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NON-PNEUMATIC TYRES (NPT)

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Abstract —*The Non Pneumatic Tyre (NPT) design was first developed by the French tyre company Michelin. Its significant advantage over pneumatic tyres is that it does not use a bladder full of compressed air and therefore it cannot burst or become flat. The inner hub of the NPT connects to flexible polyurethane spokes which are used to support an outer rim and assume the shock absorbing role of a traditional tyre's pneumatic properties. Potential benefits of the Non Pneumatic Tyre include the obvious safety and convenience of never having flat tyres. Commercial applications will be in lower weight vehicles such as wheelchairs, scooters, heavy vehicles like earth movers, military applications and NASA applied it in lunar rover. In future NPT will replace traditional tyres which could avoid checking of tyre pressure, highway blowouts and balancing between traction and comfort.*

Keywords-*Hub, polyurethane spokes, shear band, tread band, honeycomb spokes.*

I. INTRODUCTION

For more than 100 years, vehicles have been rolling along on cushions of air encased in rubber. Creating a new non-pneumatic design for tyres has more positive implications than one might think. For one thing, there are huge safety benefits. Having an airless tyre means there is no possibility of a blowout, which, in turn, means the number of highway accidents will cut significantly. even for situations such as in the military, utilizing non-pneumatic tyres has a great positive impact on safety. tyres are the weak point in military vehicles and are often targeted with explosives. if these vehicles used airless tyres, this would no longer be a concern. there is also an environmental benefit to using this type of tyre. since they never go flat and can be retreaded, airless tyres will not have to be thrown away and replaced nearly as often as pneumatic tyres.cars are things that people use every day, so any improvements over existing designs would affect the lives of the majority of people.

II. CONSTRUCTION

The 4 main parts of the non-pneumatic tyres includes:

A. Hub

B. Polyurethane spokes

C. Shear band

D. Tread band

A. Hub

The hub is generally made up of Steel or Aluminum alloy. The average weight of the hub if its made of steel is roughly 4 Kg and of Aluminum alloy (AL7075-T6) is 2.5 Kg. It is a rigid structure and cannot deform while running. The frame of the vehicle is connected to the hub using nuts and bolts just like the hub used in the Pneumatic tyres

The hub is made by ordinary casting process just like the making of ordinary hubs.

Fig.no.01 Hub

B. Polyurethane spokes

This polyurethane is used as the spokes in the Non Pneumatic tyres. It serves the function of air in this tyre. It has a capacity to take heavy loads and can deform its shape temporarily and can regain it. These are made in wedge shaped designs or in honeycomb designs. The wedge shaped design is introduced by Michelin and the honeycomb structure by Resilient Technologies, LLC.
These PMDI based PU foams showed good thermal resistance and flame retardance.

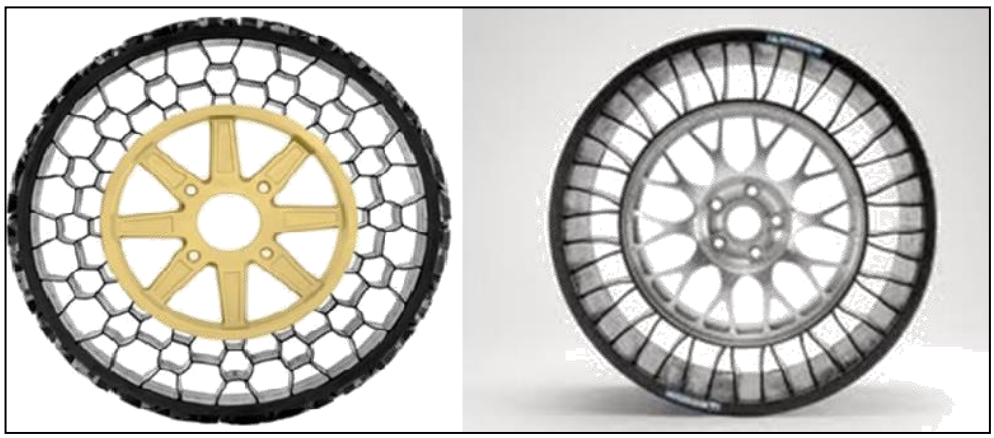

Fig.no.02 Polyurethane Spokes

C. Shear band

It is a flexible band which is between the polyurethane spokes and the tread band. The shear band mainly consists of steel wire wound in circular shapes. It gives reinforcement to the tread band from shearing off while running. Its manufacturing is done with the tread band so that it firmly sticks together with the tread and provide great cornering stiffness to the vehicle.
The material used as the shear band is ANSI:4340 (American National Standard Instruction codes) which is a high strength steel.

Fig.no.03 Shear Band

D. Tread band

It is the part of the non-pneumatic tyre which comes in contact with the road. It contains rubber grip or tread for traction and grip on the road surface or any other terrains. The design of the tread depends upon the terrain in which the vehicle meant to move. The manufacturing process of the tread band is similar to that of the tread making in pneumatic tyres which is the extrusion process.The whole assembly is vulcanised so as to give the rubber tread more durability andstrength. Vulcanisation is done by treating the rubber tread with sulphur so that it forms links within the material and becomes difficult to break.

Fig.no.04 Tread Band

III. WORKING

The Airless tyre(Tweel) doesn't use a traditional wheel hub assembly. A solid inner hub mounts to the axle and is surrounded by polyurethane spokes arrayed in a pattern of wedges. A shear band is stretched across the spokes, forming the outer edge of the tyre. On it sits the tread, the part that comes in contact with the surface of the road. The cushion formed by the air trapped inside a conventional tyre is replaced by the strength of the spokes, which receive the tension of the shear band. Placed on the shear band is the tread, the part that makes contact with the surface of the road. When the Tweel is running on the road, the spokes absorb road defects the same way air pressure does in the case of pneumatic

tyres. The flexible tread and shear bands deform temporarily as the spokes bend, then quickly go back to the initial shape. Different spoke tensions can be used, as required by the handling characteristics and lateral stiffness can also vary. However, once produced the Tweel's spoke tensions and lateral stiffness cannot be adjusted.

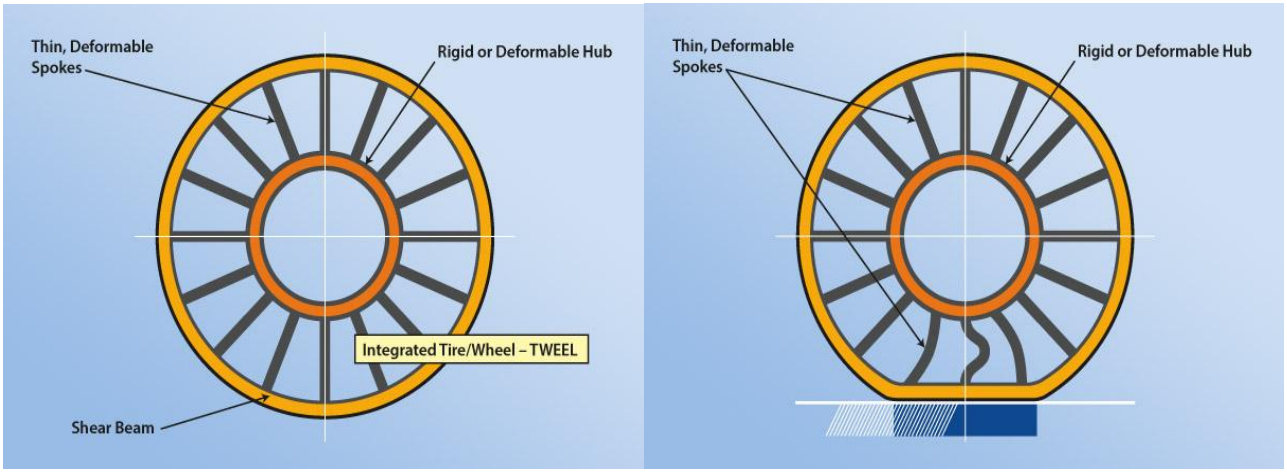

Fig.no.05

IV. ADVANTAGES

1. It provides a comfortable ride and increases vehicle handling.
2. Its flexibility provides an increase in surface area of contact thereby increases the grip with the ground.
3. It can take gun fires and spikes without becoming immobile.
4. It reduces down time as compared to pneumatic tyres as it require very little or no maintenance.
5. It increases the load carrying capacity of the vehicle.
6. It reduces the environmental impacts as the chemicals used in the manufacturing of non-pneumatic tyres are very less compared to traditional pneumatic tyres.

V. LIMITATIONS

1. The non-pneumatic tyres are expensive as compared to pneumatic tyres.
2. The replacement of any component in the non-pneumatic tyre is impossible ie. every time the tyre is worn-out we have to replace the whole assembly.
3. It can withstand police spikes which may make it difficult for law enforcement.
4. Lack of adjustability is one disadvantage of non-pneumatic tyresie if once manufactured cannot be altered or adjusted.
5. It cannot be implemented in fast moving vehicles above 50mph as the spoke vibrates considerably and is unpleasantly loud.

VI. APPLICATIONS

There are a number of vehicles using non-pneumatic tyres. Some of them are listed below:

a) Earth movers

b) Wheelchairs

c) NASA Lunar rover

d) Military vehicles

VII. CONCLUSION

This new technology will increase the safety of cars as well as have a positive impact environmentally. This innovative project is also backed and guided by engineering codes of ethics which will ensure that the development is conducted in a way that it responsible and fair. This type of innovation will become increasingly valuable in the future because of the advantages that this tyre has and the wide range of applications in which it can be used. A structural application of the flexible in-plane properties of hexagonal honeycombs was suggested – the honeycomb spokes of an NPT to replace the air of a pneumatic tire. Cellular spoke geometries for an NPT were investigated with regular and auxetic honeycomb spokes using the compliant cellular design concept.

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