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A Review on Design and Performance analysis of Shaft Driven Bicycle

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ABSTRACT: *In recent years many accidents occurs due to lack of torque required to drive and land the bicycle, especially in sports bicycle. A shaft driven bicycle is a bicycle in which the power transforms from pedals to rear wheel of the bicycle using gear and shaft arrangement instead the conventional chain drive which contains two set of bevel gear at both the ends to make a new transmission system and transmit motion through 90 degree angle. The main aim of the paper is to obtain maximum displacement of bicycle by transmitting the maximum torque from pedals to the rear wheel to reduces human efforts and also reduce an accident.*

KEYWORDS: Drive shaft, chain drive, torque, transmission system, bicycle

I. INTRODUCTION

A shaft driven bicycle is a bicycle that uses a drive shaft instead of chain drive to transmit energy or power from the pedals to the rear wheel. Shaft driven bicycle have large bevel gear. The design of bevel gear produces less noise and vibrations as compared to chain and sprocket arrangement. This meshes with another bevel gear mounted on the drive shaft. The use of bevel gears allows the axis of the drive torque from the pedals to be turned through 90 degrees. The drive shaft has another bevel gear on the hub and cancelling out the first drive torque change axis. The drive shaft needs lubrications such as grease, oil, etc. to keep the gears running smooth and efficient transfer of energy from pedals to the rear wheel.

Use of drive shaft

The torque that is produced from the pedal and transmission must be transferred to the rear wheels to push the vehicle forward and reverse. The drive shaft must provide a smooth, uninterrupted flow of power to the axles. The drive shaft and differential are used to transfer this torque.

II. COMPONENTS AND DESCRIPTION

The fabrication of bicycle driven by shaft and gear system consists of the following components:

- Pedal
- Hub
- Bearing
- Bevel gear
- Driven shaft

Pedal-

A bicycle pedal is a part of a bicycle that the rider pushes with his foot to propel bicycle. It provides the connection between the cyclist's feet and crank allowing the leg to turn the bottom bracket spindle and propel the bicycle's wheel on which the foot rest or is attached, that is free to rotate on bearing with respect to the spindle.

Fig 1. Pedal

Hub-

Centre part of wheel from which spoke radiate. Inside the hub there are ball bearing enable to rotate around in axle.

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Fig 2. Hub

Bearing- For the smooth operation of Shaft, bearing mechanism is used. To have very less friction loss the two ends of shaft are pivoted into the same dimension bearing.

Fig. 3 Bearing

Bevel gear-

A kind of gear in which the two wheels working together lie in different planes and have their teeth cut at right angles to the surfaces of two cones whose apices coincide with the point where the axes of the wheels would meet.

Fig. 4 Bevel gear

Driven shaft-

A shaft-driven bicycle is a bicycle that uses a drive shaft instead of a chain to transmit power from the pedals to the wheel. Shaft drives were introduced over a century ago, but were mostly supplanted by chain-driven bicycles due to the gear ranges possible with sprockets and derailleur. Recently, due to advancements in internal gear technology, a small number of modern shaft-driven bicycles have been introduced.

Fig. 5 Driven shaft

Merits of Drive shaft:

1. They have high specific modulus and strength.
2. Less weight.
3. Reduce energy consumption.
4. Produce less noise and vibration during working.
5. Good corrosion resistance.

III. WORKING PRINCIPLE

A chainless bicycle is a bicycle that uses a drive shaft instead of a chain to transmit power from the pedals to the wheel. Shaft drives were introduced over a century ago, but were mostly supplanted by chain-driven bicycles due to the gear ranges possible with sprockets and derailleur. Recently due to advancements in internal gear technology, a small no. of modern staff-driven bicycles have been introduced. Shaft-driven bikes have been where a conventional cycle would have its chain ring. This meshes with another bevel gear mounted on the drive shaft. The bevel gears are the most efficient way of turning drives 90 degree as compared to worm gears or crossed helical gear. In this shaft driven bicycle, the spur gear is mounted with the bicycle. It is mainly used to the gear transmission for increasing the speed of the bicycle. The shaft drive only needs periodic lubrication to keep the gears running quiet and smooth. This chainless drive system provides smooth and efficient transfer of energies from the pedals to the rear wheel.

IV. DESIGN ASSUMPTIONS

1. The shaft rotates at a constant speed about its longitudinal axis.
2. The shaft has a uniform circular cross section.
3. Centre coincide with the geometric centre.
4. The shaft is perfectly balanced
5. All damping and non-linear effects are excluded.
6. The stress-strain relationship for composite material is linear and elastic.

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V. CALCULATIONS

Drive shaft calculations-

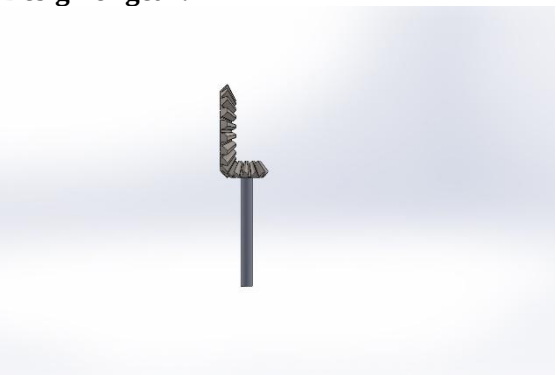
Diameter of shaft (d) = 18mm = 0.018m
Length of shaft (L) = 385mm = 0.385m
Length of pedal shaft (l) = 175mm = 0.175m
Speed of pedal gear = 100 rpm
Maximum torque will be,
T = (body mass of rider) × (9.81) × (l)
=70 × 9.81 × 0.175
= 120.17 Nm
Power (p) = 2πNT/60
= (2×π ×100×120.17)/60
= 1258.41 Watt
J = (π d^4)/32
= (π (0.018)^4)/32
= 1.0305×10-8 m4
Shear Stress = TR/J
= (120.17×0.0125)/
(1.0305×〖10〗^(-8)
= 14.57×〖10〗^7N/m2
I = (π d^4)/64 ……. (Moment of inertia)
= (π× (〖0.018〗^4))/64
= 5.152 ×10-9 m4
Bending moment:
M = EI/R
= (2.06×〖10〗^11×5.152×〖10〗^(-9))/0.0125
= 84904.96 Nm
Rate of twist = T/GJ
= 120.17/
(0.84×〖10〗^11×1.0305×〖10〗^(-8))
= 0.1388 rad/m
θ = TL/GJ = rate of twist × Length of shaft
= 0.1388 × 0.385
= 0.0534 rad.

Bevel gear calculations-

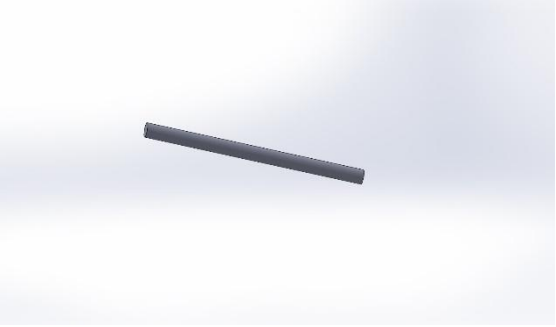
Speed of gear (N) = 120rpm
Velocity Ratio (I) = 2
Teeth of pinion (Zp) = 20
Diameter of crown (Dc) = 0.120 m
Diameter of pinion (Dp) = 0.060 m
Select suitable teeth on crown:
I = Zc/Zp = Np/Nc
2 = Zc/20 = Np/120
Zc = 20 × 2 Np = 2 × 120
Zc = 40 Np = 240 rpm
Pitch Angle:
For Pinion
Tanγp = Zp/Zc
= 20/40
= 1/2
γp = tan-1(0.5)
γp = 26.565°
For Crown
Tanγc = Zc/Zp
= 40/20
= 2
γc = tan-1 (2)
γc = 63.435°
Module (m):
Diameter of crown = Module × Teeth
120 = m × 40
m = 3
Cone Distance (A):
A = 1/2 √ (〖Dp〗^2+〖Dc〗^2)
= 1/2 √ (〖(120)〗^2+〖(60)〗^2)
A = 67.0820 mm
Pitch Circle Diameter:
Pc = πm
= 3.142 × 3
Pc = 9.425 mm
Tangential Force:
Ft = Pd × c/v
Where,
C = 0.25 m
V = πdN/60 = (3.142 ×0.060×240)/60
= 0.75368 m/s
Pd = 1.2584 KN-m/sec
Ft = Pd × c/v
= (1.2584) × 0.25/0.75398
Ft = 0.41730 KN

VI. DESIGN OF COMPONENTS AND ASSEMBLY

Design of gear:



Design of shaft:



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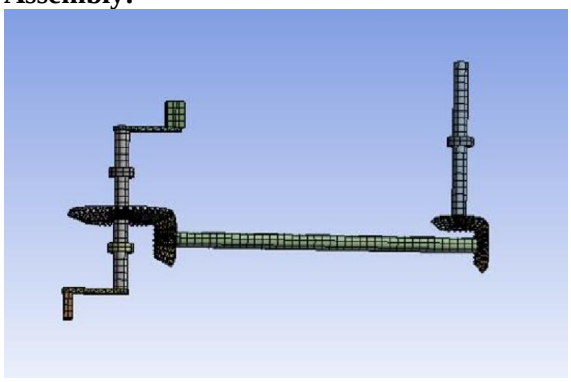
Assembly:



VII. CONCLUSION

From this work we conclude that the shaft driven transmission system is more efficient than chain drive system. The shaft driven (chainless) bicycle transmits power from pedal to rear wheel smoothly without any noise and vibration of the gear pair and also it produces high torque as compared to chin drive transmission system**.**

SOME OF THE ADVANAGES FROM THE ABOVE CONCLUSION

1. Lower maintenance.
2. More efficiency.
3. High durability.
4. Gear system creates smooth pedalling motion.
5. Less noise and vibration during working.

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