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STUDIES AND RESEARCHES REGARDING THE CALCULATION OF RESISTANCE AND DESIGNING THE VIBRATING PLATE/TABLE "MEVI"

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Abstract: *The paper presents designing and sizing some a vibrating plate/table called "MEVI", regarding the resistance of it. In this paper, the resistances calculation relating to plate "MEVI" are stopped at the basic structure of the plate, as follows: the vibrate plate, the pistons and frame, it ignoring the calculus of the others components structures resistance.*
Key words: *Vibrating plate/table, resistance.*

1. INTRODUCTION

Vibrating plates/table [6] may be used in various industrial applications, in order to achieve the concrete by compaction, sorting, like as the emptying and filling of containers with concrete etc.

Vibration plates will design according to their destination. The principle of operation of these plates consists of inducing vibrations in metal frame, that is isolated through elastic elements by the fixed part of the table (its support).

Basics of concrete they can compact on vibrating plates. Vibrating plates power will be correlated with the weight of the printing element assembly.

Vibrations [1], [2] can be produce by installing of the electrical engines by the both sides at the vibrating plate. Centrifugal force to them, it can be adjusting by changing eccentrically position of vibrators. The vibration can be of low frequency 5-15 Hz or high frequency over 100 kHz.

The plates can be fitted with restraint systems of the concrete or containers of form, which are and were used in the production processes.

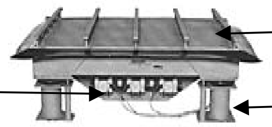

Fig. 1 Vibrating plate/table.

2.THE COMPONENTS DESCRIPTION OF THE VIBRATION PLATE

The "MEVI" plate is composed of the following components:

• frame - including table's feet, there is constructed from profiles "I" of the sized 600 x 131 mm, standardized, subjected to bending checks;

• plate structure - it is built of steel OL 37 and sized at 10 m x 4.8 m and it is checked by the calculations of bending;

• lifting and positioning the pistons, checked the deflection of these;

• the hinges which enable tilting of the vibrating plate after one side (the side of 10 m), and these are made from steel OL37, and their positions were calculated in relations with metallic frame.

• clamping screws, studs etc.

In the following, we will detail the strength calculations concerning exterior plate including in the vibrating plate, frame profile and the pistons, without present strength calculations for hinges, bolts, pins and welds.

2.1 Calculation of resistance of rectangular plane plate

In this calculus **[4]** there is a *trigonometrically series coefficient* notated *$P_n(y)$*:

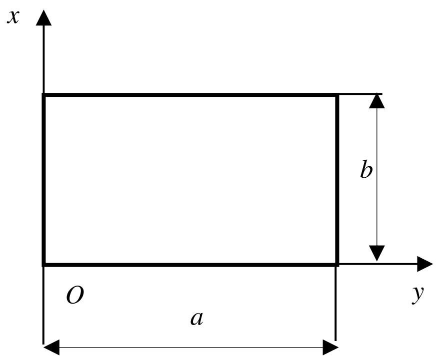

Fig. 2 Models of the rectangular plate (a-length, b-width).

$$P_n(y) = \frac{2}{a}\int_0^a p(x,y)\sin\frac{n\pi x}{a}dx \tag{1}$$

- *Displacement y=w:*

$$\sum_{n=1}^{\infty}\left[y_n^4 - 2\frac{n^2\pi^2}{a^2}y_n^2 + \frac{n^4\pi^4}{a^4}y_n - \frac{P_n(y)}{D}\right]\sin\frac{n\pi x}{a} = 0 \tag{2}$$

- D = rigidity in bending

$$D = \frac{Eh^3}{12(1-\mu^2)} = \frac{21\cdot10^{-5}\cdot0.15^3}{12(1-0.3^2)} = 6490.38\cdot10^{-9}\,N\cdot m \tag{3}$$

and $\mu = 0{,}3$; $P_{\max} = 2000\cdot9{,}81\ N$;

$E = 2000 - 2800\ \frac{N}{mm^2}$; $h = 150\ mm\ = 0{,}15m$ where H = plate thick of the vibrating table).

The displacement equation y = *w* become:

$$y_n^4 - 2\frac{n^2\pi^2}{a^2}y^2 + \frac{n^4\pi^4}{a^4}y_n = \frac{P_n(y)}{D} \tag{4}$$

2.2 Sectional Efforts

Efforts sectional are note with M_x, M_y and M_{xy}, after the two directions of transmission Ox and Oy:

$$\begin{cases} M_x = -D\left(\frac{\partial^2 w}{\partial x^2} + \mu\frac{\partial^2 w}{\partial y^2}\right) = 2474{,}404\ N\cdot m \\ M_y = -D\left(\frac{\partial^2 w}{\partial y^2} + \mu\frac{\partial^2 w}{\partial x^2}\right) = 2487{,}69\ N\cdot m \\ M_{xy} = -D(1-\mu)\frac{\partial^2 w}{\partial x\,\partial y} = 9417{,}134\ N\cdot m \end{cases} \tag{5}$$

2.3 Stresses of the plate

The stresses of the point of the rectangular plate are:

$$\begin{cases} \sigma_X = \frac{12M_x}{h^3}\cdot z = 659{,}8\cdot10^3\frac{N}{m^2} < 16\cdot10^5\frac{N}{m^2} \\ \sigma_y = \frac{12M_y}{h^3}\cdot z = 663{,}3\cdot10^3\frac{N}{m^2} < 16\cdot10^5\frac{N}{m^2} \end{cases} \tag{6}$$

where: $z \to \frac{h}{2}$ and $I = \frac{h^3}{12}$ (7)

- *Torque moments of the plate* are:

$$\tau_{xy} = \frac{M_{xy}}{I}\cdot z = \frac{M_{xy}}{\frac{h^3}{12}}\cdot z \tag{8}$$

$$\tau_{xy} = 663{,}38\cdot10^3\frac{N}{m^2} \tag{9}$$

For $z = \pm\frac{h}{2}$ it will result a torque moment give us by (10):

$$\tau_{xy\max} = \frac{6M_{xy}}{h^2} \tag{10}$$

$$\tau_{xy\max} = 663{,}384\cdot10^3\frac{N}{m^2} \tag{11}$$

3. STRAIGHT TENSION IN THE RECTANGULAR PROFILE BY BENDING

3.1. Overview

It is presents a prismatic bar, it having symmetrical right axis and a constant variation or a very slow variation at the bending, in time (see pistons).

It is considered the hydraulic pistons telescopes having a prismatic form, the section of this is rectangular with slow variation by the bending, so the calculation is going fit on the theory presented in the anterior paragraph.

General notions:

a) Simply bending - if the moment vector is located in a section on the main axis of the bar straight;

b) Oblique bending - if moment vector has components different from zero after both symmetrical axes of the straight bar.

The simplifying assumptions that is necessary for the calculation of straight bars at the bending:

- supposedly that straight beam has a plane of symmetry. The pressure between the longitudinal fibers is null.
- The normal sections entirely, remain in the plane normal to the axis of the deformed (Bernoulli's hypothesis).
- Tangential stresses are equal to 0.
- Neutral axis will be straight.
- *Specifically deformation:* $\varepsilon = \frac{z}{\rho}$ (12)

where: ρ-density, z-bar thickness.

If a request takes place in the field of linear elastic we have:

$$\sigma = E\varepsilon = E\frac{z}{\rho} \quad (13)$$

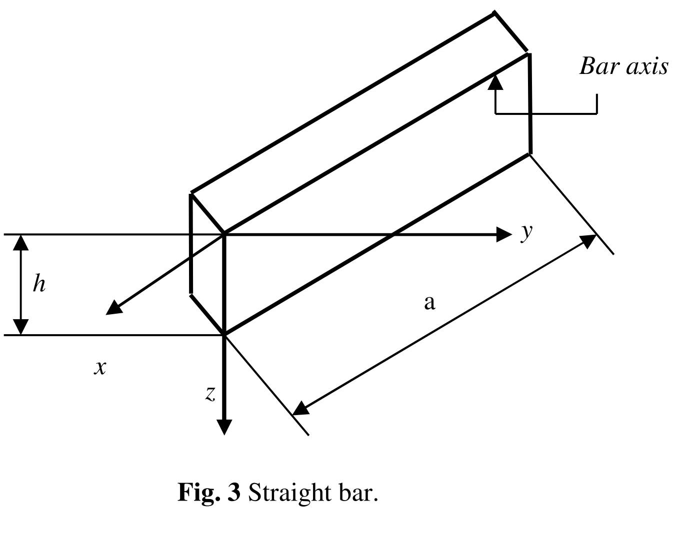

Fig. 3 Straight bar.

3.2 Curvature of axis

b) curvature of deformed axis is calculated as follows:

$$\frac{1}{\rho} = \frac{M}{EI_y} \quad (14)$$

where:

E - longitudinal elasticity module of the bar [N/m^2];

I_y - geometrical, inertial moment [m^4];

M - bending moment of bar [Nm].

EI_y-flexural rigidity of the bar [Nm^2], Navier's formula:

$$\sigma = \frac{M}{I_y} \cdot z \quad (15)$$

$$\sigma_{max} = \frac{M}{I_y} \cdot z_1 = \frac{M}{w_{y_1}}$$

$$\sigma_{max} = \frac{76{,}8 \cdot 10^3}{0{,}409} \cdot 1{,}7 = 319{,}217 \cdot 10^3 \frac{N}{m^2} \le \sigma_{xOL37};$$

$$\sigma_{max} = 16 \cdot 10^5 \frac{N}{m^2} \quad (16)$$

$$\sigma_{min} \cong 0$$

$$\sigma_{min} = \frac{M}{I_y} \cdot z_2 = \frac{M}{w_{y_2}} \quad (17)$$

where: $\left.\begin{matrix} z_1 \\ z_2 \end{matrix}\right\}$ - displacement of the foot axis towards the neutral axis.

- *Bending moments:*

$$M_y = \int_A \sigma_x z\, dA = M \quad (18)$$

$$M_z = \int_A \sigma_x y\, dA = 0 \quad (19)$$

where: $z = b = 1.7\ m$

$$M = 16 \cdot 10^5 \int_A dA = 16 \cdot 10^5 \cdot A = 16 \cdot 10^5 \cdot 4800;$$

$$M = 76{,}8 \cdot 10^3\ N \cdot m \quad (20)$$

$$A_{rectangular} = 1 \text{ x } 1\ [\text{mm}^2] \quad (21)$$

$z_1 = b; z_2 = 0;\ sau$

$z_1 = 0; z_2 = b$

$\rho_{otel} = 7.85 \frac{kg}{dm^3} = 0{,}00785 \frac{kg}{dm^3}$

$E_{otel} = 210\ GPa = 210 \cdot 10^{-6} \frac{N}{m^2}$

$M = 76{,}8 \cdot 10^3\ N \cdot m$

$$\sigma_{x\,Steel\,OL37} = 1600 \frac{daN}{cm^2} = 16 \cdot 10^5\ \frac{N}{m^2} \qquad (22)$$

$$I_x = \frac{a^3}{12} = \frac{0{,}1^3}{12} = 83{,}3 \cdot 10^{-6}\ m^3$$

$$I_y = \frac{b^3}{12} = \frac{1{,}7^3}{12} = 0{,}409\, m^3 \qquad (23)$$

4. CONCLUSIONS

• The necessity of the design a vibrating plate (vibrating table) of large size (w x l = 10 m x 4 m) is a real one, starting of the need casting concrete plates, in scope of rapid building of supermarkets.

• For this purpose were addressed in this study:

- choosing a type of vibrating plate and in terms of the generation of vibrations and determine the number of vibration generators required, that expected to load the plate/table;

- documentary concerning the calculation of resistance of it:

• Vibrating plate having three sides free and a side slider;

• The feet, in the form of the profile "I" and the telescopic, hydraulic pistons to lifting of the vibrating table "MEVI" are include it in the study.

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Studii si cercetări privind calculule de rezistenţă şi proiectare a mesei vibrante "MEVI"

Rezumat. Lucrarea isi propune dimensionarea si proiectarea prin calcule de rezistenta, a unei mese vibrante de mari dimensiuni, numite "MEVI". Calculele de rezistenta ce privesc masa "MEVI" se opresc la calculele de rezistenta la structurile de baza ale acesteia, respectiv: masa vibranta, batiul si pistoanele, neabordandu-se in lucrarea alte calcule de rezistenta ce privesc alte structuri componente.

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