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THE EIGENFREQUENCIES OF A REAL STRUCTURE EXCITED BY AN INTERNAL NOISE

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ABSTRACT

This research work attempts to present an experimental study on the structure of the former laboratory of vibration and structural dynamics in the technological hall that belong to Bechar University. This study tries to determinate the real behavior of this structure. The structure is exited by background noise generated by a vibrating table compacting concrete, placed inside the laboratory, after we simulate this noise with an electrodynamics shaker. The response of the structure was captured by a tri-axial accelerometer. The experimental results are presented under an auto spectrum, for determining the eigenfrequencies of the structure, this values are compared with those obtund from a numerical simulation bases on the finite elements method.

Keywords: Vibration, Background noise, Dynamic, Excitation, Tri-axial accelerometer, Eigen frequency.

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Contribution/ Originality

This study contributes to the determination of the real behavior of a structure, the background noise is used as excitation (real noise). So it has several advantages those conventional excitations, such as:

- The experimental time is reduced
- The absence of excitation material
- The cost of the measures is very low compared to other solicitations

1. INTRODUCTION

The background noise is a series of vibrations due to industrial machinery, human activities, wind, traffic ... etc… Frequencies of background noise belong to a domain that does not exceed 100 Hz and can set a limit average 1Hz as the "border" between natural and anthropogenic noise

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[1]; [2].

This solicitation requires no hardware means. If we compare with the various stresses, such as measurements in shock, there are several advantages, among which are:

- The experimental time is reduced
- The absence of excitation material,
- The cost of the measures is very low compared to other solicitations.

Background noise contains all frequencies likely to excite the structures, so a single measurement is sufficient to obtain a complete response. Accelerations produced are of the order of 10^{-5}g, while the exciter produces harmonic accelerations of the order of 10^{-3}g and shocks generate accelerations of the order of 10^{-2}g (g is the acceleration of gravity).Our aim is to study experimentally the influence of background noise of machines installed inside the laboratory on the behavior of the structure [3].

2. EXPERIMENTAL PART

The laboratory is a part of the large steel structure (Fig.1), with an area of (5x8) m^2 consisting of six (06) poles type HEA240 and five (05) beams type IPE270. We chose the middle pole of the wall which separates the laboratory from outside, to implement the media used tri-axial accelerometer (Fig.2) [4]; [5].

Fig-1. The structure of technological hall

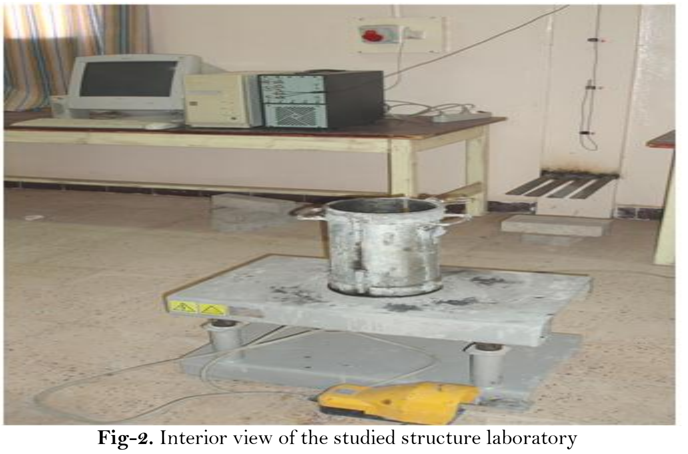

Fig-2. Interior view of the studied structure laboratory

To the study and analysis of the dynamic behavior of our structure, we used the equipment the firm Brüel&Kjær (Fig.3 and 4) [6]; [7]:

- A three-way accelerometer (tri-axial) type 4506;
- A multi-channel analyzer type 2825.

Fig-3. Tri-axial accelerometer type 4506

Fig-4. Multi-channel analyzer type 2825

Our experimental test is based on the excitation of the structure, using the vibrating table for compacting concrete specimens, placed inside the laboratory. The response of the structure is measured by a tri-axial accelerometer, and it is analyzed and processed in an acquisition channel, called multi-channel analyzer. The values obtund from a numerical simulation has allowed us to have eigenfrequencies of the structure, and compare them with those deduced from the graphs resulting from the analyzer.

3. RESULTS AND DISCUSSION

To deduce the eigenfrequencies of our structure, we will use a representation in the auto-spectrum form; witch is a representation of the amplitude as a displacement, velocity or acceleration as a function of frequency. This representation is marked by peaks that correspond to the natural frequencies of the structure studied [8]; [9].

Fig. 5, 6 and 7 are auto-spectrum of the response of the structure in the three directions x, y and z. The peaks of these curves represent the eigenfrequencies Castel, et al. [10]; Cawley and Adams [11] and Elmir, et al. [12]. The eigenfrequencies and eigenmode are shown in TAB I.

We limited our study the first six modes that correspond to the frequencies that belong to the domain of the background noise Michele and Antonino [13]; Quang Thanh, et al. [14] and Thyagarajan, et al. [15]. From the results found, the motion of the structure is either flexure modes along the axis of x (mode 1 and 6) or torsional modes around the y axis (the other modes).

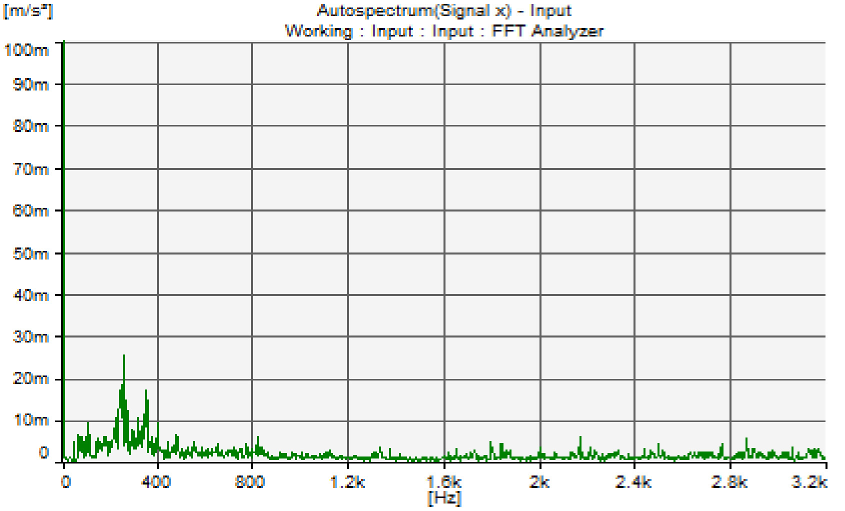

Fig-5. Auto-spectrum along x direction

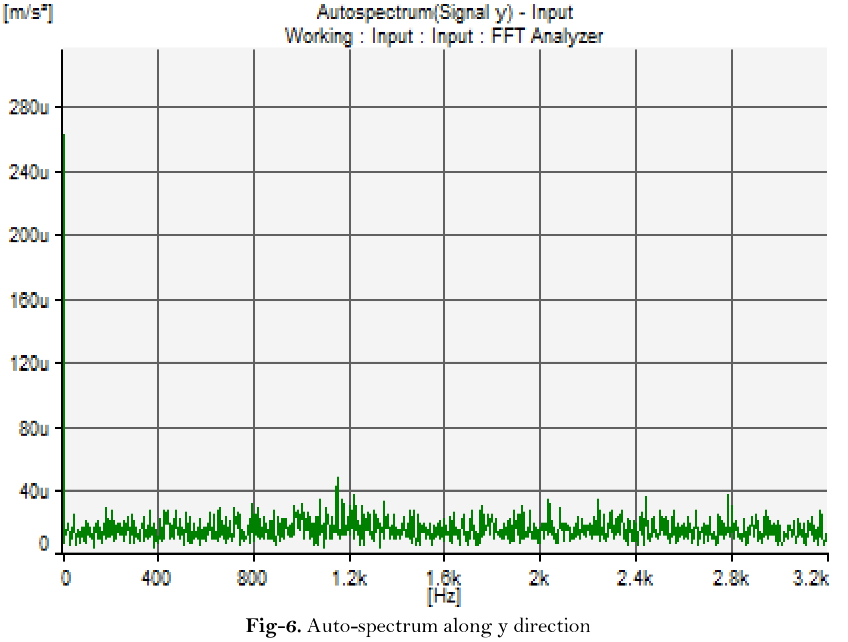

Fig-6. Auto-spectrum along y direction

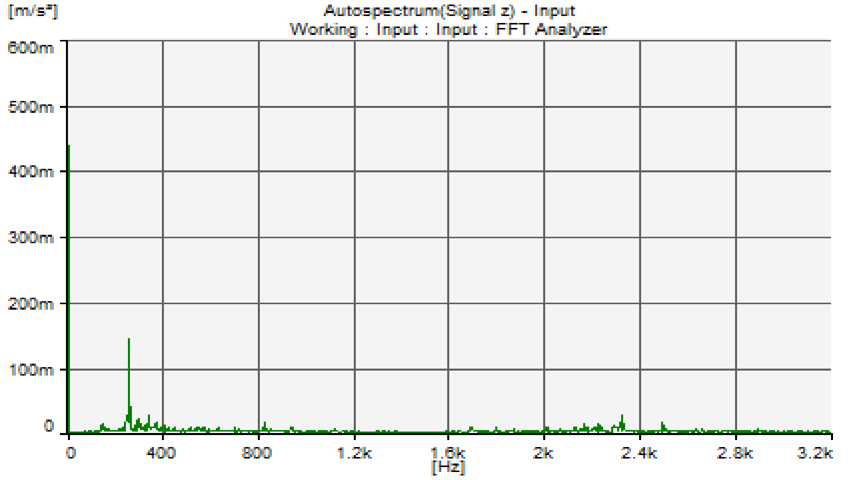

Fig-7. Auto-spectrum along z direction

Table-1. Eigenmodes, Eigenfrequencies and Damping Factor of the Structure

Mode	1	2	3	4	5	6
Along x	22	46	64	75	94	108
Along y						
Along z		46	68	76	94	
Damping factor	1.62	1.90	1.10	0.56	0.60	0.86

According to the results (TAB.1), the values of damping factors of the structure belong to a range of [0.6, 2] %. For low frequencies damping factors are in the order of 2% [16].

4. NUMERICAL SIMULATION

To compare the experimental results and found it was a study by numerical simulation which is based on the finite element method.

The Fig. 8, 9 and 10 represent the first three eigenmodes found by numerical simulation.

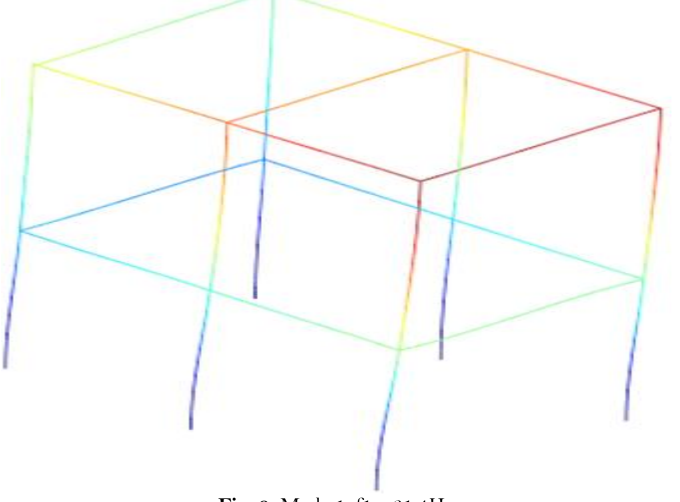

Fig-8. Mode 1: f1 =21.4Hz

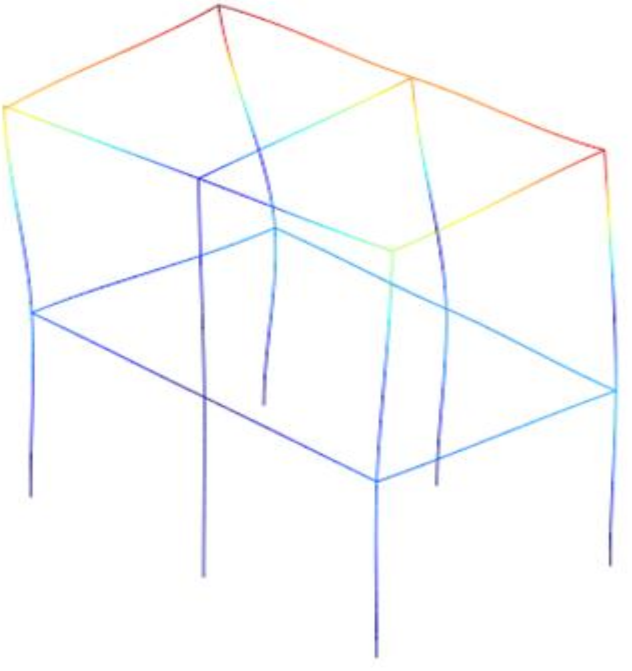

Fig-9. Mode 2: f2 =45.1Hz

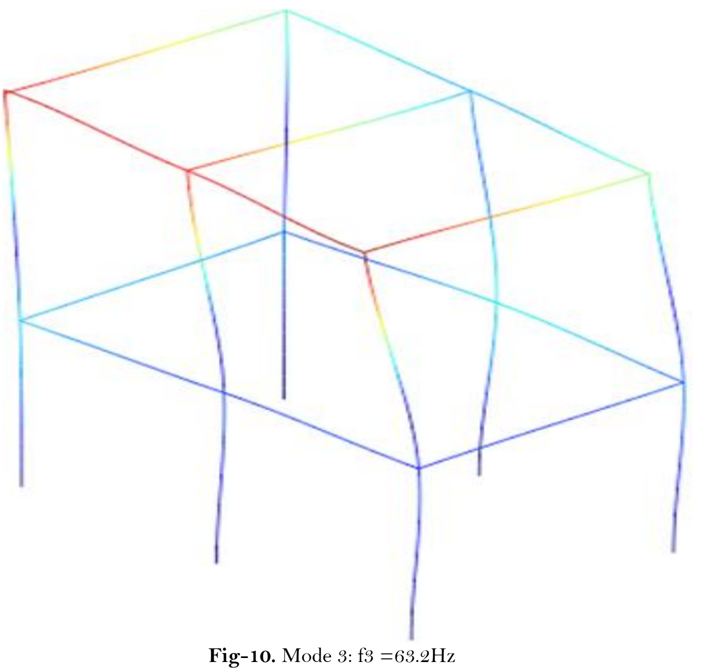

Fig-10. Mode 3: f3 =63.2Hz

The TAB II summarizes the values of the eigenfrequencies of the structure deduced experimentally and those of the numerical simulation.

Table-2. Results Comparison

Mode	1	2	3	4	5	6
fexp	22	46	64	74	94	109
fsim	21.4	45.1	63.2	76.6	92.5	109
Relative error (%)	2.8	2.0	1.3	1.9	1.6	0.9

We note that these results are in good agreement which confirms the experimental results.

5. CONCLUSION

This excitation method has shown that the structure studied from steel structure, have not vertical movement when it is excited by a background noise of the machines or human activities inside this structure.

The numerical simulation showed and confirmed the experimental results. Eigenmodes expressed experimentally and numerically are very close with a relative uncertainty of about 3%.

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Competing Interests: The authors declare that they have no competing interests.

Contributors/Acknowledgement: All authors contributed equally to the conception and design of the study.

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