EVALUATION OF ENVIRONMENTAL POLLUTION BY MECHANICAL VIBRATIONS FROM THE TECHNOLOGICAL EQUIPMENT WITH ANTI-VIBRATION SYSTEMS WITH DEGRADED VISCOELASTIC LINKS

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***Abstract*:** *In the plastic deformation industry, there are a number of machinery that producing vibrations by specific technological process, that may have adverse effects on developed industrial activity and destructive effects on the built environment. In this context, it is necessary to implement anti-vibration systems for the purpose of isolation and damping generated vibration. Due to intensive and varied loadings duty faced by anti-vibration systems, after a while of use, degradation occurs on viscoelastic links of the embedded elements. This phenomenon induces a nonlinear behavior of anti-vibration systems with significant changes in the dynamic response of the equipment and thus with changing the vibration impact on the environment.*

Keywords: *pollution, environment, vibration, spectra.*

1. INTRODUCTION

In the plastic deformation industry, the main machines that propagate vibrations of high intensity are free and die forging hammers. Generated vibration is due technological process, on which can not intervene in order to reduce vibration propagated to the environment. Isolation and damping vibration is done by implementing viscoelastic systems under technological equipment foundation. Due to intense dynamic regime faced by these systems, their viscous component suffers structural changes over time, leading to dynamic behavior change of antivibration elements. These changes are explained by the mainly nonlinear behavior of antivibration systems both for the viscous and elastic component.

2. METHODOLOGY OF MONITORING

The monitoring represents the activity of obtaining information's related to the mechanical system function, with some characteristic measuring systems and methods with the purpose of supervise and intervention for remedy [3].

The data transmitted by the monitoring and control system must allow accuracy in establishing the defection nature, the appreciation of the situation gravity, the consequences and the orientation to the required remedy actions.

The characterization of the *non-linear* behavior of the viscous elastic systems is achieved only by evaluating the effects that they induce in the dynamic answer of a mechanical system subdued to impulsive actions [5]. Considering this, it is elaborated a methodology based on experimental determination that is able to evaluate the dynamic behavior (answer) variation in time of a vibration and shock generator equipment term the characteristics variation of the viscous elastic systems installed under the equipment's fundament. In order to avoid the estimate errors when this methodology is applied, it demands its implementation from the moment that the viscous-elastic anti-vibration system is put into operation.

In order to repeat the experimental determinations at pre-established time range passing in order to obtain the comparative data analysis allows the evaluation of the variation occurred in the operational and structural characterization of the viscous-elastic dynamic isolation systems.

The main management activities for monitoring the technical systems vibration are presented in Fig. 1.

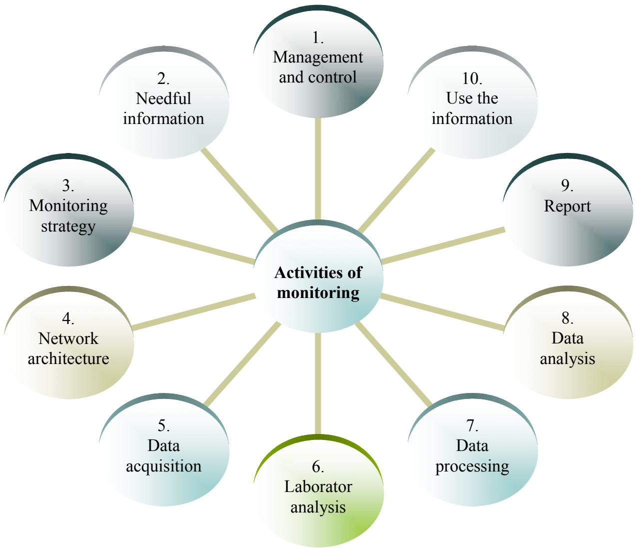


Fig. 1. Activities of monitoring

3. EXPERIMENTAL DETERMINATION

Experimental determinations were made on a die hammer of the IUS Brasov facility, with 4t capacity, focused simultaneous recordings of the acceleration signals on bed plate and vat, Fig. 2. After filtering signals, necessary step to obtain reliable results as possible, were represented kinematic parameters of vibration in both time and frequency domain.

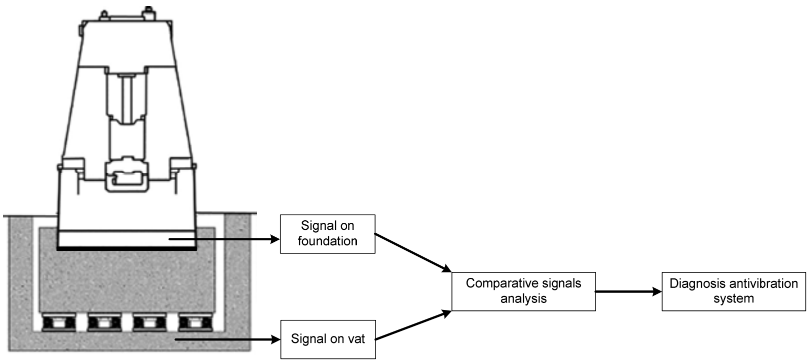


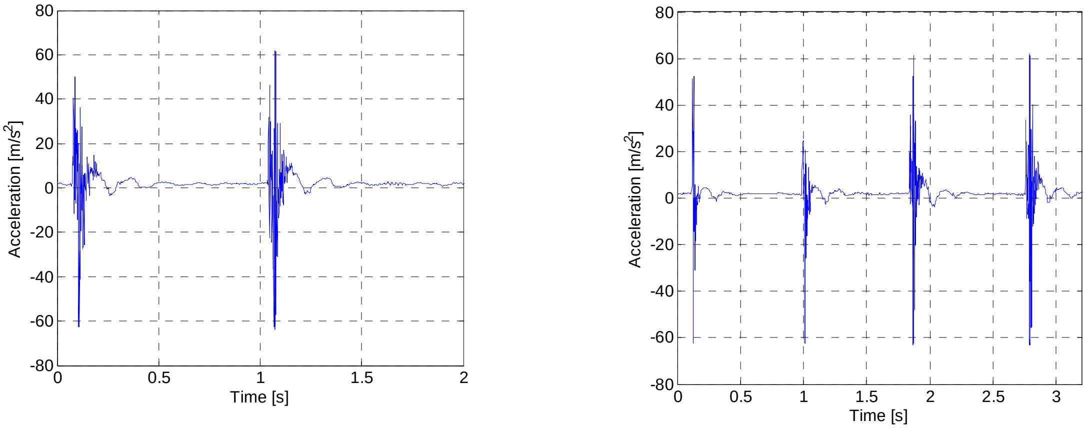
Fig. 2. Signal acquisition scheme

Further, will be played in synthetic mode these representations based on experimental determinations.

3.1 THE TIME REPRESENTATION OF THE ACCELERATION SIGNALS

The time evolutions of the recorded accelerations show an increase in amplitude of the acceleration signal on the vat towards on the bed plate, a characteristic phenomenon of the non-linear elasticity systems.

The representation of the acceleration signals recorded on the vat term the time are known as *the hammer signature* and show a real interest because based on them it can be established the noxiousness degree of the vibration source produced and propagated during the equipment operating.



c. Recording 1 **d. Recording 2**

Fig. 3. Acceleration recorded signal on bed plate

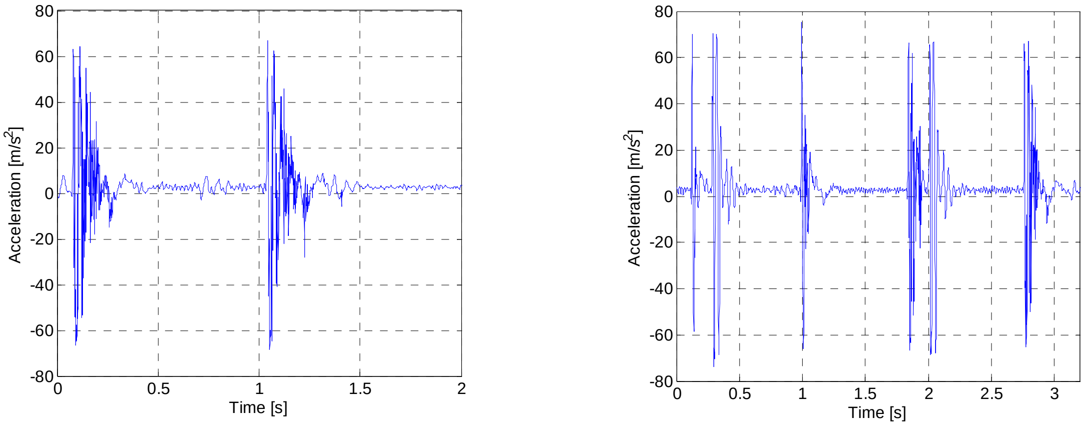


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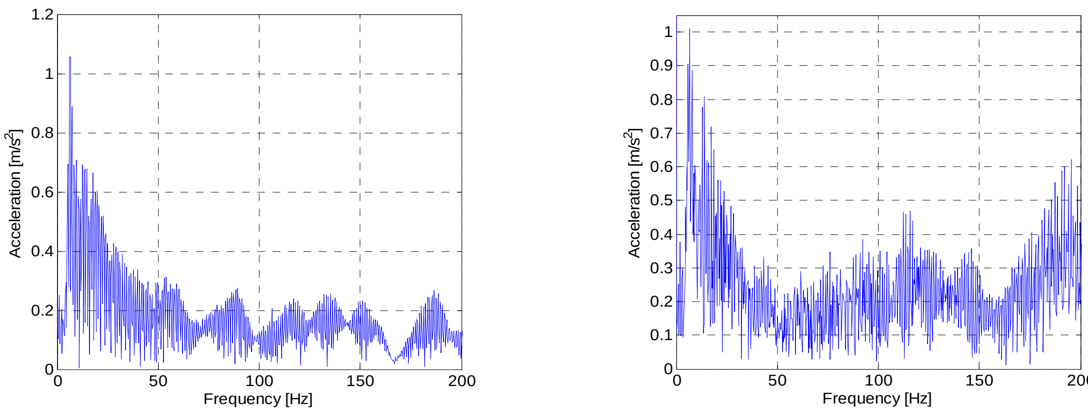
Fig. 4. Acceleration recorded signal on vat

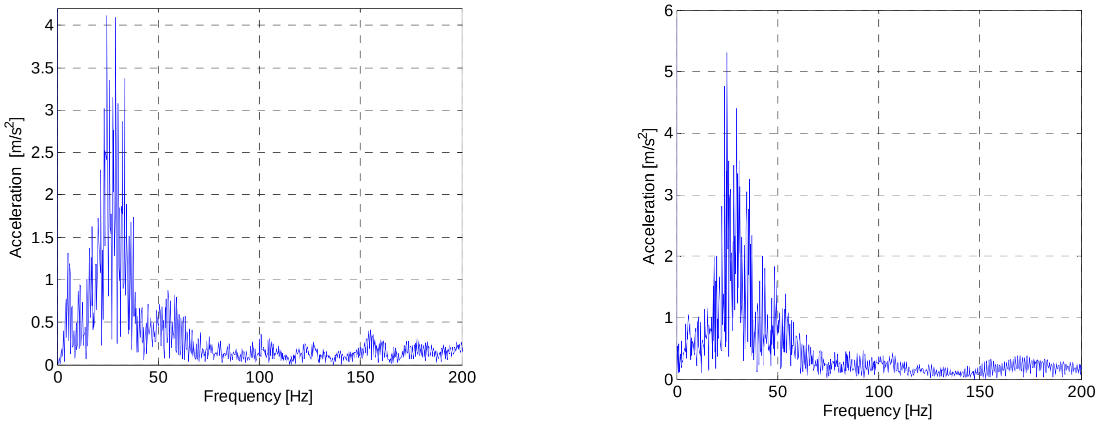
3.2 THE FREQUENCY REPRESENTATION WITH FOURIER TRANSFORMS

For bed plate respectively vat corresponding signals are represented the frequency acceleration spectra in order to show the frequency band corresponding to the maximum amplitude components (Figs. 5 and 6). The frequency spectrum representation of the acceleration signals recorded on the die hammer vat show the shock frequency spectrum in the frequency range of (24÷36) Hz known also as *the hammer signature*.



c. Recording 3 **d. Recording 4**

Fig. 5. Spectra representation of acceleration on the bed plate



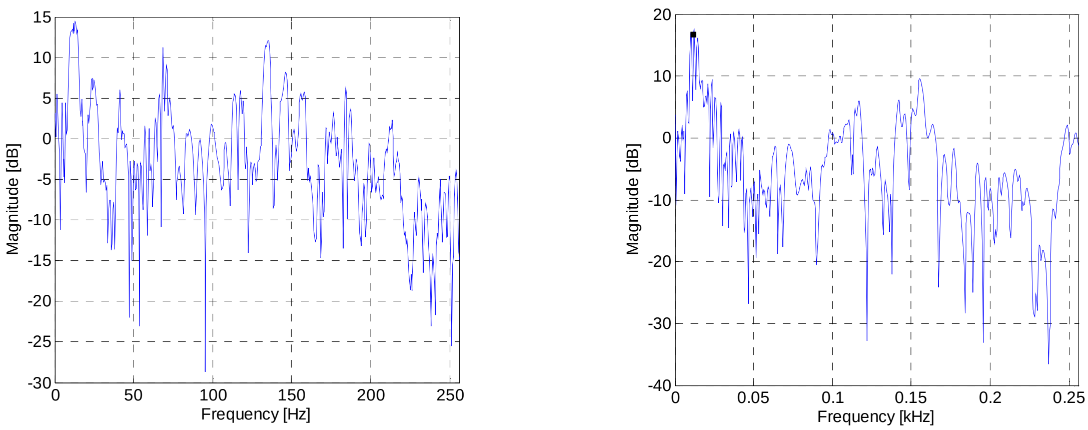
c. Recording 3 **d. Recording 4**

Fig. 6. Spectra representation of acceleration on the vat

Although the frequency answering spectrum of the hammer is continuous, most of the shock energy developed during the technological process is carried by the spectral components in the range of (24÷36) Hz.

3.3 THE TRANSFER FUNCTION DETERMINATION

This variable characterizes the way that the mechanical system respectively the viscous–elastic anti-vibration system influence the impulse spectrum that convert into the answer spectrum (Fig. 7).



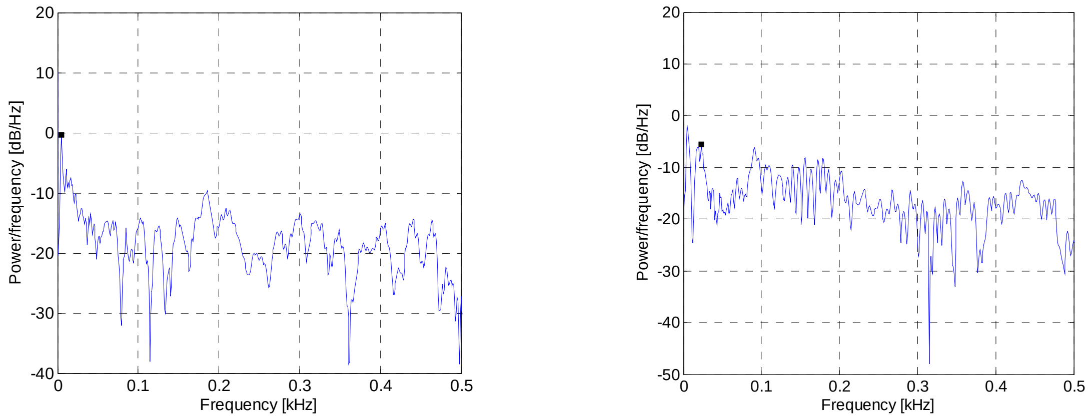
c. Recording 3 **d. Recording 4**

Fig. 7. Transfer function of bed plate - vat acceleration signals

The graphic representation analysis of the transfer function determined for multiple experimental measurements demonstrate that the viscous-elastic type anti-vibration system show significant values in the range of frequency (10÷15) Hz and (140÷160) Hz. The admission of new frequency ranges for which the transfer function has significant values, is a phenomenon due to the presence of the non-linear type amortization and elastic forces.

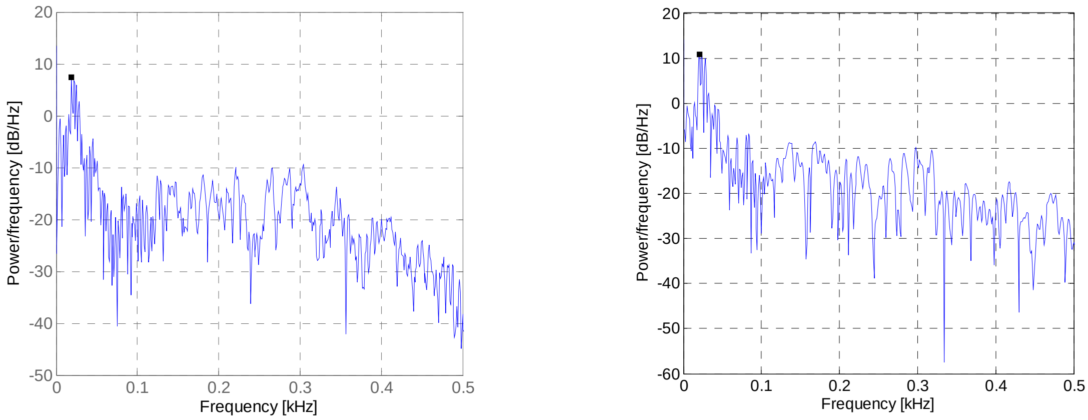
3.4 POWER SPECTRAL DENSITY

Power spectral density of acceleration signal recorded on that hammer forging bed plate, is a quantitative indicator of the power distribution signal on frequency spectrum components. From graphic representation of power spectral density to experimentally acquired signals (Figs. 8 and 9), it appears that a significant value of average power signal recorded on vat, is carried by the corresponding spectral components of frequencies in the range (4 ÷ 25) Hz.



c. Recording 3 **d. Recording 4**

Fig. 8. Power spectral density of acceleration recorded on bet plate

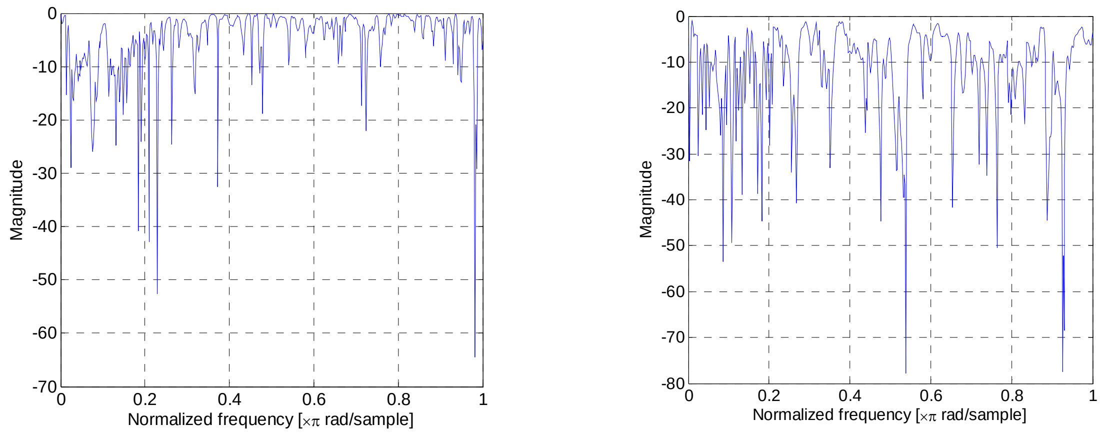


c. Recording 3 **d. Recording 4**

Fig. 9. Power spectral density of acceleration recorded on vat

3.5 COHERENCE REPRESENTATION

An explanation of mismatch of two acceleration signals of input respectively out from system, its variation of functional parameters of antivibration viscoelastic system such as elastic or damping nonlinearities appearance, Fig. 10.



c. Recording 3 **d. Recording 4**

Fig. 10. Coherence function of acceleration signals recorded on bed plate and vat

4. CONCLUSIONS

The representation of the acceleration signals recorded on the hammer's bed plate and vat in time and frequency as well as the coherency and transfer functions representation show a non-linear behavior of the passive isolation viscous-elastic systems as follows:

1. Time representation acceleration indicates higher maximum values recorded on vat toward bed plate;
2. Frequency representation of acceleration signals, indicating the occurrence supraharmonic components, a specific phenomenon to this behavior of nonlinear dynamic systems contained;
3. Representations of the power spectral density of acceleration on vat respectively bed plate hammer's, indicating an extended spectral components for the signal strength is significant
4. Coherence functions have multiple frequency ranges, which the two acceleration signals do not correspond, specific phenomenon for nonlinear behavior of viscoelastic systems of passive isolation

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