

# Enhancing Riding Comfort of Two Wheeler Using V Suspension

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**Abstract-** *With the advancement of technology, motorcycle industry is growing rapidly with new designs of bikes, sportive models, features etc., it becomes essential to ensure the safety and comfort of the rider in a better and effectual way. Suspension systems were introduced for the vehicle's handling, braking, and for providing safety and comfort by keeping the vehicle's passengers comfortably isolated from road bumps and vibrations. Thus a new design in suspension system would help to overcome the above need. A V suspension is designed in order to absorb the minor shocks due to irregularities on road surface. In this model there are two suspensions inclined to each other to form a v shape in a common base. A roller is attached on the top of both the suspensions where it rolls over a path provided by the top holder. This roller movement absorbs the minor shocks and then it resides on the top of holder where further larger loads are absorbed by suspension damper and springs. This small change in the design of the suspension improves the shock absorbing capacity of existing without affecting the normal suspension action and also the minor shocks are absorbed easily giving maximum comfort to the rider*

**Keywords-** roller movement, damper and springs

## I. INTRODUCTION

The tremendous growth of Motorcycle industry, has given arise to provide a safe and comfortable ride to the rider. To give such riding experience the use of suspension becomes an unavoidable and an ineluctable requirement. We had often experienced the discomfortness due to small cavities in roads where even a two wheeler with the latest suspension fails to give the smoothness to the rider. Thus a small change can be proposed in the design of Suspension to give a smoother drive from jerks due to cavities. Also the minor shocks on road (for e.g. Due to small curve speed breakers, small stones etc..) cannot be absorbed by suspension as it needs a minimum load for contraction. The attachment of roller on the suspension and giving it a path to glide for minor shocks finds the solution for the above problems.

The purpose of the project is to ensure the safety and comfort of the rider in a better and effectual way by

introducing a new design in two wheeler suspension for the vehicle's handling, braking, and for providing safety and comfort by keeping the vehicle's passengers comfortably isolated from road bumps and vibrations at any occasion. This project deals with the introduction of a new v suspension for motorcycle which is predominantly meant to increase the comfort of the rider. The V shape gives better shock absorption and also reduces the distance travelled by roller.

Dual shocks, even as old technology has its own charm to hold on to things. Roads previously were in a pretty bad shape. Not only bikes, even the scooters are equipped with Dual shocks. It is not just that dual means better or something, but there is a lot of science that goes into it. Indian roads used to be bad that made the bikes would have to go through a lot of stress while on the road. This meant more stress on the swing arm and hence there is a need for an able system to soak up all those bumps. Monoshocks would have done the job, but again the subject comes to loading of the bike. Today the dual shocked commuters are used in lot of rural areas, which means the bike is loaded with more than its usually rated capability. With all the superbikes and sports bikes, monoshocks are used on a regular basis. Very rarely a higher capacity bike using dual shocks is seen, unless of course the rider riding a touring machine. In that case it is necessary to have dual shocks because the stress on the swing arm is really high and hence the single shock might not be able to take the entire load. But with a Monoshocks it is best used with bikes which are perfect for cornering since dual shock are not able to take variable load on them and hence handling and stability in cornering takes a hit

The small shocks can be easily absorbed, minor ups and downs on the road are not felt by the rider easily. Four suspensions give better comfort to the rider. More useful in racing bikes where even a small disturbance on road must be taken care of. When there is a small cavity in road, the normal suspension does not give any expansion for comfort, thus the rider feels a lot uncomfortable. In v suspension the roller rolls down the path till bottom to give a smoother expansion and retract.

## II. MATERIALS AND METHODS

A conceptual design was developed and designed for v suspension in order to impart comfortness and give a smooth ride in bumpy irregular roads

## 1. Conceptual design, Components and its Description

The v conceptual prototype model design was developed to improve the riding quality in terms of comfortness is shown in Figure 1. V suspension consists of the following components Suspension, Base holder, Top holder, Roller holder, Roller, Rod, Frame, Cam and Handle.

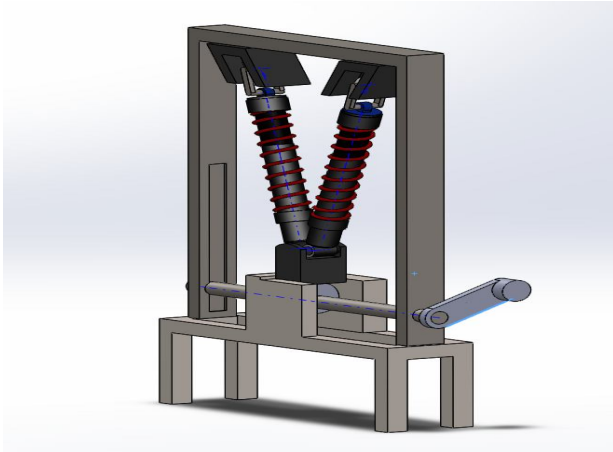


Figure 1. CONCEPTUAL DESIGN

### a) Suspension

Suspension consists of shock absorber and spring. The main objective of the suspension is to restrict road vibrations from being transmitted to various components of the vehicle and to protect the passengers from road shocks and then finally it provides the stability of the vehicle in running condition. Suspension system is very important for any type of vehicle because even if we have flat roads without any irregularities the vibration of engine and other parts cannot be neglected. If there is no suspension system in a vehicle the shocks and vibrations transmitted by the rigid body of the vehicle may damage both vehicle body and the passenger.

The V-suspension is similar to that of ordinary suspension in terms of its functions and working but there is a slight alteration in design and some additional components are added to enhance and enrich the performance of the suspension. Suspension system consist two basic component spring and shock absorber. It works on the basic principle of spring energy. When a vehicle come in contact with road bump it extract a force on wheel. On sudden application of load the spring compressed suddenly and stores this energy without transmit this load on body of vehicle. After this the spring tends to expand and compress continuously but the

shock absorber act as the damping element which convert this energy into heat energy and provide resistance between continuous oscillations of spring.so the shock generated by the road bump disappeared without transmitting to the body which provides comfort riding condition.

A shock absorber is a mechanical or hydraulic device designed to absorb and damp shock impulses. It does this by converting the kinetic energy of the shock into another form of energy which is then dissipated. Pneumatic and hydraulic shock absorbers are used in conjunction with cushions and springs. An automobile shock absorber contains spring-loaded check valves and orifices to control the flow of oil through an internal piston. In most shock absorbers, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid heats up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of shock absorbers, such as electromagnetic types, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion vehicles on uneven roads.

Damping is the control of motion or oscillation, in a vehicle's shock absorber. This may also vary, intentionally or unintentionally. Like spring rate, the optimal damping for comfort may be less than for control. Damping controls the travel speed and resistance of the vehicle's suspension. An undamped vehicle will oscillate up and down. With proper damping levels, the vehicle will settle back to a normal state in a minimal amount of time. Most damping in modern vehicles can be controlled by increasing or decreasing the resistance to fluid flow in the shock absorber.

Spring is another important part of the suspension system. Springs which are used in suspension system are helical spring, leaf spring, Torsion bar etc. In V-suspension, helical or coil spring is used. It is mainly used in the independent suspension. It is also used in the conventional rigid axle suspension as they can be well accommodated in restricted spaces. The energy stored per unit volume is almost double in the case of coil spring than the leaf springs and these springs do not have noise problems.

The spring rate (or suspension rate) is a component in setting the vehicle's ride height or its location in the suspension stroke. When a spring is compressed or stretched, the force it exerts is proportional to its change in length. The spring rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring. Vehicles which carry heavy loads will often have heavier springs to compensate for the additional weight that would otherwise collapse a vehicle to the bottom of its travel (stroke). Heavier springs are also used in performance

applications where the loading conditions experienced are more extreme. Spring that are too hard or too soft cause the suspension to become ineffective because they fail to properly isolate the vehicle from the road. Vehicles that commonly experience suspension loads heavier than normal have heavy or hard springs with a spring rate close to the upper limit for that vehicle's weight. This allows the vehicle to perform properly under a heavy load when control is limited by the inertia of the load.

#### **b) Base holder**

The function of Base holder is to hold the bottom end of both the suspension and to provide the sliding movement of suspension without any discrepancies. The bottom part of the base holder is flat and this part will rest on a cam. The upper part of the base holder consists of two rods attached horizontally at the middle portion of the upper part. These two rods placed horizontally are responsible for holding the bottom end of both the suspension and it allows the suspension to slide up to a particular angle. The base holder is made of mild steel and it can withstand any type external loads up to a permissible limit.

#### **c) Top holder**

The important function of top holder is to provide a smooth and frictionless movement inside the pathway provided on it. The pathway is inclined to a particular angle so that the roller will glide freely on the path provided for it without getting blocked. The top holder is fixed rigidly at the corner of the frame and it is made of mild steel.

#### **d) Roller holder**

The roller holder is made of mild steel. The roller holder is in square shape with an opening at its upper part. The lower part of the roller holder is attached to the tap rod of the suspension. The upper part of the roller holder consists of two pins at the ends and these pins are responsible for holding the roller from without being slipped. The use of roller holder is to provide a smooth rotating movement for the roller.

#### **e) Roller**

The roller is made of nylon. The roller will move smoothly in the pathway provided on the top holder. The movement of the roller will withstand minor loads and if the loads are higher the actual working of suspension will take place. The roller is tough hardened to withstand the suspension force without producing any damage to the pathways provided on the top holder. The roller is provided

with a hole at the middle. The roller holder pins will attach firmly on the holes provided at the roller due to the attachment of the roller pins there will be no restriction for the movement of the roller. In practice, the roller deforms flattens slightly where it contacts each race much as a tire flattens where it contacts the road. The race also yields slightly where each roller presses against it. Thus, the contact between roller and race is of finite size and has finite pressure. Note also that the deformed roller and race do not roll entirely smoothly because different parts of the roller are moving at different speeds as it rolls.

#### **f) Rod**

The rod is placed horizontally in between the frame. The rod is attached to the base holder through a cam and the cam is placed at the center of the rod. The function of the rod is to give the required movement for the base holder through a cam. The rod should be hard and tough to withstand the force and vibrations exerted by the suspension system. If the rod is not strong enough to withstand the force and vibrations exerted by the suspension system it may tend to bend or it will break. And because of this reason the rod is made of mild steel which will withstand all the forces and vibrations exerted by the suspension system.

#### **g) Frame**

The frame is made of mild steel and it is divided into two halves. The upper half of the frame is in square shape and there is a hole provided on the lower end of both the arms and this hole is used to hold the rod. A cam is placed at the midpoint of the rod. It supports the suspension system from without being collapsed and holds it firmly and it rests on the lower half of the frame. The lower half of the frame acts like a base and holds the whole setup. In this frame there is an additional support to hold the base from without being slipped or collapsed during the movement. As the rod rotates the cam also rotates and due to the eccentric rotation the base tends to move away in x direction also. To avoid this a boundary frame is provided to the base and the movement is restricted.

#### **h) Cam**

A cam is a mechanical part used to generate irregular motion of mechanical elements. The cams are used to convert rotary motion to oscillatory motion or oscillatory motion to rotary motion to a second body, called the follower with which it is in contact. Cams are of different types depending upon the application the required cam has to be selected. In V-suspension radial or disc cam is used. The base holder acts as a follower. If the rod is rotated the cam attached at the middle

portion of the rod will experience a rotating motion and it will start to rotate at the time of rotation the base holder which is in contact with the cam starts to experience an reciprocating motion and it will start to move forward and backward depending upon the movement of the cam.

### i) Handle

The handle is attached at one end of the rod. The handle is used to rotate the rod manually when a handle is rotated the rod attached to it will start to rotate because of the rotation of the rod the cam will rotate and the reciprocating motion of the suspension system can be obtained. The handle can be made of light weight material with proper ergonomic aspects.

## 2. Functions of a V Suspension

The Normal suspension comes to act only after the load on it reaches a minimum value depending upon Stiffness of spring, Minor Ups and downs and the shocks are felt easily. In V suspension due to the Presence of roller and Two Suspensions, the minor loads can be absorbed by the Roller. Also in Pits the sudden retraction of spring provides discomfort to the rider in case of normal suspension but in V Suspension the roller rolls down at slower rate thereby giving smooth retardation and comfort. The Roller rolls for a small distance and then firmly holds in a position on Top holder where the further load is absorbed by the compression of the suspension system. Thus without affecting the action of the Normal Suspension the Minor Shocks are absorbed easily in V suspension and also the Presence of Two Suspension increases the Shock absorbing capacity. Depending upon Vehicle and use, the size of Top holder can be altered.

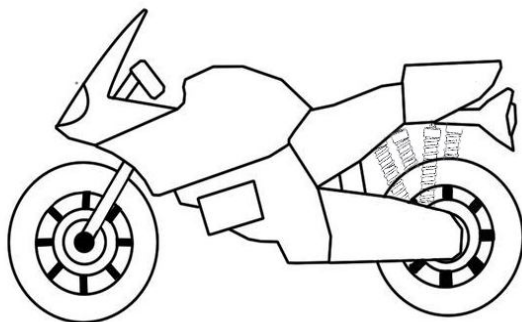


Figure 2. V Suspension fitted model

## 3. Design calculations

A prototype which was developed for V Suspension was designed based on the spring, roller holder and load calculations, in order to find out the efficiency of the v suspension.

### a. Spring calculation

In the design of spring for suspension a suitable outside diameter was opted and the material of the spring was selected as cold drawn wire steel and the properties of the steel was taken from PSG design data book. The load carrying capacity of the spring is calculated by using spring index and Wahl factor for any service life. Other dimensions of the spring were also calculated using the standard relations.

### b. Roller holder calculation

The Roller holder is subjected to pure bending stress and the design force acting on the two wheeler was calculated. Based on the bending moment equation the length of the roller holder was calculated.

### c. Load calculation

The weight of the vehicle with one and two rider was taken into account and load on each rear suspension was calculated and the load acting on each shock absorber is analyzed to check whether the shock is absorbed to keep the rider in comfort.

## 4. Experimental Trial Testing

Finally, the V suspension designed, manufactured and assembled in one piece was subjected to experimental trials by rotating the cam.

The moment caused due to the above load should not make the roller to touch the top end (Fig.3). Thus based on the above calculation for different two wheelers the roller path distance must be designed

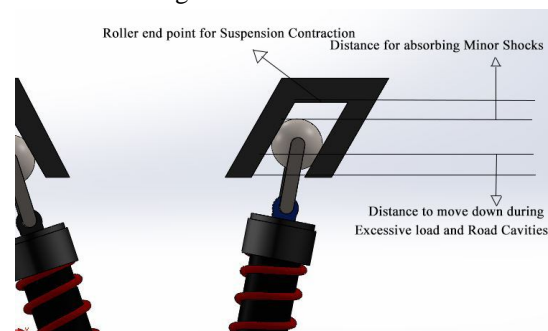


Figure 3. Roller path description

The roller movement and the displacement of the roller was checked during trial. Various observations such as different angle of two suspensions, alignment of base holder with respect to the cam and the tolerance of the roller and top holder was carried out.

### III. RESULTS AND DISCUSSIONS

The fabrication process, method of manufacturing, spring, roller holder and load carrying capacity of V suspension is given below:

#### 1. Fabrication process

The prototype of V Suspension which was fabricated is shown in figure 4.



Figure 4. PROTOTYPE V SUSPENSION

#### 2. Method of manufacturing

Table 1. Method of manufacturing

Part No.	Part name	Method of manufacturing	Machinery used
1	Suspension	Welding	Arc welding
2	Base holder	Welding, Cutting	Arc welding, Rotary Saw
3	Top holder	Welding	Arc welding
4	Roller holder	Welding, Cutting	Arc welding, Rotary Saw
5	Roller	Drilling	Drill bit
6	Rod	Cutting	Rotary saw
7	Frame	Welding, Grinding	Arc welding, Hand grind
8	Cam	Drilling	Drill bit
9	Handle	Welding	Arc welding

#### 3. Working of prototype

The fabricated prototype was tested by rotating the handle and the rotary movement of the cam is transferred to the base holder as reciprocating movement in upward and downward direction ensuring the movement of roller within the top holder.

#### 4. Part function

Table 2. Part function

Part No.	Part Name	Function
1	Suspension	Suspension absorbs shock and vibration.
2	Base holder	Holds the Base end of both the Suspension.
3	Top holder	Provides the pathway for revolution of the roller.
4	Roller holder	Holds the roller for its movement.
5	Roller	Used for the rolling movement in top holder.
6	Rod	Used to rotate the cam.
7	Frame	Holds the whole setup firmly.
8	Cam	Moves the Base holder up and Down.
9	Handle	Used to hand rotate the rod and Cam.

#### 5. Estimated Design calculation of V suspension

The size of spring, roller holder and load acting on V suspension for comfort riding is discussed below

##### a. Dimension of Spring

The Outside diameter of the spring is selected as 40mm and shear stress acting on the spring is found as 595 N/mm<sup>2</sup> for a spring index of 8. The deflection of the spring is calculated as 56.04mm. Total number of turns and solid length of spring is 13 and 65mm respectively. The Pitch of spring is calculated as 13.33mm

##### b. Dimension of Roller holder

The maximum load acting on the two wheeler was calculated as 2180N (max load that can be withstand). The bending length is 165 mm and the length of the roller holder is calculated as 17.1825mm.

##### c. Load acting on Shock absorber

The weight of the vehicle with one and two rider was taken into account. The weight of the two wheeler is assumed to be 130kg. If weight of one person be 75Kg and weight of two persons be 150Kg, then the load acting on two shock absorbers in v shape with single rider is 1307N and with two rider is 1785N and both the above weights are well below the

maximum load acting on the two wheeler which is 2180N and hence it gives comfort to the rider.

Based on the above roller calculations it is clear that the roller fitted V suspension can be installed in two wheelers which can withstand the load, moment and bending stress. The V shape gives the load equally to two rollers on the suspension so as to reduce the path travelled by it making the v suspension to be fitted in a comparatively smaller space. Thus by using V suspension in two wheelers the Small Shocks can be easily absorbed, minor ups and down on the road is not felt by the Rider.

## 6. Outcome of experimental trial testing

Based on the trial testing, the opted angle for the two suspension, the best alignment of the base holder with respect to cam gave maximum comfort to the rider.

## V. CONCLUSION

The proposed design of V Suspension will make a significant change in the two wheeler suspension system. Possibilities proved that it is the best way to give a comfort and smooth driving to the rider. The installation is also not a strenuous task, making it more possible to be installed in two wheelers in the early near future.

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