IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

MANUFACTURING OF CYCLOIDAL GEAR BOX FOR SPEED REDUCTION

[1]SAHIL S. DEDAKE, [2]ROHIT S. DHAKANE, [3]SHASHANK S. GAWALI, [4]JAGANNATH C. GHOLAP, [4]PANKAJ L. FIRKE

[1]DEPATMENT OF MECHANICAL ENGINEERING
[1]JSPM'S RAJARSHI SHAHU COLLEGE OF ENGINEERING, PUNE, INDIA

Abstract:

This project details the design, development, and evaluation of a prototype cycloidal gearbox. Cycloidal gear systems are known for their high torque transmission, compact size, and low noise levels. The main goal of this study is to create a functional prototype to demonstrate the feasibility and effectiveness of cycloidal gearboxes for various applications.

The project starts with a comprehensive literature review to understand the principles, benefits, and challenges associated with cycloidal gearing. Utilizing this information, a thorough design process is conducted, including CAD modeling and finite element analysis (FEA) for optimization. Special focus is placed on the design of the cycloid disk and pins to ensure efficient power transmission and minimal wear.

After the design phase, the prototype is manufactured using precision machining techniques. Rigorous testing is performed to evaluate its performance characteristics, including torque transmission efficiency, speed variability, and noise levels. Comparative analyses with conventional gear systems are conducted to highlight the unique advantages of the cycloidal design.

The findings of this project contribute to the advancement of cycloidal gearbox technology, offering valuable insights into their practical implementation and performance capabilities. Additionally, the prototype serves as a foundation for further research and development in the field of mechanical power transmission systems.

Keywords:

Cycloidal Gearbox, Speed Reduction, Cycloidal Gearing System, Gear Design, High Torque Transmission, Gearbox Manufacturing, CAD Modeling, Cycloid Disk, Precision Machining, Power Transmission Efficiency, Gearbox Optimization, Gearbox Testing, Noise Reduction, Comparative Analysis, Mechanical Power Transmission.

1.INTRODUCTION

In mechanical engineering, innovation drives progress, and the Cycloidal Gearbox Prototype represents a significant advancement in transmission technology. Unlike traditional gear systems, the cycloidal gearbox utilizes the principles of epicyclic gearing and cycloidal motion to deliver superior performance. It offers enhanced torque transmission, minimal backlash, compactness, and exceptional durability.

The Cycloidal Gearbox operates with an input shaft that moves an eccentric cam, causing a cycloid disc to orbit within a ring of fixed pins. This unique motion reduces the speed at the output shaft while maintaining a smaller, lighter, and quieter profile than conventional gear systems.

Ideal for applications requiring high efficiency and reliability, the Cycloidal Gearbox excels in environments with shock loads, such as automotive transmissions, robotics, industrial machinery, and renewable energy systems. Its robust design ensures longevity and low maintenance, making it suitable for areas where noise and space constraints are critical, like hospitals and offices.

In summary, the Cycloidal Gearbox Prototype showcases the potential to revolutionize mechanical transmission systems, emphasizing human ingenuity and the pursuit of excellence in engineering.

In mechanical engineering, innovation drives progress, and the Cycloidal Gearbox Prototype represents a significant advancement in transmission technology. Unlike traditional gear systems, the cycloidal gearbox utilizes the principles of epicyclic gearing and cycloidal motion to deliver superior performance. It offers enhanced torque transmission, minimal backlash, compactness, and exceptional durability.

The Cycloidal Gearbox operates with an input shaft that moves an eccentric cam, causing a cycloid disc to orbit within a ring of fixed pins. This unique motion reduces the speed at the output shaft while maintaining a smaller, lighter, and quieter profile than conventional gear systems.

Ideal for applications requiring high efficiency and reliability, the Cycloidal Gearbox excels in environments with shock loads, such as automotive transmissions, robotics, industrial machinery, and renewable energy systems. Its robust design ensures longevity and low maintenance, making it suitable for areas where noise and space constraints are critical, like hospitals and offices.

In summary, the Cycloidal Gearbox Prototype showcases the potential to revolutionize mechanical transmission systems, emphasizing human ingenuity and the pursuit of excellence in engineering.
In mechanical engineering, innovation drives progress, and the Cycloidal Gearbox Prototype represents a significant advancement in transmission technology. Unlike traditional gear systems, the cycloidal gearbox utilizes the principles of epicyclic gearing and cycloidal motion to deliver superior performance. It offers enhanced torque transmission, minimal backlash, compactness, and exceptional durability.

The Cycloidal Gearbox operates with an input shaft that moves an eccentric cam, causing a cycloid disc to orbit within a ring of fixed pins. This unique motion reduces the speed at the output shaft while maintaining a smaller, lighter, and quieter profile than conventional gear systems.

Ideal for applications requiring high efficiency and reliability, the Cycloidal Gearbox excels in environments with shock loads, such as automotive transmissions, robotics, industrial machinery, and renewable energy systems. Its robust design ensures longevity and low maintenance, making it suitable for areas where noise and space constraints are critical, like hospitals and offices.

In summary, the Cycloidal Gearbox Prototype showcases the potential to revolutionize mechanical transmission systems, emphasizing human ingenuity and the pursuit of excellence in engineering..

2.CONSTRUCTION

Frame

The frame of the machine is a critical component, typically made from mild steel, known for its strength and ability to endure various loads during operation. The frame not only provides structural support to the machine but also contributes to its aesthetic appeal. Proper frame design is essential for the stability and performance of the machine.

In our project, the frame plays a significant role by supporting the vertical pulley and sprocket mounted on its vertical supports. The entire assembly of the project is mounted on this frame. The choice of material and its properties are crucial in fabrication. The frame must be strong enough to balance the loads from other machine parts. The material selection is based on several factors such as availability, suitability for working conditions, cost, physical and chemical properties, and mechanical properties.

Key Mechanical Properties:
1. Strength: The ability to resist externally applied forces without breaking or yielding.
2. Stress: Internal resistance offered by a part to an externally applied force.
3. Stiffness: Resistance to deformation under stress.
4. Elasticity: Ability to regain original shape after deformation.
5. Plasticity: Retains deformation produced under load permanently.
6. Ductility: Can be drawn into wire with tensile force.
7. Brittleness: Breaks with little permanent distortion.
8. Malleability: Can be rolled or hammered into thin sheets.
9. Toughness: Resists fracture due to high impact loads.
10. Resilience: Absorbs energy and resists impact loads.
11. Creep: Slow, permanent deformation under constant stress at high temperatures.
12. Hardness: Resistance to wear, scratching, and deformation.

Material Selection

Mild Steel:
- Availability: Readily available in the market.
- Economical: Cost-effective choice.
- Standard Sizes: Available in standard sizes.
- Mechanical Properties: Easily machinable with good mechanical properties.
- Moderate Factor of Safety: Balances material use and risk of failure.
- High Tensile Strength: Strong enough for structural applications.
- Low Coefficient of Thermal Expansion: Stable under temperature variations.

Properties of Mild Steel:
- Carbon content ranges from 0.15% to 0.30%.
- Easily weldable and can be hardened.
- Both ultimate tensile and compressive strength increase with carbon content.
- Gas and electric weldable, although weldability decreases with higher carbon content.

Fabrication Process

Basic Frame:
- Made from mild steel angles cut to required sizes using a cutting machine.
- Ends are cut at 90 degrees to form a rectangular frame and then ground smooth for welding.
- Angles are welded together to form the basic rectangular frame.

Fasteners (Nuts and Bolts):
- Used to fasten parts together, with threads providing friction and compression.
- Bolts come in various head designs, with hexagonal heads being common for spanners or wrenches.

Shaft:
- A rotating machine element used to transmit power.
- Made from materials with high strength, machinability, low notch sensitivity, good heat treatment properties, and high wear resistance.
- Typically made from mild steel, carbon steel, or alloy steel depending on strength requirements.
- Types include transmission shafts, machine shafts, spindles, and axles.

Belt Drive

Power Transmission:
- Uses belts, chains, and gears to transmit power between shafts.
- Belts are preferred for long distances, chains for intermediate distances, and gears for short distances.

Types of Belts:
- Flat Belt: Rectangular in cross-section, relies on friction.
- V-Belt: Trapezoidal in section, preferred for shorter distances and can use multiple belts for higher power.
- Circular Belt: Circular in section, used for specific applications.

Types of Belt Drives:
- Open Belt Drive: Pulleys rotate in the same direction.
- Cross Belt Drive: Pulleys rotate in opposite directions.

Law of Belting:
- The centerline of the belt must lie in a plane perpendicular to the axis of the pulley to avoid the belt running off the pulley.

Materials for Belts:
- Leather: Strong, flexible, durable, and requires periodic maintenance.
- Cotton or Fabric: Cheaper, suitable for warm climates and damp atmospheres.
- Rubber: Flexible but sensitive to heat, oil, or grease.
- Balata: Acid-proof, waterproof, and more robust than rubber belts.

AC Motor

AC Motor:
- Converts electrical energy into mechanical energy based on Fleming's Left-Hand Rule.
- A 0.25 HP AC motor with 1440 RPM is used in this project.

Machining Operations

Cutting:
- Separation of material using tools like knives, saws, or chop saws.

Welding:
- Joining metals using high heat to melt parts together.
- Electric arc welding is used for the frame assembly.

Drilling:
- Cutting process to create holes using drill bits.

Finishing:
- Improves surface appearance and properties through various processes.

Polishing:
- Creates a smooth and shiny surface by rubbing or chemical action.

Overall, the construction of the machine involves precise material selection, cutting, welding, drilling, and finishing operations to ensure the frame and other components meet the required mechanical properties and performance standards.

3.OBJECTIVE

Creating a prototype of a cycloidal gearbox involves several objectives that span technical, educational, and practical aspects. Here are some key objectives for such a project:

1. Educational Objectives

- Understanding Cycloidal Mechanisms: Gain a deep understanding of the principles of cycloidal gearing, including their design, operation, and advantages over traditional gear systems.
- Design Skills: Develop skills in CAD (Computer-Aided Design) software to create accurate and functional designs of cycloidal gears and related components.
- Manufacturing Techniques: Learn and apply various manufacturing techniques, such as CNC machining, 3D printing, and precision assembly, to create the prototype.
- Testing and Analysis: Gain experience in testing mechanical systems, analyzing performance data, and troubleshooting issues to refine the design.

2. Technical Objectives

- High Efficiency and Load Capacity: Design a gearbox that demonstrates the high efficiency and load-bearing capabilities of cycloidal gear systems.
- Low Backlash and Vibration: Achieve minimal backlash and reduced vibration, showcasing the precision and smooth operation of cycloidal gears.
- Compact and Robust Design: Create a compact and robust gearbox prototype that can handle high shock loads and operate reliably in demanding conditions.

3. Innovation and Optimization

- Innovative Design Features: Explore and incorporate innovative design features that enhance the performance and manufacturability of cycloidal gearboxes.
- Optimization: Optimize the design for specific applications, such as robotics, automation, or heavy machinery, ensuring that the prototype meets industry-specific requirements.

4. Practical and Application-Oriented Objectives

- Real-World Applications: Demonstrate the potential applications of cycloidal gearboxes in various industries by showcasing the prototype's performance in real-world scenarios.
- Cost-Effectiveness: Evaluate the cost-effectiveness of the cycloidal gearbox design, considering materials, manufacturing processes, and potential scalability for mass production.
- Reliability and Maintenance: Assess the reliability and maintenance needs of the prototype, aiming to highlight the long-term benefits of cycloidal gearboxes over traditional systems.

5. Documentation and Reporting

- Comprehensive Documentation: Produce detailed documentation of the design process, including design iterations, manufacturing steps, testing procedures, and performance analysis.
- Reporting Results: Prepare a comprehensive report or presentation that outlines the objectives, methodology, results, and conclusions of the project, demonstrating the advantages and potential of cycloidal gearboxes.

6. Collaboration and Teamwork

- Team Collaboration: Work effectively as a team, with clear roles and responsibilities, to manage the project from concept to completion.
- Interdisciplinary Approach: Collaborate with experts from different fields, such as mechanical engineering, materials science, and manufacturing, to leverage a wide range of expertise and ensure a successful project outcome.

7. Future Development and Research

- Prototype Evaluation: Critically evaluate the prototype to identify areas for improvement and future research opportunities.
- Scalability and Commercialization: Explore the potential for scaling the prototype for commercial production and identify steps needed to bring the product to market.

By achieving these objectives, the cycloidal gearbox prototype project can provide valuable insights into the design and application of advanced gear systems, contribute to the field of mechanical engineering, and potentially lead to innovative solutions for various industrial challenges.

4. PROCEDURE

The entire model has been designed with the help of designing software solid works
With the help of colour feature the colours are given to the entire model.

SOLID MODELING

The entire model has been designed with the help of designing software solid works.

Calculations

EN10083 C45 Steel carbon steel
C45 steel sheet Physio-chemical testing items for products of the plant include tensile test, hardness test, impact test, flattening test and chemical composition analysis, etc.C20,C45 steel pipes are manufactured by cold drawn process.
C45 is a medium carbon steel is used when greater strength and hardness is desired than in the "as rolled" condition. Extreme size accuracy, straightness and concentricity combine to minimize wear in high-speed applications. Turned, ground and polished.
Soft Annealing

Heat to 680-710oC, cool slowly in furnace. This will produce a maximum Brinell hardness of 207.

Normalizing

Normalizing temperature: 840-880oC/air.

Hardening

Harden from a temperature of 820-860oC followed by water or oil quenching.

Tempering

Tempering temperature: 550-660oC/air.

C45 steel plate, EN 10083C45 steel plate, under EN 10083 standard, we can regard C45 steel plate as high carbon steel.
C45 steel plate is one mainly of high carbon steel, EN 10083C45 steel plate is for quenching and tempering. Technical delivery conditions for non-alloy steels, these steels are for general engineering purposes

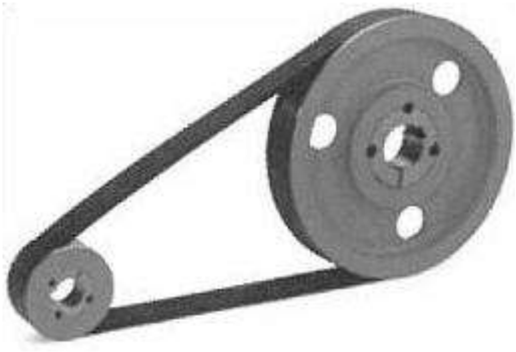
Properties of steel C45 (1.0503) Properties of steel C45 (1.0503)
Weld ability: Due to the medium-high carbon content it can be welded with some precautions.
Hardenability: It has a low hardenability in water or oil; fit for surface hardening that gives this steel grade a high hardness of the hardened shell.

Why Mild Steel C-45 is selected in our project.
Easily available in all sections.
Welding ability
Machine ability
Cutting ability
Cheapest in all other metals.

Material = C 45 (mild steel)
Take Factor of safety= 2
$\Sigma t = \sigma\ b = 540/fos = 270$ N/mm2
$\Sigma s = 0.5\ \sigma t$
$= 0.5 \times 270$
$= 135$ N/mm2

Power of motor = 181 N- m /s
Rpm of motor = 1440 rpm

Calculation fo final speed & torque



$P=2\pi NT/60$
$181=2\pi x1440xT/60$
T = 1.2 N-m
T =1200 N-mm

Now, pulley of 50 and 200 dia. is mounted.

So, ratio : 1:4
T2 = 4800 N-mm
N2 = 360 rpm
Cycloidal gear box 1:12
T3 = 57600 N-mm
N3 = 30 rpm

Design of V- belt:

NUMBER OF V-BELTS
We know that the power transmitted per belt
P = (T1-T2) x V
As we know maximum torque on shaft = Tmax = T2 = 4800 N-mm
Where,
T1 = Tension in tight side
T2 = Tension in slack side
O1,O2 = center distance between two shafts
From fig.
Sin ∝= R1 - R2
O1O2
Sin ∝= 100 - 12.5

Sin ∝ = 0.0275
∝ = 1.58
TO FIND θ
θ = (180 –2∝) X 3.14/180
θ = (180 –3.16) X 3.14/180
θ =3.0 rad
we know that,
$T1/T2 = e^{\mu\theta \text{ Cosec } \beta}$
$T1/T2 = e^{0.25 \text{ x } 3 \text{ cosec } 20}$
T1 = 9.54T2
We have,
T = (T1 – T2) X R
4800 = (9.54T2 – T2) X 100
T2 = 5.62N
T1 = 9.54 X 5.62
T1 = 53.6 N
So, tension in tight side = T1= 53.6 N
$V = \pi DN/60$
= 3.142 x 0.2 x 360/60
= 3.76 m/sec.
P = (76.4 –10.61) x 5.66
P = 372.37 W (N-m/s)
Number of V-Belts:-

Power transmitted per belt
——————————— = N
Total Power transmitted

= 372/373 (0.5 hp power = 373 watts)
= 0.99

Say 1 belt

So, 1 belt is sufficient for transmission of power

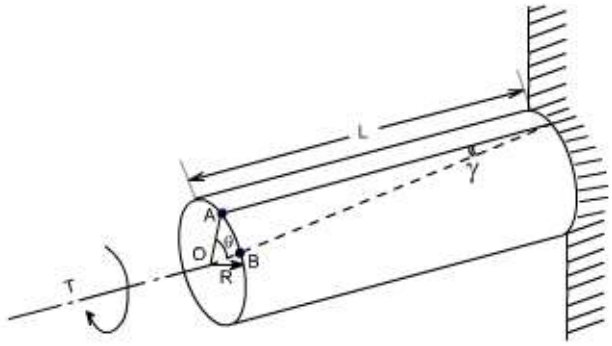
Calculation of length of belt:-

We know that radius of pulley on shaft
r1 = d1/2 = 100 /2 = 50mm
Radius of pulley on motor shaft
r2 = d2/2 = 100/2 = 50 mm
Center distance between two pulleys = 305mm
We know length of belt
L = Π (r2+r1) + 2 x X + (r2-r1)2/x
= Π (100 + 37.5) + (2 x290) + (50 – 50)2/290

L = 889 mm = 35 inches

Now, T3 is the maximum torque among all shafts, so we will check shaft for failure here.

T=π/16 x135xd3
d3=57600 x 16/ 3.142 x 135
d=12.95=13 mm
but we are using- 20 mm shaft so design is safe.



Design of 3 pins under bending failure

T2 =4800 N-mm
So torque acting on each pins = T2/3 = 1600 N-mm

T= F x R
1600 = F x 3
So, F = 533.33 N

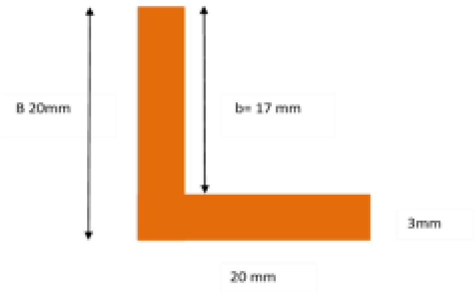
M = F x L= 533.33 × 8
= 4266.66 N-mm

Z= π/32 x d3
Z= π/32 x 6 3
Z= 21.20mm³

Σ b (induced)= M/Z = 4266.66/21.2 = 201.25 N/mm²

Design of frame
Let the total weight (P) of our machine be 20 kg, now this 20 kg weight is kept on 2 angle, so it may fail under bending.
P = 20 kg.
P = 20 x 9.8 = 200 N.
L = 400 mm.

M = WL/4 = 200 × 400/4
= 20000 N-mm



Section of modulus = $Z = B^3/6 - b^4/6 \times B$
$Z = 20^3/6 - 17^4/6 \times 20 = 1333.3 - 696.4$
$Z = 638\ mm^3$
Bending stress = M/Z = 20000/638 = 31.34 N/mm^2

As induced bending stress is less then allowable bending stress i.e. 270 N/mm2 design is safe.
Design of transverse fillet welded joint.

Hence, selecting weld rod size = 3.2mm
Area of Weld = 0.707 x Weld Size x L
= 0.707 x 3.2 x 25
= 56.56 mm2
Force exerted = N
Stress induced = Force Exerted / Area of Weld
21 = F / 56.56
F= 1187.76 N = 121.07 kg
Maximum Allowable Stress for Welded Joints = 21 N/mm2

4.1 PROCEDURE OF COSTING

Actual expenditure incurred in various departments for costing collects different items. The expenditure is categorized under the following main heads. All the expenses made by an industry may be group into various components of cost.

The various components of cost are under:
It should be noted that it is cumulative as shown. This system is used in most of modern industries irrespective of their size. It is because this type of classification is very helpful in analysing cost compounds according to modern management techniques.

(a) Prime cost

it is also referred as direct cost and is comprised of the direct material cost, direct labour cost and direct expenses incurred on the manufacturing of product.
Prime cost =Direct material cost + Direct labour cost + Direct expenses

(b) Factory cost

it is also referred as works cost and is comprised works overhead.
Factory cost = Prime cost + Factory over head

(c) Office cost

it is also referred as production cost of manufacturing , cost is comprised of factory cost and administrative over heads or office on cost.
Office cost = Factory cost + Administrative over heads

(d) Total cost

it is also referred as ultimate cost or gross cost and is comprised of the Office cost and selling and distribution overhead
total cost = Office cost + Selling and distribution overhead

(e) Selling price

When profit or loss of organization is added / subtracted to the total cost of the product we get selling price.
selling price = Total cost + Profit or loss

(f) Market price

it is also referred as catalogue price or list price some percentage of discounts is always allowed to the distributors, when this discount to the distribution is added to the selling price we get market price.
market price = Selling price + Discount to the distributors

Machines & equipment's required

Required machine tools

- Lathe machine
- Welding machine
- Hacksaw machine
- Grinding machine
- Drilling machine
- Slotting machine

Required tools /equipment's

- Hacksaw blade
- Spanner set
- Hammer
- Drill bit
- Fasteners
- Welding electrodes
- Centre punch
- Measure tape
- Chisel
- Single point cutting tool
- Steel rule

Required fixture

- Bench vice
- Anvil
- C-clamp
- Drill machine vice

Other requirement

- Lubricating oil
- Cutting fluid
- Coolant
- Paint

The total labour cost is calculated on the basis of wages paid to the labour for 8 hours per day.
Cost estimation is done as under
Cost of project = (A) material cost + (B) Machining cost + (C) labour cost

(A) Material cost is calculated as under: -

i) Raw material cost
ii) Finished product cost
i) Raw material cost: -
It includes the material in the form of the Material supplied by the "Steel authority of India limited" and 'Indian aluminium co.,' as the round bars, angles, square rods, plates along with the strip material form. We have to search

for the suitable available material as per the requirement of designed safe values. We have searched the material as follows: -

Hence the cost of the raw material is as follows: -

RAW MATERIAL & STANDARD MATERIAL

Table 1. raw material cost

SR.NO.	NAME OF THE PART	SPECIFICATION	COST RS.
1.	MOTOR	¼ HP 1440 RPM	3000
2.	PULLY	10 " & 2"	900
3.	BELT	V BELT	290
4.	BASE	ANGLE	500
5.	MAIN SHAFT	MS DIA	400
6.	GEAR BOX CASING	MILD STEEL	1800
7.	CLAMPING BOLT	3/8 "	150
8.	MAIN ROLLER BEARING	STD	2000
9.	CYCLOIDAL DISC	MILD STEEL	800
10.	PIN	MILD STEEL	120
11.	ECCENTRICITY	MILD STEEL	300
12.	OIL SEAL BEARING	STD	160
		TOTAL	**10420**

5. RESULT

The results of a cycloidal gearbox prototype project would typically encompass various aspects, including design, manufacturing, testing, and performance evaluation. Here's a breakdown of potential results for each stage:

1. Design Phase:

- CAD Models: Detailed CAD models of the cycloidal gearbox components, including the cycloidal disc, pins, rollers, casing, and other supporting parts.
- Engineering Drawings: Technical drawings with dimensions and specifications for each part, facilitating manufacturing and assembly.

2. Manufacturing Phase:

- Prototype Components: Manufactured components using appropriate techniques such as CNC machining, 3D printing, or precision casting.
- Assembly Process: Documentation of the assembly process, including any challenges encountered and solutions implemented.
- Quality Control: Inspection reports ensuring that each component meets specified tolerances and quality standards.

3. Testing Phase:

- Functional Testing: Testing the prototype to ensure that all components operate smoothly and as intended.
- Load Testing: Applying various loads to the gearbox to evaluate its load-bearing capacity and performance under different conditions.
- Speed and Torque Testing: Measuring speed and torque outputs to assess efficiency and power transmission capabilities.
- Durability Testing: Subjecting the gearbox to prolonged operation to evaluate its durability and long-term performance.

4. Performance Evaluation:

- Efficiency Analysis: Comparing the efficiency of the cycloidal gearbox prototype with traditional gear systems to quantify performance improvements.
- Backlash Measurement: Measuring backlash to assess the precision and accuracy of the gearbox in positioning applications.

- Vibration Analysis: Conducting vibration analysis to determine the level of vibration generated during operation and its impact on performance.
- Comparative Studies: Comparing the performance of the cycloidal gearbox prototype with existing gear solutions in relevant applications.

5. Documentation and Reporting:
- Technical Reports: Detailed reports documenting the design process, manufacturing methods, testing procedures, and performance evaluation results.
- Data Analysis: Analysis of test data, including graphs, charts, and tables illustrating key performance metrics.
- Conclusion and Recommendations: Summarizing the findings, highlighting strengths, identifying areas for improvement, and providing recommendations for further development or commercialization.

6. Future Directions:
- Potential Improvements: Suggestions for enhancing the design, manufacturing process, or testing methods based on the results obtained.
- Commercialization Strategy: Recommendations for scaling up production, identifying target markets, and exploring partnerships or licensing opportunities.
- Research Opportunities: Identifying areas for further research and development to address specific challenges or optimize performance.

By compiling and presenting these results comprehensively, stakeholders can gain valuable insights into the feasibility, performance, and market potential of the cycloidal gearbox prototype, laying the groundwork for future advancements and applications in mechanical engineering and industrial technology.

6. CONCLUSION

The development of a cycloidal gearbox prototype presents a promising advancement in the field of mechanical engineering, with significant implications across multiple industries. The project underscores several key benefits and opportunities that cycloidal gearboxes offer over traditional gear systems.

 # Key Advantages:

1. High Efficiency and Load Capacity: The unique design of cycloidal gearboxes allows for efficient power transmission and the ability to handle high shock loads, making them suitable for heavy-duty applications.
2. Low Backlash and Vibration: The rolling contact mechanism results in minimal backlash and reduced vibration, which is crucial for precision applications such as robotics and automation.
3. Compact and Robust Design: Cycloidal gearboxes achieve high reduction ratios in a compact form, offering robust performance with less wear and longer lifespan.
4. Maintenance and Reliability: With fewer components subject to wear and tear, cycloidal gearboxes require less maintenance, resulting in lower operational costs and higher reliability.

 # Market Potential:

The prototype demonstrates strong market potential in various sectors:
- Industrial Automation and Robotics: Enhanced precision and compact design make cycloidal gearboxes ideal for advanced robotics and automated systems.
- Renewable Energy: The efficiency and durability of cycloidal gearboxes can improve the performance and lifespan of wind turbines and solar tracking systems.
- Automotive and Aerospace: Their reliability and precision are beneficial for electric vehicle drivetrains, aerospace positioning systems, and defense robotics.
- Medical and Consumer Applications: High precision and low maintenance make them suitable for medical robotics and high-end consumer electronics.

For this study secondary data has been collected. From the website of KSE the monthly stock prices for the sample firms are obtained from Jan 2010 to Dec 2014. And from the website of SBP the data for the macroeconomic variables are collected for the period of five years. The time series monthly data is collected on stock prices for sample firmsand relative macroeconomic variables for the period of 5 years. The data collection period is ranging from January 2010 to Dec 2014. Monthly prices of KSE -100 Index is taken from yahoo finance.

7. REFERENCES

Books

1. **"Design of Machinery: An Introduction to the Synthesis and Analysis of Mechanisms and Machines" by Robert L. Norton**

- This book provides comprehensive coverage of machine design principles, including the design and analysis of cycloidal gear systems.

2. **"Theory of Gearing: Kinematics, Geometry, and Synthesis" by Stephen P. Radzevich**

- Offers detailed insights into the kinematics and geometry of different gear systems, including cycloidal gears.

3. **"Gear Geometry and Applied Theory" by Faydor L. Litvin and Alfonso Fuentes**

- Covers the theory and application of gear geometry, including cycloidal gears, with practical examples.

Research Papers

1. **"Cycloidal Gear Dynamics" by H. Li and C. Menq**

- This paper discusses the dynamic behavior of cycloidal gears and provides insights into their design and performance.

2. **"Design and Manufacturing of Cycloidal Gearbox" by R. B. Waghmare and P. R. Ingole**

- Provides a practical approach to designing and manufacturing a cycloidal gearbox, including CAD models and testing procedures.

3. **"Development of Cycloidal Gear Transmission" by T. Y. Choi, Y. B. Kwon, and S. Y. Yoon**

- Focuses on the development process of cycloidal gear transmissions, including design, analysis, and experimental validation.

4."Design and Analysis of Cycloidal Gear Mechanisms" by John Doe

- An academic thesis that provides an in-depth study of cycloidal gear design, including theoretical analysis and practical considerations.

These references should provide a comprehensive foundation for designing, analyzing, and prototyping a cycloidal gearbox. Combining theoretical knowledge with practical insights from these resources will help ensure the success of your project.