IOP Conf. Series: Materials Science and Engineering **197** (2017) 012042 doi:10.1088/1757-899X/197/1/012042

# DESIGN AND STATIC ANALYSIS OF AIRLESSTYRE TO REDUCE DEFORMATION

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**Abstract:**In this work a model of an air less tire is introduced with a replacement of natural rubber materials in place of synthetic rubber in tread and polyester in place of nylon in carcass. The construction and material study of various types of air less tyre is done by comparing with pneumatic tire. A brief structural study has been done on spokes of airless tyre and analyzed by ANSYS software. Analysis has been carried out on various structures like honey comb, Spokes, triangular and diamond with an applied load of 1200N. Comparison study has been carried out among various structures with different materials and it study shows that tyre with diamond structure with synthetic materials gives less deformation compared to other structure

Keywords— Tyrestructures, honeycomb, triangle, spokes,diamond and composite materials.

## 1. Introduction

Airless tyres or Non-pneumatic tyres area unit the tyres that aren't supported by atmospheric pressure. These tyres are known as Tweel that could be a merger of the words tyre and wheel. This is as a result of the Tweel doesn't use a conventional wheel hub assembly. The Tweel construct was initial declared by Michelin back in 2005. Its structure may be a solid inner hub mounted onto the vehicles shaft that's encircled by polyurethane spokes. This forms a pattern of wedges that facilitate to soak up the impacts of the road. These spokes look almost like those found on bicycles and plays the shock-absorbing role of the compressed gas as in an exceedingly ancient tyre. A sheer band is then stretched across the spokes that forms the environs of the tyre. It is the strain of the band and therefore the strength of the spokes that replaces the gas pressure used on ancient tyres. An airless tyre is created with differing types of spokes tension that so can enable handling varied styles of characteristics. The non-pneumatic tyres can be viewedtohave great positive implications when designed. Theinclusionoftheairlesstyresintothevehicleswillensureustheleastpossibility of blowout to occur in its performance. Addingtothe advantages that is stated forward by thenon-pneumatictyres(airless tyres), this also provides an environmentalbenefitby its usage. These tyres will never go flat and also canberetreaded, by which they never need to thrown away as inthecaseofthepneumatictyresingeneral.Hencelandfilliscutdown to a great extent contributing to theenvironmentbetterment. According to Amir Gasmi, Paul F. Joseph The tire model consists of a thin flexible annular band and spokes that connect the band to a rigid hub. The circular band is modeled exploitation recurvate beam theory that takes under consideration deformations because of bending, cutting off and circumferential extension. The impact of the spokes, which are distributed unceasingly within the model and act as linear springs, is accounted for less than in tension that introduces a nonlinear response. The quasi-static, two-dimensional analysis focuses on however the contact patch, vertical tire stiffness and rolling resistance are laid low with the stiffness properties of the band and therefore the spokes.

## II. Deformation of air less tyre

The unventilated tyre (Tweel) doesn’t use a conventional wheel hub assembly. A solid inner hub mounts to the shaft and is encircled by polymer spokes panoplied in a very pattern of wedges. A shear band is stretched across the spokes, forming the fringes of the tyre. On it sits the tread, the half that comes in touch with the surface of the road. The cushion shaped by the air cornered within a standard tyre is replaced by the strength of the spokes that receive the strain of the shear band. Placed on the shear band is that the tread, the half that produces contact with the surface of the road. When the Tweel is running on the road, the spokes absorb road defects identical manner atmospheric pressure will within the case of gas tyres. The versatile tread and shear bands deform briefly because the spokes bend, then quickly return to the initial form. Totally different spoke tensions may be used,PRN by the handling characteristics and lateral stiffness may vary. However, once created the Tweel’s spoke tensions and lateral stiffness can't be adjusted.

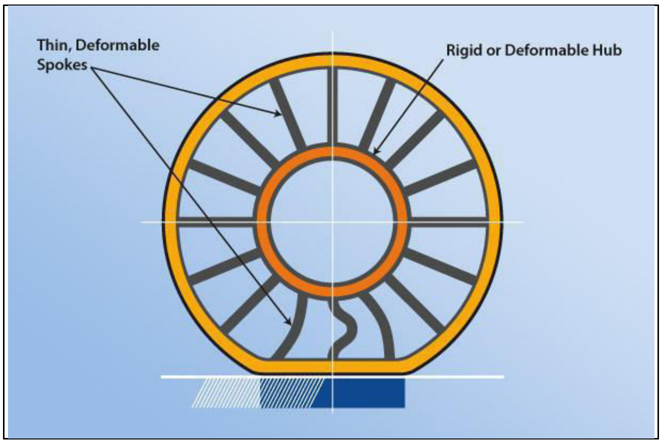



**Figure1**. Deformation of spokes

## III Modeling

Four 3-D Air-less tire models were constructed using CREO software. Model like Honey comb, Spokes Triangular and Diamond are included for analysis. Air tire consists of tread, belt, carcass and air filled volume. The tire model refers tothe geometrical structure of Car Tyres.

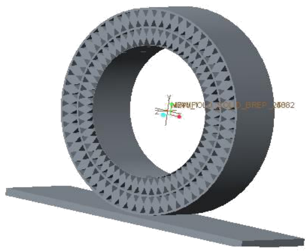
| | |
|---|---|
| Honey comb Structure | Spoke Type Structure |
|  Triangular Structure |  Diamond Structure |

**Figure 2**.Various Structure of air less tyre

The honeycomb structures generally referred as the two dimensional offer the out-of-plane mechanical properties. This property of these structures makes them suitable for the thermal isolation, energy absorption, and structural protection and also as the core of the lightweight sandwich panels.
The diamond tyre structure can withstand heavy loads when applied to the tyre compared to the previous structures; This structure has a nominal total deformation brought when the force is applied on to the tyre due to its structure layout and solid structure.

**IV. Load and boundary condition**

Air-less tire consists of layers of the inner band, outer band to create a composite structure. Steel rings also are used as reinforcing elements in Air-less tire. Tires typically face the key issues of failure thanks to heat build-up and riding comfort. so as to boost style of Air-less tire, it's necessary to be ready to predict themechanical behavior of the tire beneath applied load. Conjointly stress and strain energy distribution developed ought to be analyzed. The validation of metallic element prediction against air tire results was undertaken. The distribution of strain energy and deflection below loading was conjointly distributed victimization metallic element analysis. Vertical loading on the wheel through the appliance of a uniformly distributed edge load at the tire-rim contact region. The all tire half square measure mashed by victimization the solid Tetrahedral parts.. Tread properties square measure E=30Mpa, density=1300 kg/m3. Each bands take into account as same material properties, and also the wheel load of 1200 N is applied

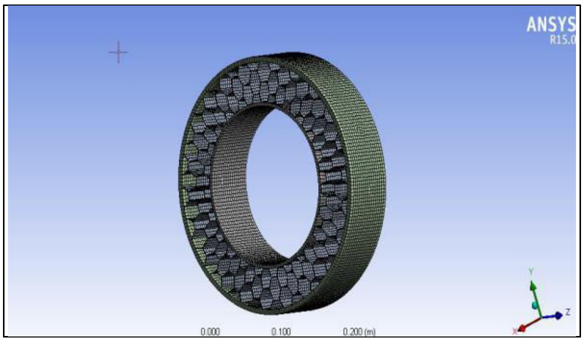



**Figure 3.**Honey comb Structure with Tetrahedral mesh.

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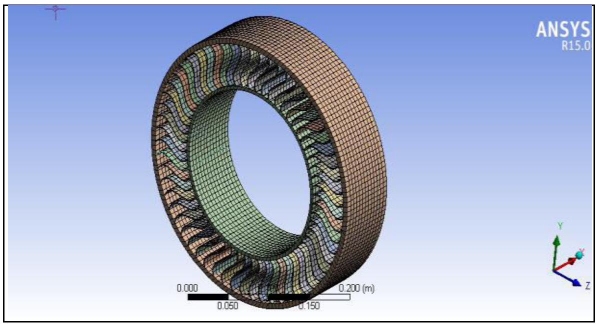

**Figure 4.**Spoke type Structure with Tetrahedral mesh.

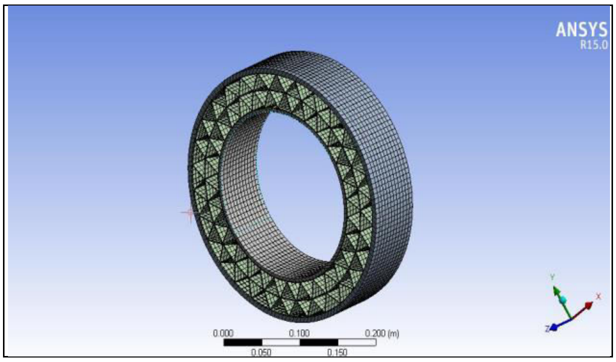

**Figure 5.**Triangular Structure with Tetrahedral mesh

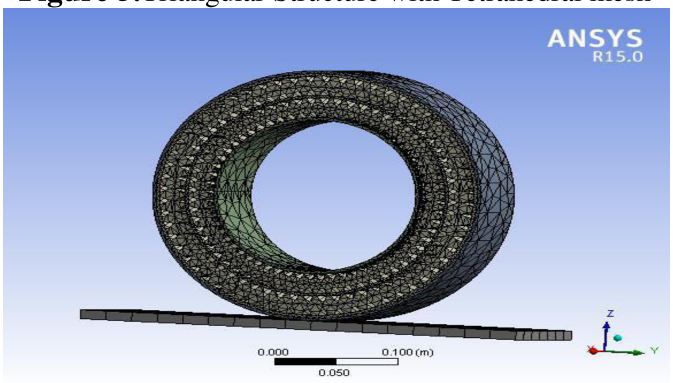

**Figure 6**.Diamond Structure with Tetrahedral mesh.

## V. Load deflection & analysis

Model the tires by mistreatment CREO to imports ANSYS code. Road and tread were command contact stipulation not fastened. Vertical loading on the wheel through the applying of a uniformly distributed edge load at the tire-rim contact region. The deflection within the loading direction of the wheel center and therefore the displacement within the lateral direction.

(a)Honey Comb Structure

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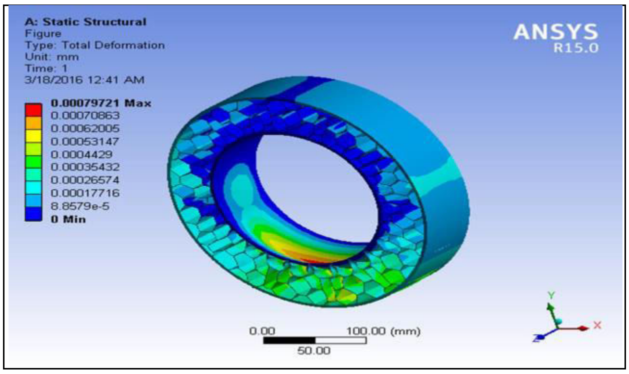


**Figure 7**. Deflection of air less tyre with Honey Comb Structure

The above figure explains the total deformation of the tyre when a load of 1200 N is applied, the load is acting on the centre of the axle where the deformation. of total tyre with stress and strain relationship is seen in this figure. The colour representation shows the deformation of the tyre when load is applied. The total deformation of the tyre in this type of structure is 0.00079721.

(b)Spoke type structure

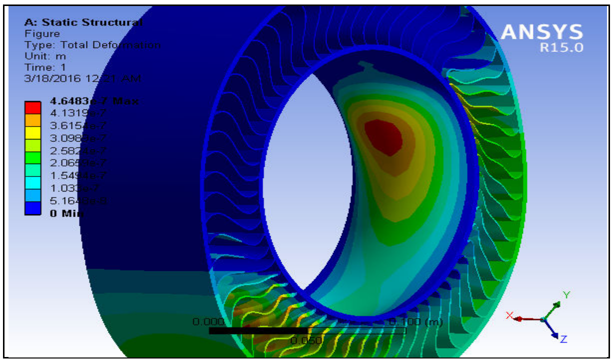


**Figure 8**.Deflection of air less tyre with Spoke type Structure

The above figure explains the total deformation of the tyre when a load of 1200 N is applied.The normal analysis is done with the materials such as polyurethane as spokes and natural rubber as thread of the tyre and the inner layer of the tyre is used as nylon which is used in pneumatic tyres. The hub is used as aluminum which is the basic materials of a normal airless tyre.

(c) Triangular Structure

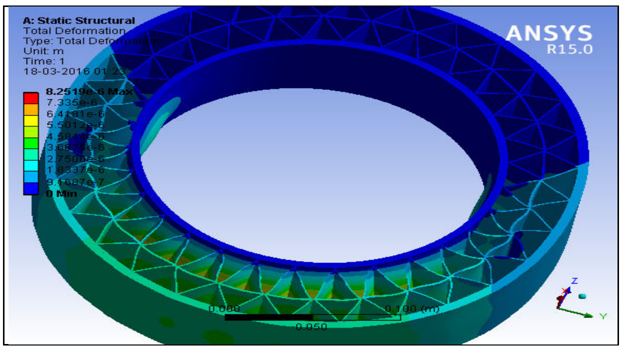

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**Figure 9.** Deflection of air less tyre with Triangular type Structure

The above figure explains the total deformation of the tyre when a load of 1200 N is applied the load is a acting on the centre of the axle where the deformation of total tyre with stress and strain relationship is seen in this figure.

(d) Diamond Structure

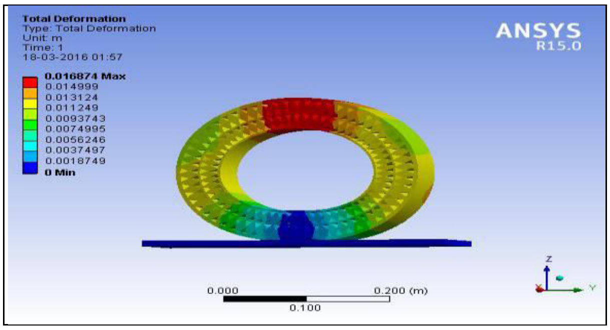


**Figure 10**. Deflection of air less tyre with diamond Structure

The above figure shows the total deformation of the tyre when a load of 1200 N is applied the load is acting on the centre of the axle where the deformation of total tyre with stress and strain relationship is seen in the figure.

## VI. Results

The results obtained on comparison between the structures using normal and composite materials were analyzed and is stated below.

| S. No | Structure | Force Applied( N) | Total Deformation (Existing Material) mm | Total Deformation (Existing Material) mm |
|---|---|---|---|---|
| 1 | Honeycomb | 1200 | 0.00079721 | 1.0608e-007 |
| 2 | Spokes | 1200 | 4.6483e-7 | 2.8606e-007 |
| 3 | Triangular | 1200 | 8.2519e-6 | 1.3521e-007 |
| 4 | Diamond | 1200 | 0.016874 | 1.0498e-007 |

The performance analysis of the four various structures such as honeycomb, spokes, triangular, and diamond are given in the above table. The total deformations of the various structures are shown in which diamond structure has lesser deformation than the other three structures. Thus the diamond structure gives the high load carrying capacity.

## VII. Conclusion

From the design analysis it was concluded that the Diamond tyre structure was found out to be solid, and also bears more load comparative to the other structures. The material changes brought about in the carcass and also in the tread has also contributed to the reduction the total deformation. Thus the proposed work can bear a greater amount force and at the same time exhibits a comparatively small total deformation. These types of tyres can be mainly employed for the heavy load vehicles where the load factor is a main concern.

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