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A Review on Study of Expandable wheels and its Applications in transportation Sector

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ABSTRACT

Expandable wheel concept is very important in case of goods transportation in off road conditions. Many times, we need to transport goods from forest area where vehicles need to travel in no road conditions. If we use expandable wheels in such conditions then transportation well be easy. As per requirement we can change diameter of wheel which allows vehicle to travel easily in off road conditions.

In this paper we have discussed various studies and research papers based on expandable wheels. There is very less literature is available on this topic but still we tried to summarized maximum available research papers. Some of the studies are related to wheels and their characteristics. We have also included such papers. Based on the research study further conclusion is drawn.

Keywords: Expandable Wheel, Transportation, Literature, off road conditions

I. INTRODUCTION

It is known that in making vehicle tires, for example for automobiles, that manufacture of a So-called carcass is first achieved by Successively assembling Several different components. In other words, the different carcass types included in a production range can be distinguished from one another depending on the presence thereon of the Various accessory components and/or the typology of the accessory components themselves.

By way of example, when carcasses for tubeless tires are to be produced, that is tires that in use do not require the presence of an inner tube, the main components can be considered to include a So-called inner liner that is a layer of elastomeric air-impervious material, a carcass ply, a pair of annular metal elements, commonly referred to as bead cores, around which the opposite ends of the carcass ply are folded. as well as a pair of Sidewalls made of elastomeric material, extending over the carcass ply at laterally opposite positions. The accessory components may in turn comprise of one or more additional carcass plies, one or more reinforcing bands for overlying the carcass ply or plies at the areas turned up around the bead cores (chafer Strips), and others.

It is well known that the components of most pneumatic tire constructions must be assembled in a way which pro motes good tire uniformity in order to provide proper tire performance. For example, a tread which "Snakes" as it goes around the tire circumference will cause wobbling as the tire is operated. For example, a carcass ply which is lopsided (longer cords on one side of the tire than the other Side) can cause a variety of tire nonuniformity problems including Static imbalance and radial force variations. For example, a tire which is not meridionally Symmetric (e.g., tread not centered between beads) can cause a variety of tire nonuniformity problems including couple imbalance, lateral force variations, and conicity. Therefore, in order to meet typical tire performance requirements, the tire industry generally expends considerable effort in producing tires with good uniformity. Tire uniformity is generally considered to mean tire dimensions and mass distributions which are uniform and Symmetric radially, laterally, circumferentially, and meridionally, thereby producing acceptable results for measurements of tire uniformity including Static and dynamic

II. Literature Survey

Ch. Grand(1,2), Ph. Bidaud(1), N. Jarrass´e(1), "Innovative concept of unfoldable wheel with an active contact adaptation mechanism". In their study work, an original expandable mechanism for unfolding wheels is proposed. This mechanism combines two elementary mechanisms. One allows the deployment of the rim while the other one ensures the contact shape adaptation. In the first section, they have analyzed the different deployment mechanisms already proposed in the literature. Then, the design of the rim expansion mechanism is described and two complementary versions are proposed. Last, based on terramechanics models, a contact surface adaptation mechanism is proposed. This system allows to adapt the wheelground interaction properties and make the wheel ables to improve its traction and steering performance on soft soil. [1]

Matic Frajnkovic, Senad Omerovic, Uros Rozic, Jurij Kern, Raphael Connes, Kristof Rener, and Matej Biček, "Structural Integrity of In-Wheel Motors". They state that in-wheel motors offer an optimized solution for novel drivetrain architectures of future electric vehicles that could penetrate into the mainstream automotive industry, moving the wheel actuation where it's required, directly inside the wheels. Obtainable literature mainly deals with optimization of electromagnetically active parts, however, mechanical design of electromagnetically passive parts that indirectly influence motor performance also requires detailed analysis and extensive validation. To meet the optimal performance requirements (also durable) of an in-wheel traction motor, their mechanical design requires topology optimization of housing elements, thermal mapping, geometrical and dimensional tolerance checks and selection of proper hub bearings, in order to assure consistent electromagnetic behavior stability Their paper uniquely describes the review of loads acting on an in-wheel motor, the workflow of a typical mechanical design process, testing, and validation processes for achieving the required durability of an in-wheel assembly. [2]

Mr. Chintapalli Shekhar, 2mr. B.V.V.V.B Lakshmipati Rao, 3 Mr. V.V.Rama Krishna, "Design And Structural Analysis of Car Alloy Wheel Using With Various Materials". They explained that wheel is a main mechanical term of the vehicular suspension system that supports the static and dynamic loads encountered during vehicle action. Since cars carry heavy loads of occupants as well as self-weight, the alloy wheel rim should be strong enough to withstand this load. Thus, their design should be done very cautiously. While designing such main kind of automotive component taking care of protection and cost are very important concerns so that user can use it safely. Major five technical considerations while

modeling any new alloy wheel rim are styling, aesthetic, mass, manufacturability and capability. While analyzing stress and displacement, shear stress distribution in vehicle wheels subjected to increase pressure and radial load. Essential efforts have been taken to discover the Finite Element Techniques. Alloy wheel rim has been designed using Catia software, after that static analysis is done with different materials (Carbon epoxy composite, AL6061, Mg alloy) load and boundary conditions taking in ANSYS14.5 Software. Finally observed results of stress, total deformation, shear stress on different wheel rims (Hexagon spoke shape and Elliptical spoke shape) materials and compared with each other. Thus, the best design and material can be selected for manufacturing of the alloy wheel. [3]

Wen Zeng *, Guoyan Xu, Hui Jiang and Feng Gao, "Development of a Novel Variable-Diameter Wheel". They explained that, variable-diameter wheels balance the high mobility and limited volume of a planetary rover. Moreover, these wheels allow a rover to adjust its body attitude to adapt to rough terrains. These functions are achieved through the expansion–retraction motion of the variable-diameter mechanisms in the wheels. Thus, the traditional wheel design focuses on these mechanisms. To further facilitate its application, they have proposed a new concept variable-diameter wheel that considers the mechanism characteristics and wheel performances. This new wheel configuration is presented along with the corresponding transmission system, design, and analysis methods. Kinematic equations of the mechanism were established and then applied to synthesize the wheel dimensions. The load–deflection relationship of the wheels was analytically derived by developing a modified pseudo-rigid-body model (PRBM). Finite element analysis (FEA) simulations were performed to validate the design and analysis. In conclusion, the proposed novel wheel is extremely beneficial for rough-terrain locomotion systems. Furthermore, the design and analysis approaches used in this study are applicable for other expandable wheels. [4]

V.Vignesh 1, R.Prakash 2, S.Mathew Stephen3, S.Anish Kumar4, "Design and Development of Two in One Foldable Stretcher Cum Wheel Chair". In their project the stretcher and wheel chair used in hospitals are combined with each other, so that it can be used for multi-purpose instead of using both of them separately. It can reduce the mobility problem of the patients. In ICU there is a problem of shifting the severely injured or fractured patients from stretcher to wheel chair those problems can be reduced by using this product. It is used to take ECG & SCAN report for the patients without changing from stretcher to wheelchair. This model consists of three rectangular couches which are joined together. These joints are not a permanent joint so that it can be adjustable to any angles and also assemble or dismantle of this product will be easy. These plates are joined by bolted joints, so that all the plates can be foldable to stretcher or to wheel chair. Four wheels are fitted in the base. The dimensions used for this project is developed for Indian standards. All the dimensions are taken from "Anthropometric and strength data of Indian agricultural workers for farm equipment design" published by central institute of agricultural engineering, Bhopal. All the parts used in their project are made up of stainless steel 202 for the Product development. The telescopic rods are used to adjust the required length and angle the holes provided in the telescopic pipe are used to fold the stretcher into different angle. The product cost is Rs 14500 which is 40% less than the conventional products. [5]

Mary M. Doyle BSc Eng, Dip Eng., "The Design of an aluminium alloy wheel using three-dimensional Finite Element Analysis and Fatigue Life Prediction." They have explained that, styling has always played a very important role in automobile design. This factor as well as the demands of new safety legislation in Europe and throughout the world makes it a very competitive industry. This often leads to complex car

designs which need to be produced and proof tested with a minimum lead time and expenditure. But these new designs and manufacturing technologies must be reliable, thus the automobile manufacturer is increasingly investigating and developing new design tools to help improve the quality of their products. Computer aided engineering helps reduce the time necessary to produce a new design. It also improves the quality of design. In their study computer aided design, finite element analysis and fatigue life prediction are the tools which have been used. The design of a cast aluminium alloy wheel has been optimised using the Finite Element technique. It simulates the behaviour of the wheel under it's working load conditions. IDEAS Master Series has been used to develop a three-dimensional linear elastic structural model. The wheel has been loaded with static load cases which represent the working load conditions. Maximum and minimum principal stresses were calculated and a comparison of these with measured test results was made to establish a correlation with acceptable accuracy. Stress time histories from the tested wheel are used for this purpose. Once the predicted results were validated, the technique was used to simulate stress patterns under a variety of possible load cases. The mechanism of load transfer from the tyre to the wheel rim was studied in detail and suggestions made as to how to optimise the FEA's model load cases. It was found that the wheel's stress level in the critical areas was below the material's allowable fatigue stress level. Thus, the geometry of the wheel has been modified to optimise the volume of the aluminium alloy used in the manufacture of the wheel, yet still keep the stress amplitudes to an acceptable level. Finally, a Procedure for the fatigue life prediction of the wheel was developed to verify that the actual lifetime of the wheel was greater than, or at least equal to the required lifetime using the Local Stress approach. Turbo Pascal is the programming language used here. [6]

Nick Winch, "The Expandable Wheel". They explained that, intended as an offshoot of the engineering project, "The Growing Bike," this honours engineering design project tackles the conceptual and technical design of a bicycle wheel which adjusts in size according to user preference. The wheel functions via controlled tightening and loosening of a stressed coil which serves as the basis for the rim. This coil is held together by six bendable mounts which are spaced evenly along the circumference. These mounts are shaped in a way to accommodate a standard size bike tire. The rim sections are held in place at mounting points by six interior spokes pinned at symmetrical, equidistant points hexagonally oriented 3 inches from the wheel's centre. The wheel is adjusted by the user manipulating a ratchet mechanism which alters the spokes' orientation and enlarges or shrinks the diameter. The wheel rim is designed to expand from a 14" to a 22" diameter. This project is purely theoretical at this stage due to fabrication complexity and specificity of the materials required to prototype. [7]

Philippe Bidaud, Faiz Ben Amar, Sebastien Poirier, "An expandable mechanism for deployment and contact surface adaptation of rover wheels". In their paper, an expandable mechanism for unfolding wheels is proposed. This mechanisms combines 2 elementary mechanisms. One allows the deployment of the rim the other one ensuring the contact shape adaptation. [8]

III.CONCLUSION

By studying all above literatures, we come to know that the expandable wheel concept is very rare and not yet implemented in required sector effectively. It needs more research and testing. For this purpose, CAD and CAE tools are helpful and less costly. Further more conclusions are given in following points.

1) Expandable wheel concept is not yet implemented

2) Researchers have focused on increasing the wheel diameter.

3) Detailed design of expandable wheel needs the structural analysis in both static and dynamic condition.

4) Finite Element Analysis will be helpful to check stability and behaviour under loading.

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