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RESEARCH ARTICLE OPEN ACCESS

Design and Installation of Hydraulic Disc Brake to Trolley

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ABSTRACT
One of the most crucial components in every vehicle is the braking system, which is utilised to slow down the vehicle. It must function effectively for the driver's and passengers' safety. This project involves the design of a braking system for an electric golf cart, as well as the calculations and analysis for it, as well as the design and analysis of the steering knuckle. A hydraulic disc brake system is constructed with four disc rotors for each wheel to stop the car in the shortest distance feasible, as required by the driver.Because this E-vehicle has six seats, weight reduction is a critical factor to consider. As a result, the steering knuckle has been engineered to withstand all forces. In addition, the forces are calculated and the steering knuckle is designed in this article. All four wheels will be equipped with bike rotor discs and callipers. Creo 3.0 was used to design the steering knuckle.

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I. INTRODUCTION

1.1 HISTORY OF BRAKE

The usage of brakes was originally reported in ancient Rome. These primitive brakes consisted of a lever that pushed a wooden block against the exterior of a metal-lined wheel when it was pulled. Friction was the principal braking force in this apparatus. Due to the sluggish speeds at which the carts moved, this strategy was effective; but it was insufficient for slowing down runaway vehicles. This braking system has been utilized for millennia with minimal improvement in design [1].

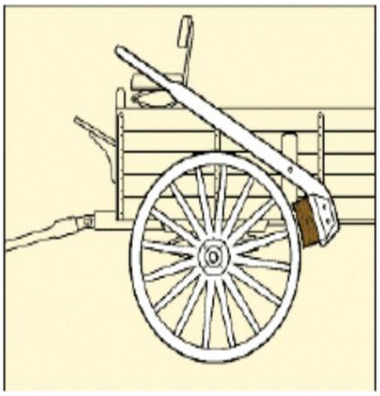

Figure:1.1 The Lever Brake System

When the Michelin brothers designed the rubber-covered wheel, drum brakes were used instead of wooden blocks. Drum brakes were created by Louis Renault in 1902. Instead of applying a block to the outside of the wheel, drum brakes were mounted inside of the wheel hubs. This helped minimize debris blockage and reduce the loss in braking friction. Drum brakes are still in use in cars as handbrakes due to the large amount of force needed in order to overcome the brake force while at rest.

Fig:1.2 Drum Brake

With the introduction of the assembly line, cars became heavier and faster, which created a need for a more powerful braking system. Malcolm Longhead [2],created a four-wheeled hydraulic braking system. The hydraulic system uses lines filled with hydraulic fluid rather than cable driven braking systems. The main advantage to hydraulic braking systems is that they can apply a greater braking force than cable systems. Cable brakes fatigue faster than hydraulic brakes due to the constant tension that the cable is under. Hydraulic brakes allowed the driver to apply less force onto the brake pedal while still stopping in the same short distance. Throughout braking history, the issue of overheating has been a constant problem. When the brake pads make contact with the braking surface, they generate heat. The key to distributing heat and allowing the brake to cool is to have a bigger surface area. Disk brakes have a huge surface area exposed to the air, which aids cooling. The rotor of the brake system has holes and grooves carved into it to allow water and debris to be transported off the braking surface and prevent interference, which causes braking force loss.

Fig: 1.3 A Disk Brake System

Disk brakes did not start becoming popular in vehicles until the 1950's even though they were invented around 1902 [3]. Disk brakes are attached inside the rim of the vehicle and spin in unison with the wheel. When force from the driver's foot is applied to the brake pedal the brake fluid travels through hydraulic cables and becomes amplified by the power braking system attached to the engine; this in turn pushes the brake fluid against the caliper which uses frictional force to slow the vehicle. Faster vehicles need brake pads and calipers to be made of different materials to replicate the same braking distance needed to stop slower less advanced vehicles, due to the greater amount of inertia that is trying to be stopped. There are five main materials used in brake rotors. The five materials most commonly found in brake rotors are cast iron, steel, layered steel, aluminum, and high carbon irons. Production cars use cast iron brakes due to the amount of abuse that they can handle without cracking or failing. Steel brakes have a lighter weight and heat capacity, but lack durability in repeated uses. Heat can disperse faster with layered steel brakes because adding layers to simple steel brakes allows for a stronger material that can withstand a more rigorous workload. Aluminum brakes have the lowest weight of all vehicle rotors. Heat is dispersed quicker, however the total capacity for heat absorption is lower than in steel brakes; this is why aluminum is most commonly used in motorcycles and other small vehicles. The final type for brake material that is used is high carbon iron. High amounts of carbon allow for increased heat diffusion, which makes this type of brake most commonly used in high performance vehicles.

Fig: 1.4 Rotors for Brakes

Various materials have been used to make brake pads over the years, depending on the intended function. Asbestos was the most popular material due to its ability to absorb and disperse heat. After scientific studies, asbestos has been found to be a highly toxic material and has been banned from use in vehicles in the United States. With asbestos illegal to use, brake manufactures were forced to create safer brakes from a material that will not harm the general public. Organic brakes are made from materials that can withstand heat, for example; glass and varieties of rubber are mixed with a heat resilient resin to produce safer brakes. The advantages of using organic brake pads are that they are usually quieter and are easier to dispose. Even so, organic brakes are not typically used because they wear easily and dust particles collect between the pad and wheel, which decreases the braking surface[4].

Fig: 1.5 Brake Pads

With a lighter weight to slow down, motorcycles use organic and ceramic brake pads. Ceramic brake pads are the most effective type of brake pads but are the most costly. The most common type of brake pad is made with a mixture of several types of metals. These metallic brakes are durable while still being cost efficient. The negative factors for using metallic brakes are that they work best when warm and it may take longer to slow down at first when driving in cold weather. With advances in material science, brakes will continue to improve to match the advances in car technology [5].

1.2 HYDRAULIC BRAKING SYSTEM

A hydraulic brake is a braking platform that contains brake fluid, which often comprises glycol ethers or diethylene glycol, to transmit pressure from the regulating mechanism to the braking mechanism [6].

1.3 WHY WE NEED HYDRAULIC BRAKING SYSTEM

Mechanical braking systems were used before hydraulic braking systems, so why employ hydraulic braking systems when we already have mechanical braking systems? Let's see how things go.

1. Because braking is such an important safety component of an automobile, the reflexes from the brake pedal to ultimate braking must be very quick, which is something that a mechanical type regenerative braking fails to achieve and which the hydraulic braking system does very well.
2. When compared to mechanical braking, the brake force generated by hydraulic braking systems is quite high, which is a crucial component for today's super and hyper series of automobiles.
3. Because there were so many moving components in a mechanical braking system, frictional wear and tear was quite high. This was greatly reduced to an acceptable level with the development of the hydraulic braking system, which has far fewer moving parts than the mechanical one.
4. Mechanical braking had a high design complexity, which was lowered with the development of the hydraulic braking system, which has a simple and easy-to-assemble design.
5. The mechanical braking system required a lot of maintenance owing to the complicated and large number of members involved, but this is not an issue with the hydraulic braking system because it has a basic design with fewer moving parts.

II. LITERATURE SURVEY

JasnaGlisovicJovankaLukic et.al. [7],This work describes the FE modelling of wet multiple-disc brakes and their braking performance. Heavy loads are delivered on public roadways at faster speeds as agricultural tractor size and speeds have risen in recent years. Brake systems with strong heat dissipation properties are necessary due to the combination of increased energy levels and faster deceleration. Wet multiple-disc brakes feature the same multiple disc design as dry multiple-disc brakes, but they function in an oil bath. ABS is the next phase in the evolution of a tractor's braking system, adding a layer of safety and control. In addition to pictures of development patterns of various components of agricultural tractors and trailers' braking systems. There is a global trend toward raising tractor speed to increase tractor transportation performance. Machines that are faster, larger, more powerful, and more agile may achieve greater speeds. Nonetheless, the increased speed of agricultural vehicles necessitates an effective braking system that allows agricultural vehicles to keep up with other fast vehicles in road traffic while maintaining traffic safety.

ZbigniewKamiński et.al. [8],Using simulation approaches, the created computer model is used to examine transient processes in the air braking system of agricultural tractors equipped with hydraulic brakes and to anticipate the dynamic features of the air braking system of tractor-trailer units (speed and synchronisation of action). An agricultural tractor's conventional air braking system is made up of two main components: an energy supply unit and a control device. The energy supply unit's job is to purify and compress the air, as well as to keep the pressure in the tractor and trailer reservoirs at a safe level for trailer braking. For tractor-trailer combinations, the control mechanism enables a smooth, progressive braking operation.A hydraulically driven trailer brake control valve allows the tractor hydraulic braking system and the trailer air braking system to work together.

Geovana P. Drumond and Marysilvia F. Costa et.al. [9], This research is focused on hydraulic hoses. Hydraulic hoses are subsea umbilical components that govern Xmas tree gate valve functioning. External pressure can force these hoses to collapse, and because they are composed of stiff polymers, this failure can result in strain concentration at specific points around the circle, culminating in rupture due to high internal pressure. As a result, the purpose of this study is to identify a new material for hydraulic hose liners that can bear internal pressure (associated to the aramid layer) following a collapse while being chemically inert to the hydraulic fluid pushed by the hose. The current material (Polyamide 11) was compared against Viton, a fluorinated elastomer, for this study. The mechanical behaviour of these materials was compared using uniaxial tensile testing and nonlinear finite element models. According to the results of finite element analysis, neither Polyamide 11 nor Viton failed under external pressure.

Manish DigambarToprakwar et.al. [10],The modelling, analysis, and optimization of the master cylinder of the hydraulic brake system are done in this study, and it is concluded that polyimide is a viable alternative to aluminium in automotive manufacture. The weight of a polyimide master cylinder (0.1 49 kg) is smaller than that of an aluminium master cylinder (0.282 kg). The stress created in an aluminium master cylinder is more than the stress induced in a polyimide master cylinder, and the induced stress in polyimide material is quite low when compared to its ultimate strength. The search for a more fuel-efficient engine began many years ago. Many automotive manufacturers are conducting additional study into how to improve vehicle mileage. In today's car market, every manufacturer is concentrating on vehicle weight reduction. With this goal in mind, this article focuses on supplying alternative materials. The goal of this project is to maximize weight reduction in order to enhance vehicle mileage. We can save several kilos at the conclusion of the design by conserving grammes at various places of the automobile. In all respects, the principal material for vehicle component manufacture, polyimide, might be the greatest alternative answer. The focus of this article is on master cylinder weight reduction. PRO-E and ANSYS are utilized for modelling and analysis. The findings achieved are superior than those of conventional materials, indicating that polyimide might be a viable option for automobile components.

Gaurav Sevda [11], The problem with current trolleys is that it is hard to stop them on slop when loaded. To solve an axle mounted with disc brake is designed. While designing the system evaluation of force, pressure, torque, heat dissipated and coefficient of friction is done. Braking system is mainly used to decelerate vehicles from an initial speed to a given speed. Friction based braking systems are the common device to convert kinetic energy into thermal energy through friction between the brake pads and the rotor faces.

Chetankawle [12],Farm vehicles like any other vehicle must comply with Road Traffic Regulations, a lot of which have been in Legislation since the 1960's. The increasing number of fatalities on our roads, together with the demand for action on road safety, has resulted in stricter enforcement of these regulations. Many farmers and contractors are discovering that their trailers do not fulfill the requirements laid down in the Road Traffic Regulations. The need for such braking system is even more important with the introduction of 30 km/h tractors. The service brakes of the tractor and those of the trailer are required to be operated simultaneously by a single control (brake pedal).The service brakes on trailers are either of the hydraulic or air type. Hydraulic braking system would be adequate up to 30 km/h.

III. CHARACTERISTICS

Brakes classification features as follows

1. **Peak force** – The most powerful decelerating effect that can be achieved is peak force. A wheel skid occurs when the peak force exceeds the kinds' traction limit.
2. **Incessant power debauchery**– When brakes are used, they become heated and eventually fail if the temperature rises too high. Continuous power dissipation is the greatest amount of power (energy per unit time) that the brake may dissipate without failing. Factors like ambient cooling air temperature and speed effect continuous power dissipation.
3. **Fade** – When a brake gets less effective as it heats up, this is known as brake fade. Some patterns are naturally prone to fading, while others are more resistant. In addition, variables like cold have a big influence on fading.
4. **Smoothness** – A grabby brake that pulses, chatters, or otherwise exerts varying braking force can induce skids. Friction brakes without an anti-skid system, for example, commonly produce skids, raising maintenance costs and giving passengers a "thud thump" sensation.
5. **Power** –Brakes are considered "strong" when a little human application force results in a braking force that is more than the average for

other brakes in the same class. This concept of "powerful" has nothing to do with continuous power dissipation, and it can be perplexing because a brake might be "powerful" and brake powerfully with a mild brake application while having a lower (worse) peak force than a less "powerful" brake.

6. **Pedal composition**– The subjective sense of braking power produced as a function of pedal travel is known as brake pedal feel. The braking fluid displacement and other variables influence pedal travel.

7. **Drag** – Brakes have various amounts of drag in the off-brake state, depending on the system's design, to account for whole-system compliance and deformation that occurs while braking, as well as the capacity to remove friction material from the rubbing surface.
8. **Durability** – The worn surfaces of friction brakes must be changed on a regular basis. All wear surfaces are the brake shoes or pads, as well as the braking disc or drum. There may be trade-offs; a wear surface with a high peak force, for example, may wear quickly.
9. **Weight** – Brakes are usually considered "added weight" since they have no other function. Furthermore, brakes are typically mounted on wheels, and unsprang weight can reduce traction in certain conditions. The term "weight" might refer to either the brake or additional support structures.

IV. COMPONENTS OF HYDRAULIC DISC BRAKE

Let's look at the many components that make up a hydraulic brake now that we've discussed hydraulics. The following components make up the entire braking system:
1. Principal cylinder (Lever)
2. Streaks
3. Liquid
4. Slave cylinder (Caliper)
5. Pads
6. Rotor

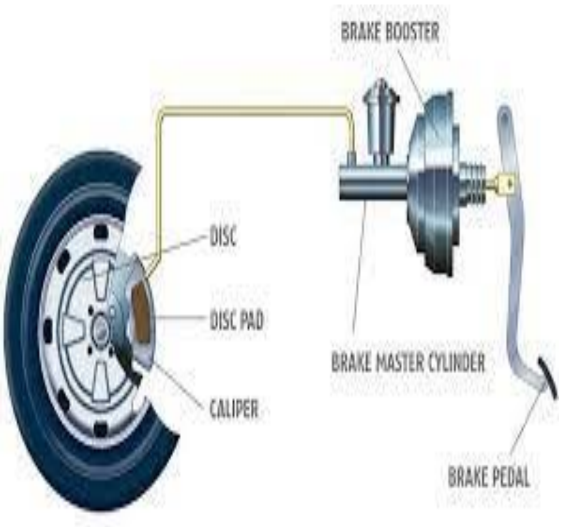

Fig: 4.1Brake system components

4.1 MASTER CYLINDER

Converts mechanical force from the brake pedal, power booster, and push rod into hydraulic pressure. Here you'll find pistons, piston seals, return springs, and internal brake fluid ports. A fluid reservoir is also provided, which can be either within or outside the device. The reservoir will have a removable top with a rubber diaphragm seal that must be in good operating order to seal properly.
A low brake fluid level switch is included in most reservoirs to inform the driver of a low fluid condition.

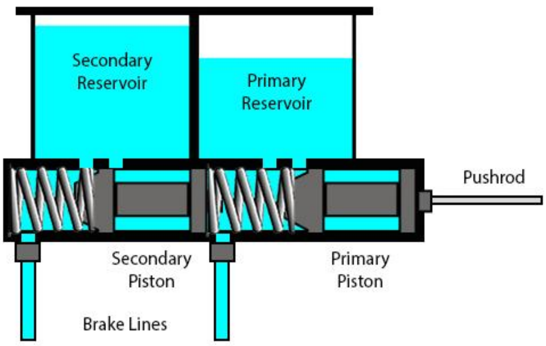

Fig: 4.2Brake master cylinder

4.2 LINES OF BRAKE

Hydraulic brake lines, also known as hoses, link the master cylinder and slave cylinder, which are the two primary functioning portions of the brake. Let's take a deeper look at hydraulic systems, which may be quite adaptable in that their lines or hoses can be routed practically anyplace.

4.2.1Hose Structure

Hydraulic hoses are multi-layered in structure, with three layers in most cases:

1. Inner Tube - The fluid is held in this layer of tube. Teflon is commonly used because it does not react or corrode when in contact with braking fluid.
2. Aramid (Kevlar) Layer - gives the hose its strength and structure This woven layer is flexible and should not expand when exposed to the high pressures of the hydraulic system. Kevlar is also lightweight, which is an advantage for any bike component, and it can be cut and reassembled with conventional hose connections.
3. Outer Casing - Reduces abrasions by acting as a protective barrier for both the Kevlar layer and the bike frame.

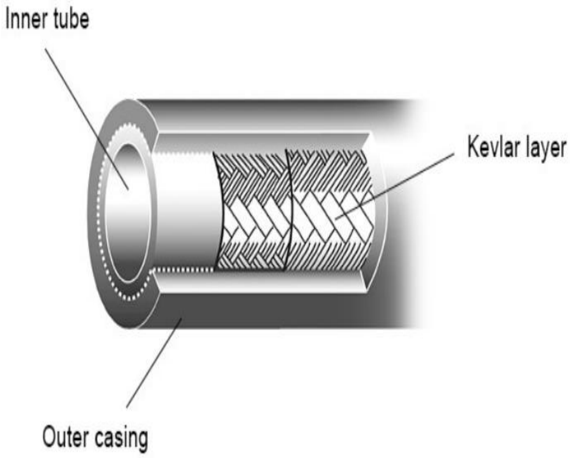

Fig: 4.3 Hydraulic house pipe

4.3 FOOTBRAKE FLUID

DOT fluid or mineral oil are the most common brake fluids used in hydraulic braking systems. Before we go into the qualities of each, it's crucial to emphasise that the two fluids should never be combined. They're made up of quite distinct chemicals, and the seals in the braking system are designed to work with either one or the other; mixing or substituting one for the other is likely to destroy the brake's internals. Mixing fluids from the same family, on the other hand, is permitted but not recommended. You may, for example, combine DOT 4 and DOT 5 brake fluid without affecting your braking system.

4.4 SLAVE CANISTER/CALLIPER

The brake calipers are located at each wheel and respond to the user's lever input. As the pistons move the brake pads to touch the rotor, this lever input is transformed to clamping force. A solid attachment to the frame or floating calipers are also options. The only method to achieve 0% free running drag is to combine fixed calipers with a fixed rotor. One disadvantage of this design is that it is less forgiving of rotor flaws. With each braking application, floating calipers glide axially and self-center.

4.4.1 Construction

The two forms of caliper construction are mono-block and two-piece caliper construction. The difference is the 'bridge' design, which connects the two portions of the caliper above the pistons and gives the strength to withstand the piston clamping forces.
1. Mono-block - A mono-block caliper is a one-piece design made of a single piece of material. Because there are no steel bolts connecting the two sides as in a two-piece construction, this can provide a distinctive design and typically a lighter caliper. The lack of a transfer port seal also implies that fluid leaks at the half-way seam are less likely. However, maintaining a mono-block calliper is tough, and manufacturing and assembly are often more challenging.
2. Two piece - For extra strength over a monoblock design, these two-piece callipers are made up of two separate components that are connected together with steel bolts. Service, manufacturing, and assembly are all made easier. Steel fasteners and additional seals add weight and may be difficult to remove during routine maintenance.

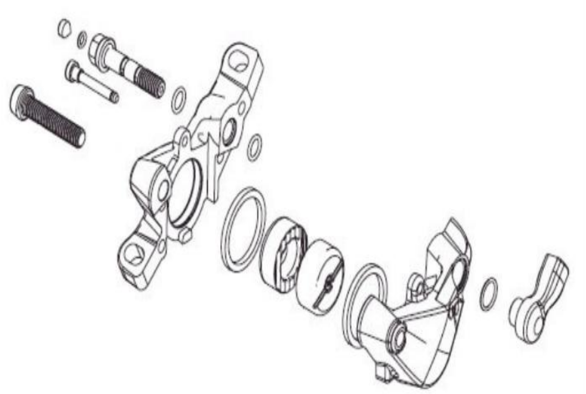

Fig:4.4 Exploded view of an Avid two-piece calliper design

3. Piston - The cylindrical components located within the calliper body are known as pistons. They protrude when the lever is pressed, pushing the brake pads against the rotor. Different callipers and brakes have different numbers of pistons. Some hydraulic mountain bike brakes feature two piston callipers, while others have four. Some car brake callipers feature six or even eight pistons.

It's worth mentioning that the number of pistons has no effect on brake power. Total piston contact area is a more reliable metric; four smaller pistons, for example, can exert the same force as two larger pistons. Single-sided or opposing pistons are available. When the brake pads are forced in the same direction to meet the rotor on both sides, opposing pistons protrude. Single-sided calliper pistons, on the other hand, only stroke on one side of the rotor and float it to the opposing pad.

4.5 BRAKE PADS

Choosing the correct brake pads might be the difference between a good and a bad brake. When it comes to replacing brake pads, the sheer variety of materials available makes it simple to make a mistake. Let's get started by looking at the various pad materials and their characteristics.

4.5.1 Organic

There is no metal in organic brake pads. They're composed of a variety of materials, including asbestos, which was utilized until it was prohibited. Rubber, Kevlar, and even glass is extensively used materials these days. The components are then glued together using a heat-resistant resin. Organic pads have the benefit of being constructed of materials that do not contaminate the environment as they wear. Because they're softer, they're also quieter than traditional brake pads. They also reduce the amount of wear on the brake rotor. Organic pads, on the other hand, disintegrate more quickly and perform badly in damp, slippery conditions .Organic pads are thus more likely to fit less aggressive riding in mostly dry conditions.

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Fig:4.5 Organic Brake pads

4.5.2 Semi-metallic

Semi-metallic pads can have a metallic composition ranging from 30% to 65 percent. The addition of metal to the friction substance modifies the situation slightly. Metal wears slower than organic materials, therefore it can extend the pad's life dramatically. As heat is passed between the pad material and the backing plate, heat dissipation is also enhanced. Some downsides include greater noise during usage and higher rotor wear due to the tougher compound.

Fig: 4.6 Semi-metallic pads

4.5.3 Sintered

Sintered brake pads are made up of hardened metallic components that are fused together using extreme heat and pressure. This composition provides better heat dissipation, a longer-lasting pad, increased fade resistance, and improved performance in humid conditions. The trade-offs are more noise, a longer bed-in time, and a poor initial bite until the friction material heats up.

Fig: 4.7 Sintered Brake pads

4.5.4 Ceramic

Ceramic brake pads are becoming increasingly popular as a replacement or upgrade for mountain bike brake pads. Ceramic brake pads are often only found on high-performance racing vehicles with brakes that must work under extreme heat. Heat like that isn't normally an issue for the ordinary mountain bike brake, so ceramic pads would be overkill for most people, but they could have other benefits.

The advantages of a ceramic material are that it can withstand tremendous heat while still working well, thanks to its excellent heat dissipation capabilities. They also last longer and produce less noise than other pads. They're also gentler on rotors and emit far less dust than conventional brake pad formulations.

Fig: 4.8Ceramic Brake pads

4.6 ROTOR ENTERPRISE

Hardness, thickness, and rub area are all important rotor design parameters. Because of the aggressive pressures imposed by the pad friction material, the material used to make rotors must be robust and lasting. Rotor wear is directly affected by this. Rotors must also be uniform in thickness. Differences in rotor thickness across the circumference might cause problems with the braking system, such as pulsating when thicker and thinner areas pass between the pads. Rotors must also run true. During usage, any lateral wobbling in the rotor might cause the brake to touch the pads intermittently.

The rub area of a rotor can be designed in a variety of ways. The three rotors above demonstrate this in further detail. The weight and strength of the rotor can be affected by the rub area design. It also has an impact on pad longevity.

4.6.1 Disc Rotor

Braking power is directly proportional to rotor size. For any given input, the bigger the brake rotor, the more power is produced. Larger rotors can be a problem since they have a more 'grabby' sensation, making it more difficult to modulate the brake.

Fig:4.9 Disc rotor

The round discs that are linked to each wheel are known as brake rotors (two in the front and two in the back). Rotors are used to convert kinetic energy (movement) into thermal energy (heat). When you press down on the brake pedal, the master brake cylinder sends a signal to your callipers, which causes your brake pads to pull together against the rotors' huge surface area. The friction caused by the pads pressing on the rotors opposes the wheel's spin, slowing its rotation and bringing the automobile to a rest.

V. DESIGN OF DISC BRAKE

The following parameters are considered for the gears

1) Kinetic Energy (KE) of the vehicle = $\frac{1}{2} \times m \times v^2$
   Where,
   m = mass (kg)
   v = velocity of vehicle (m /s)
   $KE = \frac{1}{2} \times m \times v^2$
   $KE = \frac{1}{2} \times 2000 \times (8.33)^2$
   KE = 69.388 KJ
2) Stopping Distance (D) = $v^2/2\mu g$
   Where,
   v = velocity of vehicle (m /s)
   μ= coefficient of friction between road surface and tire (0.4 for wet road from the reference Jones & Childers 2nd Ed. Sec 4.8)
   g= acceleration due to gravity, 9.81 m/s^2
   $D=V^2/2\mu g$
   $D= (8.33)^2/(2\times0.4\times9.81)$
   D=8.841 m
3) For deceleration ,
   $V^2= U^2 + 2 a D$
   Where,
   U= initial velocity during braking (m /s)
   V = final velocity after braking (m /s)
   a= deceleration (m/s^2)
   D = stopping distance (m)
   $V^2= U^2 + 2 a D$
   $(8.33)^2= (11.11)^2+2\times a\times8.841$
   a= -3.056 m/s^2 (Here value of ‘a’ is negative it is because of deceleration)
4) Time required to stop (sec),

V=U+ at
U= initial velocity during braking (m /s)
V = final velocity after braking (m /s)
a= deceleration (m/s^2)
t= time required to stop (sec)
V=U+ at
8.33=11.11+ (-3.056)×t
t= 0.911 sec

5) Total Braking force (TBF) = KE/ stopping distance(D)
Where,
KE = Kinetic Energy (KJ)
Total Braking force (TBF) = KE/ stopping distance (D)
Total Braking force (TBF) = 69.388/8.841
Total Braking force (TBF) = 7.848 KN
6) Braking Force on each wheel (F)= Total Braking Force / No. of wheels
Braking Force on each wheel (F) = 7.848/4
Braking Force on each wheel (F) = 1.962KN
7) Braking Torque (T)= μ ×F×R
Where,
F= force on the each wheel (KN)
R= radius of wheel (m)
Braking Torque (T) = μ ×F×R
Braking Torque (T) = 0.4×1.962×0.4
Braking Torque (T)= 0.31 KN-m

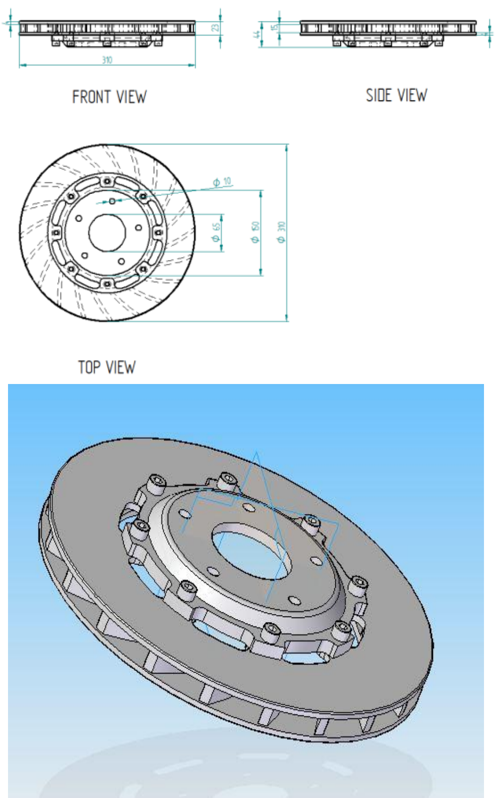


Fig: 5.1 Wheel disc rotor

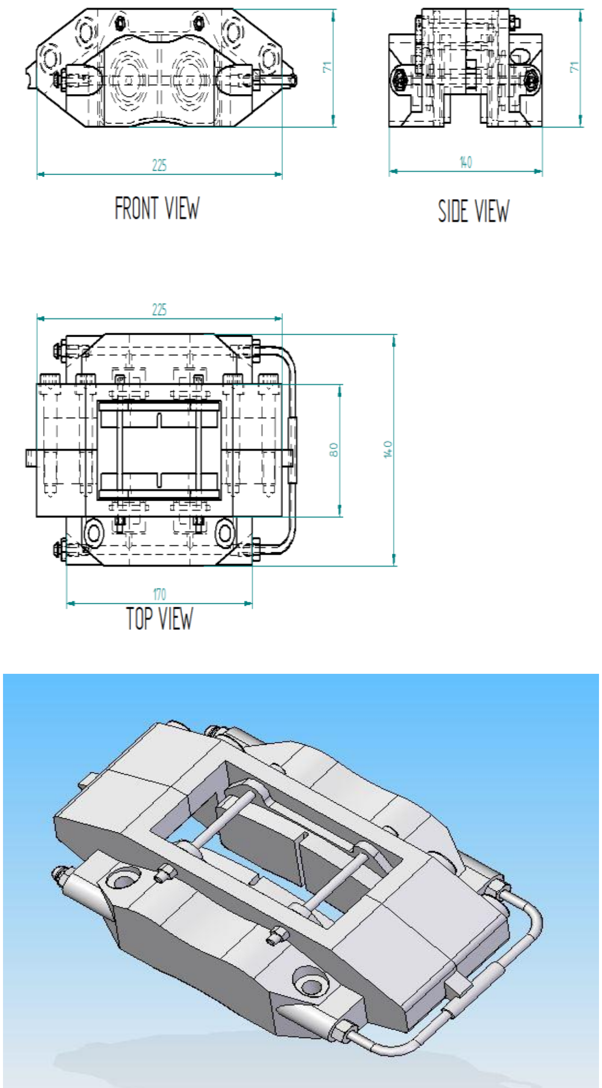
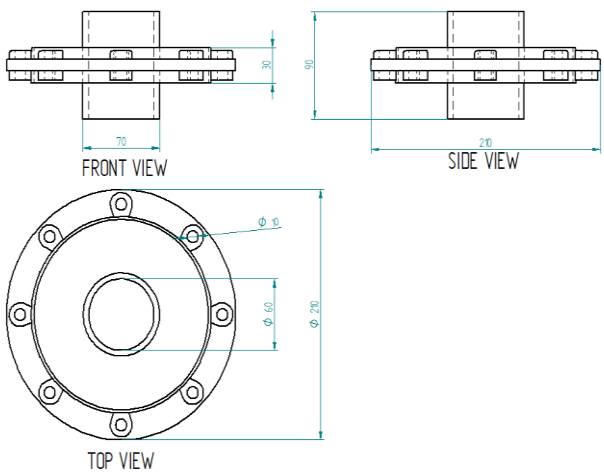


Fig: 5.2 Caliper assembly with bracket



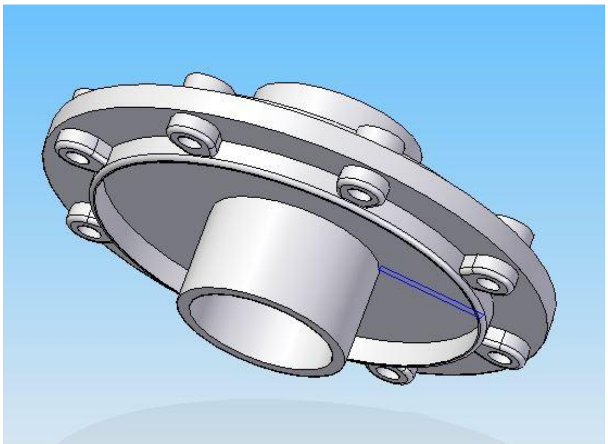
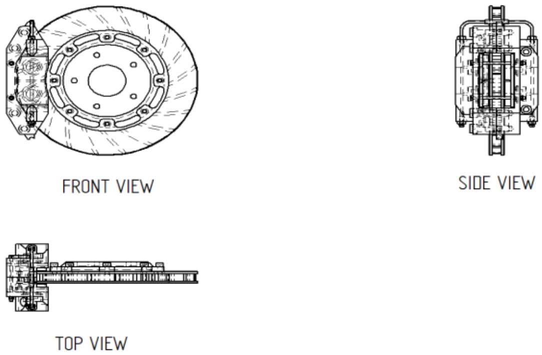


Fig: 5.3 Trolley Hub



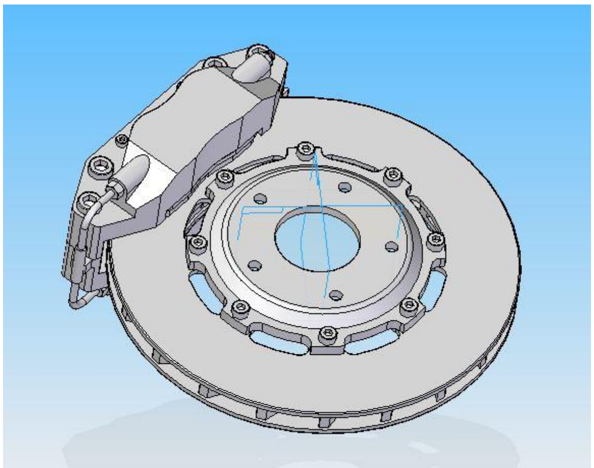


Fig: 5.4 Assembly of the Disc Brake

VI. WORKING PRINCIPLE

When the driver presses the brake pedal, the brake booster (servo system) increases the force and the master cylinder converts it to hydraulic pressure (oil pressure). The pressure is delivered to the wheels' brakes via brake oil-filled tube (brake fluid). The pistons on the four-wheel brakes are pushed by the supplied pressure. The brake pads, which are friction materials, are forced onto the braking rotors, which spin with the wheels, by the pistons. The pads clamp down on the rotors on both sides, slowing or halting the vehicle and decelerating the wheels.

1. When the brake pedal is pressed, the master cylinder's high-pressure fluid drives the piston outward.
2. The piston pushes the brake pad against the rotating disc.
3. The fluid pressure builds when the inner brake pad makes contact with the rotor, and the caliper moves inside, dragging the outward brake pad towards the rotating disc, where it makes contact.
4. Now that both brake pads are pressing on the rotating disc, a lot of friction is formed between the pads and the disc, slowing down and finally halting the automobile.
5. The piston travels inward when a brake pad is released, pulling the brake pad away from the revolving disc. The vechicle then resumes its journey.

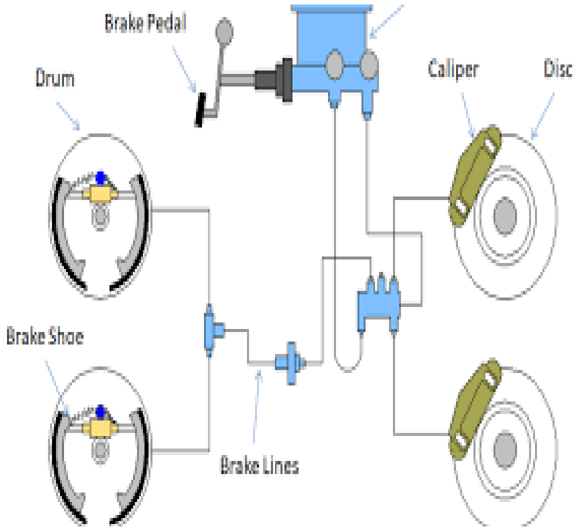


Fig:6.1 Hydraulic braking system

VII. EXPERIMENTAL SETUP

The basic idea of a Hydraulic regenerative braking system is that when the vehicle slows down or decelerates, it will store the kinetic energy that was originally momentum as potential energy in the form of pressure. This is done by using a displacement pump to pump hydraulic fluid into an accumulator. When the vehicle accelerates, the pressure is released from the accumulator which will spin the drive shaft and accelerate the vehicle. Thus the engine remains idle while the pressure is released and when the accumulator is empty, or the desired speed is achieved, the engine will then engage in order to maintain a constant velocity, or to accelerate the vehicle beyond what the capacity of the accumulator was capable of. There are tons of load carried by the trolley, on the road. The trolley moves with the help of the tractor. The master cylinder is been placed after the bolt and the spring. During the moment of the tractor the trolley is also moved along. And with which the bolt moves through tends to move forward. Expected modelling of tractor trolley. When it moves forward the I-bolt and rod which is connected to the tractor also moves and gives jerk. This jerk and sudden impact is absorbed by the spring. The rod moves inside, attached to the piston of the master cylinder, the piston moves along with it. The piston moves and the fluid is passed into the wheel cylinder and shoes is operated. When shoes are operated the brakes are applied and our project is successfully worked out. We are using this type of hydraulic braking system because of simplest working and affordable.

COST ESTIMATION

Sl.NO	Parts	Quan tity	Materia l	Amount (Rs)
1	Wheel hub	1	Cast iron	2400
2	Disc rotor connector	1	Mild steel	2000
3	Bearing	2	Steel	2200
4	Axle	1	Mild steel	2000
5	Disc rotor	1	Alloy	1700
6	Caliper	1	Alloy	4500
7	Master cylinder	1	Alloy	3500
8	Hose pipe	1	Rubber	500
	Total			18800

Table No. 8.1 Cost Estimation

LABOUR COST:
Lathe, drilling, cutting fitting:
Cost =2,500.00
Charges for overhead
The overhead charges are arrived by manufacturing cost
Manufacturing cost=material cost + labour cost
=18,800.00+2,500.00
=21,300.00
Overhead charges =20% of manufacturing charges
=4,260.00
Total cost
Total cost =material cost + labour cost + overhead charges
=18,800.00+2,500.00+4,260.00
= Rs. 25,560.00

Total cost for this project = Rs. 25,560.00
ADVANTAGES OF DISC BRAKES
1 Stopping the car using disc brakes takes less effort.
2 It produces less heat.
3 The disc brake is easy to set up and maintain.
4 The disc brake is simple to operate.
5 The disc brake will never self-lock.
6 Disk brakes can deliver a lot of torque in a short space.
7 The braking torque of a disc brake is related to the actuating force.
8 Both directions of rotation of the disc are equally effective with the disc brake.
9 Disc brakes will continue to function even if your rim is bent.
10 With disc brakes, the wheels must be sturdy and able to withstand high torque strains between the rim and the hub.
11 In rainy conditions, it is less prone to slide.
12 Disc brakes improve your bike's visual appeal.

DISADVANTAGES OF DISC BRAKES
1 Because disc brakes are more prone to noise, regular maintenance is essential.
2 The rotors wrap up more easily than the drum brakes.
3 Because disc brakes are not self-energizing, they require larger clamping pressures, necessitating the use of a power booster.
4 When compared to a drum brake, it is more expensive.
5 This brake has too many components, which adds to its weight.

VIII. CONCLUSION

This project has been successfully designed and fabricated. This hydraulic disc brake will fulfill the task of installing the effective braking system to the tractor trolley.

Hence it will help the people who risk's their life while driving a tractor with trolley. Also, this will help the transportation to the hill and congested area with ease. This simple hydraulic brake system is cheaper and easier to install compared to drum brake system, as trolley tire disc does not have any hub space to fix the drum brakes.

Hydraulic hybrid technology has the advantage of high-power density and the ability to accept the high rates/high frequencies of charging and discharging, therefore it is well suited for off-road vehicles and heavy duty trucks. The innovative design of our project was to avoid the problems caused in the tractor trolley. This helps to minimize the disasters faced below.

1. Cannot apply sudden brakes
2. Trolley falls down
3. Tractor cannot overtake on highway
4. Tractor cannot move on high speed

This hydraulic brake system could find a great scope in future for all trollies.

IX. FUTURE SCOPE

Every project work has some chances for future improvement and increasing the overall utility.

We suggest following points for future improvement.

1. With one more same setup we can implement it to any trolley.
2. This can be made more effective by using two calipers on same disc rotor.
3. Whole disc setup can be covered with extra cover plates, so that it stops any mud or unwanted particles to go inside the caliper.
4. Hand brakes can be installed to get greater stability of the trolley specially when it is parked in the slope roads.
5. For the same disc brakes, we can use pneumatic systems (air brakes) instead of hydraulic system.

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