Machine foundation monitoring

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Abstract — **This paper presents monitoring results as a consequence of environmental impact to the machinery foundations. These foundations are situated in one of the shops of machinery plant and are used for maintenance of high accuracy measuring equipment. City traffic and equipment operation have an additional dynamic environmental influence on foundation.**

Keywords – structural health monitoring; modal analysis; foundation vibration

I. FOUNDATION DESIGN

Foundations (Fig.1) are made as reinforced concrete casings with wall and bottom thicknesses equal to 250 mm. On the bottom of the casing a sandy compacted bed with 300 mm thickness is made. The foundation body is located on this bed. There is a clearance of 350 mm between the walls of the casing and the foundation itself.

There is a hollow floor round the foundation, which is made from reinforced concrete with 250 mm wall thickness. The top of the foundation is round (d = 2000 mm) with 1500x900 mm rectangular reaming lug. The top of the foundation is 150 mm above the floor level.

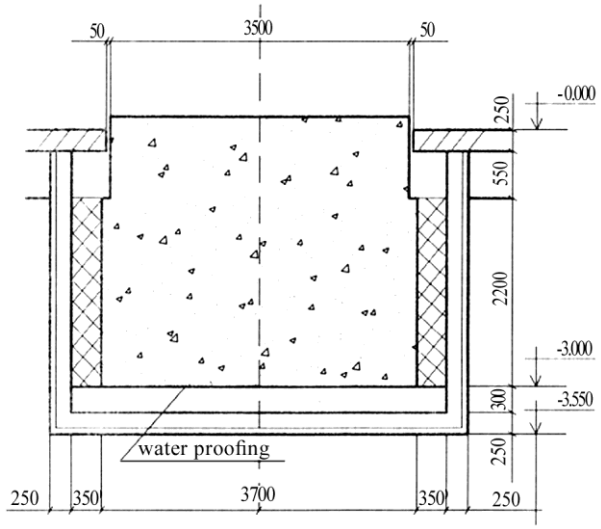

Figure 1. Foundation cross-section

There is a lot of different equipment operating on the premises of this factory. These are: ventilators, pumps, compressors etc. There are also highways with very intensive traffic incl. street railway on both sides of the factory.

II. METHODS

Methods used are presented as a block-diagram in Fig.2.

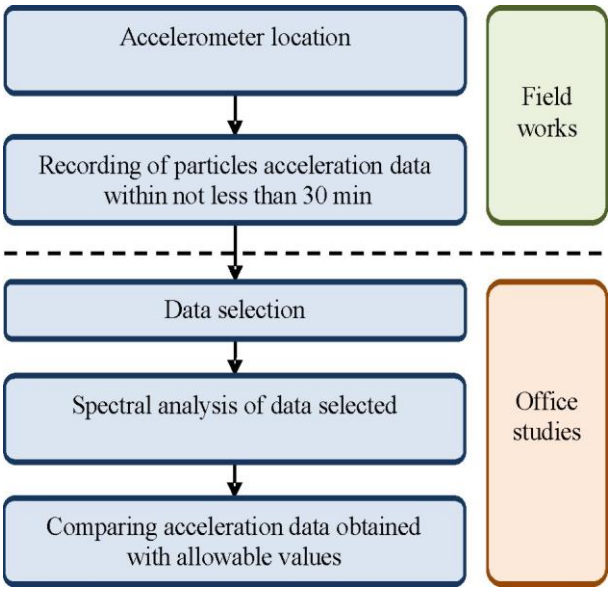

Figure 2. Foundation monitoring block-diagram

Four accelerometers were located on each foundation. RefTek 131-01/1 [1] sensors were fixed with mounting plate, which was fastened to the foundation by means of an anchor bolt. Preliminary this plate was aligned horizontally by means of trimming bolts and an electronic level. The RefTek 131-01/1 sensor was fastened directly to the foundation by means of an anchor bolt.

Signal recording is carried out by a six-channel seismoreceiver RefTek 130-01. Signal recording frequency is 500 Hz. Vibration data recording for each foundation was made within not less than 30min. Results were transferred to a PC on-line.

Vibration level of this site integrates some permanent, alternating or pulsing sources of vibration, which is due to variable or random character of movements. Vibrations were registered by means of three-dimensional measuring in 4 points simultaneously. The foundation acceleration points were obtained while recording. Spectrums were obtained by means of Fourier transform [2].The speed and displacement values were obtained through integration of measured accelerations.

III. MONITORING RESULTS

The peak amplitude of accelerations along the X axis for one of the foundations far exceeds the peak amplitude of accelerations along the Y (Fig.3).

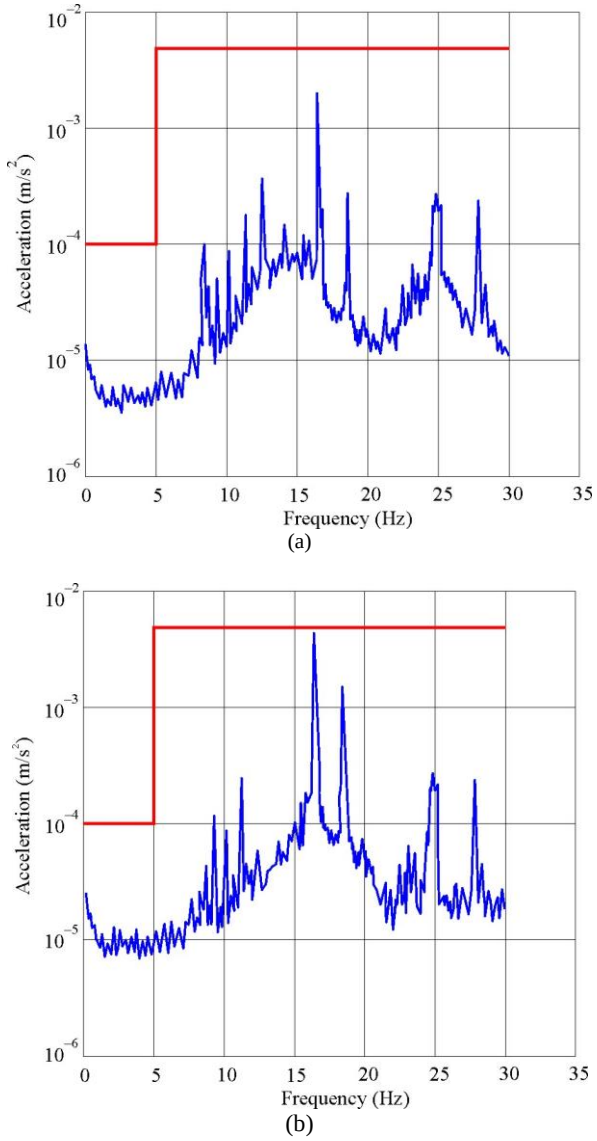

Figure 3. The spektrum of horisontal accelerations of the foundation along the X axis(a) and the Y axis (b).

As a part of this study an assumption was made that this effect is due to resonance frequency, which approximates to 16,67 Hz and which is equivalent to 1000 r/m of an engine frequency. The momentum of inertia of the foundation along the Y axis is higher comparing to the X axis. Due to the given difference of the interia moments the resonance occures only in one direction.

Using ARTeMIS Extractor [3] an experimental modal analysis was made. As a result it was obtained that the natural vibration frequency of the foundation along the Y axis is 16,44 Hz and along the X axis is 10,87Hz (Fig.4). The results obtained proved the assuption concerning the factor which effects the pulse-spike of the amplitude at the frequency of nearly 16,67 Hz.

Due to the fact, that this factory is situated within the city, it is not possible to eliminate some level of environmental vibration. The permanent sources causing vibrations are motors, pumps and other operating equipment of this factory and nearby objects. Alternating vibrations occur because of transient sources such as city and factory traffic.

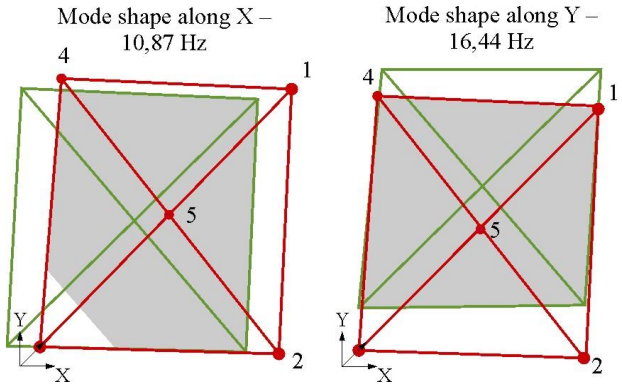

Figure 4. Foundation vibration mode

Over the whole period of measurements some amplitude pulse-spikes in one of the measuring points at the frequency of 16,67 Hz and 25 Hz were registered. However, when a transfer trolley was rolled through the tunnel of this site, for a period of some tenths of a second some pulse-spikes were registered at the frequencies, at which they were not mentioned ever before. Moreover the pulse-strike amplitude fixed commeasures to the vibration mode of permanent sources.

Thus, even though over the main period of time the parameters of foundation vibrations are within permitted values, for some short periods the foundation can experience action causing some excess of the loads permitted. It can lead to the situation when functioning properly equipment being adjusted on these premises can be wrongly rejected. A stationary monitoring system of foundation vibrations was applied to eliminate such situations. In case of the excess of the loads permitted while adjusting the equipment this system can give an alarm message.

REFERENCES

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[2] Oppenheim, R. W. Schafer, J. R. Buck, "Discrete-time signal processing". Prentice Hall, 1999.

[3] http://www.svibs.com/.