IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO - IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

A Test Rig For Vibration-based Fatigue Analysis & a Method Thereof

IITM Technology Available for Licensing

Problem Statement

- **High-performance rotating machinery**, such as compressor, turbine, generator, **often experience shaft failures.**
- The shafts are **subjected to both sinusoidal and random excitations**, leading to fatigue cracks, which if detected early can play essential role in **preventing failures & downtime**.
- Recently, vibration pattern analysis has evolved as a **means to detect fatigue cracks** by observing changes in dynamic stiffness & vibration patterns.
- Conventional methods like **S-N curves and fatigue tests** have **limitations** in **mimicking real-world loading conditions.**
- Therefore, there is a need of an **integrated sensor system** capable of measuring & recording shaft vibration, fatigue life, and strain responses during fatigue analysis.
- The present patent addresses above mentioned challenges by **relating the field of mechanics with the focus on test rig for vibration-based fatigue analysis.**

Technology Category/ Market

Category: Applied Mechanics & Mechanical Engg | Energy Storage & Renewable Energy

Industry: Energy, Transportation, Industrial Machinery & Manufacturing, Oil, Gas and Mining Industry, Shaft Fatigue and Vibration Analysis, Sensor Integration, Real-time Testing

Applications: Shaft Fatigue Analysis, Rotating Machinery, Manufacturing Quality Control, Energy Generation, Transportation, Oil, Gas and Mining Industrial Processes, Maintenance and Safety

Market: The global automated test equipment market size was valued at **$6.87 B** in **2020** and is expected to expand to **$8.94 B** by **2028** growing at **3.3% CAGR** from **2021 to 2028**.

TRL (Technology Readiness Level)

TRL- 4, Technology validated in Lab

Research Lab

Prof. Seshadri Sekhar A
Department of Mechanical Engineering

Technology

The present patent disclosure describes **a test rig used for analyzing the fatigue of a shaft through strain and vibration measurements.** This configuration allows for the replication of **real-time operating conditions** of the shaft in a rotating machine, aiding in the analysis of fatigue-induced vibration patterns. **Refer FIG 1 & 2**.

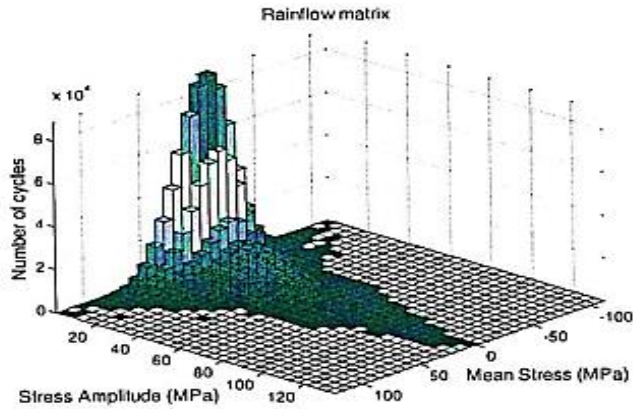


FIG 1 Illustrates:

Rainflow matrix of the initial 20 seconds stress profile

Key Features / Value Proposition

❖ ***User Perspective:***

- **Safety** is enhanced by predicting & preventing shaft failures, ensuring safer operations.
- **Cost Savings:** Users save money by optimizing maintenance & reducing downtime.
- **Reliability:** It improves equipment reliability, reducing unexpected breakdowns.

❖ ***Technical Perspective:***

- **Productivity:** Industries benefit from increased productivity and quality assurance.
- **Quality Assurance:** It helps identify design flaws and ensures compliance with standards.
- **Compliance:** Industries can meet safety and reliability standards more effectively.

❖ ***Industrial Perspective:***

- **Advanced Testing:** It advances fatigue analysis with modern technology.
- **Data-Driven:** Emphasizes the importance of data for predictive maintenance.
- **Sensor Integration:** Demonstrates the synergy between mechanical testing & sensor technology.

CONTACT US
Dr. Dara Ajay, Head
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

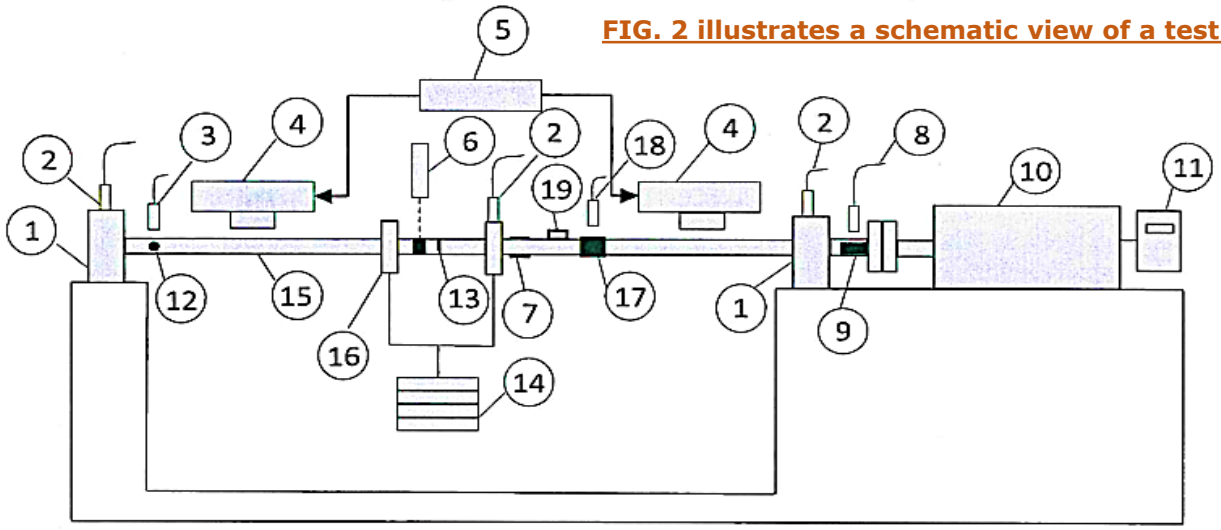
Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719

A Test Rig For Vibration-based Fatigue Analysis & a Method Thereof

IITM Technology Available for Licensing

Image

FIG. 2 illustrates a schematic view of a test rig



1. Main Bearing House 2. Accelerometer 3. Vertical Proximity Probe 4. Non-Contact Magnetic Exciter 5. Waveform Generator 6. Laser Pickup 7. Strain Gauge 8. Tachometer 9. Keyway 10. Motor 11. Frequency Controller 12. Horizontal Proximity Probe 13. Circumferential V-Notch 14. Dead Weights 15. Shaft 16. Auxiliary Bearing House 17. Inductive Power Coil 18. Inductive Pickup Power Head 19. Encoder for Strain Gauges

Technology

This Test Rig Consists of:

- **A test bed;**
- **A pair of first bearings to support one end of the shaft;**
- **At least one load inducer that applies a static bending load to the shaft;**
- **At least one non-contact magnetic shaker that generates random load patterns, simulating real-world operating conditions;**
- **Multiple accelerometers, a laser vibrometer, a strain gauge, a proximity probe, and a tachometer for measuring vibrations, strains, and shaft responses**

This test rig and method are designed for assessing the fatigue life and integrity of a shaft under various loads and conditions, enabling early detection of potential issues such as fatigue cracks.

Method for Conducting Fatigue Analysis:

1. **Positioning the Shaft:** Place the shaft between the pair of first bearings.
2. **Inducing Rotary Motion:** Use the motor to induce rotary motion in the shaft.
3. **Applying Static Load:** A static bending load is applied to the shaft using the load inducer.
4. **Inducing Random Load Profile:** Use at least one non-contact magnetic shaker to induce random load profiles onto the shaft.
5. **Analyzing Vibration Signatures:** The vibration and strain responses recorded by the data acquisition system are analyzed for diagnosis and prognosis of fatigue-induced issues in the shaft, such as fatigue cracks.
6. **Estimating Fatigue Life:** The method may involve estimating the fatigue life of the shaft using either a time-domain approach or a frequency-domain approach.
7. **Diagnosing Fatigue Cracks:** The method may also involve diagnosing fatigue cracks in the shaft before they become critical in size using various methods, including time-domain, frequency-domain, and time-frequency domain approaches.

Intellectual Property

IITM IDF Ref. 1904; Patent No. 453220

CONTACT US
Dr. Dara Ajay, Head
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: smipm-icsr@icsrpis.iitm.ac.in
sm-marketing@imail.iitm.ac.in
Phone: +91-44-2257 9756/ 9719