

Dual Sprocket in Two Wheeler (Theoretical and Experimental Studies)

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ABSTRACT: Our project is Dual Sprocket in Two wheelers. We are using two chain drive instead of using single chain drive in two wheelers. This is to obtain the required torque and power simultaneously in a same vehicle. This Dual drive in a single driver shaft gives more torque and power to the driven shaft.

KEYWORDS: Dual sprockets, More Torque, More Speed

Problem statement

The objectives and expectations are fairly clear for a research initiative focused on developing a product, and that is the working product itself. The constraints of this project aside from time are essentially the budget (low as possible) and design specifications as listed below.

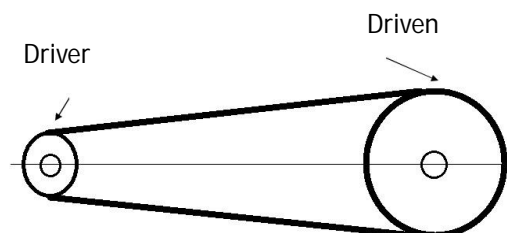
One additional side objective, however, is more professional in nature rather than technical: Teamwork/Collaboration. Working in a team effectively where each individual has unique skills to offer after four years of education was another goal as it reflects the environment we expect to work in throughout our careers.

Problem formulation

We were able to accomplish our goals for this project by identifying the key steps. The results of our design and construction are detailed in this report and have been verified through simulation and product testing. Through this report, we expect that the reader will be perfectly equipped to replicate the project and obtain the same results.

I. INTRODUCTION

Now a days we are using single sprocket ie., single chain drive in two wheelers. By using this single chain drive we are altering the speed and torque of the vehicle by changing the diameter of the sprockets based on the application of the vehicle. When we need more torque in the vehicle we are using smaller size driver and larger size driven as shown in the below figure



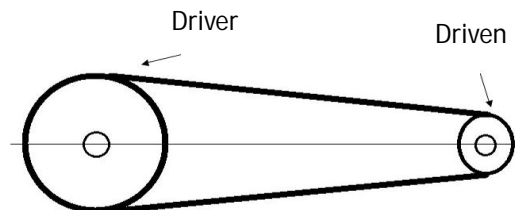
When we need more speed in such cases of racing bikes and super bikes, we alters the sprockets as larger driver and smaller driven. In this case, we can obtain more speed in the vehicle but there is no enough torque required for our ordinary usage. The sprocket assembly is shown below:

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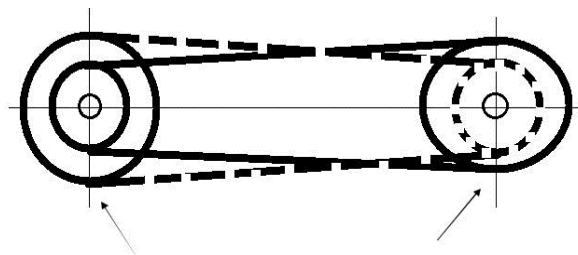
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Vol. 7, Issue 9, September 2018



We are implementing dual sprockets i.e., dual chain drive in two wheelers. Both the drives are in same shaft from the gear box. One drive is smaller driver and larger driven (ordinary usage vehicles). Another drive is larger driver and smaller driven (racing and super bikes). This drive is used to obtain both torque and speed in a same vehicle. And this dual sprocket gives more efficiency when compared to the existing racing bikes with same power. The dual sprocket assembly is shown below in the figure:



Dual Sprocket

In this above figure, the two driver and driven sprockets are governing the drive. But this drive has more efficiency than the single drive. By using this drive we reduce the number of two wheelers manufacturing. It leads in use the same vehicle for the race course and as well as the ordinary usage.

The theoretical calculations and design of the chain drive and sprockets used are mentioned below. Our project specifications are considered for the design and calculations. The design procedures and the required design parameters are taken from the PSG Design Data book. The formulas are taken from the website mentioned in the reference section of our report. In addition to that references, we refer Dr, Rathnakumar for the calculations and design.

II. THEORETICAL CALCULATION AND ANALYSIS

Drive 1:

Load	W : 49.05 N
Speed of the driver	N1: 220 rpm
Speed of the driven	N2 : 100 rpm

Diameter of the driver D1 : 67 mm
Diameter of the driven D2 : 150 mm

International Journal of Innovative Research in Science, Engineering and Technology

(A High Impact Factor, Monthly, Peer Reviewed Journal)

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Gear ratio I : 2.25
Power of the motor P : 150 W

$$\begin{aligned} \text{Torque transmitted } T &= P \cdot 60 / (2 \cdot \pi \cdot N) \\ &= 50 \cdot 60 / (2 \cdot \pi \cdot 220) \\ &= 9000 / 1382.301 \\ T &= 6.511 \text{ Nmm or } 6511 \text{ Nm} \end{aligned}$$

Drive 2:

Load W : 49.05 N
Speed of the driver N1: 220 rpm
Speed of the driven N2 : 495 rpm

Diameter of the driver D1 : 150 mm
Diameter of the driven D2 : 67 mm

Gear ratio I : 2.25
Power of the motor P : 150 W

$$\begin{aligned} \text{Torque transmitted } T &= P \cdot 60 / (2 \cdot \pi \cdot N) \\ &= 150 \cdot 60 / (2 \cdot \pi \cdot 495) \\ &= 9000 / 3110.177 \\ T &= 2.894 \text{ Nmm or } 2894 \text{ Nm} \end{aligned}$$

This above calculation is made using our project model specifications by experimenting with trial and error method.

Dual drive

Load W : 49.05 N

Speed of the driver N1: 220 rpm & 220 rpm

Speed of the driven N2 : 100 rpm & 495 rpm

Diameter of the driver D1 : 67 mm & 150 mm

Diameter of the driven D2 : 150 mm & 67 mm

Gear ratio I : 2.25
Power of the motor P : 150 W

$$\begin{aligned} \text{Torque transmitted } T &= 2P \cdot 60 / (2 \cdot \pi \cdot ((N_1 + N_2) / 2)) \\ &= 2 \cdot 150 \cdot 60 / (2 \cdot \pi \cdot ((220 + 495) / 2)) \end{aligned}$$

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$$= 18000/2246.239$$

$$= 8.013 \text{ Nmm or } 8013 \text{ Nm}$$

This calculation for dual drive is under the reference of website www.recent.engg-tech.com and this were made using our project modelspecification.

These were the theoretical calculations done with our project model and we have theoretically proved that the dual drive gives more torque than the single drive in case of racing vehicles and gives more speed with ordinary vehicles.

Design of chain drive

Step 1: Selection of transmission ratio (i)

Transmission ratio of the drive is selected as 2.25
 $i = 2.25$

Step 2: Selecting number of teeth on the sprockets (Z_1 & Z_2)

$$Z_1 = 25$$
$$Z_2 = i * Z_1$$
$$= 2.25 * 25$$

$$Z_2 = 56.25$$
$$Z_1 = 25 \text{ \& } Z_2 = 58$$

Step 3: Selection of pitch (p)

$$P = 15.875 \text{ mm}$$

Step 4: Selection of chain

Roller chain
Simplex chain

10A-1 R50 simplex chain is selected.

(Calculation of load)

Step 5: Calculation of load

$P_T = P_t + P_c + P_s$
 P_t – tangential force due to power transmission
 P_c – centrifugal tension due to speed of chain
 P_s – tension due to chain sagging

i) Calculation of P_t

$$P_t = 1020 * P/v$$
$$P_t = 6.641 \text{ kgf}$$

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ii) Calculation of Pc

$$\begin{aligned}P_c &= mv^2 \\ &= 1.01 * 23.038^2 / 10 \\ &= 53.606 \text{ kgf}\end{aligned}$$

iii) Calculation of Ps

$$\begin{aligned}P_s &= k_w a \\ P_s &= 2.727 \text{ kgf} \\ P_T &= 62.974 \text{ kgf}\end{aligned}$$

(Calculation of Design load)

Step 6: Calculation of service factor (Ks)

$$\begin{aligned}K_s &= 1 * 1.25 * 1 * 1 * 1 * 1.25 \\ &= 1.5625\end{aligned}$$

Step 7: Calculation of design load

$$\begin{aligned}\text{Design load} &= P_T * K_s \\ &= 62.974 * 1.5625 \\ &= 98.397 \text{ kgf}\end{aligned}$$

The calculated design load is 98.397 kgf.

(Check the load)

Step 8: Calculation of working Factor of Safety (FSW)

$$\begin{aligned}\text{FSW} &= Q / \text{Design load} \\ &= 2220 / 98.397 \\ &= 22.562\end{aligned}$$

Step 9: Calculation of recommended FOS

$$\text{FOS} = 9.35$$

Step 10: Checking the FSW and FOS

$$\text{FSW} > \text{FOS ie., } 22.562 > 9.35$$

Therefore the design is safe.

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(Check for Stress)

Step 11 : Calculation of Stress

$$\begin{aligned}\text{Bending stress} &= Pt \cdot K_s / A \\ &= 6.641 \cdot 1.5625 / 0.0070 \\ &= 0.007 \text{ kgf/mm}^2\end{aligned}$$

Step 12: Calculation of recommended stress

$$\text{Allowable stress} = 2.62 \text{ kgf/mm}^2$$

Step 13: Checking the stress

Calculated stress < allowable stress
ie., $0.007 \text{ kgf/mm}^2 < 2.62 \text{ kgf/mm}^2$

Therefore the design is safe.

(Calculation of other parameters)

Step 14: Calculation of length of chain

$$\begin{aligned}L_p &= 2Ap + ((Z_1 + Z_2)/2) + (((Z_2 - Z_1)/2\pi)^2 / Ap) \\ &= 2 \cdot 450 + ((25 + 56.25)/2) + (((56.25 - 25)/2\pi)^2 / 450) \\ &= 900 + 40.625 + 0.055 \\ &= 940.68 \text{ mm}\end{aligned}$$

Step 15: Calculation of Actual centre distance

$$\begin{aligned}A &= (e + \sqrt{e^2 + 8m})p/4 \\ e &= L_p - ((Z_1 + Z_2)/2) \\ &= 940.68 - 40.625 \\ &= 900.055 \text{ mm} \\ M &= 24.737 \text{ mm} \\ A &= 357.23 \text{ mm}\end{aligned}$$

These are the design procedures and design calculations were done in our project model.

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III. EXPERIMENTAL STUDIES

Our concept and its generation, reduction, construction, working of our project are shown below :

Construction of our Project



Our project model

The construction of our project is similar to the existing arrangement of the sprockets. The length of the driving and driven shaft is to be increased about 30 mm. This increased length is to fit the additional sprocket in the shaft (Driving and Driven). And the drive is connected by chain i.e., Chain drive.

The chain drive 1 has smaller driving pulley and larger driven pulley. This drive gives enough torque to the vehicle. The chain drive 2 has larger driving pulley and smaller driven pulley. This drive is to achieve more speed than the ordinary vehicle speed.

This is the construction of our project model, arrangements and assembling of our project. In practical, to execute this concept we need to increase the driver shaft (gear box output shaft) and the driven shaft (wheel axle). And then the additional sprockets are fitted in the extended length. These additional sprockets are connected by a chain drive.

IV. WORKING OF OUR PROJECT

Our project aim is to achieve the power and torque in a same vehicle. So that we are using the dual drive (Chain drive). Consider that the motor is the Engine and the Load wheel is the Wheel of the vehicle. We are using the load Wheel because to avoid the external loading setup.

The speed of the wheel depends on the Chain drive 2. Because of giving more rpm in the driven shaft, the speed depends on the drive 2.

The torque of the Wheel depends on the Chain drive 1. Because of having less number of teeth in the driving sprocket it has less speed. But it has more torque transmission ratio than the Chain drive 2.

So the chain drive 1 governs the drive and the speed I depends on the chain drive 2. Hence we obtain the speed as well as the torque in a single vehicle.

Cost analysis

Material	Cost
Load wheel	Rs 700
Motor	Rs 250
Sprockets	Rs 450
Chain	Rs 350

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Supporting arm	Rs 100
Total	Rs 1,850

The above cost details are for our experimental setup. The implementation of this system in the two wheelers needs less cost. It needs about Rs 800.

V. CONCLUSION

The dual sprocket concept that we are designed and constructed is based on the Mechanical Engineering. The engineers of this project have significant experience in apply their hands-on technical experience to an actual useable product. Using our diverse backgrounds in education, we were able to blend form and function together to create an easy-to-use and unified system. As such, we fulfilled the objectives and expectations of this design project. Additionally, we successfully remained within our other constraints: the design and construction were completed within the semester, and the cost was kept well within our budget. And, with regard to professional development, we were able to combine both of our skill sets and creativity to fulfil our research expectations and create an operational product. In so doing, we worked collaboratively to effectively walk through the entire product lifecycle.

We are designing the prototype with some safe design factors as calculated in the theoretical analysis. We are further consider this for the development of our project. We are trying to improve the project. We are in the plan to implement this concept with toggling mechanism. When we need high speed, in such cases we are using the larger driving and smaller driven drive to obtain our requirement. When we need high torque, the chain drive 1 is used for the transmission ie., smaller driving and larger driven drive. In addition to this modifications we are planned to implement some modifications in the gear box according to the drives. These are the significant modifications planned for the development of the project.

REFERENCES

1. PSG Design Data book for formulas and Design parameters
2. www.recent.engg-tech.com site for integrating the dual drives.
3. Dr. Rathnakumar for the design calculations and procedures.

BIOGRAPHY



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Previous Paper : Design and Simulation of Four Wheel Steering System for LMV in IJETCSE August 2017