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Original Article

Improve Wear Resistance of the Tyre by using Different Ceramics

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Abstract: The tyre is an important component in the vehicle. It is the source of contact between the vehicle and the road. Proper contact between tire and road is necessary for proper steering of vehicle. Tyre wear is a complex phenomenon and can be a result of variety of factors like improper inflation pressure, overloading of vehicle, improper alignment of tyre and worn out struts. Tyre wear is a major source of noise in vehicles travelling at speeds above 50 km/h. Tyre wear has an impact on the comfort of the passenger. As tyre wear increases, fuel economy decreases. When the vehicle passes through a wet road; tread depth, water depth, speed, inflation pressure, load on tyre, and tread design are the main factors which determines the ability of tyre to move without skidding. It occurs when a layer of water is formed between wheels and road that leads to loss of traction and stability.

Keywords: Wear Resistance, Tyre, Ceramics, Material Enhancement, Tyre Durability, Ceramic Composites, Abrasive Wear, Tribology, Surface Modification, Ceramic Materials, Tyre Performance, Wear Prevention, Tire Materials, Friction Reduction, Engineering Materials.

I. INTRODUCTION

The tyre is the very important component of vehicles. Reducing the tire wear and improving the operating life of tyre, it is necessary research for vehicle manufacturers. Moreover, tyre wear is an important factor of tyre noise. Tyre noise is an effective noise source of vehicles. For modern passenger cars in good condition travelling at steady speed, the tyre/road interaction noise is the dominant noise source is a significant contributor to the overall noise generated and above approximately 50km/h is the dominant noise source. Reducing the tyre wear is effective for reducing the noise of vehicles.

The process for tyre wear is very complex. Tyre wear can be caused by a number of factors. Some of these include incorrect inflation, alignment issues, vehicle over-loading and worn out shocks or struts. In the conventional research, the tyre wear is estimated by experiments. Otherwise, the tyre wear is predicted by the tyre vibration and modal analysis. Recently, with the development of the computer technology, the tyre wear calculating with FE is a growing trend. In the calculation of FE. However, simulation results are influenced a great deal by the tyre pattern.

In this paper, the tyre pattern is considered in the proposed scheme. The model is based on the tyre wear model using Archard wear theory. At first, using SOLIDWORKS and ANSYS software the tyre pattern is obtained. Next, the contact footprint and pressure between tyre and road are analyzed with the tyre rolling dynamics. In this paper, three situations are considered to analyze the state of tyre wear, the side slip angle, the Vertical load and the inner pressure.

II. LITERATURE REVIEW

SREERAJ et all says the work includes the tread wear analysis of different types of rubber used to make tire tread and also the influence of inflation pressure on tire wear will be studied. Thus the optimum tire tread material properties for various on road conditions and optimum inflation pressure can be obtained.

GAUNGTONG et all says the tire wear model is build based on Archard wear theory. In this tire wear model, the steady rolling of tire is considered. Moreover, the analysis for the steady rolling of tire is used in the simulation. In this paper, 195/65R15 tire is used to build a 3D tire FE model for simulation. The tire radial direction modal and natural frequency are calculated to validate the 3D tire FE model. At first, using Pro/E and Abaqus software the tire Patten is obtained. Next, the contact footprint and pressure between tire and road are analyzed with the tire rolling dynamics. The three situations are considered to analyze the state of tire wear, the side slip angles, the vertical load and the inner pressure.

JAWAD K.OLEIWI et all says the effect of adding the silica particles and alumina particles separately with different ratio on the hardness and wear rate of natural rubber and styrene butadiene rubber. The results shows that the hardness increases with the increase the loading level of reinforcing particles, while the wear rate decreases with the increase the loading level of the reinforcing particles.

PRAFUL DAREKAR et all says the tyre wear detection by using visualization method in this system we will and add the color coding to the tyre which will be helpful in detecting the tyre wear in simple way. This system is easy to implement and don't need extra components in the system to detect the tyre wear. Despite the advancements in technology there is no such system which indicates us with our naked eyes that the tyre has been weared out & using it further may be at risk of accidents.

D. MANAS et all says the description of a new method of rubber parts wear testing especially wear of tyre treads is the main aim of this paper. Understanding of wear procedure could help to improve the quality of tyres and other rubber parts working in heavy terrain conditions.

SANDEEP et all says The tire tread pattern is the arrangement of blocks, grooves, voids, sipes and channels designed into the tread to enhance its grip on the road. Tread is the uppermost part of any tire which contact into the road. This research work aims at conducting Finite Element Analysis on tire tread wear for its performance in steady rolling condition to predict its behavior and wear in on-road conditions. The tire wear is analyzed on the basis of Archard wear theory. The Finite Element Analysis software ABAQUS 6.14 is used for the analysis and the tire is modelled using CREO 2.0. This work includes the tread wear analysis of different types of rubber used to make tire tread and also the influence of inflation pressure on tire wear will be studied. Thus the optimum tire tread material properties for various on road conditions and optimum inflation pressure can be obtained.

RAVINDRA VARMA et all says the study of the processes of wear is a part of the discipline of tribology and the mechanism of wear is very complex. Under normal mechanical and practical procedures, the wear-rate normally changes through three different stages: primary stage or early run-in period, where surfaces adapt to each other and the wear-rate might vary between high and low; secondary stage or midge process, where a steady rate of wearing is in motion. Wear in rubber materials is one of a limited number of fault factors in which an object loses its usefulness and the economic implication can be of enormous value to the industry. This paper describes an approach to analyze of abrasive wear on soft material which as Styrene-butadiene copolymer or rubber. In this study, the abrasive wear behavior of rubber specimens are experimentally investigated in the laboratory with the help of 'Two body abrasion tester' machine and the wear results are compared with respect to load & speed. Finally specific wear rate is calculated experimentally and verified. At the end of the study, the observation is taken about wear behavior of rubber on different testing parameters. It is observed that the abrasive wear rate is increased with respect to load & speed.

III. DESCRIPTION OF COMPOSITES

Tyres are often circular in shape and made of rubber and polymers. The task of the tyre is smooth transfer of power from the vehicle to the road in various traffic conditions and provision of adequate isolation of the vibrations generated by a rough road. The construction of the tyre consists basically of a carcass, inner beads, side walls, crown belt and tread.

The carcass is made from layers of textile core piles. Cross-ply tyres tend to still use nylon whereas radial ply tyres use either Raylan or polyester. The inside diameter of both tyre walls support the carcass and seat on the wheel rim. The edges of the tyre contacting the wheel are known as beads and molded inside each bead is a strengthening endless steel wire cord.

The outside of the tyre carcass, known as the side walls, is covered with rubber compound. Side walls need to be very flexible and capable of protecting the carcass from external damage such as cuts which can occur when the tyre is made to climb up a kerb.

Between the carcass and tyre tread is crown reinforcement belt made from either synthetic fabric cord such as Raylan or for greater strength steel cores. This circumferential endless cord belt provides the rigidity to the tread rubber.

The outside circumferential crown portion of the tyre is known as the tread. It is made from a hard wearing rubber compound whose function is to grip the contour of the road.

Natural rubber has good wear resistance and excellent tear resistance. It offers good road holding on dry roads but retains only a moderately good grip on wet surfaces. One further merit is its low heat buildup, but this is contrasted by high gas permeability and its resistance to ageing and ozone deterioration is only fair. The side walls and treads have been made from natural rubber but nowadays it is usually blended with other synthetic rubbers to exploit their desirable properties and to minimize their shortcomings.

Compounds of this material are made from styrene and butadiene. It is probably the most widely used synthetic rubber with in the tyre industry. SBR forms a very strong bond to fabric and it has a very good resistance to wear, but suffers from tear resistance compared to natural rubber. One outstanding feature of this rubber is its high degree of energy absorption or high hysteresis and low resilience. It these properties which give it exceptional grip, especially on wet surfaces. Due to the high heat buildup, SBR restricted to the tyre tread while the side walls are normally made from low low hysteresis compounds which provide greater rebound response and run cooler. Blending SBR with NR enables the best properties of both synthetic and natural rubber to be utilized so that only one rubber compound is necessary for some types of car tyres. The high hysteresis obtained with SBR is partially achieved by using an extra high styrene content and by adding a large proportion of oil to extend the compound, the effects being to increase the rubber plastics properties and to lower its resilience.

Ceramics are also known as technical ceramics or advanced ceramics, which are used for engineering applications in industries. Ceramics are mainly oxides, carbides and nitrides of metals.

Solid works, developed by Assault Corporation Ltd., is one of the world's leading CAD/CAM/CAE package. Being a solid modeling tool, it not only 3D parametric features with 2D tools, but also addresses every design through manufacturing process. Besides providing an insight into the design content, the package promotes collaboration between companies and provides them with edge over their competitors.

In addition to creating solid models and assemblies, 2D drawing view can also be generated in the drawing mode of Solid works. The drawing views that can be generated include orthographic, section, auxiliary, isometric or detail views.

Solid works uses parametric design principles for solid modeling. This modeling software provides an approach to mechanical design automation based on solid modeling technology and the following features.

The essential difference between Solid works and traditional CAD systems are the models created in Solid works exist as 3D solids. Other 3D modelers represent only the surface boundaries of the model. Solid works models the complete solid. This is not only facilitates the creation of realistic geometry, but also for accurate model calculations, such as those for mass properties.

Dimensions such as angle, distance, and diameter control Solid works model geometry. You can create relationships that allow parameters to be automatically calculated based on the value of other parameters. When you modify the dimensions, the entire model geometry can update according to the relations you created.

We created models in Pro/E by building features. These features have intelligence, in that they contain knowledge of their environment and adapt predictably to change. Each feature asks the user for specific information based on the feature type. For example, a hole has a diameter, depth, and placement, while a round has a radius and edges to round.

Solid works is a fully associative system. This means that a change in the design model anytime in the development process is propagated throughout the design, automatically updating all engineering deliverables, including assemblies, drawings, and manufacturing data. Associatively makes concurrent engineering possible by encouraging change, without penalty at any point in the development cycle. This enables downstream functions to contribute their knowledge and expertise early in the development cycle.

The strength of parametric modeling is in its ability to satisfy critical design parameters throughout the evolution of a solid model. The concept of capturing design intent is based on incorporating engineering knowledge into a model. This intent is achieved by establishing features and part relationships and by the feature dimensioning scheme.

Figure 4.1. Iso metric view

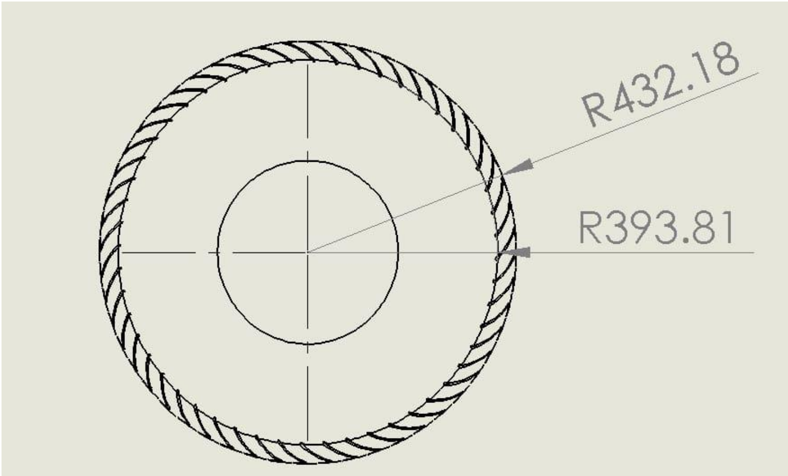

Figure 4.2 Front view

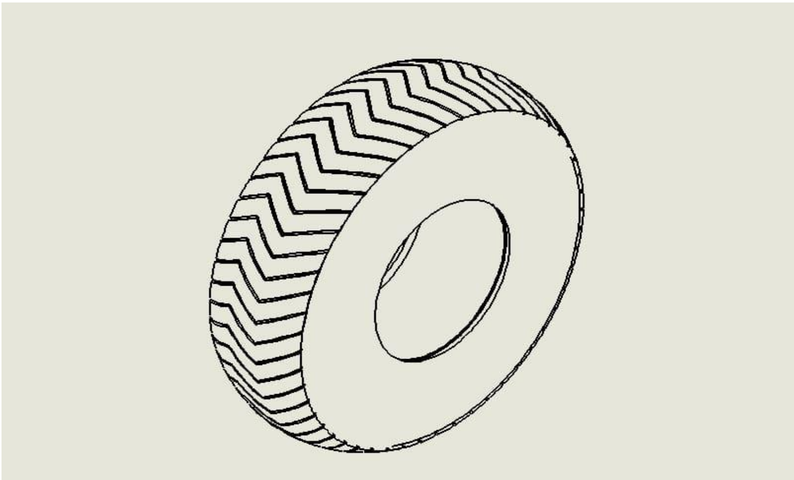

Figure 4.3. Trimetric view

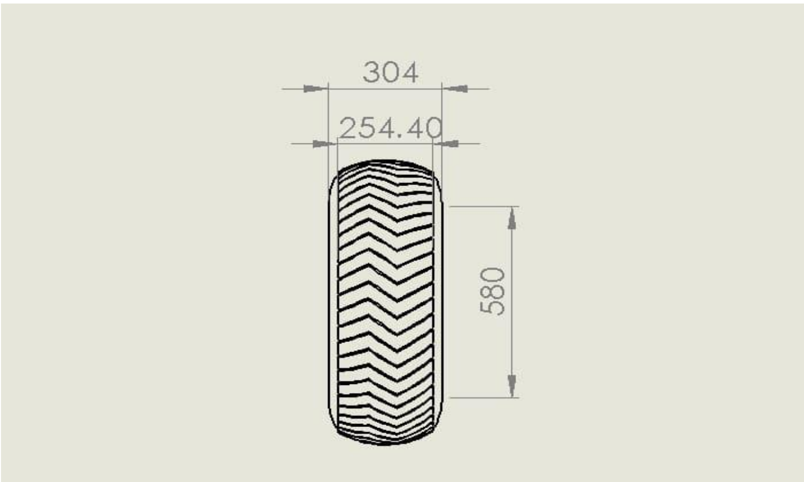

Figure 4.4. Right side view

ANSYS program is a general purpose program meaning that we can use it for almost any type of Finite Element Analysis virtually in any industry. General purpose also refers to the fact that the program can be suited in all disciplines of engineering Mechanical, Electrical, Thermal, Electromagnetic, Electronic, Fluid, Bio-Medical this is also used as an educational tool in universities and other academic institutions.

ANSYS program has a comprehensive graphical user interface (GUI) that gives users easy, interactive access to program functions, commands, documentation and reference material. Intuitive menu system helper's users navigate through the ANSYS program. User can input data using a mouse, keyboard or the combination of both.

IV. RESULT AND REVIEW

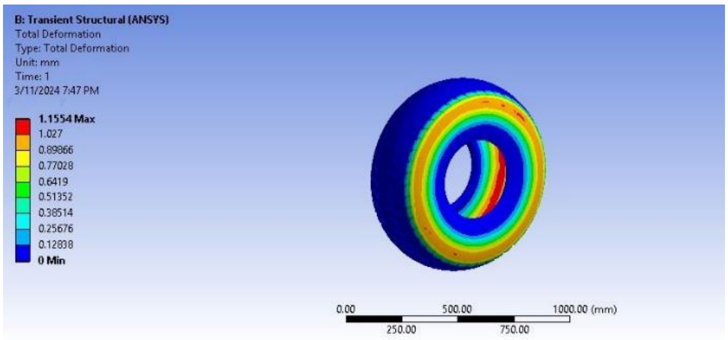

Figure 7.1 Styrene Butadiene Rubber Used Tyre

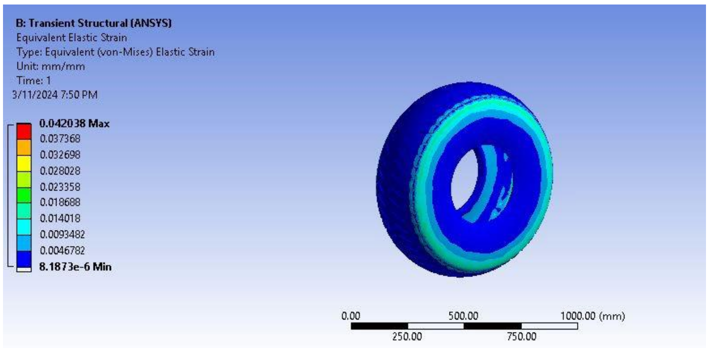

Figure 7.2 Deformation

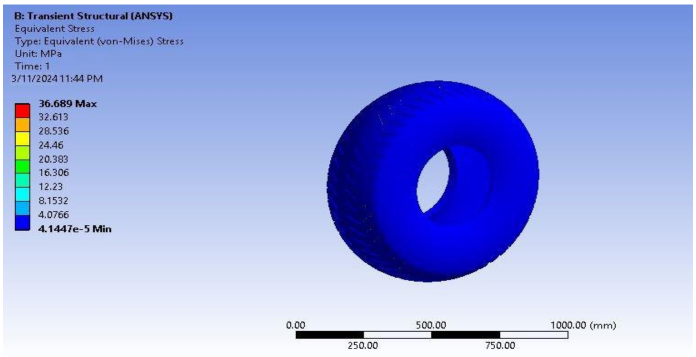

Figure 7.3 Equivalent stress

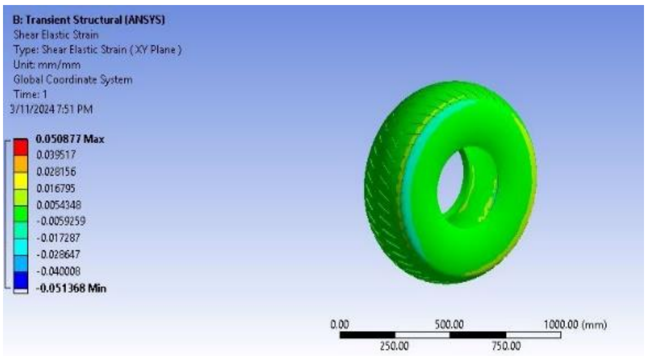

Figure 7.4. Shear Elastic Strain

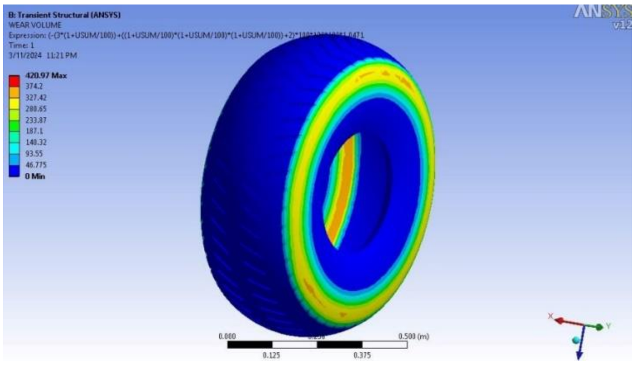

Figure 7.5 Wear Volume

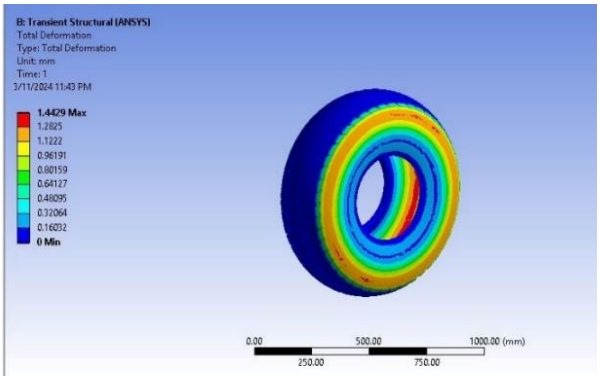

Figure 7.6 Deformation

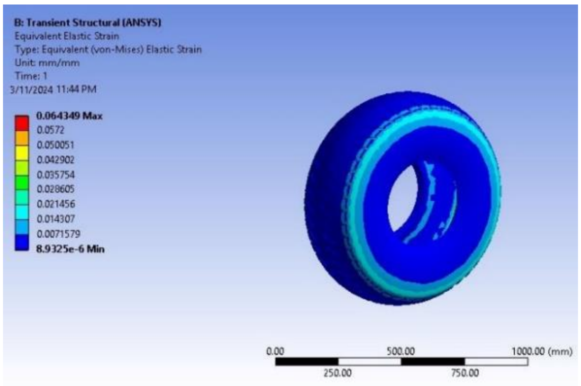

Figure 7.7 Equivalent Elastic Strain

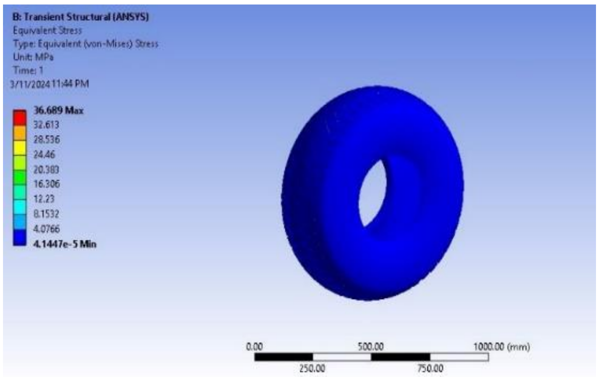

Figure 7.8 Equivalent Stress

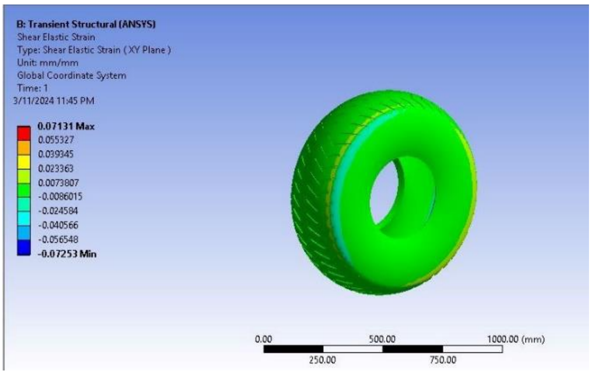

Figure 7.9 Shear Elastic Strain

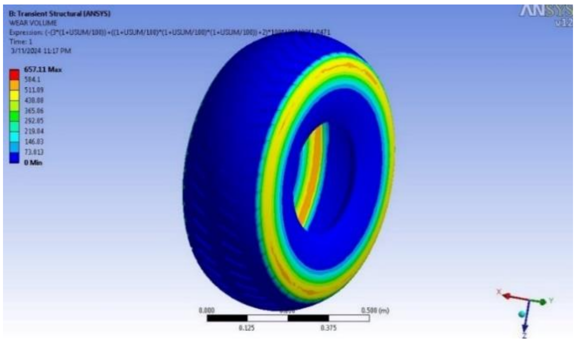

Figure 7.10 Wear Volume

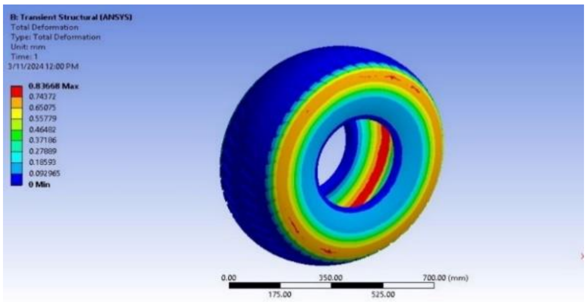

Figure 7.11 Deformation

Table no 7.1

SL.NO	DESCRIPTION	UNIT	SBR	$SBR+AL_2O_3$	$SBR+SIO_2$
1	Deformation	Mm	1.1554	1.4429	0.83668
2	Equivalent elastic strain	Mm/mm	0.04208	0.064349	0.036772
3	Equivalent stress	Mpa	36.613	36.689	35.806
4	Shear elastic strain	Mm/mm	0.050877	0.07131	0.041694
5	Wear volume	Mm3	420.97	657.11	287.43

IV. CONCLUSION

From the analysis it is seen that wear rate is a function of inflation pressure and material properties of the tread material. The obtained results through Finite Element Analysis is agreeing with those obtained through experimental methods in the literatures studied. Following conclusions are arrived from the analysis. Material with high elastic modulus is having high contact pressure, hence have high wear rate. Comparing to the two materials Silicon-di-oxide having lower wear rate then the Alumina. So we can use Silicon-di-oxide with the Styrene butadiene rubber to reduce the wear rate.

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