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Design and Analysis of Multi-Link Structure For Rear Independent Suspension of Heavy Vehicle

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ABSTRACT

In this thesis, a multi link structure for rear independent structure of heavy vehicle is designed and modeled in 3D modeling software Creo 2.0. Two models are done by varying the pitch value of spring. Finite element analysis is performed on the structure by varying materials Structural Steel, Aluminum alloy, Carbon Fiber and S - Glass. Static, Modal and Random Vibration analysis is done to determine displacements, stresses and frequencies.Analysis is done in Ansys.

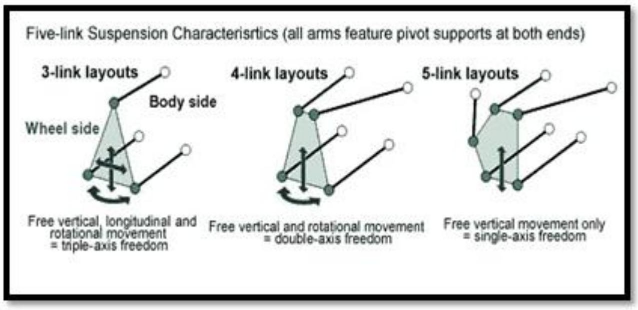
INTRODUCTION OF SUSPENSION SYSTEM

Suspension is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two.Suspension systems serve a dual purpose — contributing to the vehicle's roadholding/handling and braking for good active safety and driving pleasure, and keeping vehicle occupants comfortable and a ride quality reasonably well isolated from road noise, bumps, vibrations,etc.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 road wheel in contact with the road surface as much as possible, because all the road or ground forces acting on the vehicle do so through the contact patches of the tires. 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.

THE MULTI-LINK SUSPENSION

Ok, now that you have some basic notions about suspension as a concept, let's take a look at the multi-link one. The most important thing to know about this type of suspension is that it's an independent one. Derived from the double wishbone one, the multi-link suspension uses three or more lateral arms and one or one or more longitudinal arms, which don't have to be of equal length and can be angled away from their natural direction.



LITERATURE SURVEY

The paper presented by N.Lavanya[1], includes comparison of modeling and analyses ofprimary suspension spring made of low carbon-structural steel and chrome vanadium steel and suggested thesuitability for optimum design. The results show the reduction in overall stress and deflection of spring forchosen materials.The paper presented by ShpetimLAJQI[2], designed the suspension mechanism that fulfills requirements about stability, safety and maneuverability. Nowadays, as well as in the past, the development of the suspension systems of the vehicle has shown greater interest by designers and manufacturers of the vehicles. Research is focused to

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do a comprehensive study of different available independent suspension system (MacPherson, double wishbone, multi-link) and hence forth develop a methodology to design the suspension system for a terrain vehicle

MODELING OF MULTI-LINK STRUCTURE FOR REAR INDEPENDENT SUSPENSION OF HEAVY VEHICLE IN CREO 2.0

For modeling of multi-link structure for rear independent suspension of heavy vehicle in reference is taken from"Design and Analysis of A Suspension Coil Spring For Automotive Vehicle" By N.Lavanya.

MODELS OF MULTI-LINK STRUCTURE FOR REAR INDEPENDENT SUSPENSION

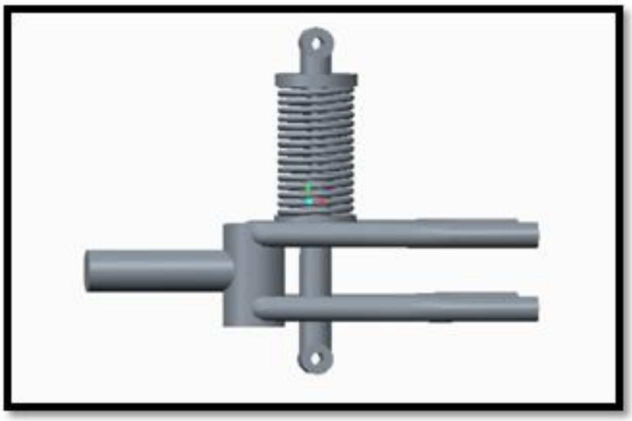


Fig: Final model

THEORITICAL CALCULATIONS FOR SPRING

Theoretical calculations are done by taking reference from journal"Design and Analysis of A Suspension Coil Spring For Automotive Vehicle By N.Lavanya

Material: Low carbon structural Steel

G = 75000 = modulus of rigidity

Mean diameter of a coil = D=56.94mm

Diameter of wire d = 9.49mm

Total no of coils n = 11

Height h = 152mm

Outer diameter of spring coil $D^0 = D + d$

Weight of car+ person

Rear suspension = 65%

We know that, compression of spring (δ) = $\frac{8W \times C^3 \times n}{G \times d}$

C = spring index = $\frac{D}{d}$

Solid length = $L_s = n \times d$

Free length of the spring $L_F = solidlength + maximumcompression + clearencesbetweenadjustiblecoils$

Spring rate K = $\frac{W}{\delta}$

Pitch of coil P = $\frac{L_F + L_S}{n^1}$

Stresses in helical springs: maximum shear stress induced in the wire

$\tau = K \times \frac{8WC}{\pi d^2}$

$K = \frac{4_C - 1}{4_c - 4} + \frac{0.615}{C}$

$\tau = K \times \frac{8WC}{\pi d^2}$

Buckling of compression springs:

$$W_{cr} = k \times K_B \times L_F$$

K = spring rate or stiffness of spring = $\frac{W}{\delta}$

$$L_F = freelengthofthesprings$$

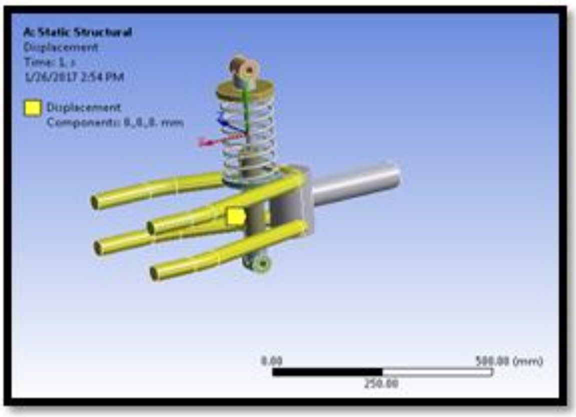
$$K_B = bucklingfactordependinguponthe ratio = \frac{L_F}{D}$$

STRUCTURAL ANALYSIS OF MULTI-LINK STRUCTURE FOR REAR INDEPENDENT SUSPENSION OF HEAVY VEHICLE

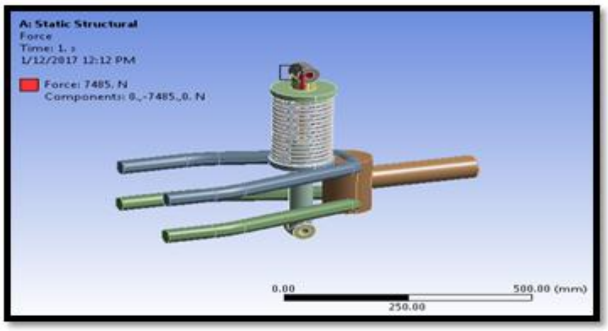
PITCH – 30mm

MATERIAL –CARBON FIBER

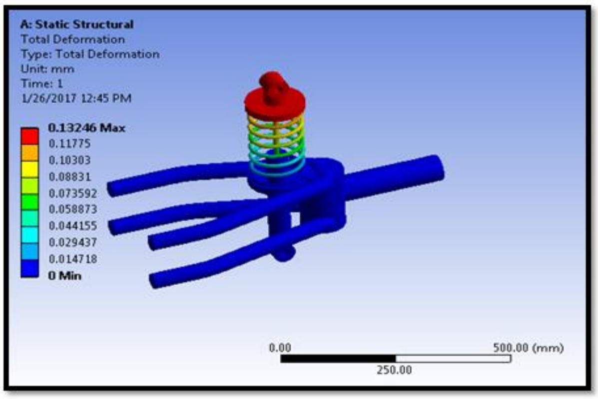
Displacement



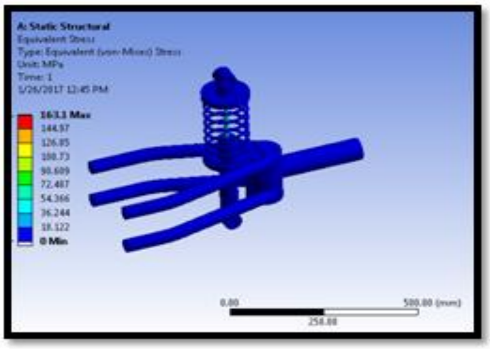
Force



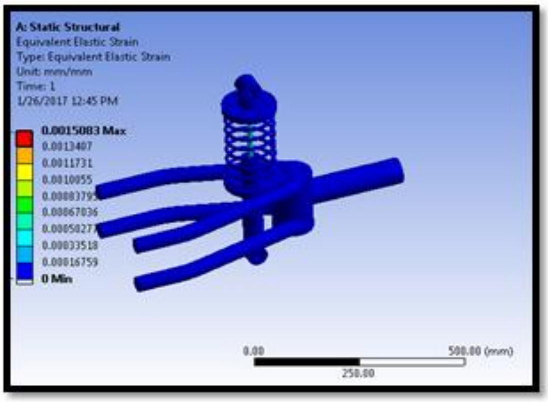
Deformation



Stress



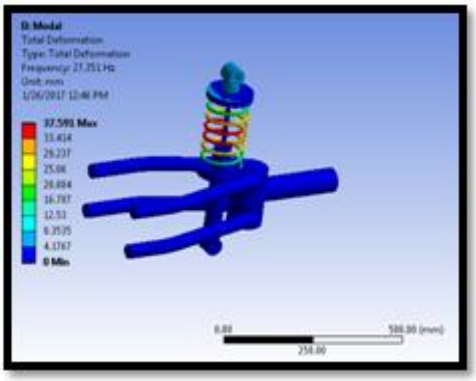
Strain



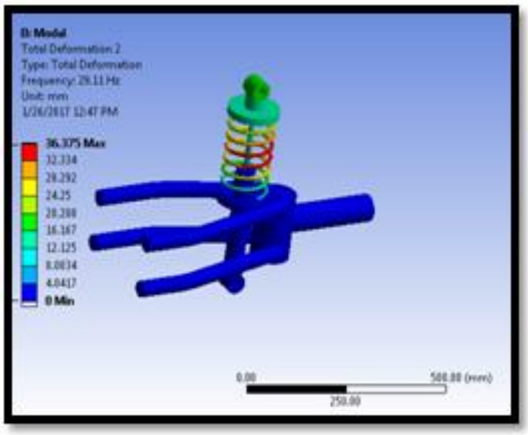
MODAL ANALYSIS

MATERIAL –CARBON FIBER

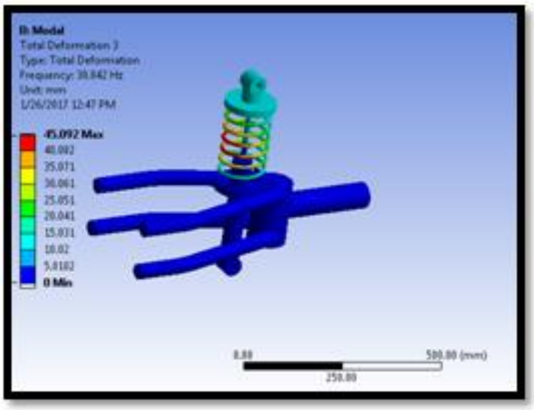
Deformation 1



Deformation 2



Deformation 3

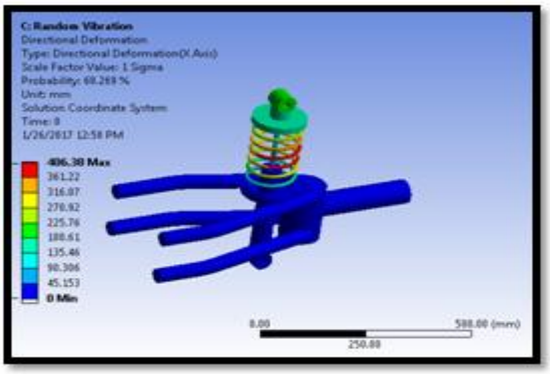


RANDOM VIBRATIONAL ANAYLSIS

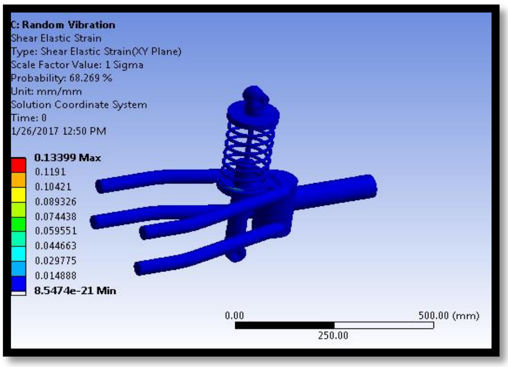
Random vibrational analysis is done by extracting results of modal analysis.

MATERIAL –CARBON FIBER

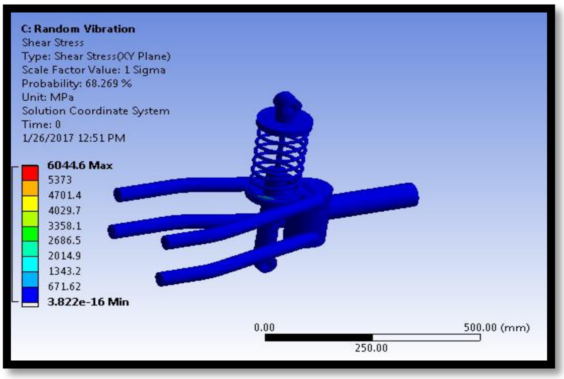
Directional deformation



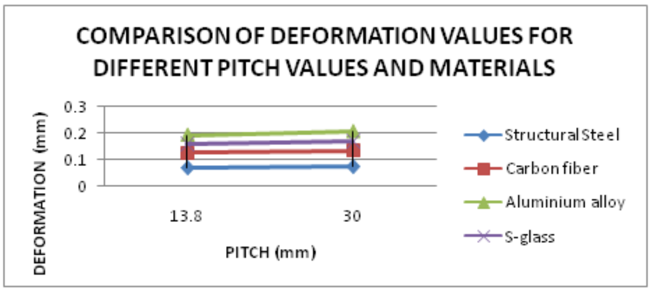
Shear elastic strain

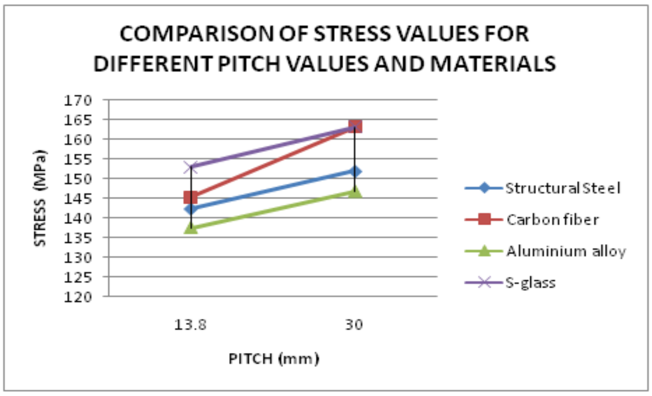


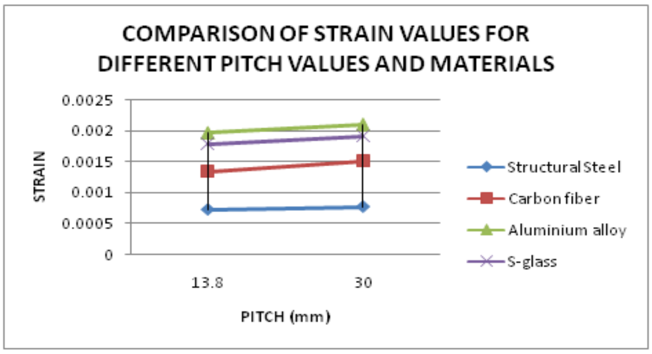
Shear stress



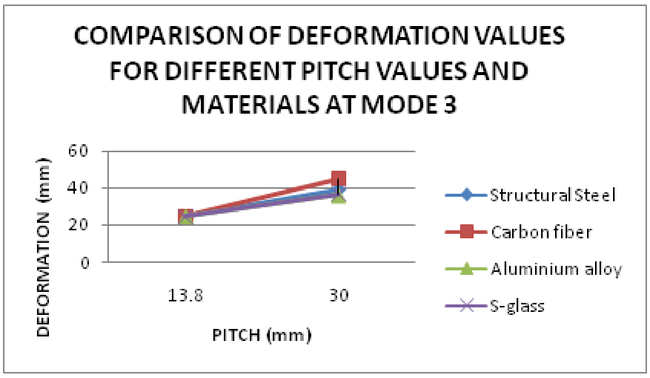
RESULT GRAPHS
STRUCTURAL ANALYSIS

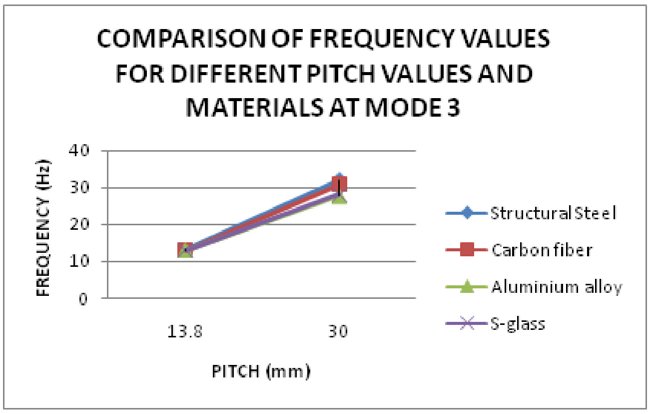






MODAL ANALYSIS





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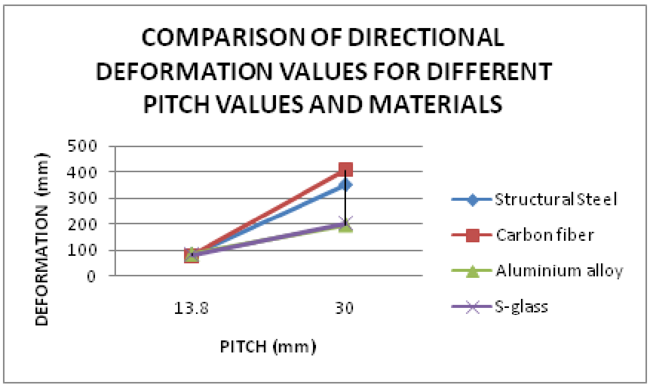
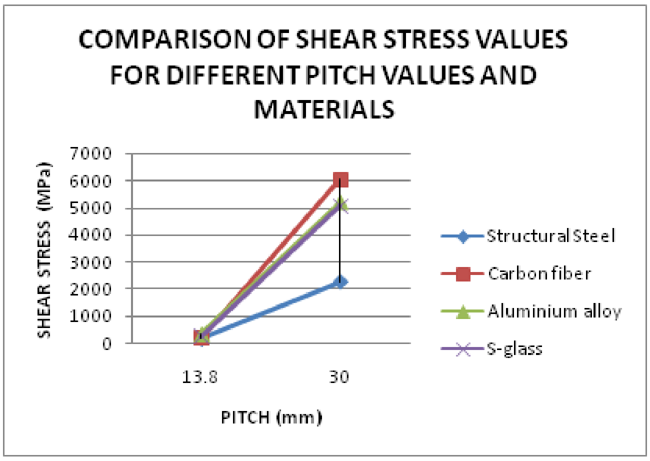
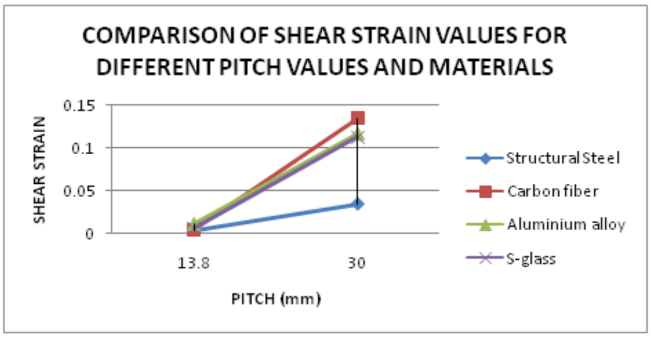
RANDOM VIBRATION ANALYSIS







CONCLUSION

By observing the structural analysis results, the deformation, stress and strain are increasing by increasing the pitch value. The deformation and strain values are less for Structural Steel and Stress value is less for Aluminum alloy. The stress values for all materials are less than the respective yield stress values.By observing the modal analysis results, the deformation and frequency are increasing by increasing the pitch value. When the frequencies are increasing, vibrations will be increase. The deformation and frequency values are less for S - Glass.By observing the random vibration analysis results, the directional deformation is increasing for Structural Steel and Carbon Fiber but reducing for Aluminum alloy and S - Glass. The shear stress and strain are increasing by increasing the pitch value. The values are less for Structural Steel. So it can be concluded that using composite materials yields better results due to their high strength to weight ratio.

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