

Dynamic and stability comparison analysis of the high-speed turbocharger rotor system with and without thrust bearing via machine learning schemes

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Abstract

To minimize carbon footprints and improve volumetric efficiency and power output, modern internal combustion engine technology employs turbochargers in automobile and marine engines as well as in several diesel generator sets. During its operation, a minor imbalance or flaw in turbocharger rotors could lead to the system catastrophic failures. The two floating ring bearings that support a turbocharger allow it to operate at

high speeds. The exhaust gases impacting the turbine and the inlet air impacting the compressor cause axial forces in the turbine, resulting in axial displacements. To balance these two components of axial forces, a thrust bearing is used in the turbocharger. The present work focuses on the comparative study of the turbocharger with and without the thrust bearing. The thrust bearing's pressure distribution is first calculated, and the nonlinear bearing forces acting on the turbocharger rotor are obtained. The exhaust gas forces are considered radial direction excitations, while blade passing excitations are taken as axial forces. The critical speeds of the rotor are first estimated using the Campbell diagram. An experimental study on an automobile turbocharger rotor is performed to validate the frequencies obtained from the present finite element model. Further, the system stability with and without thrust bearings at different operating speeds is illustrated. The influence of the thrust bearing location and preload is investigated on the system response. It is found that the thrust bearing has a significant effect on the system stability at higher speeds. The system stability condition at different operating conditions is identified by the trained neural network models.

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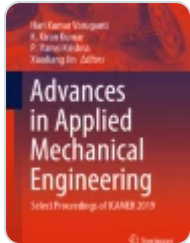
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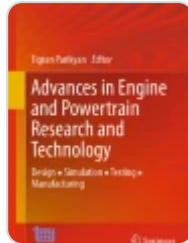
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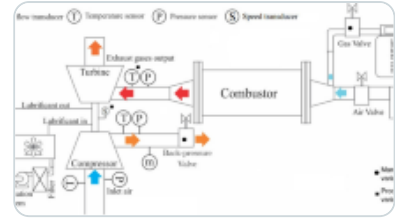
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Author information

Authors and Affiliations

Dynamics and Vibration Lab, School of Mechanical Engineering, Vellore Institute of Technology, Vellore, Tamil Nadu, 632014, India

Rajasekhara Reddy Mutra & D. Mallikarjuna Reddy

**Department of Mechanical Engineering, National Institute of Technology, Rourkela,
Odisha, 769008, India**

J. Srinivas

**Structural Dynamics Analysis and Validation (SDAV), School of Mechanical
Engineering, College of Engineering, Universiti Teknologi MARA (UiTM), Shah Alam,
Malaysia**

Muhamad Norhisham Abdul Rani & Mohd Azmi Yunus

Faculty of Computing and Multimedia, Universiti Poly-Tech, Kula Lumpur, Malaysia
Zahrah Yahya

Corresponding author

Correspondence to [Rajasekhara Reddy Mutra](#).

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^a Dynamics and Vibration Lab, School of Mechanical Engineering, Vellore Institute of Technology, Tamil Nadu, Vellore, 632014, India

^b Department of Mechanical Engineering, National Institute of Technology, Odisha, Rourkela, 769008, India

^c Structural Dynamics Analysis and Validation (SDAV), School of Mechanical Engineering, College of Engineering, Universiti Teknologi MARA (UiTM), Shah Alam, Malaysia

^d Faculty of Computing and Multimedia, Universiti Poly-Tech, Kula Lumpur, Malaysia

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