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Design and Study of a Three-Wheeled Transport Vehicle's Front Helical Coil Suspension Spring

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Abstract - *The functionality of the suspension and steering system must maintain an appropriate balance along with a strong supporting structure that strengthens the design and adds to comfortable driving. The design should be low-cost and light-weight as possible without compromising the required strength. This project result gives an optimized front suspension spring of three-wheeled passenger vehicles and offers modifications to improve the vehicle's directional stability. This improved suspension spring is also suitable for smaller versions of the three-wheeler passenger vehicle. The material IS 4454 is used in this study.*

Key Words: **Finite Element Analysis, Three Wheeler Suspension Spring, Weight Optimization, IS 4454**

1.INTRODUCTION

The suspension system of a three-wheeled vehicle must be adequately constructed in order to drive it comfortably and with firm control. The driver will be unable to direct the engine's power unless he or she gains strong control of the vehicle. As a result, without a suspension system, all other parameters for automotive performance, such as horsepower, torque, and 0-100kmph acceleration, are useless. As a result, the suspension system is one of the most crucial elements of a vehicle.

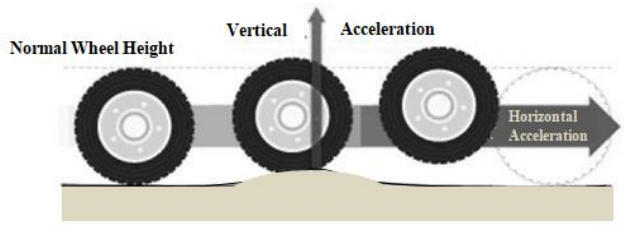

Fig -2: Concept of suspension working

The suspension system's aim is to give road grip through maximum friction between the tyre treads and the road surface, to guarantee adequate steering stability and handling, and to keep the occupants comfortable.

Whenever there is a surface irregularity, the wheel will experience a vertical acceleration. All of the wheels send vertical energy to the frame, which moves in the same direction, in the absence of intervening structure such as suspension spring. The wheels barely make touch with the road in this situation. When a wheel goes over a bump, the wheels slam back into the road due to gravity's downward force.

Therefore, it is necessary to have a mechanism that absorbs the vertically-accelerated wheels' energy allows the frame and body to ride pleasantly and without disruption while the wheel follows bumps in the road can make controlling the vehicle and driving more comfortable.

2. PROBLEM DEFINITION

After a thorough examination of the vehicle's issue, it was discovered that when the driver releases the steering wheel, the vehicle quickly drifts to the right side. Because of the weight of the suspension components, the vehicle drags to one side. The front suspension spring was modified and optimized to deal with this issue.

When the data from the competition vehicle was compared to the data from the test vehicle, it was discovered that the front suspension components' weights were higher, and the front suspension components needed to be optimised for their weight. The suspension spring is taken into account for this optimization.

3. DETERMINATION OF CENTER OF GRAVITY

The vehicle's forces are believed to act at the vehicle's centre of gravity. The CG location is important since it affects the vehicle's handling. The vehicle's weight and overall balance dictate the magnitude and direction of inertial forces. Angular acceleration, on the other hand, generates a force that acts in the opposite direction of the turn centre and is aimed at the vehicle's centre of gravity. The suspension and tyre properties together determine the capacity to endure these forces and provide a controlled and stable turn. The centre of gravity of the test vehicle is calculated using Indian Standard IS 12695: 1989.

4. DESIGN OF SUSPENSION SPRING

First of all, in the suspension spring design, the diameter of the wire (d), the Average of the internal and external diameter of coil (D), the total number of active coils, free length of spring and spring material had to be decided (STOICESCU, 2009). The spring material IS 4454 (TDSiCr) is considered having its UTS at 1620 N/mm^2, and accordingly, the wire diameter is considered 8mm.

For designing the suspension spring, as per the benchmarked competitor's vehicle, the nos. of active coils were decided as 13.5 such that the number of dead coils are less; hence the free length also decreases.

The equations used for the design of the helical coil compression spring are as follows (IS7906 Part 1, 2004):

In order to make sure the safety of the design, the working shear stress of the spring should be less than the design shear stress. Here the induced working shear stress is less than design shear stress, therefore the design is safe.

5. CAD MODELLING

The CAD model of suspension coil spring is developed using SOLIDWORKS 2019, as shown in the figure below.

Fig -2: CAD model of front suspension coil spring.

6. ANALYSIS

Analysis of helical coil compression spring was performed using ANSYS software. The analysis was performed considering

- Equivalent Von Mises Stress induced
- Maximum Shear Stress Stress induced

- Total deformation

7. RESULTS AND DISCUSSIONS

The outcome of the research shows that the theoretical calculations and the values acquired using software are very similar. The ANSYS 16.2 version analysis software is used to evaluate the CAD model of a helical coil suspension spring with updated dimensions. The force on the spring is applied in accordance with the manufacturer's requirements.

The new design's maximum shear stress was determined to be less than 0.67 Sut hence the design is considered safe. The current version is significantly shorter than the original, with a free length of 245 mm. The current design has a weight of 1.73 kilos lighter than the old design.

8. CONCLUSIONS

Some of the conclusions gained from the foregoing examination of the helical coil front suspension compression spring built for the front suspension of the three-wheeled vehicle are as follows:

1. Reduction in the free length of modified spring by 20% is achieved.
2. The reduction in the free length and wire diameter resulted in reduced mass by 68%.
3. The capacity to carry load of the helical coil compression spring is increased as the stiffness value is changed.
4. The suspension system's spring has been upgraded and reduced to 8mm of springs' wire diameter, and 50mm of springs' mean coil diameter.
5. Vehicle drifting is reduced as the spring weight on the front suspension system is reduced.

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