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THE USING OF COMPUTING TECHNOLOGY IN ACQUISITION AND INTERPRETATION OF MECHANICAL CONSTRUCTION VIBRATIONS

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Abstract

This paper wants to present an instalation to generate mechanical vibrations with variable parameters to treat mechanical constructions. The treatment with such vibrations is ment to equalize the internal tensions. The recording of the parametrs is made with computers trough LabVIEW software.

Keywords

Vibrations, detensioning, virtual instruments

1. INTRODUCTION

This paper wants to present some results obtained by the authors in the field of mechanical constructions tension releaf using vibrations. Are shown elements of system modelling, mathematical system solving, and different recordings of techical parameters measured during treatment with the vibration generation equipment.

2. THEORETICAL APROACH AND MODELLING

Figure 1 shows the main component of the forced vibration generation equipment. The parts of the instalation are: 1 – main body, 2 – DC electric motor, 3 – Rectifier bridge with controlled output voltage, 4 – construction undergoing tension relief, 5 – elastic material.

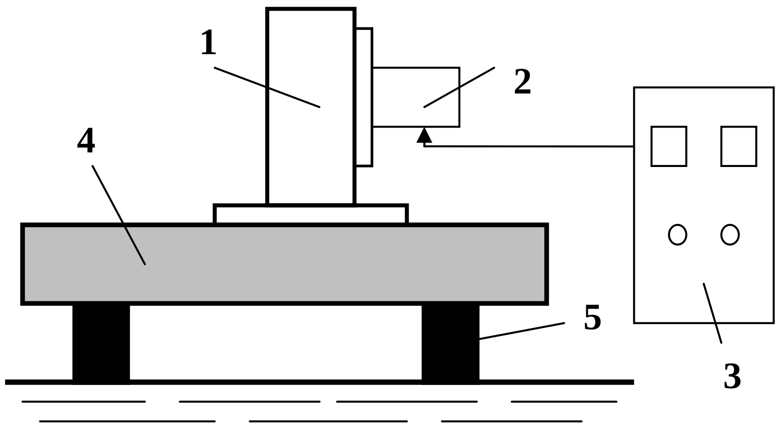

***Figure 1**. View of the instalation*

It has been considered that the vibratory system can be modelled and described by an one freedom degree system similar to the one presented in figure 2.

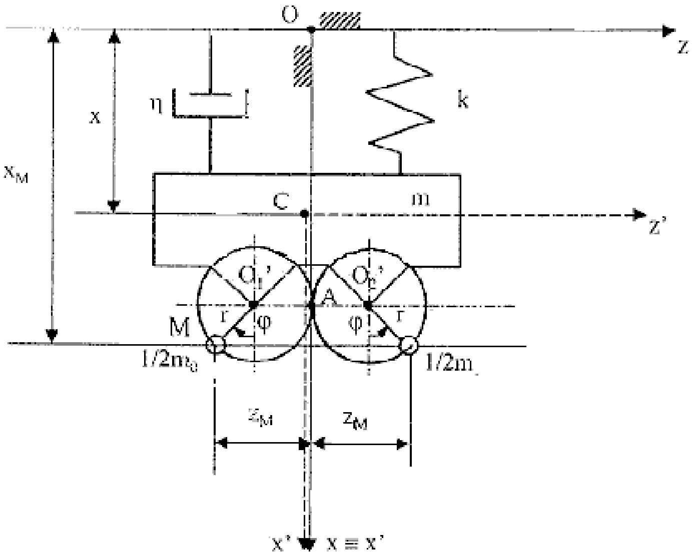

Figure 2. *Phisical model of the vibratory system*

in which m_0 is the mass of the excentric bodys situated at r distance from spinning center, ω is the angular speed of the rotating masses, K id the system elasticity conssidered as constant, ξ is flow coefficient considered nonlinear.

Ozy is an fixed reference point at which is reffered the total mass $m=m_a+m_p$ and the excentrical mass m_0. m_a is the mass of vibratory system and m_p is the mass of the construction undergoing treatment.
O'z'y' is an mobil referential system with axis paralel to the first and the center in O' in the gravity center of the mass m.

Elastic force can be modelled like:

$F(\dot{x}) = b\dot{x}, (b = ct)$ - liniar

$F(\dot{x}) = c\dot{x} + d\dot{x}^3$ - nonliniar (1)

By applying to the system from figure 2 the second degree Lagrange equations, using the coordonetes x and φ it can be obtained the following:

$$\begin{cases} (m+m_0)\dfrac{d^2x}{dt^2} + b\dfrac{dx}{dt} + Kx = \omega_0 r\omega^2\cos(\omega t) \\ -m_0 r\dfrac{d^{2r}}{dt^2}\sin(\omega t) + \omega_0 gr\sin(\omega t) = Q_\varphi \end{cases} \quad (2)$$

For ω=constant, in case of stationary movement, Q_φ represents the generalized force coresponding to the shaft force of the vibratory element .
The solution of the first equation is as follows:

$$x(t) = X\cos(\omega t - \xi) \quad (3)$$

in which

$$X = \frac{\lambda r \omega^2}{\sqrt{(\omega_n^2 - \omega^2)^2 + 4\xi^2\omega^2}} \; ; \; tg\xi = \frac{2\xi\omega}{\omega_n^2\omega^2} \; ; \; \omega_n^2 = \frac{k}{m+m_0}$$

$$\xi = \frac{b}{2(m-m_0)} \; ; \; \lambda = \frac{m_0}{m+m_0} \qquad (4)$$

where: ξ is the amortisment constant, ωn is the self pulsation of the system,
X is the amplitude of the movement and γ is the offset between movement and perturbatory force.

$$F(t) = \omega_0 r \omega^2 \cos(\omega t)$$

Movement resonance is obtained if

$$\frac{d\omega}{dt} = 0 \text{ or } \omega_{rez} = \frac{\omega_n^2}{\sqrt{\omega_n^2 - 2\xi^2}} > \omega_n \qquad (5)$$

in case of resonance the amplitude of the movement is:

$$X_{\max} = \frac{\lambda r \omega_n^2}{2\xi\sqrt{\omega_n^2 - \xi^2}} \qquad (6)$$

The medium power necessary to maintain the oscilations is:

$$P_m = \frac{(m_0 r)^2 \xi}{(m+m_0)} \frac{\omega^6}{(\omega_n^2 - \omega^2) + 4\xi^2\omega^2} \qquad (7)$$

By taking account of the presented model particularities, in course of experimentations it was used the following technique:

- The construction undergoing stress relief im mounted on rubber feet to isolate it from the ground.
- The excentricity of the vibratory mass is in concordance to the mass of the treated object.
- The vibratory equipment is firmly placed on the treatment undergoing construction.

3. EXPERIMENTAL RESULTS

Both the forced vibration generator and the measurement equipment was concieved and phisicaly constructed by the authors. Recordings were made on stres relief tests to mechanical constructions with masses between 600 and 1200 kg.

The data acquisition system used for making the measurement is based on the graphical programming language LabVIEW which make possible the real time aquiring and processing of signals.

The measured parameters are:

- Shaft speed of the electrical motor n [rot/min]
- Electrical motor current I[A]
- Vibtation x [mm]

The tension equalizing procedure was repeated at least 3 times on each object .

The results obtained are shown in figures 3, 4 and 5.

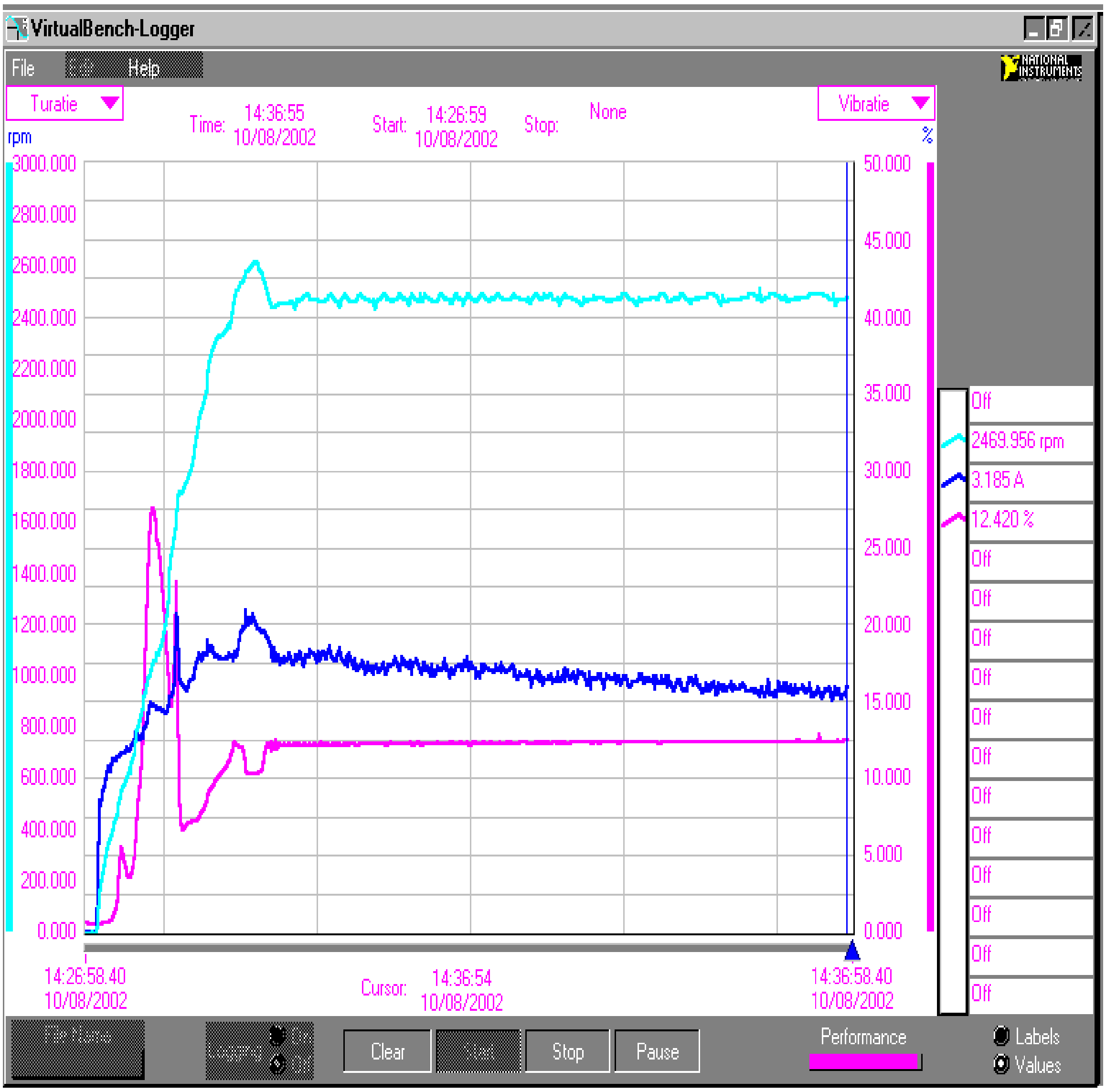

Figure 3. *Recording made at testing a beam.*

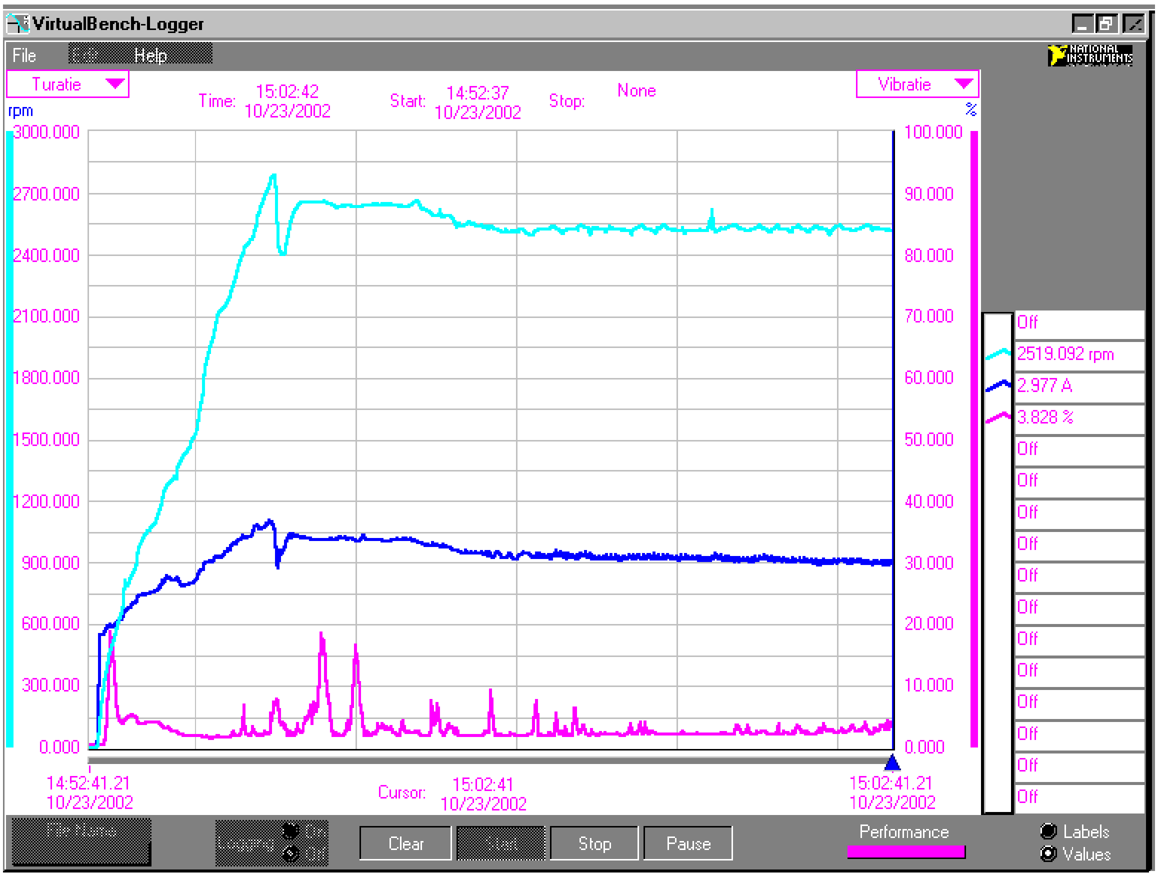

Figure 4. *Parameter recording from a holder.*

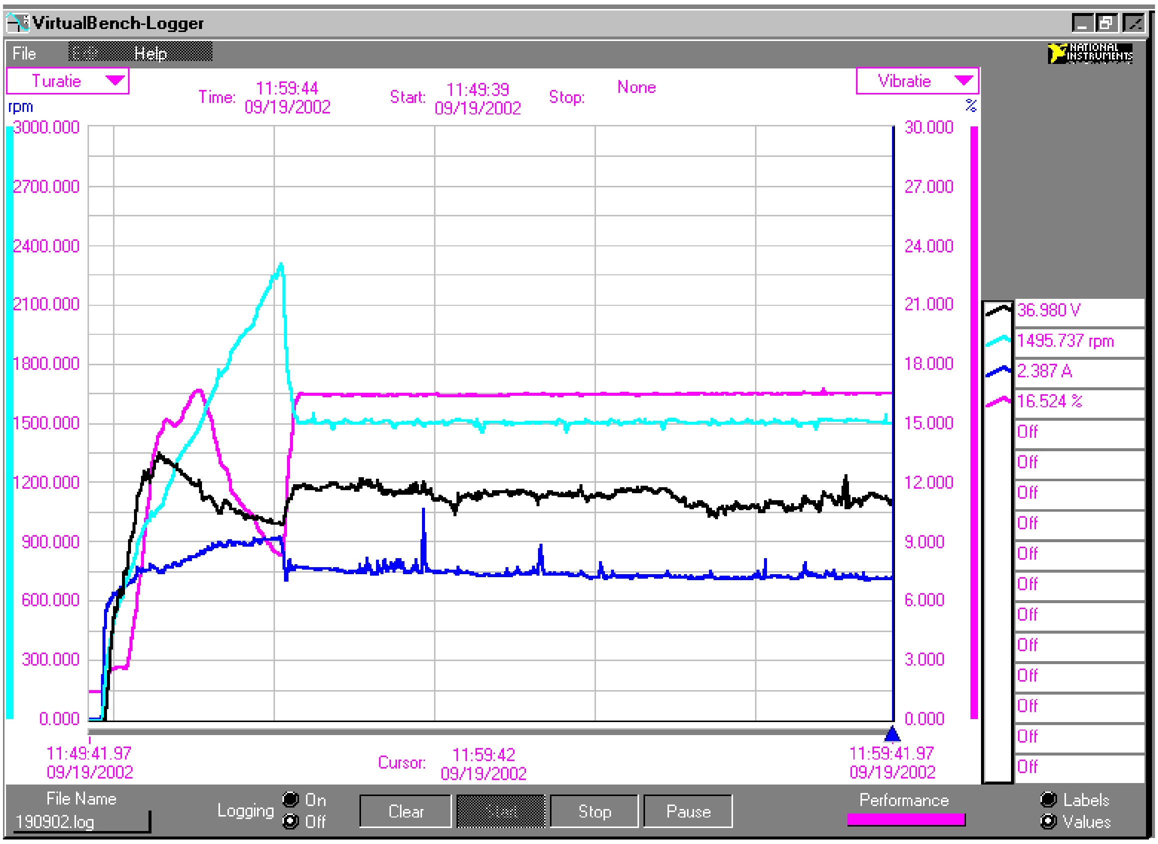

Figure 5. *Stres relief on a welded structure*

4. CONCLUSIONS

The following conclusions were drawn after analizing the experimental results:

- This technique for equalising internal stress is usefull for cast or welded constructions of any sizes.
- The technique is easily applicable if all the necessary equipment is available .
- The method can be used in non-metalical objects.
- The good results obtained can be extended with reaserch about deformation and tension repartition inside the objects

5. REFERENCES

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