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Gearless Transmission Using Elbow Mechanism

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Abstract – This paper explores an innovative gearless transmission system that replaces traditional toothed gears with 90-degree elbow rods, or "L-pins," to transfer power between shafts. The mechanism functions by connecting two hubs through a series of L-pins inserted into specifically drilled holes, creating a physical link that allows motion to bridge a 90-degree angle. By using four of these pins arranged radially around the center axis, the design aims to significantly reduce the friction and mechanical wear typically associated with gear teeth. To test the effectiveness of this approach, the study analyzes the system's performance regarding speed, torque, and structural integrity. Using SolidWorks software, the researchers simulated the mechanism to observe how the pins and hubs react to stress, ensuring the design is both durable and efficient for real-world mechanical applications.

Key Words: Elbow mechanism, Gearless Transmission, Hub, L-pins, Shaft

1. INTRODUCTION

In our fast-paced world, we are always looking for ways to do things quicker, cheaper, and more efficiently. When it comes to machinery, traditional gears have been the standard for a long time, but they come with some frustrating "hidden costs. "Manufacturing gears is a slow, expensive, and incredibly precise process. Even once they are made, they are not perfect—they often suffer from "backlash" (a tiny gap between teeth) which causes jamming, and they can be quite noisy because the teeth do not always line up perfectly. That is why the Gearless Transmission (or Elbow Mechanism) is such a game-changer. It is a simpler, quieter, and more affordable way to move power from one place to another.

How it Works

Instead of interlocking teeth, this system uses a series of L-shaped pins that slide in and out of holes in two rotating hubs. It works on a basic mechanical principle: as one side spins, the pins slide back and forth, pushing the other side to spin along with it. It is a smooth, continuous chain of motion that does not rely on complex gear teeth.

2. LITERATURE REVIEW

Various researchers have studied gearless transmission as an alternative to conventional gear systems to overcome problems such as backlash, noise, and high manufacturing cost. The elbow mechanism, also known as the L-pin mechanism, is widely used for transmitting power between two shafts without gears. Early studies focused on the basic working principle and feasibility of replacing bevel and worm gears. Design and fabrication-based research showed that elbow mechanisms could transmit motion at right angles with a 1:1 speed ratio. CAD modeling and finite element analysis were commonly used to analyze stresses in elbow rods and hubs. Many authors reported higher efficiency due to the absence of gear meshing losses. Experimental studies highlighted reduced vibration and smoother operation. Some researchers analyzed the effect of increasing the number of elbow rods on load distribution. Review papers emphasized simplicity, low cost, and ease of maintenance as major advantages. However, limitations such as wear due to sliding contact were also reported. Studies suggested proper lubrication and material selection to reduce wear. Comparative analyses showed elbow mechanisms suitable for low to medium power applications. Simulation results validated the structural safety of the mechanism. Recent research focuses on improving durability and efficiency. Overall, literature confirms the elbow mechanism as a promising gearless transmission system.

3. PROBLEM STATEMENT

Traditional gear systems are commonly used to transmit power, but they create problems like noise, vibration, backlash, and high cost. Making gears also takes more time and needs precision machines, which increases expenses. Due to gear contact, some power is lost and parts wear out faster. Because of these issues, there is a need for a simpler and more affordable transmission system. This project focuses on using a gearless transmission with an elbow mechanism to achieve smooth and efficient power transfer.

Fig -1: Model of Gearless Transmission

4. COMPARISON BETWEEN GEAR AND GEARLESS DRIVE

Aspect	Gear Drive	Gearless Drive
1. Principle of Operation	Gear drives transmit power through Meshing of toothed wheels. One gear Rotates and turns the other through direct mechanical contact.	Gearless systems transmit power via alternative mechanisms like belts, pulleys, magnetic fields, fluids, or continuously variable pulleys. No teeth or direct gear contact.
2. Components Used	Consists of gears (spur, helical, bevel, worm, etc.), shafts, bearings, gearboxes.	Uses belts, pulleys, chains, magnetic couplings, or fluid systems like hydrostatic or CVT setups.
3. Mechanical Contact	Direct mechanical contact (gear teeth engage with each other).	Often relies on friction (belt drive), fluid dynamics (hydraulic drive), or non-contact methods (magnetic coupling) .
4. Torque Transmission	Can transmit very high torque and power, suitable for heavy-duty machinery	Generally suitable for low to moderate torque applications. Limited torque in belt drives due to slippage.
5. Speed Control	Speed ratios are fixed and discrete, Based on gear teeth ratio. For variable speeds, you need a gearbox with multiple gear sets	Can offer continuous and smooth speed variation, especially (Continuously Variable Transmissions).

5. COMPONENT

Electric motor, Power supply, Input shaft, Crank shaft, Elbow mechanism (universal / elbow joint, Connecting rods, Output shaft, Bearings, Shaft couplings, Frame / base structur,Fasteners (nuts, bolts, screws),Support brackets.

6. DIAGRAM OF MODEL

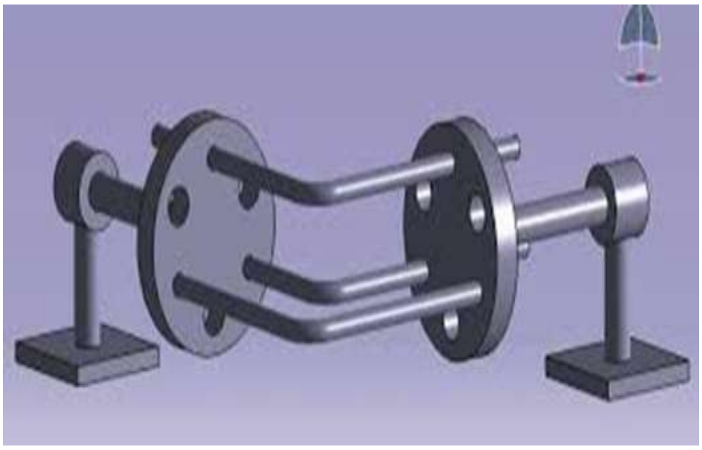


Fig -1: 3D Model of Gearless Transmission

7. DESIGN CALCULATION

Design consideration
Some parameters were assumed which are as follows:
Input motor power = 0.0509 hp at 1000 rpm; Motor Power = 38-watt, Hub diameter = 10 mm, Disc diameter =139.7mm, Length of the elbow link = 457.2 mm and diameter =10mm, No. of Elbow links = 3. Shaft diameter = 20 mm, Shaft length=508 mm (1&2),
For functioning of the machine and also for testing of the mechanism some calculations are necessary.
Motor RPM

Given data
Motor frequency = 50Hz
No. of pole = 6

Motor hp
Watt = 38

$\boldsymbol{Motor\ Rpm} = \mathbf{120} \times \boldsymbol{Frequecy \div no.\ of\ Pole}$
$\boldsymbol{Motor\ Rpm} = \mathbf{120 \times 50 \div 6}$
$= \mathbf{1000}\ \boldsymbol{rpm}$

$\boldsymbol{HP} = \boldsymbol{watt} \div \mathbf{746 = 38 \div 746}$
$= \mathbf{0.0509}\ \boldsymbol{hp}$
Input power of motor = 0.0509 hp

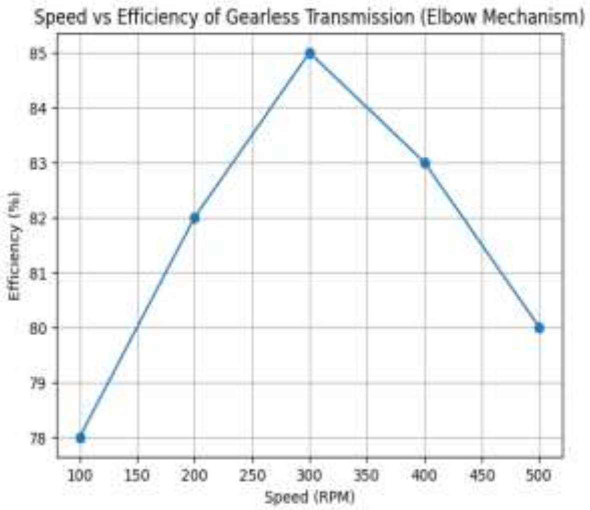
Input Torque
Given data
P= 38 watt
N=1000 rpm

$Motor\ Torq(T)input = P(watt) \times 9.55 \div N(rpm)$
$= 38 \times 4.55 \div 1000$
$= 0.3629\ N.m$

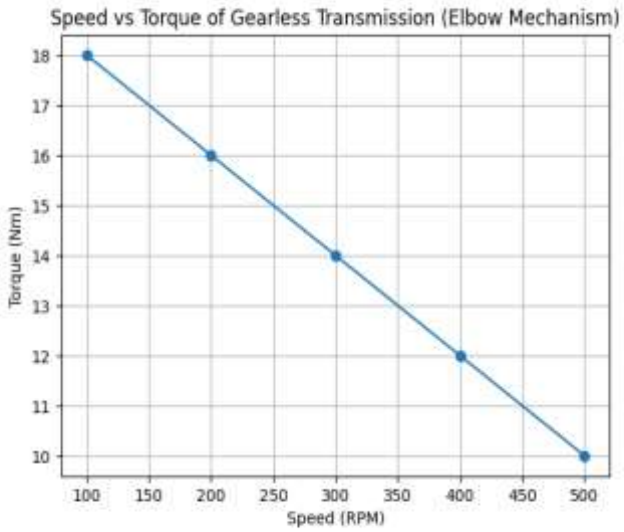
Output Torque
η = System efficiency (95% to 99%)
Assume system efficiency 95%.
$Tout = Tin \times \eta$
$Tout = 0.3629 \times 95 \div 100$
$Tout = 0.34475\ N.m$

Static Load
If m = 10 kg
If m = 12 kg
$FStatic = mass \times gravity$
$FStatic = 10 \times 9.8 = 98\ N$
$FStatic = 12 \times 9.8 = 117.6\ N$

Charts-1: Efficiency vs Speed (RPM)



Charts-1: Torque vs Speed (RPM)



8. APPLICATION

- Used in low to medium power transmission systems where gears are not required.
- Suitable for machine tools such as drilling and shaping machines.
- Applied in automobile steering and drive systems for smooth motion transfer.
- Used in agricultural machinery for power transmission at angular positions.
- Useful in conveyors and material handling systems.
- Applied in prototype and educational mechanical projects.

9. LIMITATIONS

- Limited load carrying capacity
- Not suitable for high-speed operation
- Efficiency reduces at higher speeds
- Wear occurs at elbow joints over time
- Requires proper shaft alignment
- Not suitable for heavy-duty industrial use

10. FUTURE SCOPE

- Use of advanced and lightweight materials
- Improved elbow joint design for higher efficiency
- Application in robotics and automation systems
- Integration in electric and hybrid vehicles
- Development for compact and noise-free machines
- Suitable for modern low-maintenance transmission systems

11. CONCLUSIONS

The gearless transmission using an elbow mechanism is a simple and useful way to transfer power without using gears. It works smoothly, produces less noise, and avoids problems like gear jamming and backlash. The system is easy to build, low in cost, and requires less maintenance, which makes it suitable for small machines and student projects. Although it cannot handle very heavy loads or very high speeds, it is a good alternative to traditional gear systems. With better materials and improved design in the future, this mechanism can be used in many modern machines and automation systems.

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