Comparative Stress Analysis using Ansys Software for Different Tires Performance Evaluation

Krunal Girase 1, Mr. Navneet Patil 2, Dr. Dheeraj Deshmukh 3

1P.G. Student, Department of Mechanical Engineering, SSBT’s COET, Jalgaon, Maharashtra, India
2Associate Professor, Department of Mechanical Engineering, SSBT’s COET, Jalgaon, Maharashtra, India
3Head, Department of Mechanical Engineering, SSBT’s COET, Jalgaon, Maharashtra, India

ABSTRACT: In this paper Comparative Stress Analysis using Ansys 12 software is used for different tires of same material with different structured threads in the same operating condition. Three different structured threads are used as Plane threaded tire, line threaded tire and Cross threaded tire for stress analysis. Operating conditions are kept constant as 300RPM, Plane concrete road profile, pressure on all tires are same and rubber material is used for all three tires. During this evaluation two geometries are modeled in solid-edge tool as three different tires and the road profile. In Ansys 12 Load and rotation is provided on tire models and road profile is fixed. It is observed during the simulation analysis minimum stress as well as minimum deformation occurs in Plane threaded tire as compared to line threaded and cross threaded tire.

Keywords – solid-edge, Ansys, Road profile, Tire threads, Frictional Analysis

I. INTRODUCTION

Road friction, its measurement and relation to traffic accident risks, is a problem that has engaged thousands of road engineers throughout the world. In many countries there exist specified road friction threshold values that define the lowest acceptable road friction [1]. If the friction level is below this threshold value, then the risk of accidents may increase. And this all depend on stress and deformation in tire in running conditions. These stress and total deformation in tire are the result of research into the relation between road friction and accident risks.

Friction is the resistance an object encounters in moving over another object. Often the force needed to move the object, the frictional force and if the stress is maximum then friction also increases and hence the wear in both contacting surfaces and it’s undesirable.

In a friction measurement, often three bodies are involved; the measuring tire, the road surface and some kind of contaminant interacting with both tire and road like for example water (wet friction), dust or wear particles etc. The friction values measured depend to a great extent on all three bodies, their material properties, the local contact pressures, relative velocities etc. A summary of the important factors influencing the road surface friction is given in following table –

Table-Factors influencing the road surface friction and stress

<table>
<thead>
<tr>
<th>Road</th>
<th>Contaminant (fluid)</th>
<th>Tire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macro texture</td>
<td>Chemical structure</td>
<td>Tread pattern design</td>
</tr>
<tr>
<td>Micro texture</td>
<td>Viscosity</td>
<td>Rubber composition</td>
</tr>
<tr>
<td>Chemistry of</td>
<td>Temperature</td>
<td>Rubber hardness</td>
</tr>
<tr>
<td>materials</td>
<td>Thermal conductivity</td>
<td>Load</td>
</tr>
</tbody>
</table>

A Tire
A tire (U.S. English) or tyre (British English) is a ring-shaped covering that ts around a wheel's rim to protect it and enable better vehicle performance. Most tires, such as those for automobiles and bicycles, provide traction between the vehicle and the road while providing a flexible cushion that absorbs shock.

Frictional force
As frictional force is directly proportional to stress on moving body, it’s important to take frictional force in consideration, Frictional force can be expressed as, \( F = N \)
where,

\[ F = \text{Frictional Force} \]
\[ N = \text{normal force} \]

II. Objectives

- To carry out, or procure research into all factors affecting the safe use of public roads.
- To find optimum thread pattern for optimum stress and hence friction in between road surface and tire.

III. Modeling and Analysis of Tire Modeling of Tires

For modeling of tire Solid Edge software tool is used. Three types of tires are considered for the study, with identical geometries but different thread.

Steps in a Contact Analysis

The basic steps for a typical surface-to-surface contact analysis are as follows,

1. Create the model geometry and mesh
2. Identify the contact pairs
3. Define the contact surface
4. Set the element key options and real constants
5. Define/control the motion of the target surface (rigid-to-flexible only)
6. Apply necessary boundary conditions
7. Define solution options and load steps
8. Solve the contact problem
9. Review the results

Analysis of Tires

The structural analysis has been performed using ANSYS -12.0. ANSYS supports three contact models: node-to-node, node-to-surface, and surface-to-surface. Each type of model uses a different set of ANSYS contact elements and is appropriate for specific types of problems.
Analysis of pain tire

Defining contacting surfaces

Details road surfaces

Details tire surfaces

Meshing of tire and road surface

Pressure application

Fixing of road surface

Applying Rotational Velocity

Total Deformation

Von-mises stress
Similarly, we can have Analysis of Two remaining tire threads by going through same steps.

**Analysis of line threaded tire**

![Image of line threaded tire analysis](image1)

**Total Deformation**

![Image of Von-mises stress for line threaded tire](image2)

**Analysis of Cross threaded tire**

![Image of cross threaded tire analysis](image3)

![Image of Von-mises stress for cross threaded tire](image4)

### IV. Result

The three types of threads of tire for stress analysis between road and tire surface are considered. They are Plane, Line threaded and cross threaded tire. At a constant speed of 300 m/s, all the tires are analyzed for total deformation. The Von-Mises stresses and total deformation for all of three tires as shown below,

<table>
<thead>
<tr>
<th>Type of Tire</th>
<th>Total Deformation (mm)</th>
<th>Maximum Stress (MPa)</th>
<th>Minimum Stress (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plane Tire</td>
<td>787.34</td>
<td>0.38918</td>
<td>0.010182</td>
</tr>
<tr>
<td>Line Threaded tire</td>
<td>3879.3</td>
<td>0.67153</td>
<td>0.010153</td>
</tr>
<tr>
<td>Cross Threaded tire</td>
<td>80162</td>
<td>10.135</td>
<td>0.0000001</td>
</tr>
</tbody>
</table>

### V. Conclusion

For identical operating conditions, three tire thread profiles are analysed. Comparing the maximum stresses and total deformation for the tires it is observed that the tire having no threads that is Plane tire have minimum stress in it and also the total deformation as compared to other two structured tires. Contact area of plane threaded tire is more than other tires and area of contact is directly proportional to friction, so friction will be maximum in this tire. By considering all the aspect as stress, total deformation and friction the line threaded tire is optimum to use for vehicles.

### VI. References


