ANSYS Simulation for Analyzing Monowheel Frame Performance

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Abstract: Automobiles and motorcycles that run on conventional fuels are currently not the greatest for transportation because to the rising awareness of pollution and the energy shortage concerns. There is a demand for a less expensive and more effective mode of transportation because the cost of petroleum goods is soaring right now. Additionally, it is becoming more and more crucial to conserve energy in order to assess the issue of leftover fuel depletion. Even large-scale manufacturing and industrial operations restrict their employees' use of transportation within the premises in order to reduce the risk of air pollution. Research on environmentally friendly transport has increased to fulfil these demands. Technology for electrically powered vehicles is a step in the right direction. One such environmentally friendly vehicle that aids employees in covering large distances inside of their organisations is the monowheel. A monowheel is a single-track, one-wheeled vehicle that looks a lot like a unicycle. The rider sits inside the wheel as opposed to being above it like on a unicycle. The wheel is a ring that is often propelled by smaller wheels contacting its inner rim. The smaller wheels are powered by an electric motor and a battery to turn. Changes to the frame's design and the addition of solar panels as a backup power source are proposed. Then, the car can also be powered by solar energy. Software from CATIA and ANSYS, respectively, are used for the design and analysis of the inner and exterior fames.

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1. Introduction

The best form of transportation may eventually be electrically powered automobiles. In a climate where conventional car emissions must be limited, traffic congestion and parking availability are key concerns, particularly in urban areas. With regard to all of these challenges, it is imperative to create a transit system that can address them. the creation of a one-wheeled electric vehicle with attributes that, due to its short longitudinal length and low carbon footprint, can overcome all the issues listed above. The original monocycle, which had seating inside the monowheel and was manufactured by French craftsman Rousseau of Marseilles in 1869, was driven by the rider changing weight in the direction they wanted. Even more challenging, the enormous outer wheel constantly stayed in the drivers' direct line of sight. Additionally risky was braking since if it was done too suddenly, the rider would be thrown forward along with the outer wheel [1]. The Embryo, a concept design for such a machine utilised as a sport vehicle [2], was the subject of the research. where a hydrogen fuel cell powers .Using a control mechanism similar to that of the Segway PT, Trevor Blackwell exhibited a working selfalancing unicycle and published the schematics for the device[3].where the bic ycle merely has a seat [4] Janick et al introduced a motorized transport vehicle for a pedestrian, and they filed a US patent for a compact seatless device [5]. A "self-propelled unicycle engaged with vehicle" was patent by Ford Motor Company. "A self-propelled unicycle is selectively engaged with a vehicle for use therewith and selectively detached therefrom for use independently. The self-propelled unicycle has a rotating wheel attached to the hub and a hub [6]. A two-wheeled, self-balancing mobile robot built around a control moment gyroscope module is presented by Ji-Hyun Park et al. Compared to legged robots, such as humanoid-style robots, two-wheeled mobile robots are better able to move quickly and rotate in tight places. Due to this, the two-wheeled mobile robot is typically employed as a platform for mobile robots[7]. A folding bicycle that is intended to fold into a compact form for easy transport and convenient parking is proposed by Mayur Shelke et al. When folded, the bicycle is easier to transport anywhere we need to go. Each folding mechanism offers a unique combination of folding speed and ease, frame compactness, ride, weight, durability, and price that changes with changes in material specifications. Folding mechanisms can vary [8]. A. Kadis et al. includes an overview of the system's mechanical and electrical parts. The mechanical steering system that aids the rider in maintaining balance in the roll direction is addressed. After that, Simulink is used to derive and simulate the dynamics of a generic unicycle in the pitch direction using a LaGrange formulation. Then it is suggested to use a linear PD control law to stabilise the plant in the pitch direction. Data from both the physical and simulated systems are utilised to objectively evaluate the control system, which is implemented on both [9].Due to a lack of time and a hectic lifestyle, modern man cannot devote enough time to exercise and maintaining physical fitness. In order to make up for time shortages, we can use the time spent on commutes to exercise effectively by using bicycles, helping to reduce pollution in the process. Regular bicycles, however, take up enough space to park, are difficult to move around on, and are vulnerable to theft. Given that moving about the city has become a time-consuming and expensive chore in the modern world, transport has been one of the most crucial challenges to be resolved [10].

2. Material selection & geometrical considerations

Carbon steel is steel that contains between 0.05 and 2.1 % of its weight in carbon. According to the AISI[11,12], minimum amount of chromium, cobalt, molybdenum, nickel, niobium, titanium, tungsten, vanadium, or zirconium is specified or required to produce a desired alloying effect[13,14]; the maximum content allowed for any one of the components is not greater than the percentages given for manganese (1.65%), silicon (0.60%), or copper (0.60%); the minimum copper amount provided does not exceed 0.4%.

Design & analysis

A multi-platform CAD/CAM/CAE commercial software suite called Computer Aided Three-dimensional Interactive Application was created by the French company Dassault Systems and distributed globally by IBM. CATIA[15,16], a piece of product lifecycle management software from Dassault Systems, was written in the C++ programming language. From concept to finished product[17,18], CATIA delivers revolutionary technologies for optimal efficiency and creativity through its incredibly user-friendly state-of-the-art interface. CATIA reduces the learning curve, as it allows the flexibility of using feature- based and parametric designs[19,20]. CATIA offers the P1, P2, and P3 basic systems. P1 is intended for small and medium-sized process-oriented businesses who want to expand the definition of a large-scale digitised product,21,22]. P2 is for advanced design engineering firms that demand models of resources, processes, and products. P3 is primarily used in the automotive and aerospace industries,[23,24], which require high-quality surfacing, for high-end design applications.

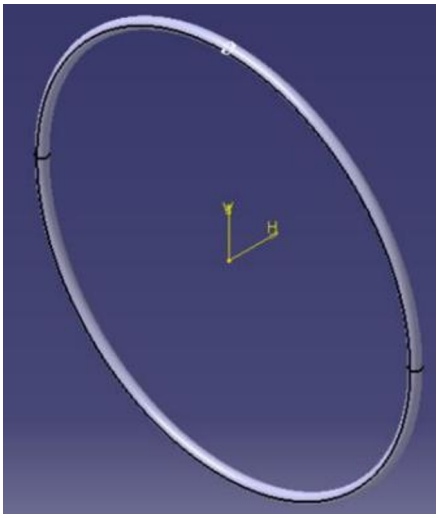

Fig.1 OUTER RIM

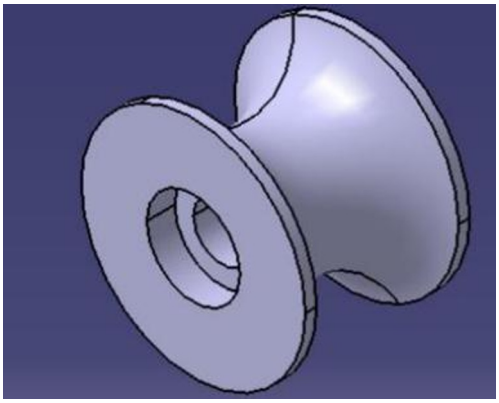

Fig.2 Roller

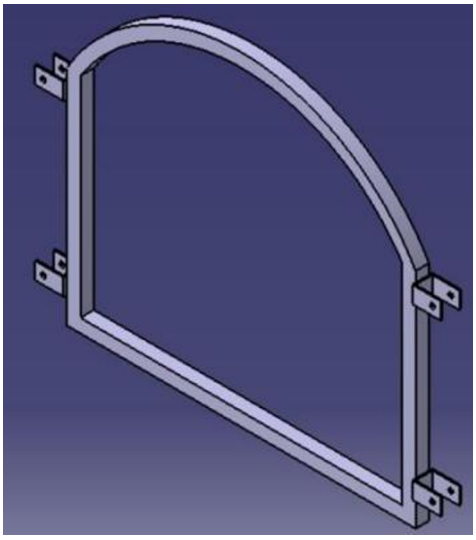

Fig.3 Inner farme

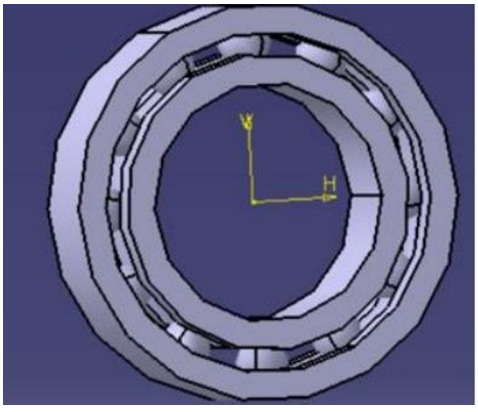

Fig.4 Bearing

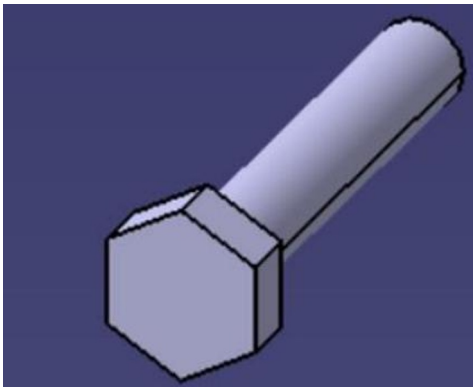

Fig.5 bolt

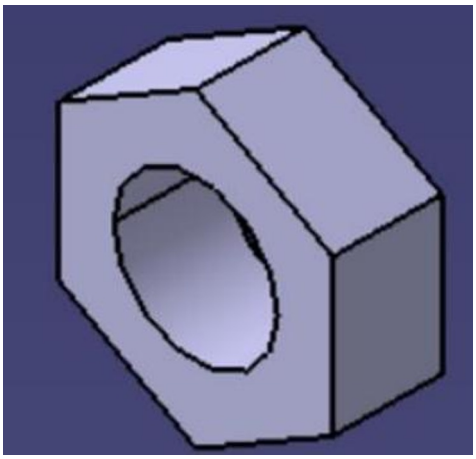

Fig.6 Nut

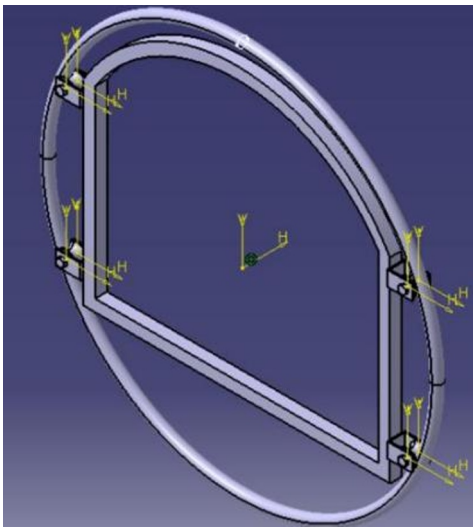

Fig.7 Assembly of monowheel

3. ANSYS

A general-purpose finite element modelling tool called ANSYS is used to numerically solve a wide range of mechanical issues. These issues include linear and nonlinear static/dynamic structural analysis, heat transfer and fluid issues, as well as acoustic and electromagnetic issues.

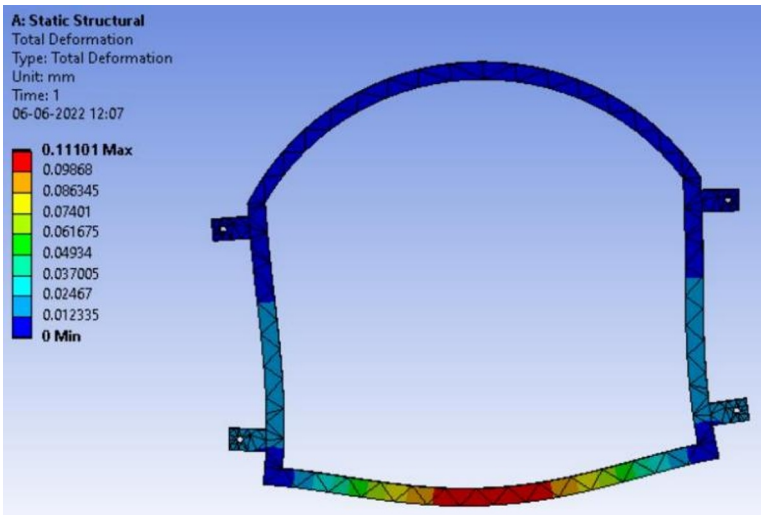

Fig.8 Structural analysis to inner rim

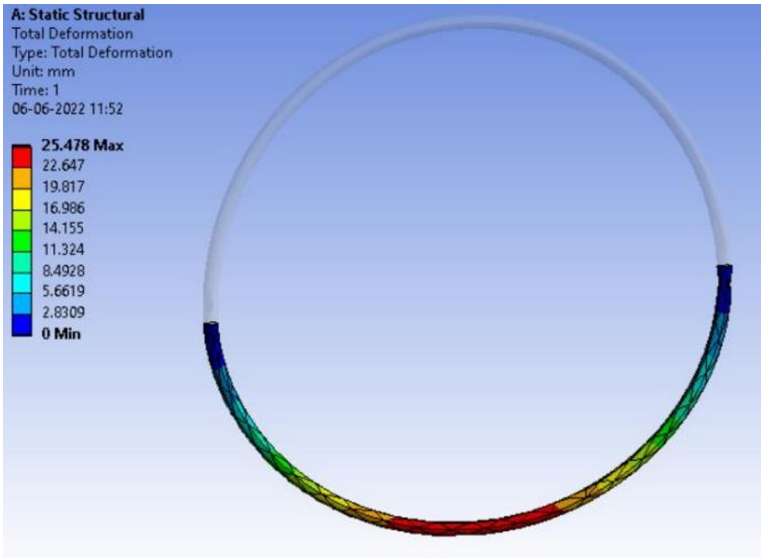

Fig.9 Structural analysis to outer rim

4. Results and discussion

Catia v5 in part design is used to complete the design task. On the part design workbench, several parts like outer rim, frame, rollers, bearings, bolt, and nut are designed in Figs (1-6). The parts are then put together in the assembly workbench in Fig.7, and the assembly is error-free. Ansys result, static structural study for the outer rim and frame is performed using the ansys software in Fig 7 and 8 respectively. As a result, we employed complete deformation in this case. Maximum load capacities of the frame are 130 kg, and the outer rim is 150 kg.

Fabrication result

• Load Capacity of Monowheel: 150 kgs

• Speed of the monowheel on single full charge: 25-30 kmph

• Battery Charging time from zero to full: 2.5-3 Hours

• Battery span after full charge: 1.5 Hours

• Noise free and smooth run. • Balance Wheels are for balancing the load of the monowheel

5. Conclusion

It was decided to finalise the height of the monowheel to be between 5 feet, weighing up to 100 kg in total, based on the practicality of the product by taking into account the 95th percentile Indian male height and the 5th percentile Indian female height, which are 184cm (6 feet) and 149cm (4 feet 10.5 inch) respectively.

It is crucial to have a strong framework that can support the weight of the rider and any additional road loads. To ensure that, it was decided to utilise grey cast iron for the little wheels and mild steel for the frames and any brackets that were used in the main construction.

We calculated the requirement for a DC motor with a capacity of 0.5 HP, which is roughly 375 watts, but we utilised a 0.3 HP motor by taking cost into consideration.

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