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Research paper



Two Wheeler Aero Braking System

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Abstract

The most commonly used transport system in our country is two wheeler transport system. In that there are varieties of vehicle with vast engine specifications which generate more power. As well as there are many advanced braking system which is invented to reduce or stop the vehicle Even though, the accident rate is increasing day by day. One of the main reasons for the accident is the stopping distance of the vehicle.This project is mainly based on reducing the stopping distance of the vehicle and balancing the vehicle at emergency conditions. We achieve that by creating a drag force against the thrust force. This drag is created with the help of wings which is fixed on both sides of the vehicle. The wings are operated by rack and pinion mechanism which was connected to the starter motor. The starter motor is activated by the driver by means of switch. By implementing our project in commercial vehicle we can reduce the rate of accidents occurring in our day to day life.

Keywords:*aerodynamics, drag force, aero braking, rack and pinion, stopping distance.*

1. Introduction

Two wheelers are the most important part in our today's competitive world. So each and every engineer is working hard to maintain the quality and integrity of two-wheeler. There are so many improvements in the two-wheeler from the day ofinvention. Each and every modification concerned about the safety of the driver as well as the environment. The modifications were done in each and every part of the vehicle including the chassis, design of the vehicle, engine etc. The chassis and the design of the vehicle should consider the shape, size and specifications of the engine. The engine specification increases the performance and speed of the vehicle. As well as to reduce or to stop the vehicle there are many types of brakes are available in the market. The most commonly used braking system is anti-lock braking system and recently developed braking system iscombi-braking system. Even though there are many developments in braking system the accidents rate are increasing eventually. Most of the accidents occur due to applying sudden brake.

When the brake is applied suddenly it stops the rotating motion of the wheel but due to friction the vehicle moves forward, this movement increases the stopping distance. The stopping distance is one of the main reasons for major accidents. Thus we created an idea called aero braking system. This braking system uses a drag force to reduce the speed of the vehicle as well as the stopping distance. The drag force is created by the wings which are mounted on the chassis of the vehicle.

2. Aerodynamics

It is the study of the motion of fluid around the solid objects. Aerodynamics is defined as the force generated by the fluid around the surface of the solid objects which affects the velocity of solid object.. It depends on the four forces performing on the surface of the solid objects. The forces acting on the objects are weight, lift, thrust, and drag.

2.1. Weight:

The weight is nothing but the mass of the solid object. Weight is directly proportional to the mass and gravity pull of the earth

2.2. Lift:

Lift is the force which helps something to move up.It is the reaction force of the gravity i.e. the opposite force of the weight. Every object which is in motion must have a lift.

2.3. Thrust:

Thrust is nothing but the force which is helps the objects to move forward. This force is opposite to the drag force. For the higher velocity of the object the thrust force should be greater than the drag force. Thrust force is responsible for the continuous movement of the objects.

2.4. Drag:

Drag is the force which is generated against the thrust force. It is responsible for reducing the velocity of any object which is in motion. If the drag is high it is hard for an object to move forward. It is tougher to walk through water than through air, because water has more drag when compared to air. The shape of an object influence the amount of drag generated.Most curved objects have less drag when compared to a flat objects. Narrow surfaces usually have less drag than wide ones.

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2.5. Causes Of Aerodynamic Drag:

Aerodynamic drag is the force of wind or air which resists the forward movement of the vehicle. This drag reduces the velocity of the objects which are in motion. In case of two-wheeler the drag is classified into two categories. They are,

- Pressure drag
- Skin friction drag

2.6. Pressure Drag:

The main type of drag acting against a vehicle is pressure drag. It is caused by the fluid being more compressed (pushed together) on the front-facing surfaces and more spaced out on the back surfaces. This makes the layers of fluid to separate away from the surface of the object and begins to swirl this is called turbulent flow.
If the air pressure on the front surfaces of the two-wheeler and the rider is more than the back surfaces, there is a drag. In the other words, if the force acting on front surface is greater than the back surface then the drag is more than the thrust force. If the design of the wing is less narrow there is a greater chance of generating more drag when compared to the narrow wings. This makes the pressure zone as much as bigger so the pressure drag will be high. Pressure drag is caused by the fluid particles which are being compressed on the front-facing surfaces of the rider and the two-wheeler and more spaced out on the back surfaces of the rider and the two-wheeler. This makes the layers of fluid to separate away from the surface of the object and begins to swirl this is called turbulent flow. Note the wing shape plays a major role in increasing the drag. The pressure zone occurs behind the arms, legs, and back of the rider as well as the back side of the two-wheeler. It is harder to reshape those parts to keep airflow attached but it helps to increase the pressure drag.

2.7. Skin Friction Drag:

The layers of fluid move over a rough surface, the fluid particles in the layer collide with the surface which slows down the movement the fluid particles over the surface at some point the fluid particles completely stops. These particles then collide with fluid in layers a bit this makes them to slow down as well. The region where the fluid particles are present is called boundary layer. If the density of the boundary layer is increased then the drag will be increased. The density of the water is more than the air so the drag is more for water than the air. Skin friction drag is depend on the force or velocity of the wind against the surfaces of the rider as well as the two-wheeler.

3. Aero braking

3.1. Concept of Aero Braking:

The braking system present in the existing conventional two-wheelers is disc brake. And, the recent development in this braking system is anti-lock braking system and combi-braking system. Both brakes uses a frictional force as the braking force. The drag force is acting as a braking force in the aero braking system. The drag force is created by the wings which are placed on both side of the vehicle. The merits of using this aero braking system are reduced maintenance cost since the wearing of brake pads is reduced, high reliability. This aero braking is more efficient when the vehicle moves in high velocity.

3.2. Principle of Generation of Aero Braking:

When aero braking system operates, the force around the vehicle is disturbed by the wings. Those wings generate a force which is against the thrust force i.e. velocity of the vehicle, that generated force is known as drag force. This drag force act as a braking force which is used to reduce the speed of the vehicle. Since the wing is placed on both the sides the drag force generated is very sufficient to reduce the velocity of the vehicle instantly.

3.3. Characteristics:

Mono directional design, the aero braking system is designed to operate in single direction only. Since the aim of the aero braking system is to reduce the velocity of the vehicle by generating the drag force.
Light weight, during inactive condition the aero braking set-up will be idle and it sum up the weight of the vehicle. So, the weight of the set-up should be lighter as possible.
Design consideration, when the wing is in its active position it should withstand the force which is applied on the surface of the wing. The wing is designed not to dispersed nor broken straight.

4. Wing

A wing is a type of flat plate which acts as a fin. If this fin is made contact with air or some fluid it produces a lift. This fin is also called as airfoils since the streamlined cross-section of the wings are subjected toaerodynamics. The aerodynamic efficiency of the wings is described in terms of lift-to-drag ratio. The lift, a wing creates at a given speed and angle of attack the total drag on the wing lesser than its magnitude
Wing blades are most important part in this set-up which helps the vehicle to slow down by its aero dynamics. The dimension of the wing proposed here is 45 centimeters long, 45 centimeters width and of 2 millimeter thickness which is made up of aluminum alloy composition which gives low weight and high strength. The respective wings placed in cantilever position which is evenly placed either sides of the vehicle, even it is placed in cantilever position it is well supported at the inner sides of the wings. The major element which affects the wings to createdragforce is its size, shape and weight.There are several types of wings such as low wing, dihedral wing, high wing, mid wing, gull wing, inverted gull. The wing is in dihedral shape as it creates more drag force when compared to other shapes of wings. . The material used for the wing is Aluminum alloy.

4.1. Wing Material-Alloy 6063:

Alloy 6063 offers good mechanical properties, commonly used material for manufacturing an airfoils of aircrafts. Its ready extrude ability enables to manufacture a thin walled and intricate hollow shapes. The standard profiles of this material areflats, angles, channels and hollow circular and square sections. Alloy 6063 responds well to chemical brightening, anodizing, polishing, and dyeing. The alloy 6063 can be replace by similar alloys such as 6061, 6005 and 6005. Alloy 6063 is suitable for all conventional welding, it commonly heat treated in T5 or T6 tempers.

4.2. Physical Properties:

Property	Value
Density	2.70 g/cm³
Melting Point	655 °C
Thermal Expansion	23.5 x10-6 /K
Modulus of Elasticity	69.5 GPa
Thermal Conductivity	201 W/m.K
Electrical Resistivity	52 % IACS
Electrical Resistivity	0.033 x10-6 Ω .m

4.3. Mechanical Properties:

Property	Value
Proof Stress	170 MPa
Property	**Value**
Tensile Strength	215 MPa

Hardness	75 HB
Elongation	8%

4.4. Design of the Wing:

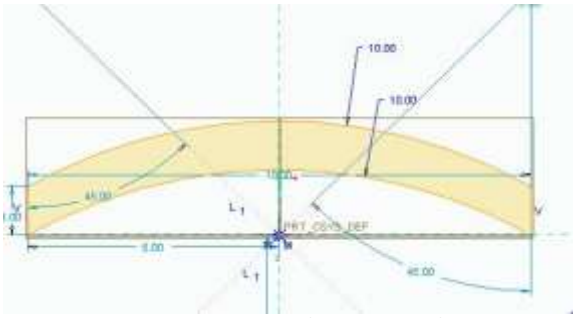


Fig 1: Top view of 2D diagram of wing

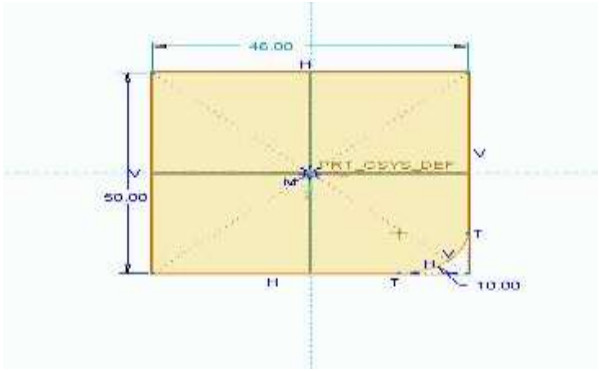


Fig 2: Side view of 2D diagram of wing



Fig 3: 3D diagram of wing

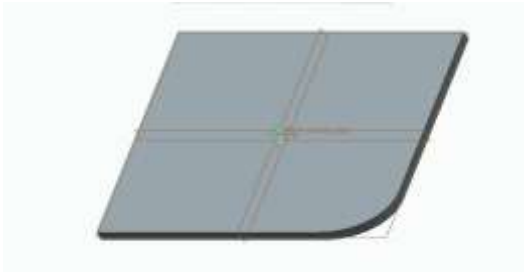


Fig 4: Side view 3D diagram of wing

5. Methodology

5.1. Rack and Pinion Mechanism:

This mechanism consists of two components they are rack and pinion. The rack is nothing but a rod which consists of teeth while a rotating gear is the pinion. This mechanism can be applied in two methods. One is to fix the rack and another method is to fix the pinion gear at a particular position but the pinion gear is allowed to rotate on its axis. If the rack is fixed, the pinion gear is allowed to rotate over the rack. Which moves the entire body which is connected to the pinion gear. This method can be found in the steering of a four-wheeler and in conventional lathes. If the pinion gear is fixed in its axis, the rack will move either in forward motion or in backward motion. This method is used in this set-up for opening and closing the wings. If the pinion rotates in clock-wise direction the rack moves in forward direction and when it rotates in counter clockwise direction the rack moves in backward direction

5.2. Working Principle:

The principle of two wheeler aero braking system is to increase the drag force by using wings on both side of the vehicle which affects the aerodynamics of the vehicle and also it reduces the thrust force i.e. speed of the vehicle. When the vehicle moves in a certain speed say 100kmph,when the brake is applied suddenly there is a risk of vehicle imbalance which makes the driver fell from the vehicle as well as there will be a major damage to the vehicle.

The imbalance was caused by the friction between the roads and tires of the vehicle. While driving in a speed which is lessthan the above mentioned speed the friction between the road and tires of the vehicle is increased thus if the speed of the vehicle is de-creased the friction is increased. So, for reducing the speed of the vehicle the wings are used. The wings are operated by the rack and pinion mechanism which was connected to the 12v electric motor. The electric motor is powered by a 12v lead-acid battery and it is initialized by a two-way switch which can be operated by the driver. While the electric motor runs in clockwise direction, the wings get to the active position and when it runs in counter clockwise direction the wings will return to its actual position.

The drag force created by the wings will reduce the speed of the vehicle and disc brake is applied to stop the vehicle. It also reduc-es the stopping distance of the vehicle.

6. Calculations

Calculation of stopping distance at normal condition,
Stopping distance = v2/ 2*μ *g m/s
Where,
v- Velocity m/s
μ- Coefficient of friction
g-Acceleration due to gravity m/s2

Velocity = v*1000/360
= 90*1000/360
= 24.59 m/s
= (24.59)2/2*0.8*9.8
Stopping distance = 38.52 m

Calculation of drag force for wings,
Drag force (fd) = ρ*v2*cd*A/2N
Where,
ρ- density of the fluid kg/m3
v- Velocity of the fluid m/s
cd- drag coefficient
A- Area of cross section m2
Drag co-efficient (cd) = 2*m*g/ρ*v2*A
Where,
m - Mass of the wing kg
g- Acceleration due to gravitym/s2
ρ- density of the fluid kg/m3
v- Velocity of the fluid m/s
A- Area of cross section of wings m2

= 2*1.3*9.81/1* (24.59)2*4.6
= 0.0183
Drag force = 1*(24.59)2*0.0184*4.6/2
= 25.59 N

7. Conclusion

This innovative concept will surely be successful where it includes safety improvements, why safety improvements? We all know in this 21st century all human beings are running for their works and their daily life so fast and not even caring others in their travel so it is most important toimprove our safety system in two wheeler especially in India where two wheeler accidents are more than any other countries and it is most used vehicle in our Nation. Still there are systems in two wheeler for safety systems like disc brakes and abs brakes but these systems will also not be enough and it also had been failure in some times so we analyzed disadvantages in these systems and analyzed which effect will be good enough for braking systems so came out with TWO WHEELER AEROBRAKING SYSTEM which overcome the disadvantage of the existing braking system. By this set-up we can achieve minimum stopping distance of a vehicle to avoid accidents and also reduce the risk of skidding. This set-up won't affect the aerodynamics of the vehicle during its initial condition. The drag force created during the active condition reduces the speed of the vehicle. The tension between the brake pad and the rotor will be less thus increasing the life period of the brake pads.

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