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DUOLEVER SUSPENSION SYSTEM IN MOTORCYCLE

Avinash Kanade[1], Suraj Gadakh[2], Prashant Jadhav[3], Viral Kadam[4], Dhiraj Sudke[5]

[1]Professor, Dept. of Automobile Engineering, Dr. D Y Patil SOET, Pune, Maharashtra, India.
[2,3,4,5]Student Dr. D Y Patil SOET, Pune, Maharashtra, India.

Abstract - *Suspension system is one of the main part of the vehicle, where the shock absorber is designed mechanically to reduce shock impulse and dissipate kinetic energy. Shock absorber used in two-wheeler for providing better handling, and braking, safety and comfort. The conventional and common type of the front suspension used in motorcycle is Telescopic forks. But this system have some problems such as uneven vibration, leakage of oil, changing of wheelbase, uneven compression of shock absorbers etc. Hence to solve these problems, a single shock absorber (Mono shock) is used as front suspension in this project. The Mono Shocks gives a better vehicle handling and provides safety at the time of braking. In this system the problem of uneven vibrations in the telescopic forks have been balanced by using the Mass Centralization concept in the pivoted center point of the front suspension in the motorcycle using Mono Shocks. In this system the mono shock is mounted between two swing arms so it is called as Duolever Suspension System. Most of the motorcycles using in India are low CC motorcycles and designed such a way that to use Telescopic suspension as a front suspension. In this paper authors introducing Duolever Suspension System for 'Bajaj Pulsar 150'.*

***Key Words*: Mono Shock, Duolever, Telescopic forks, Handling, Braking, Safety**

1. INTRODUCTION

A motorcycle's suspension system serves a dual purpose: contributing to the vehicle's handling and braking, and providing safety and comfort to passenger. By keeping the vehicle's passengers comfortably isolated from bumps, road noise and vibrations. In this system the shock absorber is designed mechanically to reduced shock impulse and dissipate kinetic energy. In a motorcycle, shock absorbers reduce the effect of traveling over rough ground, leading to improved vehicle handling and ride quality. While shock absorbers work for limiting excessive suspension movement, their main purpose is to damp spring oscillations.

1.1 Requirements of a suspension system

- Low initial cost.
- Minimum weight.
- Minimum tire wear.
- Minimum deflection consistent with required stability.

1.2 Objectives of suspension system

- To improves both the ride and handling.
- To absorb impact load caused by irregularities of road surface.
- To provide safety for passenger & driver.
- To provides safe guard to component of motorcycle

1.3 Existing System (Telescopic Forks)

Motorcycles now days use telescopic forks for the front suspension. The forks are simply large hydraulic shock absorbers with internal coil springs. They allow the front wheel of motorcycle to react to irregularities in the road while isolating the rest of the motorcycle from that motion.

The top of the telescopic forks are connected to the motorcycle's frame in a triple tree clamp, which allows the forks to be turned in order to steer the motorcycle. The bottom of the forks are connected to the front axle of front wheel. In typical telescopic forks, the upper portion, known as the fork tubes, slide inside the fork bodies, which are the lower part. As the tubes slide in and out of the body they are telescoping, thus the term telescopic forks is named to this system. The fork tubes must be smooth to seal the oil inside the fork, and typically have a mirrored finish.

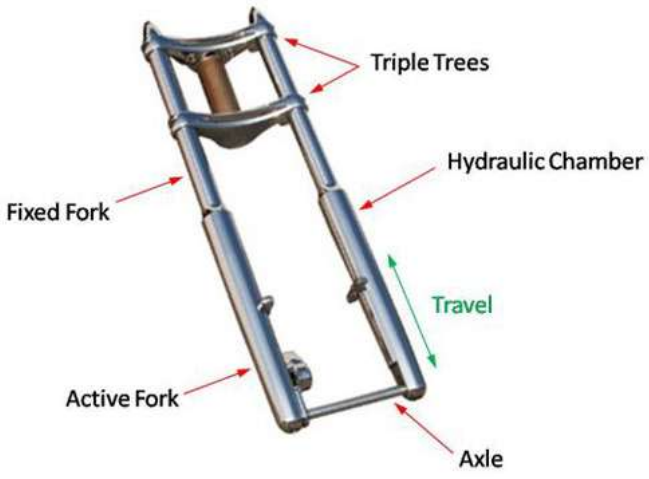

Fig -1: Telescopic Forks Suspension System

1.3 Problems in Telescopic Forks System

- Whenever a rider encounter a bump on a Motorcycle with two shocks, both the shocks

compress separately, but there is never a situation when both the shocks compress for the equal length. This leads to downgraded dynamics when it comes to stability.

- Telescopic shock absorber can only work when there is a limited space to work in.
- Fluid leakage between upper tube and lower tube during high loading conditions.

3. PROPOSAL SYSTEM

The conventional front suspension used in motorcycle is Telescopic forks. But this system have some problems such as uneven vibration, leakage of oil, changing of wheelbase, uneven compression of shock absorbers etc. Hence to solve these problems, a single shock absorber (Mono shock) is used as front suspension in this project. In this system the mono shock is mounted between two swing arms so it is called as Duolever Suspension System. This project is introducing the Duolever Suspension System for 'Bajaj Pulsar 150'. Bajaj Pulsar 150 is the most popular motorcycle in India. Most of the motorcycles using in India are low CC motorcycles and designed such a way that to use Telescopic suspension as a front suspension. This system is connected to the motorcycle steering column through triple tree clamp. So, for the implementation of the Doulever Suspension on the same bike, we have to connect whole assembly to the steering column. So it can taking care of the steering moment.

The Duolever system uses two swing arm, such as upper and lower swing arm. These swing arms are pivoted to steering column with the help nut and bolt arrangement. The mono shock is mounted between rear side of the upper swing arm and the front side of the lower swing arm. As its two semi-trailing arms absorb the forces that arise during compression and rebound, keeping the fork slider stable.

4. DIMENSIONS OF SELECTED MOTORCYCLE

"Bajaj Pulsar 150cc" Motorcycle is selected for implementation of project. Dimensions of Telescopic suspension used in Bajaj Pulsar 150cc are given below in the Table 1.

Dimensions of proposed system are given in Table 2.

Table – 1: Dimensions of Telescopic Suspension in Bajaj Pulsar 150.

Parameter	**Value**
Total Length of Fork	700 mm.
Compressed Fork Length	620 mm.
Length of Lower Tube	300 mm.
Length of Upper Tube	400 mm.
Head Angle	24°
Steering Rod to Fork offset	50 mm.

Table – 2: dimensions of Proposed Duolever Suspension System.

Parameter	Value
Total length Of Forks	700 mm.
Length of Steering Rod	250 mm.
Intermediate Distance Of Two Forks	160 mm.
Length of Lever	115 mm.
Head Angle	24°
Length of Shock Absorber	300 mm.

5. MATERIALS

5.1 Material for Frame Component

AISI 1018 Commercial Quality Mild Steel is the material using for manufacturing of the components of this system. Chemical Compositions of material is given below.

Element		Content (%)
• Carbon (C)	-	0.17%
• Silicon (Si)	-	0.27%
• Manganese (Mn)	-	0.80%
• Phosphorus (P)	-	0.050% max
• Sulphur (S)	-	0.050% max

Some required Properties of material are given below.

- It having good balance of strength,
- Good ductility and toughness,
- It provides excellent weld-ability
- And also good formability and machinability.

5.2 Material for Suspension Spring

"Alloy Spring Steel" - AISI 1074 Carbon Steel
Chemical Composition of material is given below

Element	-	Content (%)
• Carbon, (C)	-	0.7 - 0.8
• Manganese, (Mn)	-	0.5 - 0.8
• Sulfur, (S)	-	0.05 (max)
• Phosphorous, (P)	-	0.04 (max)

Some required Properties of material are given below.

- This alloy spring steel is used for high stress conditions.
- It is good for fatigue resistance and long endurance for impact and shock loads.
- These wires are used for applications at higher stresses and for spring subjected to impact or shock loads.

Some physical properties of Material

- Modulus of rigidity : 72000 mpa
- Modulus of elasticity : 190000 mpa
- Density : 7.8 g/cm^3
- Ultimate Tensile Strength : 820 mpa
- Allowable shear stress : 470 mpa

5.3 CALCULATIONS FOR SUSPENSION SPRING

Assume,
Weight of bike = 144 kg
Weight of 1 person = 70 kg
Weight of 2 persons = 70×2 = 140 kg
Weight of bike + 3persons = 354 kg =3472.74 N

By Consideration
Total Load
F. Suspension (40%) + R. Suspension (60%) = 100%

So that Total = 0.4 × 3472.74 = 1389.09N = 1400N.

Design Load (W) = Total Load × Factor Of Safety
W = 1400 × 1.5 = 2100 N.

Allowable shear stress (S): 470 mpa
Modulus of rigidity (G) : 72000 mpa
Spring Index(C) = 7
Deflection(δ) = 80mm.

K= W/δ= 2100/80
K = 26.25

Kw = ((4C-1)/(4C-4))+0.615/C
Kw = 1.2128

S= Kw (8WC/3.14 × d2)
470 = 1.2128(8 × 2100 ×7/3.14 × d2)
(d) = 9.5 mm

D=C × d
7*8 = 66.5 mm

Active No Of turns
K = (Gd4)/(8 × D^3 × N) 17.5
26.25= (72000 × 9.5^4)/(8 × 66.5^3 × N_1)
N_1=10

Total No Of Turns
N=10+2=12

Solid length
Ls=N×d =12 × 9.5
Ls = 114 mm

Free length of spring
Lf = solid length + compression + clearance
Lf = 114 +80+ (80 × 0.15)
Lf = 206 mm

Pitch of spring
p = Lf/N-1
p = 18.72 mm

Outer diameter of spring
Do = D + d = 76 mm.

Inner diameter of spring
Di = D - d = 57 mm

6. SOLID MODELING

The frame of the proposed system is modeled by using CATIA P3 V5R21. CATIA V5R21 is one of the world's leading CAD/CAM/CAE packages. Being the solid modeling tool, it is not only units the 3D parametric features with 2D tools, but also addresses every design-through-manufacturing process.

Following figures shows the components of Duolever suspension system.

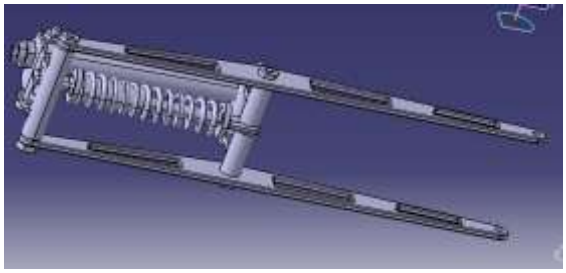

Fig – 2 Assembly of Duolevr Suspension System

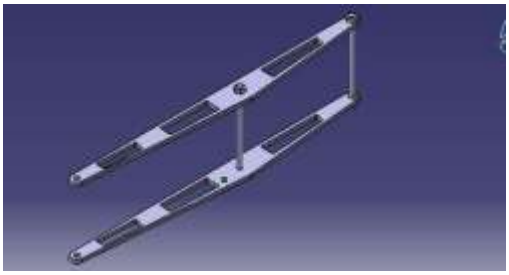

Fig – 3 Forks of System

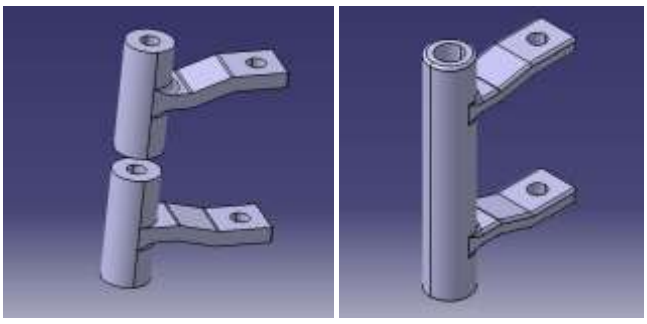

Fig – 4 Lower and Upper Swing Arm

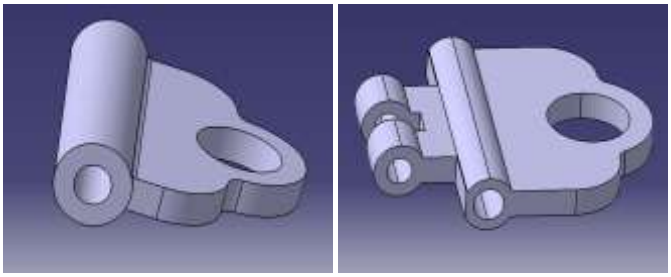

Fig – 5 Lower and Upper plate

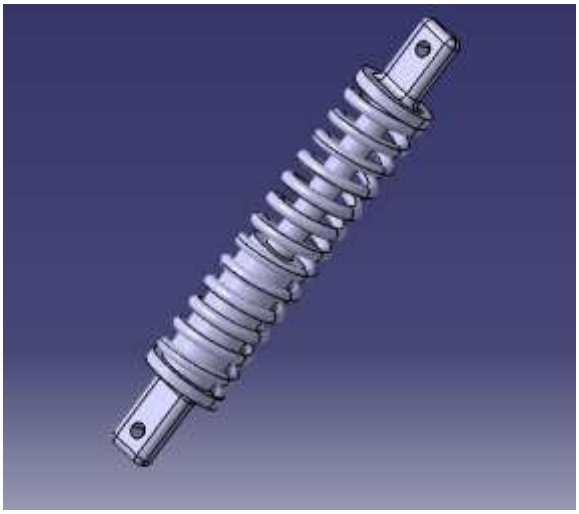

Fig – 6 Single Shock Absorber

7. ADVANTAGES

- Mono-shocks eliminate torque to the swing arm and provide more consistent handling and braking.
- They are easier to adjust, because there's only one shock to adjust, and there is no worry about matching two shocks.
- The Duolever suspension improves both the ride and handling if tuned well.

8. CONCLUSION

Whenever a rider encounter a bump on a Motorcycle with two shocks, both the shocks compress separately, but there is never a situation when both the shocks compress for the equal length. But with a single shock absorber, this problem is solved in this project. This system also overcomes problem of fluid leakage by using single shock absorber.

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