ANNALS of the ORADEA UNIVERSITY.

Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

EXPERIMENTAL TESTING OF THE CRANKSHAFT PRESS

Amalia ȚÎRDEA, Felicia DRAGU
Departament of Mechanics and Vibration University POLITEHICA of Timişoara
e-mail: amalias@mec.utt.ro, feliciadragu@yahoo.com

KEY WORDS: impulsive cutting force, dynamic effect, shock isolation

ABSTRACT

The force developed from a crankshaft press in cutting processing it an impulsive one relatively of high magnitude which induce perturbation effects in the crankshaft mechanism and in the flywheel of which kinetic energy is transferred in the cutting mechanical work.

The real impulsive inertial excitation is necessary to be determined the best isolation system to reduce the transmissibility to the surrounding place where the press is placed.

1.THE CRANKSHAFT MECHANISM

The crankshaft mechanism, in Figure 1, consists of a metallic rigid frame 1 which supports the whole mechanism of the press: an electric motor driving 2 , by a belt transmission 3, a large inertial flywheel 4, as accumulator of energy, to be supplied for stamping or cutting work, which is realized by the axle 5, crankshaft 6, connected road 7, slider 8 and plunger die 9 and die pot 10.

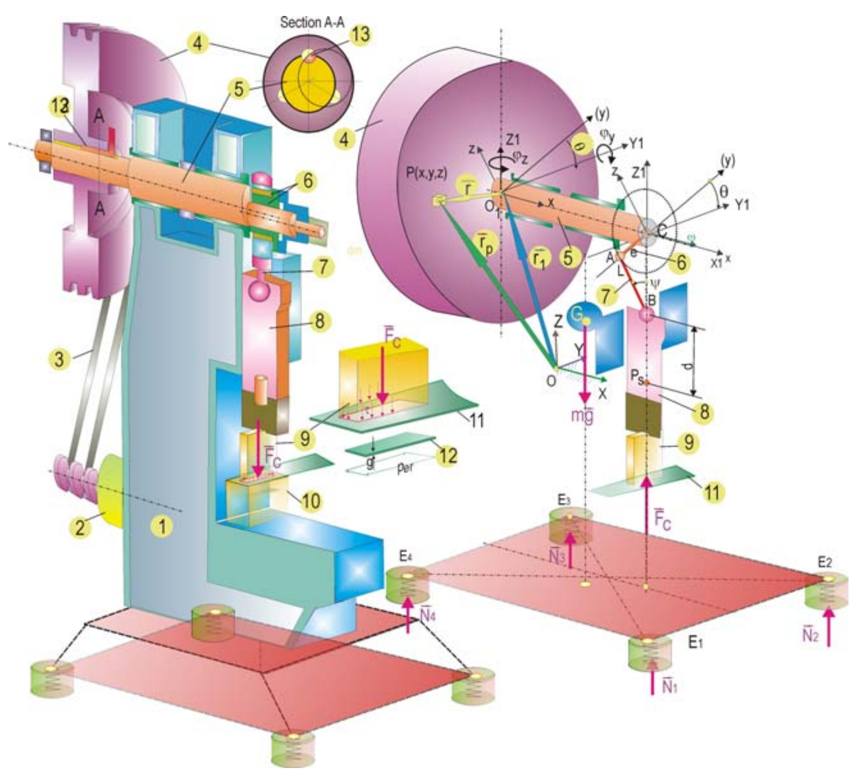

Fig.1

In view to reduce transmissibility of vibration to the supporting floor the press frame put on elastic layers or on the elastic isolators E_1, E_2, E_3, E_4 .

The rigid body motions of the press frame can be defined by three translations of the point O_1 origin of the mobile frame $O_1X_1Y_1Z_1$ fixed to press frame O_1 being placed on the axle 5 axis O_1X_1 and by three rotations φ_x, φ_y and φ_z, around frame $O_1X_1Y_1Z_1$ axes. The position of the crankshaft mechanism and flywheel 4 is defined by a rotation with angle θ around O_1X_1.

The parts linked in the ensemble press-isolation being rigid the motions of dynamical system depend of 7 degree of freedom, three translation of lows $x_1(t)$, $y_1(t)$, $z_1(t)$, three rotations of lows $\varphi_x(t)$, $\varphi_y(t)$, $\varphi_z(t)$ and rotation low θ(t) of crankshaft.

The active force, (1), is the punch force which is an inner force of the dynamical system during cutting up the piece 12 of perimeter p_{er} and thickness g.

$$F_C(\theta) = \tau \cdot g \cdot p_{er} \cdot f(\theta) \qquad (1)$$

The shear stress τ depends of piece 12 material. The function f(θ) depend of crankshaft position θ the contact between plunger die 9 and piece 12 start at a given position θ_0 and ended at the θ_e.

So that

$$\begin{aligned} \theta_0 \le \theta \le \theta_e &\Rightarrow f(\theta) \neq 0 \\ \theta_0 > \theta > \theta_e &\Rightarrow f(\theta) = 0 \end{aligned} \qquad (2)$$

The virtual work of the force $F_c(\theta)$ is:

$$\delta L_{F_C} = -\tau \cdot g \cdot p_{er} \cdot f(\theta) \cdot \delta z_S \qquad (3)$$

$$\delta z_S = -e \cdot (\cos\theta + \sin\theta \cdot \tan\psi) \cdot \delta\theta \qquad (4)$$

where z_s is the geometric coordinate along the longitudinal axis of the slider
The excitation of system depends essentially from the impulsive function f(θ) which is quit impossible to be analytically formulated, so that for its approximation is necessary to be obtained only experimentally.

2.EXPERIMENTAL TESTING

The experimental setup used for dynamical investigation of a crankshaft press is pictured in Fig.2 and Fig.3

For impulsive cutting force $F_c(t)$ measurement was applied a strain gage half bridge montage, connected to amplifier A_{m1} of which output signal is recorded digital by data acquisition DA on a file of PC computer (Fig.3).

For the slider 8 motion measurement, of low $z_s(t)$ is used an inductive displacement sensor S_{id} connected to amplifier A_{m2} of which output signal is recorded by the same way, and simultaneous with the cutting force F_c signal (Fig.3).

A high accuracy measurement is necessary for measurement of low motion θ(t) of flywheel 4 was used a digital rotary encoder E_{dr} connected by friction wheel F_{ro} in contact with flywheel 4 (Fig.2).

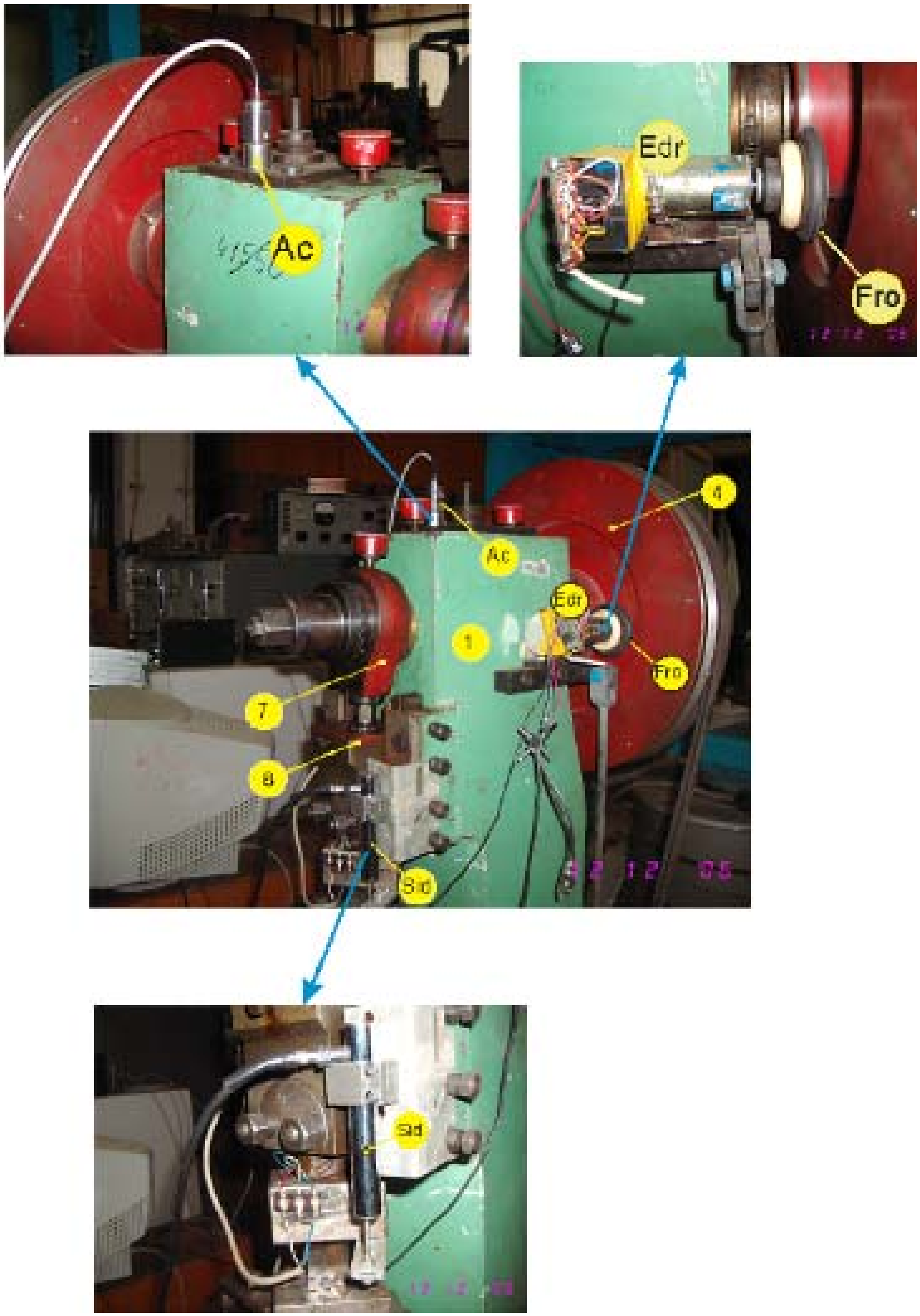

Fig.2

Fig.3

Its two output signals, of rectangular train impulse u_A and u_B, of frequency 13740/rotstion of flywheel, are recorded simultaneous with the signals of $F_c(t)$ and $z_s(t)$, and with the signal of vibration motion on a given point P on the press frame 1, measured by a seismic piezoelectric accelerometer Ac, connected to charge amplifier of which output signals is proportional with the velocity v(t) of the vibration motion along of accelerometer axis.

4.RESULTS

Figure 4 ilustrates time history of the four signals: $z_s(t)$, $F_c(t)$, v(t) and flywheel speed, $\omega(t) = \dot{\theta}(t)$.

During the test was cutting a rectangular plate of perimeter p_r = 72 mm and thickness g =2 mm, resulting by experiment an impulsive force of peak, F_{cmax}=20035 N.

The crankshaft press works in an automatic cutting process with periodicity of T=0.25

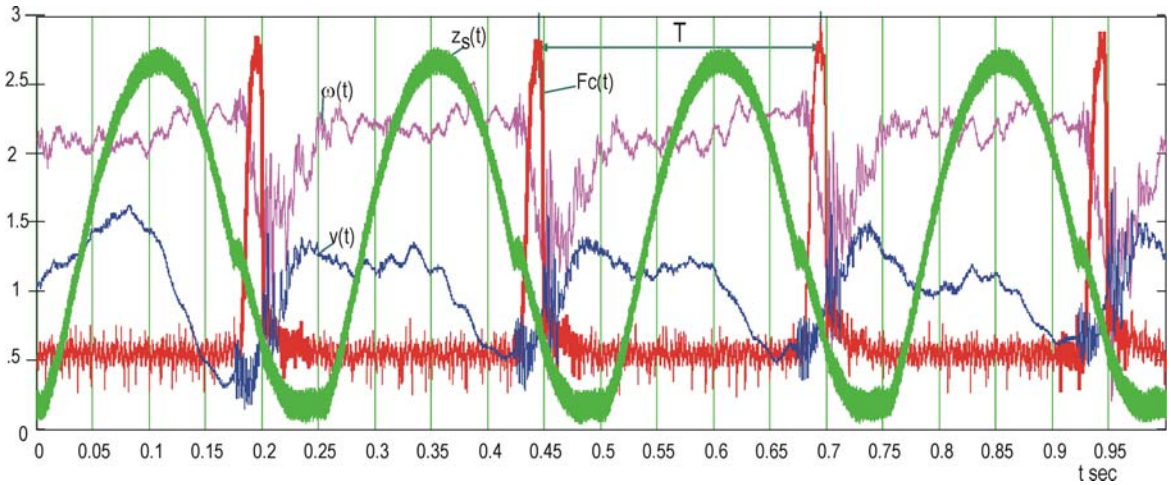

Fig.4

For more details, in the Figure 5 are zooming the time history along 0 to 0.3 s.

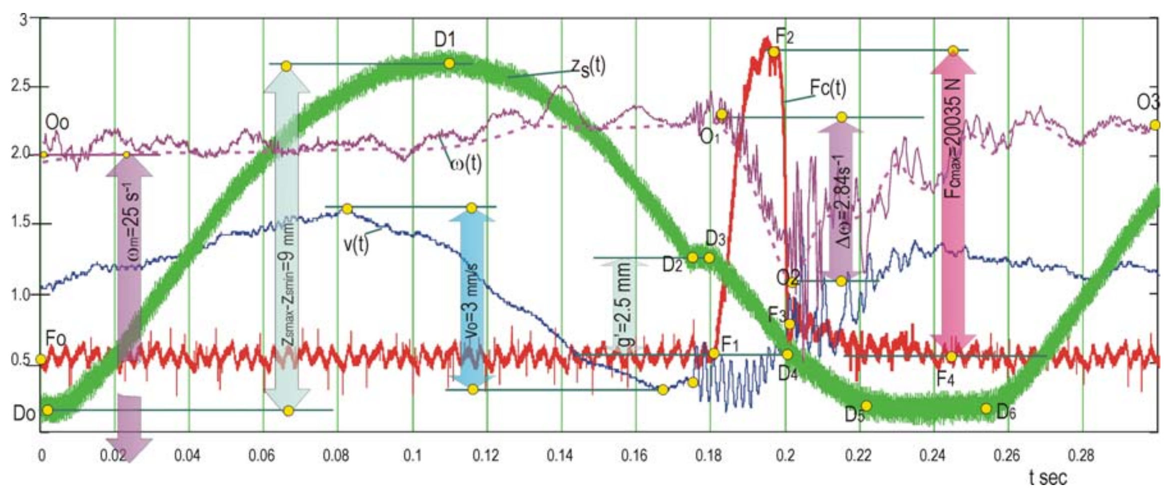

Fig.5

In the descendent motions of the plunger die 9, from point D_1 of $z_s(t)$'s curve diagram (Figure 5), the first contact with cutting piece is in the point D_2 follows by a landing stair D_2D_3 where with a lower contact force Fc(t) (unperceptible on its diagram) the clearance from crankshaft mechanism is eliminated. The cutting process starts in the point D_3 and ends in the point D_4. The cutting force F_c has an impulsive shape (points F_1-F_2-F_3). By energetically transfer, the flywheel speed $\omega(t)$ decreases from value 25 s^{-1}, in point O_1, with 2.84 s^{-1}, in point O_2, and after, under drawing motor momentum Mm, the speed increasing again at the nominal values.

As result of the speed variations on press ensemble are developing inertial forces and momentums which periodically exciting the whole ensemble.

To the time width of impulsive cutting force F_c corresponds a displacement g'=2.5 mm more large as thickness g =2 mm of cutting piece , denoting that cutting process is a complex, and the function f(θ) have to be determined experimentally.

When the cutting process is a singular, one punch, or two punch, the inertial effects increasing because before of first punch the flywheel is not coupled with the crankshaft mechanism, coupling being realized by a special profiled cotter pin acted suddenly by a pedal, occurring coupling shock between flywheel 4 and axle 5 (Fig. 1)

5.CONCLUSIONS

For a vibration isolation study it is necessary to be used a dynamical model including the above mentioned effects.

From technological reasons, the crankshaft pres or other impulsive machines, have to be placed on the elastic floor of one building.

Usually we meet unexpected situations of large resonant vibration on the building structure, induced by improper isolation of machine.

REFERENCES

[1] Tîrdea, A, Cioara, T, Gh, Dynamics Testing of a Crankshaft Press, Paper no. 1089, Proccedings of International Conference on Engineering Dynamics, 16-19 April, 2007 CARAVOEIRO ALGARVE PORTUGAL.

[2] Cioara T. Gh., "Vibration of Mechanical Systems with the Composed Motions ", MCT Grant276 Report 1998 Processing

[3] Tirdea A, "Experimental methods for dynamic testing of a crankshaft press´", PhD Report nr.2 2006, (in Romanian)