DEVELOPMENT OF CALCULATION PROGRAMS AND NUMERICAL ANALYSIS OF DISPLACEMENTS IN WOODEN BEAMS USING THE DIRECT INTEGRATION METHOD AND THE MOHR METHOD

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Abstract

This paper presents the numerical calculation programs designed by the author to determine the displacements of the sections of a wooden bar using the direct integration method and the conjugate bar method (Mohr). At the base of the realized programs was the Matlab numerical calculation software. For a good example of the two methods approached, the model considered for performing the calculations was the console bar.

Key words: numerical integration, Mohr method, beam, deflections.

INTRODUCTION

In order to achieve a physical model of the bar body considered, the author considered as valid some simplifying hypotheses, among which we mention:

- the isotropy of the material was considered both in the longitudinal plane parallel to the body fibers, and in the transversal plane, perpendicular to the fibers(Catarig, Kopenetz, 2001, Ciofoaia, Curtu, 1986);

- the hypothesis of small displacements was considered valid.

The section of the considered body is rectangular and constant along its entire length, fact for which the stiffness at bending of the body is constant. The methods that have been applied by the author are the direct integration method and the Mohr method.

This paper by the author consists in the realization and validation of analytical calculation methods (direct integration method and Mohr's method), using numerical analysis by developing programs in Matlab.

The initial, geometric and physical-mechanical data of the material are the following:he width of tj

- I= I=(b0*h^3)/12 [mm^4]
- E=0.1*10^5 [N/mm^2]
- L=1000[mm];
- F=100 [KN]
- b0=200 [mm], the width of the beam
- h=300[mm], height beam

MATERIAL AND METHOD

The programs made by the author are based on the known theoretical mathematical elements of the methods used. (Fetea, 2010), (Goia, 2000), (Ille, 1981). The designed program is presented below following (Gheorghiu, Hadar, 1998), (Muntenu Gh, Metoda Elementelor Finite 1998):.

```
% Numerical analysis of bars using the method of direct integration and al
conjugate beams %

% E, Young modulus [N/mm^2];
% I, the moment of axial inertia of the plane section [mm^4]
% L, length of bar [m];
% F, external force [N];
% h, section height [mm]
% b0, maximum width of the bar [mm];
% bX, bar width in section X [mm];
% VA, reaction force in the clamped section A [N];
% MA, bending moment from clamped section A [Nmm];
F=10^5
L=1000
b0=200
h=300
E=.1*10^5
I=(b0*h^3)/12
% Determining the reaction vertical force and the clamped moment;
VA=F
MA=F*L
% Expression of the bending moment on the interval [0,1000][mm]
syms x F MA
M(x)=-MA+VA*x
% Determining the expression for rotating the section by first integrating the
differential equation
syms v(x)
ode = diff(v,x) == (MA-VA*x)
vsol1(x) = dsolve(ode)
% Determining the expression of the section displacement by the second
integration of the differential equation
syms v(x) MA VA
Dv = diff(v);
ode = diff(v,x,2) == (MA-VA*x)
cond1 = v(0) == 0
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```
cond2 = Dv(0) == 0
conds = [cond1 cond2]
vSol2(x)=dsolve(ode)
for x=0
   C1 = - MA*x + (VA*x^2)/2
   C1
end
for x=0
   for C1=0
   C2=(VA*x^3)/6 - (MA*x^2)/2 - C1*x
   C2
   end
end
% The general expression of displacements axis (Missir-Vlad, Ioana, 2002):
x=0:100:1000
VA=F
F=100000
MA=F*L
d=((F*x.^3)/6 - (MA*x.^2)/2 )/(E*I)
plot(x,d)
x=0:100:1000
VA=F
F=100000
MA=F*L
rot = (x.*MA - (VA*x.^2)/2)/(E*I)
plot (x,rot)
```

Applying the direct integration method and by running the programs developed by the author using the Matlab numerical program, the following data were determined regarding the displacements of the points in the sections considered for x = 0: 100: 1000 and the rotations of the wooden beam sections:

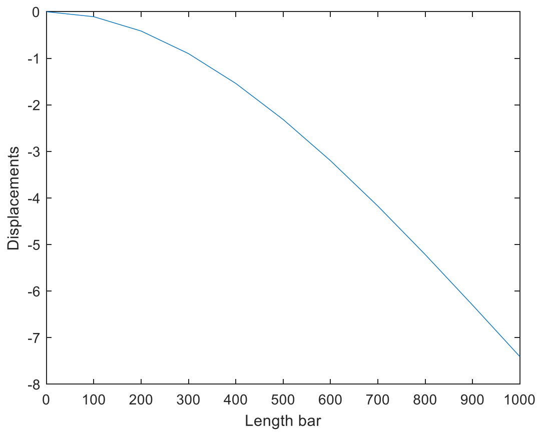

Fig.1 Displacement diagram by Integration method

Table 1

Displacements values along the beam using Integration method

x	0	100	200	300	400	500	600	700	800	900	1000
d	0	0.1074	-0.414	-0.900	-1.540	-2.314	-3.200	-4.174	-5.214	-6.300	-7.4074

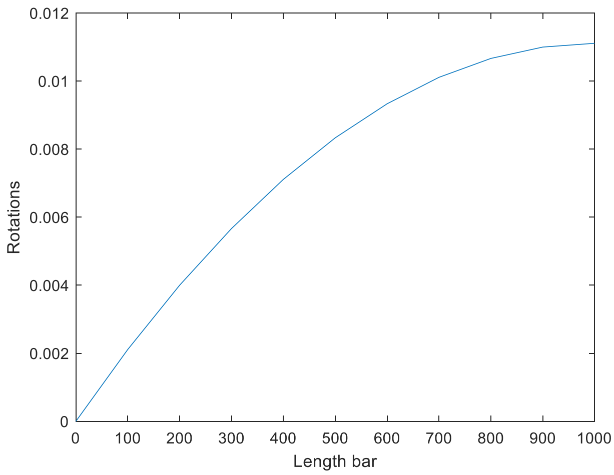

Fig.2 Rotations diagram by integration method

Table 2

Rotations values along the beam using Integration method

x	0	100	200	300	400	500	600	700	800	900	1000
rot	0	0.0021	0.0040	0.0057	0.0071	0.0083	0.0093	0.0101	0.0107	0.0110	0.0111

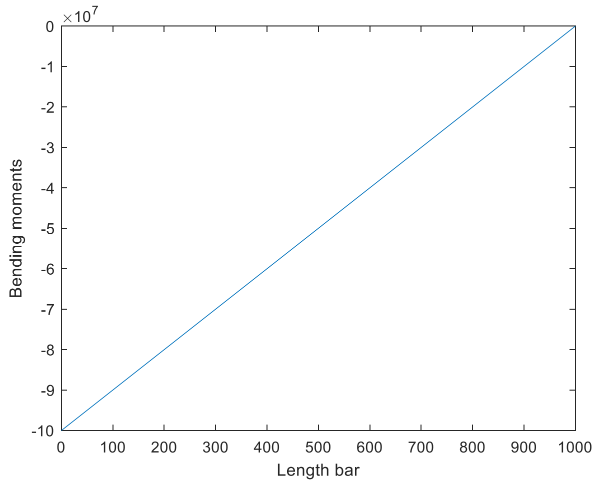

Fig.3 Bending moments diagram using Mohr method

Table 3

Bending moments values along the beam using Mohr method

x	0	100	200	300	400	500	600	700	800	900	1000
y	100	90	80	70	60	50	40	30	20	10	0

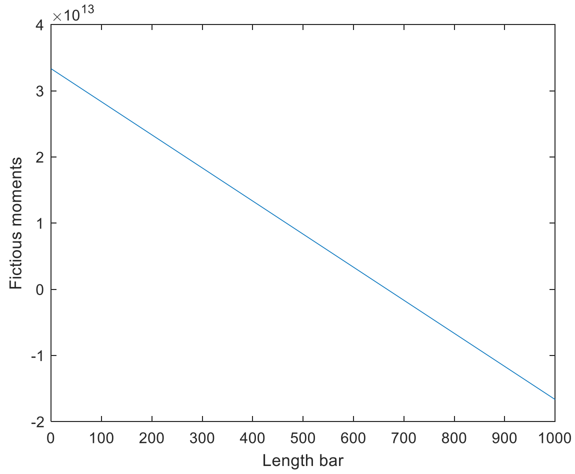

Fig.4 Diagram of the fictitious moment on the fictitious bar

Table 4

Fictious bending moments values along the fictious beam using Mohr method

x	0	100	200	300	400	500	600	700	800	900	1000
y	0	3.33	6.33	8.33	10.3	13.3	15.3	18.3	23,3	28.3	33.3

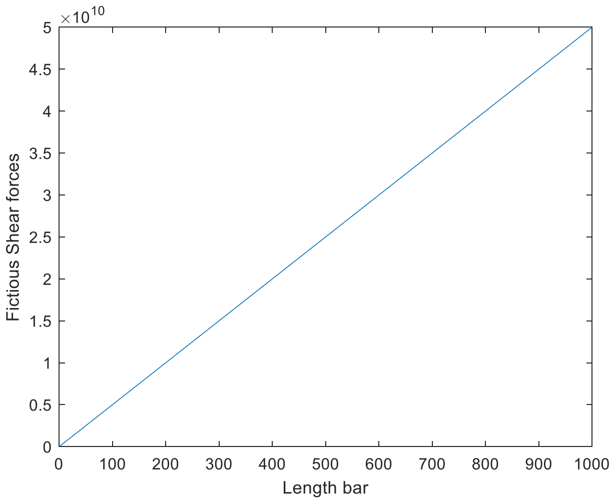

Fig.5.Diagram of the fictitious shear forces on the fictitious bar

Table 5.

Fictious shear forces values along the fictious beam using Mohr method

x	0	100	200	300	400	500	600	700	800	900	1000
y	0	5	10	15	20	25	30	35	40	45	50

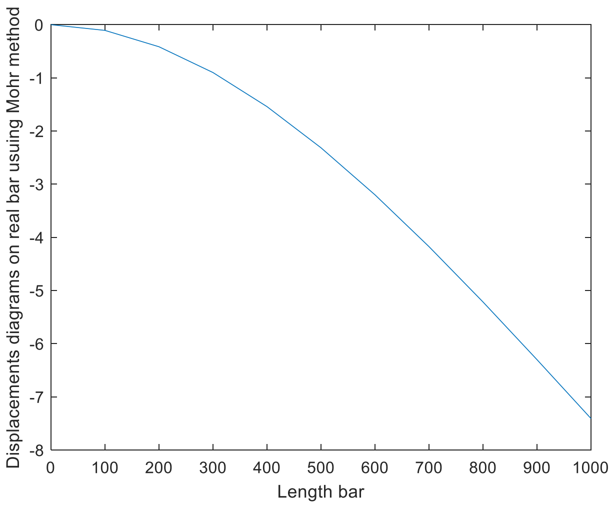

Fig.6 Displacements values along the real beam using Mohr method

Table 6

Displacements values along the beam using Integration method

x	0	100	200	300	400	500	600	700	800	900	1000
d	0	-0.1074	-0.4148	-0.9000	-1.5407	-2.3148	-3.2000	-4.1741	-5.2148	-6.3000	-7.4074

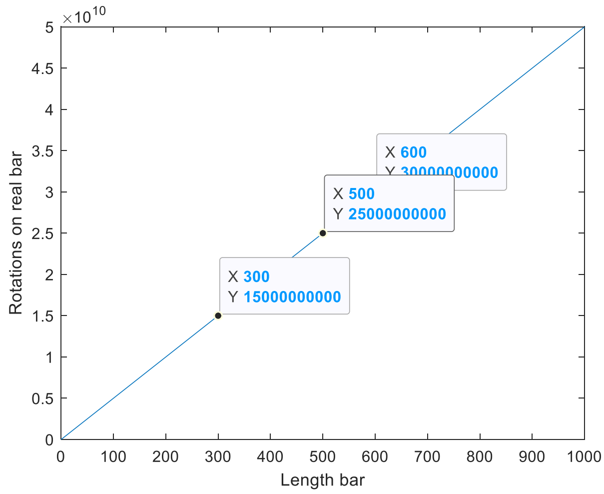

Fig.7 Rotations diagram on the real beam using Mohr method

Table 7

Rotations values along the real beam using Mohr method

x	0	100	200	300	400	500	600	700	800	900	1000
rot	0	0.0021	0.0040	0.0057	0.0071	0.0083	0.0093	0.0101	0.0107	0.0110	0.0111

CONCLUSIONS

As conclusions regarding the application of the two methods we can deduce the following:

1. The author's own contributions are given by the development of calculation programs for the wooden structure using the Matlab numerical programs;

2. The direct integration method is a faster method to apply for situations of structures with any type of support, but a simpler load in terms of external forces. For a small number of external forces acting on the structure, the number of integration constants to be determined by applying the boundary and / or boundary conditions is small;

3. Mohr's method is more laborious in terms of computational algorithm, requiring more time to solve problems; Mohr's method does not require the determination of integration constants;

5. It is found that the determined values of displacements and rotations using the applied methods are the same, which indicates the correctness of the elaboration of the calculation program and of the application of the two methods.

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