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EXPERIMENTAL SIMULATION FOR IMPLEMENTATION OF PREDICTIVE MAINTENANCE

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Abstract: *In this paper are* prezented two experimental stands: the study of vibration and mechanical and electrical defects simulation, and the study of shaft horizontal alignment. The implementation is given in the field of predictive and proactive maintenance in the industry. Attainment of these stands is necessary to simulate actual conditions of occurrence of failure for the application, the impairment corrections of the manufacturing process.
Key words: *experimental stands, implementation, predictive maintenance.*

1. INTRODUCTION

One of the most important objectives of the implementation of the comprehensive qualitative predictive and proactive industrial companies in the technical equipment is the equipment for measuring vibration simulation and experimental stands for fault in different operating regimes, necessary training of personnel.

To this end have been designed and executed two experimental maintenance implementation stands necessary predictive and proactive as well as for staff training in the sector of activity:

- Stand for simulation study of vibration and mechanical and electrical defects;
- Stand for the study of shaft horizontal alignment

These stands can be used in laboratories for studying the dynamics of the technical universities of machinery fault diagnosis and rotor.

2. STAND FOR SIMULATION STUDY OF VIBRATION AND DEFECTS

Analysis of defects by studying dynamic rotating machinery vibration is a complex phenomenon that involves both theoretical knowledge and practical knowledge, acquired over time.

In this respect, for the study of vibrations and simulation of mechanical and electrical defects was designed and executed a stand experimental, need preparation and training for maintenance engineers [Lee 04].

The stand is designed for accelerated testing by simulating the mechanical and electrical faults, the induction of disturbing forces or external requests, resulting in the reduction of dynamic equipment reliability.

The chassis was designed on the basis of experience gained from the measurements, are monitoring and analysis of vibration in rotating machinery dynamic.

The stand is shown in Figure 1 and can be simulate the following defects:

- static and dynamic imbalance in 2 or more planes;
- errors of alignment parallel or angular;
- the weakening system resistance;
- defects of transmissions by straps
- defects of gearing;
- eccentricity;
- the phenomenon of resonance;
- defects in the camps of rolling bearings;
- mechanical clearances;
- defects of sliding of the camps;
- curved shaft;

- rubbing rotor;
- problems of electric motors gearing faults.

The stand can be a range of diverse sensors such as:

- accelerometers uni and triaxiale, medium and low frequency welting, for absolute measuring of vibration;
- proximity systems for measuring relative vibration;
- the speed and motion transducers for vibrations;
- vibration transducers with output 4-20 mA and dynamic output;
- transducers with TEDS function;
- phase and speed sensors;
- temperature sensors with or without contact (thermo - resistance, thermocouples, infrared);
- sensors for measuring the torque flow;
- force transducers;
- impact hammers for resonant frequencies determination;
- laser distance sensors for measurement of relative motion;
- laser sensors for measurement of real-time 2D and 3D.

Fig. 1. Stand for vibration study

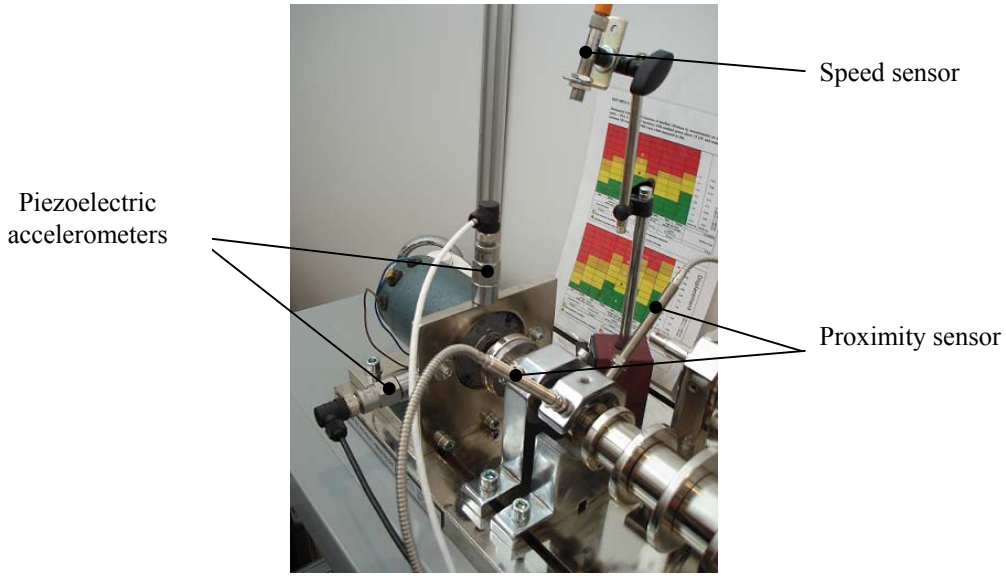


Fig. 2. Mounting stand for vibration transducers and speed sensors

In Figure 2 is given the position on the stand of the displacement transducer, piezo contact accelerometers with magnet and speed sensor. Main technical characteristics of the stand:

Electric motor power: 0.75 kW; Power supply: 220 Vac stand; Power frequency: 50 Hz; The magnitude of the frequency domain [Lal 90]

generated by fundamental-stand [Vac 06]: 0,5 to 1 x 30-400 Hz (12000/24000 rpm); Minimum resolution: 0.01 Hz frequency, adjustable from operator interface; Overall dimensions: approx. L800xl400xh200 mm; Shielding protects: Adjustable, 150% of current roll call for 1 minute; Control mode: linear v/f Control; Optimized Vector Control; PID (positive, negative); PWM; Frequency settings: Potentiometer, external analog signal (0 ~ 5V, 0 ~ 10V, 0-20mA); Terminal keys, control logic from the PLC, PWM; START/STOP Control: Keyboard or Terminal; Possibility to change the time period for raising electric motor revolution up to fundamental frequency (frequency set): 0.1 ~ 3000 s; LCD Monitor: Display: frequency, revolutions of the engine or the study of the rotor (rpm), output current, output voltage, past alarms, the system parameters; Simulation tools: elastic and rigid foundations; Transmission: by elastic coupling and rigid, belts, toothed gears.

Main parts:

1. driving Motor
2. devices for simulating drag between rotor and stator, or in camps
3. uniform rotors
4. nonuniformity rotor
5. the order, measure and control box
6. motor shaft coupling elastic
7. bearings of sliding
8. rollover camps
9. motherboard
10. strap wheel
11. toothed gears
12. elastic pads, etc.

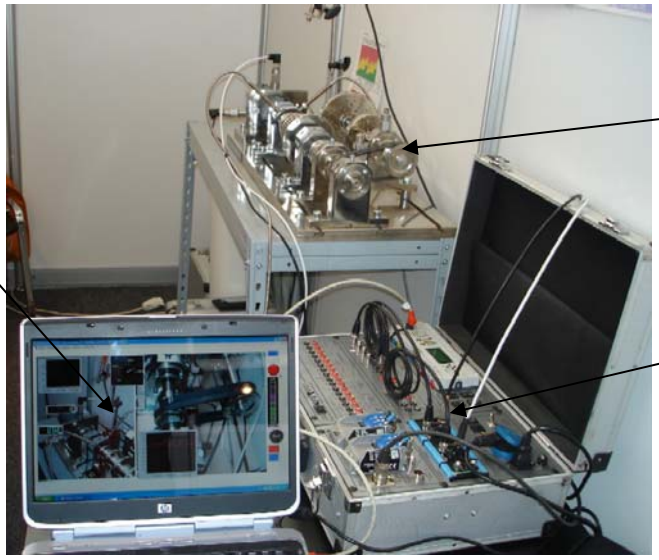


Fig. 3. Study of vibration using on-line monitoring systems

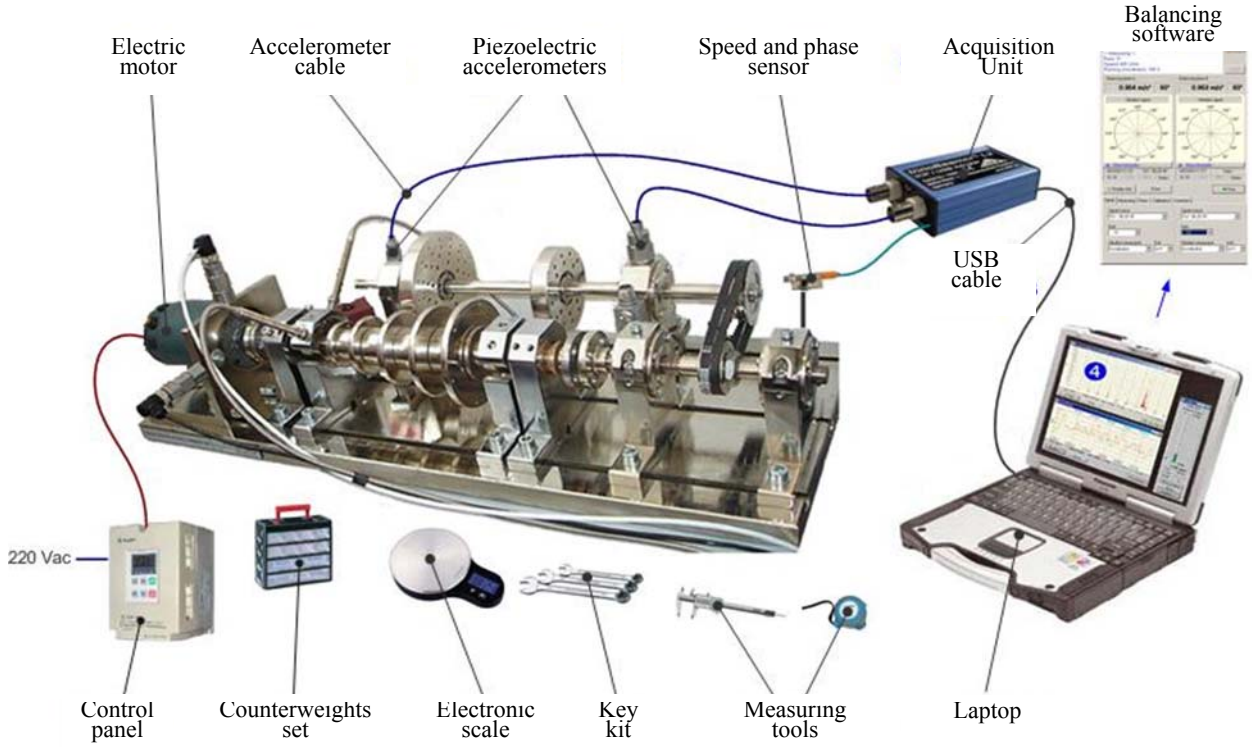
Depending on the system chosen and by connecting the sensors corresponding, on the stand can be conducted the following studies [Bay 99]:

- influence of temperature on the roll at the fiability camp thermodynamic machines;
- loading the bearings by simulating a friction in bearings or raising the upper casing;
- influence of unbalanced rotor, static or dynamic;
- determination of resonant frequencies of different types of rotors and their influence on cars;
- calculation of the thermal head and their influence on cars;
- study of motion and vibration of the time in the camps of the camp and slip-Orbit's precession time zone in camp;
- influence of sliding and dezaxed camps of axes on the consumption of electricity;
- measuring the torque in the case of the bearings axles;
- Study reaction on elastic foundations machines, namely rigid. Determination of critical speeds;
- Relaxing stiffness of the system and its influence on the reliability of dynamic rotary machines;

- study of the reaction of the flexible rotor based on their gear and measurement of the arrow;
- alignment of trees with the help of sensors or laser displacement transducer;
- static and dynamic load balancing on the stand (1 plane-2 planes), etc.

In order to achieve the proposed themes, vibrations sensors and those for technical parameters fitted stand can be connected to different measurement and diagnostic equipment, such as: vibration analyzers, data collectors, monitoring systems, etc. online.

In Figure 3 the study is presented on the stand by means of vibration monitoring systems, multichannel, online and Figure 4 shows the components necessary to carry out dynamic equilibration in two planes.



Note:

- On the stand is presented only the dynamic balance option,
- The system includes up to 6 rotor correction method with the addition or removal of material,
- The range of speeds is up to 12,000 rpm or 24,000 rpm with 1:1 transmission ratio in sheaves,
- For higher speeds the transmission ration can be changed.

Fig. 4. Stand for vibration study – balancing option

3. STAND FOR THE STUDY OF SHAFT HORIZONTAL ALIGNMENT

Aligning rotating machinery dynamic owning the following mechanical couplings is one of the most important operations that apply to them in order to eliminate the defects of misaligning of shafts.

In practice it was found that the operation of a rotor with defect of nonlinearity of shafts a long period of time lowers the service life of the bearings or sliding of the camps, the fatigue damage of trees, couplings, and the increase in energy consumption, excessive [Ste 99] internal heating or mechanical destruction of tests, in the case of pumps, etc. and, consequently, damage the equipment.

To study the phenomenon of nonlinearity of shafts horizontal was designed and made a stand shown in Figure 5.

This stand is designed for studying methods of aligning with different alignment kits, such as: laser kits, kits with analog or digital clocks comparators, travel kits with sensors with or without contact, etc [Wic 05].

Main parts: motherboard; bearings with bearings; mechanical coupling with bolts; device for adjusting the camps in the vertical and horizontal direction; mounts bearings

with or without electrical resistors for the simulation of the thermal head, etc.

On the stand can simulate different defects, such as [Don 02]:

- nonlinearity radial
- nonlinearity axial
- combined nonlinearity
- influence of thermal head on alignment
- the influence of gaming on the alignment
- correction of "soft foot" (the feet of the machine are not in the same plane with pedestal)
- radial and axial check heartbeat to elastic couplings.

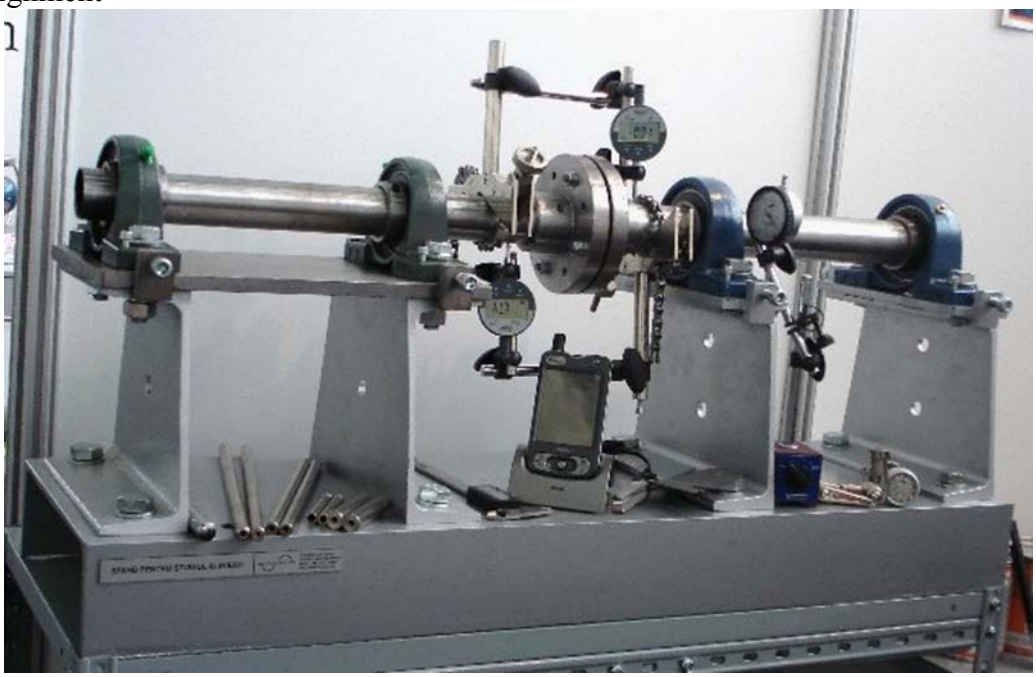


Fig. 5. Stand for horizontal shaft alignment study

3. CONCLUSION

Analysis of defects by studying dynamic rotating machinery vibration is a complex phenomenon that involves both theoretical knowledge and practical knowledge, acquired over time.

This theme issues are of concern not only at the theoretical level, but also practically the front trying to contribute to the deepening of knowledge and issues related to the analysis of vibration fault, by studying and simulating mechanical and electrical defects in rotating machinery dynamic as well as horizontal shafts on misaligning, which were designed and executed two stands trial, necessary in the first place training, preparation and maintenance engineers and study the dynamics of rotor machinery within the undergraduate laboratories.

Recognizing the importance of preparing personnel serving equipment maintainability by making the two stands has sought to deepen, especially by maintenance engineers, to work on issues related to the analysis of vibration fault, by studying and simulating mechanical and electrical defects in rotating machinery dynamic as well as concerning horizontal misaligning shafts, which are particularly useful to study the dynamics of rotor machinery within the undergraduate laboratories.

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SIMULARE EXPERIMENTALĂ PENTRU IMPLEMENTAREA MENTENANȚEI PREDICTIVE

Rezumat: *În lucrare se prezintă două standuri experimentale pentru: studiul vibrațiilor şi simulării defectelor mecanice şi electric, precum şi studiul alinierii arborilor orizontali. Lucrarea se încadrează în domeniul implementării mentenanței predictive şi proactive în industrie. Realizarea acestor standuri este necesară pentru simularea condițiilor reale de apariție a defecțiunilor în vederea aplicării corecților ce se impugn, fără afectarea procesului de producție.*

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