DESIGN AND ANALYSIS OF MOTORCYCLE LIFT

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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. 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. 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, FEA.

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 centers 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 1. Traction Lift

2.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

3.METHODOLOGY

The methodology followed for this problem statement is as follows,

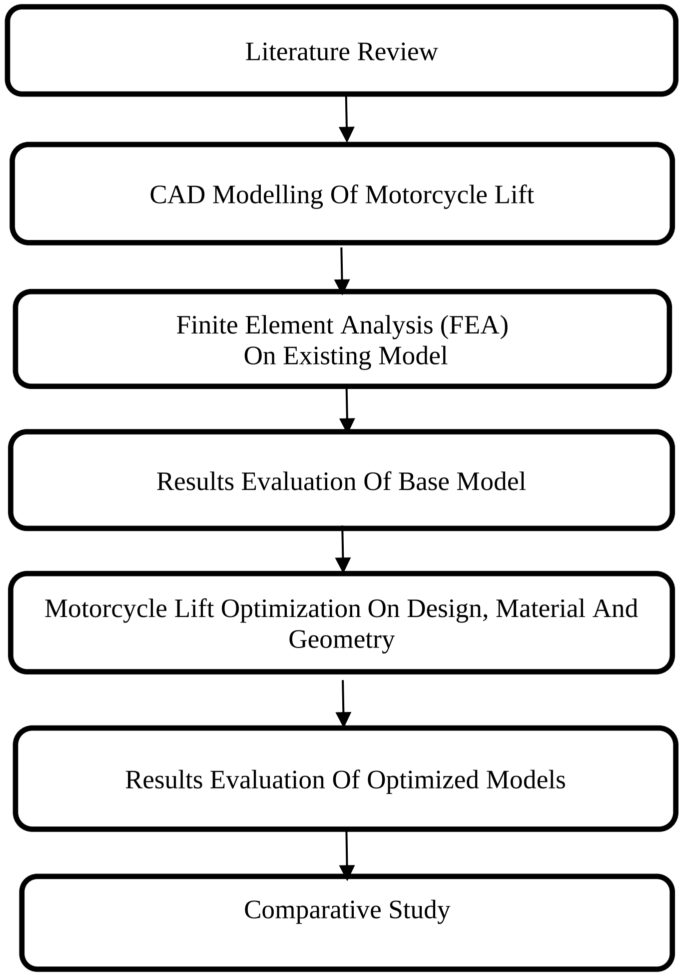

FIGURE 2. Methodology flowchart

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

4.CAD MODELING

The fig 2 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.

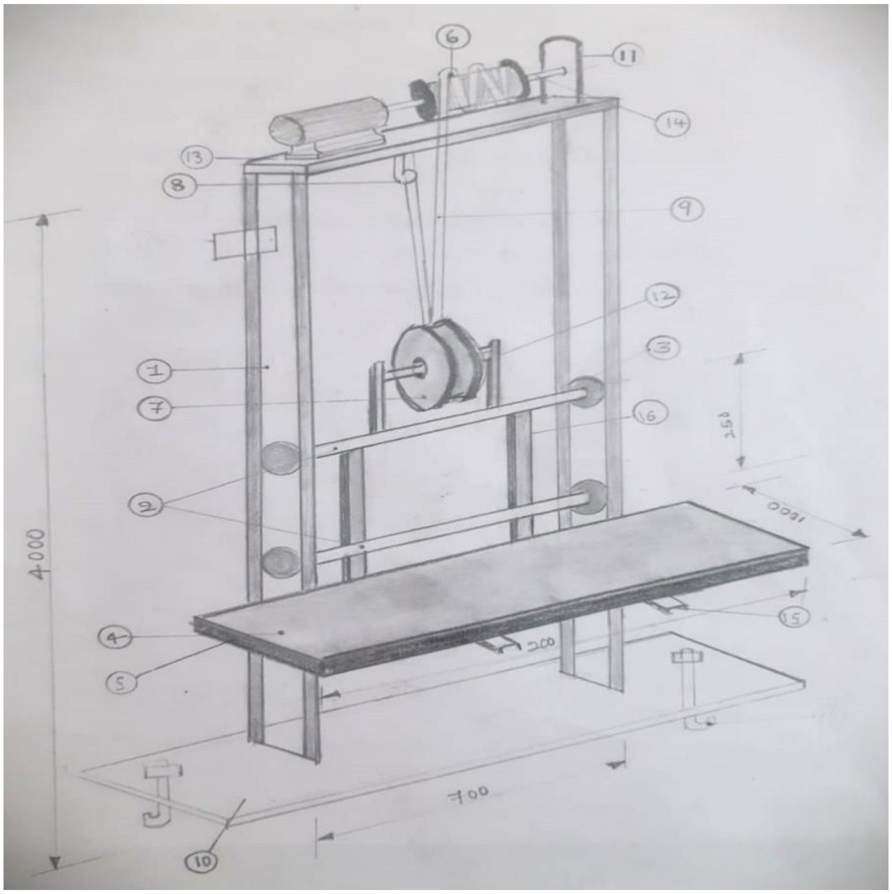

Fig 3. Conceptual Design

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.

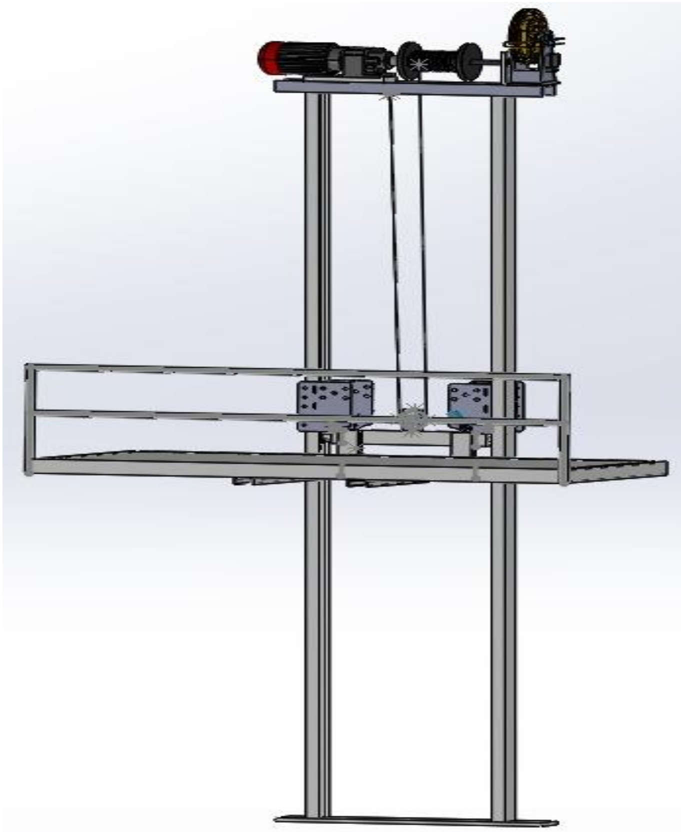

Fig 4. 3D Assembly of Motorcycle Lift

Table 1. Bill of Materials

Serial No	Part No	Part Name	Dimensions (mm)	Material	Quantity
1	1	C Channel Rail	100X50X10	ST 32	2
2	2	Forklift Parallel Channel	75X40X6	ST 32	2
3	3	Guide Rollers	Ø78X40	EN8	4
4	4	Checker Sheet	1000X2000X2	ST 25	1
5	5	Platform C Channel Frame	1000X2000X75	ST 32	1
6	6	Wire Rope Drum	Ø200X150	EN8	1
7	7	Fork Lift Pulley	Ø100X40	EN8	1
8	8	D Clamp	Ø12	SS 304	1
9	9	Wire Rope	Ø12X10000	XIP	1
10	10	Base Support Plate	1000X150X20	ST 32	1
11	11	Drum Support	180X90X17	MS	1
12	12	Pulley Support Plate	120X60X7.5	MS	2

13	13	C Channel Top Plate	950X125X60	ST 32	1
14	14	Wire Rope Drum Shaft	26X400	EN8	1
15	15	Platform Support Channel	1000X75X40	ST 32	2
16	16	Vertical C Channel	250X75X40	ST 32	2

5. FINITE ELEMENT ANALYSIS (FEA)

Ansys Workbench 2023 R2 is the numerical type of engineering problem solving software. Used to simulate interactions of all disciplines of physics, structural, vibration, fluid dynamics, heat transfer and electromagnetic for engineers.

Ansys Workbench performs the different CAD modelling as per the requirements using the FEA – Finite Element Analysis method. The software solves complex problems with geometry using different types of materials. It's able to perform any field of engineering simulations from automotive, and CFD to aerospace engineering.

The analysis is carried out in Ansys workbench, where the model is modelled in the Solid Works and imported in the Ansys workbench for meshing by applying the boundary condition and loading condition for simulation.

TABLE 2. Material Properties

Materials	ST25	ST32	XIP	40C8
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	1170	560
Tensile Ultimate Strength (MPa)	450	450	2160	660

The boundary conditions and forces are as follows

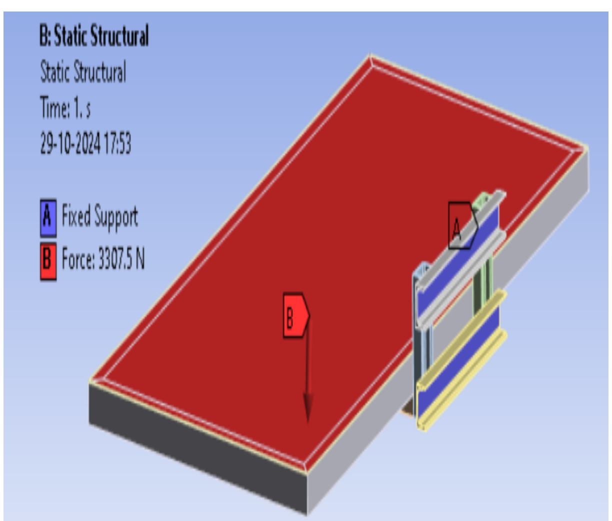

Fig 5. Fork Lift

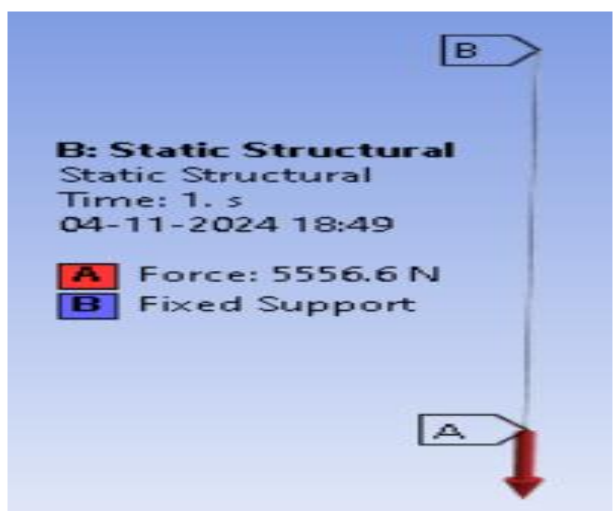

Fig 6. Wire Rope

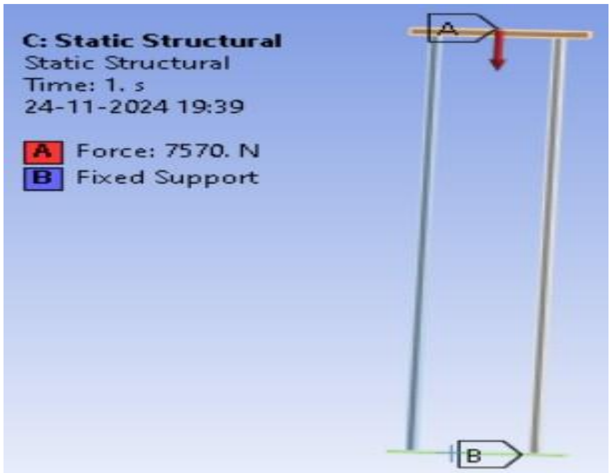

Fig 7. C- Channel

Table 3. Static Structural Analysis Results

Part Name	Material	Mass (kg)	Total Deformation (mm)	Equivalent Von Mises Stress (MPa)
Fork Lift	ST25	95.78	22.62	193.59
Wire Rope	XIP	25	0.9589	54.712
C-Channel	ST25	147.38	0.4095	26.007

The analysis results are as follows

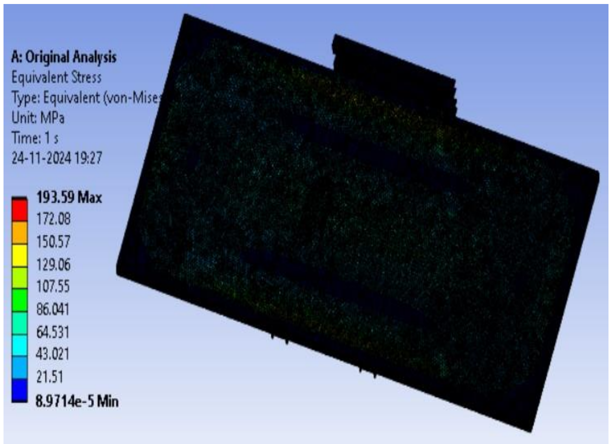

Fig 8. Equivalent Stress of Fork Lift

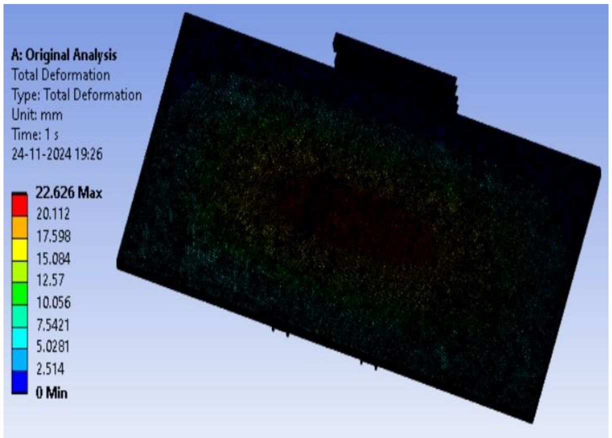

Fig 9. Total Deformation of Fork Lift

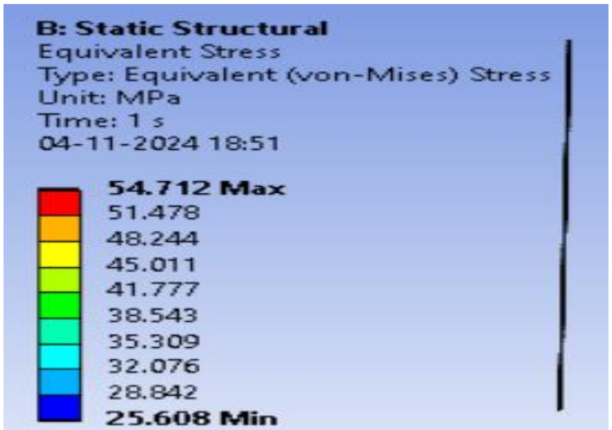

Fig 10. Equivalent Stress of Rope

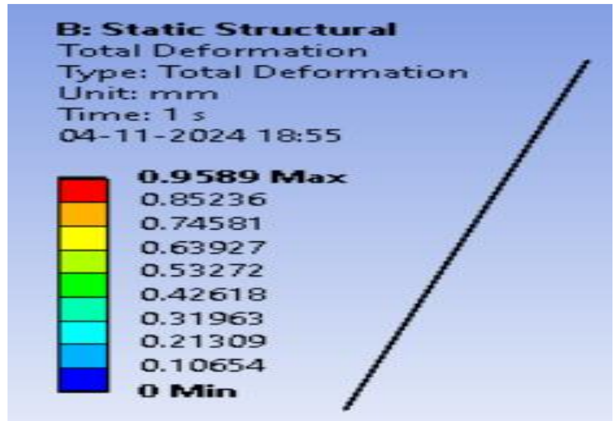

Fig 11. Total Deformation of Rope

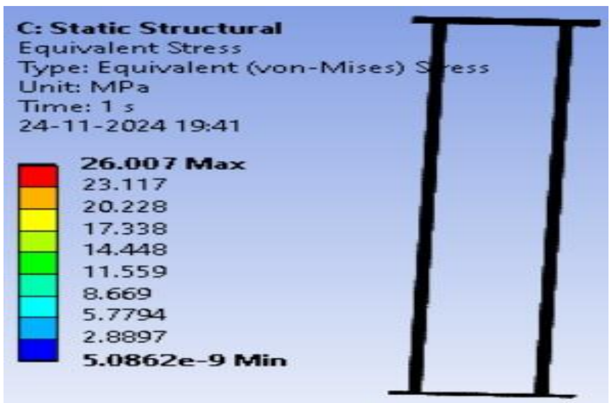

Fig 12. Equivalent Stress of C Channel

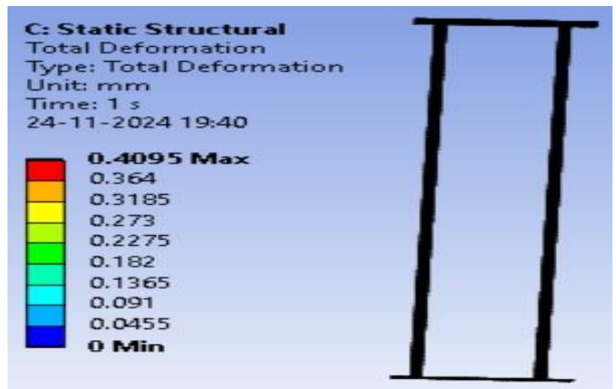

Fig 13. Total Deformation of C Channel

6. OPTIMIZATION

Selection of better design by Optimization after analysis is an essential phase in the design process since it allows us to tweak and improve our initial designs based on insights gathered from a comprehensive examination. Then, to better fit with these standards and improve overall performance, aspects such as materials, shape, or internal structures would be optimized. In our case, optimizing the lift design involves selecting a suitable material combination that will have the least total deformation, meets the safety regulations, and is cost-effective so everyone can afford it.

Table 4. Properties of Aluminum 2219

Material	Density(kg/m^3)	Poisson's Ratio	Tensile Yield Strength (MPa)	Tensile Ultimate Strength (MPa)
Aluminum 2219	2840	0.33	290	414

Table No.5 Optimization Iteration

ITERATION	Changes	Material	Total Deformation(mm)	Equivalent Von Mises Stress (MPa)	Weight (kg)
ORIGINAL DESIGN		ST25	22.62	193.59	95.78
ITERATION 01	Checker Sheet (4) Thickness Increase	ST25	10.63	189.25	108.5
ITERATION 02	C Channel Support to platform frame (5)	ST25	4.35	126.9	104.89
ITERATION 03	Checker Sheet (4) Thickness increase and C Channel support to platform frame (5)	ST25	3.81	119.73	117.61
ITERATION 04	C Channel Support to platform frame (5)	Aluminum 2219	4.74	133.49	84.85
ITERATION 05	Checker Sheet (4) Thickness increase and C Channel support to platform frame (5)	Aluminum 2219	4.21	126.71	89.45

7. CONCLUSION

The paper is successfully designed and analyzed 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 Aluminum 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.

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