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Review Article

STRUCTURAL ANALYSIS FOR SUSPENSION ARM FOR IDENTIFYING AREAS OF IMPROVEMENT OVER DESIGN

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ABSTRACT

The suspension control Arm (lower), being an intermediary with the suspension system, has a important function to cope with. The wheel base on one end and the connection to the chassis member exposes the part to high stresses while performing its function. This research work shall attempt CAE analysis over the existing model of the passenger car for identifying the problem areas while deliberating on design alternatives to suffice the function. This would help the design team to redesign the part for safe operation while aiming for adequate strength for addressing the function.

INTRODUCTION

Suspension systems serve a dual purpose—contributing to the car's road holding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and reasonably well isolated from road noise, bumps, and vibrations. These goals are generally at odds, so the tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the wheels in contact with the road surface as much as possible, because all the forces acting on the vehicle do so through the contact patches of the tyres. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear. The design of front and rear suspension of a car may be different but the following diagrams show a common type of system.

A suspension arm is designed to be attached to a vehicle's chassis; support the wheel hub and allow the suspension to move through its normal range of movement. The loadings on this component are immense and it has to work in extremes of heat, cold and extreme road conditions; a real 'hostile' environment! The suspension system supports the vehicle, allowing the wheels to move up and down over irregularities in the road. It cushions the ride for the frame, engine, transmission, and passengers, while keeping the tires in firm contact with the road under all conditions. Suspension system parts include springs, dampening devices (shocks), ball joints, steering knuckles, and spindles or axles. Two types of front suspension systems are widely used in today's vehicles: the MacPherson strut suspension and the short/long arm (SLA) suspension. Early automobiles and some medium- and heavy-duty trucks and four-wheel drive vehicles

have a straight axle (I-beam) front suspension, and up until recently some light trucks were built with a variation called a twin Ibeam suspension. Many rear suspensions still use a straight axle.

Short/Long Arm (SLA) Suspension Each side of the SLA suspension consists of two control arms attached to the frame at one end and the steering knuckle at the other. The arms pivot on ball joints at the steering knuckle, and on rubber bushings at the frame. A variety of spring arrangements may be used; a coil spring placed between the two arms is the most common, but the spring may be mounted over the upper control arm, or it may be a torsion bar attached to the lower control arm. Using a shorter upper arm allows the track width to remain constant at the road surface during spring compression, eliminating the tire slide or scrub that would occur if the arms were of the same length. A conventional steering system is commonly used with this suspension, which may also be referred to as a conventional suspension.

LITERATURE REVIEW

- J. Yamakawa*, K. Watanabe developed a spatial motion analysis model of tracked vehicles with independent torsion bar type suspensions. It has been constructed to numerically simulate the motion of the vehicle including the road wheel. It was found that the present tracked vehicle model is reasonably predictable for the motion of tracked vehicles with torsion bar type suspension.
- Dongchan Lee, ChulhoYang shown that the torsional stiffness and roll stiffness predicted using the proposed method has sufficient precision with around four percent difference from the results of finite element analysis and bench tests
- D. Croccolo*, M. De Agostinis, N. Vincenzi 's paper has the aim is to provide a methodology useful for the structural design and optimization of front motorbike suspensions. Their the research findings culminate in an innovative software (Front Suspension Design_) which is useful to design and to verify the whole front motorbike suspension, by applying correct and effective results, obtained for different geometries and materials combinations.
- Hazem Ali Attia conducted dynamic analysis of the double wishbone motor-vehicle suspension system using the point-joint coordinates formulation is presented. The mechanical system is replaced by an equivalent constrained system of particles and then the laws of particle dynamics are used to derive the equations of motion.
- Eleonor D. Stoenescu, Dan B. Marghitu investigated the effect of prismatic joint inertia on dynamics of planar kinematic chains with friction. Numerical results are obtained and compared for zero and larger values of the prismatic joint inertia at different speeds.

PROPOSED WORK

Problem Statement:

The suspension control arm of the passenger car is subjected to loads and consequently stresses of a high magnitude. The design for this component poses a challenge to the concerned team. While this component integrates with the suspension system of the vehicle, the lower arm takes up the load during the ride. The connections to the wheel hub on one side, and the Chassis on the other, make the component crucial for its intended function within the entire suspension system. Failure of this component during the ride could jeopardize the suspension system and could lead to accident including risk of life or injury. The cost of the component too needs to be controlled through structural analysis and/or redesign of the component to help arrive at an optimized geometry for the given function.

Scope of the work/ Steps of execution:

- Secure input in the form of 3D model (geometry) for the existing design of the Suspension Control Arm
- Preprocessing for the geometry with suitable mesh size and type of element
- Analysis using CAE for `Linear Static' type to find the stress levels over the component
- Identify critical areas of stress concentration or any other detrimental observation over the result of the analysis
- Redesign the geometry for easing out the stressed regions, if any
- Conduct analysis over the revised geometry
- Derive inference through comparison of the results fetched by analysis over existing and the modified geometry
- Recommend the best design alternative for the given function

EXPERIMENTATION/ VALIDATION

Given the nature of the stresses over the component, a prototype would be aimed for testing. Alternatively, the sponsoring Company would support the experimentation by sharing the standard test data compiled over the past years. The test setup typically involves a facility for tensile testing with a provision of fixture for the component. Universal Testing Machine could also be engaged for checking the resistance of the component to tensile and/or shear loads.

The experimental results shall be documented, compiled and compared for validating the analytical approach of solving the problem.

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3. **"**Recent improvements and design formulae applied to front motorbike suspensions" D. Croccolo *, M. De Agostinis, N. Vincenzi Diem, University of Bologna, Viale Risorgimento, 2 , 40136 Bologna, Italy.
4. "Dynamic modelling of the double wishbone motor-vehicle suspension system" Hazem Ali Attia ∗ *Department of Mathematics, College of Science, King Saud University (Al-Qasseem Branch), P.O. Box 237, Buraidah 81999, Saudi Arabia* Received 5 February 2001; revised and accepted 9 July 2001
5. "Effect of prismatic joint inertia on dynamics of kinematic chains." Eleonor D. Stoenescu, Dan B. Marghitu * Department of Mechanical Engineering, Auburn University, 202 Ross Hall, Auburn, Alabama, AL 36849-5341, USAReceived 6 May 2003; accepted 9 November 2003