Design and Analysis of Double Wishbone Suspension System for Sports Motorcycle

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Abstract

This research article presents the design and finite element analysis (FEA) of a double wishbone suspension system developed for a sports motorcycle. The double wishbone system provides improved control of wheel motion, enhancing stability, handling, and comfort. CAD models of the suspension components were developed, and ANSYS-based simulations were performed to evaluate stress distribution, deformation, and factor of safety under various static and dynamic conditions. Topology and material optimization were also conducted to minimize weight while maintaining structural integrity. Results indicate that the system offers robust performance and is a promising alternative to conventional telescopic fork suspensions.

Keywords- Double wishbone suspension, ANSYS, finite element analysis, motorcycle dynamics, durability analysis

1. Introduction

Suspension systems are critical in motorcycles, directly influencing comfort, stability, and safety. Conventional telescopic fork suspensions dominate the industry but face limitations such as poor stiffness and high brake dive. To overcome these challenges, double wishbone suspension systems offer superior kinematic control of the wheel, providing optimized ride comfort and road holding. The objective of this study is to design and analyze a double wishbone suspension for sports motorcycles using CAD modeling and finite element methods. This research aims to demonstrate performance improvements compared to conventional systems [1]–[3].

2. Literature Review

Several researchers have explored motorcycle suspension systems. Esat [1] optimized double wishbone motion characteristics using genetic algorithms. Yamanaka et al. [2] developed prototypes with ADAMS simulation. Attia [3] modeled suspension dynamics considering link flexibility. Sharp and Evangelou [4] investigated stability under cornering conditions. Foale [7] and Cossalter [6] highlighted limitations of telescopic forks. Studies by Pacejka [9] and Limebeer [8] addressed tire dynamics and motorcycle stability. Recent work by Evangelou [5], Shaeri [13], and Sharp [14] examined nonlinear oscillations and rider control. These studies provide a foundation for exploring advanced suspension systems such as the double wishbone.

3. Methodology

The methodology followed in this research included:

1. Development of CAD models of suspension components (upper arm, lower arm, upright, shock absorber).
2. Material selection based on strength-to-weight ratio (AISI 4130 for arms, ASTM A36 steel for upright, spring steel wire for coil springs).
3. Load calculations derived from motorcycle mass, acceleration, braking, and cornering dynamics [6].
4. Finite Element Analysis (FEA) in ANSYS to determine stress, deformation, strain, and factor of safety.
5. Topology and material optimization to reduce mass without compromising durability.

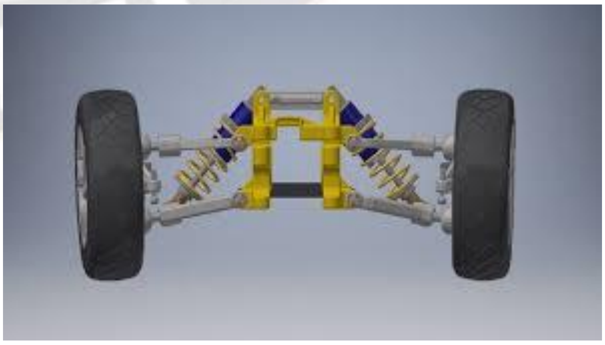

Figure 1: 3D CAD Assembly of Double Wishbone Suspension

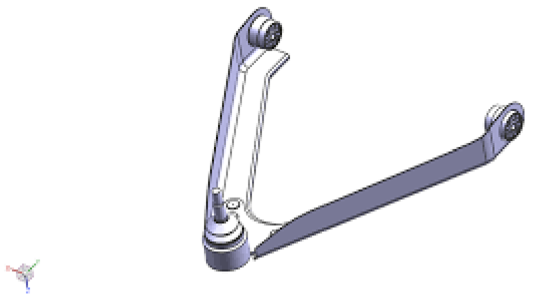

Figure 2: CAD Model of Upper Arm

Figure 3: CAD Model of Lower Arm

Tables

Table 1: Material Properties of Suspension Components

Component	Material	Young's Modulus (GPa)	Yield Strength (MPa)
Upper/Lower Arms	AISI 4130 Chromoly	205	435
Upright	ASTM A36 Steel	200	250
Spring	Spring Steel Wire	206.68	1059

Table 2: Summary of FEA Results

Parameter	Maximum Value	Minimum Value
Total Deformation (mm)	0.0607	0
Equivalent Stress (MPa)	18.69	5.8e-5
Equivalent Strain (mm/mm)	9.61e-5	4.03e-10
Factor of Safety	12.53	5

4. Results and Discussion

The FEA simulations revealed that maximum deformation was 0.0607 mm, which is negligible compared to the operational limits, ensuring structural stiffness. Equivalent stress was recorded at 18.69 MPa, well within the yield limits of AISI 4130 steel. Factor of safety ranged between 5 and 12.5, highlighting a robust design. Figures 6–9 illustrate deformation and stress distribution. Tables 1 and 2 summarize material properties and simulation results. The double wishbone suspension demonstrates superior durability and control over traditional telescopic systems [6], [7], [10].

5. Conclusion

This study successfully designed and analyzed a double wishbone suspension for a sports motorcycle. The results validate its structural reliability, reduced brake dive, and improved handling compared to conventional suspensions. FEA confirmed that the system meets safety and durability requirements with a high factor of safety. Future research should focus on prototype testing and real-world validation under dynamic riding conditions [11]–[15].

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