

Design and Development of a Plate Cam Using 3D Printing Technology for Seed Sowing Applications

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Abstract - The plate cam (disc cam) is a vital mechanical component used to convert rotary motion into controlled reciprocating or oscillatory motion. This research focuses on the design, development, and performance evaluation of a plate cam fabricated using 3D printing technology for application in a seed sowing machine. The cam profile was designed using CAD software based on motion requirements such as lift, dwell, and return periods. The model was fabricated using the Fused Deposition Modeling (FDM) process with PLA material.

The developed cam mechanism was integrated with a seed metering system to achieve controlled seed dispensing. Experimental results indicate smooth motion transfer, uniform seed spacing, and satisfactory dimensional accuracy. The study demonstrates that 3D printing offers a cost-effective, rapid prototyping solution for mechanical components. However, limitations in material strength restrict its use to low-load applications. This work highlights the potential of additive manufacturing in agricultural machinery and mechanical design education.

Key Words: Plate Cam, 3D Printing (FDM), Seed Sowing Machine, Cam and Follower Mechanism, PLA Material

1. INTRODUCTION

1.1 Overview of Plate Cam

A plate cam is a rotating mechanical element used to convert rotary motion into reciprocating or oscillating motion. It is widely used in machines requiring precise timing and motion control.

1.2 Role of Cam in Mechanical Systems

Cams control motion based on their profile and are used in:

- i. Internal combustion engines
- ii. Textile machinery
- iii. Packaging systems
- iv. Agricultural equipment

They can generate: Uniform velocity motion, Simple harmonic motion and Accelerated motion.

1.3 Cam and Follower Mechanism

Cam Rotation → Follower Movement → Output Motion

- i. Cam rotates continuously
- ii. Follower moves based on cam profile
- iii. Motion is transferred to working mechanism

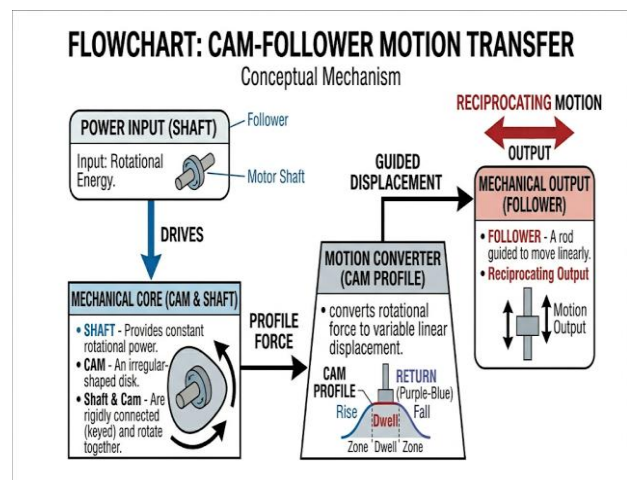


Fig -1: Cam - Follower Motion Transfer

1.4 Application in Seed Sowing Machine

In seed sowing machines, precise seed placement is required. The cam helps:

- i. Control seed dispensing
- ii. Maintain uniform spacing
- iii. Reduce seed wastage

1.5 Introduction to 3D Printing

3D printing (Additive Manufacturing) builds objects layer by layer from a digital model.

Steps:

- i. CAD modeling
- ii. STL conversion
- iii. Slicing
- iv. Printing

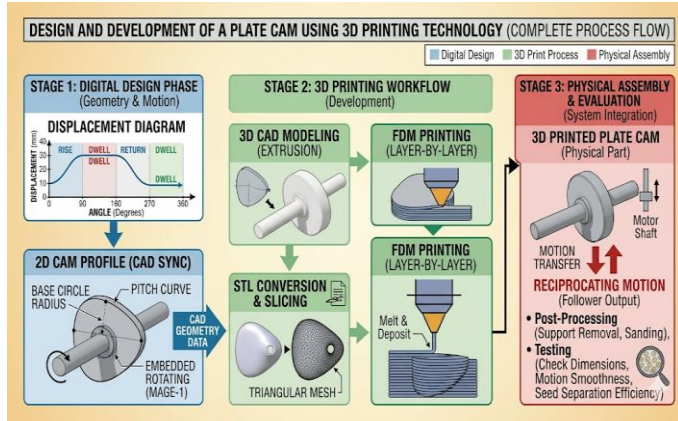


Fig -2: Design and Development of Plate Cam Using 3D Printing

1.6 Advantages of 3D Printing

- i. Low cost
- ii. Rapid prototyping
- iii. Easy design modification
- iv. Minimal material wastage

1.7 Design Parameters of Cam

- i. Base Circle
- ii. Lift (Stroke)
- iii. Dwell Period
- iv. Rise and Return

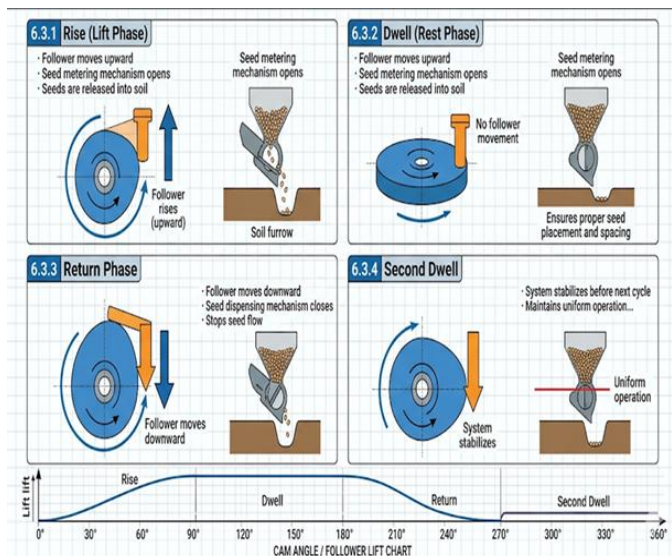


Fig - 3: Motion Analysis of Cam for Seed Metering

2. Methodology

2.1 Design and Development Approach

The methodology for the design and development of the plate cam begins with the identification of the functional requirements of the seed sowing machine. The system requires controlled and intermittent motion to ensure proper seed dispensing, uniform spacing, and minimal seed damage. To meet these requirements, a plate cam (disc cam) mechanism was selected due to its simplicity, compact design, and ability to produce precise and repeatable motion.

After selecting the cam type, a suitable follower mechanism, such as a roller or flat-faced follower, was chosen to ensure smooth contact and reduce wear. The next step involved determining key design parameters, including base circle radius, lift (stroke), and motion timing (rise, dwell, and return periods). These parameters were defined based on the displacement requirements of the seed metering mechanism.

To achieve smooth motion and minimize vibration, simple harmonic motion (SHM) was selected as the motion law. The cam profile was then developed using graphical methods by dividing the cam rotation into equal angular intervals and plotting the corresponding follower displacement. The points were joined smoothly to generate an accurate cam profile.

The designed profile was modeled using CATIA software, where a 2D sketch was first created and then converted into a 3D model through extrusion. The finalized model was exported in STL format for further processing in 3D printing.

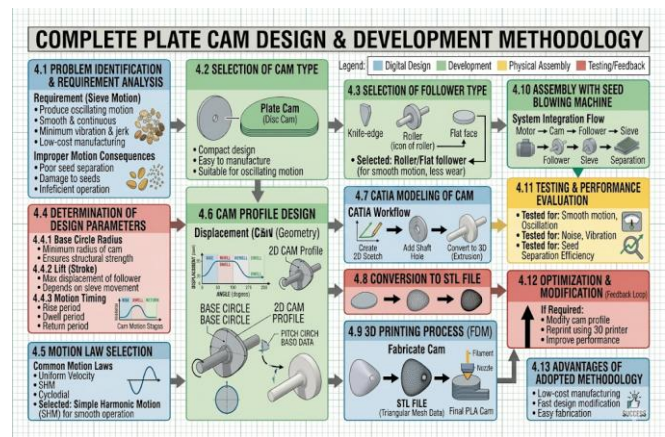


Fig -4: Plate Cam Design and Development Methodology

2.2 Fabrication, Assembly and Testing

The fabrication of the cam was carried out using the Fused Deposition Modeling (FDM) process, a widely used 3D printing technique. PLA (Polylactic Acid) was selected as the material due to its low cost, ease of printing, and sufficient strength for prototype development. The STL file of the cam was imported into slicing software, where parameters such as layer height, printing speed, temperature, and infill density were set. The cam was then printed layer by layer using a 3D printer.

After printing, post-processing operations such as removal of support material and minor surface finishing were performed to improve dimensional accuracy and surface quality. The fabricated cam was then mounted on a shaft and assembled with the follower mechanism. This assembly was integrated into a seed sowing setup to evaluate its functional performance.

The system was tested under working conditions to analyze parameters such as smoothness of motion, vibration, noise, and accuracy of seed dispensing. The cam mechanism successfully converted rotary motion into controlled reciprocating motion, ensuring uniform seed placement. Based on the observations, minor modifications were made to improve performance. This iterative process helped in optimizing the design and achieving reliable operation of the system.

3. RESULTS AND APPLICATIONS

3.1 Results

(a) Fabrication Results

- i. Accurate shape obtained
- ii. Good surface finish
- iii. Proper alignment

(b) Functional Performance

- i. Smooth follower motion
- ii. No jerks observed
- iii. Effective motion transfer

3.1.1 Working Concept

Motor → Cam → Follower → Seed Metering → Seed Placement

3.1.2 Seed Sowing Performance

- (a) Uniform seed spacing
- (b) Controlled dispensing
- (c) Improved efficiency

3.1.3 Dimensional Accuracy

Parameter	Designed	Measured	Error
Diameter	100 mm	98–99 mm	~2%
Hole	20 mm	19.8 mm	~1%

3.2 Applications

(a) Agricultural

Seed sowing machines, Grain sorting systems

(b) Mechanical Systems

Engine valve mechanisms, Packaging machines

(c) Automation

Conveyor systems, Indexing mechanisms

(d) Educational

Lab experiments, Demonstration models

3.2.1 Advantages

- i. Low cost
- ii. Lightweight
- iii. Easy modification

3.2.2 Limitations

- i. Low strength of PLA
- ii. Wear over time
- iii. Not for heavy loads

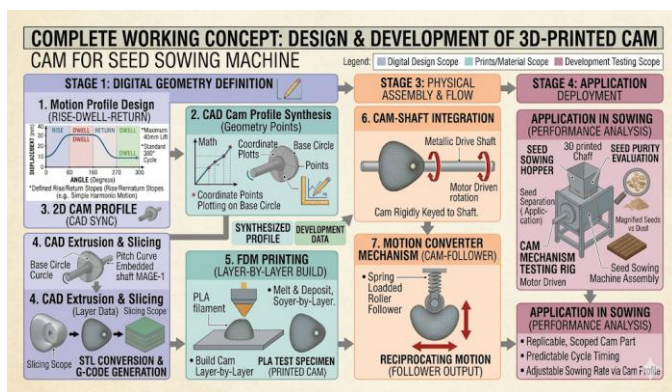


Fig – 5: Working Concept

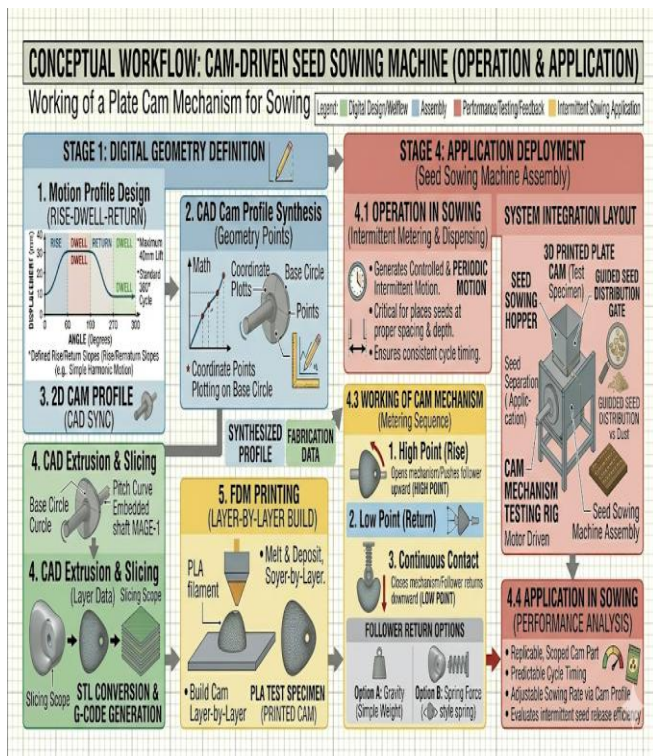


Fig – 6: Workflow of Cam Driven Seed Sowing Machine

4. Software Designs:

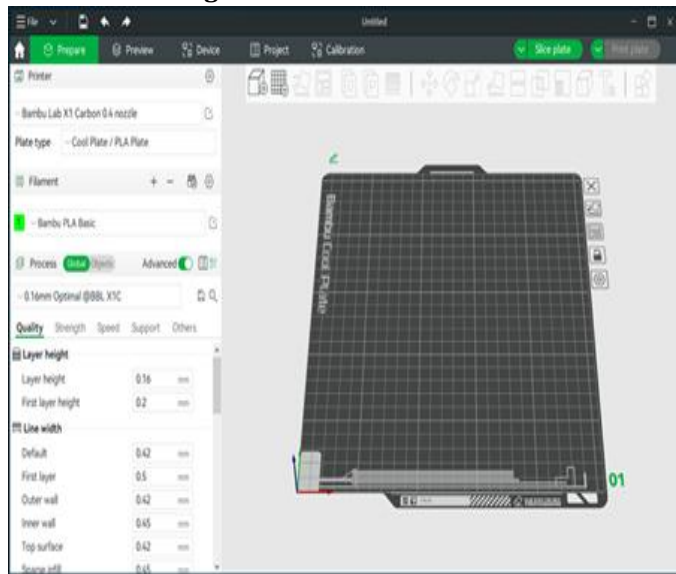


Fig – 7: Slicing Setup in Bambu Studio for 3D Printing

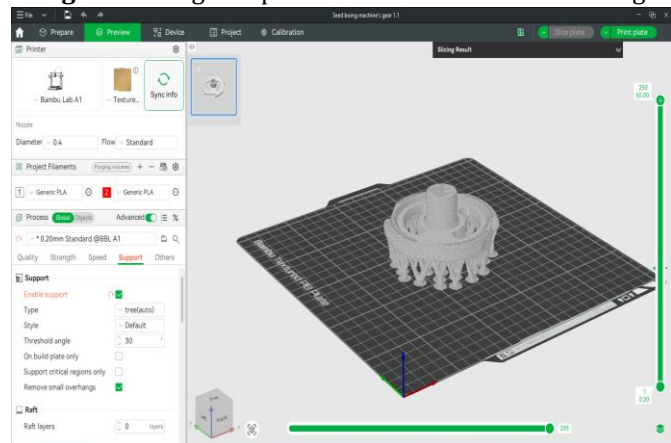


Fig – 8: Model Preparation for Printing

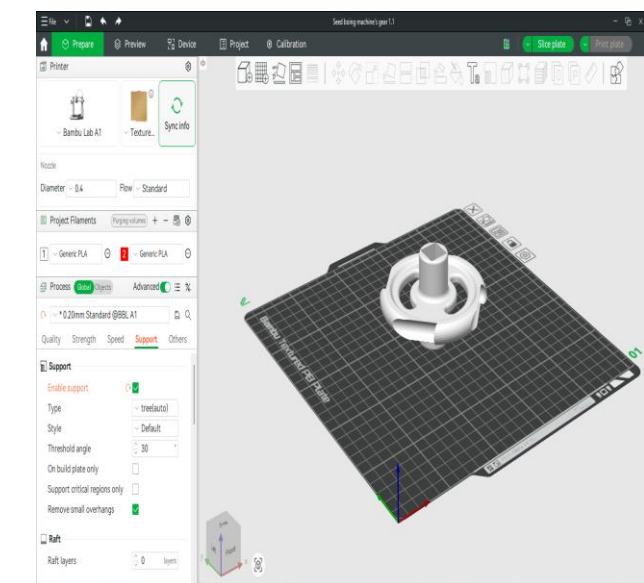


Fig – 9: Final Print Layout on Build Plate

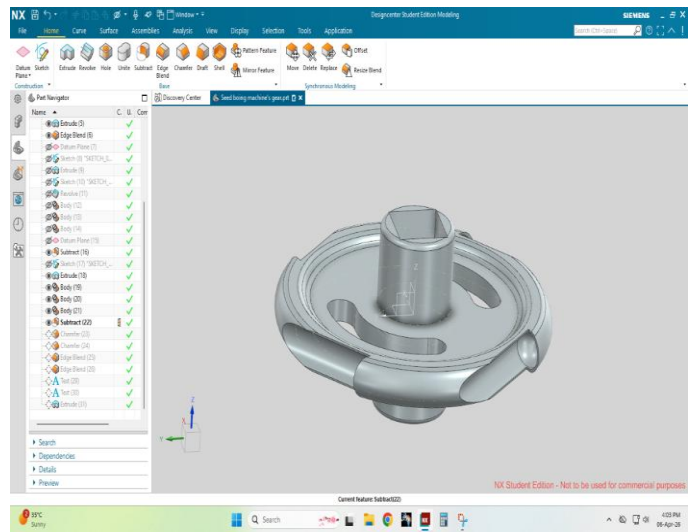


Fig – 10: 3D View of Plate Cam Designed Using Bambu Software



Fig – 11: Actual Product



Fig – 12: 3D Printer Set Up

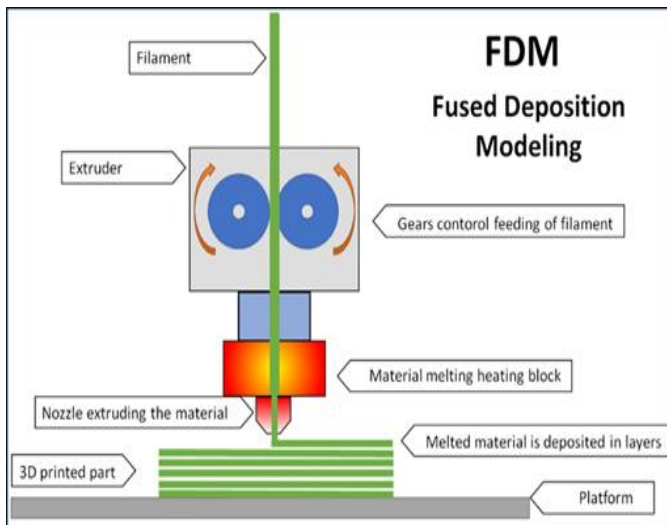


Fig - 13: FDM

4. CONCLUSIONS

The study successfully demonstrates the design and development of a plate cam using 3D printing technology. The cam effectively converts rotary motion into controlled intermittent motion required for seed sowing applications. The system exhibited smooth operation, accurate seed placement, and good functional performance.

The use of PLA material and FDM technology proved to be economical and efficient for prototype development. However, limitations in strength and wear resistance restrict its use to light-load applications. Overall, the integration of cam mechanisms with additive manufacturing offers a promising approach for low-cost agricultural solutions and educational purposes.

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