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The Diference of Wall Elements State Including the Frf Function

Ph.D.Mariusz ZOLTOWSKI
University of Technology and Life Sciences in Bydgoszcz

Abstract: *The recommendation of Polish PN - B-03002norm shows a need of quality control of wallelements production, and classified them as elements of* category I or II. *This classificationis decided in institution of quality control which should provide straight lines diagnostic tools.*

Requirement of this norm establishing the partial coefficients of wall safety, of wall treats to settlement the category of works realization on building site (A or B). They would support qualification " suitably qualified person controls" straight lines diagnostic methods indispensable the searches of new methods of opinion.

It recognize the need of improvement the methods of investigation of wall building quality, and construction. In that article we considerate to test wall elements using the modal analysis and the delimitation of passage function FRF.

Key words: *the modal analysis, function of passage the FRF, temporary course of trembling's.*

I. Introduction

Existing constructions, such as: buildings, high poles, chimneys, foundations under machines, and roofs are subject to the environment and to trembling processes as well. The dynamics caused by wind, earthquakes, machines work, railway and road movement, explosions, and sea waves are important in the process of projecting constructions and influence safety and durability.Tremblingin buildings decreases comfort of living, can have aninfluence onpeopleworking there, and can also threaten the safety level of the construction. The trembling can cause dynamic burden andeven catastrophic destruction.

The previously mentionedrecognizes the need of improving themethods for investigatingthe quality of wall building constructions, their diagnostic and the assessment of wall safety coefficients (PN - B-03002).The test used to determine the level of destruction of chosen materials was theexperimental modal analysis and the concurrent procedure of this method - the trembling's estimators.

The new tools in this area of investigations concern the possibility of usingmodal analysis methods, and also modern logging and the processing of trembling to opinion the quality of wall elements. Practically it can be used for better understanding thebehavior of constructions, which allows optimizing the projection and assessment of dangerous states.

Modal analysis has not been previously used for researches on buildings and constructions, but was adopted from the dynamics area of mechanical engineering. Itsusefulness is greater for homogeneous structures of steel constructions, than for building materials such as wall elements, where every result of investigation is connected with the structure, the shape and the physical state of the sample. The fear is that the inhomogeneity and the coarse-grained structure of concrete and ceramics can be an obstacle for effectiveness of the measuring technique.

The task of this study is to checkthe usefulness of modal analysis in diagnosing homogeneous wall elements (bricks, notepads, and hollow blocks), as well as more heterogeneous walls fragments. The objective is to determine if the investigation parameters are useful in making a state diagnostic of the studied materials.

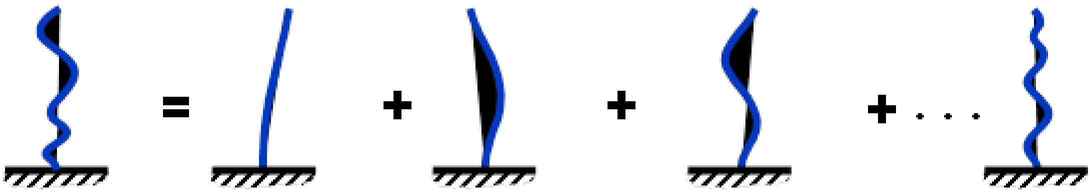
To do this the experimental modal analysismethod and the signal function (FRF Function) of passage were used, with which it was able to see differences in the states of wall elements. The function is the relation between the input and output of strength signals

II. Environment of experimental modal analysis

The modal analysis is applied to the investigation of dynamic properties of varied constructions universally. In the diagnostics of construction state, the modal analysis can be applied to the modification of construction for aims of synthesizing the steering in arrangements of active reduction of trembling, as well as for aims of verifying and validating of numeric models

Modal analysis can be applied if the following conditions are fulfilled:
-arrangement is linear and its dynamics can be described as a linear arrangement of differential ordinary equations or partial;
-thecoefficients of equations describing the dynamics of object are solid in the time of measurements;
-Existing possibility of performing measurements in all direction in order to identify the model;
-Thestudied arrangement fulfills the Maxwell'sreciprocityprinciple;
-suppression in arrangement is small or proportional.

The possibility of using this method is determined by a limited number of liberty degrees because it is an important limitation for the application of the modal analysis.



Outline.1. Schedule of trembling straight lines [11]

Mathematicallyit can be defined as an unharnessed differential ordinary equations task, describing dynamics construction.

Theoretical modal analysis is defined as an own problem of matrix observation dependent from matrix of masses, stiffness and suppression. The theoretical modal analysis requires received a structural model study of the construction and the solution of own questions. Appointed here are the gatherings of own frequencies, suppressioncoefficients of own frequencies and figures of own trembling, which allow to makebehavior simulations of the construction near any extortions. This was used in the projecting process, when there is no possibility of realizing investigations on objects.

Experimental modal analysis is one with technicalidentification of parameters in modal constructions. Experimental modal analysis is applied in practice as aninvestigation technique on property objects, both on stage constructing and exploitation. The identification of the object statein experimental modal analysis depends on extortion of the trembling, coming mostly from the phantom of acceleration. The modal model can be read from the stabilization diagram which presents accords that can be used to animate the trembling figure.

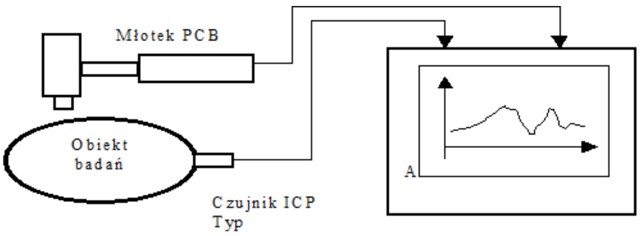
Exploitational modal analysiscan beused to identifyobjects with large spatial sizes and masses.It is all about measurements the answer in extortion point being a result of working external strengths.

The diagnostic of destruction states of materials and building constructions is present more and more often in modal models. The objective of the method is to identify the changes of model parameters (on the case of modal model) It is sends with idea of this method that changes of model parameters (in this case of modal model), coming into being a result of waste, on basis of current observations of object. Modal model in method creates object without damage, as pattern, and modal model in time of exploitation was identified then and it studies from model his correlation for undamaged object.

Experimental modal analysis

The experimental analysis process of modal building construction and wall elements can be divided infive basic stages:
- The preparation of measurements;
- Acquisitionof measurements (assembling) and processing signals;
- The estimation of parameters of the modal model;
- The verification and the validation of model; and
- The use of the model to simulate or the investigate the properties of construction elements.

The identification experiment in experimental modal analysis depends on extortion the trembling's near simultaneous measurement, of strength the object extorting and the answer of arrangement, the most often in figure of amplitude the accelerations of trembling's.



Outline.2. Investigation in experimental modal analysis [4]

III. Experiment in modal analysis

The experiment for identifying the destruction state of the studied wall elements is the basic source of information - and on its basis the value of measures and the structure of the model can beestablished. The quality of the received model depends on one side of the quality of the results of experimental investigations, and on the other side of the structure of the identified model. The modal analysis experiment can be divided in the following stages:

1. Planning:
- The choice of way of extorting trembling on the studied elements and the points of application,
- The choice of points of for measuring the trembling and the measuring apparatus,
- The choice of suitable measuring equipment,
- The choice of themodelingarrangement (the limitation of number of degrees liberty).

2. Calibration of the measuring track.
3. Acquisition and processing of the results.

The studied wall element showsthe trembling force of signal extortion proportional to state of the destruction. The signal of extortion and the answer was used for further delimitation of the FRF function and the stabilization diagram.

The equipment necessary for the execution of the experiment of modal analysis consists of the following elements:

- the arrangement for measuring the extortion of movement and the answer,
- the arrangement of signals (the preliminary processing),
- the arrangement for processing and assembling the signals,
- the arrangement for generating the extorting signal, and
- the arrangement for arousing the trembling

The use of signals analyzer is the simplest machine with regard on service solution, however the most modern and gives the largest possibilities of specialized measuring interface on the working station. The basic operation that can be done by the signals analyzer is the regular analogue-digital processing, which makes possible applying digital technology in processing the modal analysis signals.

In modal investigations it is indifferent which of kinematic sizes of movement are being measured. In practice however the measurements of dislocation are shown in a low frequencies range, and acceleration in a high frequencies range. It is universally known that the measurements of speed are the most optimum in investigations for dynamics of construction with regard on the effective value of tremblingspeed, obtained by measuring the kinetic energy of tremblingarrangements. However sensors that measure dislocations and speeds are comparatively heavy in relation to the studied materials and they can influence their behavior.

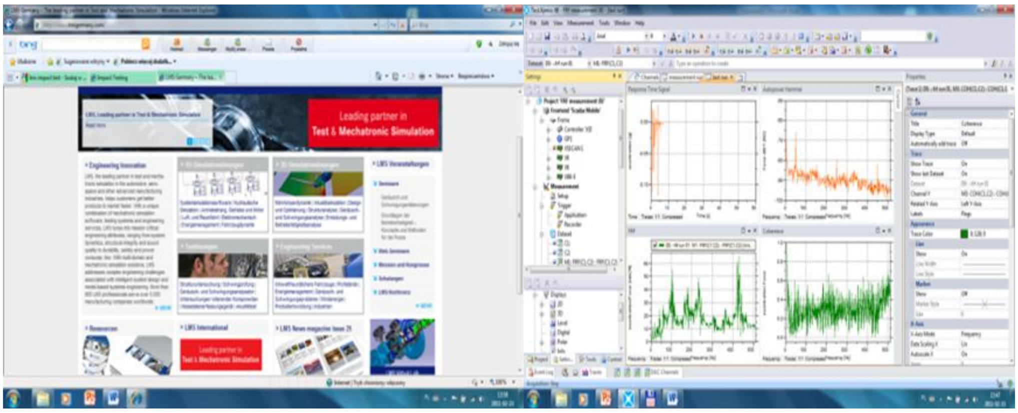
The sensors that measure accelerations have considerably smaller mass and therefore do not influencethe movement of the arrangement. The additional advantage of sensor use is the fact that they receive integrated acceleration signals of speed and tremblingdislocation. The backwards operation depends on differentiating trembling, which can lead to large mistakes particularly in range of higher frequencies. With this regard the sensors have their own resonance, which limits the frequency in which they can be applied.

The selection of the place for fastening the sensor is very important as it has influence on results of modal investigations. Sensors should be fixed in such way that they will not influence the trembling of arrangements; as well they should be fixed in characteristic places of the construction.

The experimental modal analysis requires precise laboratory conditions for the execution of investigations. Model must be subjected from mountain well-known and put extortions. Extortions can run away from these, which they act on object in time of normal exploitation. During experiment realization we can encounter the difficultybehavior peaceable with reality of shore conditions: fastening studied object. In the case of large models the realization of this experiment is very expensive.

IV. Measuring Software

To measurements of temporary courses of the extortion and the answer, also the qualification of FRF and COH functionthe most modern measuring apparatus, named LMS TEST.XPRESS, was used. This software makes possible in easy way to conduct the modal analysis of wall elements and many different building constructions.



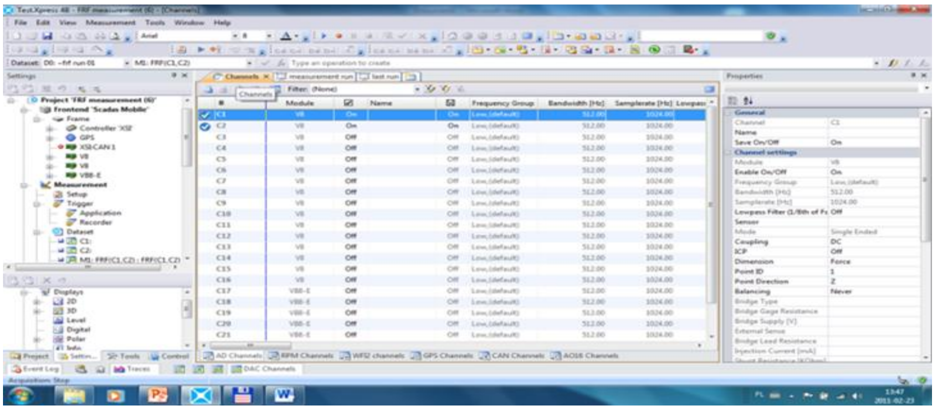
Outline.4. Internet Shop window of manufacturer of software [www.ects.pl.]

The program possesses an easy and friendly user interface. After the program is started a new project must be created by clicking on the new projecticon. From this moment all measurements will be automatically recorded in the active project.

Defining all the necessary data for the calibration of the measuring track is the next step. Then, for the investigations to be conducted at this stage the quantity of active measuring channels must be defined. The number of channels depends on the measuring card and the number of slots it contains.

Outline.5. Example measuring segment[http://www.ects.pl]

For the measurement of temporary courses of strength two channels should be used. First calibrate the modal hammer (strength imput), and second the output of trembling accelerations (signal passage through element). With measurements obtained from this channel calibration allows developing the FRF function.



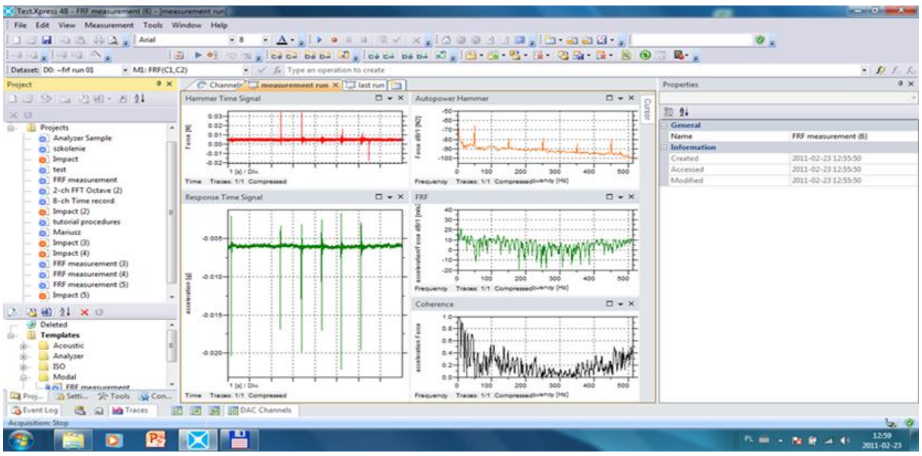
Outline. 6. Calibration of place of connecting the sensors **-** the own study

The calibration window that is shown in Outline 6 shows all the sensors that can be used to make the measurements, from which two have to be selected: C1 and C2. This Window opens after clicking on **channels**. On the right, the characteristic values are shown for each selected sensor. After the sensors have been calibrated and connected, then the investigation can proceed to performing the measurements by clicking on the record icon.

This article shows that using the LMS program it is possible to make measurements FRF function in wall elements and to obtain a graphic visualization of the FRF function. The measurements were made for different kind of materials in all directions.

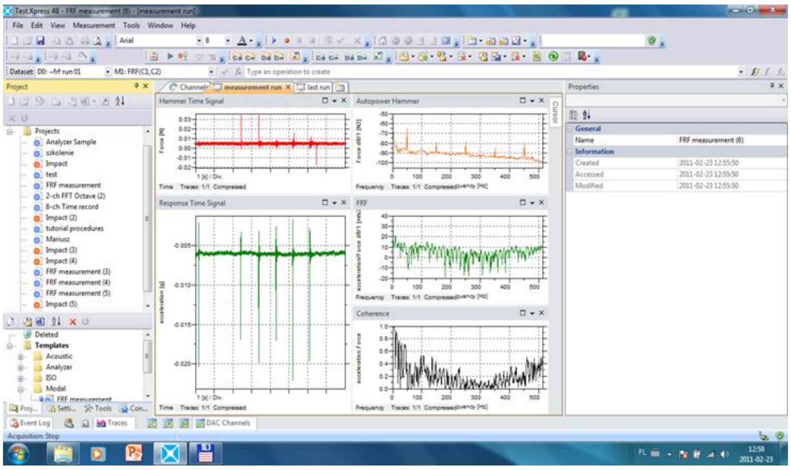
V. Results

The results are presented in real time in thecenter of screen for the time range of measurements. by all the time of leadership of investigation. The screen allows visualizing the temporary courses of extortions and the answer, as well as the function the FRF and the function of coherence.



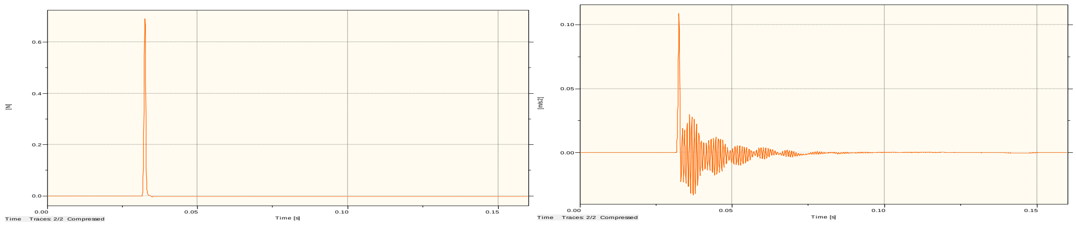
Outline.7. Example exposition of results of measurement **-** the own study

From a large group of materials, a fit and a damaged brick were selected to compare their fitness. Outline 8 shows the results obtained after performing measurements from three possible directions: X, Y, Z.

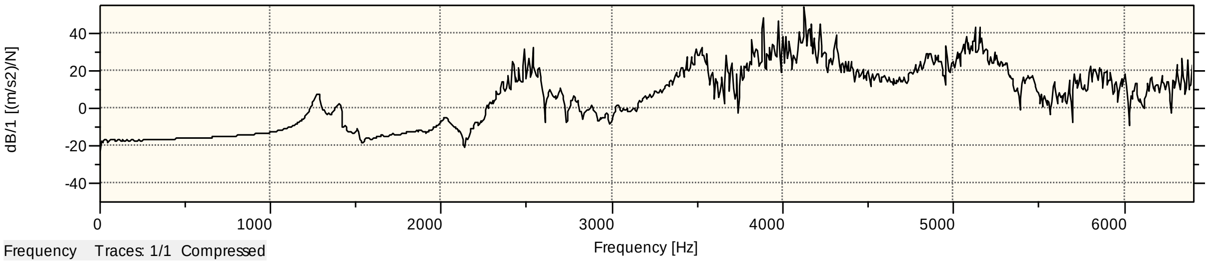


Outline.8. Example exposition of results of measurement - the own study

For a better visualization of the results of the investigation, the results are shown below separately for all axles. Every axle includes the graphic interpretation of input and output trembling signals and the FRF function that results from the extortion and answer frequencies.

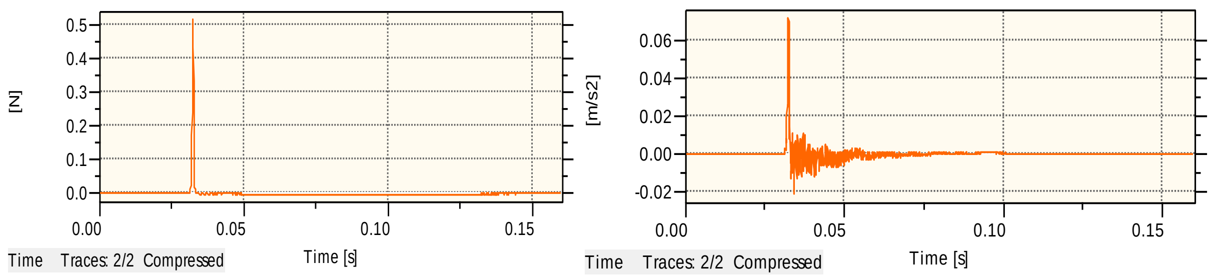


extortion answer

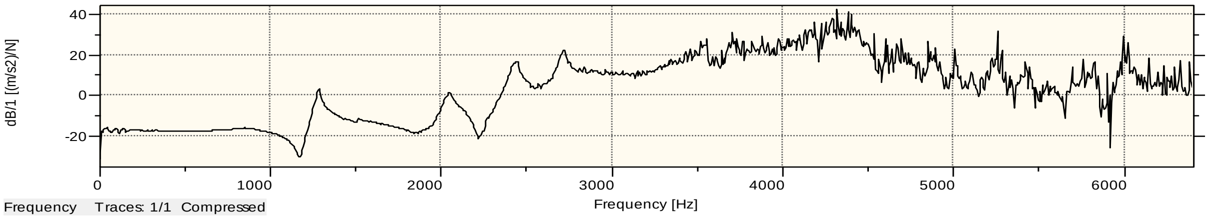


FRF

Outline.9. Composition of results of measurements (the temporary course of extortion, temporary course of answer, function the FRF) the full brick in axis X

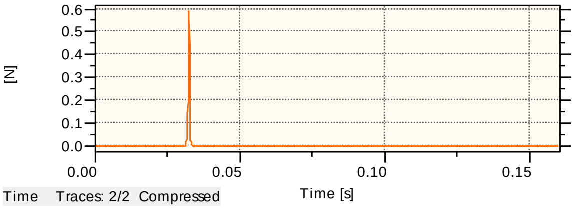


extortion answer

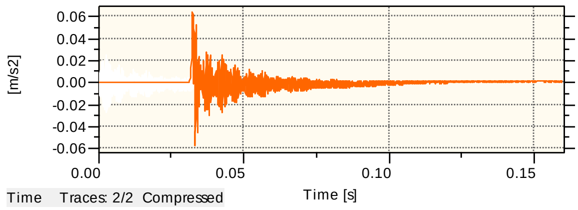


FRF

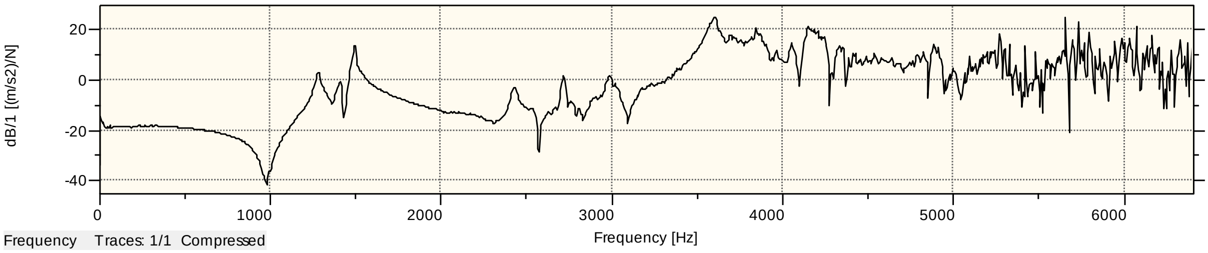
Outline.10. Composition of results of measurements (the temporary course of extortion, temporary course of answer, function the FRF) the damaged full brick in axis X



extortion

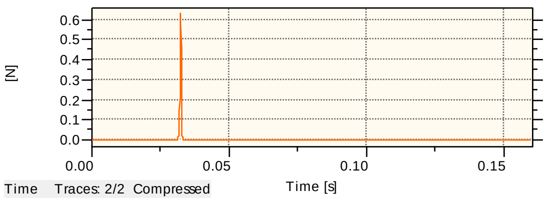


answer

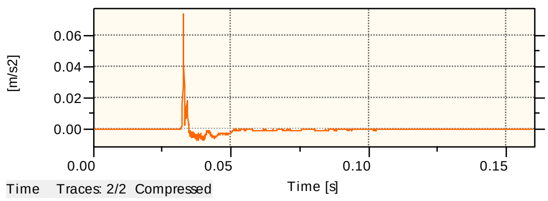


FRF

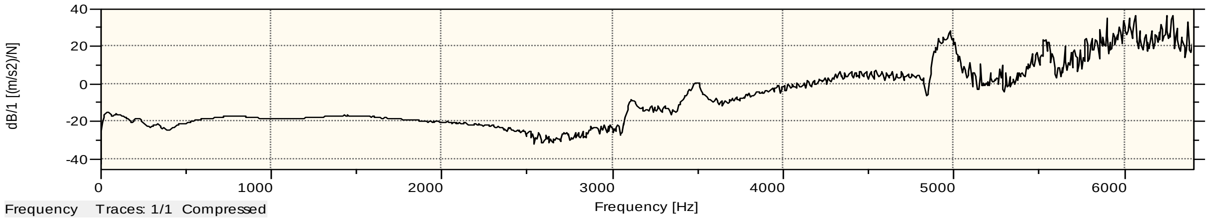
Outline.11. Composition of results of measurements (the temporary course of extortion, temporary course of answer, function the FRF) the full brick in axis Y



extortion

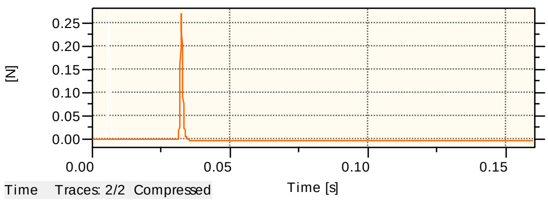


answer

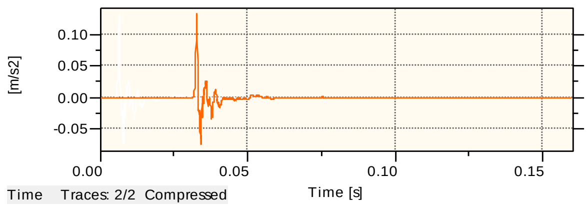


FRF

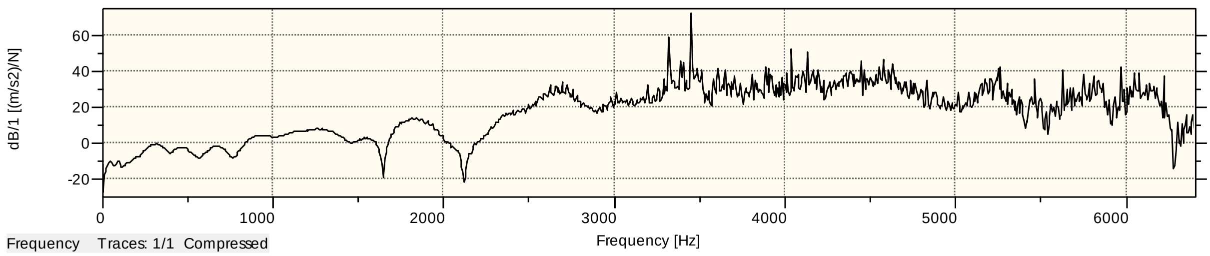
Outline.12. Composition of results of measurements (the temporary course of extortion, temporary course of answer, function the FRF) the damaged full brick in axis Y.



extortion

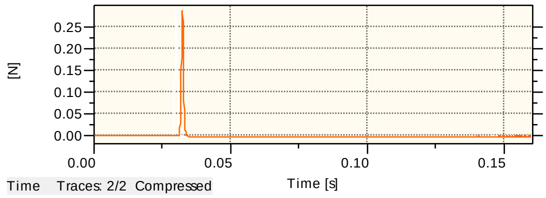


answer

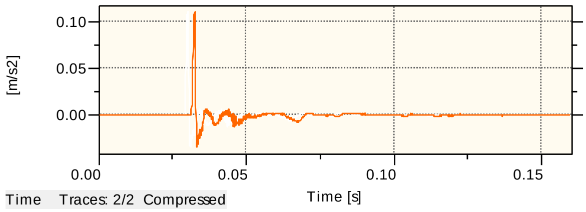


FRF

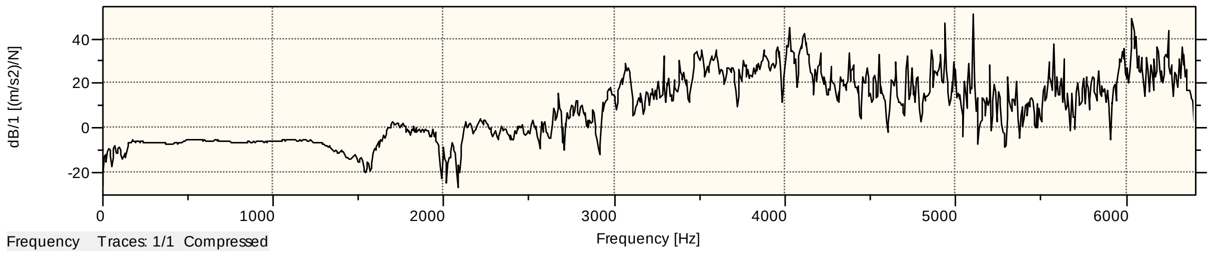
Outline.13. Composition of results of measurements (the temporary course of extortion, temporary course of answer, function the FRF) the full brick in axis Z.



extortion



answer



FRF

Outline.13. Composition of results of measurements (the temporary course of extortion, temporary course of answer, function the FRF) the full brick in axis Z.

VI. Summary

The introduced results show the fact that the difference between good and bad materials can be observed from the quality of the FRF function generated through the passage of the signal from input to output. The change on the state of the studied construction materials can be reflected in the change of the value and the character of course ofthe FRF function. Therefore, the possibility exists of distinguishing the property of material constructions by using the experimental modal analysis. The performed identification investigations confirmed the usefulness of the LMS apparatus for investigations of constructional elements, what should be continued.

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