Rotating machines are one of the most frequently used devices in power engineering and have a wide spectrum of application in various industrial sectors. Their main elements include rotor with bladed disks and bearings integrated with a supporting structure. Rotors are under the influence of interactions taking place between all the subsystems that constitute a rotating machine. In that respect, the oil-film forces of a slide bearing (expressed in the form of stiffness and damping coefficients), are of particular importance. It should be noted that these coefficients, from a mathematical point of view, combine motion of the system as a whole and hydrodynamic pressure distribution into a single consistent logical structure. The system's motion is described by ordinary differential equations, while pressure distribution by partial differential equations. Within the project, stiffness and damping coefficients of slide bearings will be calculated for a rotor-bearing system by means of non-linear models, giving a better description of the phenomena occurring in actual operational conditions. The adopted calculation model uses a numerical technique called a finite element method (FEM) during rotor dynamics computations, which includes beam elements with 6 degrees of freedom in each node. The identification of stiffness and bearing coefficients of slide bearings at each time point of an iterative approach is a big problem. This fact causes non-linear calculations are needed in this case. Even the most advanced commercial software does not offer such solutions. Within the framework of the project, it is planned to run the calculations through NLDW software, which is being developed by the Szewalski Institute of Fluid-Flow Machinery PAS, in Gdańsk. Special attention will be paid to the relationship between machine and its bearings. This relationship is not always explicitly indicated in publications about slide bearings or rotating machinery. Specialists that handle issues of rotor dynamics often treat bearings as a part of the dynamic system, and are of the opinion that can also be successfully described by linear equations with constant stiffness and damping coefficients. In reality such an approach is appropriate only in certain cases. The project aims to identify the ranges in which a classical, linear approach can lead to errors of a qualitative nature.

Within the project, dynamic force coefficients (stiffness, damping and mass coefficients) will be determined for a system, consisting of a rotor supported by hydrodynamic bearings. The experimental research will be conducted on the real object by means of an impulse response method. The linear calculation algorithm, widely known in scientific literature, which was expanded in such a way that he additionally has the possibility to identify mass coefficients will be applied in the calculations. The calculation of mass coefficients allows an initial verification of experimental results. The impulse method consists in the excitation of a rotating shaft using an impulse hammer. On the basis of measured displacement signal in bearings, it is possible to identify stiffness, damping and mass coefficients of a rotor-bearing system. The experimental study will be carried out on a laboratory test rig equipped with the rotor having a shaft diameter of 3/4’’ which is supported by hydrodynamic bearings. Maximum permitted rotational speed of the rotor is 14000 rpm. As a result of the experiment, a set of 24 force coefficients characterizing two hydrodynamic bearings will be identified as well as the uncertainty intervals corresponding to their identification. A summary of linear/non-linear calculation results and experimental results will certainly give a complete picture of the use of existing capabilities to calculate force coefficients of slide bearings.

Hydrodynamic bearings have a significant influence on the dynamics of rotating machinery. In large turbine-generator sets with multiple bearing supports, bearings can run under unstable operating conditions for a long time. In these operating conditions, coefficients of hydrodynamic bearings change, even when the machine operates at a constant rotational speed. Dynamic force coefficients of bearings are affected by flow phenomena, impacts inside a bearing that act together with other impacts related to the whole machine. In order to make a precise calculation of these coefficients it is necessary to apply non-linear calculation methods. The project outcomes will allow to answer the following questions: To what extent is it correct to use linear simplified methods for the identification of force coefficients of hydrodynamic bearings?; And when is it necessary to take into account in this calculation the additional parameters linked with rotor motion inside a bearing? The proposed, experimental research method may find in the future an application, for example, in calculations of other types of bearings such as magnetic and foil bearings. The creation of numerical models for bearings of this type is a challenging task, as they exhibit properties specific to strongly nonlinear dynamical systems.