Design and Fabrication of Portable Wear Measurement Machine used for sustainable development

Abdulrahman Khaled AL-Shammari , Salman Fahad Al-Harbi

Supervised by Prof. Dr. Maaz Akhtar

Al- Imam Mohammad Ibn Saud Islamic University

Mechanical and Industrial Engineering Department, College of Engineering

ABSTRACT

In many engineering applications in industries metals are in contact with other materials. This contact may destroy and damage the surface by material removal and is termed as wear [1]. Abrasion, erosion and corrosion are the main causes of wear. Wear degrade the surface first by initiation of crack and later crack propagation grows and it eventually causes the material failure. Wear generally causes the material to fail plastically. [2]

MOTIVATION

- The motivation of current project is to design and fabricate portable wear measuring machine which can be used to determine wear rate of dissimilar materials that will ultimately help in sustainable production.
- Design and fabrication of pin-on-disc wear measurement device is done to have cost effective and portable solution that perform efficiently.

OBJECTIVES

- The purpose of current project is to initiate the research on tribological field by designing a portable wear measurement instrument and then calculate the wear resistance of different metals.
- The current project's objective is to search for an alternative and sustainable material that work efficiently. Wear resistance helps in deciding that which material works better for any application.

METHODOLOGY

- Review ASTM Standard Test Method for Wear Measurement [2].
- Structural analysis of Wear Machine.
- Development of CAD model.
- Procurement of material and equipment required for fabrication.
- Fabrication of Wear Machine.
- Test Run and Calibration of Machine.

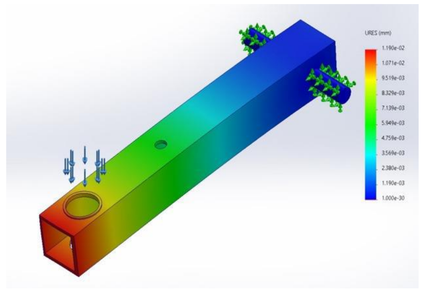
FINITE ELEMENT MODELING

- **Beam**

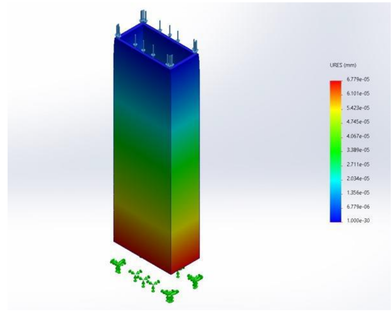
Analyzing a beam with a finer mesh is a common practice in engineering, particularly when using finite element analysis (FEA). It involves dividing the beam geometry into smaller elements.

- **Leg (Columns)**

Studying fractures requires capturing stress concentrations and crack propagation accurately. Finer meshes provide a more precise picture of these phenomena, aiding surgeons in diagnosis, treatment planning, and predicting healing outcomes.



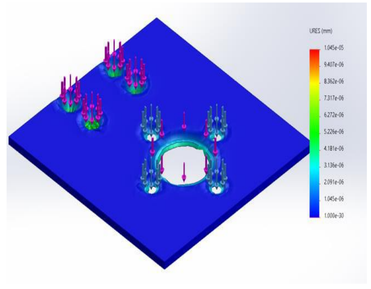
Stress Beam Test



Stress Leg Test

- **Table**

Simulating loads applied to a table (heavy objects) requires capturing localized stresses and deformations. COMSOL helps you identify natural frequencies and resonance points, allowing you to adjust the design, (materials, thickness) to avoid problematic frequencies.



Stress Table Test

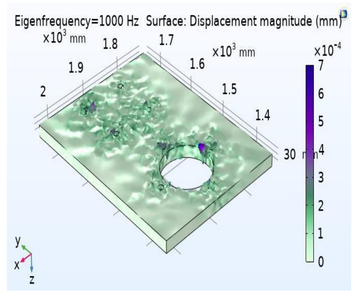
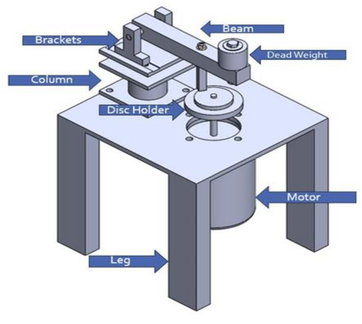


Table Model (Frequency Analysis 1000 RPM)

FINAL EQUIPMENTS DESIGN



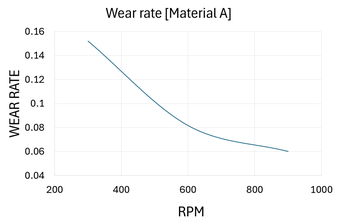
- Table with legs: it is to support the structure.
- Column: it is to support the swivel and the beam.
- Swivel: it is to support beam and brackets.
- Beam: it is to hold pin and the load is applied at the end of beam too.
- Pin: which is in contact with the specimen so that it can wear out.
- Specimen: it is wear is to be calculated.
- Brackets: it is to support the beam.
- Motor: which rotates the specimen.
- Disc: at which our specimen is placed.
- Coupling: to couple disc with motor.
- Applied load: The load applied at the top of beam

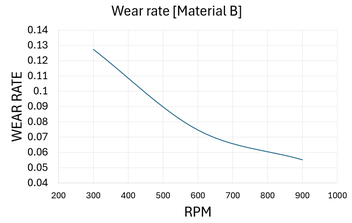
RESULT & DISCUSSION

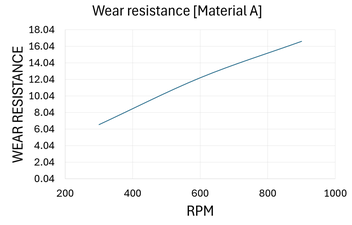
- After the fabrication and final assembling machine is first tested without sample to check its working. Later experimental investigation is done. Two grades of aluminum material are used as a disc sample while pin made of HSS material is used. For each case mass loss and finally wear resistance is measured.

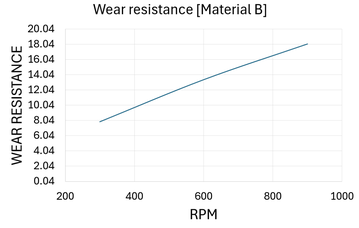
INITIAL MASS (Grams)	
Material-A	Material-B
133.9	128.7
133.3	128.2
127.8	134.4

RPM	MASS LOSS	
	Material-A	Material-B
300	0.27	0.3
600	0.29	0.23
900	0.32	0.27









CONCLUSIONS

- Portable wear measuring instrument is designed and fabricated for determining wear resistance. Wear measuring instrument is fabricated in cost effective manner plus light weight that helps in testing remotely. Two types of aluminum alloy were tested with HSS pin at three different speeds. Olympic alloy shows better wear resistance at all three speeds. This study will help in improving the reliability of the equipment and guided to design equipment in sustainable manner.

REFERENCES

[1] Maaz Akhtar, Muhammad Muzamil, Muhammad Samiuddin, Naser Alsaleh, Rashid Khan, Mahad Khan, Joy Djuansjah, Ali Khurshid Siddiqui, and Arfan Majeed, 2024. Post-Wear Surface Morphology Assessment of Selective Laser Melting (SLM) AlSi10Mg Specimens after Heat Exposure to Different Gas Flames. Coatings 2024, 14, 252.

[2] ASTM: “Standard Test Method for Wear Testing with a Pin-on-Disc Apparatus”. Designation: G 99-95a (Reapproved 2000)