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Design & Structural Analysis of Oppressive Tweel Tyre

M. Vijay Krishna[1], Ch. Mani Kumar[2]
Asst. Professor, Mechanical Engineering, Sasi Institute of Technology & Engineering, Tadepalligudem, India [1, 2]

***Abstract*— Wheels and tyres are plays an important role in automobiles. The self weight of the vehicle and external loads of the vehicle are carried out by wheels and tyres. Wheels must be strong to support vehicle and withstand the load in normal operations. Wheels must be light as possible, which keeps the unsprung weight of the vehicle will minimum. Tyre provides the cushioning effect between vehicle and road. The stress strain analysis also very important for wheels and tyres when those are exposed the loads this paper aims to model and simulate the stress strain analysis on three different configurations of tweel tyres (Air less tyres) applications of 49050N. This paper focused on the design of a oppressive tweel tyre (OTT) based on properties of stiffness and contact pressure. The three different configuration models were designed by using Solidworks software The FEA analysis was done by using the ANSYS. Based on the results suggested best configuration of Tweel tyres for automobiles.**

***Index Terms*— Oppressive Tweel tyre, Solidworks, FEA.**

I. INTRODUCTION

In automobiles different types of wheels and tyres are used. Based on the cross section area of rim, pattern of tyre and materials will determine the performance of the vehicle.

Wheels:

Fig.1. Wheels

Two types of wheels are used. Those are spoke wheels and drum wheels.

Tyres:

Fig.2. Tyres

The following types of tyres are used.

1. Radial tyres.
2. Cross play tyres.
3. Tube less tyres
4. Air less tyres.

II. LITERATURE SURVEY

Mohammad Fazelpour et al (2013) Concluded as follows below. To increase fuel efficiency in NASA manned exploration system. They replaced elastomeric material with shear of shear band with materials which can tolerate harsh temperatures and shear loads or to replace the materials with linear elastic low hysteretic loss materials. Topologies were created such as honeycombs; new shapes like s-type meso-structures and the structural analysis were carried out of shear band of non pneumatic tyre with meso-structure was investigated through shear flexure, shear strain, and contact pressure. At the end of research they set up guidelines on custom-designing meso structures for challenging applications such as non-pneumatic tyre and passive morphing airfoils which will be addressed in future research [1].

M. Aboul-Yazid et al (2013) Examined three dissimilar structures of the Tweel, resistant technologies, and NPT by seeking yielding spoke structures. Conducted the quasi-static, 2D analysis on contact pressure, vertical tire stiffness and stress which are affected by spoke structures and shear band by creating two NPTs, a tire with a composite ring and another without composite ring. The results showed that shape and size of spokes has effect on tire behavior and the shear layer reduces the impact of the deformed spokes shape in contact pressure distribution [2].

Balawi S and et al (2008) Investigated different properties of honeycomb structure. The modeling of the effective properties of these honeycomb cores is of key importance to predict the overall mechanical response of the honeycomb structures [3].

Masters IG et al (1996) Presented a model about the elastic deformations in honeycombs. A theoretical model has been developed for predicting the elastic constraints of honeycombs based on the deformation of the honey comb cells by flexture, stretching and hinging. The oppressive tweel tyre is being designed by the following components that are mainly thread, shear band, spokes and hub. In this design we are using different spoke designs by varying its size, shape and its thickness [4].

III. DESIGN CONSIDERATIONS

a) Tyre specification

1	Hub diameter	380.2mm
2	Total diameter of the tyre	675mm

b) Tyre dimensions

Diameter of the hub= 380.2mm
Distance between the inner and outer tyre= 675mm
Base diameter= 380mm
Diameter above the base=675mm
Thickness of the shear band=50mm
Thickness of the thread=25mm

c) Modeling

The 3-D modeling was done by using Solidworks software. The proposed three different tweel tyres are shown in figures.

Fig. 3 Proposed Model of Tweel Tyre

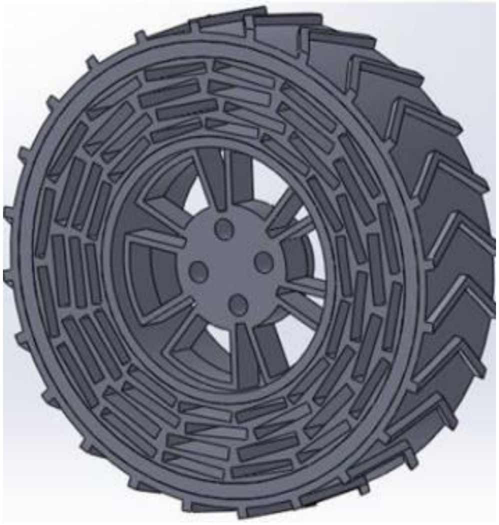

Fig.4 Proposed Model of rectangular Tweel Tyre

Fig.5 Proposed Model of bee hive Triangular-Tweel Tyre

d) Meshing

All the components was meshed by using ANSYS software

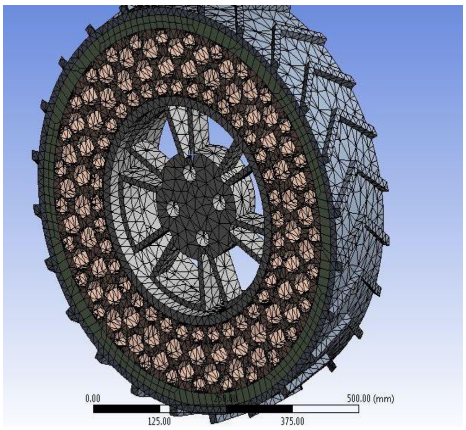

Fig.6 The proposed sample meshed (Tetrahedral element) model

e) FEM analysis

The deformation, equivalent elastic strain, equivalent stress, strain energy and shear stress are very important for air less tyres. To meet these requirements to perform structural analysis on Nitrile Rubber. The finite element analysis was carried out by using Ansys software. This analysis was performed based on the following assumptions.
The maximum load for three different models of air less tyres during applications of 49050N and minimum load is 19620N; this data is related in structural analysis for three models of tweel tyres.

f) Boundary condition

The inner surface of the wheel is completely constrained in all direction because hub of the wheel is fixed and it acts as a fixed support to the wheel. It fixed inner surface of the wheel. The surface load of 5000 N is applied in the y-direction at the outer surface of the wheel because it is the reaction force that acts upon wheel by the road and to that to the road because conduct analysis in static mode the contact area of the tyre to the road is considered.

IV. MATERIAL

a) Hub (AL7075)

1	Density in (kg/cm³)	2800
2	Young's modulus in (MPa)	7200
3	Poissons ratio	0.33
4	Tensile strength (Mpa)	220
5	Yield strength (Mpa)	95
6	Shear strength (Mpa)	150
7	Fatigue strength (Mpa)	160
8	Hardness	60
9	Elastic modulus	70-80Gpa
10	Elongation at brake	17%

b) Shear band (AISI4340)

1	Density in (kg/cm³)	7800
2	Young's modulus in (MPa)	28000
3	Poissons ratio (Mpa)	0.3
4	Tensile strength (Mpa)	75
5	Yield strength (Mpa)	470
6	Bulk modulus (Gpa)	140
7	Shear modulus (Gpa)	80
8	Elastic modulus	190-210
9	Elongation at break	22%

c) Thread (Synetthic rubber)

1	Young's modulus in (MPa)	11.9
2	Poissons ratio	0.49

d) Spokes (Nitrile rubber)

1	Density in (kg/cm³)	9500
2	Young's modulus in (MPa)	1.1e9
4	Poissons ratio	0.4
5	Tensile strength (Mpa)	≥10
6	Elongation after fracture%	≥300%
7	Max. temperature range	35/+100°c

V. Results And Discussion

Static structural analysis of three different configurations of tweel tyres ware performed. The total deformation of of bee hive, rectangular and triangular tweel tyres were 0.0002237mm, 0.0017476mm and 0.000398mm. The Von missies stress of bee hive, rectangular and triangular tweel tyres were 0.28404 Mpa, 1.42 Mpa and 0.8742 Mpa as well as the Von missies strains of bee hive, rectangular and triangular tweel tyres were 1.42, 1.13 and 7.37.

a) Structural analysis of bee hive Tweel tyre

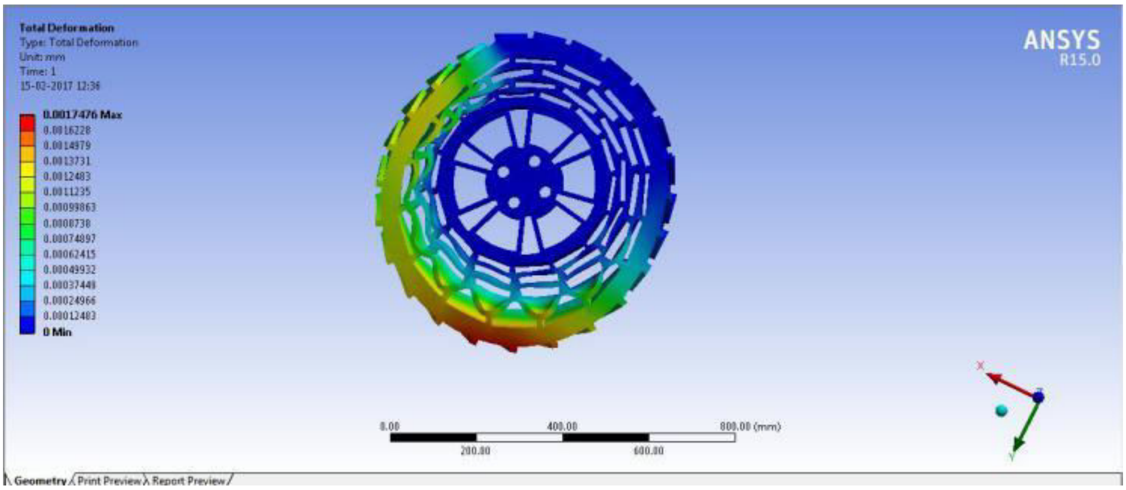

Fig.7 Total deformation of bee hive tweel tyre

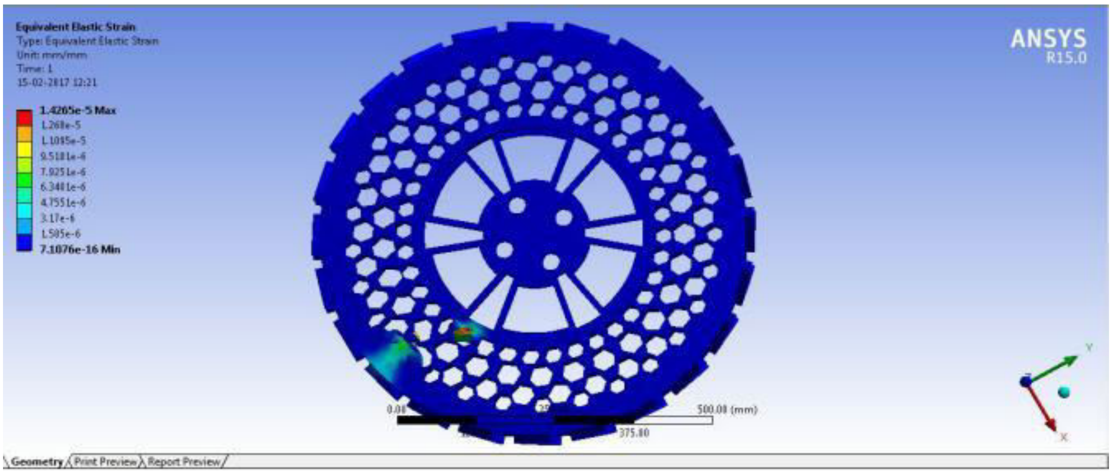

Fig.8 Equivalent elastic strain of bee hive tweel tyre

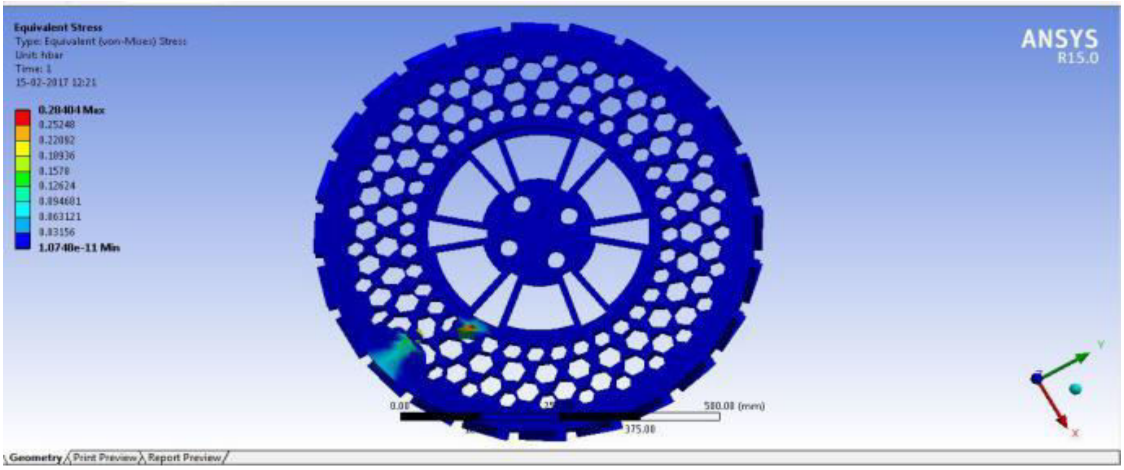

Fig.9 Equivalent stress of bee hive Tweel tyre

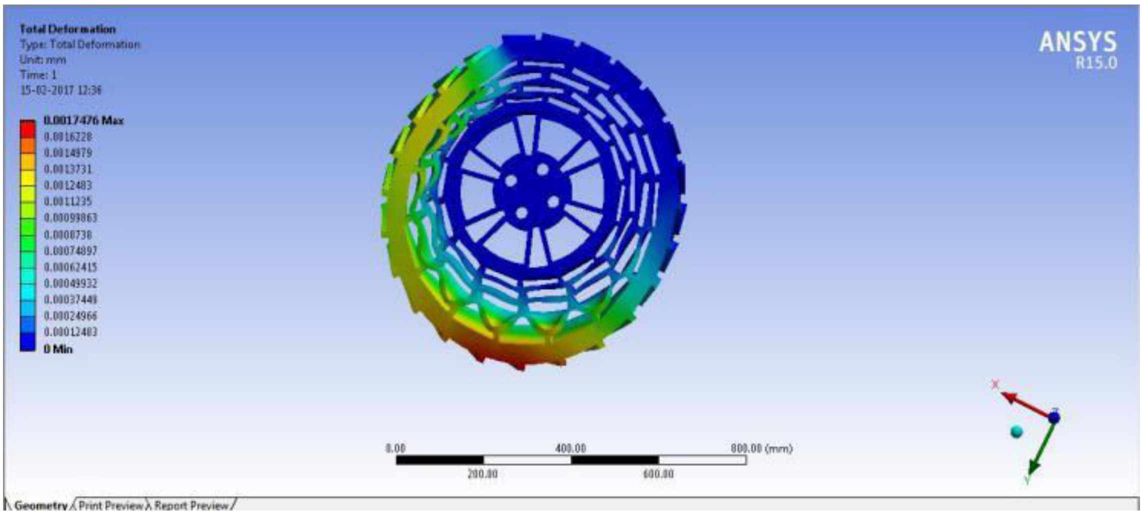

Fig.10 Total deformation of bee hive Tweel tyre

b) Structural analysis of rectangle Tweel tyre

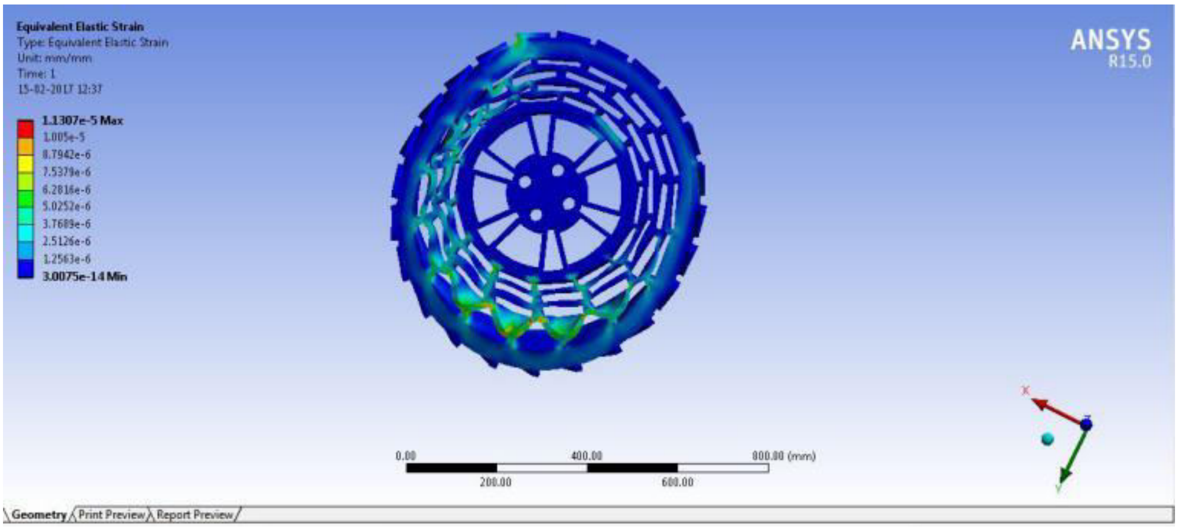

Fig.11.Equivalent elastic strain of rectangular Tweel tyre

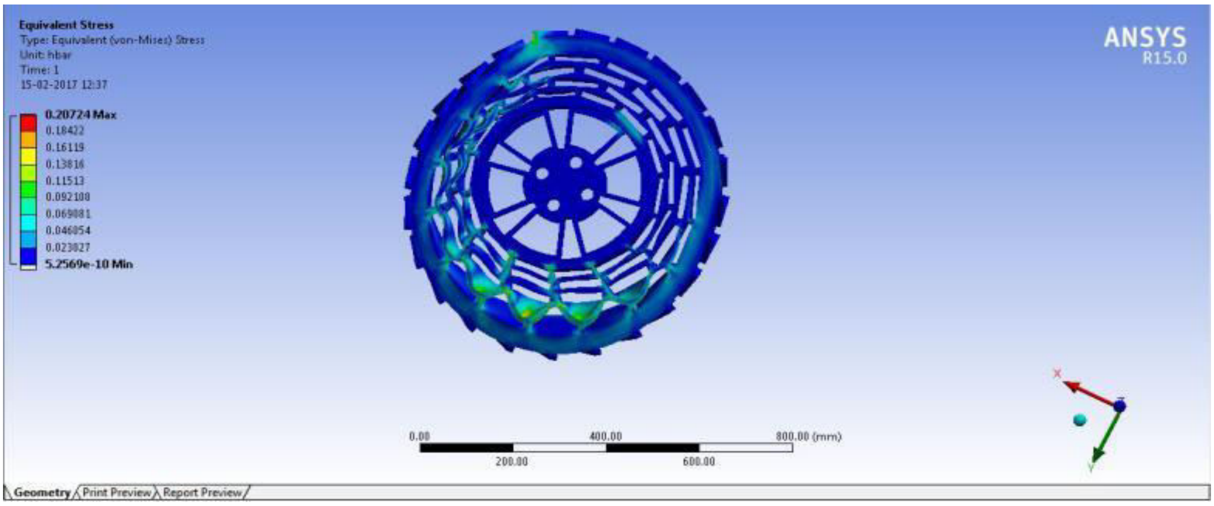

Fig.12.Equivalent stress of rectangular tweel tyre

c) Structural analysis of triangular tweel tyre

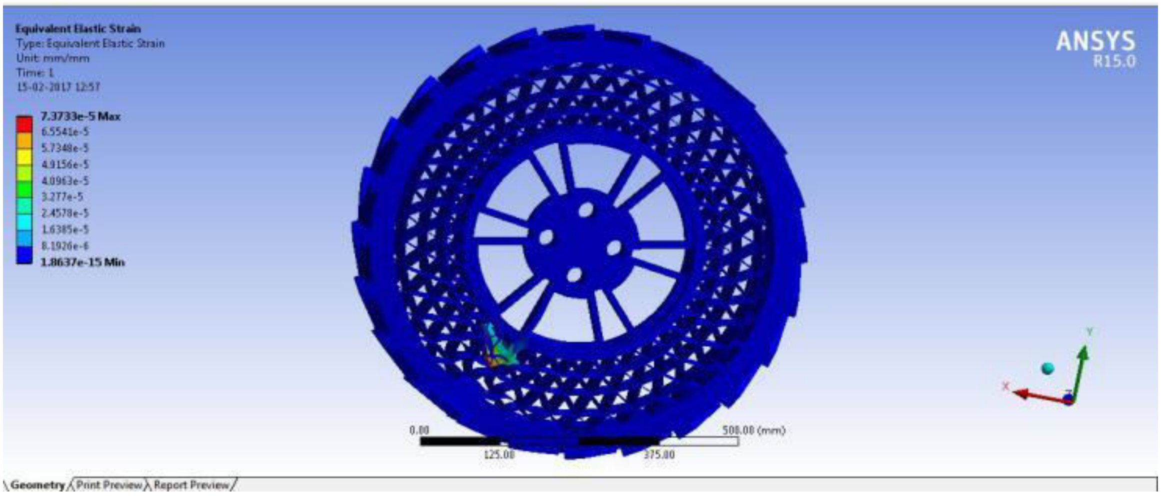

Fig.13 Equivalent elastic strain of triangular tweel tyre

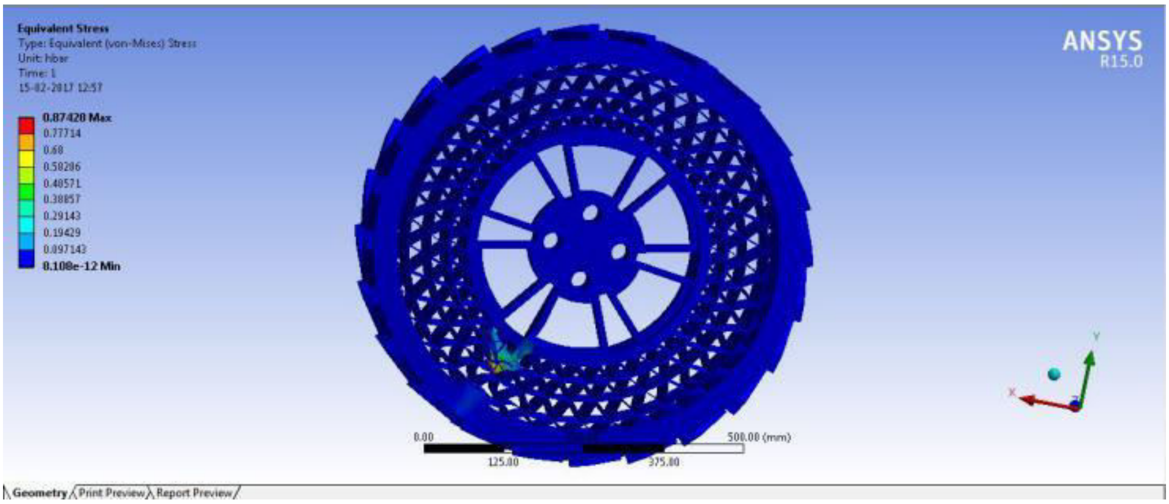

Fig.14 Equivalent stress of triangular tweel tyre

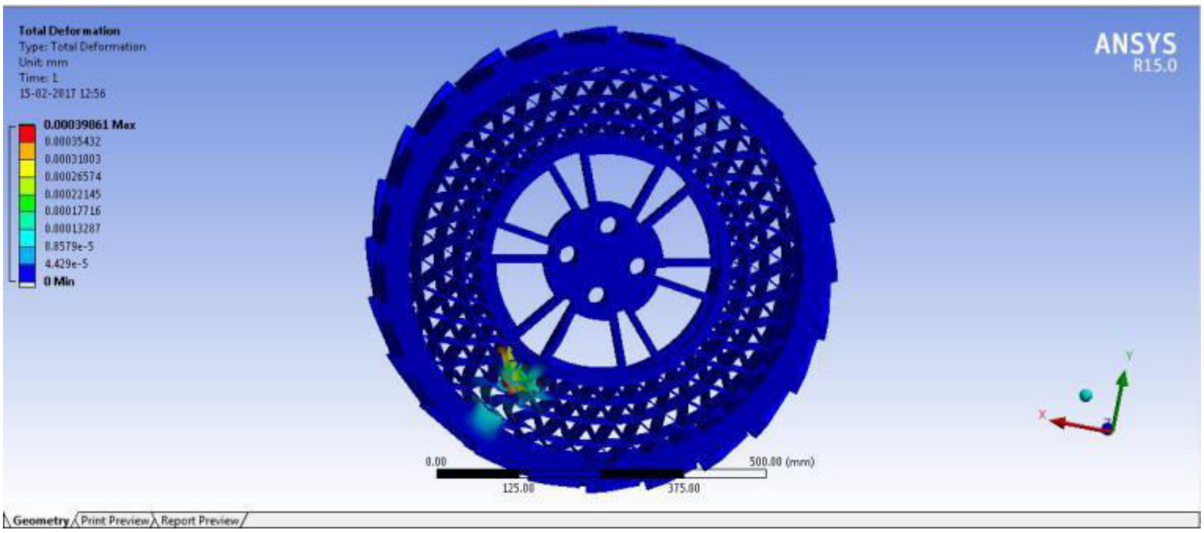

Fig. 15 Total deflection of triangular tweel tyre

VI. Conclusion

In this paper three different geometries of oppressive tweel tyre were designed. The static analysis of triangular tyre had been carried out better deformation, strain and stress compared to other tweel tyres. The von-Mises stress of the triangular tweel tyre was 0.87Mpa (Yield strength of Hub (AL7075) 95 Mpa and Shear band (AISI4340) 470 Mpa). The triangular tweel tyre is suitable for automobiles application of 49050N.

REFERENCES

[1] Mohammad Fazelpoue "A comparison of design approaches to meso-structure development". ASME journal paper DETC 2013-12295, 2013, doi: 10.115/ DETC 2013-12295.

[2] A.M. Aboul-Yazid., "Effect of spokes structure on characteristics performance of non-Pneumatic tyres," ISSN: 2180-1606 Volume 11, pp. 2212-2223, JanuaryJune 2012

[3] Balawi S and Abot JL., "A refined model for the effective in-plane elastic moduli of hexagonal honeycombs", Compos Struct, Vol. 84, 2008, pp. 25-42.

[4] Masters IG and Evans KE, "Models for the elastic deformation of honeycombs", Compos Struct, Vol. 35, 1996.