International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 01 | Jan 2020 www.irjet.net p-ISSN: 2395-0072

THE EFFECTVOF TYREOVER LOAD AND INFLATION PRESSURE ON THE ROLLING LOSS AND FUEL CONSUMPTION

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Abstract : Impact of type over-burden and fuel utilization of car vehicles is an ever significant property for the tire and car ventures in light of its handy ramifications. The tire moves under a heap, it twists. The heap pushes down on the tire and squashes it against the street. As the tire kills, the squashed part falls off the street and comes back to its unique shape while another piece of the tire gets squashed. The sidewalls of the tire flex again and again, near 500 times each moment at interstate rates. Furthermore, the track goes from a roundabout to a level shape and back to round again there are some down to earth things that can decrease twisting and warmth. Swelling pressure has an impact. Underinflated tires twist significantly more, get a lot more smoking, and cut mileage. So appropriately expanded tires spare fuel by decreasing moving opposition.

Fuel utilization and tire moving misfortune in a wide range of vehicles have become progressively significant in view of unfriendly natural impacts and monetary expenses. On the off chance that moving obstruction is diminished as a result of better tire upkeep, shoppers may wind up spending less on tires, in light of the fact that appropriately swelled tires will have longer wear notwithstanding giving better mileage. In this proposition, the impact of moving opposition on fuel utilization of spiral traveler and truck tires is examined. A potential technique for streamlining fuel use by changing the tire load/pressure Conditions will be recommended. Every one of these evaluations will be acquired for outspread tires. Limited component investigation is done on the tire by applying tire burden and swelling pressure. The examinations are made on two tire models of vehicle autos Skoda Rapid and Ford Classic. Demonstrating is done in Star/Engineer and examination is done in Ansys.

Key Words: Ansys, Rolling loss or rolling resistance, Pro/Engineer, Tyre.

1 .INTRODUCTION

The pneumatic tire assumes an inexorably significant job in the vehicle execution of street. Notwithstanding, this status is accomplished on account of more than one hundred years' tire advancement since the underlying innovation of the pneumatic tire by John Boyd Dunlop around 1888. Tires are required to create the powers important to control the vehicle. As we realize that the tire is the main methods for contact between the street and the vehicle yet they are at the core of vehicle taking care of and execution (Nicholas, 2004). The expanded elastic structure gives agreeable ride to transportation. With the developing interest for the pneumatic tire, numerous enhancements have been made dependent on the underlying origination, for example, the fortification lines, the dots, the vulcanization, the materials and the presentation of the tubeless tire. The connection among human and tire and ecological encompassing assume a significant job for creating of tire innovation. These worries incorporate car crashes brought about by tire disappointment, the misuse of vitality because of terrible tire conditions, the contamination through the discharge of destructive mixes by tires, and the corruption of street surfaces identified with tire execution, etc.Tyre as one of the most significant parts of vehicles requires to satisfy an essential arrangement of capacities are to give load-conveying limit, to give padding and hosing against the street surface, to transmit driving and braking torque, to give cornering power, to give dimensional solidness, to oppose scraped spot (Mir Hamid, 2008). Tires have capacity to oppose the longitudinal, sidelong, and vertical response powers from the street surface without extreme twisting or disappointment. Tire execution is relies upon the tire moving obstruction, cornering properties, tire footing, tire wear, tire temperature, tire commotion, tire taking care of and qualities, and so forth. There are different misfortunes related with the vehicle that influence its efficiency as it is being worked. These misfortunes incorporate motor, driveline, streamlined and moving misfortunes, while the moving misfortune is related with the vehicle tires.

Tire as one of the most significant segments of vehicles requires to satisfy a key arrangement of capacities are to give load-conveying limit, to give padding and hosing against the street surface, to transmit driving and braking torque, to give cornering power, to give dimensional security, to oppose scraped spot. Tires have capacity to oppose the longitudinal, horizontal, and vertical response powers from the street surface without serious disfigurement or disappointment. Tire execution is relies upon the tire moving opposition, cornering properties, tire footing, tire wear, tire temperature, tire clamor, tire taking care of and attributes, and so on. There are different misfortunes related with the vehicle that influence its efficiency as it is being worked. These misfortunes incorporate motor, driveline, streamlined and moving misfortunes, while the moving misfortune is related with the vehicle tires.

1.1. TYRE AXIS TERMINOLOGY

It is have to see a portion of the fundamental phrasing for tire, particularly in regards to the frameworks of directions, directions, speeds, powers, minutes. Terminology and definitions dependent on the SAE standard as appeared in Figure 1 X-hub is the crossing point of the wheel plane and the street plane with positive heading forward. The Z-hub opposite to the street plane with positive heading descending. The Y-hub in the street plane, its course being picked to make the pivot framework symmetrical and right hand. There are a few powers, minutes and points that end up being significant in tire conduct. Every one of these powers can be viewed as the powers and minutes following up on the tire from the street. To begin with, there are two primary points to consider, the camber edge and the slip edge. The camber point is the tendency edge from its vertical position while the slip edge is the distinction in wheel heading and course.

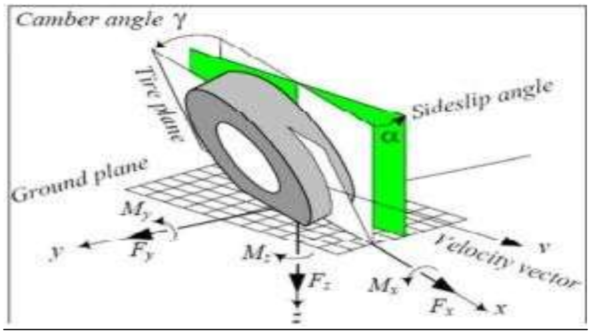

Figure 1.Tyre Axis Terminology

Fig 1.2: Inflation pressure of Tyre

INTRODUCTION TO PRO/ENGINEER

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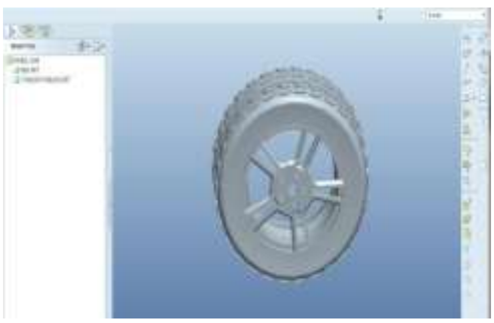


fig.1.3.3D models of tyre and rim assembly

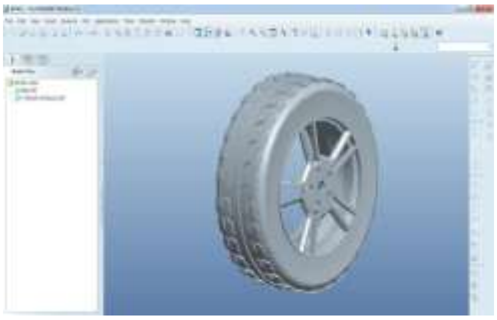
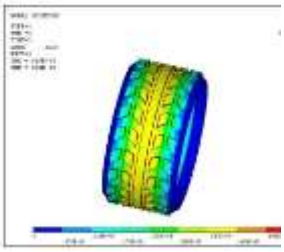
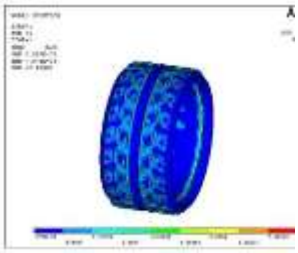
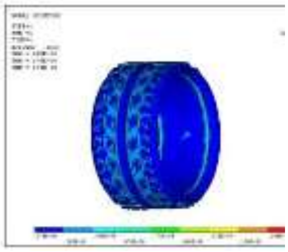


Figure 1.4.Assembly of Skoda

STRUCTURAL ANALYSIS OF SKODA TYRE



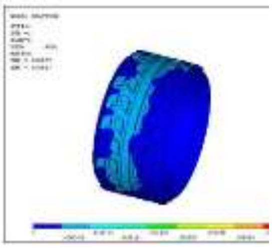


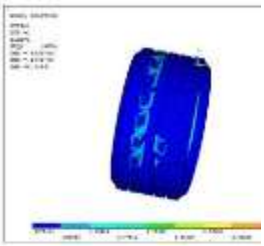


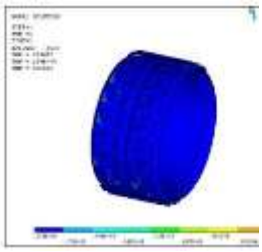
4.1.1 Car weight + 5 persons weight (at pressure 1.116 n/mm2)

Figure 5. Displacement Figure 6. Stress Figure

Strain

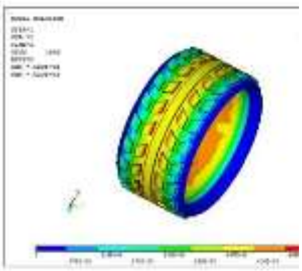


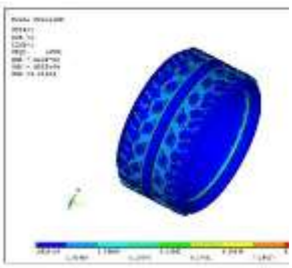


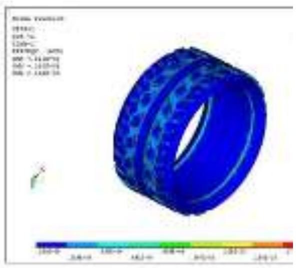


Car weight + 6 persons weight (pressure - 1.118n/mm2)

Figure 7. Displacement Figure 8. Stress Figure 9. Strain



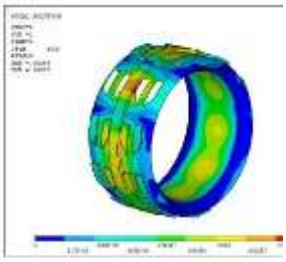
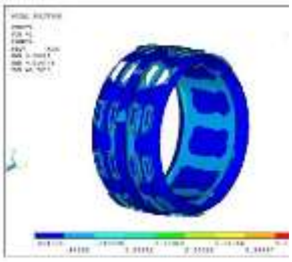
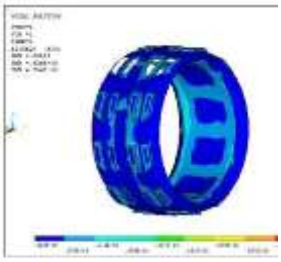




4.1.2 Car weight + 7 persons weight (at 1.214 pressure)

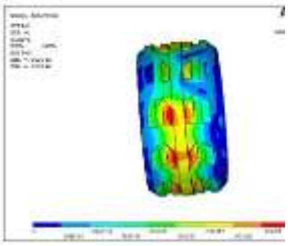
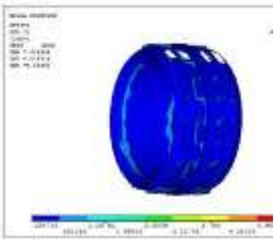
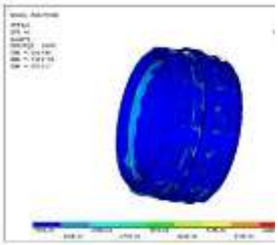
Figure 10. Displacement Figure 11. Stress Figure 12. Strain

STRUCTURAL ANALYSIS OF FORD TYRE

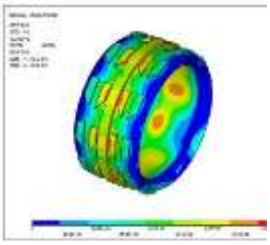
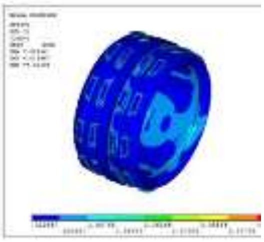
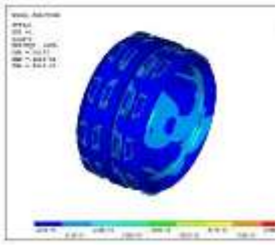
4.2.1 Car weight + 5 persons weight (pressure at 0.6211)

Figure 13. Displacement Figure 14. Stress Figure 15. Strain

4.2.2 Car weight + 6 persons weight(at pressure 0.65 n/mm^2)

Figure 16. Displacement Figure 17. Stress Figure 18. Strain

4.2.3 Car weight + 7 persons weight (at pressure 0.6790 n/mm^2)

Figure 19. Displacement Figure 20. Stress Figure 21. Strain

Calculation:

Aspect ratio(a)=$\frac{setion\ height}{section\ width}$ ×100

Section height = $\frac{od-id}{2}$

=$\frac{13.6620}{2}$=6.831

Width =OD-ID

=63.6620-50

=13.6620mm

Inflation pressure;

P=$\frac{3p}{2\pi a^2}\sqrt{1-(\frac{r}{a})^2}$

=$\frac{3\times 250}{2\times 3.14(50*50)}\sqrt{1-(\frac{31.83}{50})^2}$

=.04777070064×0.7711941649

=0.0368404N/mm^2

CALCULATION FOR FUEL CONSUMPTION WITH RESPECT TO INFLATION PRESSURE:

R=rolling resistance

W=tire load

P=Inflation pressure

R=$\frac{energy\ input\ into\ a\ type-energy\ output\ by\ tire}{speed}$

R=$\frac{Energy\ lost\ in\ tire}{speed}$

General equation for Rolling resistance in terms of tore load(W) at a constant inflation pressure is

R=$\frac{nWa}{A}(W) = c_1$W

Where h=Hysteresis ratio

W=foot print width

D=deflection

A=Area

W=Weight(N)

Here c_1 is the constant.the main slope $c_1$was found to be 0.010 and 0.0078 for truck and passenger respectively.

Rolling resistance for considered loads

Skoda rapid Ford classic

(kerb wt-1500kg) (kerb wt-1150kg)

1.1850kg 1500kg

2.1920kg 1570kg

3.1990kg 1640kg

Skoda rapid

R=1850*0.0078*9.81 =141.55N

R=1920*0.0078*9.81 =146.99N

R=1850*0.0078*9.81 =152.27N

Ford classic

R=1500*0.0078*9.81 =114.77N

R=1570*0.0078*9.81 =120.13N

R=1640*0.0078*9.81 =125.48N

A general relation between R and P can be expressed as

$$R = c_1 \frac{1}{p^{0.5}}$$

Where

P=inflation pressure

$$\frac{hWd}{A}(W)$$

$$R = c_1 \frac{1}{p^{0.5}}$$

On substituting the values in above equation

$$R = (0.0078) * \frac{1}{(0.036)^{0.5}}$$

R=0.0411N

By observing the above calculations, with the increase of weight, the rolling resistance increases, the fuel consumption also increases. Applying Schuring's rolling resistance versus fuel consumption result, it can be concluded that a 100% increase in rolling resistance of a tire would cause about

25-30% increase in fuel consumption.

Skoda Rapid

R=1850*0.0078*9.81=141.55N

R=1920*0.0078*9.81=146.9N

By increasing Rolling resistance from 114.77N to 120.13N the fuel consumption increased by 1.33%

R=1500*0.0078*9.81=114.77N

R=1640*0.0078*9.81=125.48N

By increasing a rolling resistance from 114.77N to 125.48N, the fuel consumption increased by 2.56%

THE PRESSURES CONSIDERED FOR ANALYSIS

Skoda Rapid (kerb wt-1500)

1. 5 persons weight each 70kgs (350) + kerb weight=1850kg

   P= $\frac{l}{a}$ =1.116N/mm^2 (a=1657.7mm^2)

2. 6 persons each of 70kgs (420) = kerb weight=1920kg

$P=\frac{l}{a}=1.118N/mm^2$ ($a=1717.35mm^2$)

3. 7 persons each of 70kgs (490) = kerb weight = 1990kg

$P=\frac{l}{a}=1.214N/mm^2$ ($a=1639.20mm^2$)

Ford classic (kerb wt-1150kg)

1. 5 persons each of 70kgs (350) + kerb weight = 1500kg

$P=\frac{l}{a}=0.621N/mm^2$ ($a=2415.07mm^2$)

By observing the above calculations, with the increase of weight, the rolling resistance increases, the fuel consumption also increases. Applying Schuring's rolling resistance versus fuel consumption result, it can be concluded that a 100% increase in rolling resistance of a tire would cause about

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1. 5 persons each of 70kgs (350) + kerb weight = 1500kg

$P=\frac{l}{a}=0.621N/mm^2$ ($a=2415.07mm^2$)

MATERIAL PROPERTIES OF RUBBER

Physical Properties	Metric

Density	1.34 - 1.60 g/cc
Water Absorption	0.155 - 0.920 %
Linear Mold Shrinkage	0.00110 - 0.00790 cm/cm
Mechanical Properties	Metric
Hardness, Rockwell E	43.0 - 76.0 Tensile Strength
Ultimate	34.0 - 74.0MPa
Elongation at Break	0.730 - 1.47 %
Modulus of Elasticity	4.50 - 9.60Gpa
Flexural Yield Strength	56.0 - 115Mpa
Flexural Modulus	3.60 - 8.90Gpa
Compressive Yield Strength	82.0 - 157Mpa
Izod Impact, Notched	0.233 - 0.470 J/cm
Charpy Impact, Notched	0.281 - 0.450 J/cm²
Electrical Properties	Metric
Electrical Resistivity	2.00e+11 - 6.40e+11 ohm-cm
Dielectric Constant	4.50 - 5.80
Dielectric Strength	10.5 - 13.2 kV/mm
Dissipation Factor	0.0770 - 0.0830
Arc Resistance	67.0 - 135 sec
Comparative Tracking Index	150 - 175 V
Thermal Properties	Metric

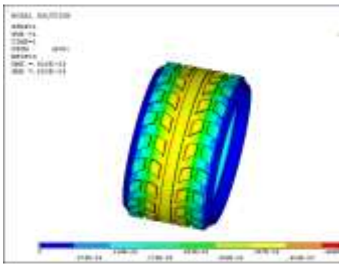
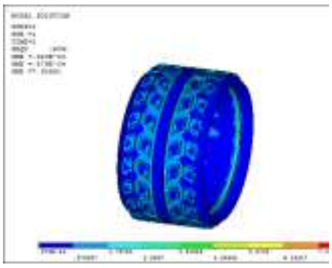
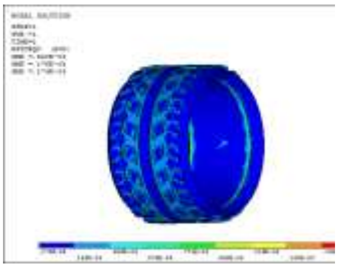
CTE, linear 53.0 - 53.0 µm/m-°C @Temperature 40.0 - 130 °C

Thermal Conductivity 0.440 - 0.440 W/m-K @Temperature 100 - 100 °C

Maximum Service Temperature, Air 92.0 - 244 °C

Deflection Temperature at 1.8 MPa (264 psi) 136 - 241 °C

SKODA TYRE: Meshed model

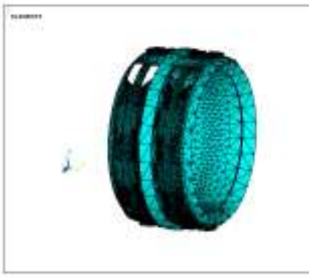
At pressure 1.116N/mm²

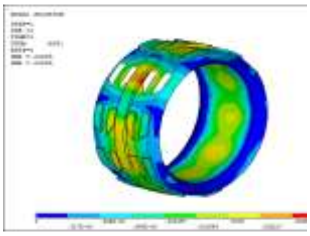
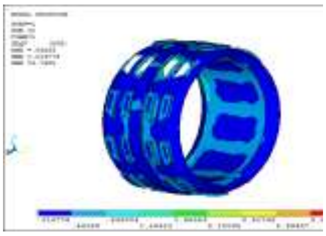
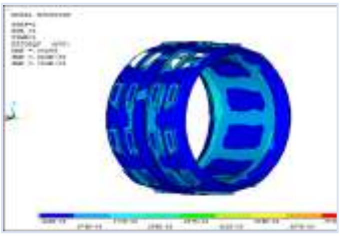
Displacement Stress Strain

We At Present case have calculated Displacement, Stress, Strain at Pressures 1.118 N/mm², 1.214 N/mm² shown in Results Table.

FORD TYRE:

Meshed model



Pressure At 0.621N/mm²

Displacement Stress Strain

We At Present case have calculated Displacement, Stress, Strain at Pressures 0.650 N/mm², 0.6790 N/mm² shown in Results

Table. ANSYS RESULTS:

SKODA TYRE

Pressure (N/mm²)	Displacement (mm)	Stress(N/mm²)	Strain
At 1.116	0.520e-03	7.90991	174e-02
At 1.118	0.003657	8.33431	0.001615
At 1.214	0.520e-03	9.31402	0.192e-03
Inflation pressure(0.036)	0.130e-04	0.160046	0.325e-05

FORD TYRE

Pressure (N/mm^2)	Displacement (mm)	Stress(N/mm^2)	Strain
At 0.6211	0.00285	3.7688	0.754e-03
At 0.650	0.002346	5.58364	0.001117
At 0.6790	0.00256	4.62169	0.954e-03
Inflation pressure(0.036)	0.739e-03	0.510433	0.112e-03

RESULTS TABLE

Skoda tyre

Pressure (N/mm^2)	Displacement (mm)	Stress(N/mm^2)	Strain
At 1.116	0.520e-03	7.90991	174e-02
At 1.181	0.003657	8.33431	0.001615
At 1.214	0.520e-03	9.31402	0.192e-03
Inflation pressure(0.036)	0.130e-04	0.160046	0.325e-05

Table 1.Results of skoda tyre

Ford tyre

Pressure (N/mm^2)	Displacement (mm)	Stress(N/mm^2)	Strain
At 0.6211	0.00285	3.7688	0.754e-03
At 0.650	0.002346	5.58364	0.001117
At 0.6790	0.00256	4.62169	0.954e-03
Inflation pressure(0.036)	0.739e-03	0.510433	0.112e-03

Table 2.Results of ford tyre

CONCLUSIONS

In this theory, the impact of tire over burden and swelling pressure on the moving misfortune and fuel utilization is broke down. The examinations are made on two models of tire Skoda Rapid and Ford Classic. The examination is finished by applying the heaps of vehicle weight and people weight. At the point when the vehicle is over-burden, additionally examination is finished. Examination is finished by applying expansion pressure. The material utilized for tire is rubber.Modeling is done in Pro/Engineer and examination is done in Ansys.

The investigation is finished by applying the vehicle weight + 5 people weight, over-burdening the tire, that is, vehicle weight + 6 people weight and vehicle weight + 7 people weight. The examination is additionally done by applying the swelling pressure.

By watching the examination results, the anxieties delivered are not exactly the yield quality estimation of elastic even the tire is over-burden. The moving misfortune will be more for over-burdening than the predefined load and the fuel utilization will likewise be more. A potential strategy for advancing fuel utilization by changing tire working burden/pressure conditions is proposed. Expanding tire pressure is a helpful and economical strategy for halfway or completely making up for moving obstruction increment. Some fuel sparing may be practiced by this technique.

By contrasting the outcomes passage great tire is best which is getting less pressure esteems contrasted with Skoda tire on account of over-burden condition and the fuel utilization additionally more for Skoda contrasted with portage exemplary.

By the results the following Observations are made:

1. The more pressure is created when the vehicle is over stacked.
2. The moving misfortune additionally expanded by over stacking.

3. The burdens are delivered more than the material yield quality on account of over stacked condition.

4. If the moving misfortune expanded the weight on the tire likewise expanded all the while the heap on the motor will be more with this impact the fuel utilization will be more.

5. From the above perceptions we are inferring that by the over heap of the tire the fuel utilization is more and swelling of moving misfortune additionally increments.

6. In the instance of over-burdening condition likewise passage stress esteems are less contrasted with Skoda so we are presuming that portage tires are superior to Skoda in the fuel utilization of over stacking condition.