

NON-PNEUMATIC TYRES

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Abstract - NON- PNEUMATIC TYRES (NPT) as its name suggests it does not use compressed air which is filled in hollow rubber tyres. Every vehicle needs tyres, but in pneumatic tyres problem of puncturing of tubes occurs, in tubeless tyres puncturing occurs after specific running time. But what if this problem gets solved forever? The solution is NPT. It consists three main parts, a rigid hub, Deformable spokes that supports vehicle load and shear band and threads made of rubber that came into contact of roads. The properties of NPT like load carrying capacity, rolling resistance; contact pressure etc. can be varied by varying dimensions or material of manufacturing. In recent years many tyre manufacturers and inventors have been working on creating airless tyres that would be nearly impossible to puncture. The most well known design in this field was firstly invented by Michelin called it Twill; combination of Tyre and Wheel. Hankook Tyre, Bridgestone, NASA, Tesla are also working on this technology to make it better and economical and environment friendly. In future NPT is definitely going to replace traditional pneumatic tyres which could avoid much human efforts and accidents due to blowouts

Key Words: Tyres, NPT, NASA, Bridgestone, Airless tyres, Michelin, Wheel, Non-pneumatic tyres

1. INTRODUCTION

More than a century vehicles are running on tyres made up of rubbers and pneumatically inflated with air. A tyre is one of the most important parts of any automobile. Tyre provides sufficient traction on road surface for accelerating, driving and breaking. Also carries the weight of the vehicle and provides cushion over road irregularities and eliminate noise. Tyre made up of rubber is mounted on wheel's rim, there is tube present inside the tyre and in case of tubeless tyres tube is absent in it. One of their advantage is they are comparatively low value of unsprung mass and easily changing of tyre stiffness by changing the pressure of air inside the tyres. An important disadvantage of pneumatic tyres is the danger of blowing off or unsealing the tyre during running vehicle causes vehicle immobilization. This drawback is more important when vehicle is using in off-road condition (exp. raw roads, construction sites etc.) or where it is exposed to enemy fire.

After number of years this convectional tyre technology is developing, some companies are trying to develop Airless

tyres means which are not pneumatic. Michelin and Bridgestone are among the first few tyre companies who firstly designed NPT. The Non-pneumatic Tyres have been replaced by polygon spokes and elastomeric layers with internal and external rings. There is also an environmental benefit of using this type of tyres. Since they never fall to the ground and can be trampled again, airless tyres will not need to be discarded and replaced as often as air tyres. Automotive companies are currently looking at all possible ways to reduce the car's weight to meet the government's fuel economy standards. Focus research is mainly focused on the option of reducing tyre weight. This will benefit us to reduce weight of the vehicle.

Vehicles are the things that people use every day in mass number and in various fields, so any positive development can affect majority of people. So begins discussing the development of airless tyres, something that has widespread is recent years

1.1 METHODOLOG

Before you begin to format your paper, first write and save the content as a separate text file. Keep your text and graphic files separate until after the text has been formatted and styled. Do not use hard tabs, and limit use of hard returns to only one return at the end of a paragraph. Do not add any kind of pagination anywhere in the paper. Do not number text heads-the template will do that for you.

Finally, complete content and organizational editing before formatting. Please take note of the following items when proofreading spelling and grammar

2. METHODOLOGY

2.1 Construction and Working

The pneumatic wheel is made of polymer with high resistance to road shock and has good elastic properties. They are made of tread, band shear, wheelbarrow and flexible spoke. Thread is a place on the upper side of the wheel that provides good durability and assists in driving to stay in shape. The shear band is the outer cover of the pneumatic wheel that transmits the shock. Flexible spokes are attached to a shear band that is usually in a triangular shape. The shock from the shear band was absorbed by these spokes. Spokes are also attached to a deformable wheel. The

wheel are attach to the vehicle. While the vehicle in running faces various shock effects by the vehicle. As the shock is caught the flexible spokes bend and shock enters. As the shock leaves the spokes they enter their original state. Primarily the spokes act as shock reducers.

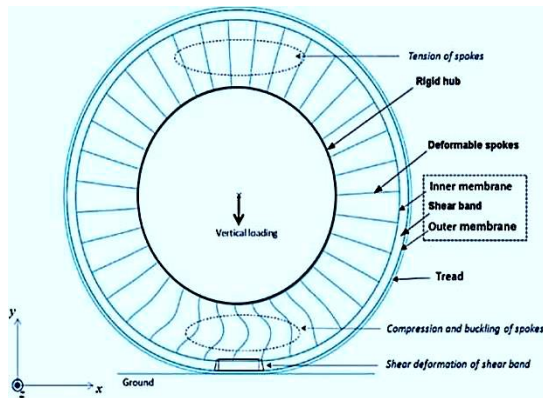


Fig -1: Construction of Non Pneumatic Tyre

2.2 Different Design Approaches

i. NASA And The Apollo Lunar Rover:

The first major attempt to create an airless wheel was in 1970 with NASA's Apollo Lunar Rover Vehicle. This tyres were made of steel strips that are joined together to form a shape, and then zinc. To gain traction, chevrons made up of titanium were added to the outer surface.

This design worked well on the moon, when the comfort of the drivers was not a problem (e.g. tightening the tyres), but it would not work in the present world. Also the design would be very costly for regular automobiles, which is not attractive to the average consumer.



Figure2: NASA AB Scarab Wheel Design

ii. Michelin Tweel:

The next main attempt at creating an airless tyre was called the Tweel (combination of tyre and wheel) by the tyre company, Michelin. Their design consisted of a thin rubber band with V-shaped spokes made of polyurethane.

There were very high hopes for this model when it came out. Columnist Don Sherman of Car and Driver writes, introductory claims compared to conventional air therapy doubled to three times the life of a treadmill and five times more potent strength with a slight increase in folding resistance. This upgrade has a positive effect because it means that the tyre can last about twice as long as a normal air tyre before it is replaced. The only major problem with this model is the highway speed; the spokes often vibrates, causing excessive noise. When asked about Tweel's latest developments, Michelin declined to comment, either because they had quit the project, were working with the military, or were unwilling to disclose their competitors.



Fig -3: Michelin Tweel Tyre Design

iii. Bridgestone NPT

Another model for the non-pneumatic tyre came from the well-known tyre company, Bridgestone. While very similar to Michelin's tweel concept but there is a big difference.

The core is made of solid aluminum and has thermoplastic spokes that protrude outwards in different directions on each side. This creates more stability and less lateral movement on the wheel. Bridgestone also solved the problem of vibration and noise in this way. A major problem with their design is that the debris had a tendency to be caught in the spaces between the spokes. In addition, the materials used on the tyres are recyclable, which contributes to the efficient use of the equipment. Moreover, by pursuing very low resistance and contributing to reducing CO₂ emissions through related technologies, Bridgestone believes that it is possible to achieve the highest levels of friendliness and environmental safety. Bridgestone is pursuing these technological advances with the goal of finding a more effective "cradle to cradle" procedure maximizes the cyclical use of resources from worn tyres into new tyres and the use of recyclable resources.



Fig -4. Bridgestone NPT Design

Advantages of NPT's:

- 1) No more air valves
- 2) No more air compressors at Petrol Pumps.
- 3) No more flat tyres and tyre blow outs
- 4) The Tweel promises performance level beyond those possible with conventional pneumatic technology.
- 5) The potential benefits of Tweel include the obvious and common safety of never having a flat tyre. And the concept has the potential for real performance.
- 6) The Tweel can also withstand with a police 'stinger' spike strip, which would force enforcement to adapt in order to catch a suspect in a vehicle equipped with twill.
- 7) It provides a comfortable ride and increase vehicle handling.
- 8) Its flexibility provides increase in surface area of contact thereby increase the grip with the ground.
- 9) It can take gunfire and spikes without becoming immobile.

2.3 Limitations of NPT's

- 1) The NPT's are expensive as compared with pneumatic tyres.
- 2) The replacement of any component in the non-pneumatic tyre is impossible i.e. 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 forces to catch criminals.
- 4) Lack of adjustability is one disadvantage of non-pneumatic tyre if once manufactured cannot be altered or adjusted.

2.4 Applications of NPT's:

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

- 1) Earth movers
- 2) Wheelchairs
- 3) NASA Lunar rover
- 4) Military vehicles
- 5) Bicycles

3. CASE STUDY

3.1 Problem Statement

Road accidents are very serious issue in our country. Every year more than 10,000 accidents occurred in the Indian subcontinent due to Tyre bursts that killed 3,031 in year 2014-15 in total and injured 9,081. Also it's shown that every year more than 20% of total scrap of tyres is due to puncture, blowouts or due to non-uniform wear caused by non-maintaining specific pressure. In military vehicle there is chance that tyre may be shot by bullet or intentionally placed sharp object by enemy. In earthmoving or heavy vehicles which used in places like stone crushing or mining, it's more likely to puncture of tyre; it's also not possible to move utility at remote area like mine. Tyre blow out occurs when a tyre encounters an object, say a pothole or some sharp edged stone or metal piece that cuts or tears vehicles tyre structure at particular point where it is unable to contain the pressure of air, thus escaping the pressurized air by adding further tear through the tyre construction.



Fig -5. Blow Out Of Truck Tyre

3.2 Solution

We can say that we should have to find a new or better alternative to overcome these drawbacks and risks, the solution is using Non Pneumatic Tyres. As its name indicates they are not filled with air, so the biggest reason to blow outs or puncture is eliminated here. These NPT's are supported by the unique spoke structure specially designed to support the weight of vehicle and absorb shocks while rolling over road irregularity. These tyres are very rigid, resistant to puncture and can be used for light applications such as

bicycles to heavy applications such as military vehicles. Even if some spoke structure is broken in worse condition it will be sustain its application. As there no need of air filling or maintaining pressure the maintenance is almost neglected, which causing NPT's to be suitable for heavy duty applications such as mining vehicles, JCB's, earthmovers, trucks etc. These tyres are also bulletproof, NPT's can widely use in military vehicles. As they are exposed to enemy there is chance of assassination by enemy. By using these tyres for normal vehicles such as buses, cars, auto etc. can cause the decrease it road accidents due to blowing out of tyre.



Fig -6. Military Vehicle using NPT's



Fig -8. Construction vehicles



Fig -7. Under Ground Mining Machine

4. RESULTS AND BENEFITS

No more air valves. No more air compressors in Petrol Pumps. No more flat tyres in the middle of a long drive. Tweel promises superior performance levels that can be achieved with standard air technology. The potential benefits of Tweel include the obvious safety and ease of use of never having low tyres. Also, the concept has the potential to benefit real performance. Finally, it can outperform regular tyres because they can be designed to have high lateral strength (good handling) without losing comfort because the shape of the nails allows for vertical and lateral stiffness to be adjusted independently. Trampling patterns can add holes in the construction thus eliminating or significantly reducing aquaplaning. Because only the tread around the perimeter can be discarded when worn differently from the rest of the wheel, the environmental impact should be minimal. The Tweel can also hold out against a police 'stinger' spike strip, which would force law enforcement to use new technics in order to catch a suspect in a vehicle equipped with Tweels.

5. FUTURE SCOPE

The first and most comprehensive application would be for a military application, a flat proof / striking wheel can help. Military tests have shown that Tweel moves the mine explosion away from the car better than regular wheels and that Tweel stays afloat even when other spokes are damaged or lost.

NASA has contracted with Michelin to develop next generation lunar tyres for interplanetary missions based on Twill technology. This has result in the Lunar Rover Initiative AB Scarab Twill. The Twill has some limitations. Above 50mph twill vibrates considerably. This might be not a major problem but it leads two major problems Heat and noise. Making Tweel is also quite dissimilar process than making a pneumatic tyre. The sheer scale of the changes that would need to be made to numerous factories, not to mention tyre balancing and mounting equipment in thousands of but repair shops, presents a significant (though not insurmountable) obstacle to the broad adoption of non-pneumatic tyres.

Given the high speed problems with the Tweel, the first commercial applications will be in lower-speed, lower-weight vehicles such as scooters, wheelchairs and other such devices. Michelin also has additional Tweel projects on smaller construction machines, such as skid steer loaders, which appear to be suitable. Rigidness of the airless design will be a major advantage on a rugged, construction sites. The Tweel is durable. Forget a nail, an armored vehicle with Tweel can go over an exploding landmine and keep moving after bullet shots also. The NPT's honeycomb structure is designed to support the load placed on the tyre, dissipate heat and offset some of these issues.

Many companies are working to make this innovation more useful and affordable to everyone. Companies like Tesla, Hankook, Bridgestone, and NASA are working in it as a future scope. Hankook I-flex is a NPT developed by Hankook which shows very promising results.



Fig -9. Hankook I-flex

6. CONCLUSIONS

Tyres are the most important component of any automobile. Tyre seem to be an essential part of an automobile that cannot be improved, but research in the Non Pneumatic tyres gives more safety advantages and having very less environmental impact. Cost of these tyres are much more higher than the conventional pneumatic tyres due to use of high quality rubber polymers, but with research and advance manufacturing methods we can made it as affordable as pneumatic tyres. It's important that to think about the implications of a technology such as this. This type of innovation will be very important because of the benefits and variety of applications that can be used. The use of a flexible structure on six beehive aircraft was proposed– the honeycomb spokes of an NPT to replace the air of a pneumatic tyre. So that in almost every case and parameter non Pneumatic tyres are more valuable and having big scope in future. Thus it concludes that non-pneumatic tyres are more profitable in future than pneumatic tyre.

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