IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 12, April 2025
Impact Factor: 7.67

Design and Manufacturing of Curve Surface Milling Mechanism

Saurabh Veer[1], Shivam Punde[1], Vaibhav Gourkar[1], Sahil Parab[1], Prof. J. A. Kute[2]
[1]B. Tech Student, Mechanical Engineering Department
[2]Assistant Professor, Mechanical Engineering Department
JSPM's Rajarshi Shahu College of Engineering, Pune, India

Abstract: *Convex surface milling plays an important role in industries requiring complex shapes. CNC machines typically handle this task but are expensive and complex. This paper introduces a manual convex surface milling mechanism that is affordable, efficient, and suitable for materials like aluminum, MDF, and acrylic. The mechanism uses a lead screw-driven curved platform beneath a stationary milling tool. Experimental tests demonstrated acceptable surface finishes comparable to CNC machining within educational and prototyping tolerances*

Keywords: Convex Surface Milling, Manual Milling, Lead Screw Mechanism, CNC Alternative, Surface Roughness.

I. INTRODUCTION

Machining convex profiles is crucial in many sectors. Traditional CNC machining is precise but costly. The aim of this project is to design an economical, manual convex surface milling mechanism.

Objectives:

- Design a cost-effective convex milling mechanism.
- Enable milling on aluminum, wood, and acrylic.
- Maintain acceptable surface precision.
- Provide manual control using a lead screw.

II. METHODOLOGY

The design involves a platform mounted on inclined rods, moved manually using a lead screw. Material selection includes:
Frame: Mild Steel
Guide Rods and Lead Screw: Hardened Steel
Work Platform: Aluminum
Standard fabrication processes like turning, drilling, welding, and surface finishing were used. The assembled mechanism was tested for smooth motion and accurate material feed.

III. SCHEMATIC REPRESENTATION

Side View: Showing inclined platform setup.
Top View: Showing material feed path and motor arrangement.
Force Analysis Diagram: Showing distribution of forces during milling.

DOI: 10.48175/IJARSCT-25926

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 12, April 2025
Impact Factor: 7.67

Figure 1: Side View Schematic

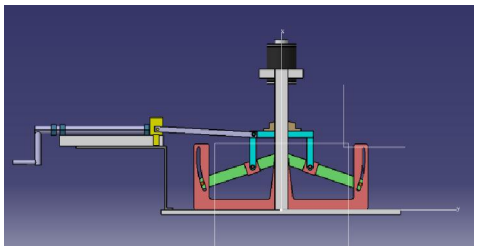
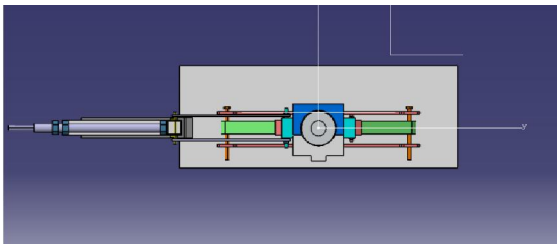


Figure 2: Top View Schematic



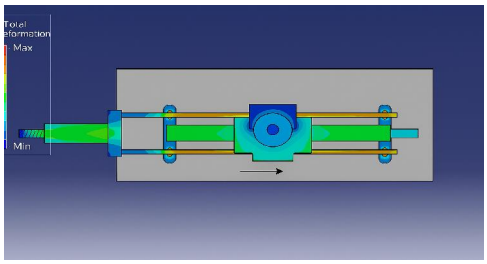


Figure 3: Force Analysis Diagram

IV. ANALYSIS AND CALCULATIONS

Lead Screw Pitch: 2 mm/rev
Platform Feed Rate: ~120 mm/min at 60 RPM
Cutting Force Estimation: 30–50 N
Platform Deflection: <0.02 mm
Surface Roughness: Measured using a profilometer.
Lead Screw Displacement
Pitch: 2 mm/rev
Speed: 60 RPM
Feed Rate = 2 × 60 = 120 mm/min
Cutting Force
Fc = k· t ·w
For Aluminium (k ≈ 0.8 N/mm²), MDF (~0.5 N/mm²)
Platform Deflection

$$\delta = \frac{F \cdot L^3}{3EI}$$

Result: < 0.02 mm (within tolerance limits)

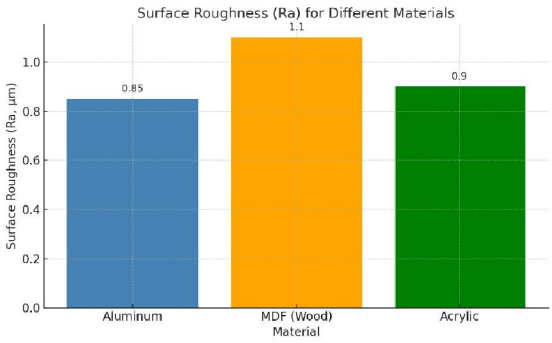
V. EXPERIMENTAL RESULTS

Materials tested: Aluminum, MDF, Acrylic

Material	Surface Roughness (Ra, µm)	Tool Speed (RPM)	Feed Mechanism	Platform Feed Rate (mm/min)
Aluminum	0.85	~1500–2500	Manual	~120
MDF	1.1	~1500–2000	Manual	~120
Acrylic	0.9	~1800–2200	Manual	~120

DOI: 10.48175/IJARSCT-25926

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 12, April 2025
Impact Factor: 7.67



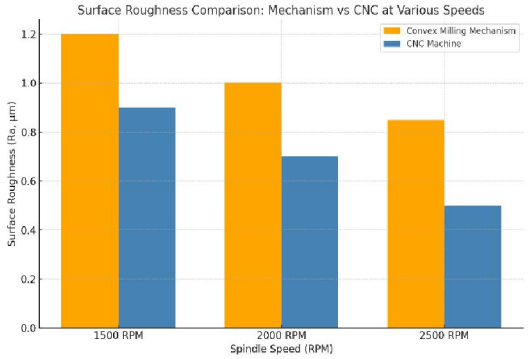


Figure 4: Surface Roughness for Different Materials

Figure 5: Surface Roughness Comparison between Mechanism and CNC Machine

VI. MECHANISM SPECIFICATIONS

Component	Specification
Platform Size	300 mm × 200 mm
Platform Material	Mild Steel Frame with Aluminum Top
Platform Motion	Manual (Lead Screw Driven)
Lead Screw Pitch	2 mm/rev
Crank Rod Length	250 mm
Inclined Rod Fixed Angle	15°
Angle Adjustment Slot Range	±10°
Maximum Platform Tilt	25°
Minimum Platform Tilt	5°
Milling Tool Mount	Stationary Vertical Spindle
Bearings	Deep Groove Ball Bearings
Overall Mechanism Size	600 mm × 400 mm × 500 mm

VII. ANGLE SETTINGS FOR CONVEX SURFACE MILLING MECHANISM

Parameter	Value
Default Inclined Rod Angle	15°
Maximum Platform Inclination	25° (15° + 10°)
Minimum Platform Inclination	5° (15° - 10°)
Practical Working Range	5° to 25°

VIII. DISCUSSION

The developed convex surface milling mechanism provides a low-cost alternative to CNC for convex surface generation, suited for educational institutions and small workshops.

Although manual, the mechanism maintains good surface finish and dimensional accuracy.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 12, April 2025
Impact Factor: 7.67

Observations:
Surface roughness achieved: 0.85–1.1 µm.
Aluminum required slower feed rates.
MDF and Acrylic allowed moderate speeds without surface defects.

Limitations:
Operator-dependent feed rate variations.
Restricted to 2D convex surfaces.

Advantages:
Very low initial and maintenance cost.
Simplicity of operation and setup.

IX. CONCLUSION AND FUTURE SCOPE

The manually operated convex milling mechanism successfully mills curved profiles without CNC dependency. Future improvements include:

- Motorized platform movement.
- Automated angle adjustment.
- Better surface finish strategies.

ACKNOWLEDGMENT

It gives us immense pleasure to present the project report on “Design and Manufacturing of Curve Surface Milling Mechanism.”
We would like to express our deep gratitude to Prof. J. A. Kute, our project guide, for his valuable support, encouragement, and guidance throughout the course of this project.
We are also thankful to Dr. S. N. Khan, Head of the Mechanical Engineering Department at JSPM’s Rajarshi Shahu College of Engineering, Pune, for providing us with the necessary resources and infrastructure to carry out our work successfully.

REFERENCES

[1] I. Castanhera, A. E. Diniz, "High-Speed Milling of Hardened Steel Convex Surface," Procedia Manufacturing, 2016.
[2] J. Krishnaraj, et al., "Design and Analysis of Work Holding Device for Convex Milling," Journal of Physics: Conference Series, 2024.
[3] X. Hao, C. Yue, et al., "Modeling of Convex Surface Topography," Metals, 2020.
[4] S. D. Dhebe, et al., "Convex Surface Milling Mechanism," IRJMETS, 2024.
[5] C. K. Toh, "Surface Topography in Ball Nose End Milling," Journal of Materials Processing Technology, 2004.
[6] M. Arizmendi, et al., "Surface Roughness Prediction in Ball-End Milling," International Journal of Advanced Manufacturing Technology, 2009