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THE INFLUENCE OF THE MATERIAL PROPERTIES ON A TYPICAL CONTROL LINK OF A VEHICLE SUSPENSION SYSTEM UNDER DIFFERENT LOADING CONDITIONS

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Abstract The suspension system of a vehicle contributes to the active safety by participating to the handling and braking of the vehicle and to the driver' s and passengers' comfort by damping the road noise, bumps, and vibrations. The control links of such a system withstand various loadings during the movement and the braking of the vehicle. The control links specifically control the movement of the wheel without supporting the vehicle's weight and are mainly subjected to the horizontal forces that act only at their joints. In the present paper a typical control link has been designed in the Solidworks CAD software. Different materials, such as steel, aluminum and composites, have been considered and the influence of their mechanical properties has been investigated through static, modal and dynamic analysis in the Ansys Workbench CAE software. For both the static and the dynamic analysis different loading conditions simulating different movement and braking conditions have been simulated.

Keywords: *Suspension system, CAD, Finite elements, Elastic modulus*

Introduction

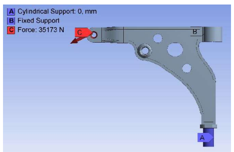
Suspension links couple the wheel hub to the chassis of the vehicle and they are used to transfer considerable forces to the vehicle while it is initiating its movement, accelerating, braking or turning. In the present paper a commercial control link has been designed in Solidworks and its performance has been investigated through static and modal analysis, using Ansys Workbench. Additionally, utilizing the modern optimization and design analysis tools available in Ansys, different materials widely used in automotive industry have been simulated.

Material	Density (kg/m3)	E (GPa)	Yield strength (MPa)	Maximum elongation (%)
Steel	7800	210	1000	10
GGG	7300	150	400	2
Titanium	5300	120	750	6
Aluminum	2700	70	250	4
Forged composite	1480	55	230	-

Materials & Methods

5 different materials have been simulated in modal and static analysis. For the static structural analyses 4 different loading cases retrieved in the literature have been considered (typical loading during movement of the vehicle[1], a pot-hole brake case and a reduced case [2])

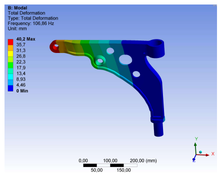
LC	F_x (N)	F_y (N)
1	-31460	-15730
2	-28460	-14230
3	-24200	-8200
4	-5900	-2020



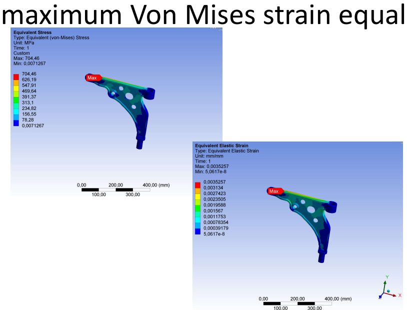
Results & Discussion

Modal analysis of the control link manufactured with steel provided the first 3 eigenfrequencies as 106.86 Hz (U_z), 194.12 Hz (U_z) and 373.15 Hz (U_y). Regardless material used the 1st eigenfrequency is a lot higher than the dominant frequencies in vehicles[3,4].

Material	1st eigenfrequency (Hz)	Deformation (mm)
Steel	108.21	40.34
GGG	97.18	41.83
Titanium	102.01	49.09
Aluminum	109.15	68.78
Forged composite	133.77	93.26



In the static analysis, for all LCs the maximum Von Mises stress and strain appear on the rib that surrounds the main body of the control link. LC 1 is the worst case scenario, with maximum value of Von Mises stress equal to 704.5 MPa and maximum Von Mises strain equal to 3.5 %.



Material	Max Von Mises strain (%)
Steel	3.5
GGG	4.7
Titanium	5.9
Aluminum	10.1
Forged Composite	1.1

The Maximum Von Mises strain in the control link consisting of Forged composite is the lowest (1.1%) but still the maximum value of Von Mises stress (635 MPa) is higher than the tensile strength of the material.

Conclusions

- A 3D CAD model of a commercial control link has been built and analyzed in a CAD and a CAE software.
- Simulating different materials control links with different eigenfrequencies have been built.
- All the alternatives result in control links with higher eigenfrequencies than the ones of the typical loading of the vehicle but lower weight.
- The maximum total deformation, in all cases appears at the left tip of the control link, increases as the density and the elastic modulus of the manufacturing material decrease.
- Only titanium seems to be an adequate alternative material, since the rest have an elongation limit lower than the resulting value of the analysis.

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