DESIGN AND DEVELOPMENT OF AIR-LESS CAR TIRE

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ABSTRACT

In this work, models of air-less tire is constructs to simulate the loading condition. The driver mind-stress may reduce by using air-less tire in automobile field by avoiding air related problems in the tire. Mean while uniform traction and wear as possible to use air-less tire. Air-less tire, air-tire are modeled by SOLID-WORKS modeling software. Model imported from SOLID WORKS to ANSYS to simulate the static compressive loading condition. Both were analyzed through Non-Linear material model. A uniformly distributed edge load acting at the tire-rim contact region. The tire is made by rubber of the hyper-elastic property. Both tires are analyzed by the FEA. Analysis parameters of Air-less-tire are A) Max.deflection-46.8mm, B) Max. Von Mises stress-149 N/mm2, C) Max. Strain energy= 6.14 J. Analysis parameters of Air tire such as A) Max. Deflection= 46.5mm, B) Max. Von Misses stress-49 N/mm2, C) Max strain energy=6.52 J. In the air-less tire manufacturing point of view, material saving is obtained by replacing outer band only after tread wear. The results from analysis can be replaced the air tire by Air-less tire of following parameters. Air-less tire is provide the deflection (46.8mm) nearly same the air tire deflection (46.5mm). Von-Mises Stress of air-less tire and Air tire are within allowable limit. Air-less tire is store adequate Strain energy.

KEYWORDS: *Air-less car tire; Design; Finite element analysis; Stress; Deflection; Strain EnergyI*

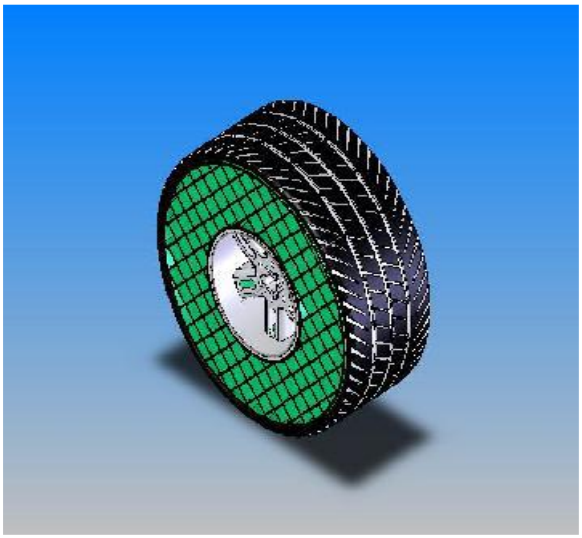
I. INTRODUCTION

Tire is one of the important engineering parts in Automobile. Consider engine and tire, engine is the high cost. If engine or tires are failure, can't run the vehicle. Tire is failure that idling the engine. So that low cost tire failure to initiate the high cost engine idle. Thus overcome this to develop air-less tire. Car used for handling passengers and goods. Tire consists of layers of the various rubber compounds of varying thickness to form a composite structure. Steel rings are also used as reinforcing components in tires. In order to improve design of tires, it is necessary to be able to predict the mechanical behavior of the tire under applied load. Also stress-strain distribution and deflection developed should be Analysis. Finite element analysis (FEA) is a powerful and economical method that has been used widely for engineering design purpose. The air-less tire being modeled constitutes of rubber based outer band and flexible band with different properties and steel wires (2) and Air tire consists of tread, belt, carcass, air filled volume by solid works(1),(4),(5). This project is to design and development of air-less tire of car. Safe and stress free drive are to be provided in cars by air is to be eliminated. Tube and tubeless tires are facing many problems like puncture, bursting, etc. Air is to be eliminated in the tire and provide good traction, cushion effect. Load carrying capacity, deflection, stress of tire is to be analyzed by non-linear approach (3).The tire made entirely with the rubber of the same hyper-elastic property.

II. MODELLING

A 3-D Air-less tire model was constructed using solid works .An air-less tire (a) being modeled constitutes of rubber based outer band(block) and flexible inner band(green) with different properties and steel wires(2), Air tire consists of tread, belt, carcass and air filled volume. The tire model refers

to the geometrical structure of Car Tyres, 55 series-205/55 R16 H91 tire (1),(5).Both tire are as shown in fig.2.1



(a)

(b)

Figure: 2.1 3D models of (a) air-less tire (b) air tire.

III. LOAD AND BOUNDARY CONDITION

a) Air-less tire:

Air-less tire consists of layers of the inner band, outer band to form a composite structure. Steel rings are also used as reinforcing components in Air-less tire. Tires usually face the major problems of failure due to heat build-up and riding comfort. In order to improve design of Air-less tire, it is necessary to be able to predict the mechanical behavior of the tire under applied load. Also stress and strain energy distribution developed should be analyzed. The validation of FE prediction against air tire results was undertaken. The distribution of strain energy and deflection under loading was also carried out using FE analysis. Road and tread were held contact boundary condition not fixed. Vertical loading on the wheel through the application of a uniformly distributed edge load at the tire-rim contact region (2). The all tire part are mashed by using the solid Tetrahedral elements. Road is meshed by brick element as shown figure 3.1. Tread properties are E=40Mpa, density=1400 kg/m^3. Both bands consider as same material properties, and the wheel load of 6150 N is applied (3).

b) Air tire:

Tread properties are E=40Mpa ,density=1400, the belt properties are set to *E*= 55 GPa, n=0.3 and density = 7644 kg/m3; the carcass properties are selected as *E*= 794 MPa, n=0.45 and density =1390 kg/m3; the inflation pressure 2.8 bar (280MPa) and the wheel load of 6150 N is applied (3).

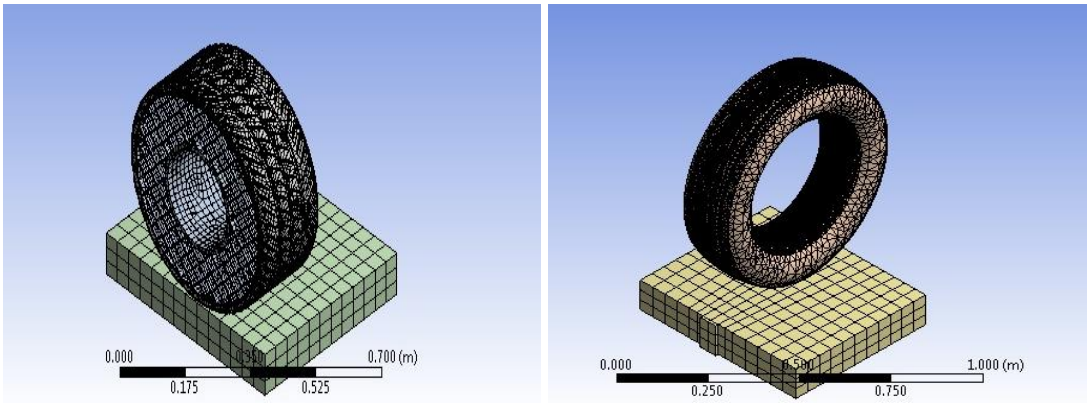


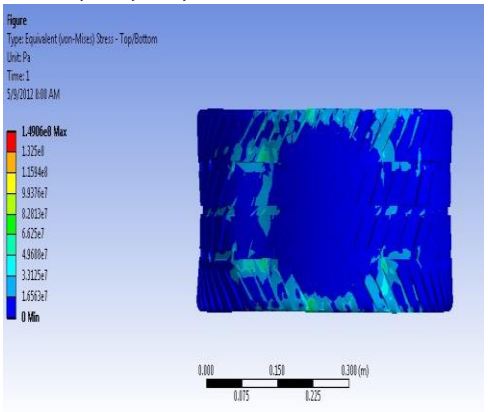
Figure 3.1 Air-less tire and air tire parts are mashed by using the solid tetrahedral elements. Road is meshed by brick element.

IV. LOAD-DEFLECTION VALIDATION OF AIR-LESS AND AIR TIRE AT FULL LOAD (6150 N)

Model the tires by using SOLID- WORK to imports ANSYS software. Road and tread were held contact boundary condition not fixed (2). Vertical loading on the wheel through the application of a uniformly distributed edge load at the tire-rim contact region. The deflection in the loading direction of the wheel center and the displacement in the lateral direction.

a) Air-less tire:

In air-less tire maximum stress =149 N/mm^2, deflection =46.8 mm, strain energy=6.1 J as shown in figures 4.1, 4.2, 4.3, and in table 4.1 has result comparison of both tires



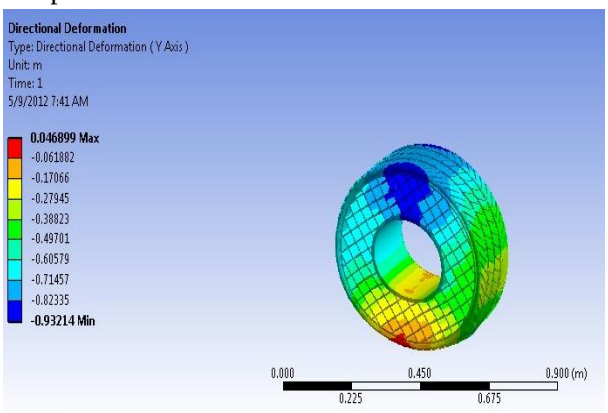


Figure 4.1 Equivalent Stress of air-less tire **Figure 4.2** Deflection of air-less tire

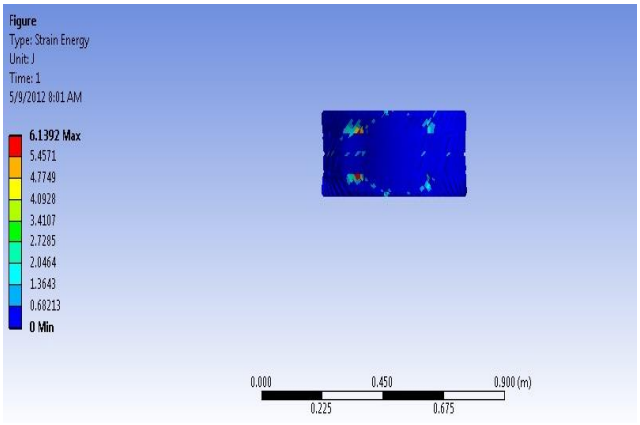


Figure 4.3 Strain energy of air-less tire

b) Air tire

In air tire maximum stress =49 N/mm^2, deflection =46.5 mm, strain energy=6.5 J as shown in figures 4.4, 4.5, 4.6, 4.7 and in table 4.1 has result comparison of both tires.

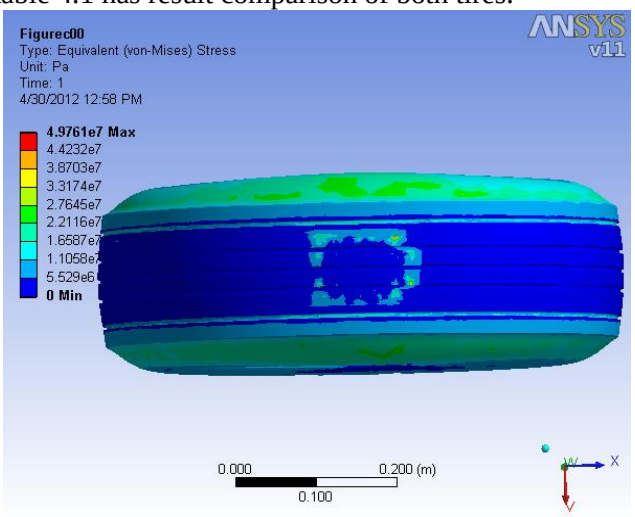


Figure 4.4 Equivalent Stress of air tire

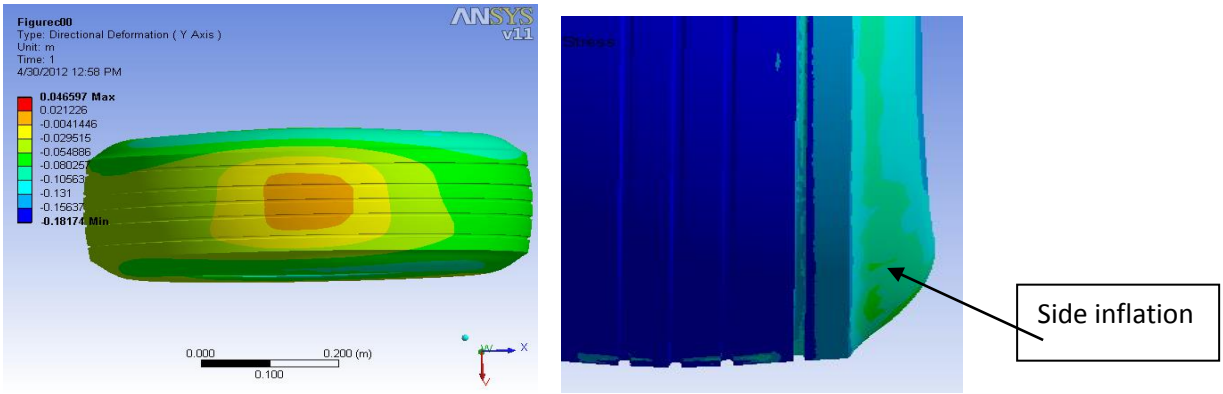


Figure 4.5 Deflection of air tir

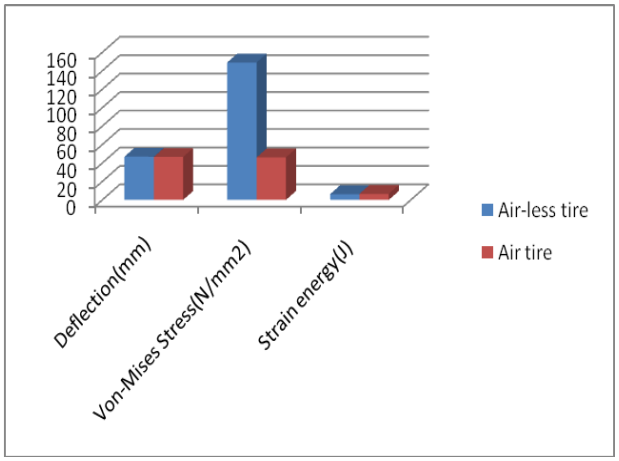


Figure 4.6 Comparison between Air less tire and Air tyre.

Table 4.1 Prediction parameters at full load (6150 N) condition of air-less and air tire.

Parameters	Air-less tire	Air tire
Deflection(mm)	46.8	46.5
Von-Mises Stress(N/mm^2)	149	49
Strain energy(J)	6.14	6.52

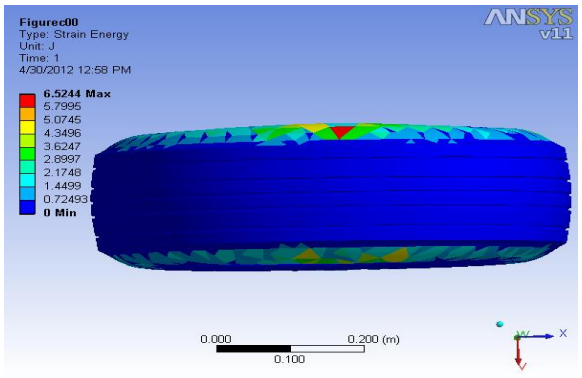


Figure 4.7 Strain energy of air tire

V. RESULT & DISCUSSION

The results from analysis can be replaced the air tire by Air-less tire. Air eliminated in the tire that provides good traction, cushion effect. Both tires are analyzed by the FEA. Analysis parameters of Air-less-tire are A) Max.deflection-46.8mm, B) Max. Von Mises stress-149 N/mm2, C) Max. Strain energy= 6.14 J. Analysis parameters of Air tire such as A) Max. Deflection= 46.5mm, B) Max. Von Misses stress-49 N/mm2, C) Max strain energy=6.52 J. In the air-less tire manufacturing point of view, material saving is obtained by replacing outer band only after tread wear. Air-less tire is providing the required deflection. The load-deflection behavior of the air-less tire and air tire were predicted at the acceptable limit. The air-less tire Von Mises stress=149 N/mm^2 (Allowable stress of reinforced rubber up to 250 N/mm^2 (12). Air-less tire is store adequate Strain energy.

VI. CONCLUSION

Design and development of air-less tire eliminates air in the tire. Air-less tire can provide uniform traction and uniform wear while absence of air. The 4 side polygon design satisfies the main functions of the tire. Air-less tire has two components that are outer band and flexible inner band. In the air-less tire design manufacturing point of view, material saving is obtained by replacing outer band only after

tread wear. The flexible inner band repeated use obtained green engineering and also reduce the environmental pollution. The driver mind-stress may reduce by using air-less tire in automobile by avoiding air related problems in the tire. The Max. deflection (46.8mm) of air-less tire provide comfortable ride by obtain required cushioning.

VII. FUTURE WORK

- To be analyze Thermal behavior
- To be analyze Vibration behavior

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