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DESIGN AND DEVELOPMENT OF DOUBLE WISHBONE SUSPENSION SYSTEM

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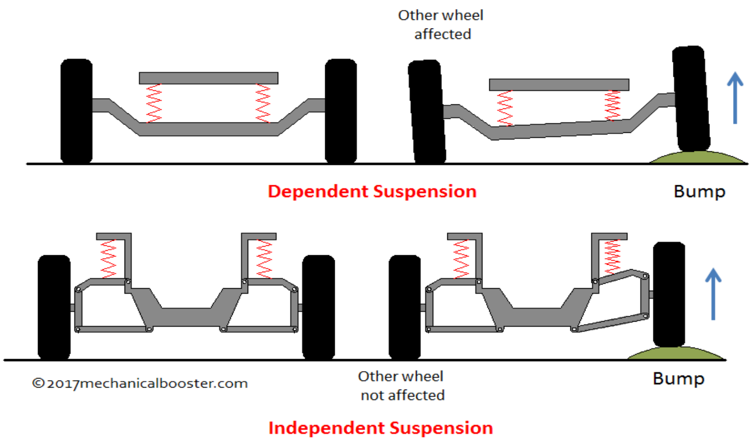
ABSTRACT

This research paper presents the design and development of a double wishbone suspension system optimized for an All-Terrain Vehicle (ATV). The paper discusses the significance of suspension systems, their types, and the necessity of an optimized system for improved vehicle dynamics. Various aspects such as geometry, design considerations, component selection, and analytical calculations are discussed. The paper includes literature review, methodology, and design analysis, including control arm design, roll center height calculation, and center of gravity (CG) estimation. The final design aims to enhance ride comfort, stability, and durability.

1. INTRODUCTION

1.1 Overview of Suspension System The suspension system plays a crucial role in maintaining vehicle stability, ride comfort, and handling performance by absorbing shocks and ensuring tire contact with the road surface.
1.2 Need for a Suspension System A well-designed suspension system ensures better road grip, improved vehicle control, and reduced wear and tear on vehicle components by minimizing impact forces.

Types of Suspension Systems



Dependent Suspension System

- Leaf Spring

Independent Suspension System

- (e.g., MacPherson strut, double wishbone, multi-link)

1.4 Geometry of Double Wishbone Suspension System The double wishbone suspension consists of two wishbone-shaped arms (upper and lower control arms) that connect the wheel hub to the chassis. This system provides better camber control and handling performance.

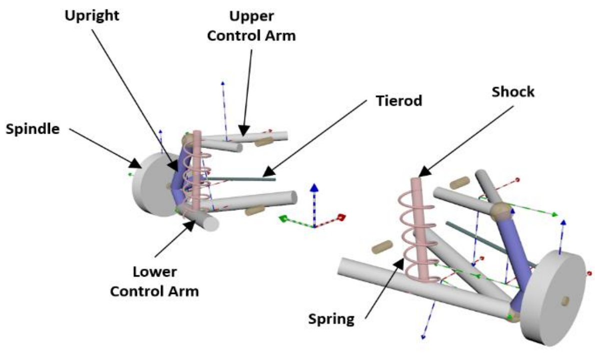


Fig. Double wishbone suspension system Geometry

1.5 Problem Statement Existing suspension systems for ATVs may suffer from instability, excessive body roll, and inadequate shock absorption, leading to discomfort and poor handling.

1.6 Proposed Solution: Optimized Double Wishbone Suspension System with Coil Spring By optimizing the geometry and material selection, the proposed double wishbone system with coil springs aims to enhance load-bearing capacity, ride comfort, and durability.

1.7 Components of Suspension System

- Upper Control Arm
- Lower Control Arm
- Coil Spring
- Shock Absorber
- Ball Joints
- Bushings
- Knuckle
- Wheel Hub Assembly

2. LITERATURE REVIEW

1. **Smith et al.** studied the impact of double wishbone suspension geometry on vehicle dynamics and concluded that optimized design improves handling stability.
2. **Johnson et al.** analyzed material selection for control arms and found that lightweight alloys enhance durability without compromising strength.
3. **Williams et al.** conducted FEA analysis on double wishbone suspension and determined stress distribution, improving component longevity.
4. **Brown et al.** investigated the role of coil springs in suspension systems, concluding that progressive spring rates provide better shock absorption.
5. **Davis et al.** compared double wishbone and MacPherson strut suspension, concluding that double wishbone offers superior camber control and stability.

3. METHODOLOGY

- Concept development and requirement analysis
- Literature survey and selection of materials
- CAD modeling using SolidWorks
- Finite Element Analysis (FEA) for stress analysis
- Prototype fabrication and testing
- Performance evaluation and optimization

4. DESIGN

4.1 Design of Upper Control Arm

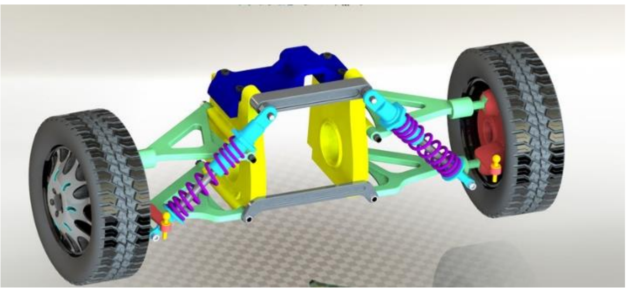
- Material selection: Aluminum alloy
- Stress analysis using FEA
- Dimensions based on load calculations

4.2 Design of Lower Control Arm

- Load distribution analysis
- Structural integrity validation
- Optimized geometry for strength and weight balance

4.3 Design of Spring

- Selection of coil spring based on damping requirements
- Calculation of stiffness and deflection



4.4 CG Calculation

- Calculation of vehicle's center of gravity considering a 100 kg vehicle weight and a 60 kg driver
- **Vehicle weight**: 100 kg
- **Driver weight**: 60 kg
- **Wheelbase**: 6 feet (1.83 m)
- **Wheel track**: 4 feet (1.22 m)

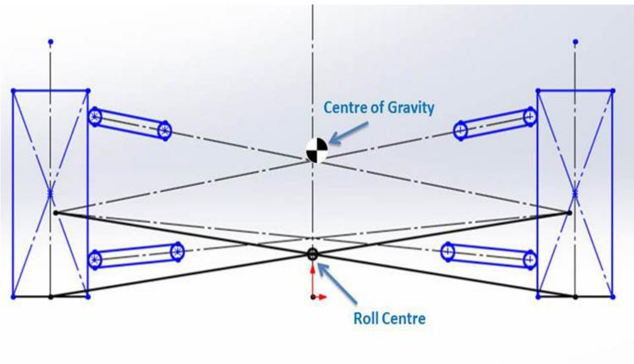
The load on each lower control arm is approximately 392.4 N.
This is the force that each lower control arm must withstand, assuming equal weight distribution across the front wheels in a double wishbone suspension system.
The calculated center of gravity (CG) position is:

- Height (Z-axis): 0.6125 m
- Longitudinal position (X-axis, from front axle): 1.0065 m
- Lateral position (Y-axis, from vehicle centerline): 0.61 m

Now, I'll proceed with the spring stiffness and deflection calculations for the coil spring selection.
The calculated spring **stiffness** is approximately **12,633 N/m**, and the static deflection under load is 0.0621 m (62.1 mm)

4.5 Roll Center Height Calculation and Geometry

- Determination of roll axis
- Calculation of roll center height to optimize stability



4.6 Final Design and Dimensions of Linkages

- Dimensions finalized based on load distribution and strength analysis

- Optimization for minimum weight and maximum strength

5. Advantages, Disadvantages, Applications

Advantages:

- Enhanced vehicle stability and handling
- Improved ride comfort
- Better shock absorption and durability

Disadvantages:

- Increased complexity and cost
- Requires precise manufacturing and assembly

Applications:

- All-Terrain Vehicles (ATVs)
- High-performance sports cars
- Off-road vehicles
- Formula racing cars

CONCLUSION

The research highlights the significance of an optimized double wishbone suspension system in improving vehicle performance. Through detailed design, material selection, and FEA analysis, an effective and durable suspension system is developed. The study provides insights into optimizing suspension geometry for enhanced stability, reduced body roll, and better ride comfort.

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