# Experimental And Theoretical Modal Analysis Of Three Support Rotor Test Rig Using LMS CADA-X and ABAQUS

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*Summary* In the paper presented are the preliminary activities for the test, its course and the results of conducted investigations. The comparison of results obtained by means of impact test and numerical simulation and expected further scope of research have been presented.

## Introduction

Numerical models find a wide application in diagnostics of turbines of large power. Such models are tuned based on the results of experimental investigations and measurements conducted both on real objects and laboratory apparatus. The objective of tuning a numerical model is a more precise mapping of the real object. In the research conducted at the Division for Rotor Dynamics and Slide Bearings utilized are codes simulating the dynamic states of the turboset. Tuning of such codes is based, amongst the others, on the results of experimental investigations performed on the large-scale laboratory stand for investigations of a three-support rotor fixed in slide bearings. One of the methods of acquisition of data regarding dynamic properties of laboratory rotor and the support structure is experimental method of modal analysis. The present work presents the results of investigations of the support structure and the rotor obtained by means of impact test. The impact test is relatively fast and easy to perform, but the obtained results are approximate. These, however enable planning of a more accurate test using the electro-dynamic shaker, which will be a subsequent part of conducted research. The objective of the presented investigations are preliminary determination of the modal model of supporting structure with the rotor founded at a standstill in the supports together with determination of the further progress of investigations. Also the results of numerical simulation was performed. The results of test and simulation were compared. The paper includes 4 main parts – description of an investigated object, FEM based simulation, modal test and comparison of results.

## OBJECT OF INVESTIGATIONS

The object of investigations is a steel frame (6), which is a part of a support structure, bearing's mounts (2) and rotor (1). In the bearings fitted in the bearings stands there is a rotor, which during the tests remained at standstill. In the course of investigated configuration the rotor was founded in three supports. Investigated setup has been presented in Fig. 1

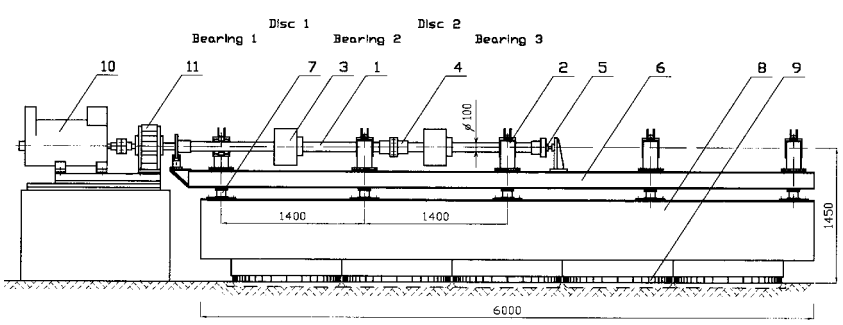



Fig. 1. Rig for investigations of rotor and bearings dynamics.
1 - shaft, 2 – bearings stand, 3 – bearings loading disc, 4 – coupling, 5 – resistance bearing, 6 – frame, 7 – frame supports, 8 - foundation block, 9 – pneumatic absorbers, 10 – propelling engine, 11- gear box

## NUMERICAL SIMULATION (ABAQUS)

This part of investigation was performed in three stages: calculation of natural frequencies of rotor, calculation of natural frequencies of steel frame and calculations of eigenvalues of combined structure incorporating rotor and frame - Fig. 2

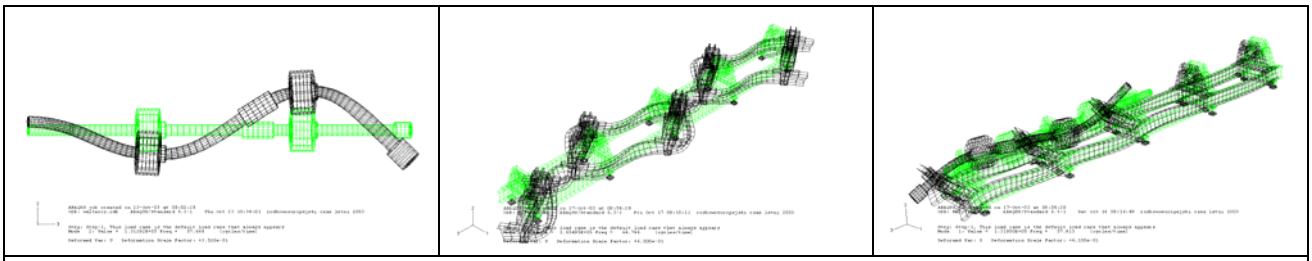


Fig. 2 Three stages of numerical simulation of test rig

## EXPERIMENTAL MODAL ANALYSIS

The test has been performed in two excitation and measurement planes – horizontal and vertical in 30 measurement points. Values of spectral transition function, ordinary coherence and spectral function of power density have been measured. Estimation of modal model parameters has been performed by means of the Time Domain MDOF module for both series separately. Estimated were the poles of spectral transition function, constructed has been the stabilisation diagram, selected have been the poles, determined have been the forms of the object free vibrations, compared have been measured and determined during analysis distributions of spectral transition functions, conducted has been the assessment of identified modal model by means of the MAC criterion, enabling orthogonality testing of identified forms of free vibrations, constructed have been distributions of determined forms

## COMPARISON

Results of both methods were compared. Two criteria of comparison were established: the accordance of value of natural frequency and corresponding forms – Fig. 3

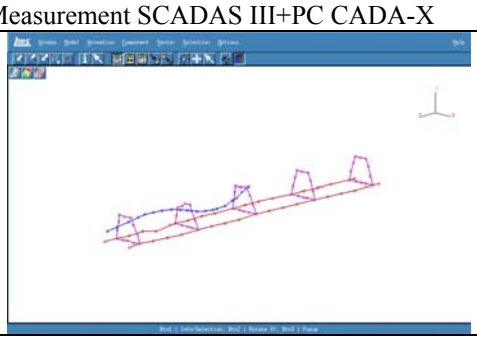
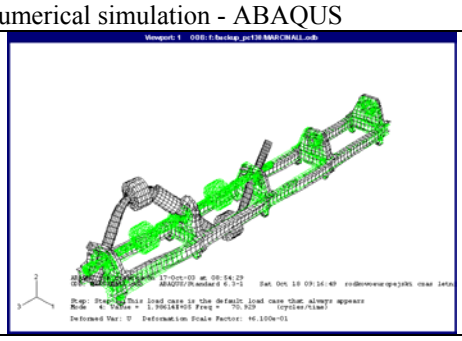
| Measurement SCADAS III+PC CADA-X | Numerical simulation - ABAQUS |
|---|---|
|  |  |

Fig. 3 Comparison of results

## CONCLUSIONS

As a result of investigation two modal models of the object have been estimated. The comparison of results of numerical simulation and test is a proper point to continue investigation by means of both methods. FEM model has to be adjusted in order to bring its modal properties closer into line with the measured results. As far as experimental part is concerned, the use of electro-dynamic shaker in test will excite more modes, which could be observed in numerical results, and cannot be excited with relatively small modal hammer.The more precise results of test will enable more precise adjustment of numerical model.

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