Bachelor of Engineering in Mechanical Engineering

Report on
"DESIGN AND ANALYSIS OF MOTORCYCLE LIFT"

SENIOR DESIGN PROJECT
(20EMEW401)

Under the Guidance of
Prof. U. P. Hosmani

Submitted By

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CERTIFICATE

This is to certify that the Senior Design Project (20EMEW401) report entitled **"DESIGN AND ANALYSIS OF MOTORCYCLE LIFT"** submitted by Mahantesh R Aralikatti (01FE22BME442), Soundarya Nagaraj Koti (01FE22BME441), Vishwanath Patil (01FE21BME108), Anand Kammar (01FE22BME475), and Manoj Tawade (01FE22BME473) in partial fulfilment of the requirements for the degree in Bachelor's in Mechanical Engineering of the KLE Technological University, Hubballi-31 during the academic year 2024-25, is a bona-fide record of work carried out by him/her under our supervision. The contents of the project report, in full or in parts, have not been submitted to any other institute or university for award of any degree or diploma.

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1.		
2.		

ACKNOWLEDGEMENT

The successful completion of any task would be incomplete without mentioning the people who made it possible and whose guidance and encouragement has made our efforts successful.

At the outset, we would like to express our deep sense of gratitude for our guide **Prof. U. P. Hosmani** for making this project report successful through their invaluable guidance at every stage of the project report.

We also thank **Prof. G. U. Raju** for his encouragement in undertaking the task of this project.

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List of Abbreviations

Abbreviations	Description
ANSYS	Analysis System
FEA	Finite Element Analysis
FEM	Finite Element Method
AISI	American Iron and Steel Institute
XIP	Xtra Improved Plow steel
ST	Structural Steel
3D	3 Dimensional
CAD	Computer Aided Design
N	Newton
MPa	Mega Pascal
kg	Kilogram
mm	Millimetre
N/m^2	Newton per square millimetre

List of Symbols

Symbol	Description
N	Newton
E	Young's Modulus
P	Density
σ	Stress
η	Nita
M	Mass
V	Velocity

Contents:

Abstract

The paper represents the design, analysis and optimization carried out on a motorcycle and material lift system that focuses on safety, efficiency, cost effectiveness. The research highlights on developing a lift capable of elevating motorcycle and person to a required height while ensuring operational safety and structural integrity. For safety purpose the lift safety gear is used, the gear will lock the c channel after the governor speed activates the gear. The design incorporates dual C channel configuration, guide roller system, wire rope mechanism, powered by 3 hp helical brake gear motor with a 60:1 gear ratio, this gear motor will produce required speed needed for movement. Through Finite Element Analysis (FEA) and iterative optimization, the design underwent five iterations resulting in significant improvements. The paper describes the overall method and analysis of motorcycle and material lift. The main objective of this project is to achieve the safety, efficiency and cost effectiveness.

KEY WORDS: - Fork Lift, Safety Gear, Wire Rope.

CHAPTER 1

INTRODUCTION

The design and analysis of motorcycle lifts is critical to ensure efficient and safe maintenance operations in workshops and showrooms. This research focuses on the mechanical and structural aspects of motorcycle lifts, investigating factors such as load capacity, stability, cost effectiveness and ease of use. Generally, the service and maintenance of motorcycles are done at properly equipped service centres and with highly skilled mechanics. By conducting a comprehensive analysis, this study aims to identify potential design improvements and optimize the performance of motorcycle lifts. Motorcycle lifts are essential tools for servicing and repairing motorcycles. They provide a stable and elevated platform that allows technicians to effectively access various components of the motorcycle lifts. However, the design and construction of motorcycle lifts must adhere to strict safety standards to prevent accidents and injuries.

In industries one of the important tasks is handling materials. The movement of goods over a short distance within a facility or between a buildings and transportation of a vehicles [1]. Some regulations should be takin into considerations while making of these material lifting systems. These laws could include things like moving items to the right place safely and effectively, moving goods whenever needed, supplying at the right rate, storing materials in the least amount of space, and handling materials in an economical way [2]. There are different types of lift available in the industries like hydraulic lift, hydraulic scissor lift, traction lift, Dead weight lift. The area of focus should be on capacity, management, storage area, vehicle delivery timings and movement of goods [3]. Most of the commercial buildings uses a wire rope traction system this machine operates by hoisting a wire rope on a sheeve thus vertically lifting a vehicle platform [4]. The most important factor in traction lift design is the consideration of safety measures. If a rope breaks while the lift is operating, it should be halted right away to protect the passengers and the items. The safety gear grips the guide rail and stop the lift [5].

Fig 01. Rope Pulley Lift

1.1 Design Objectives: -

The design objectives required for the lift are: -

1. Desired Height Reach
2. Sufficient Load Capacity
3. Low Maintenance Requirements
4. Cost-Effectiveness
5. Safety
6. Efficient Space Utilization
7. Performance
8. Easy to use

1.2 Functional Requirements: -

1. **Height Adjustment**: The lift must be able to elevate materials to various heights as needed.
2. **Load Bearing**: The lift should safely move the required load and size.
3. **Operational Efficiency**: The lift should perform its tasks quickly and accurately.
4. **Compact Design**: The lift should have a minimum space when in use
5. **Safety Mechanisms**: The lift must include emergency stop button.
6. **Durability**: The lift should operate effectively for desired period of time.
7. **Maneuverability**: The lift should be easy to control and position in two work environments

1.3 Specifications: -

1. Maximum Height: Approx 10 Feet
2. Load Capacity: 567 kg
3. Lift Speed: - 1 Ft/s
4. Safety Features: Emergency stop button
5. Control System: Push Button control for precise movements
6. Power Source: Electric 3 phase AC 415volts
7. Operating Temperature Range: 10°C to 45°C
8. Materials: Structural steel coated with anti-corrosive material (0.3 to 0.5 carbon steels)

CHAPTER 2

LITERATURE REVIEW

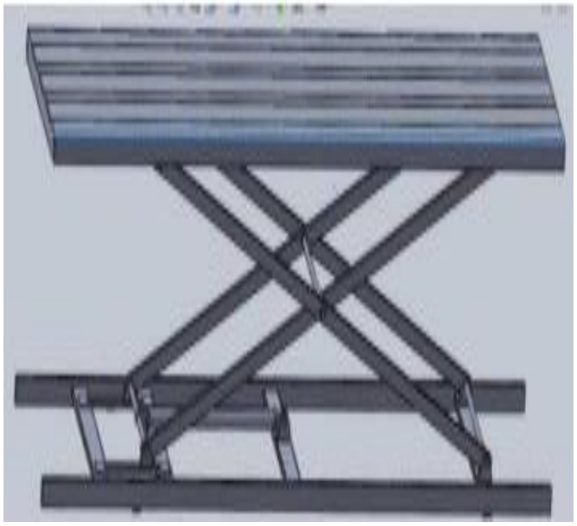
2.1 Literature Survey

The paper designed and optimized the motorcycle lifts. The main objective is including low maintenance requirements, cost effectiveness, efficient space utilization, safety, and performance [6]. These are the main factors compared to others. Ropes and pulleys are used and require less maintenance. These systems are safe, stable, and support a large weight [7]. When paired with pulleys and support structures like C-channels, high-strength steel ropes have durability even after frequent usage. Because of these factors, this design system is the best option for motorcycle lifts since it has a good balance between cost and efficiency.

One of the main advantages of a design system is that it requires less initial setup and ongoing maintenance than a hydraulic system [8], and affordability compared to hydraulic systems is that maintenance is less since the simple components like rope and pulleys of these systems don't require specialized repairs because they are easy to replace individual parts. They are also adaptable to different motorcycle types and operational needs compared to hydraulic systems [8]. In conclusion, rope and pulley systems are the best option for motorcycle lifts because they strike a balance between cost, performance, and safety [6]. They are a useful option for workshops and individual usage due to their simplicity, durability, and low maintenance requirements, especially where affordability and dependability are important factors

2.2 Literature on Publications

Paper Name/ Date/	Information
Title: Design And Development of Vertical Material Handling Lift for Reduce Cycle Time and Cost Optimization. **Date:** June-2017 	Material handling is important thing for the industries. Material handling involves short-distance movement within the confines of a building or between a building and a transportation vehicle. It utilizes a wide range of manual, semi-automated, and automated equipment and includes consideration of the protection, storage, and control of materials throughout their manufacturing, warehousing, distribution, consumption, and disposal. Material handling can be used to create time and place utility through the handling, storage, and control of material, as distinct from manufacturing, which creates form utility by changing the shape, form, and makeup of material.

Title: Design & Analysis of Hydraulic Scissor Lift **Date:** June-2016 	This paper is mainly focused on force acting on the hydraulic scissor lift when it is extended and contracted. Generally, a hydraulic scissor lift is used for lifting and holding heavy weight components. Material selection plays a key role in designing a machine and also influence on several factor such as durability, reliability, strength, resistance which finally leads to increase the life of scissor lift. The design is performed by considering hydraulic scissor lift as a portable, compact and much suitable for medium type of load application. Drafting & drawing of hydraulic system scissor lift is done using solid works with suitable modelling and imported to Ansys work bench for meshing and analysis. Hence, the analysis of the scissor lift includes Total deformation load, Equivalent stress, was done in Ansys and all responsible parameters were analysed in order to check the compatibility of the design value. The computational values of two different materials such as aluminium and mild steel are compared for best results.
Title: Development Of Lift Machine (Using Cable and Pulley) **Date:** November 2008 	Idea to development of lift machine (using cable and pulley) is come from the FKM lecturer that gives a task and a title for this project. This project focuses in design, fabrication and analysis the mechanical part of machine and the system at the lift machine body. To achieve this project objective, this lift machine body structure and pulley system need to concern some other criteria such as strength, safety and ergonomic design. This project flow must start from design, analysis, and lastly fabrication process. Before develop the lift machine (using cable and pulley), it must compare with other product (forklift) in market. It is because to study the customer need and to create a new design with new feature.

<table>
<tr>
<td>Title: Development of an automated mechanical lift for material handling purposes.
Date: 13/06/2020
DOI: Farayibi, P. K., Abioye, T. E., & Ayodeji, O. Z. (2020). Development of an automated mechanical lift for material handling purposes. African Journal of Science, Technology, Innovation and Development, 12(5), 561–569. https://doi.org/10.1080/20421338.2020.1765478
</td>
<td>In this paper, the development of an automated mechanical lift for material handling purposes in a manufacturing environment was carried out and reported. The lift was designed for a rated load capacity of 10 kg which required a 1-hp electric motor. The power transmission was achieved using belt-pulley, worm gear and chain-sprocket mechanisms; and the system automation was achieved using contactors and limit switches. The performance evaluation of the system revealed that the relationship between the time required to raise and to return loads within a range of 5–15 kg through a distance of 1070 mm followed a third-order polynomial with high correlation coefficients of 0.996 and 0.998 respectively. The first region had a slope of 0.25 sec/kg which decreased gradually to near zero, the second region had a near-zero slope over a load range of 7–10.60 kg and a consistent travel time of about 5.67 ± 0.03 sec, and the third region had a slope which increased from near zero to 0.64 sec/kg. The automated mechanical lift developed could successfully carry out the vertical displacement of materials, hence fulfilling the design purpose.</td>
</tr>
<tr>
<td>Title: Design and Analysis of Hydraulic Scissor Lift By FEA
Date: Oct-2016
</td>
<td>A hydraulic pallet lift is a mechanical device used for various applications for lifting of the loads to a height or level. A lift table is defined as a scissor lift used to stack, raise or lower, convey and/or transfer material between two or more elevations. The main objective of the devices used for lifting purposes is to make the table adjustable to a desired height. A scissor lift provides most economic dependable & versatile methods of lifting loads; it has few moving parts which may only require lubrication. This lift table raises load smoothly to any desired height. The scissor lift can be used in combination with any of applications such as pneumatic, hydraulic, mechanical, etc. Lift tables may incorporate rotating platforms (manual or powered); tilt platforms, etc, as a part of the design. A multiple height scissor lift is made up of two or more leg sets. As per the discussion with</td>
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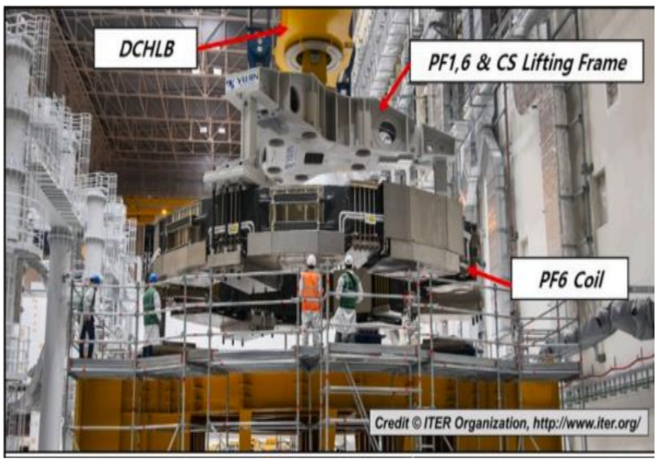
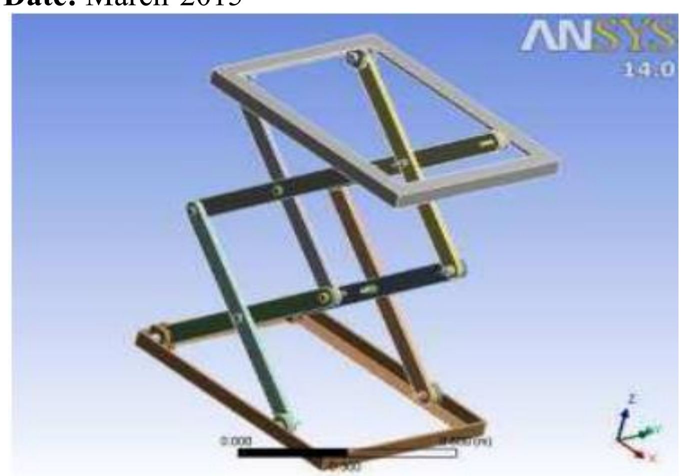
	the concern person of DS Engineering, Pune, it is found that they are facing some problems regarding hydraulic scissor lift like job to be lifted are heavier which causes more deformations in hydraulic lift frame checking deformations & stresses induced in it is a major objective of this project.
Title: Fabrication and load test of LIFTER assembly tools for lifting heavy components. **Date:** 2024  	The lifting tools described in this paper are special tools used to lift and transfer the VV, TFC and pre-assembled 40◦ sectors at sector subassembly tool from the upending tool to the sector sub-assembly tool or to the Tokamak pit. The assembly and installation tools for the ITER Tokamak machine are special tools which are used to assemble and install ITER Tokamak machine components such as magnets, vessels and thermal shields. The function and structural integrity of lifting tools were verified by Factory Acceptance Test (FAT) at Korea. The lifting tools have been well used to handle the heavy component at ITER.
Title: Design and Fabrication of a Hydraulic Motorcycle Lifter  	The major objective of the study was to design and fabricate an instructional equipment that will be used as a multi-purpose lifting device for motorcycle servicing. The project developed is made up of locally-available materials, thereby making it cost efficient. The project can be used indoors and outdoors, since it designed to lessen the stress experienced by both teachers and students who are involved in motorcycle repair. Although it is intended as an instructional device, it can also be used in actual motorcycle servicing, particularly for small to medium-sized motorcycles. It has two major parts, the hydraulic jack and the hydraulic cylinder.

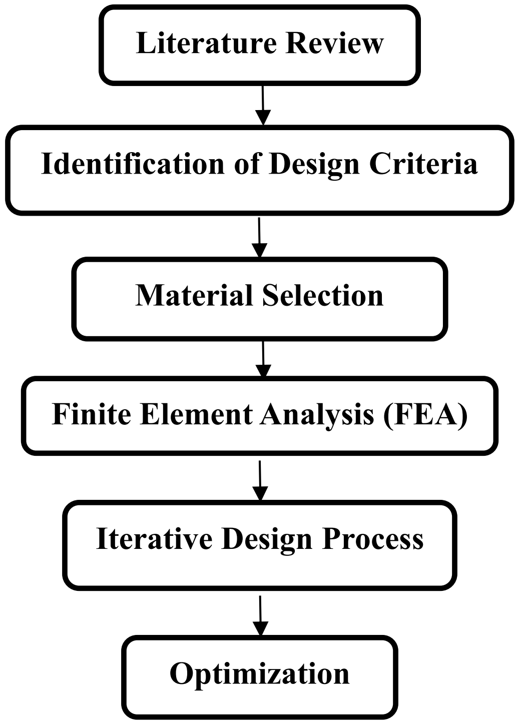
Title: Mobile Motorcycle Lift for the Common Man **Date:** 2017 	Motorcycle enthusiasts often need to spend significant amounts of time tuning and improving their bikes. Traditionally this is done by hobbyists by using the bike's own stand which can be dangerous due to its instability. For those with a little more money, a dedicated free-standing bike stand is the fixture of choice. Unfortunately, many of the bike stands are too expensive, too big, or have very weak ergonomics. In this paper, we present a motorcycle lift designed using Axiomatic Design that has a small footprint, is adjustable for a large range of different bikes and users, and can be mounted without the user lifting the bike. Though this prototype design is more expensive than the simple bike stands, we believe its functionality makes it well worth the extra cost.
Title: Design, Manufacturing & Analysis of Hydraulic Scissor Lift **Date:** March-2015 	The paper describes the design as well as analysis of a hydraulic scissor lift. Conventionally a scissor lift or jack is used for lifting a vehicle to change a tire, to gain access to go to the underside of the vehicle, to lift the body to appreciable height, and many other applications Also such lifts can be used for various purposes like maintenance and many material handling operations. It can be of mechanical, pneumatic or hydraulic type. The design described in the paper is developed keeping in mind that the lift can be operated by mechanical means by using pantograph so that the overall cost of the scissor lift is reduced.

Title: Design and Analysis of Lifting Tool Assemblies to Lift different Engine Block **Date:** 2017 	Engines block is required to be lifted from one place to another while they are being processed. The human effort required for this purpose is more and also the engine block may get damaged if it is not handled properly. There is a need for designing a proper lifting tool which will be able to conveniently lift the engine block and place it at the desired position without any accident and damage to the engine block. In the present study lifting tool assemblies are designed and analysed in such way that it may lift different categories of engine blocks. The lifting tool assembly consists of lifting plate, lifting ring, cap screws and washers. A parametric model and assembly of Lifting tool is done in 3D modelling software CREO 2.0 and analysis is carried out in ANSYS Workbench 16.0. A test block of weight equivalent to that of an engine block is considered for the purpose of analysis.

CHAPTER 3

METHODOLOGY

The methodology followed for this problem statement is as follows,



Extensive literature reviews and surveys were undertaken to assess the current state of motorcycle lift systems and their implementation costs. Various configurations were examined in a wide variety of environments and settings. The major constraints for consideration included the overall weight, reliability and cost of the lift. The design process is to select the best motorcycle lift to satisfy the given requirements criteria:

- Operational efficiency
- Low maintenance
- Compact design
- Safety mechanism
- Durability
- Height Adjustment
- Cost effective

To reduce stresses and deflection in motorcycle lift the load should transfer equally between the two C - channels. The C – channels mounted on the surface of the ground

CHAPTER 04

ALTERNATE DESIGNS

4.1 Available alternate designs:

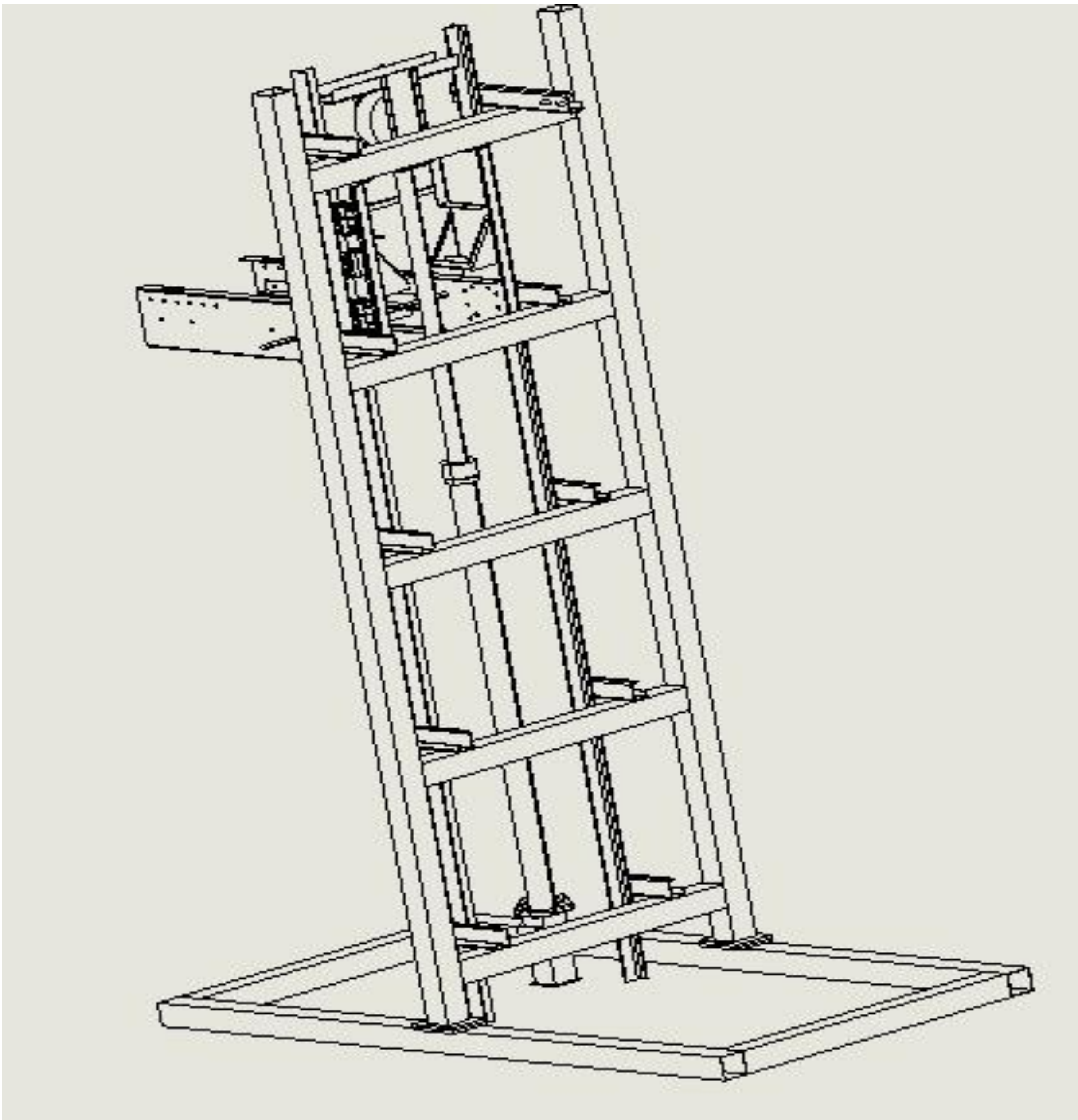


Fig No 02. Represents Hydraulic lift

A hydraulic lift uses fluid pressure to raise or lower heavy loads. It operates based on Pascal's principle, transmitting force through a confined liquid to perform mechanical work efficiently.

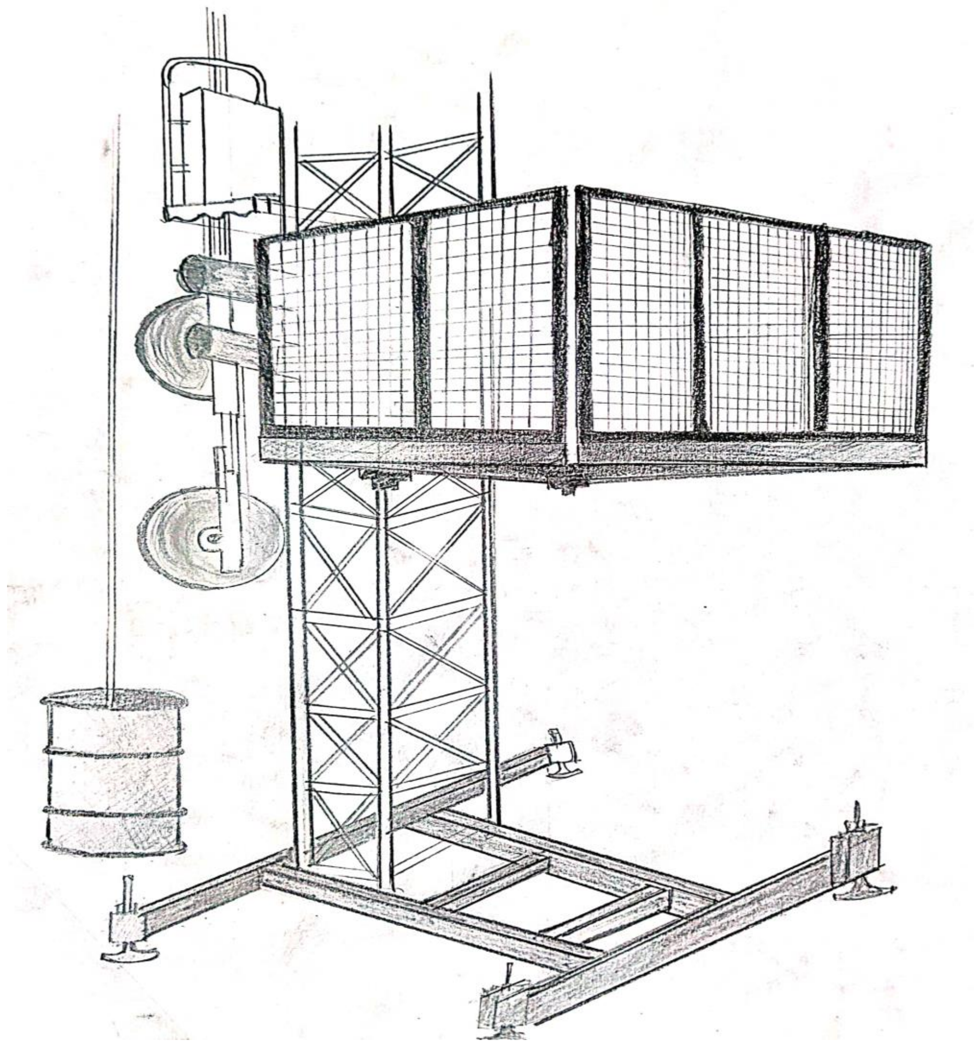


Fig No 03. Dead Weight Pulley Lift

A dead weight pulley lift uses counterweights and pulleys to lift and balance a load. The system operates by offsetting the load's weight with a fixed counterweight, simplifying lifting tasks without requiring external energy.

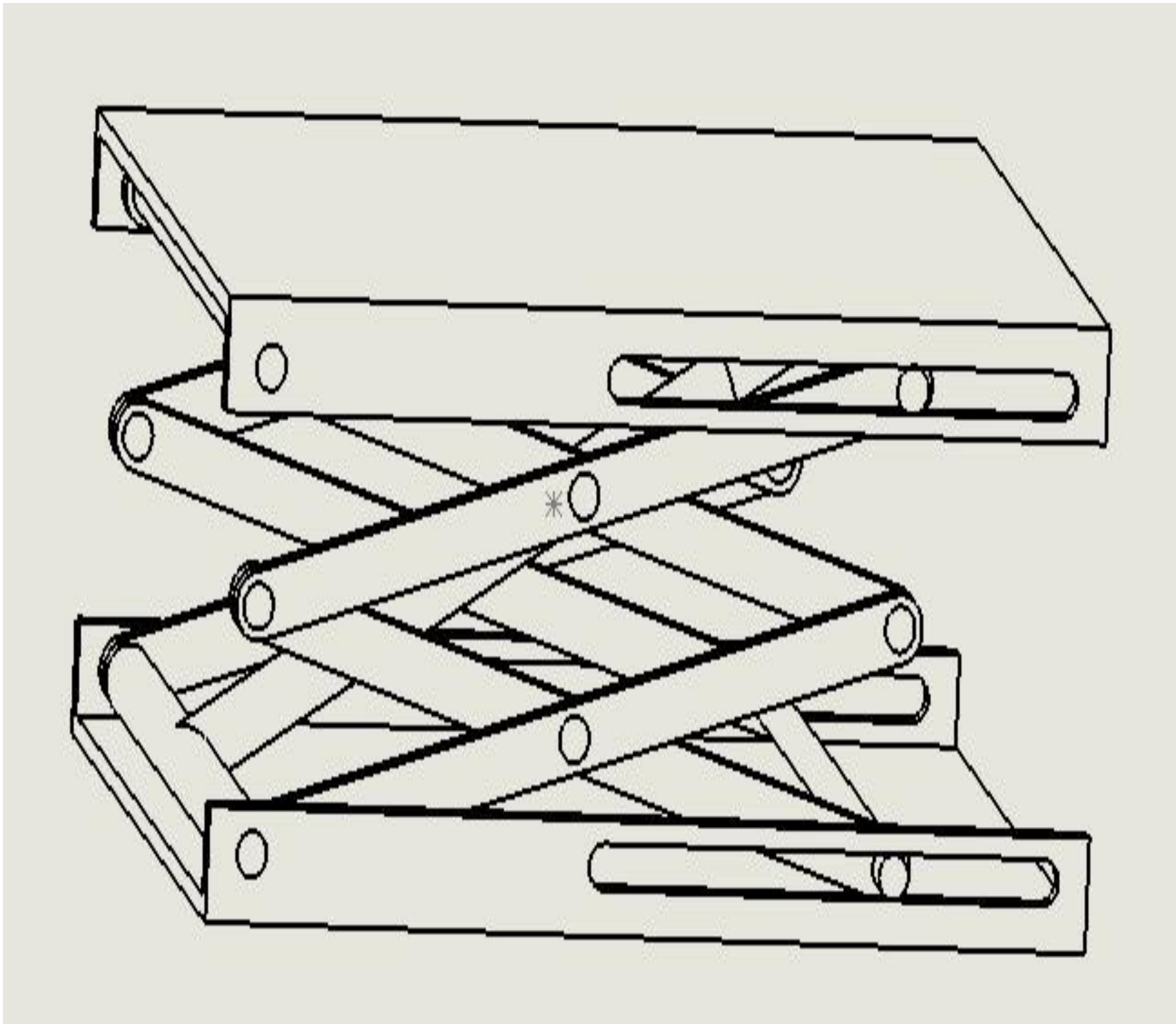


Fig No 04. Hydraulic Scissor Lift

A scissor lift is a mechanical platform that uses crisscrossing supports, resembling scissors, to raise and lower loads vertically. It is powered by hydraulic, pneumatic, or mechanical systems and is commonly used in maintenance, construction, and warehouse operations

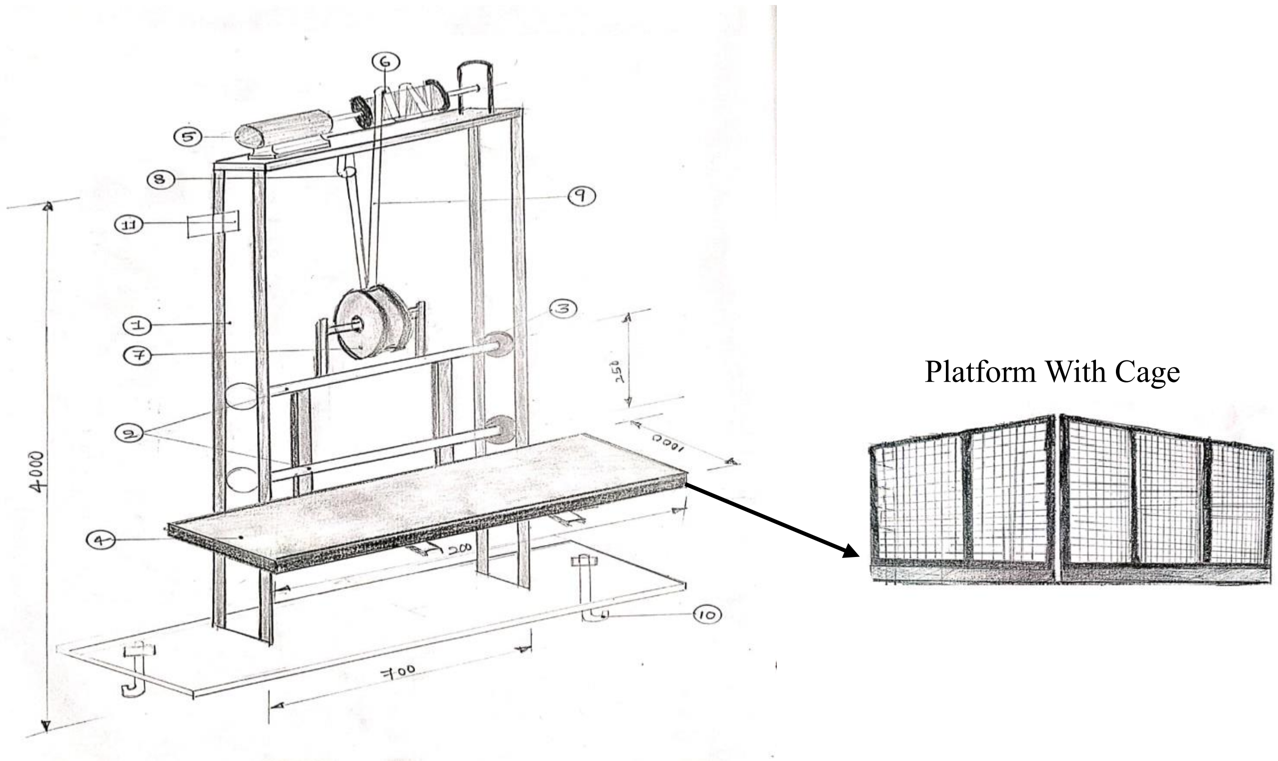


Fig No 05. Rope Pulley Lift

A rope pulley lift uses a system of ropes and pulleys to lift or lower loads by reducing the effort needed. It works on the principle of mechanical advantage, allowing heavier weights to be moved with less force by changing the direction of applied force

Table No 01. Represents Parts Details of Rope Pulley Lift

Part No	Part Name	Size	Material
1	C-Type Channel	100X50X10	MS Channel (ST25)
2	Fork Bracket	75X40X6	MS Channel (ST25)
3	Guide Rollers	Ø78X40	EN8
4	Platform	1000X2000X75	MS Channel (ST25)
5	Brake Gear Motor	200X400X200	-
6	Wire Rope Drum	Ø200X150	MS/EN8
7	Fork Lift Pulley	Ø100X40	EN8
8	Rope Clamp	Ø12- D Clamp	Steel (304/306)
9	Steel Wire Rope	Ø12X10000	Steel (XIP)
10	Foundation Bolt	Ø20X600	EN8
11	Wall Bracket	Flat 70X15	MS Flat (ST25)

4.2 Design Selection

PUGH CHART

Table No 02. represents PUGH Chart

Requirements	Weight	Hydraulic Lift	Deadweight Pulley Lift	Hydraulic Scissor Lift	Rope Pulley Lift
Height	5	4	2	2	5
Capacity	5	5	3	3	5
Maintenance	5	3	3	3	4
Cost	5	4	3	3	4
Safety	5	4	3	3	4
Space	5	5	3	3	5
Performance	5	5	4	4	5
Overall total	35	30	21	21	32

4.3 Parts Details

1. **C TYPE RAIL CHANNEL of** size 100WX50HX10TH made up of MS structural steel to hold required designed weight. The maximum holding capacity is 1 Ton up to 5meter.
2. **LIFTING FORK BRACKET** fabricated by ISMS channel 75X40X6mm, welded with four sliding guide rollers and top fitted with lifting pulley.
3. **GUIDE ROLLER** made of high carbon steel (EN8) as good tensile strength better than mild steel, and also good surface hardness, and is fitted with ball bearing and hardened shaft (EN8).
4. **PLATFORM:** -MS Fabricated framed by ISMS 75X40X6, and top welded by 2mm thick checker sheet, which withstand constant load and rugged.
5. **BRAKE GEAR MOTOR: -** BRAKE MOTOR AND GEARBOX is combination of A.C induction motor with electromagnetic brake fitting on non-driving end of motor and another end fitted with gearbox of ratio 60:1 with oil filled heavy duty carbon steel gear.
6. **WIRE ROPE DRUM: -** Made up of MS pipe with MS end plates as flange welded on drum shaft, which is coupled with gear motor.
7. **Fork Lift Fully: -** Made up of EN8 material because to sustain the hardness fitted with ball bearing for smooth rotation.

8. **Rope Clamp:** - D clamp forged steel.
9. **Steel wire rope**: - To durable corrosion free, bending stress, good strength Flexibility. To overcome length of 4m height for smooth operation with handling extra load, and having a capacity to lift 1Ton. (Extra Improved Plow Steel)
10. **Foundation Bolt:** - Made up of EN8 which are ankled in RCC concrete to hold entire lift machine.
11. **Wall Bracket:** - Made up of MS Flat welded with C- channel for vertical holding of entire lift machine.

ST25 Structural Steel Properties

Chemical Composition (approximate):

- Carbon (C): 0.20-0.25%
- Manganese (Mn): 0.40-0.70%
- Silicon (Si): 0.10-0.30%
- Phosphorus (P): Max 0.045%
- Sulphur (S): Max 0.045%

Mechanical Properties

- **Tensile strength**-450 MPa
- **Yield Strength-** 275MPa
- Impact Resistance Good (Typically tested at room temperature)

Physical Properties:

- **Density**: 7850 kg/m^3
- **Modulus of Elasticity**: 210 GPa
- **Poisson's Ratio**: 0.29-0.30
- **Thermal Conductivity**: ~50 W/mK

LIFT SAFETY GEAR

Fig No 06. represents Lift Safety Gear

INTRODUCTION: -

The instantaneous or progressive safety gear, together with the overspeed governor, plays a key role in the safety of the elevator It is a safety device, directly related to the overspeed governor.
The safety gear is the device that allows the braking of the elevator.

When the intervention speed is exceeded, i.e. when an abnormal acceleration is detected in the plant, the governor intervenes, giving a signal to the safety gear linkage which is activated by tightening the guide and blocking the plant.

SELECTION: -

Safety gears BP1, BP2, BP3 single roller: ideal for home lifts, hydraulic and rope elevators with guides from 5 to 9, 10 and 16 mm, with a maximum load capacity of 4059 kg.

Based on our problem statement BP1 with 5 mm guide roll is required. The activation time is 115% of actual speed of elevator.

CHAPTER 5

DESIGN CALCULATIONS

To calculate the required horsepower (HP), torque, motor specifications, Rope diameter for lift

Assumptions:

- 1. Weight of a Royal Enfield bike: approximately=200kg
- 2. Average weight of a man=70kg
- 3. Weight of the elevator platform=108kg
- 4. Total height of lift= 10 ft (3.05 m)
- 5. Desired speed of ascent/decent=1 ft/s (0.3 m/s)
- 6. Efficiency of the system: 75% (accounting for friction and mechanical losses)

Step 1: Calculate the total weight to be lifted

Total weight = (Bike weight + Man's weight + Platform weight) x FOS

Total weight = (200+70+108) x 1.50=**567kg**

Step 2: Calculate the force required to lift the weight

Force = Mass × Acceleration due to gravity

Force = 567 kg × 9.81 m/s^2 = **5556.6 N**

Step 3: Calculate the power required

Power = Force × Velocity

Power = 5556.6 N × 0.3 m/s = 1666.98W=**1.66kW**

Step 4: Account for system efficiency

Required power =1.66KW**=1666.98/.75=2.22kW**

Step 6: Calculate torque

Drum diameter of 12 inches (0.3048 m) for the elevator:

Torque = Force × Radius (Ref: https://youtu.be/d-3lXRnVSGw?feature=shared)

Torque = 5556.6× (0.3048 m ÷ 2) = **846.82 Nm**

Based on these calculations, here are the requirements:

1. Minimum motor power: **3 HP** (rounded up to 3 HP for safety)

2. Minimum torque: **846.82 Nm**

Gear box Specifications: -

Input rpm=**1440**

Gear ratio= **60:1**

Output Rpm=**36**

CHAPTER 6

CAD MODELLING

The Fig No. 5 shows the conceptual design of motorcycle and material lift. The conceptual design is the initial phase of the design process where the broad outlines of a product and system are established. It consists of 16 parts in 3D sketch.

The CAD modelling of motorcycle and material lift is done by using SolidWorks software. The finished CAD model is converted into the STEP format, which Ansys software was able to read and edit.

Two C-channels, each measuring 100X50X10 mm and having a total length of 4000 mm, are placed 650 mm apart to form the lift. Between these channels, a forklift slides using guide rollers with a 78 mm diameter. The forklift consists of an L-shaped welded C-channel, which houses the platform, and two parallel forklift channels. The C-channel is positioned above the forklift pulley.

Above the platform, which is a 1000X2000X75 mm C-channel frame made of ST 32 material, is a 2 mm ST 25 checker sheet. This platform is designed to support a person and their motorcycle.

The lift's 60:1 ratio gearbox and 3-horsepower brake gear motor will provide the necessary speed. The motor's output shaft will be connected to the input shaft of a 100 mm diameter wire rope drum. A 12 mm diameter, 10,000 mm long XIP wire rope will be coiled around the wire rope drum shaft. All of these components will be mounted on top of the C-channel plate.

Tools For Experiment Design and Analysis

Design Tools

- Catia
- SolidWorks

Analysis Tools

- Ansys
- Hyper mesh

Data Analysis

- Direct stress due to axial load in Rope.

Static structural analysis on platform

6.1 Individual parts that were modelled in SolidWorks

- C Channel
- Fork Lift
- Guide Rollers
- Platform
- Brake Gear Motor

- Wire Rope Drum
- Fork Lift Pulley
- Rope Clamp
- Steel Wire Rope

The fig no 07 represents C channel, fig no 08 represents fork lift, fig no 09 represents Guide rollers, fig no 10 represents platform, fig no 11 represents Brake Gear Motor, fig no 12 represents wire rope drum, fig no represents 13 Fork Lift Pulley

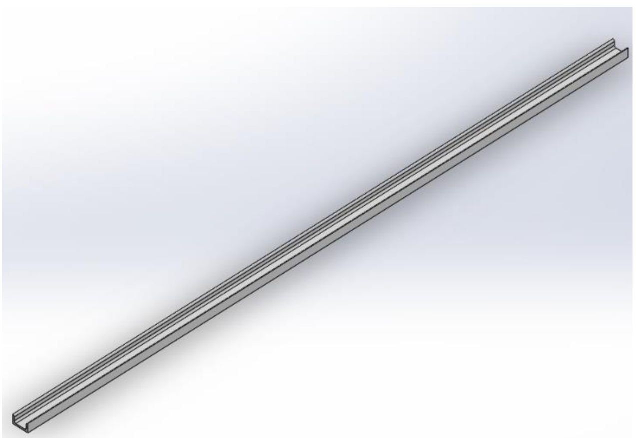


Fig No 07. C Channel

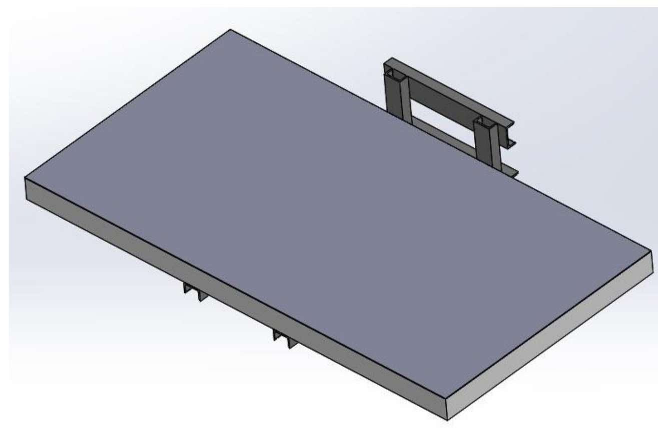


Fig No 08. Fork Lift

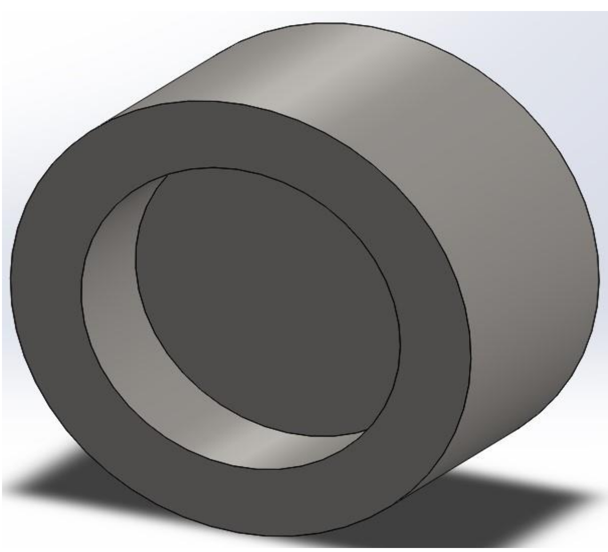


Fig No 09. Guide Rollers

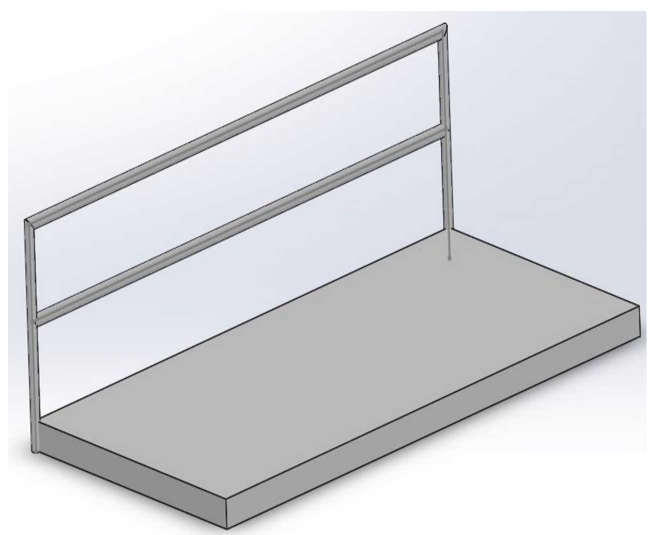


Fig No 10. Platform

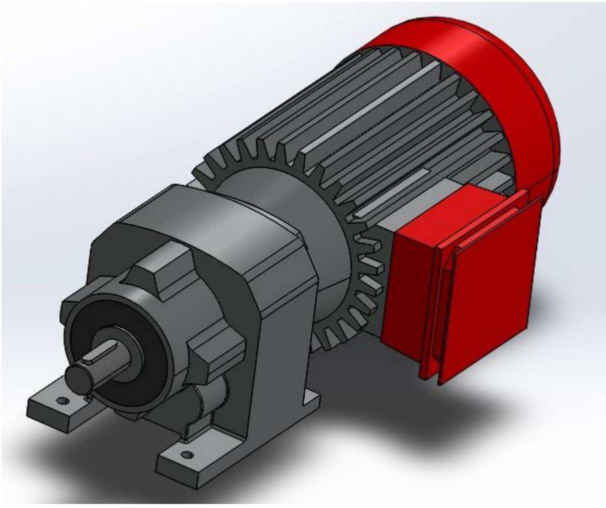


Fig No 11. Brake Gear Motor

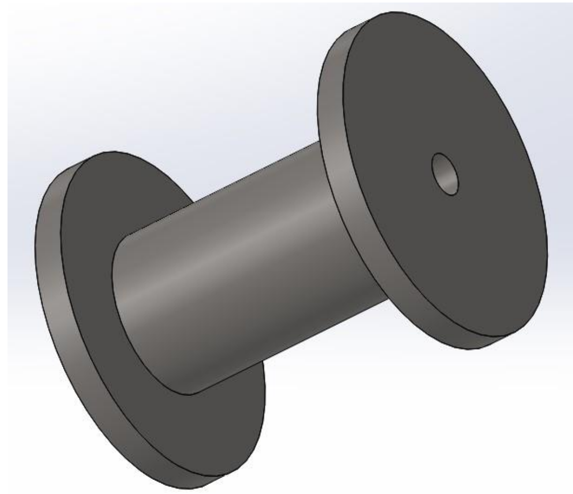


Fig No 12. Wire Rope Drum

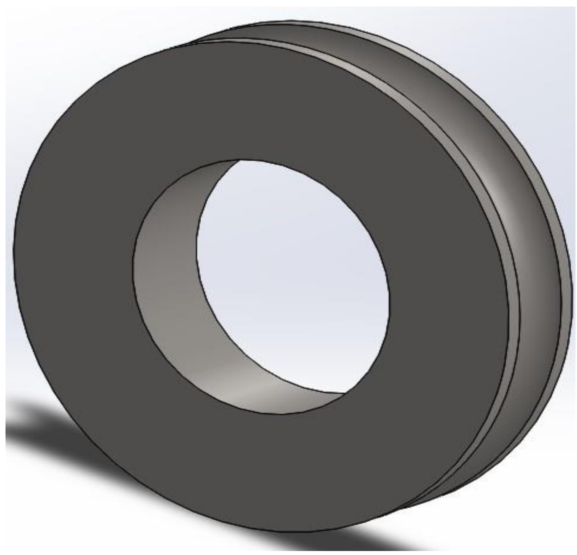


Fig No 13. Fork Lift Pulley

6.2 2-D sketches of part

The following figures shows the 2D sketches of the 3D models.

C Channel

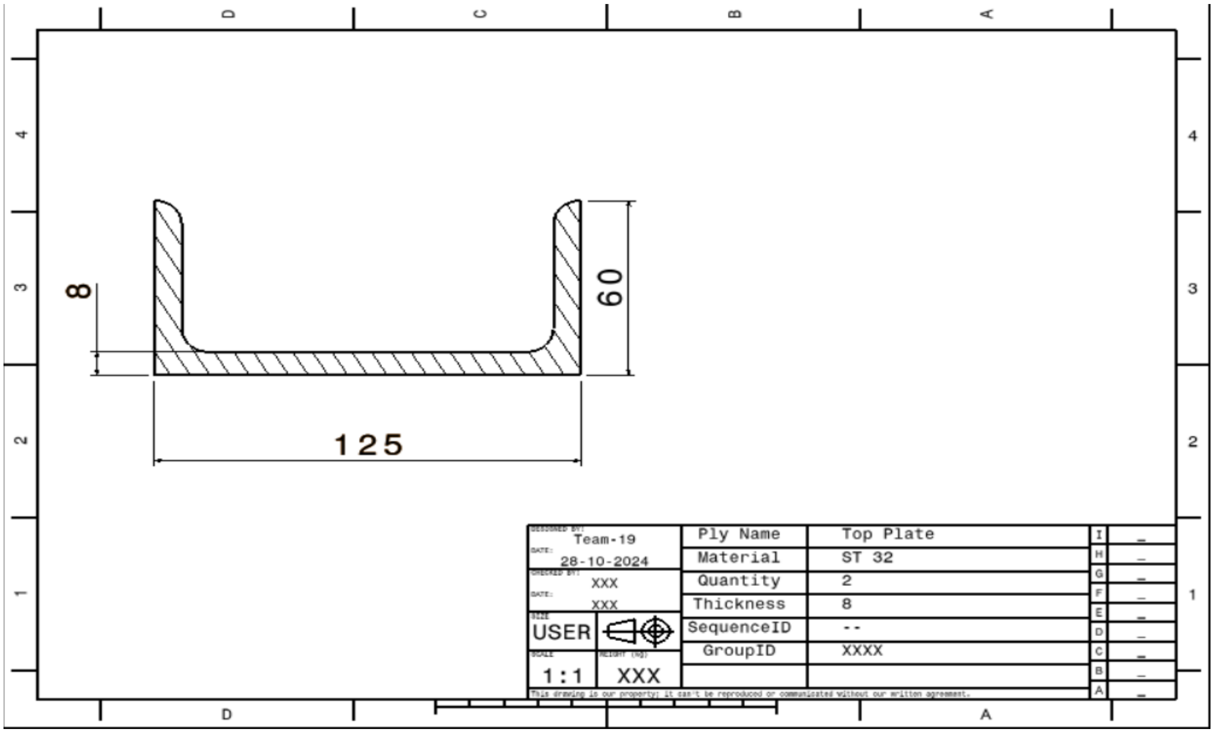


Fig No. 14 2D Sketch of C Channel

Guide Rollers

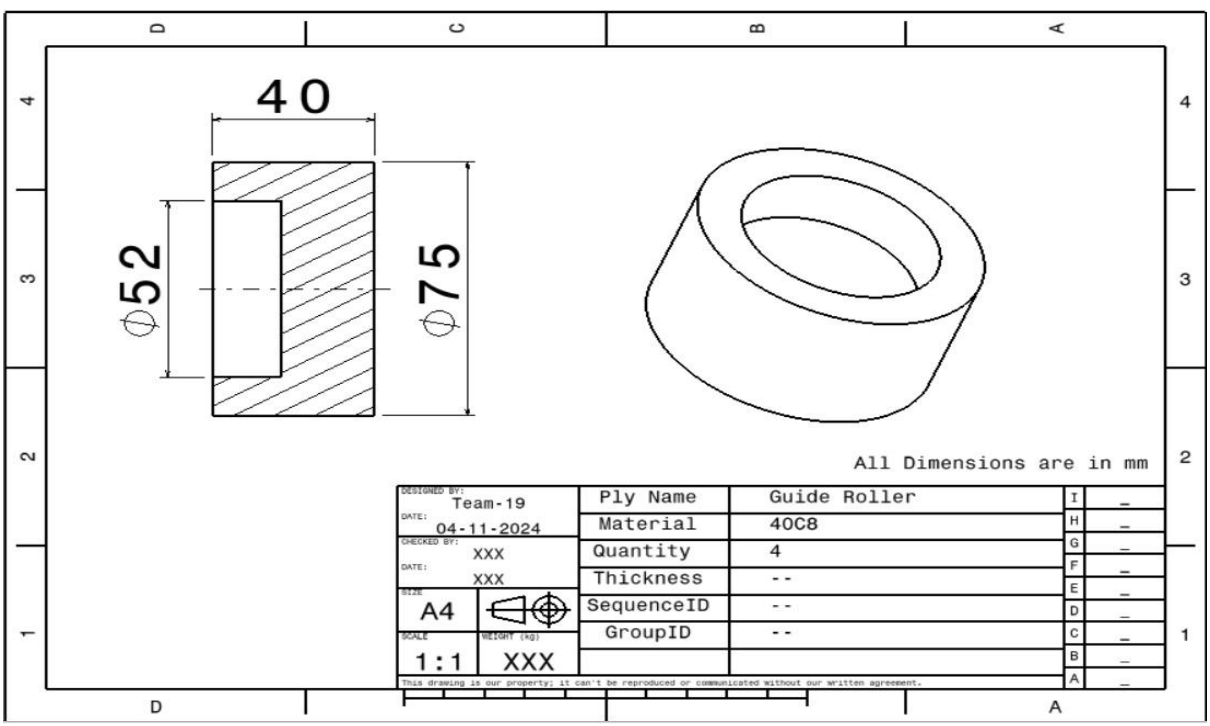


Fig No. 15 2D Sketch of Guide Rollers

Wire Rope Drum

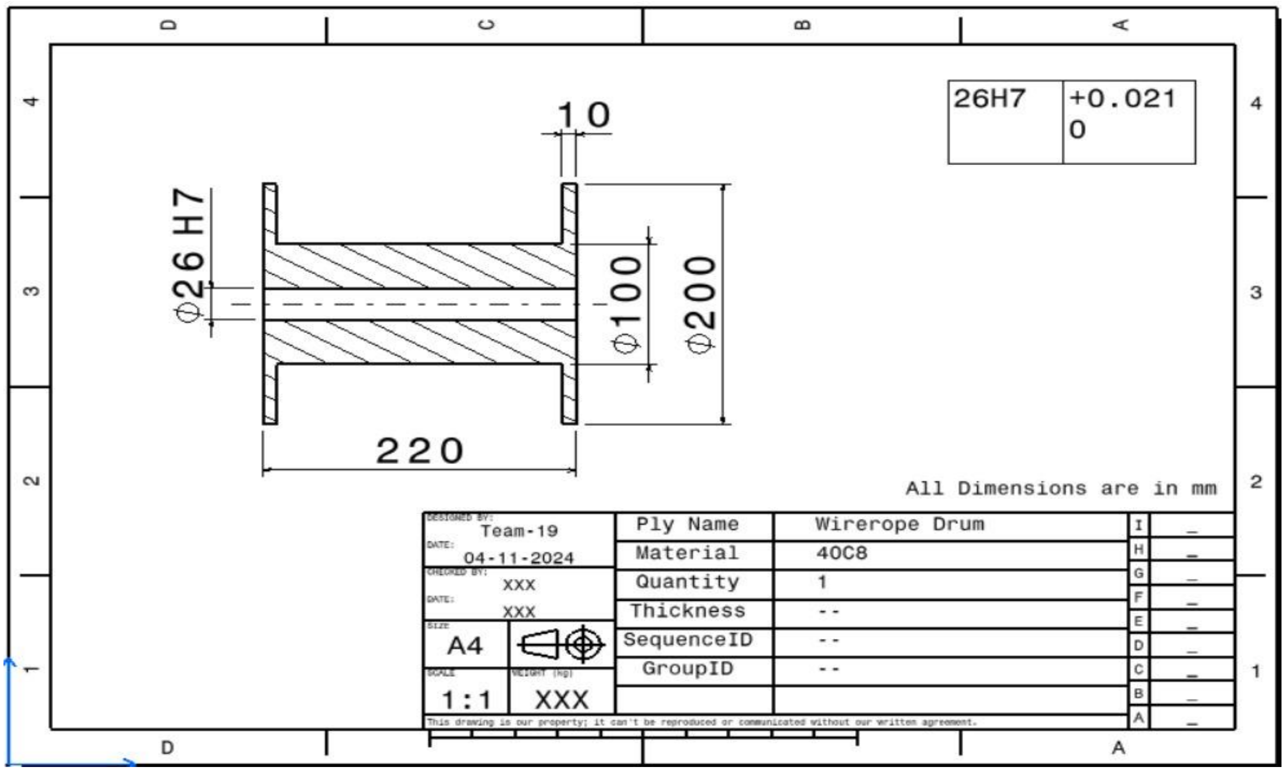


Fig No 16. 2D Sketch of Wire Rope Drum

Pulley

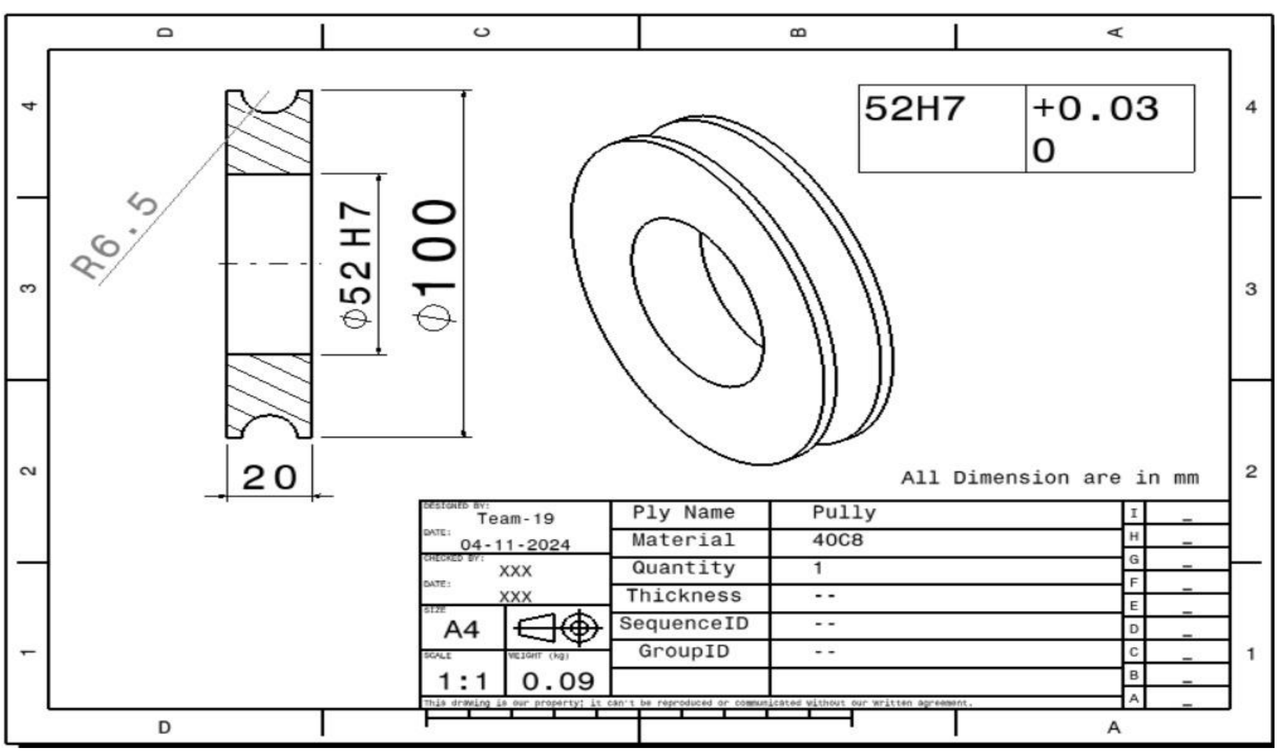


Fig No.17. 2D Sketch of Pulley

6.3 Final Assembly

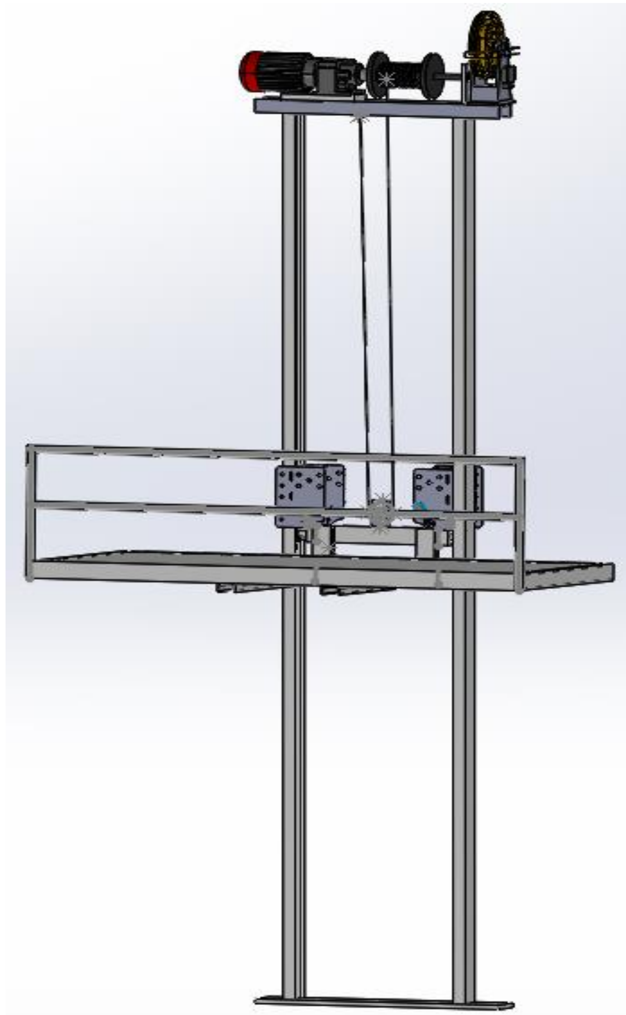


Fig No 18. 3D Assembly

The figure no 18 represents 3D assembly of Rope Pulley Lift

Materials Used and Their Properties

Table No 03. Properties of Materials

Materials	**ST25** (Steel 25)	**ST32** (Steel 32)	**XIP** (Extra Improved Steel)	40**C8(Steel)**
Density(kg/m^3)	7850	7850	7850	7250
Poisson's Ratio	0.30	0.30	0.30	0.26
Tensile Yield Strength (MPa)	275	250	1770	560
Tensile Ultimate Strength (MPa)	450	450	2160	660

CHAPTER 07

FINITE ELEMENT ANALYSIS

7.1 Introduction to FE Analysis

Finite Element Analysis (FEA) is a numerical technique used in engineering to simulate and analyse the behaviour of structures and components under various conditions. It provides a comprehensive understanding of how a system responds to different loads, helping engineers make informed design decisions and optimize performance.

Key Concepts:

Numerical Simulation:

- FEA involves breaking down complex structures into smaller, finite-sized elements. · These elements are interconnected at nodes, forming a mesh that represents the entire structure.

Mathematical Modelling:

- FEA relies on mathematical equations to describe the physical behaviour of each element. · The behaviour of the entire structure is then simulated by solving these equations.

Applications:

- FEA is widely used across various engineering disciplines, including mechanical, structural, aerospace, and civil engineering.
- It helps analyse static and dynamic behaviours, heat transfer, fluid flow, and electromagnetic interactions.

Problem Solving:

- FEA is employed to solve complex engineering problems that may be challenging or impractical to address through traditional analytical methods.
- It provides insights into stress distribution, deformation, and other critical factors influencing the performance of a design.

Structural Analysis:

- In structural engineering, FEA is used to analyse components subjected to different loads, ensuring they meet safety and performance standards.
- Modal analysis, a subset of FEA, helps understand the natural frequencies and mode shapes of structures.

FEA Process:

- The FEA process involves defining the geometry of the structure, assigning material properties, applying loads and constraints, meshing, and solving the system of equation
- Post-processing includes interpreting and visualizing results to gain valuable insights.

Static Structural Analysis

Static structural analysis involves determining the stresses, strains, and deformations in a structure under static or stationary loads. It evaluates the structure's ability to withstand forces without motion, ensuring stability and safety in engineering designs

7.2 Static Structural Analysis on Fork Lift

Static structural analysis is performed on fork lift to check its strength and deformation produced when it is fully loaded.

FORCE AND BOUNDARY CONDITION

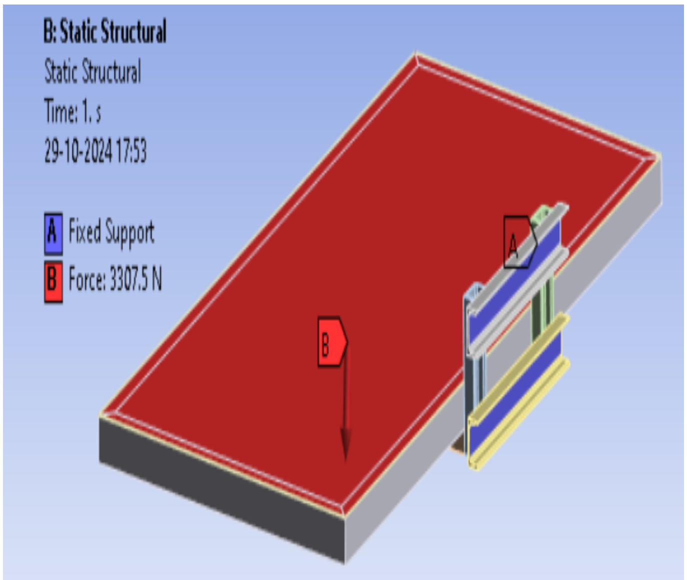


Fig No 19 Boundary Conditions

The Total Force acting on platform will be the sum of weight of Bike and man.

Man Weight=70 kg

Weight of bike=200 kg

Total Weight=270 kg

FOS=1.25

Force=270*1.25*9.80=3307.50 N

TOTAL DEFORMATION

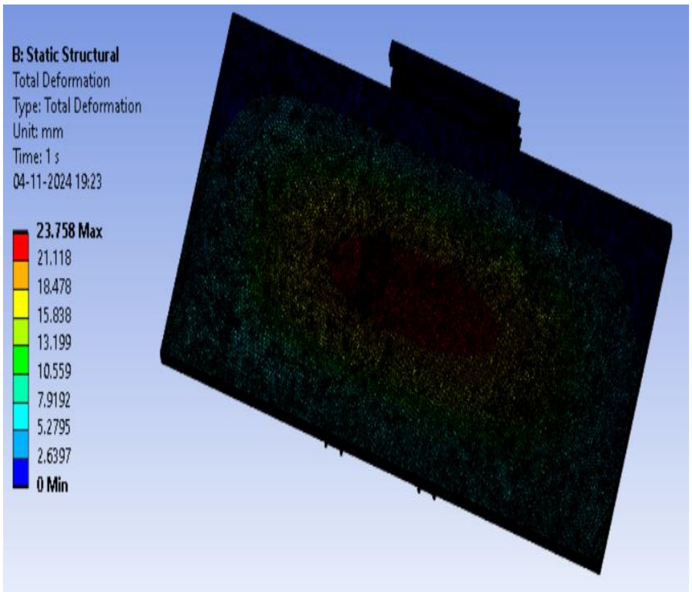


Fig No 20 Total Deformation

EQUIVALENT VON MISSES STRESS

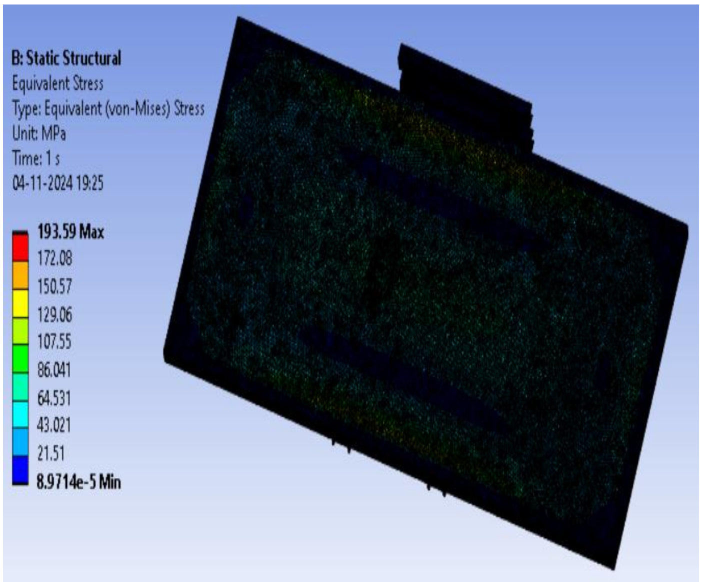


Fig No 21 Equivalent Von Misses Stress

7.3 Static Analysis on Rope

This Analysis Carried on rope to check its strength and deformation. Static analysis on a rope evaluates its stress, strain, and deformation under steady loads. This analysis considers the applied forces, such as tension and weight, along with material properties like elasticity, to ensure the rope's integrity and safety under expected conditions.

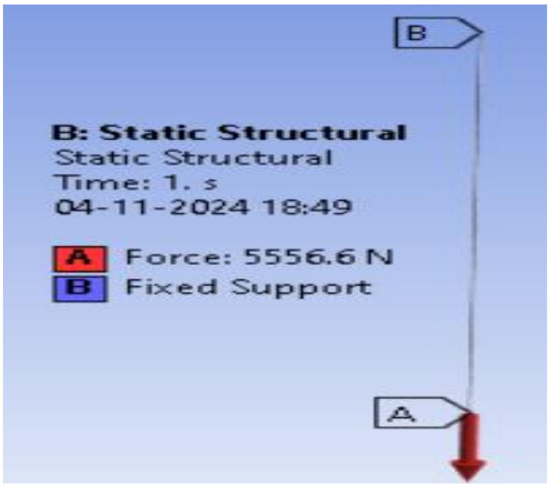


Fig No 22. Boundary Conditions

The Total Force acting on Rope will be the weight of fork lift along with bike and man

Man Weight=70 kg

Weight of bike=200 kg

Weight of Fork Lift=108 kg

Total Weight=378kg

FOS=1.5

Force=377.5*1.50*9.80=5556.6 N

TOTAL DEFORMATION

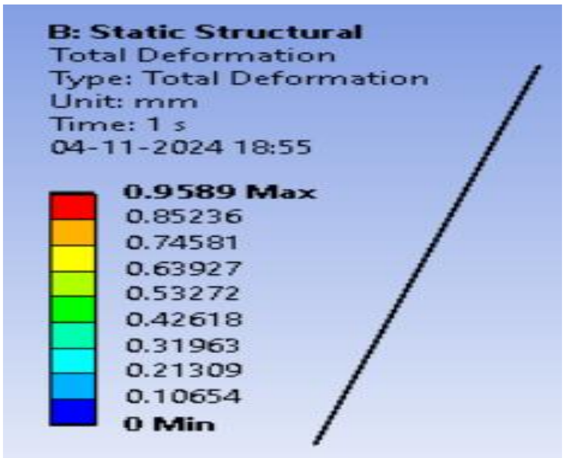


Fig No 23 Total Deformation

EQUIVALENT VON MISSES STRESS

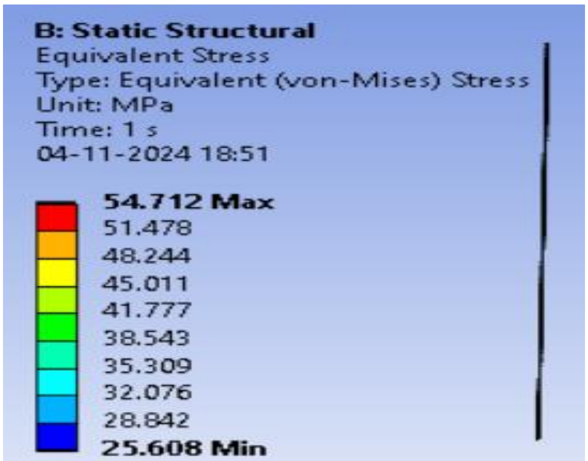


Fig No 24 Equivalent Von Misses Stress

7.4 Static Structural Analysis on Top Plate and C Channel

This Static structural Analysis performed Top Plate and C channel to check its stability and deformation when the platform is at desired height.

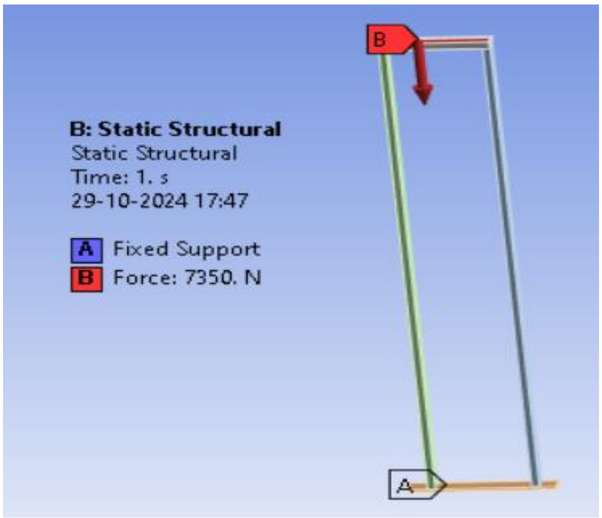


Fig No 25. Boundary Conditions

The Total Force acting will be equal to sum of platform, man, bike and parts on top plate.

Total Weight=500 kg

Force=500*1.50*9.80=7350 N

Total Deformation

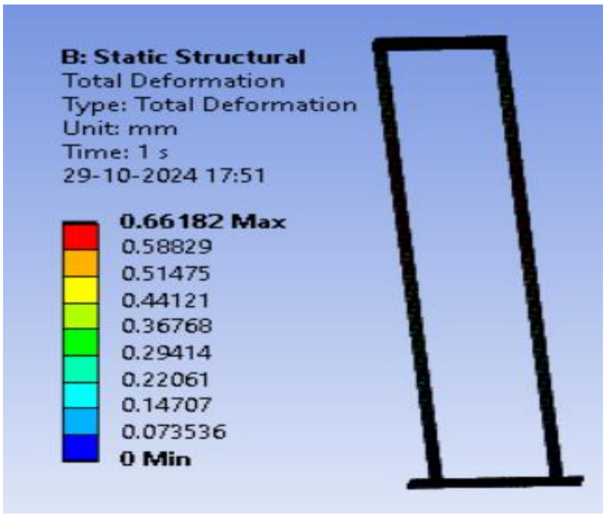


Fig No 26. Total Deformation

Equivalent Von Mises Stress

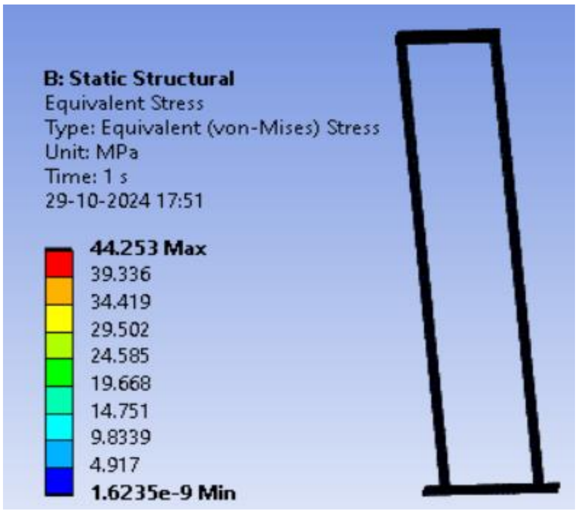


Fig No 27. Equivalent Von Misses Stress

CHAPTER 08

OPTIMIZATION

Optimization is the process of finding the best solution from a set of possible alternatives while meeting given constraints. It aims to maximize or minimize an objective, such as cost, efficiency, or performance, using mathematical or computational method

Optimization is a key tool in decision-making across many industries, helping organizations improve efficiency and achieve desired results in a structured, mathematical manner

8.1 Fork Lift Optimization

1.Design:

The new design will be consisting of two ISMC C Channels of 75*40 mm welded at equidistant to the sheet. These channels provide extra strength to platform by widely distribution of load on it.

2.Material:

The checker sheet is available in different materials in market. Trying with different material the better results can obtained.

3.Thickness:

The thickness of current sheet is 2mm. Taking the next available sheet size the optimization can be done. The next preferred sheet size is to be 2.80mm.

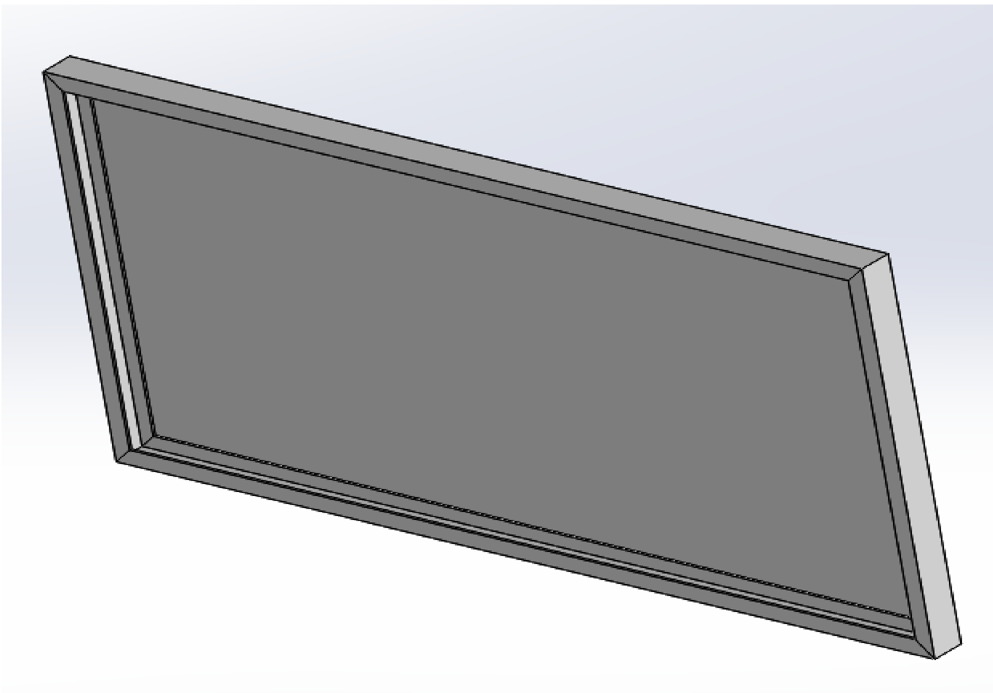


Fig No 28. Old Design

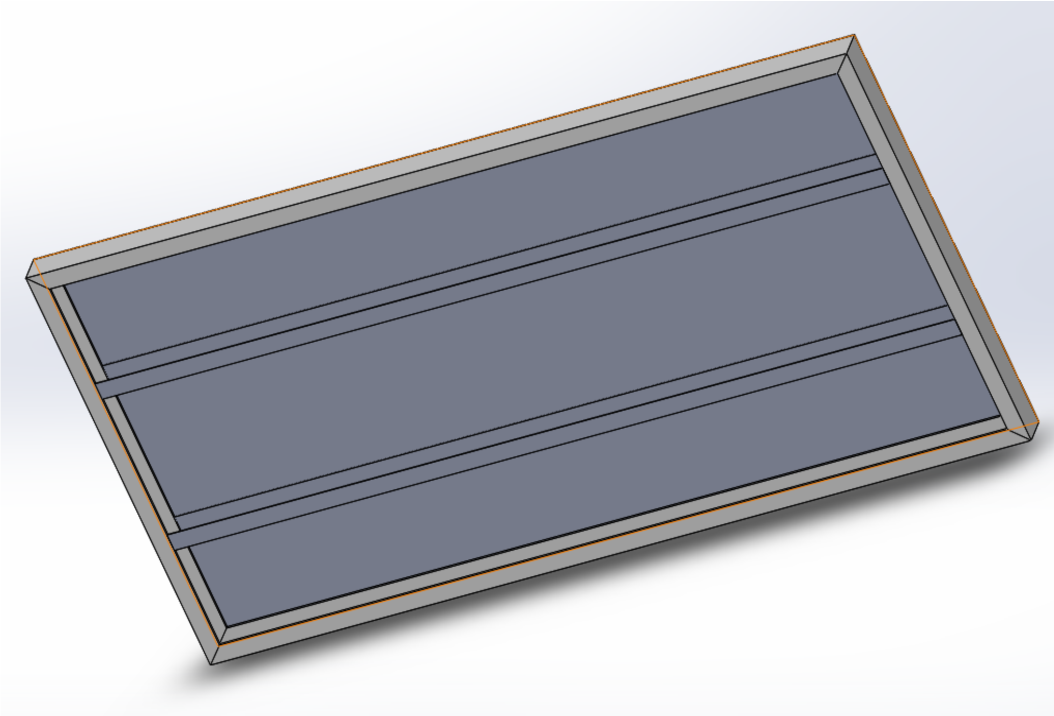


Fig No 29. New Design

Material Properties

Table No 4. Material Properties

Material	**Aluminum 2219**	**ST 25(Old material)**
Density (kg/m^{3})	2840	7850
Poison's ratio	0.33	0.30
Yield Strength (MPa)	290	275
Tensile strength (MPa)	414	450
Young Modulus (GPa)	73.1	210

Table No 5. Fork Lift Iterations

	Iterations	Changes
Iteration 1	Checker sheet thickness increase	2.80 mm
Iteration 2	C Channel support to checker sheet	
Iteration 3	Checker sheet thickness increase and C Channel support to checker sheet	275 MPa
Iteration 4	C Channel support to checker sheet having different material	Aluminum 2219
Iteration 5	Checker sheet thickness increase and C Channel support to checker sheet having different material	Aluminum 2219

8.2 RESUTS COMPARISION:

Table No 06 represents the Results Comparison of optimization models

Table No 06. Results Comparison

	TOTAL DEFORMATION (mm)	EQUIVALENT VON MISES STRESS(MPa)	Stiffness(N/mm)	Weight(kg)
ORIGINAL DESIGN	22.62	193.59	146.22	95.78
ITERATION 1	10.63	189.25	311.14	108.51
ITERATION 2	4.35	126.9	760.34	104.89
ITERATION 3	3.81	119.73	868.11	117.61
ITERATION 4	4.74	133.49	697.78	84.85
ITERATION 5	4.21	126.71	785.62	89.45

FORK LIFT OPTIMIZATION-01

The fig no 30,31 represents total deformation and equivalence von Mises stress of iteration 01.

TOTAL DEFORMATION **EQUIVALENT VON MISES STRESS**

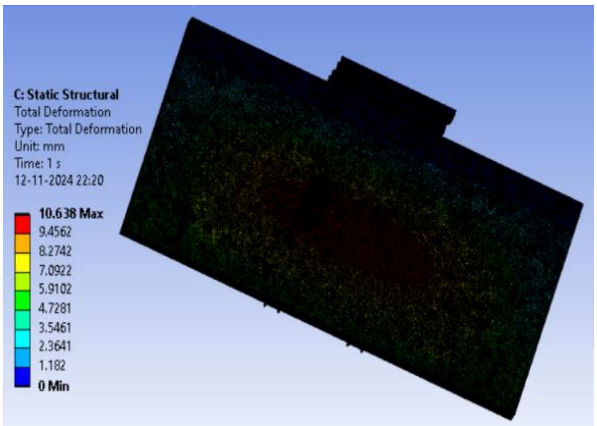


Fig No 30 Total Deformation

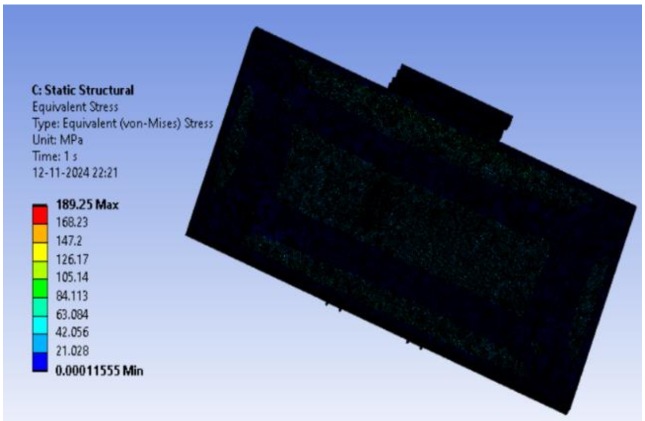


Fig No 31 Equivalent Von Misses Stress

FORK LIFT OPTIMIZATION-02

The fig no 32,33 represents total deformation and equivalence von Mises stress of iteration 02.

TOTAL DEFORMATION **EQUIVALENT VON MISES STRESS**

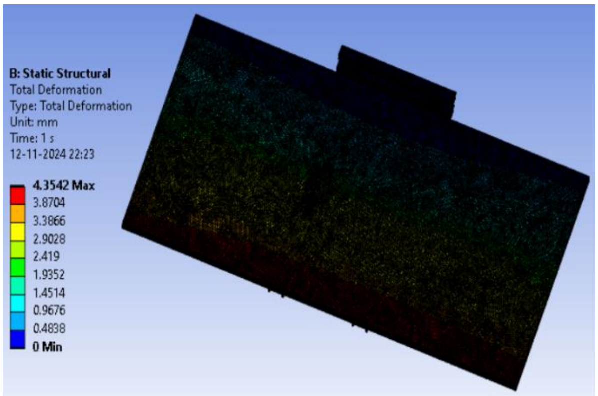


Fig No 32 Total Deformation

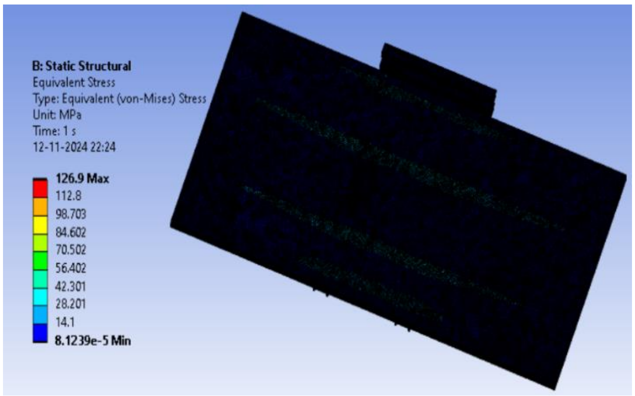


Fig No 33 Equivalent Von Misses Stress

FORK LIFT OPTIMIZATION-03

The fig no 34,35 represents total deformation and equivalence von Mises stress of iteration 03.

TOTAL DEFORMATION

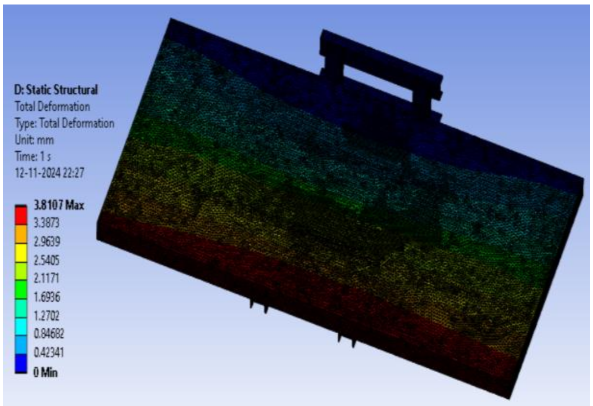


Fig No 34 Total Deformation

EQUIVALENT VON MISES STRESS

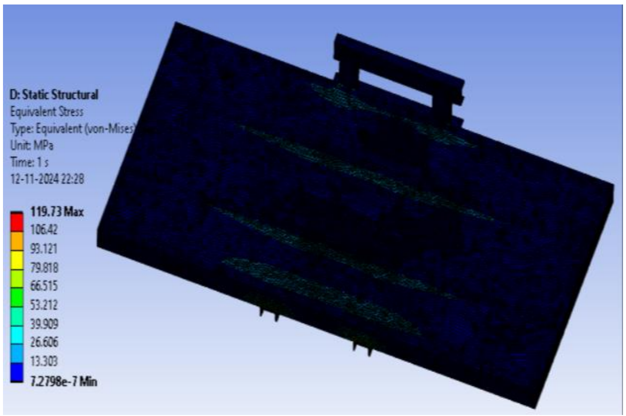


Fig No 35 Equivalent Von Misses Stress

FORK LIFT OPTIMIZATION-04

The fig no 36,37 represents total deformation and equivalence von Mises stress of iteration 04.

TOTAL DEFORMATION

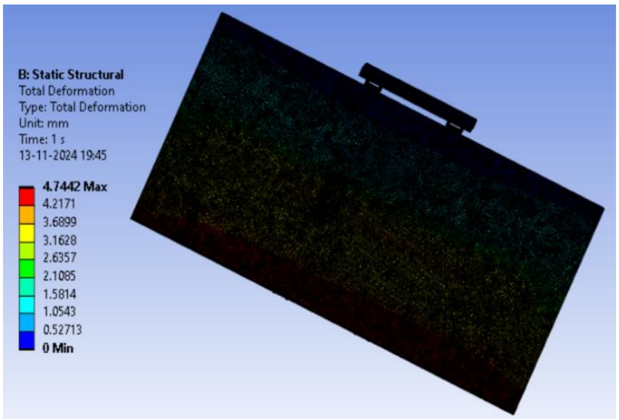


Fig No 36 Total Deformation

EQUIVALENT VON MISES STRESS

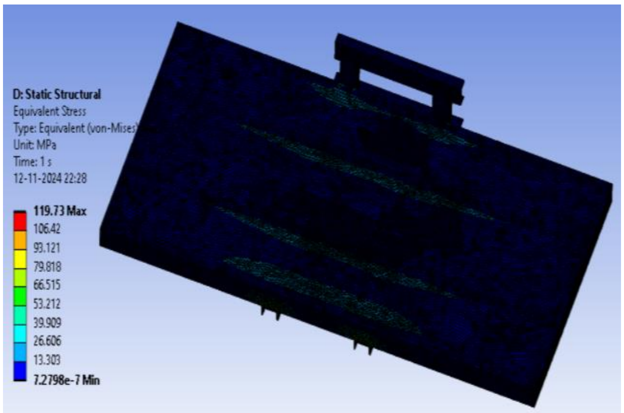


Fig No 37 Equivalent Von Misses Stress

FORK LIFT OPTIMIZATION-05

The fig no 38,39 represents total deformation and equivalence von Mises stress of iteration 05.

TOTAL DEFORMATION

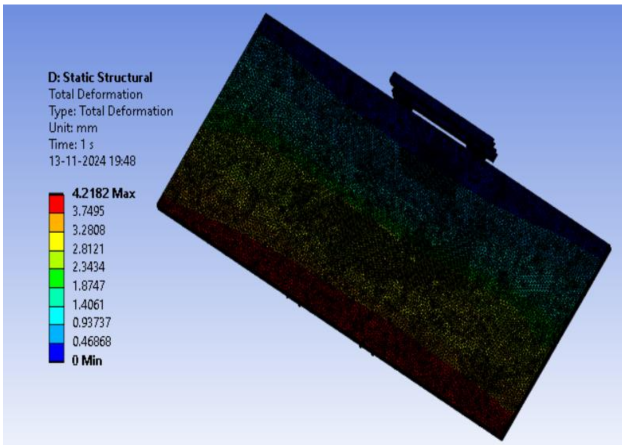


Fig No 38 Total Deformation

EQUIVALENT VON MISES STRESS

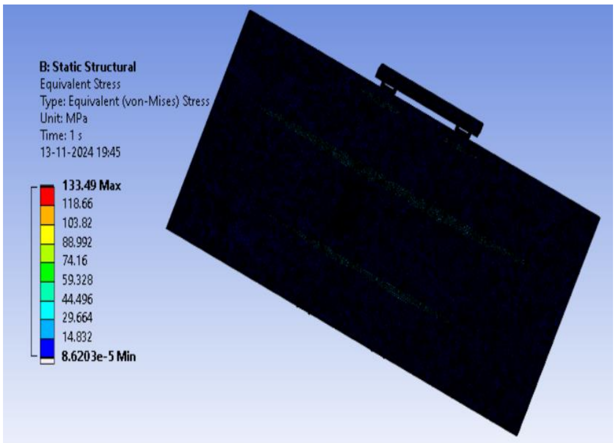


Fig No 39 Equivalent Von Misses Stress

CHAPTER 9

CONCLUSION

The paper is successfully designed and analysed for motorcycle and material lift system that balances safety, efficiency and cost effectiveness. Through FEA analysis and iteration optimization, several key improvements have been done in final design

The study conducted on five iterations of design optimization, resulting in improvements from the original design. The final iterations using Aluminium 2219 achieved a notable reduction on total deformation from 22.62mm to 4.21mm, while maintaining structural integrity with an agreed equivalent von mises stress of 126.71 MPa. The optimized design achieved a weight reduction from 95.78kg to 89.45 kg, enhancing the lift’s portability and ease of installation.

The implemented design features, including the dual c-channel configuration, guide roller system, wire rope mechanism, proved effective in creating a stable and reliable lifting platform. The 3 hp brake gear motor with 60:1 gear ratio provide the required operational speed.

CHAPTER 10

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