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THE IMPULSIVE LOADINGS CHARACTERIZATION, A NEEDFUL STAGE IN DYNAMIC PROCESSES SIMULATION

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Abstract: *As definition, in general term, the industry is a national economy and materials production branch which comprises the totality of the companies (plants, electrical stations, factories, mines etc.) that deal with working tools production, combustibles, materials and prime material extraction, then the treating of the products obtained. Thus, the presence of the mechanical vibration within some of the industrial processes in inevitable and their propagation in the environment promotes the destructive phenomena on the constructed environment or pathological symptoms on the human factor. This paper suggests based on the study of industrial equipment, meaning a forging hammer, to quantify the three measures that characterize the mechanical excitation: shape, amplitude and duration time function by combining the techniques of experimental investigation with theoretical analysis.*

Key words: equipment, vibration, loading, impulsive, simulation

1. INTRODUCTION

Related to the negative effects of the vibration on the human factor as well as to the legislative regulations that establish their admissible limits, there is a continuous concern in identifying and applying the viable solutions of antivibration isolation systems.

Although this systems proved their working efficiency, their safety depends on one hand on the operation state (exp: the dynamic behavior) and on the other hand on the operation conditions (corrosive agents exposure).

Considering the previous statements, one cannot determine with accuracy the safety of the systems for the vibration isolation and damping, because there is the risk that during the exploitation they might have a deficient operating regime that has direct evil repercussion on the vibration generating source as well as on the propagation environment. Therefore, it is required the achievement of a predictor monitoring methodology for the impulsive actions of mechanical system functioning regime parameters.

The methodology validation as well as the physical measures determination that are relevant to the monitoring activity is accomplished both theoretically and experimental. Theoretically speaking, the conceptual validation is achieved by analyzing the mathematical and physical theoretical models corresponding to real cases of dynamical systems exploitation. An important stage in the mathematical model development is the determination true to reality of the dynamic loading function within the technological process by describing its characteristic parameters: the shape, amplitude and application time.

Determination of characteristic parameters of technological equipment excitation force, who work with dynamical loading, can by make from real case starting, in the following way:

- Impact energy of equipment working element is determined , in the forging hammer case since it at ram;

- The collision duration between drop hammer ram and deformed semi-product is experimentally determined;
- A dynamical loading shape depending on type of technological process is adopted;
- The delimited area by the dynamical loading shape is actually the input system energy; by equalization two energies will be determined the excitation function amplitude.

2. DURATION OF THE LOADING FORCE

An very important parameter for analyze of dynamic loadings from mechanical systems, is their during, in another word, in the shock type loading case represent the collision duration between working element and semi-product who is plastic deformed.

An experimental determination of duration of loading force was made by the forging hammer of 400 kgf capacities, like in fig. 1. Experimental determinations were made for two modes of free forging hammer working.

a. Free work scheme of the hammer: ram hit directly the anvil, contact corresponds to an elastic collision.

The recorded movie has processing with MIDAS player software (Fig. 2), the results of experimental determinations interpretation are as following:

- Elastic collision during the ram and anvil of 0.82 ms;
- Average speed of the ram before the collision is 3.8 m / s.

The variation of both parameters previously determined, is explained by the fact that the equipment staff deserving can influence the parameters blow by handling the control lever of hammer.

b. Load work scheme of the hammer: the ram hit a piece (previously heated at optimum temperature for hot plastic deformation), corresponding to a collision contact predominantly plastic, Fig. 3.

In plastic collision cases between ram and piece (semi-product) during free forging process, it was found that:

- Average length of plastic collision between ram and anvil is 13 ms
- Average speed of the ram before the collision is 1.56 m / s.

Fig. 1 Forging hammer 400 kgf capacity

Fig. 2 Elastic blow

Fig. 3. Plastic deformation

Duration of plastic and elastic collisions between the ram and semiproduct, respectively that ram and anvil, and ram velocity during the collision are parameters that depend on a number of factors among which the most important are:

- masses of two bodies that collide;
- ram speed in the early collision;
- semi-product temperature in plastic collision case;
- materials constituting the parts in contact;
- how to order the hammer.

3. SHAPE OF THE LOADING FORCE

The dynamical loading forces generated by forging hammer are usually non-periodical function.

The shock loading represents a particular case of non-periodical functions, which means that whole kinematic energy, are transmitted in a very short time.

The most common used functions in dynamical mechanical system modeling are: rectangular pulse, semi-sinusoidal, half-cycle sine pulse, rectangular pulse, exponential pulse, triangular pulse, trapezoidal pulse and cycloid pulse.

3.1 Rectangular wave form

Rectangular wave function is defined mathematically as follow:

$$f(t)=\begin{cases} A, & 0 \le t \le T \\ 0, & -\infty < t < 0, T < t < \infty \end{cases} \quad (1)$$

Apply Fourier transform of this function

$$F(\omega)=\int_{-\infty}^{\infty} Ae^{-i\omega t}dt = \\ = \frac{A}{\omega}\left[\sin\omega T + i(\cos\omega T - 1)\right] \quad (2)$$

and obtain pulsation spectra

$$\left|F(\omega)\right| = AT\left|\frac{\sin\frac{\omega T}{2}}{\frac{\omega T}{2}}\right| \quad (3)$$

The shape of rectangular wave with T=0,013 s and A=1000N is presented in fig. 4.

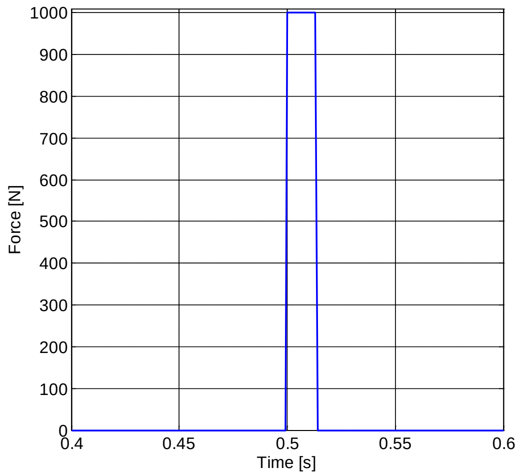

Fig. 4 Rectangular impulse - T=0,013s

3.2 Cycloid wave form

Cycloid wave function is defined mathematically as follow:

$$F(t)=\begin{cases} \frac{A}{2\pi}\left(\frac{2\pi t}{T} - \sin\frac{2\pi t}{T}\right), & 0 \le t \le T \\ 0, & t > T \end{cases} \quad (4)$$

Apply Fourier transform of this function

$$F(\omega)=\int_0^T \frac{A}{2\pi}\left(\frac{2\pi t}{T}-\sin\frac{2\pi t}{T}\right)e^{-i\omega t}dt = \\ = A\frac{\left(-4\pi^2+e^{-i\omega t}\left(-i\omega^3T^3+\pi^2\left(4+4i\omega T\right)\right)\right)}{4\omega^2\pi^2T-\omega^4T^2} \quad (5)$$

The shape of cycloid wave with T=0,013 s and A=1000N is presented in fig. 5.

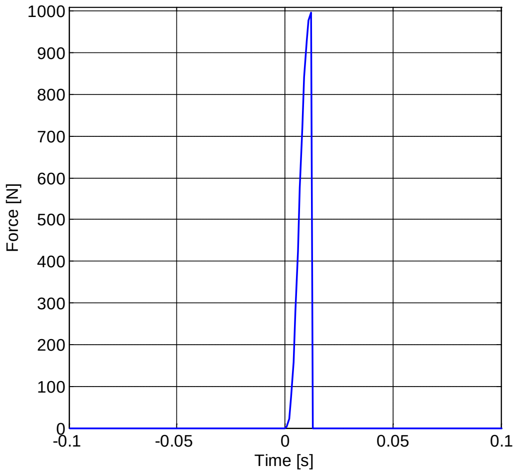

Fig. 5 Cycloid impulse - T=0,013s

4. THE AMPLITUDE OF LOADING FORCE CALCULUS

The kinetic energy of the ram before impact can write:

$$E=\frac{mv^2}{2} \quad (6)$$

where:

m - mass of the ram; m=400 kg;

v - speed of the ram; v=1.56 m/s;

In these hypotheses we obtain E=486J.

For the rectangular pulse we obtain an excitation force value 34700 N, fig. 6, in case of cycloid pulse 81100 N, fig. 7. The differences between the two types of features are evident in the frequency domain representation, fig. 7, 9, so it is very important that the choice of excitation function shape to be as close to reality.

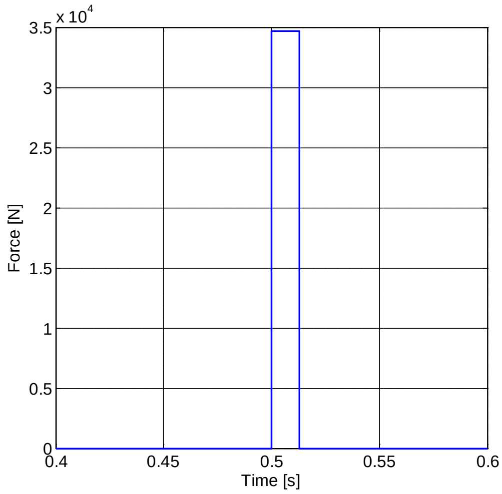

Fig. 6 Rectangular impulse - T=0,013s

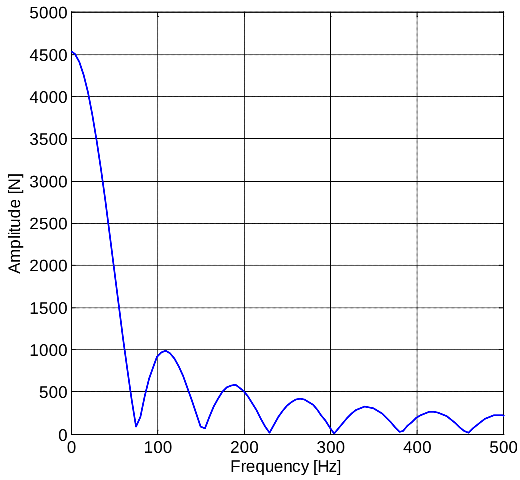

Fig. 7 Pulsations spectrum of the rectangular impulse function - T=0,013s

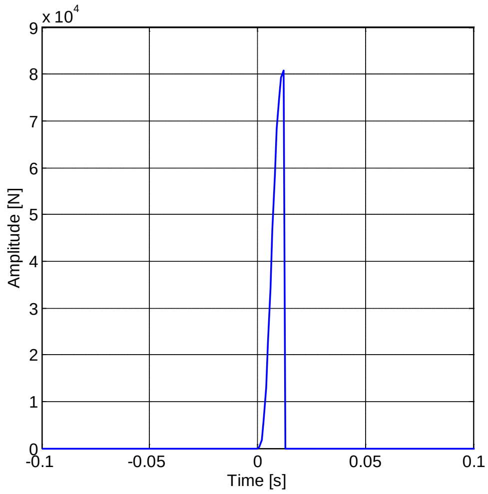

Fig. 8 Cycloid impulse - T=0,013s

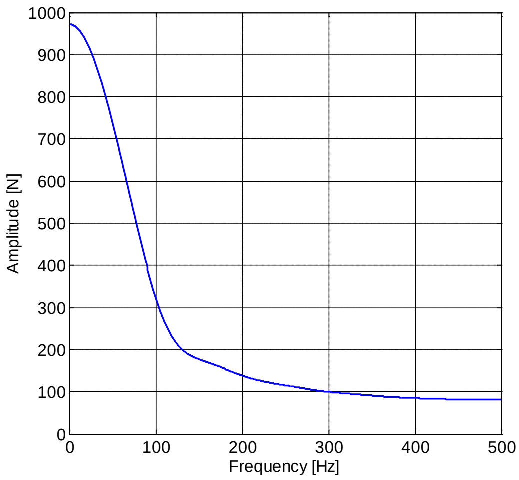

Fig. 9 Pulsations spectrum of the cycloid impulse function - T=0,013s

The shapes of excitation forces will be established based on technological process peculiarity, because observe differences between pulsation spectrum representations of the each loading forces Figs. 7, 9.

5. CONCLUSIONS

The presents paper represents an efficiency method for dynamical loading evaluation process by theoretical and experimental methods combine. This evaluation consists into useful instrument for physical and mathematical modeling of the mechanical systems with impulsive action such as die forging hammers. For perfect characterization of the dynamical loading it must determinate the length, the shape and the amplitude of loading. For this purpose in this paper were complete characterized two functions cases: rectangular and cycloid type. The right choice of the exciting functions is very important because these modify the theoretical technological equipment frequency response and in consequently can become a vibration pollution source for different neighbor objective, by incorrect choice of anti-vibration systems.

6. REFERENCES

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