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Testing Stand for Antifriction Bearings with Applications in Biomechanics

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***Abstract*—The paper presents a new testing stand for antifriction bearings, suitable for all types of rolling and sliding bearings, especially for those having small diameters and operating at high rotation speeds. The design of this stand occurred as a necessity of additional equipment to the research endowment required by several research projects developed in partnership by the author's institutions. It also can be used in proper conditions to test artificial joints for knees or elbows, consistent at model level with cylindrical bearings.**

***Index Terms*—bearings, friction, stand, test.**

I. Introduction

Sliding bearings are involved in wide ranged fields of operation considering their outstanding properties as accuracy, endurance, rigidity, low friction levels, superior behaviour during vibrations or oscillating strains. Besides they are able to work in contaminated environments and the expenses for the manufacturing and maintenance are acceptable.

Choosing the most appropriate materials for bearings is a very complex and delicate issue, due to the difficult and sometimes contradictory requirements, high level of mechanical and thermal strains, with complex changes in time, direction and amplitude, possible chemical attacks or radiations influence. As a follow, many types of wear may occur due to metal-metal contact when discontinuities appear within the lubricant film, abrasions due to contaminations with various micro particles or corrosion due to the interaction of aggressive chemical agents resulting from the working environment or even from the lubricant itself.

The multitude of the factors acting upon the operating bearings requires a wide range of properties that need to be met by the materials used for their manufacturing and not least optimal possibilities of testing them for all the situations, which may affect their proper functionality, before starting mass production,.

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II. Theoretical Concepts

The testing stand represents the response to the requirement of completing the research endowment of a consortium involved in complex research projects in the field of bearings for different types of applications, not only for mechanical but also for biomechanical purpose.

This equipment should be able to determine various performances of bearings, such as: load capacity, endurance, friction moments, for changing load values, even small diameters (starting from 5mm), various rotation speeds from 0 to 60000 rot/min. The loads may be axial or radial, static applied or vibratory.

The stand will work within two modes of operation:

- continuous operation
- repeated turning on and off

The main shaft of the equipment works on air bearings, having different diameters, the bigger one being the most strained, as its position is nearer to the tested bearing.

For the same reasons, this bearing is supplied with pressured air by means of two rows of holes, while the second bearing is supplied by means of a single row. The number of holes for the second bearing is only three (0,63mm diameter).

The main bearing has three holes on each row, with the same size and geometry, plus for each row of holes there is an additional hole, with a 0,25mm diameter, opposed to the supply source,.

The holes rows are located at about 12,7mm from the bearing margin, so for a supply pressure of about 1,2atm, we can apply a load of 12kg, the radial clearance being at about 0,025mm.

The tested bearing will be positioned on the shaft.

If we are dealing with rolling bearings, the external part can be fixed in a floating bearing supplied with pressured air by means of two rows of holes, having the same construction as those above described.

A mechanical arm placed on the internal part of the floating bearing allows us to measure the friction moments with high accuracy.

For axial loads, a special constructed bearing was designed at the end of the main shaft.

This bearing consists of two circular disks, supplied by a central hole, continued with very accurate manufactured conical surfaces. This way, at the border between the frontal and the conical surface, we will get an intermediate pressure among the one near the supply hole and the atmospheric pressure.

This pressure will increase with the axial load applied to the bearing, because the thickness of the air film between the frontal and the conical surfaces decreases.

At the same time, the clearance between the conical surfaces and the intermediate pressure port represents an analogous capacity chamber, contributing to the cancelling of the possible axial vibrations during operation. This construction was used precisely to avoid the occurrence of uncontrolled axial vibrations.

III. STAND PRESENTATION

The stand was designed in AutoCAD and is generally presented in fig.1.

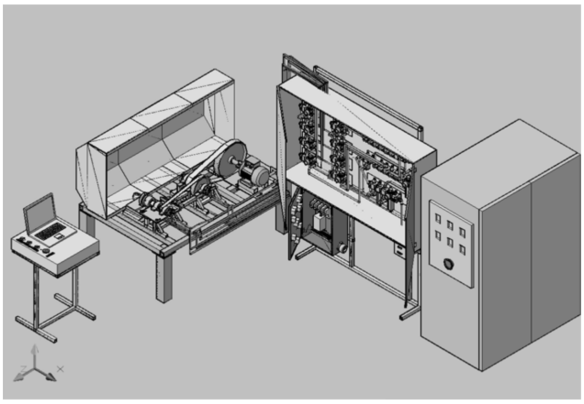

Fig.1 Testing stand (overview)

The stand consists of:

- testing module with loading and measurement systems
- transmission and amplifying motion system
- pneumatic supply system for the air bearings
- electrical system
- data acquiring and processing system
- equipment frame

The equipment frame is a resistant welded structure, which is going to be fixed to the ground.

The motion transmission between the shafts is achieved by help of belts made of compound type of material in order to hold for high rotation speeds.

Each bearing is powered separately and bearing distributor has a pressure regulator and a manometer so that the equipment operator is able to monitor the pressure individually.

If the pressure drops under a certain limit, then power is automatically turned off and the motor stops.

Also, the motor does not start and of course the shafts will not start their rotation if the air pressure in the bearings is not consistent to a certain value.

Due to the belt transmission system, it was necessary to design a system for belt tensioning, which also allows the motor alignment and the belt alignment with respect to the shafts.

The belt tensioning system is shown in fig.2.

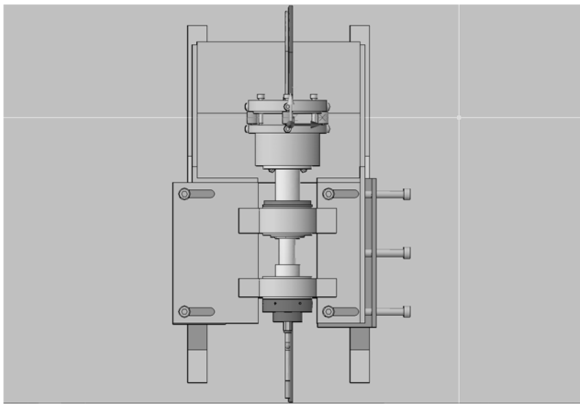

Fig.2 Belt tensioning system

The pneumatic driving system consists of:

- system for compressed air generation
- system for air preparation and adjustments
- distribution system
- automation system

The system for compressed air generation consists of three serial connected piston compressors with soundproof covers.

From the main module for air preparation (fig.3), two principal lines are going one directly to the distributors, supplying the stand bearings with clean air, while the other one to the active area where we test sliding or rolling friction bearings in lubricating operation mode.

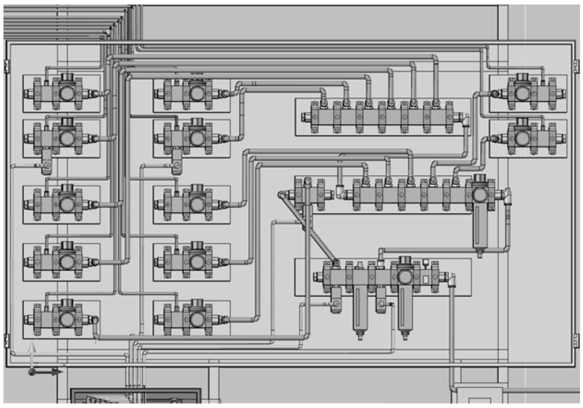

Fig.3 Air preparation and adjustments system

An electric valve and a pressure regulator controlled from the panel or the process computer adjusts the air flow and the lubricant amount that enters the area of the tested bearing.

The other line carrying clean air goes to the air bearings each bearing being connected to a pressure regulator and a manometer, which are controlled from a control panel.

Separate lines were also designed to get air in the testing area, in order to change the type of load from axial to radial or vice versa, according to the beneficiary requirements.

Of course, outside the fact that the axial or radial load may have different magnitudes, they may be applied or not or we can simulate the vibrations phenomenon. We may apply variable loads, which can be symmetrical or not, by help of a special distributor controlled by the computer.

Below the pneumatic drive panel, there is an electric panel (fig.4), which allows the following controls: turning the stand on and off, switching the motor on and off, adjustment for the axial load, and adjustment for the radial load.

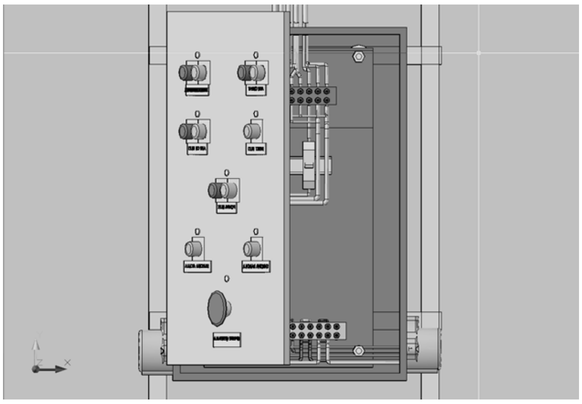

Fig.4 Electric panel

The electric panel provides two lateral plugs, one for the network power supply, the other one to power the compressors system.

The data acquiring and processing system (fig.5) consists of: computer, acquisition card, sensors, software for acquiring and processing data, and systems for signals transportation.

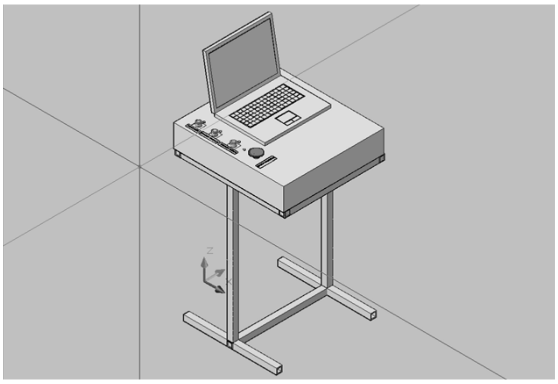

Fig.5 Data acquiring and processing system

The general shut down button and the controls for charging the axial load, radial load and lubricant (if required) will be on the computer panel. All the equipments signals are coming and going from it, and will be processed by help of a dedicated software.

The computer will be loaded with mainly two types of menus: one for establishing the operational parameters and their control and the other one for acquiring and processing the data provided from the active part of the testing equipment.

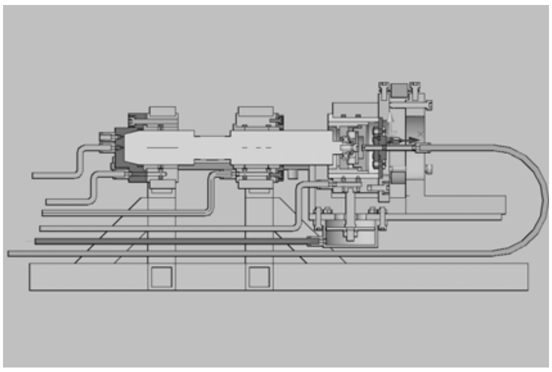

Fig.6 Active part of the stand (main shaft)

The active part of the stand is the one where the bearings are tested (fig.6), using the sensors information.

For each group of tested bearings or for each type of requirements from the beneficiary, the active part module can be adapted or changed accordingly, with minimum expenses and labour. There is also the possibility of even designing a new one consistent with the other parts and connections on the existing stand.

The active area can also be provided with thermal sensors in order to be able to measure the temperatures developed during the bearing operation process.

IV. CONCLUSION

The presented stand will be a useful tool in our further researches concerning all types of bearings, subjected to various strains. It has the advantage of combining several features and testing possibilities for acceptable expenses.

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