

# Contact stress Analysis of Tyre and Mild Steel Plate

K. Viswanath Allamraju, Deepak Rajan



**Abstract:** In this paper presented contact stress of tyre and mild steel, which includes history of tyres, classification of tyres and heat dissipation. Tyres play very important role in carrying the loads from one place to another place.

**Index Terms:** Contact stress, Mild steel, Tyre , Analysis.

## I. INTRODUCTION

Nowadays every person has a driven car. Tyre is one of the important part of a car. In early days, wheels are made by stone or wood and further due to the growing intelligence of humans, it has developed to rubber technology. Comparing the wheels and nowadays tyres there is a lot of difference between them. In the middle of 19th century, pneumatic tyres were introduced. Then pneumatic tyres for automobiles were introduced. The Japanese rubber industry started at the time of which the tyre industry started developing. Effects such as cushioning effect and the clearance effect is given to a vehicle due to tyres. It is a ring shaped component and used in automobile, bicycle, motorcycle.

The four functions of a tyre is as followed:

1. Bearing a load (support)
2. Acting as a spring (absorption),
3. Conveying driving and braking forces (transmission),
4. Facilitating steering of the vehicle (turning).

## II. BEGINNING OF A WHEEL



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**Fig.1 Wooden wheel**

The origin of tyres began 4,000 years ago which was unclear. By the using these wheels at least it came to known that

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rolling results in very less friction comparing sliding results. The first wheel(fig.1) is made up of slides of log later it was replaced by several planks joined together. Then it is followed by spoked wheels. Before automobile came into existence wagons were the important means of transportation. It has hubs of evergreen oak these were supported by spokes. Then it is encircled by a rim, while the outside consists of the iron band to prevent wear and tear from contact with the ground and it could truly be called as a tyre [1].

## III. INTRODUCING TYRE

At beginning stage vehicles used to have iron or wooden wheels. But pull of these vehicles were difficult on roads that has rough surfaces. So, these tyres at the early stage made peculiar for many inventors to overcome this problem. The solid tyre which is called now, were with so many attempts to give tyres a greater elasticity. This solid tyre is wholly made up of rubber which has no air inside(Fig.2). It was invented at the year of 1835. Gasoline engine was the first automobile engine built a by German company named Daimler-Benz at the year1886 [1].



**Fig. 2: Replica of Benz-Motorwagen**

The pneumatic tyre was first invented by R.W Thomson in the year 1845. Pneumatic tyre is a tyre which is inflated with air. It works as the same principle as the tyres of today. This tyre was elastic body around the wheel which reduced the running resistance and noise level thereby increasing riding comfort. However, it was not very effective by the invention of actual tyre by Dunlop in 1888.



**Fig.3: Dunlop Pneumatic tyre.**

Materials used for Pneumatic tyre:

The modern Pneumatic tyres mainly uses two materials namely cords and elastomers.

Cords: It forms a ply and also a bead which provides a tensile strength. It necessary to contain inflation pressure. It also consists of materials like steal, cotton, silk, nylon.

Elastomer: It forms the tread and encases the cords for the protection from abrasion It holds them in place. It is the main feature of design of the pneumatic tyre. Elastomers are de composed of various composites that are of rubber material. The main common is the styrene-butadiene copolymer with the mixing of other chemical compound such as carbon black and silica.

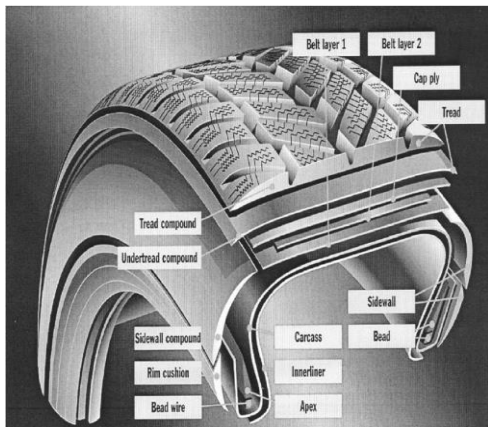


Fig. 4: Pneumatic tyre. [2]

Advantages:

1. More comfort.
2. Improve safety.
3. Puncture can be repaired easily.
4. Simple assembly.
5. Longer tread life.

Disadvantages:

1. Instability during cornering.
2. At low speed that causes heavier steering.
3. At low speed that doesn't give any comfortable ride

#### IV. NON-PNEUMATIC TYRES

These are the tyres which are not inflated with air. These are generally called as airless tyres. These provide a very high rolling friction and much less suspension though it is similarly shaped and sized as pneumatic tyre. These tyres are compressed with polymers rather than air, which is shown in Fig.5



Fig. 5 : Non Pneumatic tyre.

Advantages:

1. No air valves.
2. No air compressions.
3. Can be used for long drives.

4. More safety.
5. More comfortable.

Disadvantages:

1. Lack of adjustability.
2. More expensive.
3. Replacement of any component is impossible.

Types of tyres:

Generally, the tyres are of two types. They are tube tyre and tubeless tyre

Tube tyre(Fig.6): It is a conventional tyre. It consists of tube filled with air. The tyre is manufactured by vulcanization process to obtain desired properties.



Fig.6: Tube tyre

Tubeless tyre(Fig 7):It is an advanced version of a tube tyre. It doesn't have a tube inside which specifies the difference between a tube tyre and a tubeless tyre. They are lighter.It runs cooler comparing a tube tyre [3].



Fig. 7: Tubeless tyre

#### V. CLASSIFICATION OF TYRES

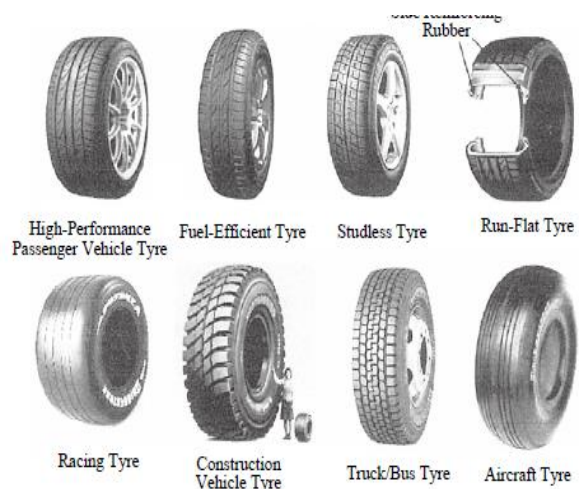
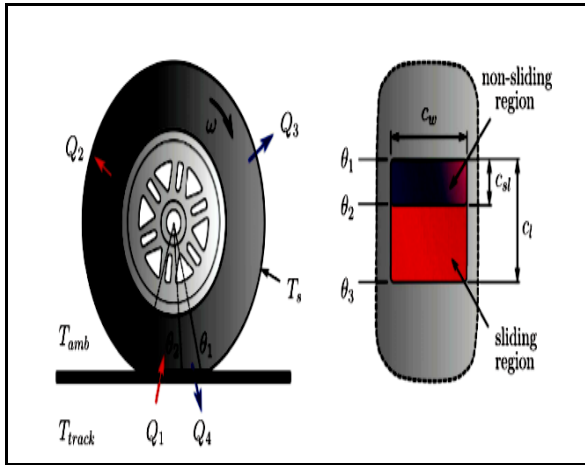


Fig. 8: Classification of Tyres



**Fig. 9: Dominant heat flow analysis**

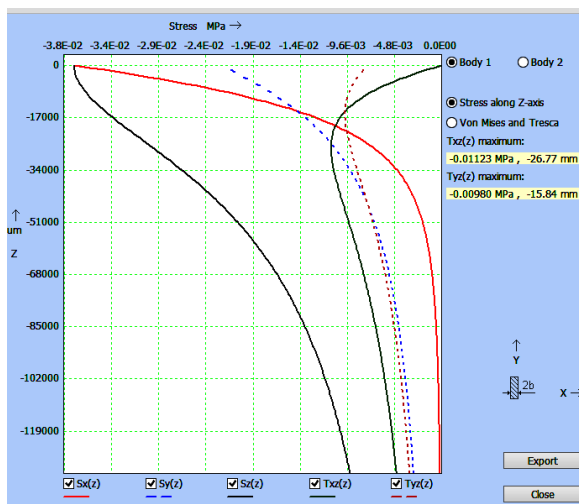
Various levels of traction are formed by the classification of tyre on different wheels. It is dangerous when driving at a high speed at a slippery roads or uneven roads that are not mended or newly tarred. Similarly, this can be suggested in such a way that almost all types of tyres used by all similar mediums of vehicles to use tyres of same brand, size and similar thread patterns that provides balance to vehicles in terms of dynamic properties [4]. Tyre model thermodynamically. The heat flux through mass of isotropic thermal tyre describes the lumped parameter model used by the tyre surface temperature through thermal behaviour. The dominant heat flows considered through the analysis are:

- (i) Q1 –heat generation of contact patch in the sliding region
- (ii) Q2 –heat generation because of tyre carcass deflection [5].

**Scrap tyres:**

Tyres are composed of many components. The main component is the vulcanised rubber. In addition to that is the rubberised fabric that contains reinforcing textile cords and steel. Also contains steel wires reinforcing beads and fabric belts. A number of synthetic and different natural tyres and also the rubber formulation which are used to produce tyres. For slow thermal conversion of scrap tyre, the best suitable technology is the ‘batch reactor’. For product distribution. It is by increasing of the gas and volatile fraction yield by the aromatization [7].

**Contact stress analysis :**



**Fig.10 Contact stress on Tyre (Body1)**

Youngs modulus of steel is considered as 0.001 GPa, Poisons ratio is 0.3, Maximum stress is 12 MPa. E for mild steel is 200 GPa, Poisons ratio is 0.3 and maximum stress is 400 MPa. The contact stress is observed as 0.03741 MPa between tyre and mild steel is shown in figure 10.

**VI. CONCLUSION**

Tyre industry is working on technologies and a vital role on the production by industrial infrastructure and economic growth are many external factors for the demand of tyres, due to this vehicle manufacturing segment as on overall economic growth which in turn have been dependent by the tyre industry. The contact stress analysis plays key role for designing of tyres at various contact environments.

**REFERENCES**

1. By Yasuhiro Ishikawa, Systematic Review of Tyre Technology, vol:16, 2011.
2. By Mir Hamid Reza Ghoreishy, A State of the Art Review of the Finite Element Modelling of Rolling Tyres, vol 17, issue:8, 2008.
3. By Pranav A. Rangdale1 , Kumar R. Chandak 2 , Prof. Ganesh M. Bagade3, Non Pneumatic tyre, February, 2018.
4. By Brajesh Loya, Different types of tyres used under different operating conditions, vol:3, 2016.
5. By A. J. Tremlett & D. J. N. Limebeer, Optimal tyre usage for a Formula One car, vol:54, 2016.
6. By BoLi, ShaoyiBei, and JingboZhao, Research Method of Tyre Contact Characteristics Based on Modal Analysis, 2017.
7. By Martin Bajus, Natália Olahová, Thermal conversion of scrap tyre, vol 53, issue:2, 2011.

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**K Viswanath Allamraju**, completed his M-Tech from **MANIT Bhopal** and PhD from **NIT Warangal**. His research areas are finite element method, neural networks, material characterization of metals and composite materials, vibration analysis and machine design. He has published more than 50 articles in various International journals (Scopus indexed). He had participated 60 International conferences at various IITs and IISC.



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