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Static structural analysis of tire model

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ABSTRACT

In this work, we evaluate Tire Design and Tire Mechanics to identify the most important advancements in improving the design reliability through efficient material selection, design optimization and carrying out reliability analysis. We categorize the research into the areas of Tire Behavior and Mechanics, Design, and Surface Interaction Study. This paper aims to carry out static structural analysis of passenger car tire subjected to real road conditions. The Tire model used in the analysis is designed in Solidworks and includes primary assembly complexity by the inclusion of Carcass, Beads, and Working Belts. Analysis was performed in the Static Structural Suite of Ansys Workbench.

Keywords: *Static Structural Analysis, Tire Model, Mesh, Setup, Ansys, Solidworks*

1.INTRODUCTION

Apart from the aerodynamic loads, all control forces act through the tire contact patches and thetire ground interface which is not larger than a hand shape. Knowing and understanding the physical phenomena at work in the contact patch is a key issue to tackle vehicle dynamics. Tyrehas three main functions: 1. Sustain the vertical load while ensuring a first damping against the loading from the road. 2. Develop longitudinal forces to enable acceleration and Braking. 3. Develop lateral forces to act against centrifugal loads in turning and dynamic movement.

1.1 Tire Construction:

Mechanical layout (Toroidal hollow shell composed of) 1. The carcass: a flexible shell made of rubber reinforced with several plies of high modulus fibre layers. 2. Some stiff beads made of steel cables keeping the contact between the tire and the wheel rim. 3. The tread, which offers high wear resistant layers in contact with the ground, ensures a good life time, water and snow evacuation, thermal cooling between the tire and the external flow.

1.2 Tread Design:

Tread has three main functions: 1. To ensure a high wear resistance. 2. Water and snow evacuation (Aquaplaning). 3. Heat exchange with the air external flow to ensure a sufficient cooling of the tire rubber.

2. MATERIAL PROPERTIES

Tires contain many rubber compounds and other materials because they are required to safely perform in the face of a wide range of demanding conditions. It can be composed of various composites of rubber material – the most common being styrene-butadiene copolymer – with other chemical compounds such as silica and carbon black .Steel wire is used in the tire belts and beads, and the plies for truck tires. The belts under the tread serve to stiffen the tire casing and improve wear performance and tire handling. The bead wire anchors the tire and locks it onto the wheel.

Material	Tensile strength (M pa)	Young'sModulus(G pa)	Density (Kg/m3)	Specific Heatj/Kgk	Thermal Conductivity (W/K m)
StructuralSteel	250	207	7850	466	45
High CarbonSteel	525	200	7850	490	50
SB Rubber	15	0.05	1100	1300	0.5

3. MODELLING

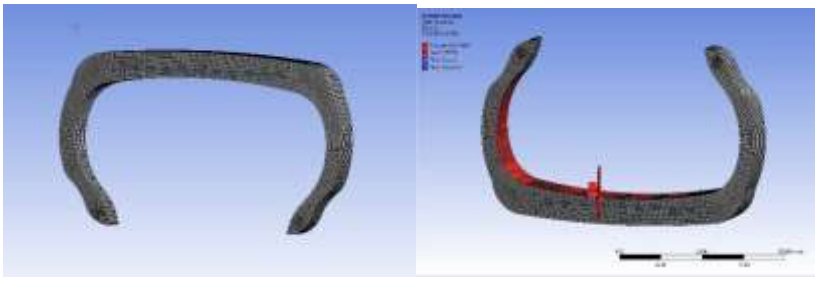
The Tire was modelled by using the SOLIDWORKS software by considering the dimensions of a Passenger SUV Car (Tire Specifications Used - P175/60 R14 82S) . Static Structural Analysis was carried out by using ANSYS software. This Analysis is

used to find out the distortion of physical dimensions of the Tire Model. The amount of distortion will depend on the tire model, materials used, complexity of assembly and mainly depends on the setup for the analysis; hence in this paper static structural analysis of tires has been carried out.

Process Flow: 1. Design of Tire Profile Based on its specifications 2. Tire Specifications Used- P175/60 R14 82S 3. Design of Tread Pattern over Tire Carcass 4. Design of Tire Bead 5. Design of Working Belts

3.1 Generating Meshing and Static Structural Analysis

First the CAD model of Tire was designed in Solidworks and saved in the format of IGES. Thenit was imported into ANSYS. The first step after importing into ANSYS is to select the material which is SB Rubber, High Carbon Steel in this case. To perform this meshing change the span angle size accordingly to your choice as medium, coarse, fine. The below tire model cut section is meshed to the span angle size as FINE. To change the normal curvature angle, set "advanced size function" and then specify the angle at which you want to do meshing. Then right click on meshing and select generate mesh then the mesh will generate.

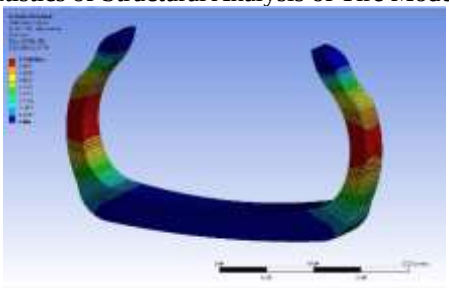


Material Assignment -Carcass - Styrene- Butadiene Rubber , Working Belt and Beads - High Carbon Steel
Mesh Parameters - Tetrahedral Mesh with custom element size of **1mm**. Fine spanangle and transition set to smooth.
Setup for Analysis -Inflation Pressure - 36 psi Weight of Vehicle - 287.5 N

Fixed Support Surface Selection - Base of Tire , Bead SurfaceSet for Large Deformations owing to material nature.

4. RESULTS

The Static Structural analysis calculates the distortion of components of interest under the conditions which they are employed to carry out their function. Here are the final statistics of Structural Analysis of Tire Model:



Maximum Distortion	Sidewalls	5 mm
Minimum Distortion	Beads and Contact Patch	0 mm

5. CONCLUSION

The Static Structural Analysis of Tire Model in real road driving conditions has been performedand with comparison by defining different parameters have completed successfully. The key point to be noted is Inflation pressure has a weak influence on the altercation of physical dimensions.For a given inflation pressure, larger vertical load leads to longer contact patches,which is favourable to develop more braking/tractive forces. In addition to the above analysis, inclusion of higher level of complexity in tire modelling would yield more refined results subjected to adequate material selection.

6. REFERENCES

[1] W. Milliken & D. Milliken. « Race Car Vehicle Dynamics », 1995, Society of AutomotiveEngineers (SAE)
[2] NPTEL – Vehicle Dynamics (Tire Mechanics) - IIT Madras.
[3] T. Gillespie. Fundamentals of Vehicle Dynamics. Society of Automotive Engineers (SAE). 1992.

