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Design and Analysis of Attachable Trailer for Electric Three- Wheeler

Assistant Professor Mr. C.K. Murugesan, Mr. K. Kathiresan
Mahendra Engineering College

Abstract- This paper describes the design and analysis of three-wheeler electric vehicle with detachable loading trailer. The problem to be dealt for this work is to design and analysis of the chassis frame using the software. The design modelling was prepared using PRO-E and the analysis is carried out using Ansys. The chassis frame is considered as an overhanging beam with supports corresponding to rear wheels and single steering system for front wheel. The total load acting on the chassis is taken as the sum of the weight of the chassis frame, weight of the persons and the other components. This total load is considered as uniformly distributed load, bending stress, shear stress and deflection is evaluated using ANSYS. The load at the seat was considered 80KG and 250KG in the loading carrier. The maximum stress obtained in the vehicle was at the joint of steering wheel with chassis. Though, its acceptable stress it should be strengthen for better results. The total deformation also was high at the driver part which cause minimum effect in the damage for the vehicle.

Keywords- ANSYS, Electric Vehicle, Chassis, Trailer

I. INTRODUCTION

Technical innovations in vehicle design, will play a very considerable role in the future in reducing emissions. Electric drive vehicles are becoming an attractive alternative to combustion engine cars with global gradual fossil fuel prices rise. In addition, increasing energy prices also have led to an increase interest in the development of electric vehicles. In the European Union, the car manufacturers have agreed to an overall 25% increase in fuel efficiency by the year 2005 compared to 1990 [1]. In addition, concerns over climate change and reduction of greenhouse gas emissions, and dependence of economies on foreign energy sources, have also become an initiative for extensive research on the use of electric cars as an alternative [2, 3, 4]. Quality has been one of the key issues for the automotive industry. The breakdown of Initial Quality Survey 1997 by [5] indicates that the problems related to body and dimensional quality count for up to 41% percent of the total problems. Cars with electrical drive systems represent a solution for the future, and will in a steadily increasing degree be seen on the roads. The history of electric cars is closely related to the history of batteries [6, 7, 8]. Electric cars appear to be the most suitable candidates to fulfil the environmental demands. In electric cars, efficiency of energy usage is very important. For an electric car to perform at its best it must have adequate structure, this means it must have a stiff frame. Since most of the car's weight is between the front and rear suspension, frame stiffness is absolutely the key between these points where it will not easily bend. For the electric car, stiffness is very important. Apart from safety requirements the chassis structure should also provide torsional and bending stiffness as well as direct support for the front suspension and steering system mounting points. Some value of the safety factor for various condition of loading and material of structures was recommended by Vidosic [9]. Two aspects of frame stiffness should be considered which are beaming and torsional. Therefore, the chassis is considered as the most important element of the vehicle as it holds all the parts and components together. The chassis is the "skeleton" of the car which providing the structural strength, and the mounting points for other components. The chassis provides necessary support to the vehicle components placed on it such as suspension components and the weight of the driver. Electric car chassis designing and fabrication involves trade-offs. There is no one ideal design.

II. METHODOLOGY

The main objective of the study is to obtain a preferable design safety factor, maximum stress and deflection for a cross over electric car chassis using finite element method. Chassis was analysed with solid plate beam chassis. The analysis was conducted using Academic version of PRO-E. There are three main steps, namely: preprocessing, solution and postprocessing. The preprocessing (model definition) step is critical. A perfectly computed finite element solution is of absolutely no value if it corresponds to the wrong problem. This step includes: define the geometric domain of the problem, the element type(s) to be used, the material properties of the elements, the geometric properties of the elements (length, area, and the like), the element connectivity (mesh the model), the physical constraints (boundary conditions) and the loadings [15]. The next step is solution, in this step the governing algebraic equations in matrix form and computes the unknown values of the primary field variable(s) are assembled. The computed results are then used by back substitution to determine additional, derived variables, such as reaction forces, element stresses and heat flow.

Actually, the features in this step such as matrix manipulation, numerical integration and equation solving are carried out automatically by software [16]. The final step is postprocessing, the analysis and evaluation of the result is conducted in this step.

Design Modelling

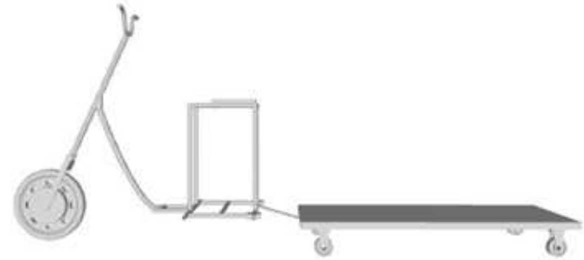

Fig:1. 3D Model Side View

Analysis

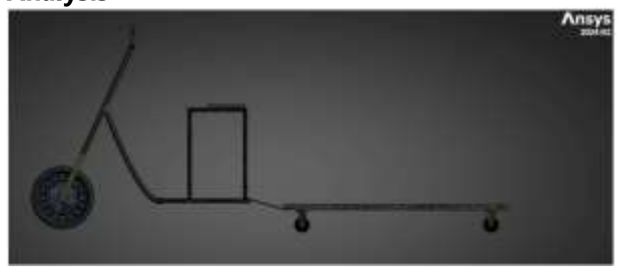

Fig:2. Meshed Body

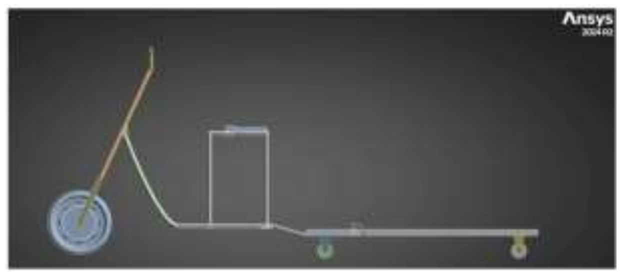

Fig:3. Boundary Conditions

The boundary conditions applied in this vehicle are at two points. One on the passenger seat and another at luggage carrier.

III. RESULLTS AND DISCUSSION

The previous model of the material handling system operated on a sequential cycle, where the trolley was required to transport the load to the unloading station, wait until the unloading process was fully completed, and then return to the loading area to begin the next cycle. This workflow introduced significant idle time between operations, reducing the overall efficiency and responsiveness of the system. In the improved model, the cargo handling cycle has been optimized to minimize these delays. The updated design enables direct and immediate unloading of the trolley, eliminating the need for prolonged waiting periods. Once the unloading begins, the trolley is free to move to the next loading station without interruption, resulting in a smoother, faster, and more continuous operational flow. This enhancement significantly increases cycle frequency and ensures a more streamlined material handling process.

One of the key mechanical improvements in the new system is the shift from a rear- drive to a front-drive configuration. The previous rear-drive system posed limitations in terms of maneuverability and traction, particularly under heavy-load conditions or when navigating confined or complex pathways. The front-drive system in the current model offers better traction control, improved turning radius, and enhanced overall handling. These advantages translate to more stable movement, better load distribution, and greater operational reliability across various working environments. Additionally, the improved drive mechanism reduces strain on the trolley components and contributes to more consistent performance.

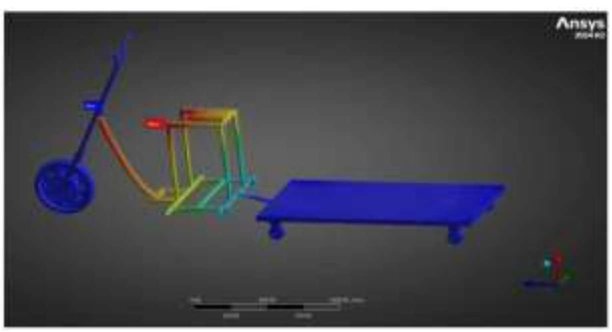

Fig:4. Total deformation

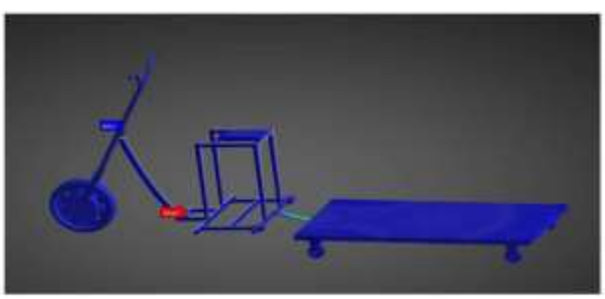
Fig:5. Equivalent Stress

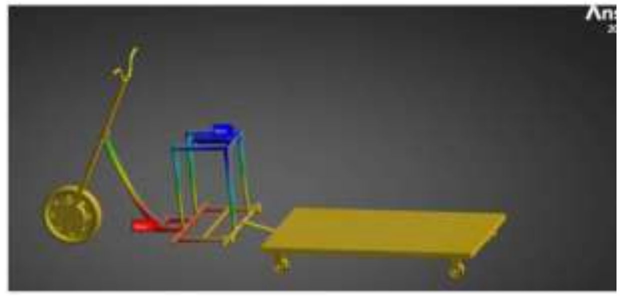
Fig:6. Shear Stress

The current model also features a significantly higher load-carrying capacity compared to its predecessor. While the earlier design was limited in terms of the volume and weight it could transport in a single cycle, the upgraded version accommodates larger and heavier loads, allowing more material to be moved per trip. This increase in capacity not only boosts the throughput of the system but also contributes to a more efficient use of operational time and resources. The design enhancements ensure safe and stable transport of bulkier parts, while maintaining speed and maneuverability. Overall, the advancements in operational flow, drive system configuration, and loading capacity make the new model a more capable and efficient solution for modern material handling requirements.

IV. CONCLUSION

I have reviewed many papers respective to chassis analysis for various vehicles. I also studied about the requirements and necessity for the chassis which induce into the electric vehicle. The automobile chassis for electric vehicle varies from normal automobiles as the load positions vary. For example, in normal automobiles the maximum load of engine will be mounted in front of engine and whereas in electric vehicle the maximum load of fuel cells will be mounted in the rear part. According to these considerations I have designed the chassis for electric vehicle which could be needed to analyse in second phase pf the project work. The modelled chassis was imported in ANSYS and from its results we can conclude tat the deformation and stress obtained was acceptable for work.

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