International Journal Of Engineering Research And Development
e- ISSN: 2278-067X, p-ISSN: 2278-800X, www.ijerd.com
Volume 14, Issue 5 (May Ver. II 2018), PP.38-41

Design And Analysis Of Suspension System For E-Bike

[1]Sai Krishna Koleti, [2]Rahul Reddy Boyapalli And [3]Ravi B
[1,2]Student, Sreenidhi Institute of Science & Tech, Hyderabad, Telangana
[3]Scholar, Department of Mechanical Engineering, Sreenidhi Institute of Science & Tech, Hyderabad, Telangana
Corresponding Author: Sai Krishna Koleti

ABSTRACT: The competitive and ever progressive world made mankind to channel the available natural resources for its own benefit devoid of the unfathomable conditions that would prevail in near future. The fear of running out of fuel reserves, forced mankind to depend on other forms of energy. Electrical energy had been amusing mankind with its diverse ways of existence, with which mankind was successful to exploit this energy in many fields. One of such field that needs generic concern of human kind is automobile engineering. This field had been successfully exploited and the production of electric vehicles was made feasible. E bike known for its advantages over petroleum engine in regards with the emission is likely to emerge in the market and become one of the fastest and progressing vehicle. With the scope of enhancing the performance of the e bike we have channelled efforts of all the team to achieve optimum design in Suspension system. The prescribed engineering process for design is documented in the following report, including problem definition, project scheduling, design research, design development, and design analysis. The overall objectives are to increase the vehicle performance, quality and overall efficiency.

The design process of the vehicle was based on several engineering and reverse engineering methods. The following are the parameters that were taken into consideration while designing the vehicle, Endurance, Safety and Ergonomics, Availability, Kerb weight, Cost of the Components and Safe Engineering Practices.

We began the process of designing by conducting various researches for main parts of the vehicle. Our team had carried out market research for the desired parts. SOLIDWORKS 2016 was the CAD software used for designing and ANSYS 15.0 was used for analysis of the vehicle. Besides performance, consumer needs of serviceability and affordability were also kept in concern which we got to know through the internet research.

KEYWORDS: Suspension, Shock absorbers, Rake, Trial, Active coils, Swingarm.

Date of Submission: 05-05-2018 Date of acceptance: 21-05-2018

I INTRODUCTION

Suspension is the term given to the system of springs, shock absorbers and linkages that connects a vehicle to its wheels

Serve a dual purpose –contributing to the bike's handling and braking. Protects the vehicle itself and any cargo or luggage from damage and wear. Comfortable ride to the driver.

[1]. The suspension system that has been opted is
Front: Dual shock telescopic hydraulic suspension.
Rear: Dual shock absorbers with swing arm (H-Shaped).

Suspension Geometry:

[1]. Less trail means less stability, which means a quicker-steering bike. This makes the bikes a lot less stable to ride in a straight line, but a lot more flickable in the corners. More rake means more trail, which means more stability, which makes the bike harder to turn. However, bikes with more rake work better in a straight line, which is why bikes to be long-distance cruisers use it.

[1]**Front Suspension (Telescopic Suspension):**

[1]. Motorcycles today use mainly use telescopic forks for the front suspension. The forks consists of large hydraulic shock absorbers with internal coil springs. They allow the front wheel suspense up and down giving a comfortable ride. The bottom of the forks are connected to the front axle around which the front wheel spins. On typical telescopic forks, the upper portion, known as the fork tubes, slide inside the fork bodies, which are the lower part of the forks. The fork tubes must be made smooth in order to seal the fork oil inside the fork.

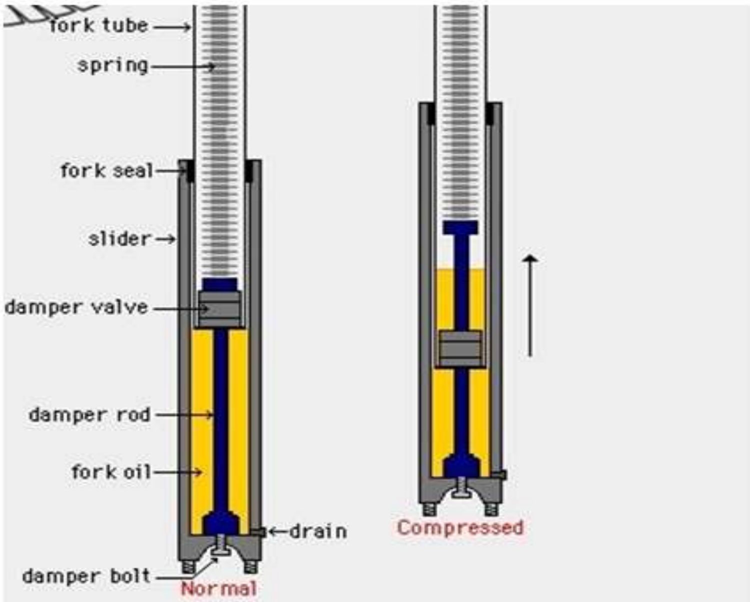

Fig. 1: Telescopic Suspension

Fig. 2: conventional Tube Fork

[2]. The Telescopic Shocks are such selected so that it can overcome dynamic loads during traveling on different terrains which have varying bumps and droops.

[3]. The wheel Travel is selected considering the muddy terrain as well as flat terrain with an optimum wheel travel of 150 mm which satisfies the needs of both a commercial and dirt bike needs.

[4]. The Stanchion Diameter is around **35 mm** for the desired stiffness that has to be provided to the front wheel suspensions during motion.

[5]. The Front Suspension Sag is set to around **20%** of the front wheel travel which is around **30 mm**. As the vehicle is operating at a reasonably low loads so a moderate level suspension oil of **5WT** with Viscosity Index of **372.00** for **26.27 cSt @ 40C** and **9.46 cSt @ 100C**.

[6]. Considering all the parameters under static and dynamic conditions and also keeping availability into picture the telescopic shocks that we choose are of Hero Honda Splendor which suited our requirements.

[2,3]Rear Suspension (Twin Shock - Regular Swingarm):

[1]. An H-shaped swingarm is pivoted at the front to the motorbike frame. On either side there are basic coil spring units which provide the suspension. The shocks are inside the coil spring units. This style of suspension is the most used type of suspension in vehicles.

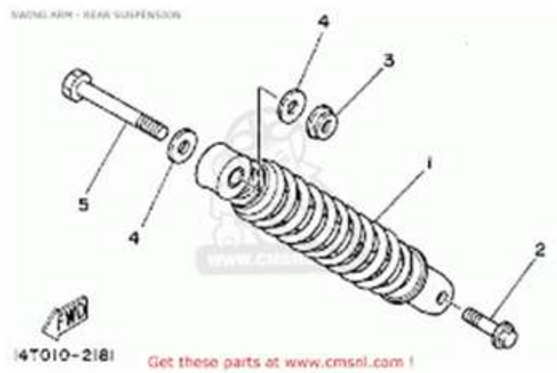

Fig. 3: Rear Suspension

II CALCULATIONS

[4]Designing of the spring:

1) Diameter of the spring wire = **8mm**
2) Mean coil diameter = **62 mm**
3) Number of active coils = **14**
4) Shear Modulus G = **80 Gpa**
5) Spring Force F = **1617 N**
6) Spring outer diameter = **70 mm**
7) Solid spring length = **112 mm**
8) Spring deflection = **131.72 mm**
9) Energy stored = **106.5 J**
10) Spring stiffness = **12.28 N/mm**
11) Spring free length = **243.72 mm**
12) Pitch = **17.41 mm**
13) Shear Stress = **498.62 Mpa**

Determining the suspension parameters:

M = Sprung mass (kg) = 80 kg (estimation)
U = Un-sprung mass(Kg) = 23 kg (Estimation)
KS= Suspension stiffness (Spring stiffness- N/mm)
KT= Tire stiffness (N/mm)
CS= Suspension damping N-sec/mm
Ride rate (RR) = **(KS*Kt)/(KS+KT)**
KS = **12.28 N/mm**
KT = **57.9 N/mm**
RR = **10.13 N/mm**
Ride Frequency FN = **1.688 Hz**
Damped Frequency FD = **1.5834 Hz**
Critical Damping ratio CCR = **2427.83 N-sec/mt**

Suspension Damping CS = **Damping Ratio * CCR**
CS = 0.3 * 2427.83
CS = **728.35 N-sec/mt**

Static Deflection = $\left(\frac{0.159}{FN}\right)^2$ ***9.81 mm = 87.03 mm**

Rear Suspension Sag is set such that the driver experiences enough comfort during the time of pits and speed breakers.

The Suspension Sag without driver is set to around **8 mm**.

The Suspension Sag with Driver is set to an optimum of 28% of the total rear wheel travel which is around **36.7mm**

Suspension Frequency (f) = **1/2π× √SR / WR**

Where, WR = Wheel Rate. SM= Sprung Mass.

So, as we know that the suspension frequency is = **1.688 Hz**.
Sprung mass is approximately estimated to about **80 kg** , so by substituting the values In the above equation we get Wheel Rate **= 8.993 N/mm.**
The formula for Motion Ratio is give as
Motion Ratio (MR) = $\sqrt{\mathbf{WR}/\ \mathbf{SR}}$
From the above data spring rate is SR = **12.28 N/mm**.
So, Motion Ratio = **0.8557**
And also Motion Ratio = **Spring deflection / Wheel deflection**
So Maximum Spring deflection = **131.72 mm**
By substituting the above parameters into the Motion Ratio formula, we get
Total Wheel Travel = **131.72 / 0.8557** = **153.93 mm.**
Therefore, the Total Rear heel travel = **15.393 cm or 6.06"**

Table I: Suspension parameters

Front Suspension(Forks)	**Specifications**
Wheel Travel	150mm
Stanchion diameter	35mm
Front Suspension sag	30mm
Rear Suspension (Shock Absorbers)	**Specifications**
Number of Active Coils	14
Total number of coils	18
Mean coil Diameter	62mm
Spring Stiffness	12.28N/mm
Ride rate	10.13N/mm
Ride Frequency	1.688Hz
Suspension Damping	728N-sec/mt
Suspension Sag : without Driver With Driver	9mm 47mm
Length of the Swing Arm	370mm

III CONCLUSION

[1]. The present work is optimum design and analysis of a suspension system of an E-Bike subjected to designing of spring the work shows various parameters of spring and suspension such as Ride Rate, Critical Damping Ratio, Suspension Damping, Static deflection, Suspension frequency, Wheel Rate, Motion Ratio. With these parameters Total Wheel Travel is determined
[2]. In this design and analysis, we got satisfied suspension travel. The main acceptance criteria is to provide good damping without failure and we used a suspension analyser software to determine the performance.

REFERENCES

[1]. Wilson, Hugo (1993). The Ultimate Motorcycle Book. Dorling-Kindersley.p.181. *ISBN 0-7513-0043-8*.
[2]. "Motorcycle Handling and Chassis Design: The Art and Science" -Tony Foal.
[3]. We have also learned most of the Swingarm types from Wikipedia.
[4]. K Pavan Kumar, S Praveen Kumar and G Guru Mahesh "static analysis of a primary suspension spring used in locomotive" IJMERR, Vol. 2, No. 4, October 2013.
[5]. Smith, Carroll, Engineer to Win. MBI Publishing Company, Minnesota, 1984.
[6]. Gaffney, Edmund F., and Anthony R. Salinas. Introduction to Formula SAE® Suspension and Frame Design. No. 971584. SAE Technical Paper, 1997.

Sai Krishna Koleti. "Design And Analysis Of Suspension System For E-Bike." International Journal Of Engineering Research And Development , vol. 14, no. 05, 2018, pp. 38–41