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DESIGN & FABRICATION OF COMPACT LOAD CARRIER

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ABSTRACT :

Different loads are transferred from one place to other place as a part of day-to-day activities by most of us or as a part of commercial activities by industries like manufacturing, logistics, storage, distribution, servicing, medical, education, sales, etc., Some small loads can be transferred manually and medium loads can be transferred using towing carts or vehicles but the transfer of large loads needs fork lifts, cranes and trucks. We have different verities of load carriers available in the market to handle large size objects / loads efficiently and they come in Manual, IC engine, Electric drive variants. How ever it is difficult to find a compact load carrier which handles compact (small to medium) loads. As a part of our project dissertation, we are planning to fabricate compact load carrier with fallowing advantages; ➢ Consumes less energy ➢ Runs on electric energy hence not dependent on imported fuels ➢ No pollution hence best suitable for indoor applications ➢ Can be remotely operated - best suitable for operations in hazardous areas as well ➢ Load can be lifted or lowered to some extent to provide extra convenience to users ➢ As it is indigenous technology, we need not to pay royalty to other countries, spares and maintenance can be easily sourced ➢ Low Cost Project involves; ➢ Study of various types of load carriers, materials, manufacturing processes etc., ➢ Modelling of various components of compact load carrier ➢ Assembly of modelled components ➢ Fabrication of components of load carrier ➢ Assembly of components

Keywords: Compact load carrier, material handling, electric drive, lifting mechanism, low-cost fabrication.

1. INTRODUCTION :

A load carrier refers to a device or vehicle designed to carry or transport goods, materials, or equipment from one location to another. It can be used in various industries, including logistics, construction, manufacturing, and transportation. The primary purpose of a load carrier is to help in the safe and efficient movement of loads, which can range from small packages to heavy machinery or large construction materials. Load carriers come in different forms depending on the nature of the load and the transportation requirements. They can be manual, such as carts, trolleys, or pallet jacks, or motorized, such as forklifts, trucks, or conveyor systems. Some load carriers are designed for specific applications, like cargo carriers for vehicles, shipping containers for ocean freight, or trailer beds for heavy loads. Key features of load carriers include: 1. Capacity: The maximum weight or volume the carrier can support. 2. Mobility: Whether the carrier is stationary or can be moved easily, either manually or with machinery. 3. Design: Tailored to the type of load, such as flatbed designs for large items or enclosed containers for fragile goods. 4. Durability and Strength: Built to withstand the stresses of carrying heavy or bulky loads, often made from steel, aluminum, or reinforced materials. Overall, load carriers play a critical role in modern supply chains and industries by facilitating the efficient and secure transportation of goods.

Automation of load carriers

Automation of load carriers refers to the integration of advanced technologies such as robotics, sensors, artificial intelligence (AI), and machine learning (ML) into load carrying systems to perform tasks that were 2 traditionally done manually. This process is aimed at improving efficiency, safety, and cost-effectiveness in the transportation of goods, both within warehouses and in logistics operations.

1.1.1 Key Features of Automated Load Carriers

a) Autonomous Mobile Robots (AMRs): These are self-driving robots equipped with sensors and cameras that can navigate through warehouses or factories. They can pick up, transport, and deliver loads from one point to another without human intervention.
b) Automated Guided Vehicles (AGVs): AGVs are similar to AMRs but follow predefined paths (such as magnetic strips, sensors, or tracks) to move loads. They are commonly used in manufacturing environments or warehouses for transporting materials.
c) Conveyor Systems: Automated conveyor systems move goods through a production line or storage area. These systems can automatically adjust speed, direction, and even divert items to different routes depending on requirements.
d) Drones: In certain industries, drones are used as load carriers, especially for delivering smaller packages or transporting lightweight goods across short distances. They can navigate autonomously and avoid obstacles using sensors and GPS.

1.1.2 Examples of Automated Load Carrier Systems

a) Warehouse Robotics (e.g., Kiva Systems/Amazon Robotics): These robots are used in warehouses to transport items to human operators or other parts of the facility, improving efficiency in order fulfillment.
b) Automated Tow Trains: Used in industrial settings, these systems automate the process of pulling carts or load carriers across a facility, reducing the need for manual labor.
c) Forklift Automation: Automated forklifts can pick up, transport, and drop off loads without human operators. These forklifts typically use laser sensors, cameras, and other guidance systems to navigate.
d) Automated Shipping Containers: Some automated systems are designed to load and unload shipping containers, using robotics or cranes to move large quantities of goods between ships and storage areas.

1.2 Material Handling Equipment (MHE)

Material Handling Equipment for load carriers are devices and systems used to move, store, control, and protect materials and goods in various stages of production, warehousing, distribution, and disposal. These equipment types can be manual, semi-automated, or fully automated, depending on the requirements of the operation. They are essential in helping move goods efficiently from one location to another, facilitating productivity and reducing labor costs. Here's a look at the types of material handling equipment commonly used for load carriers:

a) Conveyors: Conveyors are a common and versatile material handling solution, designed to move goods along a defined path.
- Belt Conveyors: Used for transporting bulk materials or packaged goods over a fixed path. They are ideal for long-distance transportation.
- Roller Conveyors: Often used for moving goods manually or via gravity, roller conveyors are highly flexible and can be adjusted for various loads.
- Chain Conveyors: Primarily used for heavy-duty loads and industrial applications, chain conveyors can transport heavy and bulky materials.
- Overhead Conveyors: Used in scenarios where the floor space is limited, these conveyors hang from the ceiling and are ideal for transporting products in assembly lines.

b) Automated Guided Vehicles (AGVs): AGVs are mobile robots used to transport materials in factories and warehouses. They can operate autonomously or follow a predefined path using various guidance systems such as magnetic strips, sensors, or GPS.
- Towed AGVs: These carry multiple carts or loads behind them and are suitable for handling large amounts of materials at once.
- Unit Load AGVs: These transport a single load per trip, which can be especially useful in high precision environments like electronics manufacturing.
- Automated Guided Carts: These are similar to AGVs, but typically, AGCs are smaller and operate on a set path. They're useful for transporting smaller loads over short distances, such as between workstations in a factory.

c) Cranes: Cranes are large, heavy-duty material handling equipment used to lift and move heavy loads, particularly in construction sites, ports, and warehouses.
- Overhead Cranes: Used for lifting materials within a defined workspace, often used in factories and industrial plants for heavy lifting.
- Jib Cranes: Smaller cranes with a horizontal arm, used for moving materials within a limited area, commonly found in warehouses and smaller manufacturing environments.
- Bridge Cranes: Ideal for handling heavy loads, these move along tracks mounted above a factory floor, typically used for large-scale material movement.

Applications of Compact Load Carrier

a) Warehouse and Inventory Management
- Storage Replenishment: In warehouses, compact AGVs can be used to transport goods between storage areas and picking zones. They can automatically bring inventory to assembly lines, packing stations, or shipping areas.
- Order Picking: Some AGVs are used in automated order picking systems where they bring items to a human worker or another automated system for packing.

b) Manufacturing and Production
- Material Handling: Compact AGVs are often used to transport small parts and components between production lines, assembly stations, or workstations. In environments where small components need to be transported frequently, these AGVs optimize workflows and reduce human error.

c) Medical and Pharmaceutical

- Pharmacy Inventory Transport: In hospitals or pharmacies, compact AGVs can be used to move small medical supplies, medications, or diagnostic equipment between rooms, floors, or storage areas, reducing the need for manual labor and minimizing the risk of contamination.

2. LITERATURE REVIEW :

2.1 History of Load Carriers

Manual material handling work contributes to a large percentage of the over half a million cases of musculoskeletal disorders reported annually in the United States. Musculoskeletal disorders often involve strains and sprains to the lower back, shoulders, and upper limbs. They can result in protracted pain, disability, medical treatment, and financial stress for those afflicted with them, and employers often find themselves paying the bill, either directly or through workers' compensation insurance, at the same time they must cope with the loss of the full capacity of their workers. Scientific evidence shows that effective ergonomic interventions can lower the physical demands of MMH work tasks, thereby lowering the incidence and severity of the musculoskeletal injuries they can cause. Their potential for reducing injury related costs alone make ergonomic interventions a useful tool for improving a company's productivity, product quality, and overall business competitiveness. But very often productivity gets an additional and solid shot in the arm when managers and workers take a fresh look at how best to use energy, equipment, and exertion to get the job done in the most efficient, effective, and effortless way possible.

Planning that applies these principles can result in big wins for all concerned Manual handling refers to the use of a worker's hands to move individual containers by lifting, lowering, filling, emptying, or carrying them. It can expose workers to physical dangers that can lead to injuries: a large percentage of the over half a million cases of musculoskeletal disorders reported in the U.S. each year arise from manual handling, and often involve strains and sprains to a person's lower back, shoulders and upper limbs. Ergonomic improvements can be used to modify manual handling tasks to reduce injury. These improvements can include reconfiguring the task and using positioning equipment like lift/tilt/turn tables, hoists, balancers, and manipulators to reduce reaching and bending.

The NIOSH (National Institute for Occupational Safety and Health) 1991 Revised Lifting Equation can be used to evaluate manual lifting tasks. Using the exact conditions of the lift (height, distance lifted, weight, position of weight relative to body, asymmetrical lifts, and objects that are difficult to grasp), six multipliers are used to reduce the maximum recommended weight for less-than-ideal lifting tasks. Now a day's lifting of loads has become a big problem in each and every countries, on daily basis an average man or women lifts a load about 50 to 70 kgs at the time of work by different techniques, some people lifts the load from front which is very common, some carry on their back while some slide the load on surface or lift it on their head, but these all activities requires a lot of effort and manpower due to some poor techniques and misbalancing leads to accidents that can put them into a medical trauma mostly injuring them physically, lots of things happens nowadays in the department of labours in every company on each field most of the labours that lifts are loads are treated with similar conditions such as spine saggital, slip disc, spine disorder, and many more related to ergonomics department. Keeping all this into consideration and after deep research on a model of **Mr. vikrampanchal et al [1],** Load carrier which is made of bamboo we have developed our own model which deals with the most common load carrying techniques not only that we have also done an analysis on the model making it very durable and affordable mostly without damaging the environment tress Our model is made from mild steel and after doing simple operations, our load carrier contains two frames adjustable frame which participate its self as gripping device and a main frame which carries load on its self. Our model has load carrying capacity of maximum 120 kgs, it contains three type of load carrying techniques trolley backpack and over head load carrier, it is made in such a way that it performs each task very easily all we need to do is just keep the load on load carrier. Load carrying capacity is measured by doing complete analysis and physical testes and concludes that it is a safe way of carrying load in any place anywhere and it is compatible to any average height without any physical damage which increase the load carrying capacity by distributing load and increases the labour efficiency and above all it is affordable. Technologies available in art and market for reducing head load drudgery were studied and discussed with stakeholders. Panihari developed by grassroots innovator Khimjibhai Kanadiya has two extended supporting rod from circular disk that is put on the head to keep the vessel. Any women can place these two supporting rods on her shoulder, which in turn raises the circular disc just above her head. It costs Rs 350. Load Carrier for Labour developed by VikramPanchal, is a simple, durable, light weight and cost effective carrier is intended to reduce the pressure put on the spine when load is carried on the head. There is also a good hand grip which reduces stress on the spine when load is carried on the back or while pushing a cart. Ergonomically the load is distributed on the shoulder and at the lumber support by softer material. It can take load up to 50 kg and costs Rs. 500. Relief for laborer developed by A Priya is quite similar to solution developed by Mr. Panchal. It can be used to carry a load of 20 to 30 kg per trip at one time and costs Rs. 700.

Vajra developed by Raghunath Lohar [2] is a vessel desk like device which distributes load of a worker from his head to shoulders with the help of a vertical support assembly. Its lower part is fitted to the body with the help of flexible belts and the upper part can be fitted and removed as per requirement. It reduces cumulative trauma like headache, backache and other body strains. There is no need to balance the objects. It can take weight up to 75 kg and costs Rs. 700.

Md. A. Hossain, nafis a. Chowdhury, rubaiat i. Linda in jan-2010 have concluded that in the initial design, every wheel contained frame, a solar wheel and three planetary wheels. The planetary wheel was linked with the solar wheel via an idler. The reason of the usage of the idler become to rotate the planetary wheels within the same path of sun wheel. Every planetary wheel become aligned in a instantly line with loafer and sun wheel. The directly wheel body takes more thrust to tilt the wheel body to engage subsequent planetary wheel. The length of every arm is excessive and for this reason creates vibration and the automobile would be unstable. In the gift layout, the wheel frame turned into made curve in order that the front floor of the arm couldn't collide with the threshold of the stair.

Mr. Pratik h. Rathod, mr. Ravi r. Mishra, mr. Nitin a. Waghamare in sept2013 have researched that stair climber trolleys have a total of six wheels, 3 on each facet. They're set in a triangular sample. The uppermost wheel rests at the top step, with the alternative two wheels set at the decrease step. This allows you to apply leverage as you pull the trolley up a fixed of stairs. Though this undertaking had a few challenge as a primary step of creating any stair mountain climbing hand truck, it became a pioneer venture. At some stage in the check run of this assignment, it was realized that it would capable of carrying heavy load with out suffering any deformation or neighborhood fractures if it might go into real international manufacturing at a great scale. Though the initial cost of the project seemed to be higher but more accurate manufacturing would shorten this.

Prajan Pradip Gondole, Kamlesh Diliprao Thakre in April-2015 have concluded that the stair-climbing hand truck is designed to reduce liability rather than increase it. Conventional hand trucks work well on flat ground, but their usefulness decreases when it becomes necessary to move an object over an irregular surface. Package deliverymen, for example, often find it necessary to drag loaded hand trucks up short flights of stairs just to reach the front door of a building. The entire purpose of using a conventional hand truck is to avoid having to lift and carry heavy objects around.

3. METHODOLOGY :

3.1 CATIA V5 (Computer Aided Three-Dimensional Interactive Application)

is a powerful, multi-platform software suite developed by Dassault Systèmes for computer-aided design (CAD), computer-aided engineering (CAE), and computer-aided manufacturing (CAM). It is widely used in industries such as aerospace, automotive, industrial machinery, and more. CATIA V5 is part of Dassault Systems' 3DEXPERIENCE platform, providing a comprehensive set of tools for product design, engineering, and manufacturing.

3.1.1 Overview of CATIA V5

CATIA V5 is a CAD software suite that supports product design and innovation in a collaborative environment. It enables designers, engineers, and manufacturers to create 3D models of products, simulate behavior, test designs, and manage product lifecycles. CATIA V5 is known for its flexibility, power, and ease of use, making it one of the leading solutions for designing complex products in various industries.

3.1.2 Key Features of CATIA V5

- Parametric Design: CATIA V5 uses a parametric design approach, where 3D models are driven by parameters (like dimensions and constraints), allowing easy modification and updates to models.
- Surface Modeling: CATIA V5 excels in surface modeling, enabling designers to create complex, organic shapes such as car bodies, aircraft wings, and consumer products.
- Sheet Metal Design: Specialized tools are available for designing sheet metal components, including flattening, punching, and bending features.

3.1.3. CATIA V5 Modules

CATIA V5 consists of various modules designed for specific tasks, which include:

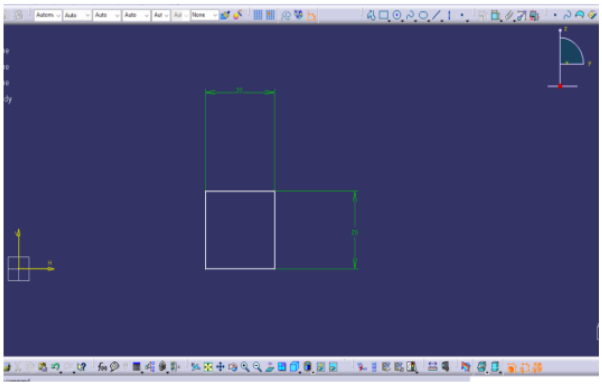
a) Part Design: For creating and designing 3D parts.
b) Assembly Design: Used to assemble parts and analyze their interactions.
c) Sheet Metal Design: Focuses on the creation of sheet metal components.
d) Generative Shape Design (GSD): For surface modeling.
e) Wireframe and Surface Design: For designing curves and advanced surfaces.
f) Kinematics Simulation: For analyzing motion and mechanisms.
g) Generative Drafting: To create 2D drawings from 3D models, including detailed views, annotations, and dimensioning.

3.2 DESIGN & MODELLING

All the part modelling for this project is prepared using Catia V5 Software. Initially chassis modelling is prepared with making 20mm x 20mm square on Y-Z plane as shown in Fig 3.1

Equations and formulae should be typed in Mathtype, and numbered consecutively with Arabic numerals in parentheses on the right-hand side of the page (if referred to explicitly in the text). They should also be separated from the surrounding text by one space.

Mild Steel metal properties are added to the chassis for analysis 250N load is applied from the top as the load of the carrier will act downwards.



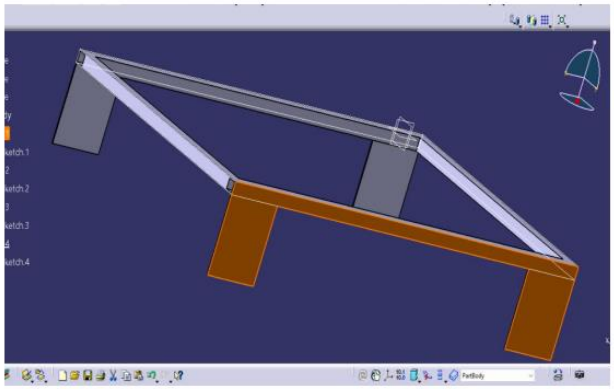
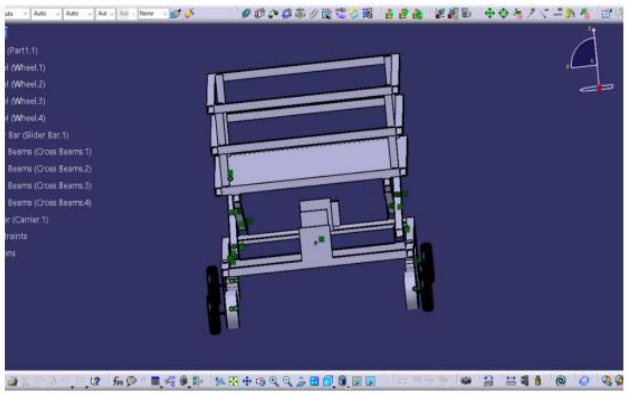
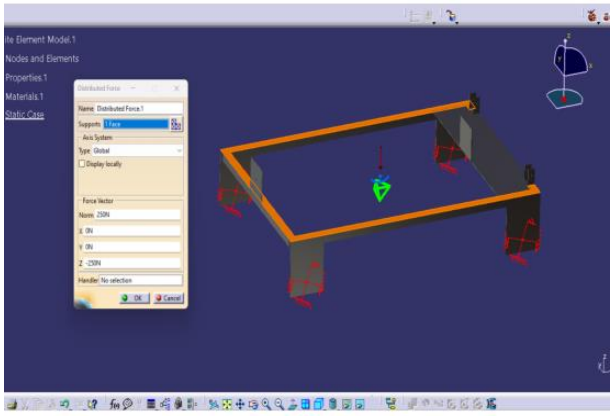


Fig 3.1 Chassis square pipe 2 D





4. FABRICATION :

4.1 MATERIAL

Mild Steel (MS): Steel is any alloy of iron as shown in figure (4.2.1), consisting of 0.2% to 2.1% of carbon, as a hardening agent. Besides carbon, many other metals are a part of it. They include chromium, manganese, tungsten and vanadium. Other than a maximum limit of 2% carbon in the manufacture of carbon steel, the proportions of manganese (1.65%), copper (0.6%) and silicon (0.6%) are fixed, while the proportions of cobalt, chromium, niobium, molybdenum, titanium, nickel, tungsten, vanadium and zirconium are not. What is known as mildest grade of carbon steel or mild steel is typically the variety which has a comparatively low amount of carbon (0.05% - 0.26%). Mild steel is overwhelming the market demand makes it the cheapest form of steel available. With such widespread usage, the knowledge of its properties is necessary for anybody who's into the manufacturing business or a student of metallurgy. You will find the most important characteristics of mild steel presented in the following lines. An alloy is a mixture of metals and non-metals, designed to have specific properties. These metallurgical innovations make it possible to compensate for the shortcomings of a pure metal by adding other elements.

Fig 4.1 Mild steel

4.2 PROPERTIES AND USES: -

Here is a compilation of mild steel properties and its uses in various fields of technology.

- The calculated average industry grade mild steel density is 7861.093 kg/m3. Its Young's modulus, a measure of its stiffness is around 210,000 MPa.
- A moderate amount of carbon makes this steel different from other types. Carbon atoms get affixed in the interstitial sites of the iron lattice, making it stronger and harder. However, the hardness comes at the price of a decrease in ductility.
- Compared to other types of steel, this type is ideal for welding purposes, as it conducts electric current effectively without tarnishing the metal surface in any way.
- Mild steel has ferromagnetic properties, which make it ideal for manufacture of electrical devices and motors. It yields itself easily to magnetization.
- Unlike other grades of carbon steel, which tend to be brittle, mild steel is hard, yet malleable, making it the ideal choice for the construction of pipelines, construction materials and many other daily use products like cookware.
- Mild steel can be machined and shaped easily due to its inherent flexibility. It can be hardened with carburizing, making it the ideal material for producing a range of consumer products.

Table 1

Square Hollow Section / Square Tubing Dimensions / square tubes weight chart,

Square Tubing Size(mm^2)	Square Tube Thickness(mm)	Square Tubing Kg / Metre
20 X 20	2	1.11 Square Tube
25 X 25	2	1.43 Square Tube
25 X 25	2.5	1.74 Square Tube
25 X 25	3	2.04 Square Tube
30 X 30	2	1.74 Square Tube
30 X 30	2.5	2.14 Square Tubes
30 X 30	3	2.51 Square Tubes
30 X 30	3.2	2.65 Square Tubes
40 X 40	2	2.37 Square Tubes
40 X 40	2.5	2.92 Square Tubes
40 X 40	3	3.45 Square Tubes
40 X 40	4	4.46 Square Tubes
40 X 40	5	5.40 Square Tubes

4.3 MATERIAL USED AND ITS COMPOSITION

The chassis material is considered depending upon the various factors such as maximum load capacity, absorption force capacity, strength, rigidity. The material selected for the chassis building is AISI 1018. AISI 1018 is a mild/low carbon steel.

Tables:

Composition	AISI 1018
Iron	98.8 to 99.25%
Manganese	0.6 to 0.9%
Carbon	0.15 to 0.2%
sulphur	0 to 0.050%
Phosphorus	0 to 0.040%

Table 3 Composition of AISI 1018

4.4 MATERIALS USED

In this project we used MS (Mild steel) square pipes, steel metal, MS (Mild Steel) plates, drill screws, Wise, metal flat.
For marking and measuring we have been used different types of materials like

- Marker
- Steel rule
- Try square
- Whitener

For performing operations, we have been used different types of machines like

- Cutting Machine
- Grinding machine
- Welding machine

4.5 PARTS ASSEMBLY

We have assembled all the components together and the final image of the project is as shown in figure (4.27)

Fig 4.27 Project image after assembling chassis and carrier

We have fixed the motor in between the Carrier for lifting as shown in the figure (4.28)

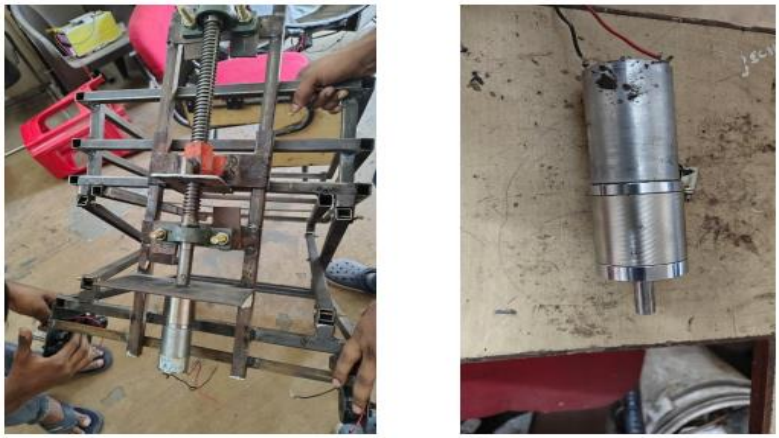


Fig 4.28 Fixing the motor in between carrier for lifting

The overall assembling of Compact Load Carrier has been completed and the vehicle is ready to drive and carry loads as shown in the figure (4.35)

Fig 4.35 Compact Load Carrier

5. RESULTS AND DISCUSSIONS :

5.1 ANALYSIS

Upon computation, the stresses developed in chassis are shown in von-mises stress diagram Fig 3.24. The maximum Von-mises stresses found is 8.52 x 105 N_m2 (0.85MPa). The material being used for fabrication of chassis is mild steel whose yield stress is 240MPa which is much higher than the maximum von-mises stress. Hence the selected material and thicknesses can easily withstand the loads. Maximum transitional displacement found upon application if 250N load is 0.000837mm which is negligible. Hence the selected material and

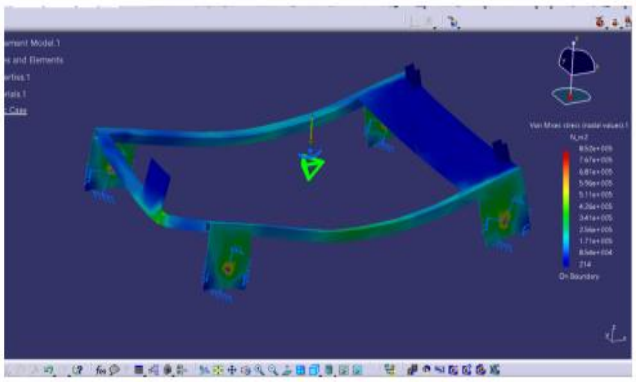


Fig 5.1 Von-mises stress diagram

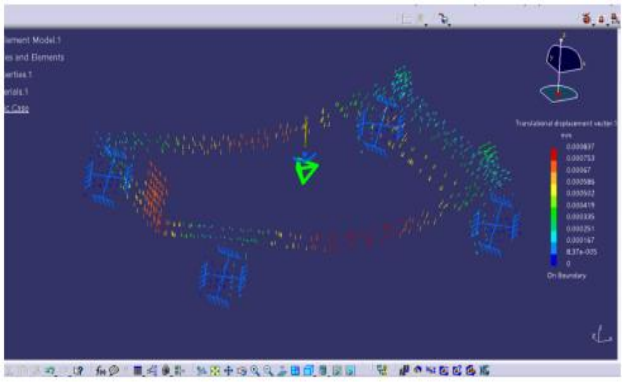


Fig 5.2 Transitional Displacement Diagram

thicknesses can easily withstand the loads. Load carriers are essential in logistics and transportation, and their management can significantly impact efficiency. Here are some insights. For heavy load handling we find several equipment's in the market but, it is difficult to find a compact load carrier which handles compact (small to medium) loads Part modelling, Assembly and analysis is done using Catia software Upon computation, the stresses developed in chassis are shown in von-mises stress diagram. The maximum Von-mises stresses found is 8.52 x 105 N_m2 (0.85MPa). The material being used for fabrication of chassis is mild steel whose yield stress is 240MPa which is much higher than the maximum von-mises stress. Hence the selected material and thicknesses can easily withstand the loads. Maximum transitional displacement found upon application if 250N load is 0.000837mm which is negligible. Hence the selected material and thicknesses can easily withstand the loads.

6. CONCLUSIONS :

For heavy load handling we find several equipment's in the market but, it is difficult to find a compact load carrier which handles compact (small to medium) loads

- ✓ Part modelling, Assembly and analysis is done using Catia software

- ✓ Upon computation, the stresses developed in chassis are shown in von-mises stress diagram. The maximum Von-mises stresses found is 8.52 x 105 N_m2 (0.85MPa). The material being used for fabrication of chassis is mild steel whose yield stress is 240MPa which is much higher than the maximum von-mises stress. Hence the selected material and thicknesses can easily withstand the loads.
- ✓ Maximum transitional displacement found upon application if 250N load is 0.000837mm which is negligible. Hence the selected material and thicknesses can easily withstand the loads.
- ✓ Compact load carrier designed by us will have fallowing advantages;
- ✓ Consumes less energy
- ✓ Runs on electric energy hence not dependent on imported fuels
- ✓ No pollution hence best suitable for indoor applications
- ✓ Can be remotely operated - best suitable for operations in hazardous areas as well
- ✓ Load can be lifted or lowered to some extent to provide extra convenience to users
- ✓ As it is indigenous technology, we need not to pay royalty to other countries, spares and maintenance can be easily sourced
- ✓ Low Cost

Acknowledgement

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