Improvising Airless Tire Design by Adding Sidewalls

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Abstract— An airless tire is a solitary unit supplanting the pneumatic tire, in getting assembly. It replaces every one of the segments of a regular outspread tire and is comprised of an unbending center point, associated with a shear band by methods for adaptable, deformable polyurethane spokes and a tread band, all working as a solitary unit. But the Airless tires tends to reduce the cornering efficiency, there is possibility of water, dust and air particles entering the design, there is possibility of temperature rise too. Thus, to counter act on these problems the new prototype design will be designed and tested in our project. Our project includes improvising the design of the ongoing Airless tire design for better efficiency. The model will be done in Creo 3.0 and investigation will do in Ansys 19.

Keywords: Airless tires, Sidewalls, Creo 3.0, Ansys 19

I. INTRODUCTION

A tire is most important part of any vehicle. The airless tire is tires that are not upheld by air pressure. Tires made out of shutting cell polyurethane froth are additionally made for bikes and wheelchairs. Tire provides cushioning effect as well as provides clearance to vehicle. The rubber member is mounted on wheel rim. In tube tire, tube is present inside the tire while in tubeless tire there is no tube. A tire is a ring-shaped component that was mounted on a wheel's rim to transfer the vehicle's load from the axle. Tire which is used in automobile, bicycle, motorcycle is pneumatically inflated structures which provide a good rolling, cushioning effect. They are used in small vehicles, for example, riding yard cutters and mechanized golf trucks. They are additionally used in overwhelming hardware, for example, excavators, which are required to work on locales, for example, building obliteration, where the danger of tire punctures is high. Some companies are trying to develop tire which are airless that means they are non-pneumatic. Michelin and Bridgestone are the tire which are firstly design, they are non-pneumatic. But due to the absence of sidewalls, the efficiency reduces, the Cornering ability is affected, the water particles, dust particles can enter in the design. Thus, the design has to be improvised.

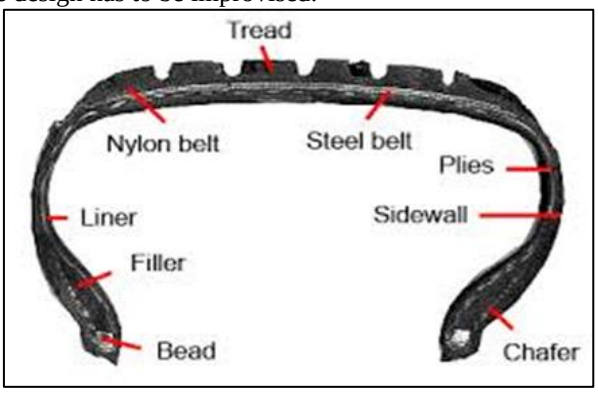

Fig. 1: Cut Section of a Conventional Tire

Non-pneumatic tire (NPT), or Airless tires, are tire that is not supported by air pressure. Airless tire generally have higher rolling friction and provide much less suspension than similarly shaped and sized pneumatic tires. Other problems for airless tire include dissipating the heat buildup that occurs when they are driven. Airless tire is often filled. with polyurethane spokes. The tires are expected to maintain a speed of 75 mph for 60 miles.

The unventilated tire (Tweel) doesn't use a conventional wheel hub assembly. A solid inner hub mounts to the shaft and is encircled by polymer spokes panoplies in a very pattern of wedges. A shear band is stretched across the spokes, forming the fringes of the tire. 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 tire 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.

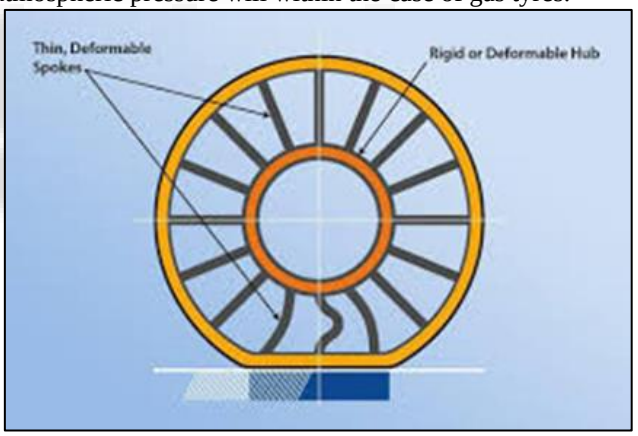

Fig. 2: Deformation in Airless Tire

II. LITERATURE REVIEW

The airless tire is better than the conventional tire, it was studied in many research papers, the design of the airless tire can withstand the weight and forces applied on it. The airless tire is made of recycled materials like polyurethane and nylon 6, 6, etc. The airless tire eliminates the use of air for sustaining the vehicle weight and uses spokes or pattern structure to do it so. Different type of spokes structures and load were considered to get the best out of the airless tire data. It was observed that the deformation results in different types of spokes pattern [1] differed accordingly. Following are few types of spokes pattern:

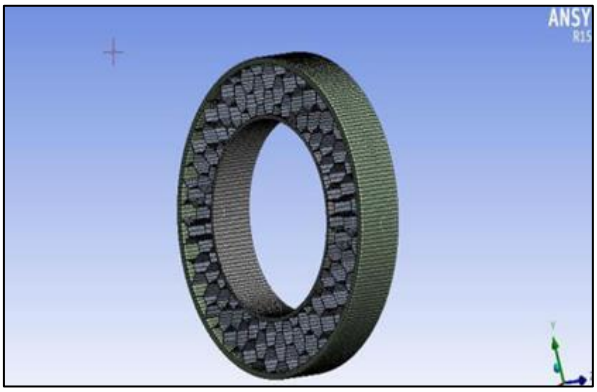

Fig. 3: .Honeycomb Structure with Tetrahedral mesh

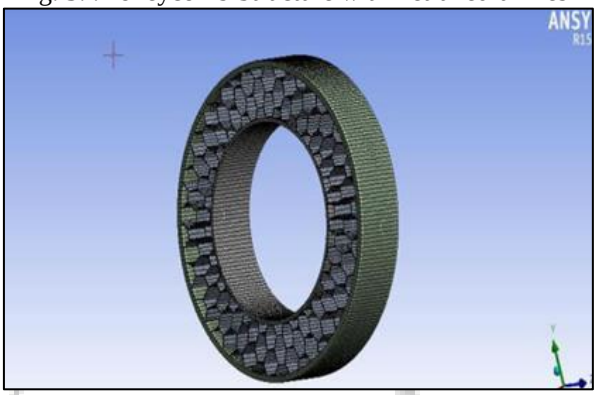

Fig. 4: .Triangular Structure with Tetrahedral mesh

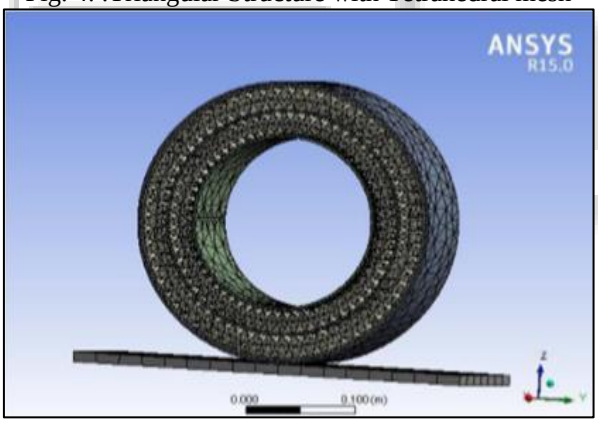

Fig. 5: Diamond Structure with Tetrahedral mesh

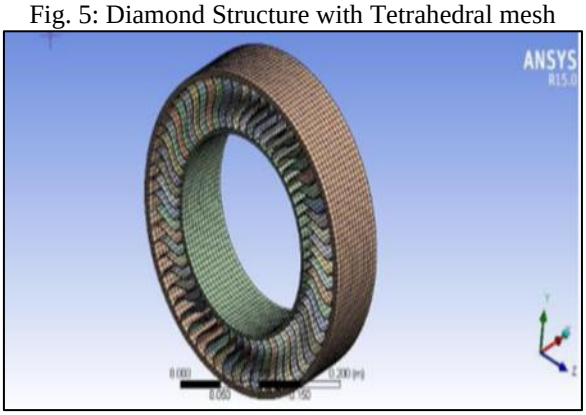

Fig. 6: Spoke type Structure with Tetrahedral mesh

The Research paper published by Nibin Jacob Mathew, Dillip Kumar Sahoo, E.Mithun Chakravarthy was based on the Design and Static Analysis of Airless tire to Reduce deformation. It was observed that honeycomb structure and diamond structure were suitable for withstanding load of about 1200 N acting on the Centre of the axle of the tire. The total deformation of the tire in this type of structure is 0.00079721.

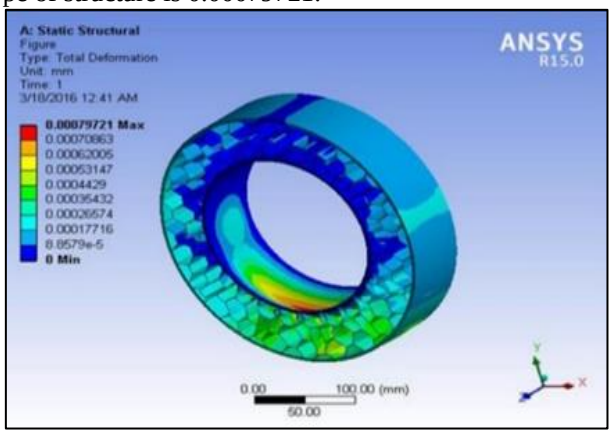

Fig. 7: Deflection of air less tire with Honey Comb Structure

From the design analysis it was concluded that the Honeycomb structure and Diamond tire 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 tires can be mainly employed for the heavy load vehicles where the load factor is a main concern [2] And hence the Airless tires are equivalent to air or pneumatic tires in terms of load bearing and performance.

Its mentioned in tire dynamics that the wheels profile plays an important role in cornering ability or drift ability. The wheel profile includes of the wheel base and side-walls. Better the wheel profile, more efficient it becomes for facing centrifugal forces while cornering.

Hence from all the research papers we understand that Airless tire works better with honeycomb structure or diamond structure, and there is need of addition od sidewalls for enhancing the cornering ability and overall performance of the Airless tire.

III. PROBLEM STATEMENT

The Airless tire is no less than that of a pneumatic tire. But the design structure of airless tire is different as compare to that of pneumatic tire or tubeless tire. As very less research has been done on this topic. Most of the people are unaware of the fact that the present design is faulty. The present airless tire design is not having side walls hence the cornering ability of the tire decreases plus there will be increase in impurity passage inside the spokes arrange- -ment. Thus, to avoid that We will have to add side walls and change the present design of airless tire.

IV. OBJECTIVES:

The objective of this project is to solve the problems and make the world a better place and to reduce the wastage of the material and concentrate more on using renewable resources.

We being the students of Engineering college should take up the challenges and solve the problems.

Today's world is still not a safety concerned world, in the goal of being cost efficient, humans tend to neglect the safety standards.
Our goal is to:

1) Eliminate the use of air so that there will be no sudden air pressure drop or bursting of tire which could lead in a major life threatening accident.
2) There is a possibility of sand, water and dust particles entering the structure of spokes.
3) Since the sidewalls is absent in the tire profile, the cornering ability and the drifting ability is been affected and the overall performance drops.
4) Overall look of the Airless tire will be more appealing.
5) By the addition of sidewalls, the cornering ability will be similar to that of pneumatic tires.
6) The honeycomb structure is the best spokes design to withstand the tire movement pressure or sustain the weight of the vehicle.

V. METHODOLOGY

The steps created to attain a particular product or goal by undergoing its study of design, problem statement, design sketches, testing and 3-D printing arranged in a flow chart is called methodology.
For our project, following is the methodology flow chart.

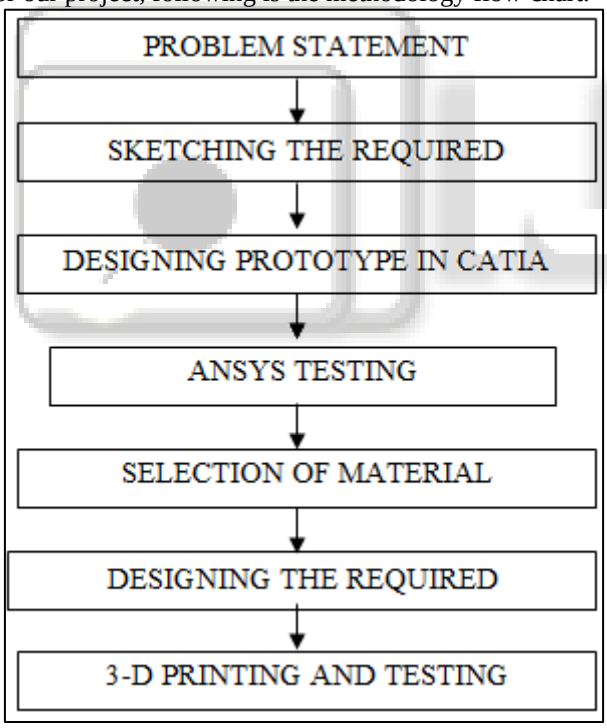

Fig. 9: Methodology flow chart

VI. MATERIAL SELECTION

SR.	MATERIAL	PRICE
1	Smart 3D filament (FLEX 1.75mm)	₹ 1250
2	TPU filament (shore value: 85a)	₹ 1250
3	Plastic filament	₹ 1500
4	Acoustic sound mesh	₹ 840

VII. PROTOTYPE DESIGN OF AN AIRLESS TIRE (VERSION-G)

In this design we have to added the side walls, we have also added the Acoustic sound mesh, which will allow only air passage and will stop the water passage inside the spokes arrangement. It is a basic sketch design done while studying the airless tire problem statement and figuring out the possible design. You can see the prototype design in the figure alongside (Fig. 8)

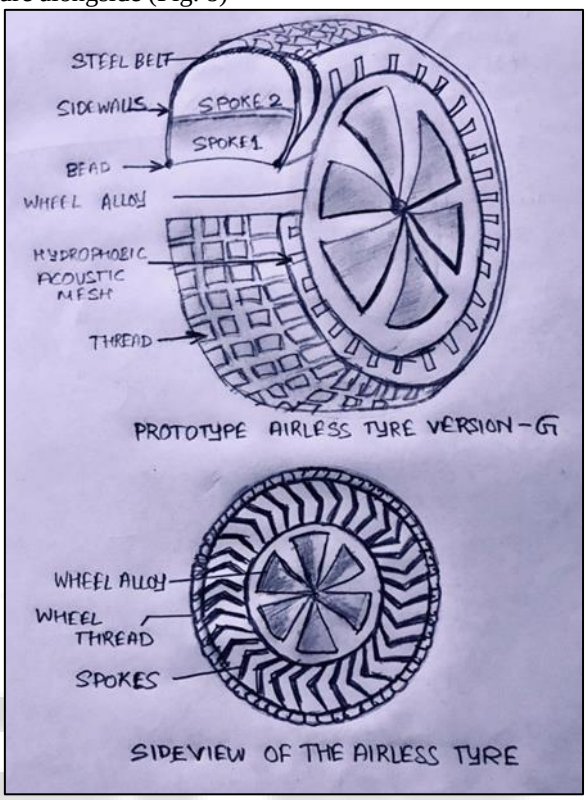

Fig. 8: Airless Tire (Version-G) Prototype Design

We can see the difference in the initial design and the final design of our Airless tire (version-G). It was due to the ability of honeycomb type structure to perform better than the spokes type structure.

VIII. 3D MODEL OF THE AIRLESS TIRE (VERSION-G)

The following 3-D design is been rendered in creo 3.0 software.

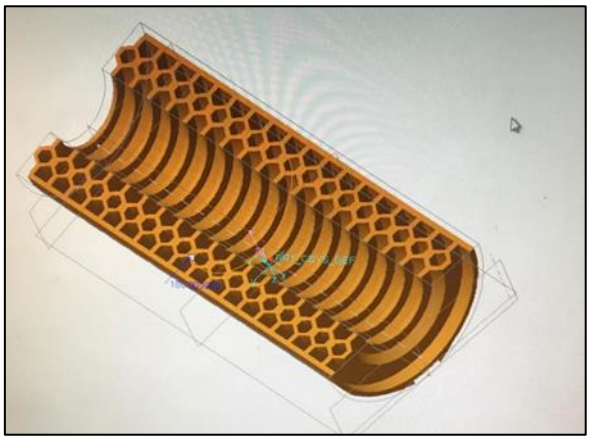

Fig. 10: 3-D Cut section of Airless tire (version-G)

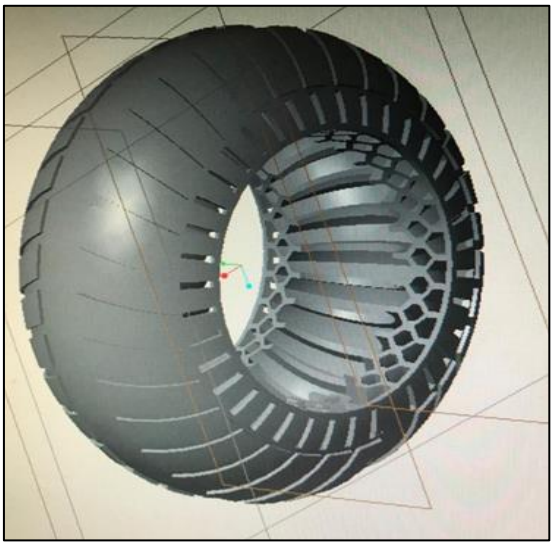

Fig. 11: 3-D Airless tire design (Version-G)

The following Creo 3-D Design has the following dimensions:

1) Diameter: 40 cms
2) Thickness of the side walls: 0.5 cm
3) Acoustic Soundmesh slit width: 0.2 cm
4) Honeycomb str. thickness: 0.5 cm
5) Angle of curve: 120 degrees.

IX. FUTURE SCOPE

1) Use of more lighter recyclable materials as the material for production of Airless tire.
2) Using a better alternative for the acoustic sound mesh which is used to avoid water, sand and dust particles passage into the honeycomb structure.
3) Use of less heat conducting materials for the spokes or internal support structure.
4) Designing a tire to fit on the present wheel hubs (alloys).

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