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EXPERIMENTAL DETERMINATION OF RIGIDITY FOR MECHANICAL PRESS PAI 40

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ABSTRACT

Because the complex configuration and variation of sections does not allow for sufficiently accurate theoretical calculations to determine the elastic strain, and it is necessary to perform experimental determination also. The paper experimentally determined elastic deformation of the framework and it's calculated rigidity characteristic. Calculate the linear rigidity characteristic – on the direction of the force and angular rigiditys characteristic. Calculate also the mechanical work consumed for elastic deformation of the fight and then determines how much percent of mechanical work of the press.

Keywords: rigidity, press, linear deformation, angular deformation, mechanical work

1. Introduction

Framework is an organ whose functions are to take the force that develops during pressing, to ensure, through guides, slide comand and support all parts of the press. Due to the special importance it has to ensure its performance and behavior of the press operation, framework represents a part whose dimensioning and testing have to be performed with maximum care.

Under the action of pressing task appear elastic deformations of framework and some of the parts which compose the press. The size of the strains and deformation of framework depend on many factors, of which most important are: the magnitude and direction of pressing force, pressing speed, shape and sections dimensions, the material that is executed its components, the position of the crank shaft, particularities of construction and manufacturing, etc.

Framework is the most solicited part of a press and his deformation therefore falls not only above cinematic precision of the press but also on operation parameters.

Elastic deformation of framework is manifested by the appearance of linear and angular displacements it represented dashed, fig. 1. Thanks to go top of the framework to change the position of the axis of rotation of the eccentric shaft and position of slide sizing. Due to the movements of the lower part changes the position of the surface table layout of the cut press or matrix.

Reporting the press to a fixed system, fig. 2, you can highlight important changing the position of parts of the press as a result of framework deformation.

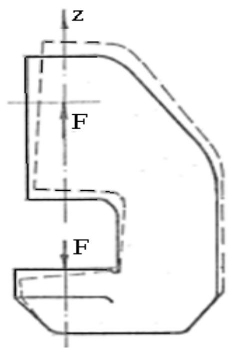

Fig.1 Frame work with C shape, before and after the deformation

If before applying load F_n, Γ_c and Γ_m planes that defines the lower area of the slide and the surface table are parallel, while pressing, as a result of the elastic deformation, these planes are removed with each other and rotate in opposite directions making the distance between them grow H_0.

Also, the two planes rotate with angles θ_c and θ_m. Under these conditions, the distance between table and slide increase becoming $H_0 + \Delta H_0$ and cinematic axis of the slide no longer coincides with the axis of the table, but you want to cross it under the deformed framework angle θ_b in B point, located at the height of the z_0 the original location of the table.

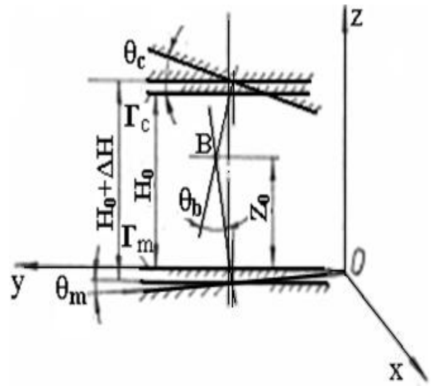

Fig. 2 The drawing of movements of different functional surface after the deformation of framework

Increase of the share H_0 with ΔH_0 is the result of the combined effects of elastic deformations of framework, the main movement mechanism.

Implications of elastic deformation of framework are over: the quality of pressed parts, tools durability, energy consumption and use of the full availability of the press.

Below, increasing the share H_0 due to deformation of framework, will be denoted with δ_{zb}.

2. Experimental and material used

Request press will run with the help of a hydraulic device 1. It sits on the board of the press, as shown in fig. 3.

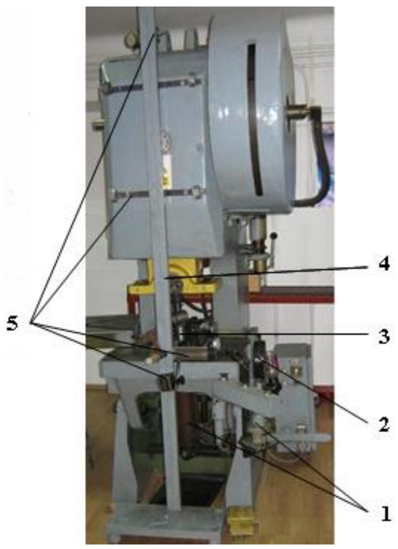

Fig. 3 Experimental bench

To operate the hydraulic device, rod 3 acts on the slide, asking the framework with a force F proportional to the pressure quoted by pressure gauge 2. The comparators for measurement should be fixed by stands of 5, you can move on to the rod 4.

Loading with force was accomplished with low speed to be complied with the conditions of static request.

In order to determine, on an experiment, the rigidity of the framework it is necessary to measure the deformations. For this purpose with the help of comparators will be carried out measurements of:

- movements of the upper part of the framework and framework table;
- angular movements of the top of the table.

For deformation measuring is used comparators with accuracy 1/100 mm.

Measurements shall be carried out in the points and the distances shown in fig. 4.

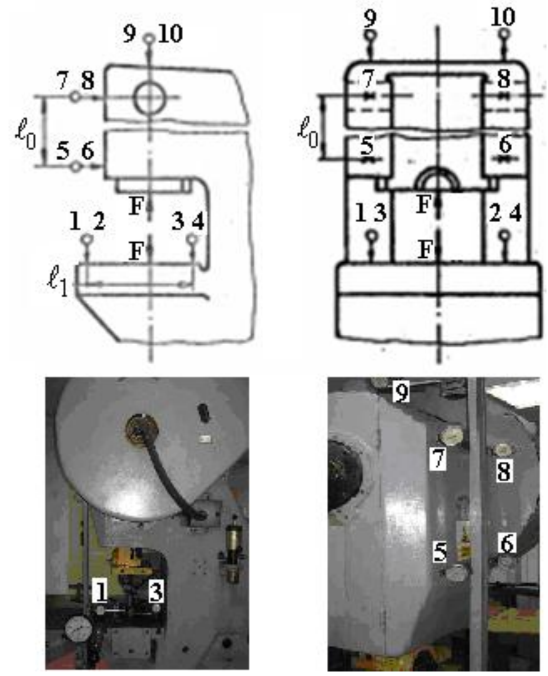

Fig.4 Locations where masurements are made on the framework

Deformations in the slide axis transmissions will be calculated taking into account the comparators indications 1 ... 10.

Distances ℓ_0 and ℓ_1 (fig. 4) shall be so selected as to be as big in order to ensure a significant difference between the comparators indications. So

ℓ_0 = 430 mm and ℓ_1 = 330 mm.

The linear deformation of the slide will be obtained experimentally [1, 3]:

$$\delta_{zb} = \frac{\delta_1 + \delta_2 + \delta_3 + \delta_4}{4} + \frac{\delta_9 + \delta_{10}}{2} \qquad (1)$$

where: $\delta_1 \ldots \delta_{10}$ are the measured values of comparators.

The angular deformation to slide and to press table (fig. 2) shall be determined by the relations:

$$tg\theta_c = \frac{\frac{\delta_7+\delta_8}{2} - \frac{\delta_5+\delta_6}{2}}{\ell_0} \qquad (2)$$

$$tg\theta_m = \frac{\frac{\delta_1+\delta_2}{2} - \frac{\delta_3+\delta_4}{2}}{\ell_1} \qquad (3)$$

and the total angle of deformation of framework is obtained experimental:

$$\theta_b = \theta_c + \theta_m = arctg\frac{(\delta_7+\delta_8)-(\delta_5+\delta_6)}{2\ell_0} + arctg\frac{(\delta_1+\delta_2)-(\delta_3+\delta_4)}{2\ell_1} \qquad (4)$$

3. Results and conclusions

Based on the results recorded, were made by the following:

- with the help of the relation (1) it has plotted the *linear* deformation of the slide obtained experimentally δ_{zb} = f (F), for the force F was assigned discrete values from 50 up to nominal force 50kN (fig. 5);

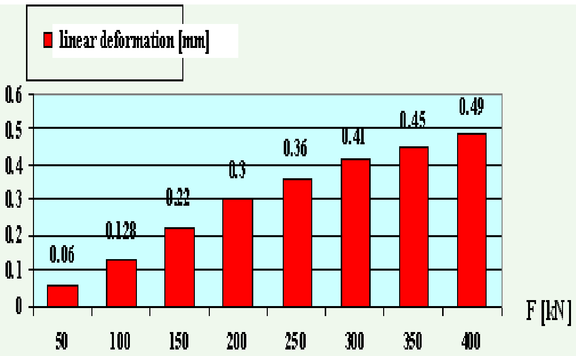

Fig.5 Linear deformation of the framework

- with the help of the relation (4) it has plotted the total angle of deformation of framework obtained experimentally, θ_b = f (F);

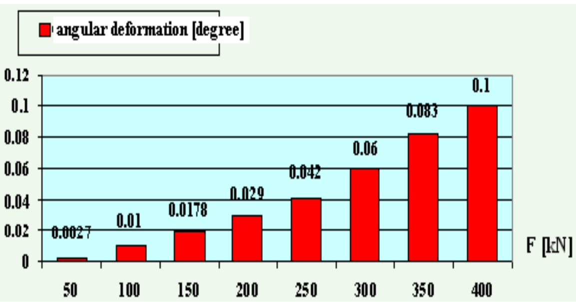

Fig.6 Angular deformation of the framework

Knowing the deformations measured experimentally, you can set the feature to linear and angular rigidity with relations:

$$C_l = \frac{F}{\delta_{zb}} \text{ [kN/mm]}; \qquad C_\theta = \frac{F}{\theta_b} \text{ [kN/degree]} \qquad (5)$$

Their variation depending on force , applying press, are shown in fig. 7 and fig. 8.

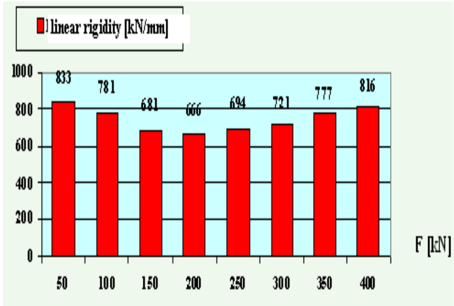

Fig.7 Linear rigidity of the framework

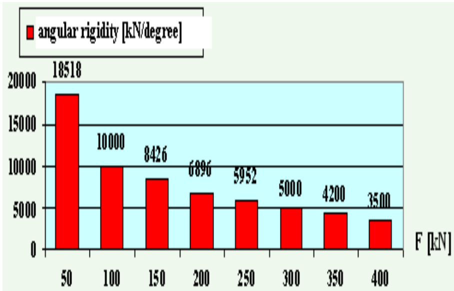

Fig.8 Angular rigidity of the framework

For elastic deformation with δ_{zb} of the framework is consumed with a certain work. The mechanical work consumed will be:

$$L_e = \frac{F \cdot \delta_{zb}}{2} \text{ [kNmm]} \qquad (6)$$

The mechanical work available to the press can be calculated with relation (5):

$$L = 0{,}355\sqrt{F_N^3} \qquad (7)$$

Using relations (6) and (7), it was established as per cent of the work available is consumed by the elastic deformation of the framework in the case of an application there of by force F with values from 50 in 50kN. The results are shown in the graph of fig. 9.

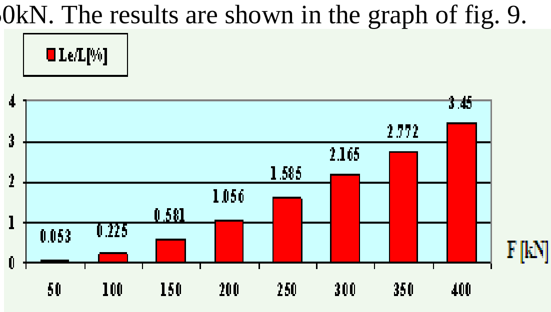

Fig.9 Mechanical work (L) for elastic deformation of the framework

On the basis of the processing results of measurements and calculations, detached the following conclusions:

- one may approximate that linear and angular deformation of the framework (fig. 5 and fig. 6) increases the force applied, which was expected to be in the field of elastic deformation;
- linear rigidity (fig. 7) is constant across the whole range of forces, having however values something lower mid range;
- angular rigidity (fig. 8) decreases with increasing force, more sharply at the beginning of the range and after much more slowly;
- the mechanical work consumed for the elastic deformation of framework increases with force (fig. 9), as the nominal force of 400kN to 3.45% of the work available to the press. From this point of view it may be considered a PAI 40 press with good rigidity characteristics compared to other presses, where the speciality literature gives this percentage over 10% [1, 3].

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