Design and Analysis of lower Control Arm In Front Suspension System

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Abstract- *The suspension system caries the vehicle body and transmit all forces between the body and the road without transmitting to the driver and passengers. The suspension system of a car is used to support its weight during varying road conditions. The suspension system is made of several parts and components. These include the front and rear suspensions, the shock absorbers, and the Macpherson strut system. The suspension system is further classified into two subgroups, dependent and independent. These terms refer to the ability of opposite wheels to move independently of each other.*

I. INTRODUCTION

Suspension is the term given to the system of springs, shock absorbers and linkages that connects wheels to a vehicle. Suspension systems serve a dual purpose contributing to the car's 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 .The suspension also protects the vehicle itself and any cargo or luggage from damage and wear. Under the static load conditions deflection and stresses of steel lower wishbone arm and composite lower wishbone arm are found with the great difference. Carbon fiber suspension control arms that meet the same static requirements of the steel ones they replace. Deflection of Composite lower wishbone arm is high as compared to steel lower wishbone arm with the same loading condition. The redesigned suspension arms achieve an average weight saving of 27% with respect to the baseline steel arms. The natural frequency of composite material lower wishbone arm is higher than steel wishbone arm.

PROBLEM IDENTIFICATION:

All parts manufactured by Rare Parts will meet or exceed original equipment manufacturers specifications (OEM).Some of the most critical factors in LOWER CONTROL ARM are to choose right materials and ensure greater strength at lower cost of production .In this case the project work is to modeling and to perform the structural Analysis of lower control arm in Automotive front Suspension System by the process of CAE to determine the BUCKLINGLOAD OF LCAAssembly. To find out the maximum load at which the failure occurs due to load acting on the LCA.

OBJECTIVE

To reduce the batch production cost and to increase the strength of LCA.Our project is to optimize the lower control arm by suggesting suitable material, and reducing sheet metal thickness. To prolong the life cycle of the lower arm. Try to reduce the buckling load acting on the lowerarm.

II. TYPES AND CHARACTERISTICS OF SUSPENSION AND LOWER ARM

SUSPENSION:

The suspension system caries the vehicle body and transmit all forces between the body and the road without transmitting to the driver and passengers. The suspension system of a car is used to support its weight during varying road conditions. The suspension system is made of several parts and components. These include the front and rear suspensions, the shock absorbers, and the Macpherson strut system. The suspension system is further classified into two subgroups, dependent and independent. These terms refer to the ability of opposite wheels to move independently of each other.

DEPENDENT SUSPENSION SYSTEM

A dependent suspension normally has a beam (a simple 'cart' axle) or (driven) live axle that holds wheels parallel to each other and perpendicular to the axle. When the camber of one wheel changes, the camber of the opposite wheel changes in the same way (by convention on one side this is a positive change in camber and on the other side this a negative change). De Dion suspensions are also in this category as they rigidly connect the wheels together.

INDEPENDENT SUSPENSION SYSTEM

An independent suspension allows wheels to rise and fall on their own without affecting the opposite wheel. In this case, the wheels are connected through universal joints with a swing axle. Suspensions with other devices, such as sway bars that link the wheels in some way are still classed as independent (Example: The two important types of independent systems are Macpherson strut and Double wishbone system).

III. TYPES OF INDEPENDENT SUSPENSION SYSTEM

- Double Wishbone
- Trailing Arm Suspension
- Macpherson Strut Suspension

DOUBLE WISHBONE

The double wishbone suspension can also be referred to as double 'A' arms, and short long arm (SLA) suspension if the upper and lower arms are of unequal length. A single wishbone or A-arm can also be used in various other suspension types, such as McPherson strut and Chapman strut. The upper arm is usually shorter to induce negative camber as the suspension jounces (rises). When the vehicle is in a turn, body roll results in positive camber gain on the inside wheel. The outside wheel also jounces and gains negative camber due to the shorter upper arm. The suspension designer attempts to balance these two effects to cancel out and keep the tire perpendicular to the ground. This is especially important for the outer tire because of the weight transfer to this tire during a turn.

Between the outboard ends of the arms is a knuckle with a spindle (the kingpin) hub or upright which carries the wheel bearing and wheel. Knuckles with an integral spindle usually do not allow the wheel to be driven. A bolt on hub design is commonly used if the wheel is to be driven. In order to resist fore aft loads such as acceleration and braking, the arms need two bushings or ball joints at the body. At the knuckle end single ball joints are typically used in which case the steering loads have to be taken via a steering arm, and the wishbones look A or L shaped. An L shaped arm is generally preferred on passenger vehicles because it allows a better compromise of handling and comfort to be tuned in. The bushing in line with the wheel can be kept relatively stiff to effectively handle cornering loads while the off-line joint can be softer to allow the wheel to recess under for aft impact loads. For a rear suspension, a pair of joints can be used at both ends of the arm, making them more H-shaped in plan view. Alternatively, a fixed-length driveshaft can perform the function of a wishbone as long as the shape of the other wishbone provides control of the upright. This arrangement has been successfully used in the Jaguar IRS. In elevation view the suspension is a 4-bar link and it is easy to work out the camber gain (see camber angle) and other parameters for a given set of bushing or ball joint locations.

TRAILING ARM SUSPENSION

The trailing arm system is literally that A shaped suspension arm is joined at the front to the chassis, allowing the rear to swing up and down. Pairs of these become twin trailing arm systems and work on exactly the same principle as the double wishbones in the systems described above.

The difference is that instead of the arms sticking out from the side of the chassis, they travel back parallel to it. This is an older system not used so much anymore because of the space it takes up but it doesn't suffer from the side to side scrubbing problem of double wishbone systems. If you want to know what I mean, find a VW beetle and stick your head in the front wheel arch that‟s a double trailing arm suspension setup.

MACPHERSONSTRUT SUSPENSION

The McPherson strut is a type of car suspension system which uses the axis of a telescopic damper as the upper steering pivot, widely used in modern vehicles and named after Earle S. McPherson who developed the design. It consists of a wishbone or a substantial compression link stabilized by a secondary link which provides a bottom mounting point for the hub or axle of the wheel. This lower arm 5 system provides both lateral and longitudinal location of the wheel. The upper part of the hub is rigidly fixed to the inner part of the strut proper, the outer part of which extends upwards directly to a mounting in the body shell of the vehicle. The McPherson strut required the introduction of unibody (or monocoque) construction, because it needs a substantial vertical space and a strong top mount, which unibodies can provide, while benefiting them by distributing stresses. The strut will usually carry both the coil spring on which the body is suspended and the shock absorber, which is usually in the form of a cartridge mounted within the strut. The strut also usually has a steering arm built into the lower inner portion. The whole assembly is very simple and can be preassembled into a unit also by eliminating the upper control arm. it allows for more width in the engine bay, which is useful for smaller cars, particularly with transverse-mounted engines such as most front wheel drive vehicles have. It can be further simplified, if needed, by substituting an anti-roll bar (torsion bar) for the radius arm. For those reasons, it has become almost ubiquitous with low cost manufacturers

IV. LOWER CONTROL ARM

The lower control arm is the most vital component in a suspension system. There are two control arms, lower control arm and upper control arm. Lower control arm allows the up and down motion of the wheel. It is usually a steel bracket that pivots on rubber bushings mounted to the chassis. The other end supports the lower ball joint. Significant amount of loads are transmitted through the control arm while it serves to maintain the contact between the wheel and the road and thus providing the precise control of the vehicle. There are many types of control arms are available. The selection of the arm is mainly based on the type of suspension system.Control arm are designed to allow necessary movement required for steering and bump control but cannot allow free play, slacks which will cause uncontrolled tire and wheel motion. The control arm which is taken to optimize in this project is Macpherson type.

BALL JOINT

In an automobile, ball joints are spherical bearings that connect the control arms to the steering knuckles. More specifically, a ball joint is steel bearing stud and socket enclosed in a steel casing. The bearing stud is tapered and threaded. It fits into a tapered hole in the steering knuckle. Control arm is connected with wheel by using the ball joint. It is acting as a link. All loads acting on the wheels are transferred to the control arm only through the ball joint end only.

BUSHES

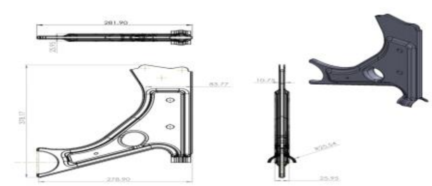
A bushing is a type of bearing. It is a cylindrical lining designed to reduce friction and wear inside a hole, or constrict and restrain motion of mechanical parts. In the control arm mounding bush is act as a spring which is permitted the up and down motion of the control arm to some extent. The bushes used for the suspension is different from the bushes which are used for other purposes.

V. CONTROL ARM GEOMETRY

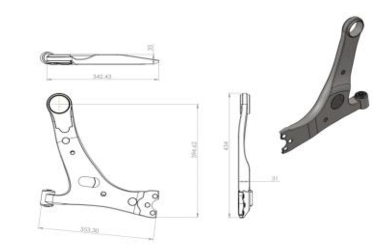
Control arm design is matched with the size of the spring to provide optimum control arm position, tire to travel over bumps, and comfortable car ride characteristics. In a static position (i.e. no bump condition), the lower control arm is horizontal or, in a new car, slightly lower at the outer end. The ball joint at the end of this arm travels in a arc, pivoting at the inner bushing as the tire and wheel move up and down. The centre point of this arc is the inner bushings; the radius of the arc s the length of the lower control arm. This arc is not only up and down but also slightly horizontal, depending on the midpoint and the end locations of the arc. The more the control arm is inclined, the more the side motion will occur. In a car, this side motion causes tire side scrub. If the springs sag, the lower control arm incline more and more upward at the outer end, resulting in more tire scrub and wear. The amount of side scrub resulting from movement of the lower control arm can be reduced by the length and mounting angle of the upper control arm. The arc of the travel for the upper ball joint is designed not to match that of the lower ball joint. As a consequence of the arc differences, the steering knuckle changes vertical position during the wheel travel, this results in a change of the camber tire.

LOWER CONTROL ARM DIAGRAM AND DETAILS:

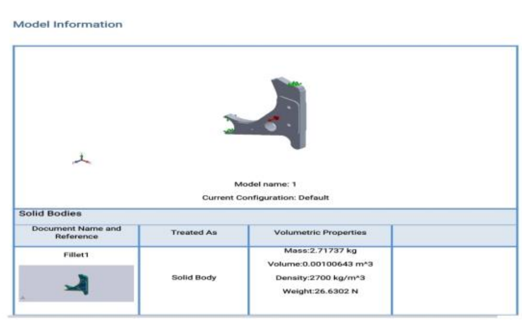
MODEL NO : 1



MODEL NO : 2



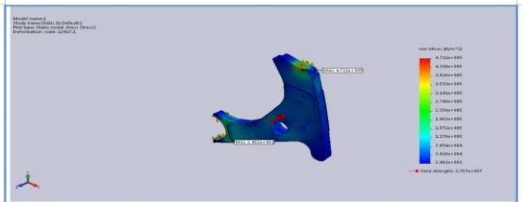
1060 ALLOY (MODEL :1) –BUCKLING LOAD



Material Properties

Model Reference	Properties		Components
	Name:	1060 Alloy	SolidBody 1(Fillet1)(1)
	Model type:	Linear Elastic Isotropic	
	Default failure criterion:	Max von Mises Stress	
	Yield strength:	2.75742e+007 N/m^2	
	Tensile strength:	6.89356e+007 N/m^2	
	Mass density:	2700 kg/m^3	
	Elastic modulus:	6.9e+010 N/m^2	
	Poisson's ratio:	0.33	
	Thermal expansion coefficient:	2.4e-005 /Kelvin	
Curve Data:N/A			

1060 ALLOY (MODEL:1) – STATIC LOAD



1-Static 1-Stress-Stress2

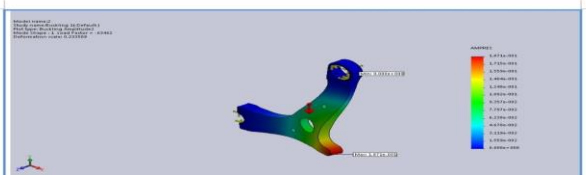
1060 ALLOY (MODEL:2) – BUCKLING LOAD

Model Information

Model name: 2
Current Configuration: Default

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	
Cut-Extrude2 	Solid Body	Mass:2.59595 kg Volume:0.000961461 m^3 Density:2700 kg/m^3 Weight:25.4403 N	



2-Buckling 1-Amplitude-Amplitude2

Mode List

Mode Number	Load Factor
1	-63462

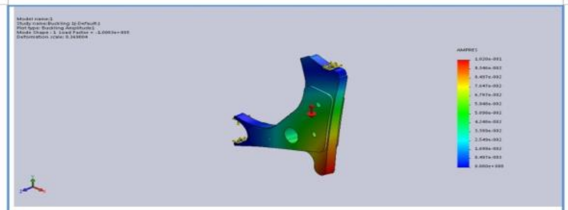
CHROME STAINLESS STEEL (MODEL:2)

Model Information

Model name: 1
Current Configuration: Default

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties
Fillet1	Solid Body	Mass:7.85017 kg



1-Buckling 1-Amplitude-Amplitude1

Mode List

Mode Number	Load Factor
1	-1.0083e+005

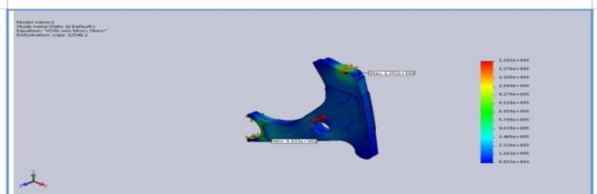
CHROME STAINLESS STEEL (MODEL:1) – STATIC LOAD

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 2 face(s) Type: Fixed Geometry

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	2.36291e-005	0.0020556	77.0155	77.0155
Reaction Moment(N.m)	0	0	0	0



1-Static 1-Equation-Equation1

CHROME STAINLESS STEEL (MODEL:2) – BUCKLING LOAD

Model Information

Model name: 2
Current Configuration: Default

Solid Bodies

Document Name and Reference	Treated As	Volumetric Properties	
Cut-Extrude2 	Solid Body	Mass:7.4994 kg Volume:0.000961461 m^3 Density:7800 kg/m^3 Weight:73.4941 N	

Material Properties

Model Reference	Properties	Components
	Name: Chrome Stainless Steel Model type: Linear Elastic Isotropic Default failure criterion: Max von Mises Stress Yield strength: 1.72339e+008 N/m^2 Tensile strength: 4.13613e+008 N/m^2 Elastic modulus: 2e+011 N/m^2 Poisson's ratio: 0.28 Mass density: 7800 kg/m^3 Shear modulus: 7.7e+010 N/m^2 Thermal expansion coefficient: 1.1e-005 /Kelvin	SolidBody 1(Cut-Extrude2)(2)
Curve Data:N/A		

CHROME STAINLESS STEEL (MODEL:2) – STATIC LOAD

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 2 face(s) Type: Fixed Geometry

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	0.000592113	0.00090915	73.5662	73.5662
Reaction Moment(N.m)	0	0	0	0

2-Static 1-Equation-Equation1

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