



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 13, Issue 5, May 2024

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.423

9940 572 462

6381 907 438

ijirset@gmail.com

www.ijirset.com

Design and Analysis of Multipurpose Wheel Barrow

Akshaje D¹, Albin Thomas², Anandhu S Nair³, Nikhil S Madhu⁴, Kiran Reghunath⁵

¹⁻⁴U.G. Student, Department of Mechanical Engineering, Mount Zion College of Engineering, Kadammanitta, Kerala, India

⁵Assistant Professor, Department of Mechanical Engineering, Mount Zion College of Engineering, Kadammanitta, Kerala, India

ABSTRACT: A wheelbarrow is a hand-operated vehicle with one or more wheels, designed to carry and transport small loads. It typically consists of a tray or bed supported by a frame and handles, allowing a person to push or pull it with ease. Wheelbarrows can stuck easily, especially if you put too much stuff in them. They can be hard to push on bumpy ground, and carrying heavy loads may be tough for some people. The main negatives of wheelbarrow are limited capacity of wheelbarrow, wheelbarrow may take up significant storage space, maintenance and terrain conditions are also a negative factor for wheelbarrow. These negatives were solved by making a new foldable wheelbarrow is like a regular one, but it can be folded up when you're not using it. This makes it easy to store in small spaces and convenient to transport. In this project we are planning to build a foldable wheelbarrow which has more increased storage, light weight compared to normal wheelbarrow.

KEYWORDS: Wheelbarrow.

I.INTRODUCTION

Foldable wheelbarrows are an innovative solution in the world of garden and construction tools, blending traditional function with modern convenience. Designed for efficient outdoor tasks, these wheelbarrows are particularly suited for gardening, landscaping, construction, or any heavy-duty work that requires the transportation of heavy materials from one place to another. What sets foldable wheelbarrows apart from their traditional counterparts is their unique ability to fold up. This distinctive feature allows for ease of storage and transport. Unlike the conventional wheelbarrow that can take up a lot of space, foldable wheelbarrows can be conveniently tucked away in compact spaces, making them an excellent choice for those with limited storage areas. They can easily fit into tight corners of sheds, garages, or even car trunks, making them highly portable and handy for on-the-go tasks. Despite their compact nature, foldable wheelbarrows do not compromise on stability or durability. They are typically constructed with robust materials such as steel or aluminium, ensuring they can withstand the weight of heavy loads without buckling under pressure. A multipurpose foldable wheelbarrow is a versatile and portable equipment designed to assist with various tasks, such as gardening, landscaping, construction, and hauling. It typically features a foldable design that allows for easy storage and transportation when not in use. This sturdy construction provides the user with confidence that the wheelbarrow can handle substantial weight without sacrificing its structural integrity most foldable wheelbarrows are designed with a single wheel at the front. This feature not only aids in easy manoeuvring but also allows for a higher degree of control when moving around corners or navigating through narrow spaces. The single wheel design is particularly beneficial when moving heavy loads, as it provides balance and prevents the wheelbarrow from tipping over. They come with comfortable handles that offer a good grip, reducing strain on the hands when pushing heavy loads. This ergonomic design can make a significant difference in reducing fatigue during prolonged use. Some models of foldable wheelbarrows are equipped with pneumatic tires.

II.RELATED WORK

The ergonomic wheelbarrow features adjustable handles, ergonomic grips, and balanced weight distribution for comfort and stability. Lightweight, durable materials and puncture-resistant tires with swivelling front wheels ensure smooth movement and versatility [1]. Enhance a semi-automatic wheelbarrow with adjustable handles, power-assist, balanced design, easy braking, puncture-resistant tires, and user feedback for ergonomics [2]. Our novel wheelbarrow

design features adjustable handles and wheel positions to improve comfort and functionality for users of various heights and preferences [3]. This paper details the design and implementation of an electric wheelbarrow with a battery-powered motor to enhance efficiency and reduce user strain [4]. This paper presents the design, development, and testing of a versatile, durable, and user-friendly multi-utility wheelbarrow with interchangeable attachments for various professional tasks [5]. This paper presents the design, development, and implementation of a motorized wheelbarrow with a battery-powered motor to enhance efficiency and reduce user strain by assisting in transporting heavy loads over various terrains [6].

II.METHODOLOGY



Fig. 1 Methodology

III.PROBLEM STATEMENT

Wheelbarrows, essential tools in various industries for centuries, typically feature a single wheel, a load-carrying tray, and handles for manoeuvring. They come in various designs, such as single-wheel and dual-wheel configurations, with different tray shapes and sizes to suit specific tasks and environments. Traditional wheelbarrows are made of durable materials like steel and wood, while modern versions may use lightweight aluminium or plastic. Load capacities vary, catering to both light-duty gardening and heavy-duty construction needs. Designed for easy manoeuvrability, single-wheel models offer agility, and dual-wheel models provide stability. Ergonomics are key, with handles positioned for user comfort to minimise strain. Regular maintenance is necessary for optimal performance. Wheelbarrows are used in construction, landscaping, gardening, agriculture, and waste management. Despite their utility, they face challenges such as limited load capacity and difficulty navigating rough terrain. Recent innovations, including motorised and adjustable models, aim to enhance efficiency and reduce physical strain.

Traditional wheelbarrows, though highly useful, present several issues. They depend entirely on human effort, which can cause fatigue and strain, particularly when moving heavy loads over long distances or rough surfaces. Their load capacity is limited by their design, which can lead to instability and accidents if overloaded. Single-wheel models are difficult to manoeuvre on uneven terrain and are prone to tipping. Poor ergonomic design can cause discomfort and strain with extended use. Additionally, traditional wheelbarrows lack versatility, being tailored to specific tasks and not easily adaptable to different load types. They require regular upkeep, such as lubrication and parts replacement, to maintain functionality. Storing and transporting bulky wheelbarrows can be challenging, especially in tight spaces. Furthermore, their instability on slopes or uneven ground can pose safety hazards, leading to potential injuries and damage.

IV.DESIGN AND ANALYSIS

Using SolidWorks 3D design software, we designed a wheelbarrow frame that supports loads, resists forces, and maintains stability. The process involved sketching the basic design, selecting durable materials like steel or aluminium, and creating 3D models of structural components such as the tray support, handles, and wheel mount. We performed load analysis to ensure the frame can handle the weight and optimized the handle height and angle for user comfort. The design focused on stability and ease of maneuverability, with considerations for manufacturability and



maintenance. Finally, we assembled the model in SolidWorks, ensuring all parts fit together seamlessly. To design a robust wheelbarrow frame using SolidWorks, we start by assessing functional requirements, including load-bearing capacity, stability, and durability. We identify the types and magnitudes of loads, select suitable materials like steel or aluminum, and develop a conceptual design outlining the frame’s layout and member sizes. Structural analysis is performed to ensure the frame can withstand anticipated stresses. The frame is then fabricated and assembled according to detailed design specifications, followed by testing and inspection to verify structural integrity and performance. This process ensures a durable and functional wheelbarrow frame.

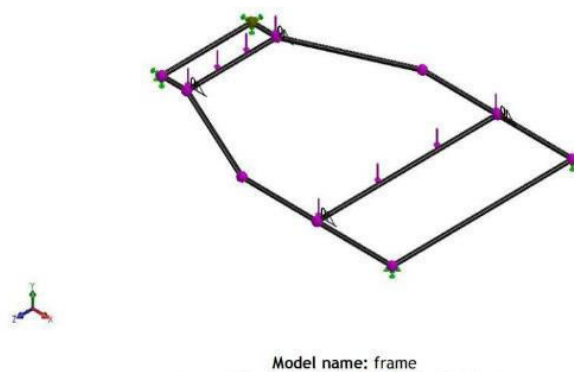


Fig. 2. Frame Design

The von Mises stress analysis method plays a vital role in engineering, particularly in predicting material yield under complex loading conditions based on uniaxial tensile tests. This approach is essential for evaluating the strength and reliability of structures and mechanical components. The process involves several steps: defining the problem by considering material properties, geometry, and loading conditions; creating a mathematical or computational model of the structure; specifying the applied loads, which may include forces, moments, or thermal loads; solving the governing equations using computational tools or mathematical techniques; and calculating the stress distribution within the material, with von Mises stress being a key measure derived from the combined effect of normal and shear stresses. By following these steps, engineers can ensure the integrity and safety of engineering components.

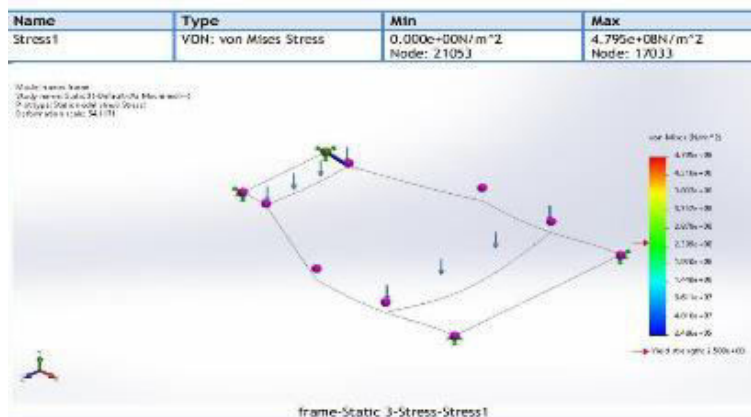


Fig. 3 Von Mises stress analysis

Resultant displacement analysis is a crucial process in engineering, particularly in structural and mechanical fields, where understanding how structures respond to external forces is vital. This method involves determining the overall

displacement of a structure or system under various loads or disturbances. The process begins with defining the problem, considering factors like geometry, material properties, boundary conditions, and applied loads. A mathematical model of the system is then created, and loads or disturbances, such as forces, moments, thermal loads, or pressure, are specified. Computational tools or mathematical techniques are used to solve the equations governing the system's behavior under these loads. Finally, the displacements at various points within the structure are calculated. These steps ensure a comprehensive understanding of structural response, aiding in the design of safer and more efficient systems.

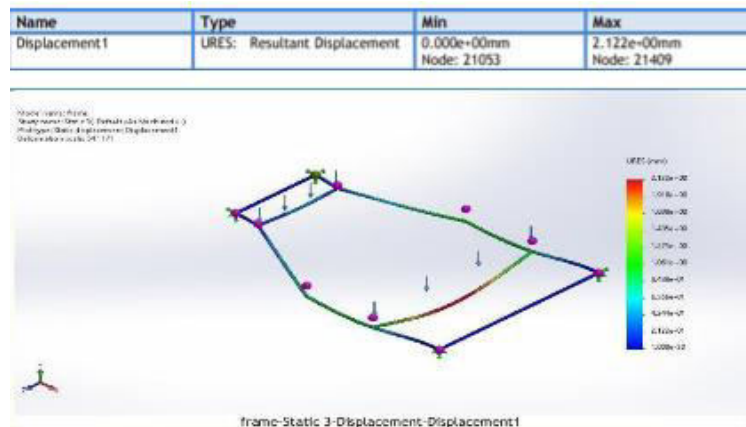


Fig. 4 Displacement Analysis

Equivalent strain analysis, also known as Von Mises strain analysis, evaluates how materials deform under complex loading conditions. Unlike stress analysis, it focuses on strain, using the strain tensor to describe deformation in three dimensions. Similar to stress analysis, it identifies principal strains and calculates the von Mises strain, a scalar value derived from these principal strains. This analysis provides crucial insights into material deformation, aiding in the design and assessment of structural components subjected to diverse loading conditions.

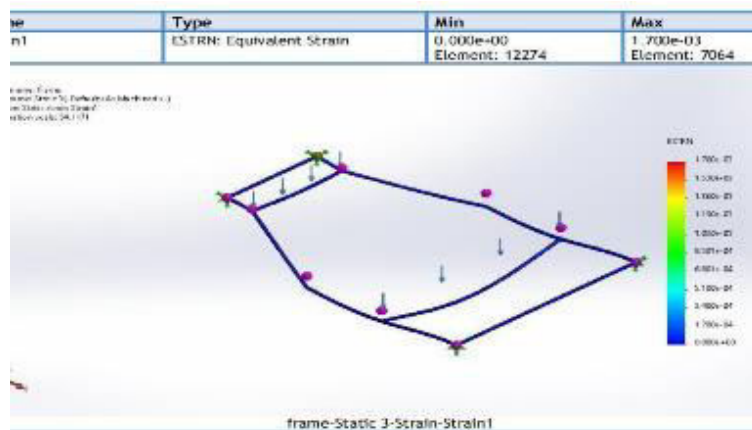


Fig. 5 Von Mises Strain Analysis

V.MATERIALS USED

Mild steel A36, a prevalent carbon steel type, is extensively utilized across construction, manufacturing, and various industries due to its advantageous properties. With its low carbon content of typically 0.25% to 0.29%, it offers exceptional malleability, weldability, and versatility, earning it the moniker "mild" steel. A36 grade stands out for its excellent weldability, machinability, and cost-effectiveness compared to alternative steel grades. Its widespread adoption is attributed to its affordability and ease of fabrication, making it a preferred choice for diverse projects. Particularly noteworthy is its remarkable weldability and ductility, rendering it ideal for construction applications.



Moreover, its favorable mechanical properties, including a high strength-to-weight ratio, further underscore its utility. Additionally, its ready availability bolsters its appeal as a go-to material for numerous applications.

SAE Grade 2 nuts and bolts, made from low carbon steel, offer moderate strength and are easy to machine, fitting well into non-critical roles in automotive and construction. However, their susceptibility to corrosion limits their use in demanding conditions.

Pneumatic wheels, commonly seen on bicycles, automobiles, and industrial machinery, feature an inflatable inner tube encased in a flexible outer tire made of durable rubber. This design allows for traction, cushioning, and protection, with tread patterns tailored to different surfaces. The inner tube, usually of natural rubber or synthetic materials, maintains pressurized air, delivering a cushioning effect that absorbs shocks and vibrations. Proper inflation, based on wheel size and load, is essential for optimal performance. These wheels offer advantages like shock absorption, vibration damping, and improved traction on rough terrain, contributing to their widespread use across various applications. Regular maintenance ensures prolonged functionality and durability.

A 16V battery, prevalent in high-performance automotive settings, offers a higher voltage output compared to standard 12-volt batteries, enhancing electrical power and vehicle performance.

Bearing 6000 signifies a deep groove ball bearing from the 6000 series, commonly used in machinery and automotive applications. It supports radial loads perpendicular to the axis of rotation and can handle some axial loads. Variations in size, construction, and material determine its load capacity for diverse industrial needs.

Hinges enable pivotal motion between objects, crucial in doors, gates, and machinery, providing support and control. In our project, hinges facilitate the foldability of the carrying box, while a round hinge allows free rotation of the front tyre.

DC motors convert electrical energy to mechanical energy via electromagnetism, powering rotational motion. Found in household appliances, industrial machinery, and transportation, they're crucial across diverse sectors. These motors are fundamental in converting electrical power to drive mechanical systems. Here, a 200W / 16V 1100 rpm DC motor is utilized.

VI.MANUFACTURING

The construction of the multipurpose wheelbarrow began with making its base frame from mild steel tubes, ensuring strong welding for durability. Next, we securely attached the rear wheel and axle to provide a stable foundation. Using a round hinge, we then added the front wheel to the frame for flexible maneuvering. Finally, we carefully crafted a carrier from mild steel sheets and integrated it onto the frame, resulting in a well-assembled structure ready for different tasks.



Fig. 6 Fabrication

VII.RESULTS AND DISCUSSION

The development of the multipurpose foldable wheelbarrow involved a meticulous process, starting with the design and simulation of its frame using SOLIDWORKS 23. Through the comprehensive capabilities of SOLIDWORKS simulation, various analyses were conducted to assess critical factors such as von Mises stresses, displacement, and strain. These analyses provided valuable insights into the structural performance and durability of the wheelbarrow frame, guiding iterative design improvements to optimize its functionality. After extensive efforts and iterations, the final design was meticulously crafted to meet the stringent requirements of versatility, portability, and durability. The culmination of this rigorous design process resulted in the successful manufacturing of the multipurpose foldable wheelbarrow, embodying a commitment to excellence and innovation in engineering.

VIII.CONCLUSION

The multi-purpose foldable wheelbarrow stands out for its numerous benefits, offering practical solutions for a variety of tasks and environments. Its foldable design is a key advantage, allowing for effortless storage in compact spaces, making it an ideal choice for those with limited storage options. Furthermore, its versatility makes it suitable for a range of activities, including gardening, construction, and transporting goods, enhancing its utility for users across different sectors. The portability of the wheelbarrow is another notable feature, enabling easy transportation to various locations without hassle. Additionally, the foldable design contributes to safety by reducing the risk of workplace injuries such as muscle strains, back injuries, and accidents caused by fatigue. Overall, the multi-purpose foldable wheelbarrow proves to be a convenient and practical tool, offering efficiency and safety for a wide range of outdoor tasks.

REFERENCES

1. E. C. Godilano, K. V. Casas and A. J. Vargas, "Design of an ergonomic wheelbarrow to reduce physiological demands of general users," 2018 5th International Conference on Industrial Engineering and Applications (ICIEA), Singapore, 2018, pp. 424-428, doi: 10.1109/IEA.2018.8387138.
2. Nawik, N. S. M., Deros, B. M., Rahman, M. N. A., Sukadarin, E. H., Nordin, N., Tamrin, S. B. M., ... Norzan, M. L. (2015). Conceptual design of semi-automatic wheelbarrow to overcome ergonomics problems among palm oil plantation workers. IOP Conference Series: Materials Science and Engineering, 100, 012045. doi:10.1088/1757-899x/100/1/012045



3. Mazlee, N. I. N., Ngah, N., Zakaria, M. K., & Said, N. A. (2021). Design and Fabrication of Adjustable Wheelbarrow . International Journal of Synergy in Engineering and Technology, 2(2), 106-112. Retrieved from <https://tatiuc.edu.my/ijset/index.php/ijset/article/view/108>
4. Electric Wheel Barrow. Krushna Babasaheb Bhakare*1, Aditya Rajendra Supekar*2, Kunal Uttam Thombre*3, ... (2020) Wheelbarrow. Retrieved 19 October 2020, from. [5].4 pages
5. Development of Multiutility Wheelbarrow” (2020). Bharath L Gowda, Deepak R, Karthik S Shinde,Rakshith Raju C, Ashwini M,
6. Motorized Wheelbarrow Dr. Shunmugesh K1 , Abin Antony2 , Akhil Sebastian3 , Akhil Shijo4 , Edwin Xavier



INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  ijirset@gmail.com



www.ijirset.com

Scan to save the contact details