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A REVIEW PAPER ON MODELLING AND 3D PRINTING OF TRACTOR TYRE

P. Varalakshmi[1], Chavan Ravi Nayak[2], Banavath Srinu[3], Vishesh Agarwal[4], Kashamoni Abhishek[5]

[1] Assistant Professor, Dept. Of Mechanical Engineering, Gurunanak Institute Of Technology, Khanapur, India.

[2,3,4,5 UG] Scholars, Dept. Of Mechanical Engineering, Gurunanak Institute Of Technology, Khanapur, India.

Abstract - 3D printing could revolutionize tractor tires. It allows for customization, optimized designs, and advanced materials. The paper explores design software, material selection, and new printing techniques like multi-material for improved tires. Challenges include production scale, machinery compatibility, and post-processing optimization. Overall, 3D printing holds promise for better tractor tires and a more sustainable agricultural sector.

***Key Words*:** Revolutionize, Customization, Postprocessing.

1. LITERATURE SURVEY

Mike Staton et alin 1914 [1]The first attempt to study three areas where tractor performance and fuel efficiency can often be improved was carried out by Mike Staton et alin 1914 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. From the early 1920s, efforts were made to develop a resilient wheel by adding wire spokes in order to deliver a quality pneumatic tire while guaranteeing safety

S.A Al -hamed et [2] After 79 years S.A Al -hamed et al continued studyof the tractor tire performance parameters for radial tire. It includes parameters such as wheel slip,drawabar pull and tr-active efficiency

Tyler Olmstead and Erika[3] In feb 2009 Tyler Olmstead and Erika Fischer study the effectiveness of pressure pads originally designed for ergonomics in displaying real data for vertical pressure distribution when buried in soil. Smooth the test section as much as possible to reduce bouncing of vehicles. This allows for better prediction of vertical force exerted on the test section above the area of interest

Hisanorishinone et al [4] At constant inflation pressure, the bulk density and cone index increased with increasing dynamic load. Soil beneath the edge of a tractor drive tire is likely to be compacted less, and to provide a better crop root environment than soil beneath the centerline of the tire. One year later Hisanorishinone et al carried out experimental analysis of tread pattern effects on tire tr-active performance on sand using an indoor traction measurement system with forced-slip mechanism. To verify the capability of updated traction measurement system, and secondly to clarify the effects of four tread patterns—smooth, lug, rib and block—on tr-active performance of tires running on sand using this updated system. Among the four tread patterns of tires tested, the tire with lug pattern or block pattern generally showed higher draw bar pull than the tire with other tread patterns for slip greater than 17.

J. **R cho et al [5]** In 2011 J.R cho et al did Optimum design of run-flat tire insert rubber by genetic algorithm (GA)to present a generalized multi objective optimization method making use of GA in order to simultaneously enhance the passenger comfort and the durability of a side-wall reinforced run flat tyre by optimally tailoring the side-wall insert rubber

V.T. Atkari, P.B. Aroteand S.B. Pat [6] In 2013 V.T. Atkari, P.B. Aroteand S.B. Patil studied Effect of different tire inflation pressures on drawbar performance of tractor

in different gear setting to evaluate the height for maximum pull and power for wheel slip in recommended range and to evaluate maximum draw bar pull, draw bar power, wheel slip and fuel consumption at various tire inflation pressures in different gears for the best suitable hitch height.Optimum tr-active performance of a driving tire can be obtained by adjusting the inflation pressure of the tire according to the soil conditions over which it moves. The benefits of lower inflation pressure include decreased soil-tire interface pressures, increased tire performance, decreased soil compaction, and a smoother ride.

MallikarjunVeeramurthy [7] MallikarjunVeeramurthy did Optimization of geometry and material properties of a non-pneumatic tyre for reducing rolling resistance.Geometric optimisation of the shear band thickness and spoke thickness of the NPT. Material property optimisation of a non-linear hyperelastic elastomer with finite element based numerical experiments. Shear modulus of PU(Polyurethane) is the most important design parameter to decide rolling resistance, vertical stiffness, and contact pressure. Increase in shear modulus of PU and shear band thickness makes an NPT have a low rolling resistance owing to the lower deformation of shear band.NPT has low rolling resistance when shear modulus of PU and the shear band thickness increase associated with a lower shear deformation while rolling.

A.M. Aboul-Yazid et al [8] In 2014 A.M. Aboul-Yazid et al studied Effect of spokes structures on characteristics Performance of non-pneumatic tires in this Two cases of NPTs are investigated a tire with a composite ring and a tire without a composite ring. The spoke pairs model have the best shape due to its lower rolling resistance, low contact pressure, and least Von Mises stresses on its spokes. Honeycomb spoke have the best shape due to having the least rolling resistance, low mass value, lower and more uniform contact pressure distribution, and accepting Von Mises stresses on its spokes.

Ankur Singhal et al [9] (2016) performed finite element analysis of pneumatic tyre static load conditions on different tread pattern to find which has good traction with road surface by performing total deformation, stress, strain.

ALON [10] has very high impact strength due to which it has high load carrying capacity. ALON is a new oxynitrile material and literature is available regarding its synthesis and characterization.

KshitijNimkar et al [11] 2021 did optimization of cell angle of honeycomb spokes for non-pneumatic tyre to design 3D model of a Non-pneumatic tyre using CATIA software and then that model was analysed using ANSYS software. Three types of honeycomb spokes are designed in AUTOCAD, Ansys finite element analysis is used to study about the deformation and stresses developed in different type of honeycomb spokes.

Akshay Kumar A Kalahastimath [12] 2021 did review airless tyre to study of different types of NPT tyres and got that Military Usage Tweel deflects mine blasts away from the vehicle better than standard tyres and that the Tweel remains mobile even with some of the spokes damaged or missing.SciTech's tyre has closed sidewalls and no spokes, there's no noise or warming issue yet as no issues with dust.In Resilient Technologies, LLC load is equally distributed round the tyre.

Dots. MakhmudjonMelibaev et al [13] 2021 determined the Parameters Affecting The Performance Of Tractor Tires to determine the value of the half-transverse deviation from the specified trajectory, slipping, the amount of fuel consumption, the average resource of the operating time and wear of the tire tread, the number of steering influences during the period of correcting the trajectory of the tractor.

Liz Hutton & John O'Connor [14] 2021 study Tractor tyre selection to study the methods for selecting tyres, types of tyres and factors affecting it. There are two distinct types of tyre construction: bias ply and radial ply. For most farming applications, radial tyres are preferred as their construction improves stiffness along the tread and results in greater traction.

KunalDangane et al [15] 2021 studied Non-pneumatic tyres of different designs NASA And The Apollo Lunar

Rover, Michelin Tweel and Bridgestone NPT and found 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. NPT are more profitable in future than pneumatic tyre.

Z. Hryciów et al [16] 2020 studied the Influence of Non-Pneumatic Tyre Structure on its operational Properties to study the structure of NPT tyres, to solve highly non-Linear statics on dynamics problems and to study characteristics of NPT tyres.

Cristobal Gonzalez Diaz et al [17] 2014 studied Dynamic behavior of a rolling tyre Experimental and numerical analysis. They studied the effect of rotation on the tyre. To improve the ability to control and optimize the noise and vibrations that result from the interaction between the road surface and the rolling tyre.

V.T. Atkari, P.B. Aroteand S.B. Patil [18] 2013 studied Effect of different tire inflation pressures on drawbar performance of tractor in different gear setting to evaluate the height for maximum pull and power for wheel slip in recommended range and to evaluate maximum drawbar pull, drawbar power, wheel slip and fuel consumption at various tire inflation pressures in different gears for the best suitable hitch height.Optimum tractive performance of a driving tire can be obtained by adjusting the inflation pressure of the tire according to the soil conditions over which it moves. The benefits of lower inflation pressure include decreased soil-tire interface pressures, increased tire performance, decreased soil compaction, and a smoother ride. Include decreased soil-tire interface pressures,increased tire performance.

LibinRajan et al [19] 2020 did Design and Comparative Analysis of Non-Pneumatic Tires for a Tractor to Study, design and static analysis of three types or tires i.eMichelin Tweel, Honeycomb structure by Resilient Technology and Airless Tire concept introduced by Bridgestone.

K. Tarakaram et al [20] did Modeling and analysis of NPT with different design structures using fem method. To Study different types of NPT's structures that are: honeycomb, plate, triangle and curved shape. Triangular, Plate, and Curved shapes. To design and analyses different types of spokes by using Ansys

Vladimir Mazur [21] 2018 carried out Experimental research in automobile NPT force heterogeneity to study Coefficient of force heterogeneity and Amplitude of radial force buckling. Radial force es of new type wheeled movers but depends on the terms of their manufacturing. Intensive buckling leads to the enhancement of vibration load level for a driver, passengers and cargo transported by a motor vehicle, as well as to the decrease of hauling and speed properties, fuel saving, stability and motor vehicle controllability.

NandikantiSupriya Reddy &Mr.G.Vinodreddy [22] did Modeling And Analysis Of NPT By Using Ansys to model, simulate and perform static analysis of a NPT used in a four wheeler under working conditions and NPT is modeled in CATIA

Umesh G C et al [23] 2016 did Design and Analysis of Non -Pneumatic Tyre (NPT) With Honeycomb Spokes Structure to study the honeycomb structure of NPT tyres and structural analysis of NPT tyres by using Ansys. The equivalent stress value obtained in static analysis for honeycomb tyre is 76.344 MPa which is under permissible limits of material properties. So the structure is safe. Honeycomb tyres are most convenient to replace the conventional tyre since they provide uniform traction and wear as that of conventional tyre.

N. Nankali et al [24] 2012 developed a 2D multi-laminated model of a tractor tire on soil and compared Analysis with 3D model. The model provides a reliable pattern of soil-tire interface stress distribution and compared to the 3-D analysis, more accuracy is observed in the present 2-D model, due to using fine meshing soil particle

J.R cho et al [25] 2011 did Optimum design of run-flat tire insert rubber by genetic algorithm (GA)to present a generalized multi objective optimization method making use of GA in order to simultaneously enhance the passenger comfort and the durability of a side-wall reinforced run flat tyre by optimally tailoring the side-wall insert rubber.

3. CONCLUSION

3D printing tractor tires offers exciting possibilities for customization, rapid prototyping, and innovative materials. This could lead to better performing, more efficient, and sustainable tires for agricultural equipment. However, there are challenges like limited material options, rougher surface finishes, and high costs. Despite these hurdles, 3D printing technology is constantly evolving, opening doors for future advancements. By carefully considering both the benefits and drawbacks, and through collaboration between researchers, developers, and industry professionals, 3D printing has the potential to revolutionize tractor tire design and manufacturing, ultimately improving agricultural productivity and sustainability.

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