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Perimetric Brakes

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ABSTRACT: A disc brake is a type of brake that uses callipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed. Hydraulic disc brakes are the most used form of brake for motor vehicles, but the principles of a disc brake are applicable to almost any rotating shaft. Compared to drum brakes, disc brakes offer better stopping performance because the disc is more readily cooled. Consequently, discs are less prone to the brake fade caused when brake components overheat. Drum brakes and disc brakes are most of the brakes used today with disc brakes being more efficient but costly than drum brakes. A disc brake consists of brake callipers that squeeze the pair of pads against the rotating brake disc and with the help of friction the speed of rotation is reduced. They are better at managing heat and since they are open to environment convection can occur easily because of this less brake fade occurs and consistent braking is obtained. The brake pads are found to last longer than the brake shoes in the drum brakes. The disc braking system is simple and effective in its operation this leads to easy replacement of the damaged parts.

KEYWORDS: Brakes, Disc Brakes, drum

I. INTRODUCTION

A disc brake is a type of brake that uses callipers to squeeze pairs of pads against a disc in order to create friction that retards the rotation of a shaft, such as a vehicle axle, either to reduce its rotational speed or to hold it stationary. The energy of motion is converted into waste heat which must be dispersed. Hydraulic disc brakes are the most used form of brake for motor vehicles, but the principles of a disc brake are applicable to almost any rotating shaft. Compared to drum brakes, disc brakes offer better stopping performance because the disc is more readily cooled. Consequently, discs are less prone to the brake fade caused when brake components overheat. Disc brakes also recover more quickly from immersion (wet brakes are less effective than dry ones). Most drum brake designs have at least one leading shoe, which gives a servo-effect. By contrast, a disc brake has no self-servo effect, and its braking force is always proportional to the pressure placed on the brake pad by the braking system via any brake servo, braking pedal, or lever. This tends to give the driver better "feel" and helps to avoid impending lockup. Drums are also prone to "bell mouthing" and trap worn lining material within the assembly, both causes of various braking problems. The brake disc (or rotor in American English) is usually made of cast iron but may in some cases be made of composites such as reinforced carbon-carbon or ceramic matrix composites. This is connected to the wheel and/or the axle. To retard the wheel, friction material in the form of brake pads, mounted on a device called a brake calliper, is forced mechanically, hydraulically, pneumatically, or electromagnetically against both sides of the disc. Friction cause the disc and attached wheel to slow or stop. When it comes to manufacturing any vehicle, brakes are a crucial part of the system and thus a lot of attention is given to the problems associated with it. Drum brakes and disc brakes are most of the brakes used today with disc brakes being more efficient but costly than drum brakes. A disc brake consists of brake callipers that squeeze the pair of pads against the rotating brake disc and with the help of friction the speed of rotation is reduced. They are better at managing heat and since they are open to environment convection can occur easily because of this less brake fade occurs and consistent braking is obtained. The brake pads are found to last longer than the brake shoes in the drum brakes. The disc braking system is simple and effective in its operation this leads to easy replacement of the damaged parts. However, there are certain problems associated with them like brake howl, brake judder and longer

braking distance. Perimetric brake disc is a new concept that aims to reduce such issues and simultaneously improve the existing qualities of disc brake.

II. LITERATURE REVIEW

Shivankur Mittal Et. Al. for the lighter weight front wheel vehicles the inside out disc along the rim can give the best results for the braking end effects. It will induce less bending and shear stresses in the wheel assembly. The So called peripheral brake system also produces less radial thrust at the wheel bearing [1].

Heidrich, Lukas, Augsburg Et. Al. tells about how to overcome the bottle necking of design space constraint for the conventional disc brake design, perimeter disc brake constructions can be used. The focus of this paper are to check properties of perimeter disc brake systems for use during on-brake and off-brake periods, and investigation of scaling effects on these properties due to the principle of this brake [2].

Crowe, P e t. Al. research says the brake disc which is larger in diameter provides larger surface area for braking and heat dissipation which intern increases braking efficiency. The perimeter brakes can be very effective as compared to conventional disc brakes [3].

Emanuele Toson, Brakko Et. Al. tells disc brake, preferably for motorcycle front Wheels, with use of peripheral annular disc arranged in such a way that its brake caliper reaction force passes through a fixed axle which is coaxial with the wheel. The brake caliper is mounted at the end of a steering fork which is rigidly connected to the axle [4].

Li Jin, Xu Jianchang, Luo Fang Et. Al. tells about the brake noise and vibration generated during braking. Variation in the friction force between pads and brake disc can cause the brake disc to vibrate at different frequencies and will produce different brake noise. In this paper, the author considers that Brake torque variation (BTV) is the main cause of brake vibration and brake noise. Research also says that, not only just replacing the friction plate but can decrease the vibrations but also we should change the structure design and careful selection of brake friction parts in order to minimize brake noise [5].

III. PROBLEM DEFINITION, SCOPE AND OBJECTIVES

Problem Definition:

1. For two-wheeler front wheels, braking system requires large manual force to stop the vehicle. So, there is a requirement to decrease the braking force.
2. When rider applies the brake, the vehicle which is running at very high speed, it is required to stop the vehicle within a short distance which is not possible with conventional disc brake system. So, there is a need to design a new brake disc system which can stop the vehicle without skidding and within a short distance.

Scope

- It is required to design and optimize the perimeter disc brake system for motorcycle front wheel. To carry out the validation of the conventional and peripheral disc brake system, it is required to manufacture the experimental setup and carry out the experimentation.

Objectives

1. For the optimized peripheral disc it is required to check stresses developed at the braking load condition for the safety of the disc and the heat dissipated with the help of analysis tools such as ANSYS.
2. Experimental testing of the conventional disk brake system is to be done to determine braking distance and brake power absorbed at various vehicle speeds.
3. Experimental testing of the perimeter disk brake system is to be done to determine braking distance and brake power absorbed at various vehicle speeds.

IV. CONSTRUCTION DESIGN AND WORKING

CONSTRUCTION AND WORKING OF THE SETUP

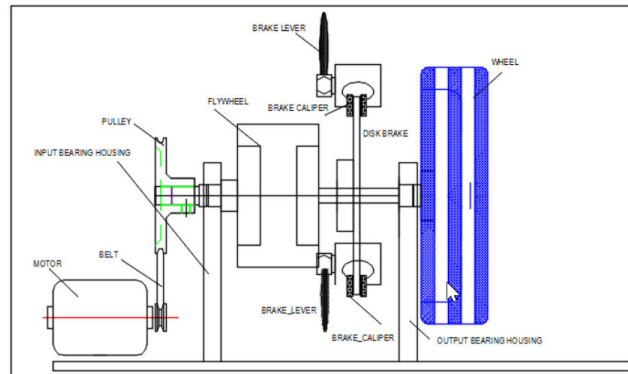


Figure 1: Schematic diagram of Disc brake test rig

DESIGN AND ANALYSIS OF SYSTEM COMPONENTS:

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 & efficiency. Hence a careful design approach must be adopted. The total design work has been split up into two parts.

- System design
- Mechanical Design.

System design mainly concerns the various physical constraints and ergonomics, space requirements, arrangement of various components on main frame at system, man + machine interactions, No. of controls, position of controls, working environment of machine, chances of failure, safety measures to be provided, servicing aids, ease of maintenance, scope of improvement, weight of machine from ground level, total weight of machine and a lot more.

In mechanical design the components are listed down and stored based on their procurement, design in two categories namely,

- Designed Parts
- Parts to be purchased.

For designed parts detached design is done & distinctions thus obtained are compared to next highest dimensions which is readily available in market. This amplifies the assembly as well as postproduction servicing work. The various tolerances on the works are specified. The process charts are prepared and passed on to the manufacturing stage. The parts which are to be purchased directly are selected from various catalogues & specified so that anybody can purchase the same from the retail shop with given specifications.

SYSTEM DESIGN In system design we mainly concentrated on the following parameters: - 1. System Selection Based on Physical Constraints While selecting any machine it must be checked whether it is going to be used in a large-scale industry or a small-scale industry. In our case it is to be used by a small-scale industry. So, space is a major constrain. The system is to be very compact so that it can be adjusted to corner of a room. The mechanical design has direct norms with the system design. Hence the foremost job is to control the physical parameters, so that the distinctions obtained after mechanical design can be well fitted into that. 2. Arrangement of Various Components Keeping into view the space restrictions the components should be laid such that their easy removal or servicing is possible. Moreover, every component should be easily seen none should be hidden. Every possible space is utilized in component arrangements. 3. Components of System As already stated the system should be compact enough so that it can be accommodated at a corner of a room. All the moving parts should be well closed & compact. A compact system design gives a high weighted structure which is desired. Man, Machine Interaction The friendliness of a machine with the operator that is operating is an important criterion of design. It is the application of anatomical & psychological principles to solve problems arising from Man – Machine relationship. Following are some of the topics included in this section.

- Design of foot lever
- Energy expenditure in foot & hand operation
- Lighting condition of machine.

4. Chances of Failure The losses incurred by owner in case of any failure is an important criterion of design. Factor safety while doing mechanical design is kept high so that there are less chances of failure. Moreover, periodic maintenance is required to keep unit healthy.

5. Servicing Facility The layout of components should be such that easy servicing is possible. Especially those components which require frequents servicing can be easily disassembled. Scope of Future Improvement Arrangement should be provided to expand the scope of work in future. Such as to convert the machine motor operated; the system can be easily configured to required one. The die & punch can be changed if required for other shapes of notches etc.

6. Height of Machine from Ground For ease and comfort of operator the height of machine should be properly decided so that he may not get tired during operation. The machine should be slightly higher than the waist level, also enough clearance should be provided from the ground for cleaning purpose.

7. Weight of Machine The total weight depends upon the selection of material components as well as the dimension of components. A higher weighted machine is difficult in transportation & in case of major breakdown, it is difficult to take it to workshop because of more weight.

MECHANICAL DESIGN Mechanical design phase is very important from the view of designer .as whole success of the project depends on the correct deign analysis of the problem. Many preliminary alternatives are eliminated during this phase. Designer should have adequate knowledge above physical properties of material, loads stresses, deformation, and failure. Theories and wear analysis, He should identify the external and internal forces acting on the machine parts These forces may be classified as.

1. Dead weight forces
2. Friction forces
3. Inertia forces
4. Centrifugal forces
5. Forces generated during power transmission etc.

Designer should estimate these forces very accurately by using design equations. If he does not have sufficient information to estimate them, he should make certain practical assumptions based on similar conditions which will almost satisfy the functional needs. Assumptions must always be on the safer side. Selection of factors of safety to find working or design stress is another important step in design of working dimensions of machine elements. The correction in the theoretical stress values is to be made according in the kind of loads, shape of parts & service requirements. Selection of material should be made according to the condition of loading shapes of products environment conditions & desirable properties of material. Provision should be made to minimize nearly adopting proper lubrications methods. In, mechanical design the components are listed down & stored on the basis of their procurement in two categories.

- Design parts
- Parts to be purchased.

For design parts a detailed design is done & designation thus obtain are compared to the next highest dimension which is readily available in market. This simplification the assembly as well as post production service work. The various tolerance on the work is specified. The process charts are prepared & passed on to the work are specified. The parts to be purchased directly are selected from various catalogues & specification so that anybody can purchased the same from the retail shop with the given specifications.

COMPONENTS OF SYSTEM:

1. Motor:

Motor Type: - Single Phase AC Motor.

Power: - 1 /15 HP (50 WATTS)

VOLTAGE: - 230 VOLTS, 50 Hz

CURRENT: - 0.5 AMPS SPEED: - MIN = 0

rpm MAX = 9500 rpm TEFC CONSTRUCTION, COMMUTATOR MOTOR.

2. Open Belt Drive:

The open belt drive has following specifications: Power is transmitted from the motor shaft to the input shaft of drive by means of an open belt drive,

Motor pulley diameter = 20 mm

IP _ shaft pulley diameter = 100 mm

Reduction ratio = 5

IP_shaft speed = 9500/5 = 1900 rpm

$T_{motor} = 0.05 \text{ N-m}$

Torque at IP_shaft = $5 \times 0.05 = 0.25 \text{ Nm}$

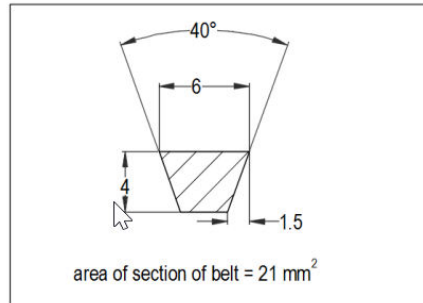


Figure 2: V Belt

Power transmitting capacity = $(T_1 - T_2) v = (142.9 - 35.4) \times 4.81 / 1000 = 21.5 \text{ Kw}$

Thus the belt can safely transmit power of 0.05 Kw

$T_{design} = P \times 60 / (2 \pi \times 9500) = 0.05$

Reduction ratio of pulley drive = $100 / 20 = 0.252 \text{ N-m}$

Considering T_{design} to be 0.4 N-m for 100 % overload as we are going for braking application.

3. Flywheel:

The flywheel is made of cast iron with objective to provide momentum to the set-up shaft to indicate the brake power.

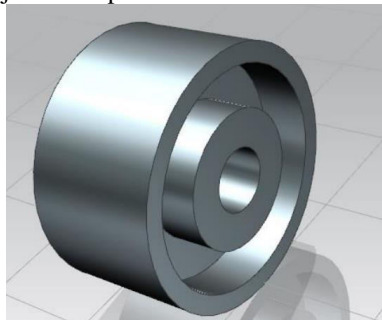


Figure 3: Flywheel

4. Input shaft: This is a high-grade steel EN24 material shaft that holds the input cam. The shaft is held in ball bearings 6004 and 6003 respectively.

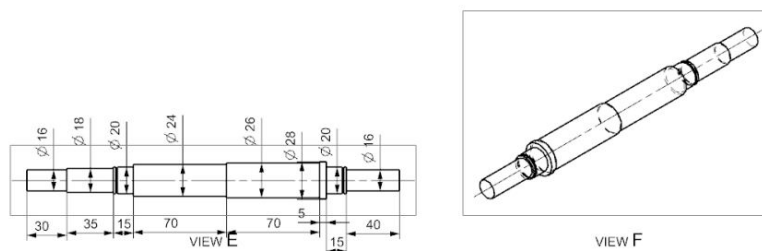


Figure 4: Input shaft

Assuming 100 % efficiency of transmission

$\Rightarrow T_{design} = 0.4 \times \text{GEAR RATIO} = 0.4 \times 4.8 = 1.95 \text{ Nm}$

CHECK FOR TORSIONAL SHEAR FAILURE OF SHAFT.

Torque is applied at the driven gear mounting point on the shaft which 16mm in diameter.

$T_d = \pi / 16 \times f_{s_{act}} \times d^3$

$f_{s_{act}} = 0.310 \text{ N/mm}^2$

INPUT SHAFT is safe under torsional load.

5. Disk Brake and calliper: Disk is made from plain carbon steel EN8 with 160 mm outside diameter and 37.5 mm inside diameter. Holes are drilled on the disk using DRO milling machine precisely equi-spaced for proper balancing. Calliper is connected to the load application lever to apply the brake.

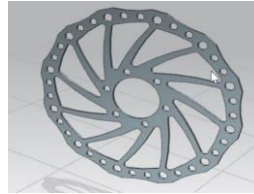


Figure 5: Disc

6. Braking Hub:

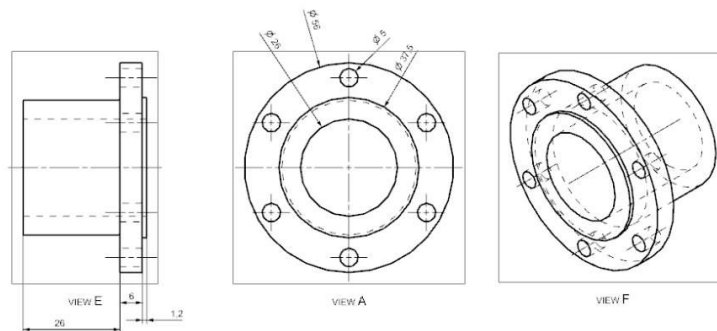


Figure 6: Braking hub

Assembly of project:

Thus, after assembly of the project it looks as follow:



Figure 7: Assembly of the project

V. ADVANTAGES, DISADVANTAGES AND APPLICATIONS

Advantages

1. Better heat dissipation: They stay cooler during heavy braking, avoiding performance loss.
2. Stronger stopping power: They can stop the vehicle more quickly and effectively.
3. Improved wet weather performance: Water and debris are quickly cleared, maintaining good braking.
4. Easy maintenance: They are easier to inspect and replace, reducing costs and time.
5. Weight reduction: They are lighter, improving fuel efficiency and performance.
6. Compatible with ABS and advanced systems: They work well with modern braking technologies, enhancing safety and control.

Disadvantages

1. Cost: They can be more expensive to make and install compared to other brakes, which can affect the overall price of the vehicle.
2. Complexity: They have more parts and can be more complicated to maintain and repair, requiring specialized knowledge and tools.
3. Vulnerability to Damage: Since they are exposed, they can get damaged more easily by debris or road hazards, affecting their performance and safety.
4. Noise and Vibration: Sometimes, they can make noise or cause vibrations during braking, which can be bothersome. This can happen due to uneven wear or other factors.
5. Corrosion: Being exposed to moisture and road salt, they can be prone to corrosion, which can reduce their effectiveness and lifespan.

Applications

1. Cars and Trucks: They are commonly used in cars, SUVs, and trucks for reliable and safe braking.
2. Motorcycles: Many motorcycles use peripheral disc brakes for strong and responsive braking.
3. Racing and Performance Vehicles: They are crucial in racing cars and high-performance vehicles for powerful and efficient braking.
4. Commercial Vehicles: Buses, trucks, and trailers rely on peripheral disc brakes for their heavy-duty braking needs.

VI. CONCLUSION

1. It can be concluded that the conventional disc brake system can perform braking within a short distance and time.
2. From the theoretical analysis it is found that the brake force required to stop or to minimize the speed of the wheel is less in case of the peripheral disc as compared to the conventional disc brake.
3. From the theoretical analysis it is concluded that the brake force does not pass through the wheel through spokes in case of the peripheral disc brake system. Design of the spokes can be optimized.
4. The modelling is done using Solidworks and the analysis have been performed using Ansys considering static structural analysis and steady state thermal analysis.
5. In case of static structural analysis, the maximum strain, stress, shear stress and total deformation has been studied whereas in case of steady state thermal analysis, total temperature and heat flux analysis have been studied.

REFERENCES

- [1] Shivankur Mittal, —Peripheral Disc Brake System and its Comparison with Conventional Disc Brake System for use in Motorcycle Front Wheel an Introduction to Signal Detection, International Journal of Aerospace and Mechanical Engineering, Volume 3 – No.4, August 2016.
- [2] Crowe, P. 2007, —Wilwood Stealth Perimeter Brake System, viewed 10 July 2016.
- [3] Heidrich, Lukas, Augsburg, Klaus, Albrecht, Rico, Eisele, Christian; Mäurer, Peter; Stibbe, Thorald, — Study of Operational Behavior and Design Of Perimeter Wheel Brakes For Active Corner Modules, Ilmenau University of Technology, Germany EB2015-BAS-002.
- [4] Manjunath T V et al. [2013] Structural and Thermal Analysis of rotor disc, brake <http://core.ac.uk/download/pdf/9554608.pdf>
- [5] Li Jin, Research on brake noise of air disc brake, 2011 Third International Conference on Measuring Technology and Mechatronics Automation.
- [6] Adam Adamowicz, Piotr Grzes, " Analysis of disc brake temperature distribution during single braking under non-axisymmetric load-ScienceDirect 2010-31 (2011) 1003e1012.



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