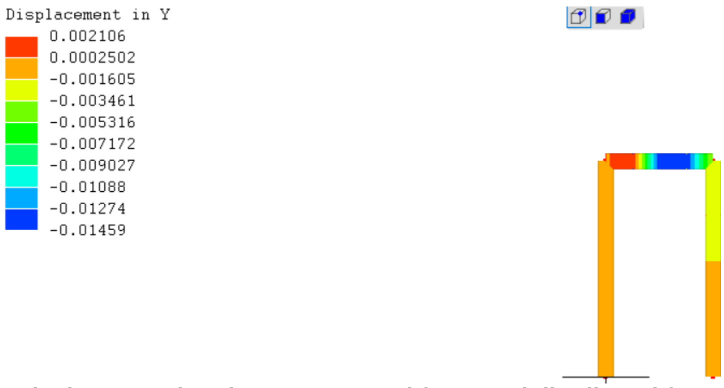

Figure 3 **Displacement in Y by concentrated force and distributed force**

Figure 4 **Displacement in Y by concentrated force**

Figure 5 **Rotation about Z by concentrated force**

Figure 6 **Rotation about Z by concentrated force and distributed force**

Figure 7 **Tensile force by concentrated force**

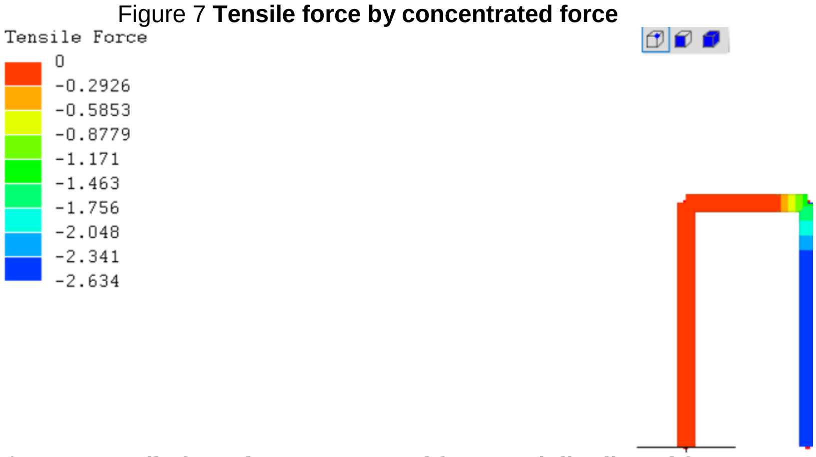

Figure 8 **Tensile force by concentrated force and distributed force**

Figure 9 **Shear Force by concentrated force**

Figure 10 **Shear Force by concentrated force and distributed force**

Figure 11 **Bending Moment by concentrated force**

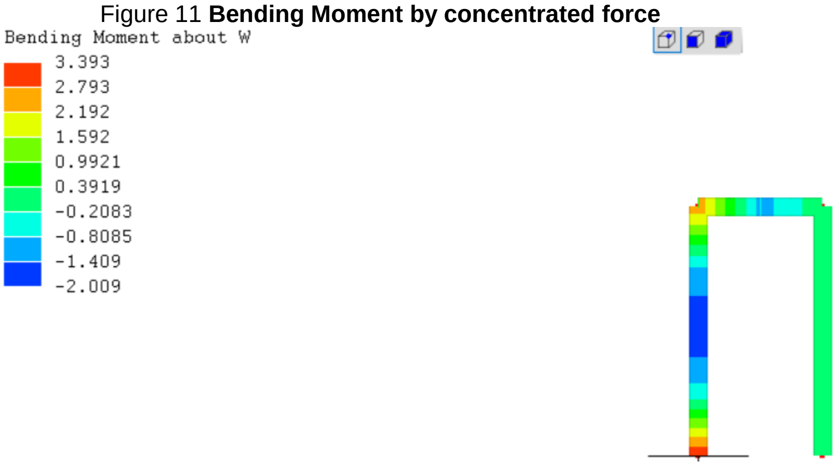

Figure 12 **Bending Moment by concentrated force and distributed forces.**

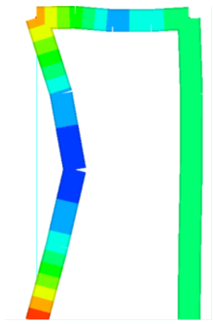

Figure 13 **The deformed shape of the structure for compound loading.**

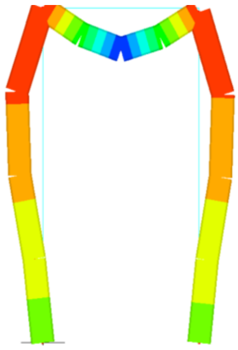

Figure 14 **The deformed shape of the structure for concentrated force.**

CONCLUSIONS

The analysis of the results carried out by the author takes into account only the extreme values run by the program. The minimum displacement on the X axis from the concentrated force is 5 [mm] compared to the value 0 [mm] in the case of the compound load. The maximum displacement on the X axis in the case of compound loading is 81% higher than in the first case of concentrated force action. For the values of the maximum displacement on the Y axis, the displacement from the compound load is 80% higher than the case with a concentrated load. The analysis of the results carried out by the author only considers the extreme values run by the program. The minimum displacement on the X axis from the concentrated force is 5 [mm] compared to the value 0 [mm] in the case of the compound load. The maximum displacement on the X axis in the case of compound loading is 81% higher than in the first case of concentrated force action. For the values of the maximum displacement on the Y axis, the displacement from the compound load is 80% higher than the case with a concentrated load. In the case of the static parameter - axial force -, the maximum value is obtained in the case of loading with concentrated force approximately 53% higher than the case of compound loading. The maximum values are recorded on the right pole of the structure. The value of the cutting force on load case 1 is 63% compared to the compound load. These extreme values are manifested in the sections of the structure on the crossbar in both loading cases, respectively also on the left pillar in the case of compound loading. The value of the bending moment for load case 1 is 55% compared to the case of compound load. The maximum values for both cases appear on the cross member, respectively and in the sections of the left pillar for the compound load. Therefore, for the same type of structure as the geometric and dimensional shape, in the case of compound stresses, an oversizing of the cross-section should be taken into account in order to ensure its strength and rigidity.

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