Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7276

DEVELOPMENT OF A STRUCTURE VIBRATIONS MONITORING INSTRUMENT USING TRIAXIAL ACCELEROMETER

J.G.S. de Jesus[1(*)], M. S. Vieira[1], T.L. Santos[1], R.S. Gonçalves[2]
[1]Department of Electrical and Electronics (DEE), Instituto Federal do Maranhão, São Luís, Brazil
[2]Department of Mechanics and Materials, Instituto Federal do Maranhão, São Luís, Brazil
[(*)]*Email:* teslaguto@gmail.com

ABSTRACT

Civil construction is an activity that produces a high proportion of noise and vibrations. This occurs through several different processes, such as the passage of trucks and heavy machinery; pile drivers; impact due to chipping, drilling processes, explosions and debris removal; percussive processes and stacking. Such vibrations, induced in constructions at their sites, for example, can cause severe damage to the structure of the construction in question. Depending on some physical parameters of the wave (such as amplitude, frequency and duration time) the structure can suffer material fatigue or even collapse. This paper aims the creation of a vibration monitoring instrument for structures using, as the main sensor, the triaxial accelerometer. This sensor performs, in real time, the acceleration reading printed on the three spatial axes. It is coupled to a microcontroller/microprocessor, which is responsible for interpreting and processing the data read by the accelerometer, applying the Fast Fourier Transform to measure the frequency levels inherent to the wave recorded in the time domain. In addition, the measured frequency values are afterward compared with the values described in national and international technical regulations that standardize limit values that guarantee the integrity of the construction.

Keywords: accelerometer, structure, instrument, vibrations.

INTRODUCTION

Some national and international standards define critical values of frequency that a given structure can suffer without structural damage and that preserve the comfort of its users. For example, NBR 6118 of the Brazilian Association of Technical Standards defines some frequencies considered critical for certain types of physical structures. The Switzerland standard SN 640312 defines a more specific classification of the structures as well as their frequencies and critical transversal velocities of wave.

The practical methodology consisted of to disturb the accelerometer sensor so as to impart accelerated movement in the same. By means of a microcontroller, the data measured by the accelerometer is processed and interpreted. As a result, we have a data matrix that expresses acceleration values, in g or m/s2 as a function of time.

The sensor in use in this development is the ADXL345 which features interesting features such as low power consumption (30 to 140 μA), range up to ± 16 g and a data output rate and 3.2 kHz band, ensuring reasonable performance for initial testing. Already the microcontroller used was the ATmega 2560 linked on the Arduino platform. All code that interprets the data provided by the ADXL345 has been programmed in C language on the previously mentioned platform.

RESULTS AND CONCLUSIONS

The prototype in question was subjected to vibrations in an industrial environment, with great activity of vibrating machines such as mechanical lathes, bench drills and hydraulic cranes. The structure of the site consists, in its predominance, of reinforced concrete and steel studs characterized as a Class I structure of the standard SN 640312. The experiment consisted in coupling the prototype (in ground) at the base of a bench drill. The drill has nominal power of 1 HP operating at 380 V. The pulley configuration used generated a 155 RPM mandrel rotation (lower rotation). The simulation had duration of 17.81 seconds and the size of the data matrix was of the order 3563x3. Figures 1 and 2 illustrate the time signal and the frequency spectrum, respectively. When analyzing the graphs, it is noticed that the amplitudes of the frequencies acting in the ground are not so high as to offer risk to the structure in question. However, it is worth mentioning that in the developed experiments critical frequencies occurred, since the place where they were performed is classified as being a type I structure, in accordance with the regulatory norms already mentioned.

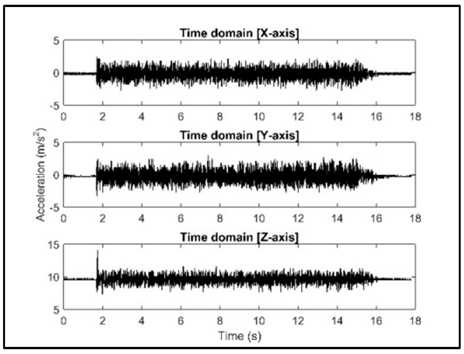

Fig. 1 - Recording of ground vibrations caused by the bench drill at a rotation of 155 RPM

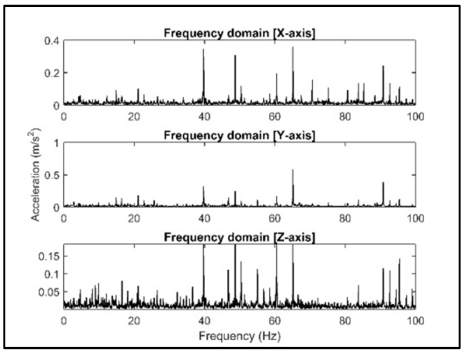

Fig. 2 -Frequency spectrum acting on the ground in the presence of a disturbance caused by the bench drill at 155 RPM

The preliminary results of tests carried out with the prototype of tests were shown to be feasible as to the primary purpose of this development. Initially, the results showed a completely acceptable acuity considering the value, the quality of the sensor used and the microcontroller chip used to perform the interpretation of the measured data. Due to the low computational load of the chip used the simultaneous operations (monitoring, storage, treatment and transmission in real time of the data) are compromised, thus needing the use of a chip with the ARM architecture (Advanced RISC Machine) which is a 32-bit processor used primarily in embedded systems.

It is also intended to treat the noise (in a deeper way) present in the measurements, since this interference can influence directly in the results. In addition, by achieving all the optimum performance parameters, the construction of a vibration measurement instrument is built on the basis of the accuracy of the results and the low cost, democratizing access to this instrumentation tool.

ACKNOWLEDGMENTS

The authors are grateful for the encouragement of the Instituto Federal do Maranhão which corroborated with the development of this work.

REFERENCES

[1] Devices, A. (2010). ADXL345 datasheet. USA: Analog Devices.

[2] NBR, A. (2014). 6118: Projeto de Estruturas de Concreto. Rio de Janeiro.