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Experimental Analysis of Tyre Drum Spacer

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ABSTRACT: The tyre building drum serves as the foundation for the assembly of a tyre. It is a large cylindrical drum made of sturdy materials such as mild steel or aluminum. The drum's diameter and length are designed to match the specifications of the tyre being produced. The outer surface of the drum features specialized grooves or patterns that facilitate the proper adhesion of the rubber components during the assembly process. The drum rotates at controlled speeds, allowing for the systematic placement of various components that form the tyre's structure. To ensure a smooth and precise tyre assembly, 12 spacers are fixed on the tyre building drum. These spacers play a crucial role in maintaining a uniform gap between the drum and the tyre. The main objective of this project is to analyze issues in the tire building process to reduce defects and enhance the reliability and performance of the finished tyres. The engine block design is done in solid works simulation and analysis of strain energy, thermal strain, equivalent elastic strain, directional deformation carried out in ANSYS work bench 2024.

I.INTRODUCTION

1.1 BACKGROUND AND PROBLEM STATEMENT.

In this project, we will delve into the challenge to tackle the angle problem in the assembly of 12 parts combined to form a spacers for Tyre Company. The goal is to find an effective solution that ensures precise alignment and fixing of the spacers on the tyre building drum. They have been trusted by various industries to deliver high-quality products.

1.2 CHALLENGES IN MANUAL SPACER ASSEMBLY.

A Tyre Company produces the 12 parts spacer for their tyre building drum assembly process. The tyre building drum Is a vital component in the tyre manufacturing process. It plays a crucial role in achieving the desired shape and structure of the tyre. The Tyre Company relies on the efficient functioning of the tyre building drum to produce high-quality tyres for various applications. However, during the manual assembly process of fixing 12 spacers on the drum, a significant problem arises – the angle problem. This issue poses challenges to the overall tyre production and necessitates the urgent development of a solution.

1.3 THE TYRE BULIDING DRUM.

The tyre building drum serves as the foundation for the assembly of a tyre. It is a large cylindrical drum made of sturdy materials such as steel or aluminum. The drum's diameter and length are designed to match the specifications of the tyre being produced. The outer surface of the drum features specialized grooves or patterns that facilitate the proper adhesion of the rubber components during the assembly process. The drum rotates at controlled speeds, allowing for the systematic placement of various components that form the tyre's structure. To ensure a smooth and precise tyre assembly, 12 spacers are fixed on the tyre building drum. These spacers play a crucial role in maintaining a uniform gap between the drum and the tyre. They prevent any unwanted contact between the rubber components and the drum,

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ensuring that the tyre's surface remains smooth and flawless. The spacers also aid in controlling the tyre's dimensions, shape, and alignment during the building process. The manual assembly process of fixing the spacers on the drum at Rali Engineering Works presents a unique challenge. The absence of a dedicated machine or automated system for this task necessitates the reliance on human operators to achieve accurate spacer positioning. The angle problem arises when the employees encounter difficulties in consistently and precisely fixing the spacers at the desired angles. The angle problem can have various Implications on the overall tyre production process. Firstly, the inconsistent positioning of the spacers can lead to variations in the tyre's dimensions and shape. This can result in imbalanced or uneven tyres, affecting their performance, durability, and safety. Secondly, the smoothness of the tyre surface can be compromised, leading to an inferior finish and potential defects. Moreover, the angle problem may result in increased friction and wear during subsequent manufacturing steps, impacting the overall efficiency and quality of the process.

1.4 PROJECT OBJECTIVE.

Recognizing the significance of addressing the angle problem, the manufacturing college has sought an effective solution to enhance their tyre assembly process. They have entrusted our team with an industrial project to develop an innovative solution that tackles this challenge head-on. Our objective is to create a solution that improves the accuracy, consistency, and efficiency of fixing the 12 spacers on the tyre building drum.

1.5 APPROACH AND METHODOLOGY.

In order to tackle this problem, our team will undertake a comprehensive analysis of the current manual assembly process. We will closely examine the factors contributing to the angle problem, including the work environment, techniques used by the operators, and any underlying constraints. Through this analysis, we aim to identify the root causes of the problem and gain a deeper understanding of its complexities. Utilizing our expertise in mechanical engineering and innovative design, we will explore various concepts and methodologies to develop a solution that addresses the angle problem effectively. This may involve the introduction of specialized tools, fixtures, or improved techniques that aid the operators in achieving accurate spacer positioning. We will prioritize simplicity, practicality, and user-friendliness in our proposed solution, considering the manual nature of the assembly process. Collaboration with the employees at Rali Engineering Works will be integral to the success of this project. Their first-hand experience and insights will provide valuable guidance in refining our solution to align with their specific requirements and operational constraints. By involving them in the development process, we seek to ensure that our proposed solution integrates seamlessly into their existing assembly workflow and enhances their overall productivity. Furthermore, the implementation of our solution holds significant benefits for Rali Engineering Works. With improved accuracy in fixing the spacers at the desired angles, they can expect enhanced tyre quality, increased production efficiency, and reduced waste. The proposed solution aims to streamline their assembly process, minimizing errors, optimizing resource utilization, and ultimately contributing to their operational excellence.

1.6 CONCLUSION AND COMMITMENT.

In conclusion, the angle problem encountered during the manual assembly of 12 spacers on the tyre building drum presents a critical challenge that must be addressed to ensure efficient and high-quality tyre production. The manufacturing company has entrusted us with an industrial project to find an innovative solution to this problem. Our team will conduct a thorough analysis, develop feasible concepts, and collaborate closely with the employees to create a solution that improves accuracy, consistency, and efficiency in the spacer fixing process. We are committed to overcoming this challenge and contributing to the success of Rali Engineering Works in their tyre manufacturing endeavor

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1.7 TYRE DRUM SPACER DIAGRAM

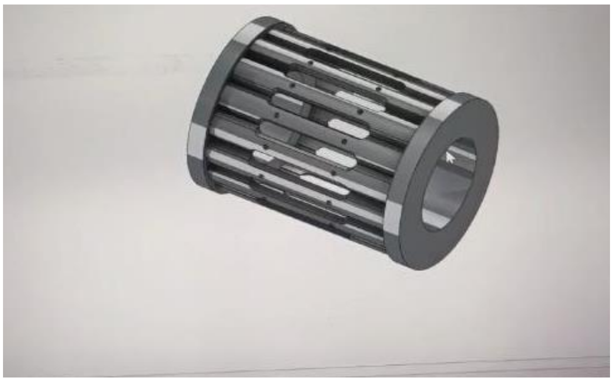

Fig 1. Tyre drum spacer

II.LITERATURE SURVEY

Research papers are studied to find the new method and new area of study that increases the efficiency, performance and life of connecting rod. So various design are studied to reach the appropriate conclusion. **1**.CN1792623A, china High crown uni-stage tire building drum. A tire building drum and a method of building a tire carcass are disclosed. The tire building drum has a center section comprised of a plurality of segments that are radially and axially movable. The building drum further comprises shoulder sections that are axially movable. The shoulder sections include radially expandable bead locks. The method employs the steps of applying one or more carcass layers, locking the bead locks and moving the center section radially outwardly while moving the bead locks axially inwardly. Claim: Tire assembly drum is characterized in that: have the rotatable moulding drum of core and first, second tire shoulder part, each can be radially and axially motion independently in the wherein said tire shoulder part; Described core is radially inflatable, and the feature of described core also is the first half ones and the second half ones, and wherein the first half ones and the second half ones relative to each other can move axially so that core has adjustable width. **2.**US3867231A,United States Tire building machine Building a tire having a circumferentially inextensible belt, and particularly a multi-condition tire building drum providing in an intermediate condition, a high crown firmly supported for stitching a cylindrical tire band, a radially expansible sleeve secured radially on and extending axially between a pair of drum end assemblies movable toward and away from each other and cooperating with the sleeve to form a chamber into which air is admitted to expand the sleeve into toroidal form as the end assemblies are moved toward one another, bead locating segment assemblies adjacent to and axially outboard of the sleeve ends to locate beads of the tire in firm axial and concentric position as the tire is shaped from a cylindrical to a toroidal form and particularly useful in securing the beads in proper location during conventional stitching operations. The drum features expansion of the internal supporting segments by rotation of scroll plates each having a plurality of spiral cam grooves by which the segments are moved radially inwardly and outwardly. Claim :In tire building apparatus for building a tire having therein a circumferentially inextensible belt; a building drum comprising an expansible sleeve providing a continuous exterior surface for contiguously supporting said tire and terminating in radially fixed inwardly turned ends; a hollow cylindrical center shaft disposed coaxially within said sleeve and extending axially outwardly of said ends; a pair of rigid end bodies mounted coaxially and corotatably on said shaft for movement toward and away from each other, said ends being secured respectively to said bodies; a plurality of rigid interior support segments mounted within said sleeve on each of said bodies for movement radially of the drum rotation axis and cooperable to provide in one condition of said drum firm continuous cylindrical support to said sleeve between said ends; and a plurality of bead locating segments disposed close to and axially fixed outwardly of each of said inwardly turned ends and supported for movement radially of the drum axis, a rigid annular member mounted outwardly of each of said ends for coaxial movement toward and away from the respectively associated end, and a plurality of rigid links each pin-connected to one said member and respectively to one of said bead locating segments to maintain the segments concentric with the drum axis. **3.**US4010058A,United States, Tire building drum. A tire building drum having simple economical means for expanding both drum shoulders and bead-locating fingers as well as for convenient and simple adjustment of the length of the drumbetween shoulders. Air for inflating pairs of ply-turnup bladders is supplied externally by way of an air ring on the drum shaft from an externally mounted air manifold. Claim :A tire building drum including a shaft and a pair of drum end assemblies each having a plurality of segments disposed about the shaft which cooperate to form shoulders of

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the drum, and a plurality of bead positioning fingers disposed about the shaft adjacent to and axially outward of the shoulders which cooperate to position the tire bead, a righthand-lefthand screw disposed coaxially of the shaft, a nut disposed within the shaft adjacent to each end assembly, each nut being cooperable with a respective threaded portion of said screw to move axially of the shaft in response to rotation of the screw and characterized by means for actuating the segments and the fingers of the drum comprising a plurality of slides rigidly connected to each nut and disposed slidably in the respective end assemblies for movement parallel to the shaft, a first rigid link associated with each said slide and pivotally connected at its respective ends to one of said segments and to the associated slide, and a second rigid link associated with each said slide and pivotally connected at its respective ends to one of said fingers and to the associated slide. **4.**WO2023060861A1,WIPO (PCT),Working diameter-variable building drum.The present invention relates to a working diameter-variable building drum, comprising a main shaft group, a turn-up capsule cylinder mechanism, a sliding locking block assembly, and a power mechanism. The sliding locking block assembly comprises a guide plate, a guide disc, sliding blocks, and locking blocks; the guide plate and the guide disc are sleeved on the main shaft group, and a sliding way is formed therebetween; there are a plurality of sliding blocks and a plurality of locking blocks in one-to-one correspondence; the plurality of sliding blocks are circumferentially embedded in the sliding way and are fixed to the corresponding locking blocks; gaps are reserved between the locking blocks and a side surface of the sliding way, so as to separate the locking blocks from the sliding way; the power mechanism is mounted on the main shaft group; and the turn-up capsule cylinder mechanism is detachably connected to the power mechanism. According to the building drum, the size of the building drum can be changed by replacing the turn-up capsule cylinder mechanisms having different diameters, such that the building drum can meet the production of tires of different inch levels, the application range of the building drum is widened, the number of building drums configured for users is reduced, the device purchase cost is reduced, and the production efficiency is improved. Claim :A forming drum with a variable working diameter is characterized in that it includes a main shaft group, an anti-encapsulating cylinder mechanism, a sliding lock block assembly and a power mechanism; The sliding lock block assembly includes a guide plate, a guide plate, a slider and a lock block. The guide plate and the guide plate are sleeved on the main shaft group and a slideway is formed between the two. The slide block and the lock block have many One and one corresponding, a plurality of the sliders are embedded in the slideway in a circumferential shape and fixed with the corresponding lock blocks, and the lock blocks leave a gap with the side of the slideway so as to be separated from the slideway .

III. METHODOLOGY OF TYRE DRUM SPACER

3.1 The ANSYS Workbench Interface:

The ANSYS Workbench interface consists primarily of a Toolbox region, the Project Schematic, the Toolbar, and the Menu bar. Depending on the analysis type and/or application or workspace, you may also see other windows, tables, charts, etc. One way to work in ANSYS Workbench is to drag an item such as a component or analysis system from the Toolbox to the Project Schematic or to double-click on an item to initiate the default action. You can also use the context menus, accessible from a right-mouse click, for additional options. You will view your analysis systems -- the components that make up your analysis -- in the Project Schematic, including all connections and links between the systems. The individual applications in which you work will display separately from the ANSYS Workbench GUI, but the results of the actions you take in the applications may be reflected in the Project Schematic.

3.2 Toolbox:

The ANSYS Workbench Toolbox presents the types of data that you can add to your project. The Toolbox is context-sensitive; as you select different items in the Project Schematic or other workspaces, the contents of the Toolbox may change to reflect the components and actions available to you. When working in other workspaces, such as Engineering Data or Parameters, you can return to the Project Workspace by clicking the Return to Project button on the Toolbar.

3.3 ANALYSIS TYPES:

The different type of analysis that can be performed in ANSYS Structural static analysis:

1.Strain energy.
2.Thermal strain.
3.Equivalent elastic strain.
4.Directional deformation.

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IV. RESULT AND DISCUSSION

4.1 STRENGTH TEST ON SPACER

We used to determine the limited strength of the spacer so we apply the force in KN on the spacer and it limits up to 50KN (Fig 2)

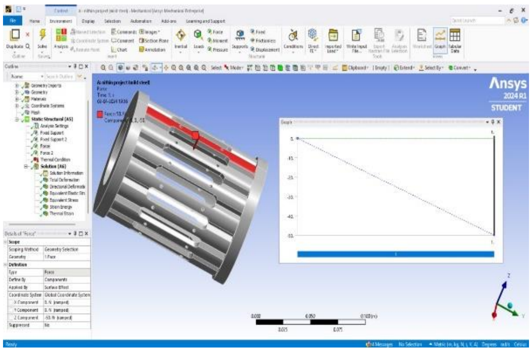

Fig 2 . STRENGTH TEST

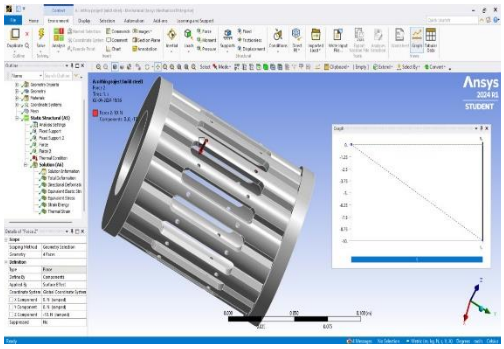

Fig 3 . NUT FORCE TEST

4.2 NUT FORCE TEST

In this test we used to determine whether the nut stress is able to bend the spacer the nut force is exceed at 10N which the small amount of nut force will not stress the spacer(Fig 3)

4.3 THERMAL TEST

In this test we test the thermal condition of the spacer it smoothly transfer the heat in all area so there is no availablity of thermal damage.(Fig 4)

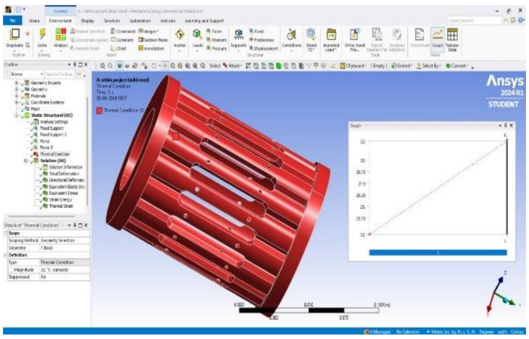

Fig 4 . THERMAL TEST

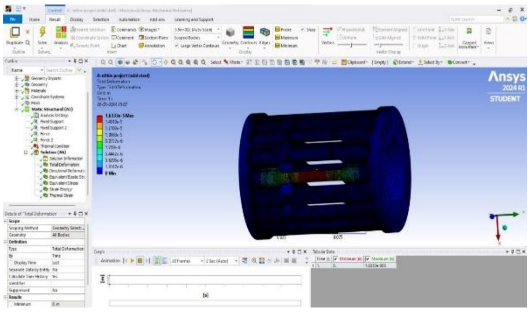

Fig 5 . TOTAL DEFORMATION

4.4 TOTAL DEFORMATION

In analysis software, total deformation is often a key output or result parameter that is calculated during structural analysis. During the simulation of a particular structure or part, total deformation provides information about how much an object or structure will deform under the applied loads or forces. Software such as ANSYS Mechanical, for example, can calculate total deformation in a number of different ways, depending on the specific analysis being performed. In typical finite element analysis (FEA) simulations, the total deformation output shows the total movement or displacement of each node of the finite element mesh in the X, Y and Z directions, as well as the resultant vector.Total deformation provides insight into the state of the structure under load, and can play an important role in validating the design, evaluating the strength and stiffness of the structure, and ultimately determining whether or not a particular design will meet the desired performance criteria.(Fig 5)

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4.5 EQUIVALENT STRESS

Equivalent stress is another important output parameter in analysis software that is calculated during structural analysis. Equivalent stress represents a simplified stress state that considers both von Mises stresses and the effect of different principal stresses acting on a particular point in the structure. In ANSYS Mechanical, for example, equivalent stress is calculated using material properties and load information, and is derived from the stresses calculated at each integration point of the finite element mesh. The equivalent stress result is useful for comparing the results of different simulations and for evaluating the strength and durability of a structure under load. It is important to note that equivalent stress does not provide the complete picture of the actual stress state in the structure, but rather provides a simplified representation of the stress state at particular points in the structure. However, it is still a valuable metric for evaluating the strength and stability of the structure.(Fig 6)

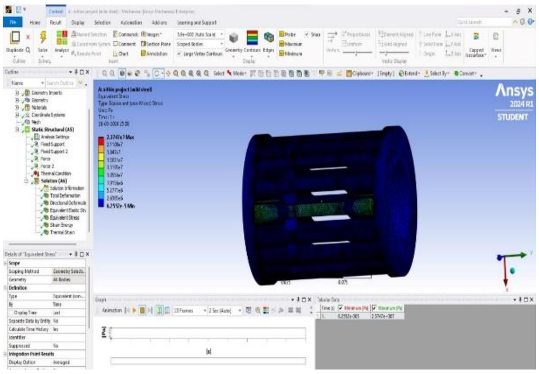

Fig 6 . EQUIVALENT STRESS

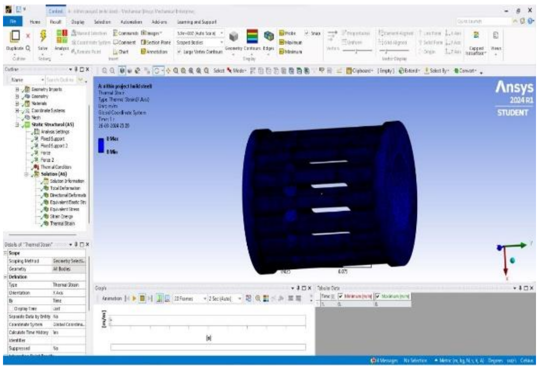

Fig 7 . THERMAL STRAIN

4.6 THERMAL STRAIN

Thermal strain is a parameter that is considered in structural analysis software, such as ANSYS, when analyzing the behavior of structures under thermal loads or temperature changes. When a structure is subjected to temperature variations, the different materials within the structure may expand or contract at different rates. This leads to thermal strains, which are the deformations or displacements that occur as a result of thermal expansion or contraction. In ANSYS, thermal strains can be calculated by accounting for the coefficient of thermal expansion of each material in the structure, as well as the temperature change. The thermal strains calculated can then be used to determine the resulting stresses and deformations in the structure due to the thermal load. Considering thermal strains is crucial in analyzing structures that experience significant temperature variations, as they can affect the overall integrity and performance of the structure. By accounting for thermal strains, engineers and designers can ensure that the structure can withstand thermal effects without compromising its functionality or structural integrity. .(Fig 7)

4.7 STRAIN ENERGY

Strain energy is a parameter that is calculated by structural analysis software, such as ANSYS, and represents the energy stored within the structure due to deformations and displacements caused by external loads. When a structure is subjected to loads or forces, it undergoes deformations and displacements, which require energy to be stored within the structure. The energy stored is known as strain energy and is calculated by integrating the product of the material properties, deformation, and strain over the entire volume of the structure. In ANSYS, strain energy can be calculated by examining the internal forces and deformations within the structure and applying the appropriate material properties. Strain energy is an important parameter for evaluating the strength and performance of a structure under load, as it provides insight into the amount of energy required to deform and displace the structure. In addition, strain energy can be used to evaluate the effectiveness of different design modifications or material choices. By comparing the strain energy values of different designs, engineers and designers can determine which design is more efficient and requires less energy to achieve the same level of performance. (Fig 8)

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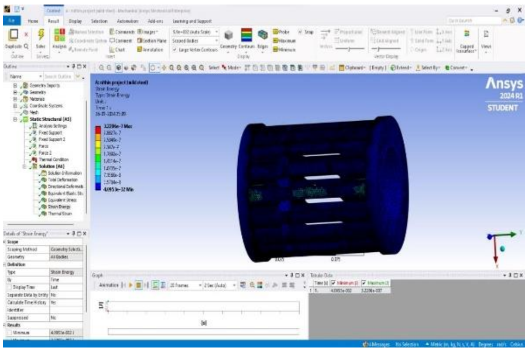

Fig 8 STRAIN ENERGY

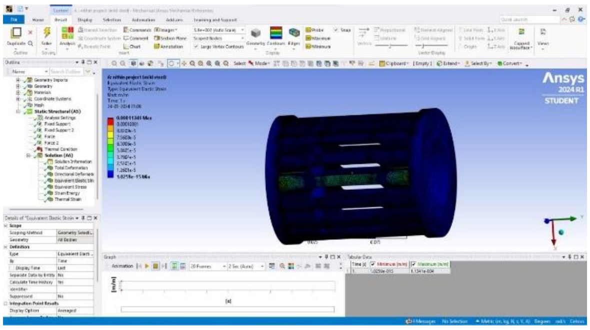

Fig 9 EQIVALENT ELASTIC STRAIN

4.8 EQUIVALENT ELASTIC STRAIN

In ANSYS, the term "equivalent elastic strain" refers to a calculated parameter that represents the amount of strain experienced by a material under mechanical loading conditions. It is a measure of the deformation or elongation that occurs in a material when subjected to external forces. Equivalent elastic strain is typically calculated based on the concept of Von Mises stress, which is a measure of the combined effect of normal stresses and shear stresses on a material. Von Mises stress is then used to calculate the equivalent elastic strain. By analyzing the equivalent elastic strain in ANSYS, engineers and designers can assess the extent and distribution of strain within a structure. This information is important in understanding the potential for material failure, evaluating the structural integrity, and determining the suitability of the design for the intended applications. Moreover, equivalent elastic strain also serves as a valuable input for assessing fatigue life, determining load capacity, and making design modifications to optimize the performance and durability of the structure. It helps in identifying critical regions and potential failure points, allowing engineers to make informed decisions during the design and analysis process in ANSYS.(Fig 9)

4.9 DIRECTIONAL DEFORMATION

In ANSYS, the term "directional deformation" refers to the analysis and visualization of the deformation patterns or changes in shape that occur in a structure under mechanical loading conditions. It helps to understand how the structure responds and deforms in different directions. Directional deformation can be visualized by applying loads or forces to the structure in various directions and observing the resulting displacements and deformations. ANSYS provides tools and functionalities to analyze and represent these deformations graphically, allowing engineers and designers to gain insights into the behavior of the structure. By examining directional deformation in ANSYS, engineers can identify areas of high deformation or stress concentration and make informed decisions to optimize the design and improve structural performance. It helps in assessing the structural integrity, identifying potential failure points, and making design modifications to ensure that the structure can withstand the intended loading conditions. Additionally, ANSYS also offers the ability to animate the deformation to provide a dynamic view of the structural response. This can be particularly useful in visualizing complex deformations and understanding the behavior of the structure under different loading scenarios. Overall, the analysis of directional deformation in ANSYS aids in the evaluation and optimization of structural designs, allowing for improved performance, reliability, and safety. (Fig 10)

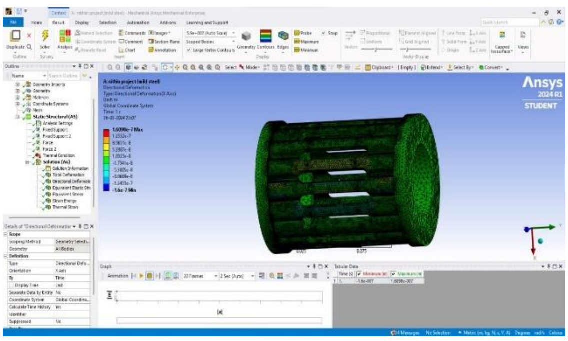

Fig 10 DIRECTIONAL DEFORATION

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4.10 MATERIAL DATA OF MILD STEEL

Density	7.85e-006 kg mm^-3
Tensile Yield Strength	400 MPa
Young's Modulus	2.1e+005 MPa
Poisson's Ratio	0.28
Bulk Modulus	1.5909e+005 MPa
Shear Modulus	82031MPa

4.11 TEST SOLUTIONS

TEST	MINIMUM SOLUTION	MAXIMUM SOLUTION
Strain Energy	$4.0953e^{-029}$ MJ	$3.2206e^{-004}$ MJ
Equivalent Stress	$6.2552e^{-011}$ MPa	23.747 MPa
Equivalent Elastic Strain	$1.0259e^{-015}$ mm	$1.1341e^{-004}$ mm
Directional Deformation	$-1.6e^{-004}$ mm	$1.6098e^{-004}$ mm
Total Deformation	0 mm	$1.6333e^{-002}$ mm

4.12 RESULT CONCLUSION

In result conclusion by testing our design in Ansys there is nothing wrong in design or material selection and we assume that the problem is arises in assembly process.

V.RESULT

5.1 INTRODUCTION

Bevel protectors can indeed be used to solve angle problems. A bevel protector is a tool that helps measure and mark angles accurately. It can be used to set and transfer angles, making it easier to cut or shape materials at specific angles. Whether you're working on woodworking projects, construction, or any other task that requires precise angles, a bevel protector can be a useful tool to have

5.2 SOLUTION AND FEATURE WORK

To address the angle issue when assembling the 12 parts on the tyre building drum, one potential solution could be to use a bevel gear protector. A bevel gear protector is a device that helps align and fix the angle of the parts during assembly.

Here's how it could work

- Design a bevel gear protector: Create a customized bevel gear protector that fits around the cylindrical drum and has specific features to hold the 12 parts in place. The protector should have beveled surfaces that correspond to the desired angle for the parts.
- Install the bevel gear protector: Attach the bevel gear protector securely onto the drum, ensuring proper alignment with the mounting features.
- Position the parts: Place the 12 individual parts of mild steel onto the drum, aligning them with the beveled surfaces of the gear protector. The beveled surfaces will guide the parts to the correct angle, preventing any misalignment issues.
- Secure the parts: Once the parts are in the correct position, use appropriate fixtures or clamps to secure them firmly against the drum, ensuring they maintain the desired angle.

By using a bevel gear protector, you can ensure accurate and consistent assembly of the parts, minimizing any angle problems that may arise during the manual assembly process.

In conclusion, the utilization of a bevel protector as a solution for the tapper angle problem in the Tyre building process is a significant step towards improving efficiency and reducing errors in Rali Engineering Works' project for ATG Tyre

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Company. By suggesting the use of this protective component, the potential risks associated with incorrect or misaligned placement of the 12 segment parts within the drum can be effectively mitigated. The bevel protector acts as a safeguard, ensuring a smooth and secure fit between the drum and the parts. Its implementation aids in maintaining the desired angle, thereby enhancing the overall precision of the Tyre building process. This solution not only resolves the tapper angle problem, but also contributes to increased productivity and decreased downtime, as potential issues during assembly are minimized. Furthermore, the incorporation of bevel protectors demonstrates Rali Engineering Works' commitment to innovative problem-solving and customer satisfaction. By providing a practical and effective solution, they solidify their position as a reliable and trusted product producing company. The bevel protector solution and to make any necessary adjustments or improvements. By maintaining open communication with ATG Tyre Company and staying responsive to their feedback, Rali Engineering Works can further refine their product offerings and ensure continuous improvement.

Overall, the implementation of the bevel protector solution paves the way for smoother, more efficient Tyre building operations and serves as a testament to Rali Engineering Works' dedication to providing innovative solutions for their customers.

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