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Design and Analysis of Chainless Transmission

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Abstract**—** Power transmission through chain drive is the oldest and widest used method in case of bicycle. In this paper we implemented the chainless transmission to the bicycle to overcome the various disadvantages of chain drive. The detail procedure for the design and analysis for strength consideration is discussed in this paper.

Keywords**—** Chainless transmission; spur gear train; hubless bicycle.

I. Introduction

In general the bicycle run on chain drive system .in which the sprocket head is having 44 number of teeth and sprocket tail is having 18 number of teeth. from this combination we get the gear ratio up to 2.44. Thus the driver often feels fatigue and stress while driving the bicycle on this small gear ratio. Hence there is need to replace this chain drive or there is need of further improvement is the same, one method already implemented in this mechanism is use of different size of tail sprocket to obtain different velocity ratio but this shifter mechanism has intricate structure and complex working, hence proper method of gear ratio improvement is required.

Hence we implemented the 4 stage spur gear train drive in this paper in which 6 spur gears are used with identical module as 3. Through which the gear ratio is drastically improved. Previously in conventional design we get the gear ratio as 2.44 as discussed, due to design of 4 stage gear box the speed ratio is improved to 4.5.

Hence the design is highly reliable and useful for the racing bicycle and for three wheelers.

Fig. 1. Actual prototype of chainless power transmission.

II. Literature Review

M. Rama Narasimha Reddy, Design and fabrication of shaft driven bicycle, International journal of emerging research and technology,[1]

In this paper the user developed a model to rotate the back wheel of a vehicle with the help of propeller shaft the Engine is connected at the front part of the vehicle. The shaft of the engine is connected with a long rod. The other side of the long rod is connected with a set of bevel gears. The bevel gears are used to rotate the shaft in 90 ^{o} angle. The back wheel of the vehicle is connected with the bevel gear (driven). Thus the back wheel is rotated in perpendicular to the engine shaft. Thus the two wheeler will move forward. According to the direction of motion of the engine, the wheel will be moved forward or reverse. This avoid the usage of chain and sprocket method

Mayur linagariya, dignesh savsani, dynamic chainless bicycle, International journal of advance research in engineering science & technology.

This author also developed shaft driven bicycle

A shaft-driven bicycle is a bicycle that uses a driven 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. The shaft drive only needs periodic lubrication using a grease gun to keep the gears running quiet and smooth. This “chainless” drive system provides smooth, quite and efficient transfer of energy from the pedals to the rear wheel. It is attractive in look compare with chain driven bicycle. It replaces the traditional method.

III. Design Methodology

Design consists of application of scientific principles, technical information and imagination for development of new or improvised machine or mechanism to perform a specific function with maximum economy and efficiency. Hence a careful design approach has to be adopted. The total design work has been split up into two parts;

1. System Design
2. Mechanical Design

All the gears are made up of steel EN24. They are having following physical and mechanical properties.

1. Ultimate Tensile strength - 800 N/mm2
2. Yield Strength –680 N/mm2

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3. Hardness –220 to 280 BHN
4. Melting point - 1500°C
5. Density - 7840 kg/m3
6. Thermal conductivity - 41.9 W/m-°C
7. Young's Modulus - 207 x 109 N/m2

Following components are designed in the system

a. Design of the driver pedal
b. Design of pedal shaft\
c. Selection of bearing 6004z for shaft
d. Design of gear train
  i. Design for stage 1 gear pair
  ii. Design for stage 2 gear pair
  iii. Design for stage 3 gear pair
  iv. Design for stage 4 gear pair
e. Design of bearing for each stage of gear

TABLE I. Gear and speed ratio.

Gear Stage	Gear		Pinion	
	Number of teeth	Speed of gear (rpm)	Number of teeth	Speed of pinion (rpm)
1	44	60	24	110
2	44	110	24	202
3	24	202	18	270
4	18	270	18	270

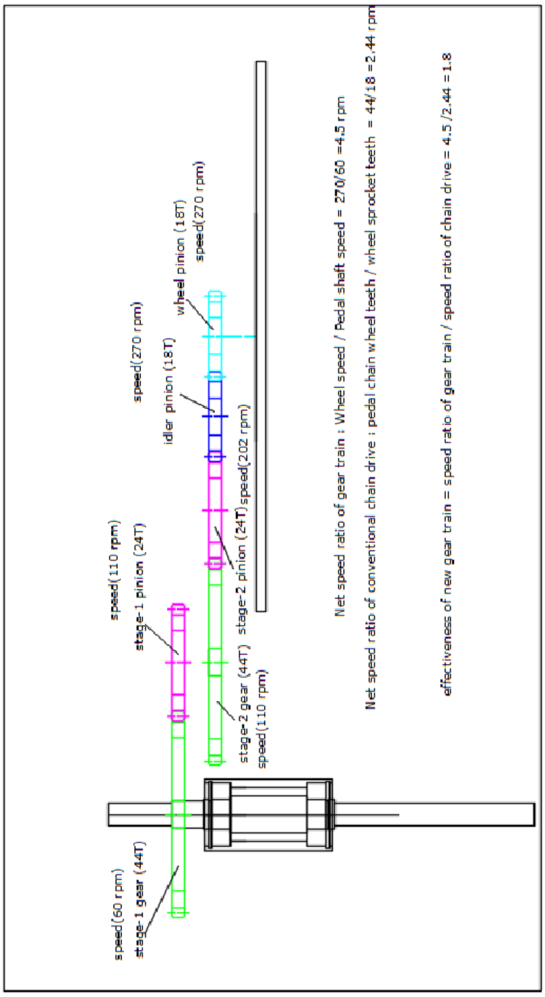

Fig. 2. Gear train design.

Finite element analysis of the gear

Here in this chapter we will discuss the stress analysis of gear teeth by applying point load as calculated

Tangential component on gear or tangential force is given by

$$Ft = \frac{P}{V} = \frac{Tp}{\frac{dp}{2}} = \frac{Tg}{\frac{dg}{2}}$$

From above equation we can calculate torque on each gear

1. Torque on first gear

T= F × L =200 × 120 =2400

$$Ft = \frac{2400}{\frac{132}{2}}$$

Ft=36.3636 N

Similarly we get the tooth load on each gear as

TABLE II. Force on gear.

Gear	Teeth	PCD	Force on teeth (N)
1	44	66	36.3636 N
2	24	36	36.3636 N
3	44	66	19.83469 N
4	24	36	19.83469 N
5	18	27	19.83469 N
6	18	27	19.83469 N

Gear 6

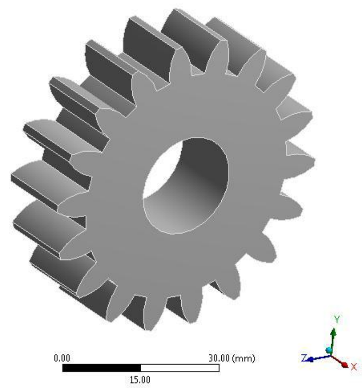

Fig. 3. Model of gear.

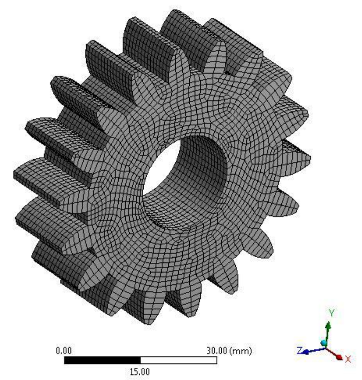

Fig. 4. Meshing.

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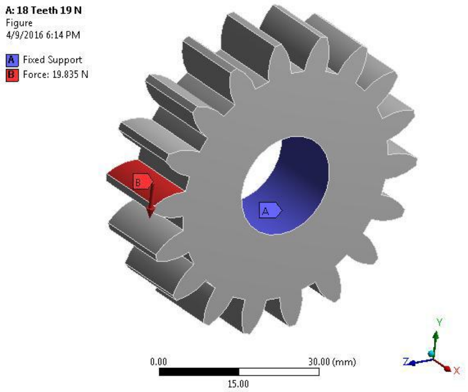

Fig. 5. Load application.

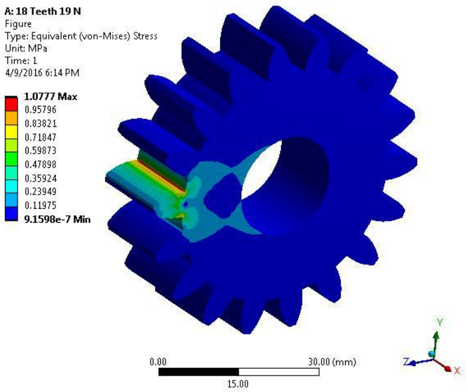

Fig. 6. Equivalent Von Mises stress.

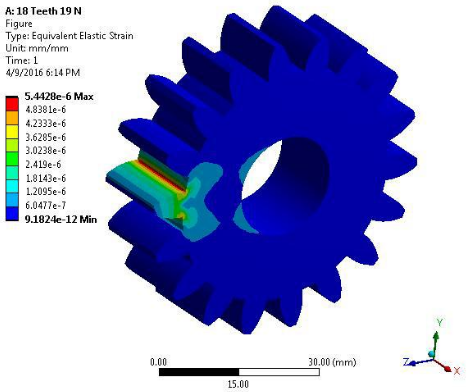

Fig. 7. Equivalent elastic strain.

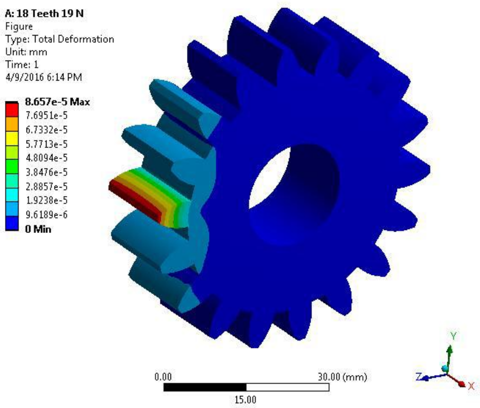

Fig. 8 Total deformation.

TABLE III. Gear 6 stress calculation.

Part name	Maximum Theoretical stress	Von-Misses stress	Result
Gear 6 18 teeth	680 N/mm2	1.077 N/mm2	Safe

Considering another gear with 44 no teeth with load application of 36 N

Gear 1

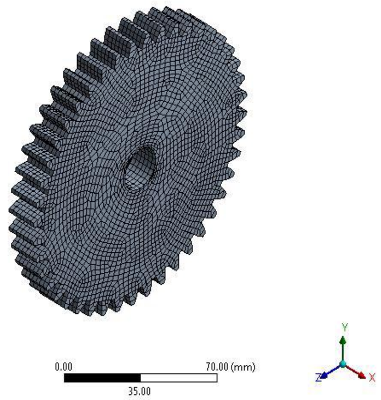

Fig. 9. Meshing of gear.

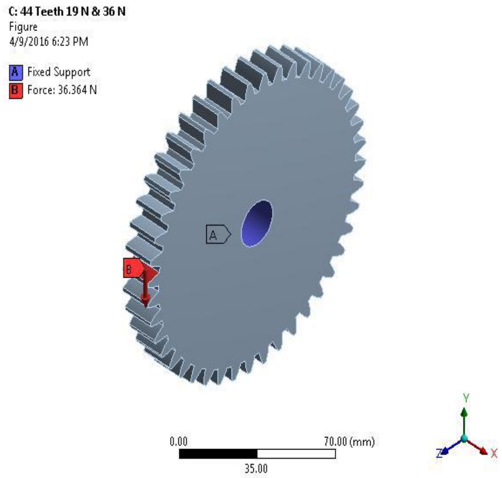

Fig. 10. Load application.

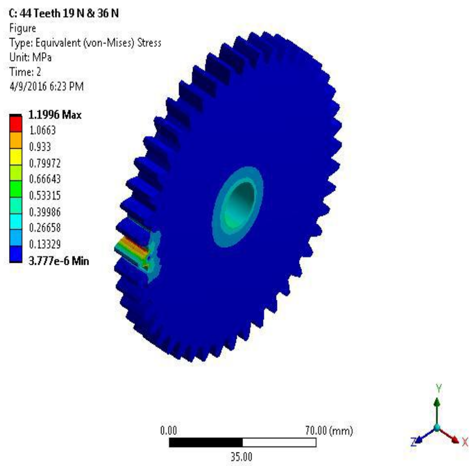

Fig. 11. Equivalent Von mises stress.

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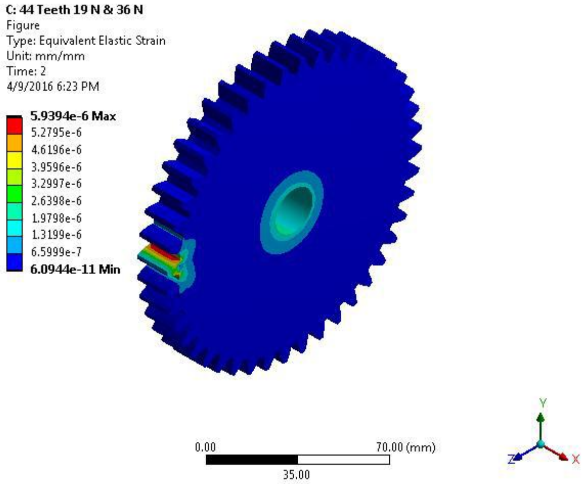

Fig. 12. Equivalent elastic strain.

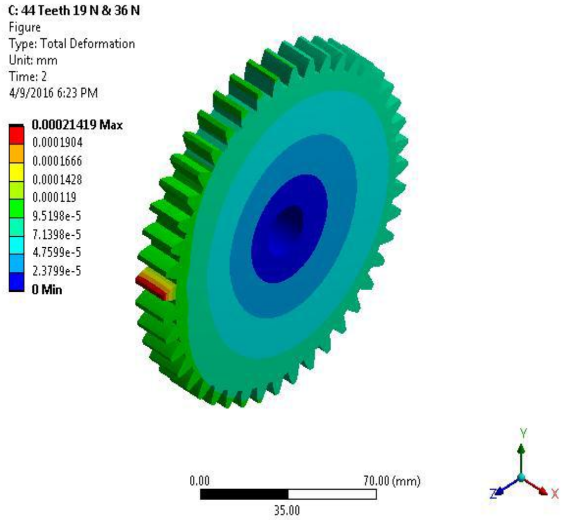

Fig. 13. Total deformation.

TABLE IV. Gear 1 stress calculation.

Part name	Maximum Theoretical stress	Von-Misses stress	Result
Gear 1 44 teeth	680 N/mm2	1.1966 N/mm2	Safe

IV. CONCLUSION

As seen from the above analysis of the component we can easily predict that the gear train design is safe under the given load.

ACKNOWLEDGMENT

It will be great pleasure to present the paper on analysis and design of gear train on chainless transmission. I am thankful to prof. Dr. Zope S. B. Principal SVCET Rajuri. And Prof. Patil A. R. HOD Mechanical SVCET Rajuri, for their valuable guidance

REFERENCES

[1] S. Helman, S. Christmas, and S. Buttress, “Cycling, safety and shearing the road: Qualitative research with cyclist and other road users,” Department for Transport London, 2010.
[2] A. Berwald, P. Bonkoski, and H Kohring, “Chainless challenge project,” BLUE Lab at University of Michigan, 2010.
[3] Prof. P. P. Deshpande, R. U. Urunkar, “Study of drive mechanism of bicycle, tricycle or like vehicles to optimize operating performance,” *IJERA*, 2010
[4] P. E. Lew, “Hubless wheel”, United States Patent, Patent Number 5,419,619, Date of Patent May 30, 1995.
[5] PSG College of Technology, *Design Data Book*, Material Selection, Kalaikathir Achchagam Publication, Coimbatore, India, pp. 1.10 -1.12
[6] R. S. Khurmi and J. K. Gupta, *Machine Design*, Eurasia Publishing House New Delhi Edition 2005, pp. 1024 -1046, 510-513 & 1004 -1010.
[7] J. E. Shingley and C. R. Mischke, *Standard Handbook of Machine Design*, McGraw - Hill Publication New York, Second Edition.
[8] J. B. Spicer, C. J. K. Richardson, M. J. Ehrlich, “Effects of frictional loss on bicycle chain drive efficiency,” *ASME*, vol. 123, pp. 598-605, 2001.