Thermo-Mechanical Defect on Commercial Vehicles Tyres

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Abstract- *Tyres are the one of the most essential part of vehicle as cost as well as performance measurement of vehicle. As diverse researches come about to increase tyre life span by the means of overall performance of vehicle with the help of different technique, however this research is rooted in Design & Alignment associated consideration which causes a great deal on tyre life and hence increasing the tyre life as much expected.*

Keywords- Alignment, Commercial Vehicles, Design, Thermo-Mechanical defect. Tyres, wear out

I. INTRODUCTION

A tyre is a ring-shaped vehicle component that covers the wheel's rim to protect it and enable better vehicle performance. Most tyres, such as those for automobiles and bicycles, provide traction between the vehicle and the road while providing a flexible cushion that absorbs shock. Today, the majorities of tyres are pneumatic inflatable structures, comprising a doughnut-shaped body of cords and wires encased in rubber and generally filled with compressed air to form an inflatable cushion. Pneumatic tyres are used on many types of vehicles. Reducing the tyre 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 above 40 km/h. During acceleration this source is a significant contributor to the overall noise generated and above approximately 50 km/h is the dominant noise source. Reducing the tyre wear is effective for reducing the noise of vehicles. The process of tyre wear is very complex. Tyre wear can be caused by a number of factors. Some of these include incorrect inflation (outer edge wear equals low tyre pressure), alignment issues, vehicle over-loading and worn out shocks or struts. In the conventional research, the tyre wear is estimated by experiments.

Types of Tyres used in commercial vehicle

According to Construction:

a) Cross ply/Bias tube type tyre (eg-10.00X20)
b) Radial tube tyre (eg- 10.00R20)
c) Radial tubeless tyre (eg- 11R22.5)

According to Tread Design:

a) Rib Tyre
b) Lug Tyre
c) Semi Lug Tyre
d) Mines Tyre

II. OBJECTIVES

The purpose of this study is to investigate how various degrees of tyre wear affect the tyre performance. A secondary objective is to investigate how tyre age affects the tyre performance as well how to increase tyre life span by the means of overall performance of vehicle with the help of different Design & Alignment techniques

III. LITERATURE SURVEY

Mr. M. Barquins, studied Mechanisms of dry friction and wear of elastomers. On Applications to the running and wear of tyres on road surfaces Mr. S.H. Yeow, M. El-Sherbiny, and T.P. Newcomb, research Thermal Analysis of a Tyre During Rolling or Sliding, Wear. Mr. M.J. Otto, E.T. Steyn, and F. Elkink, Heat generation in textile tyre cords. Mr. B.T.F. Chung, P.C. Yang, M.H.N. Naraghi, and D.J. Schuring. Heat Transfer in rolling tyres. Mr. B. Yavari, W.W. Tworxydlo, and J.M. Bass, Thermo mechanical model to predict the temperature distribution of steady state rolling tyres, Tyre Science & Technology. Also studied on Tyre Rolling Resistance by the Cummins shows that Rolling resistance results from the internal friction of tyre as it deflect during motion. Energy spent generating heat in the tyres is energy that does not contribute to moving the vehicle. Cooler running tyres more Fuel-efficient than tyres that run hotter. Complex rubber compounds advanced casing construction and enhanced tread designs have led to new standards in tyre performance. 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 Pro/E and Abaqus

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. The effects of reductions in rolling resistance on tyre wear life and scrap tyres are difficult to estimate because of the various ways by which rolling resistance can be reduced. The tread is the main factor in tyre wear life and the main component of the tyre contributing to rolling resistance. Pneumatic, or air-filled, tyres are used on vehicles as diverse in form and function as airplanes, bicycles, tractors, and race cars. Accordingly, they encompass a wide range of sizes, designs, materials, and construction types. Nevertheless, structural elements that are common to all of these tyres are the casing, bead, and tread band. The casing often called the carcass is the structural frame of the tyre.

IV. PROBLEM STATEMENT

There are not many researches about irregular tyre wear publicly available. The available information mainly consists of practical knowledge. The aim of this project is to get a better understating on the dynamical irregular tyre wear problem. The investigation needs to be done by using analytical tyre simulation models. The models should help to visualize the possible origin and solutions of irregular tyre wear. Experiments are executed to verify the theoretical simulation models. Following are the different tyrs of Commercial vehicle tyre wear

IV.1 Alternate lug wear: At Alternate Lug Wear the tyre's lugs do not wear consistently because they are not making uniform contact with the highway. This can be on one shoulder or both. Alternate lug wearoften the first stage of diagonal wear.

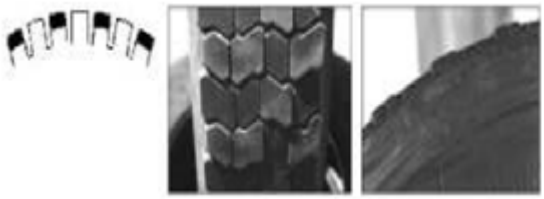

Figure 1.

IV.2 Both sided shoulder wear: In this case the shoulders of the tyre wears more rapid compared to the tread centre. The tread is not making a flat contact to the road and the shoulders are carrying most of the forces.

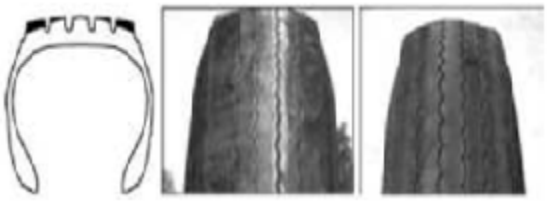

Figure 2.

IV.3 Centre wear : The tread centre has a rapid wear compared to the shoulders. The centre of the tread bears most of the load and wears out faster than the outside edges. This is mostly caused by over inflation.

Figure 3.

IV.5 Diagonal wear: The diagonal wear is recognizable on localized sections of comparatively rapid tread wear that run diagonally across the tread, from shoulder to shoulder.

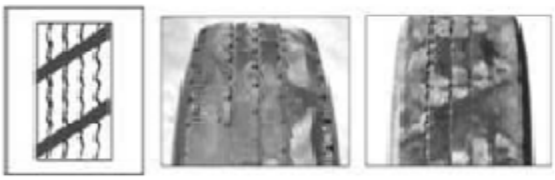

Figure 4.

IV.6 One-sided wear: When one-sided wear does not have a "scrubbed" appearance, it is caused by a camber error. The cam be error is creating excess contact pressure on one shoulder, which results in rapid wear on that shoulder.

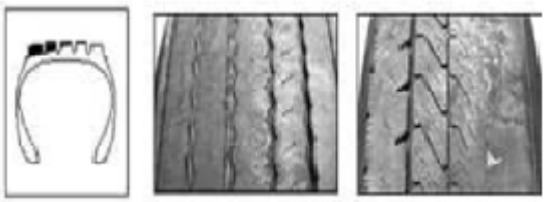

Figure 5.

IV.7 Rib punch wear: Erratic tread wear where the smaller ribs wear more rapidly than the larger ones. The worn are as are scrubbing the highway because the tread are as distorting in the footprint.

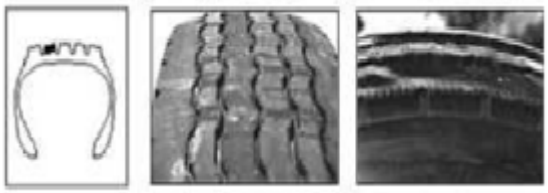

Figure 6.

IV.8 Spot wear: The tyre slid across the road surface, scung away the tread in one area. One or more small, localized spots of comparatively rapid tread wear.

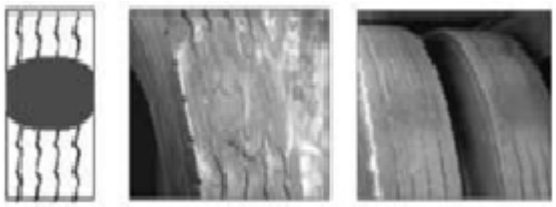

Figure 7.

IV.9 Heel & Toe: The trailing portions of the lugs are scuffing like a rubber eraser. The lugs are distorting during acceleration or during operation so they are not making flat contact with the highway.

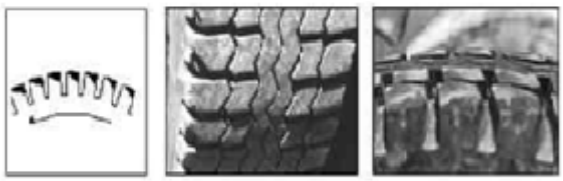

Figure 8.

IV.12 Erosion/ River/Channel Wear: This condition happens most frequently in free rolling wheel positions and is typical of tyres with a slow rate of wear.

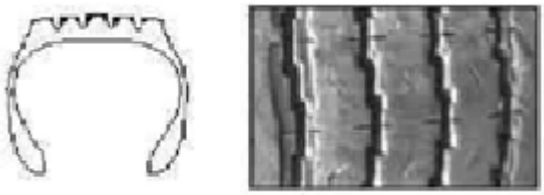

Figure 9.

V. METHODOLOGY

We are inducing effort to take permission from the fleet Manager/owner who is having large amount of fleet and who are operating the vehicle in PAN India for transportation. Truck tyre wear under realistic conditions was studied by actually driving around on public road. We will check all the parameter of the vehicle and find out the main issues which are causing the tyre wear in commercial vehicle. If any modification is needed in the vehicle from the design team we will interact with the relative design team update the appropriate design of the parts. This required 50,000 to 1 Lac km driving, especially for long lasting truck tyres. To obtain a suitable result with a reasonable effort a quite aggressive road course in India has been chosen. The testing track was chosen to represent typical Indian roads and traffic situations as well as several different types of road surfaces. The total length of the rout from Delhi to Chennai is 4700 km up-down and the estimated lap time was about 10-15 days. Test series of 50,000 km will perform, one in the winter and one in the summer. The track has been used for both side optimum payloads (under load). Tyre wear rates and wear patterns (i.e., wear rate across the tyre width) were monitored by measuring tread depths across the tyre width after each trip of driving. . Figure 27 shows that, for truck rear (middle panel) and front tyres (right panel), tread depths were measured at six and four positions across the tyre width, respectively. Tread depths at each position across the tyre were averaged for four positions along the tyre circumference (left panel).

Figure 10. Tyre treads depth measurement location

VI. ELEMENTS OF METHODOLOGY (FLOW CHART)

Select Customer: We find a customer who is having fleet of different types of manufacturers in same application.

Low tyre life vehicle: We will create a list of vehicle whom tyre life below 50,000kms and having different – different tyre of wear on the vehicle.

Check the Vehicle: When we starts work in the owner's fleet we will check all the parameters which are related to axle, break and steering division. At the time of vehicle attending we observe some mis-match parameter then we correct and make the observation sheet.

Trip Start: After completing all the work on the vehicle we sent the vehicle for the trip with in under load condition. Within the trip we maintain the tyre air pressure as per tyre manufactures recommended and tyre rotation as per specification.

Route Mapping: Most important thing is route of the vehicle which explores the road condition the then according to condition of road the parameter of vehicle and the tyre life could be calculated.

Tyre Tread measurement: While the vehicle closes its trip we check the tread depth of the tyre by digital depth gauge at 6 TWI points. We made a excel sheet to calculate the projected tyre life of tyre and also calculate the wear rate of the tyre rubber on the route to get maximum tyre life.

Schedule Work: Check Vehicle all parameter related to schedule maintenance 20,000kms. This work will do to maintain the tyre life or explore the tyre life. At this stage the vehicles closely have to observe for any uneven wear mark on the tyre.

Monitoring: After all the schedule work we will monitor the vehicle minimum 50,000kms or further maximum life to be covered by the tyre by proper maintenance.

Calculation: At 50,000kms we will calculate the maximum life of the tyre and cost of tyre per kms, total import of the tyre minimization, and profit per tyre as per month / per year.

Testimonials: A report which will show the profit which we gave to the customer is satisfactory. It will be the conclusion of the project.

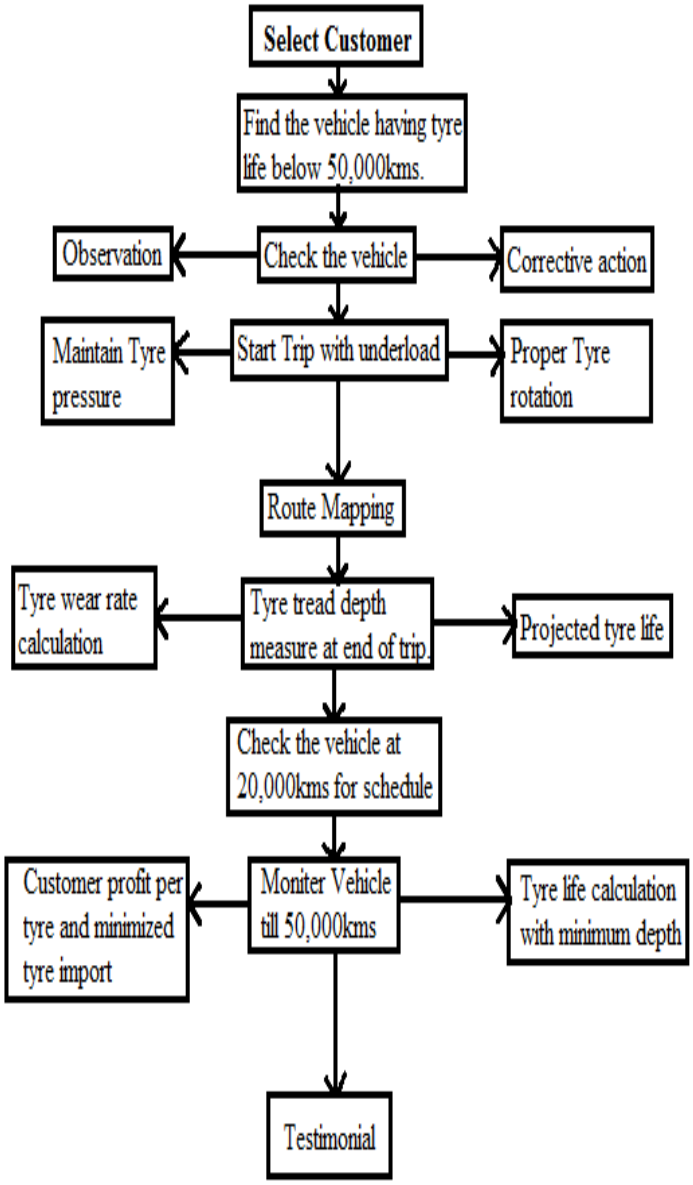

Figure 11.

VII. CONCLUSION

This case study contains the main conclusions of this research and recommendations for future projects. The aim of this project is to provide a better tyre life and minimize the tyre wear problem. This work has been performed at the customer hub or authorised dealers of the manufacturer to controlled environment to be able to verify the correlation between the design parameters and the actual work done on the vehicle.

Outcomes:

- Tyre life will be increase.

- Tyre purchasing will reduces.
- Re-use of the tyre will increase.
- Re-moulding of the tyre will increase.
- The practice they are following to minimize the issue are right or not.
- Mechanic will be trained and there observation skill will be developed.
- Performance of the vehicle will increase in terms of FE.
- The study`s observation will show the working standard and accuracy of the working practices of the dealer`s mechanic or the owner`s mechanic.

VIII. ACKNOWLEDGMENT

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REFERENCES

[1] Harper, Douglas. "tyre". Online Etymology Dictionary. Peters, Pam (2004). The Cambridge Guide to English Usage. Cambridge University Press. p. 553. ISBN 978-0-521-62181-6.

[2] Chisholm, Hugh, ed. (1911). Encyclopadia Britannica, vol. 26. Encyclopædia Britannica. p. 1007.

[3] Fowler, H. W. (2009). David Crystal, ed. A Dictionary of Modern English Usage: The Classic First Edition. Oxford University Press. p. 655. ISBN 978-0-19-953534-7. Retrieved 2010-10-23.

[4] Bertman, Stephen (2005). p.35 Handbook to Life in Ancient Mesopotamia Check |url= value (help). Oxford University Press. Retrieved 2 August 2014.

[5] Dunlop, John Boyd (2008). Hutchinson Dictionary of Scientific Biography. AccessScience. Retrieved 9 July 2009.

[6] Werner Obrecht, Jean-Pierre Lambert, Michael Happ, Christiane Oppenheimer-Stix, John Dunn and Ralf Krüger "Rubber, 4.

[7] Emulsion Rubbers" in Ullmann's Encyclopedia of Industrial Chemistry, 2012, Wiley-VCH, Weinheim. doi:10.1002/14356007.o23_o01

[8] http://www.michelinag.com/Innovating/Radial-vs.-Bias-technology

[9] http://www.jags.org/TechInfo/2001/05May01/tyres/historyoftyres.htm

[10] Samuel K. Clark, V. E. Gough (1981). Mechanics of Pneumatic Tyres. U.S. Department of Transportation. p. 245. Consider two mechanisms of force transmission acting in parallel.

[11] Ashok Leyland www.ashokleyland.com

[12] Voltas Limited, www.voltas.com