TRANSCOM 2025: 16th International Scientific Conference on Sustainable, Modern and Safe Transport

Title of A Modular Test Stand for Studying Rotor Characteristics and Vibration Diagnostics

Matúš Vereš[1], Daniel Kozárik[1], Lucia Deganová[2], Róbert Kohár[1], Rudolf Madaj[1]

1 Department of Design and Mechanical Elements, Faculty of Mechanical Engineering, University of Žilina, Žilina, Slovakia
2 Department of Applied Mechanics, Faculty of Mechanical Engineering, University of Žilina, Žilina, Slovakia

INTRODUCTION

Rotor and bearing behavior significantly influences the reliability and safety of rotating machinery in industries such as aerospace, energy, transport, and manufacturing.

Diagnostic methods for rotor dynamics are essential to prevent critical issues, including imbalance, vibration, and misalignment, thus avoiding unexpected machinery breakdowns.

Understanding rotor and bearing dynamics facilitates condition-based maintenance, extending machinery lifespan and reducing operational costs.

Current market solutions predominantly focus on single-shaft test stands; multi-shaft stands with adjustable axial distances and flexible torque transmission methods are limited.

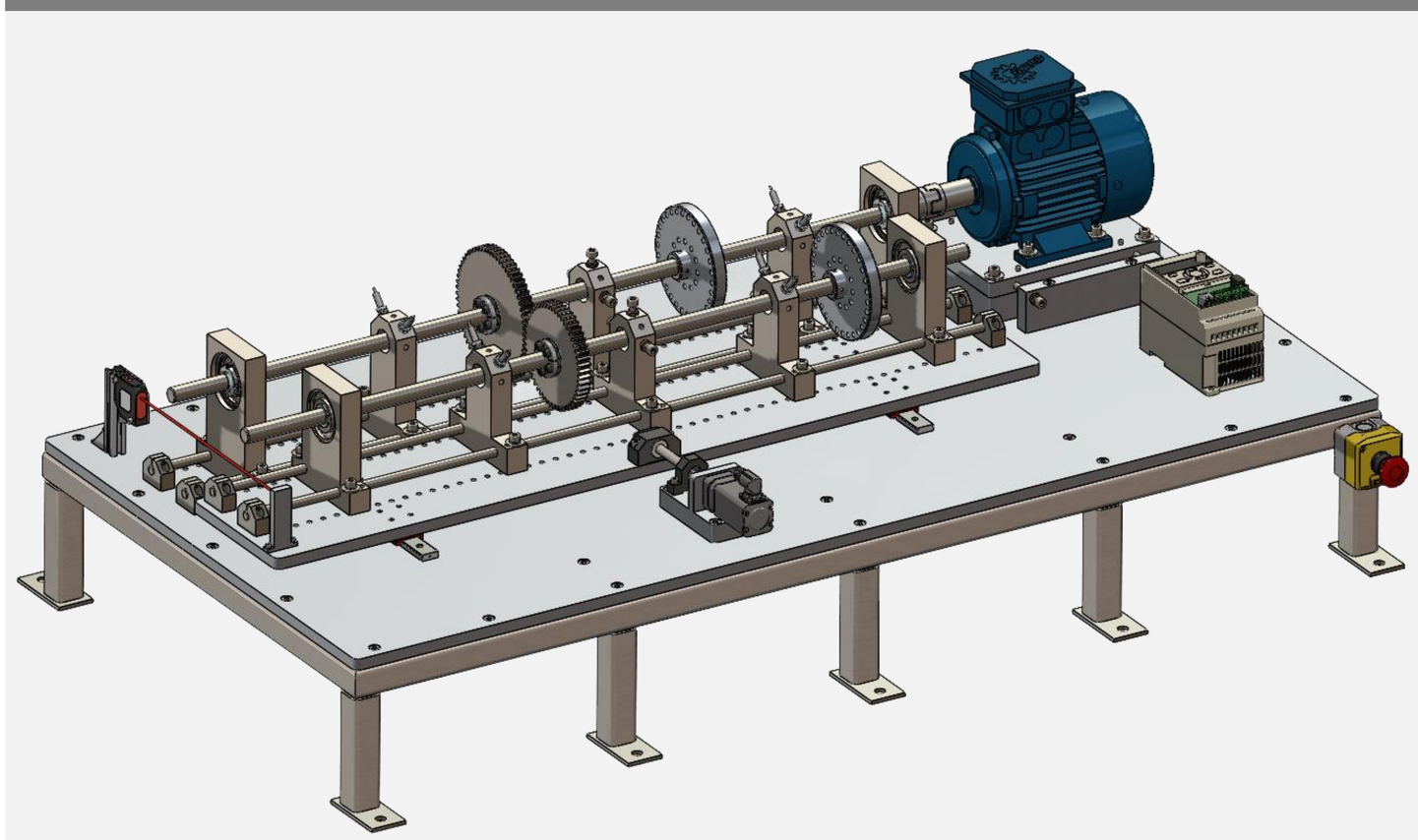
Research objective: To design a modular test stand allowing precise study of rotor characteristics, bearing vibrations, and gear dynamics under varied configurations and fault simulations.

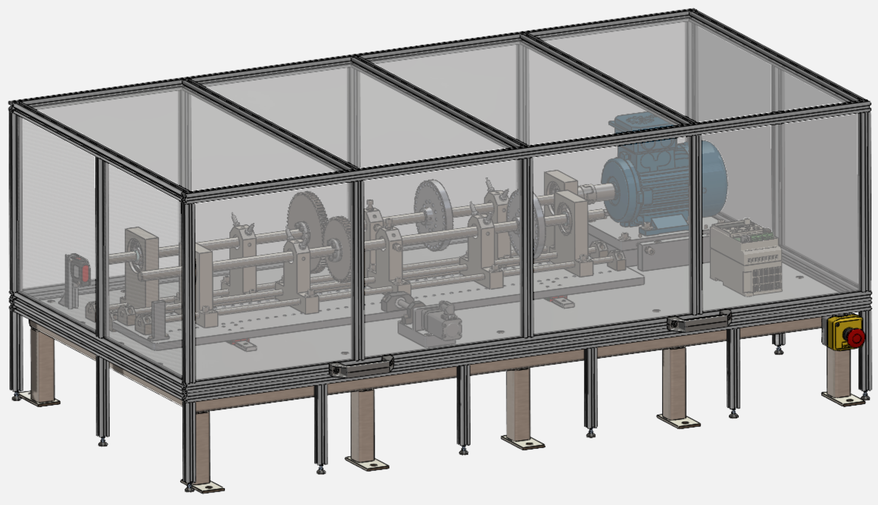
Expected impact: Enhanced diagnostic capabilities, improved reliability of rotating equipment, and support for the development of predictive maintenance strategies.

KEY DESIGN FEATURES

- **Structural design:** Steel frame made from square tubes and aluminum plates ensures rigidity and stability.
- **Shaft configuration:** Two parallel shafts (fixed and adjustable) equipped with modular housings, allowing customizable bearing placement and spacing adjustments.
- **Distance adjustment:** Shaft spacing precisely controlled by a servo-driven linear guide system, with laser-based measurement ensuring accurate axial positioning.
- **Torque transmission:** Flexible setup allowing the use of interchangeable belt-driven or gear-driven torque transfer mechanisms.
- **Sensor integration:** Inductive sensors placed strategically to measure shaft deflection and bearing vibrations during operation.
- **Safety measures:** Robust protective enclosure made from aluminum profiles and transparent plexiglass to ensure visibility and operator safety.

FINAL DESIGN





CONCLUSION & IMPLEMENTATION PATH

- The proposed modular test stand addresses existing limitations by providing adjustable shaft spacing and interchangeable torque transmission systems, significantly enhancing experimental flexibility.
- Its robust design ensures safe operation while allowing precise rotor and bearing diagnostics.
- Future enhancements may include the integration of additional sensors for comprehensive data collection and the implementation of radial preload mechanisms to simulate more complex operational scenarios.
- The next development steps involve constructing a prototype, performing modal analyses to avoid resonance, and conducting extensive experimental validation to confirm performance and reliability.

ACKNOWLEDGEMENTS

This work was supported by the Scientific Grant Agency of the Ministry of Education, Science, Research and Sport of the Slovak Republic (VEGA), project no. 1/0568/24, *Research in the field of loading and stress deformation states of rolling bearing cages.* The authors gratefully acknowledge this support.