Design and manufacture of lift and towing trolley for automatic transmission vehicles.

Thesis submitted for the undergraduate degree in Mechanical Engineering at the University of Central Punjab

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Session 2019-2023
Department of Mechanical Engineering,
University of Central Punjab, Lahore Pakistan

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ABSTRACT

This project aims to design and manufacture a tow trolley that can transport any automatic vehicle by lifting and towing its front wheels. This project is helpful in our local market because if a car breaks down in the middle of the road, then there are very few and limited options available for the driver to transport his vehicle to a nearest garage or workshop. Our project aims to solve this problem by allowing the vehicle to be towed easily and hassle-free also consuming less time of the user. Most vehicles in Pakistan ranges from 600cc to 1300cc so our tow trolley is designed in such a way that it endures the weight of the vehicle and ensures a smooth towing experience while keeping the towed vehicle safe and balanced. The parts and of this tow trolley are easily available in the local market however there is no such product available in the market hence making this tow trolley a potential product. We will be using mild steel as the main material in this tow trolley as the main structure will be mild steel bars welded together. Stubs axle will be used which is more accurate in this type of tow trolley. Tow trolley will have a steering mechanism that will allow the tow trolley to be moveable more easily and will also allow turns. Drum brakes will be used in this tow trolley.

DEDICATION

We dedicate our project to our parents, family, and teachers and to each group member because of our parents and family and our teachers makes us able to face different challenges and win those challenges. Last but not the least group members, who support us a lot and comfortable their full effort to make this project possible.

ACKNOWLEDGEMENT

Thanks to Allah, the almighty which enabled us to present this project within this stipulated time period. all respect for the Holy Prophet Hazrat Muhammad (S.A.W) who enables us to recognize our creature .after that we would like to express or sincere gratitude and heartily thanks to our respected project advisor professor Taimur Qureshi. who encourage us for this interesting project. Through this he tries to polish our minds towards our project. We are thankful to our parents without their love encouragement it was not possible for us to complete our project.

TABLE OF CONTENTS

Contents

LIST OF FIGURES

LIST OF ABBREVIATIONS AND ACRONYMS

Ah	Ampere
AC	Alternating Current
DC	Direct Current
H	Height
Kg	Kilograms
Km/h	Kilometers per hour
LTV	Light Transport Vehicles
L	Length
Mm	Millimeter
N	Newtons
Rpm	Rounds per minute
Rs	Rupees
V	Volt
W	Width

MAPPING WITH COMPLEX ENGINEERING PROBLEMS

- Project Management
- Engineering Knowledge
- Problem Analysis

MAPPING WITH UN SDGs

- Descent work and economic growth
- Industry, innovation and infrastructure

Figure 1 UN SDGs

CHAPTER ONE: INTRODUCTION

Problem:

Previously, there were flatbed trailers which completely loaded the vehicle on the flatbed trailer. But there were several issues regarding the flatbed such as it required a lot of time to load the vehicle on the trailer and one of the major issues were that there was a risk of car damage during the loading of vehicle. After understanding these problems, a solution was introduced that is tow trolley. Tow trolley as since then been a success globally however in Pakistan we are still facing this issue due to which we think our project can be a major change in transportation of breakdown vehicles.

Tow Trolley:

A new device which is named as Tow Trolley also known as Tow Dolly and is used to tow(lift) the vehicle from the front wheels to transport too somewhere else. It is made of two wheels which are connected with each other by the support of center axle and an elongated drawbar. Steering mechanism is introduced to give direction and brake system is involved to hold the motion. The shape is designed in such a pattern that its balance is dependent on a hitch center. It can easily hold the vehicles front wheels because of the placement which is being installed in it. So that the wheels should not move and be fixed firmly. The material which is used to form Tow Trolley is mainly Mild Steel because of its tensile strength, endurance as it is low carbon steel and called as Ferro-magnetic. This material is also used with respect to proper measurements and sharp finishing accordingly. Mild Steel is tempered to increase the strength for load capacity. The wheels which are connected by the center axle are high load bearing and tube less, in case of rough places this type of tire is more convenient to go through. Draw bar is fixed at the center of axle perpendicularly facing forward. At the top point of hitch draw bar there is controlling setup which involves braking and steering mechanisms. A lever is used to stop the rotation of tire, braking system. Handle is installed for the direction of rotation.

Figure 2 Tow Trolley

Project Scope:

The main scope of this project is to design and fabrication of a tow trolly for LTVs with automatic transmission. The tow dolly will lift the front wheels of the vehicle. Its power and steering mechanism can transport the vehicle to nearby garage. It will require less time in transporting a vehicle. The Tow Trolley should be easy to use. The main purpose of the project will be to develop a low budget tow trolley that can be acquired by any garage owner or a vehicle owner and secondly it will be easy to handle and store.

Benefits and Market Gap:

There are various benefits of this tow trolley. It will be a budget friendly tow trolley making it a more suitable option to transport any vehicle rather than loading on a flatbed trailer. Secondly the maintenance of this tow trolley will be very easy because all the parts are already used in the local automobile industry and also, they are cheaper if needed to be replaced.
Tow Trolley for automatic vehicles are not currently present in the local market making our product a helpful item to transport any vehicle from one point to another. This will also the traveling on highways and motorways more convenient as if a car breaks down then there is a source to transport it to a place where it can be repaired.

CHAPTER TWO: LITERATURE REVIEW

There are several manufacturers of Tow trolley in international market however there are none in Pakistan so there is a potential market gap and therefore a lot of types and date is available through which we can design our tow trolley that will be easy to use, manufacture and will be also budget friendly for the customers.

Tow Trolley:

In generally tow trolleys are not suitable for heavy transport vehicles and also there is certain weight limit for light transport vehicles. There are no certain types of tow trolley however then can be differentiated upon the weight of the car they can tow. The tow trolley we have designed can lift up to 800kg to 1200kg depending upon the type of vehicle. The size of the tire varies across the weight and type of the vehicle we will lift so according to our design we will use 14in tires.

Drawbar:

There are many Drawbars that are used in different types of tow trolleys depending on the weight it can carry and how well they manage the position of the car. The drawbar does a lot of work while towing. Every little bump in the road and every turn you make transfers stress through the drawbar and compresses, twists and stretches the drawbar material constantly. If the trailer has been built with an undersized drawbar or the trailer is constantly overloaded or unbalanced, this repeated loading and unloading (cycling) of stresses on the drawbar can create cracks within the structure of the drawbar material.

There are 3 main styles of drawbars:

- The straight drawbar
- The Composite drawbar
- The “A” frame drawbar

We have chosen the composite drawbar because it is a variation of the single drawbar design with lateral supports to both strengthen the drawbar and provide support to the chassis. This style enables the drawbar to be slightly longer as well as not so heavy a section of steel. Composite drawbars give the benefits of good clearance to the tow vehicle.

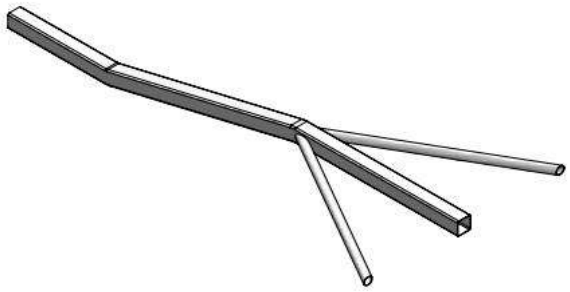


Figure 3 Drawbar

Axle:

Stub Axles are used in tow trolley in which wheels are connected to the stub axle by means of kingpins. It is made up of nickel steel and alloy steel which contains chromium.
Types of stub axle:

- Elliot
- Reverse Elliot
- Lamoine
- Reverse lamoine

Lifting of the Vehicle:

The process is done by the manual screw jack which lifts the front wheels of the car and tyre plate of tow trolley is placed beneath the wheels of the vehicle.
The types of screw jacks used in lifting the vehicle:

- Floor Jacks
- Scissor Jacks
- Hydraulic Jacks

The scissor jack was designed for a specific vehicle, so this type of jack, if made for a small sedan might collapse if you try lifting a vehicle with more weight than what it was designed for. Floor jacks, on the other hand, come in capacities from two tons and up, capable of lifting anything from an any vehicle of any weight and size and moreover they are more commonly used in local workshops and garages. The purpose of scissor jack was to change flat tires and not tolift the entire vehicle for more time however the floor jacks are designed for repeated lifting of vehicles and are more durable.

Figure 4 Floor Jack

CHAPTER THREE: RESEARCH DESIGN

The basic methodology for this project requires precise measurements of the tow trolley so the vehicle we have to tow can be balanced and stable on the trolley. The objective of this research and design is to manufacture a tow trolley that fulfills its purpose of towing any hatchback or sedan vehicle. The model was designed on Solid works.

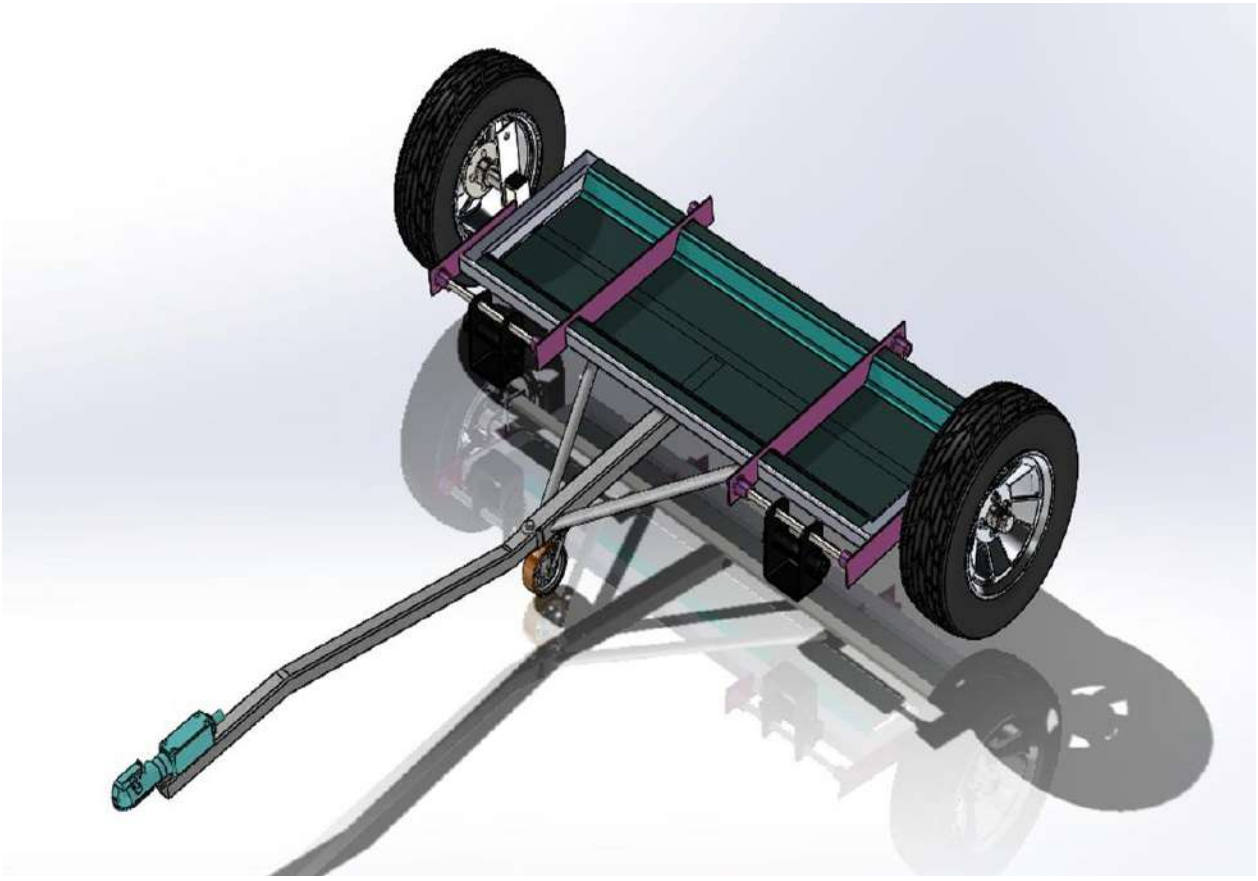


Figure 5 Complete Assembly

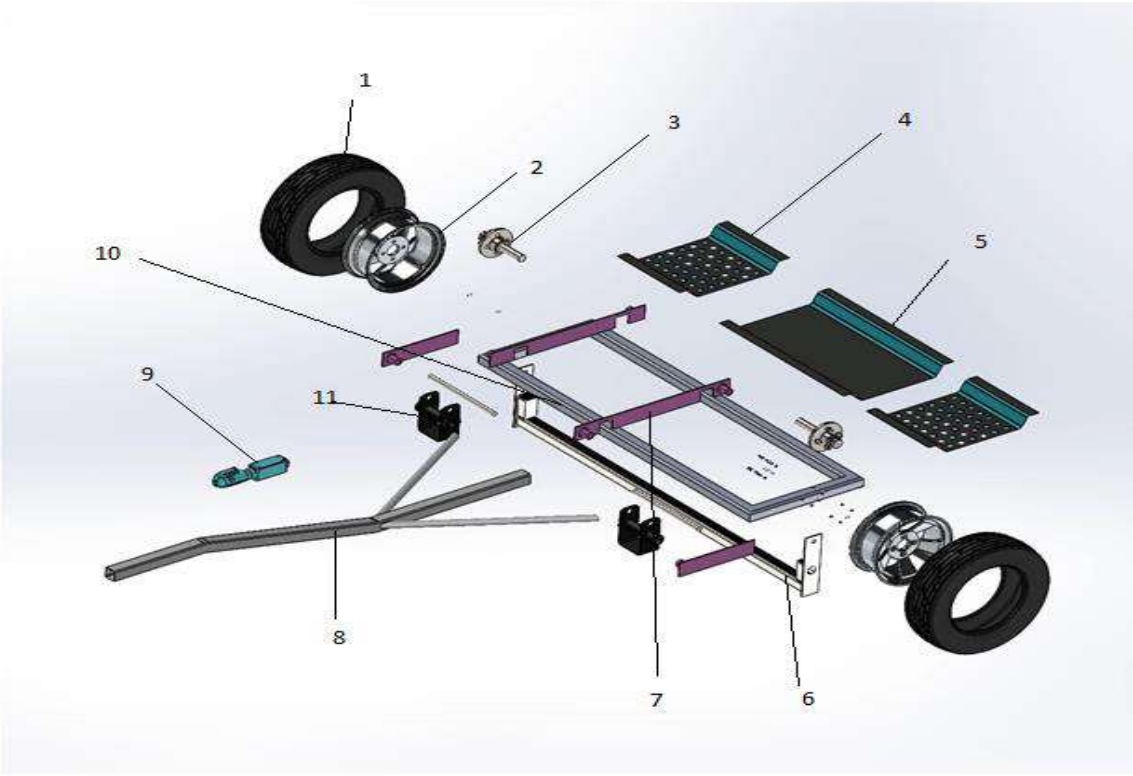


Figure 6 Exploded view of tow trolley

1. Tire
2. Rim
3. Hub and Stub axles
4. Wheel plate
5. Center Plate
6. Axle Beam
7. Support Plate
8. Drawbar
9. Hitch
10. Center Frame
11. Wheel Strap Hook

Tire:

Every tow trolley has its own size of tires according to the weight it can lift and the type of the car which will be towed on the trolley. In our design the tires are suitable at 14in because our tow trolley will be able to lift cars 1200kg so the tires should be big enough to carry the load and balance the trolley also. Rims are selected according to the size of the tire.

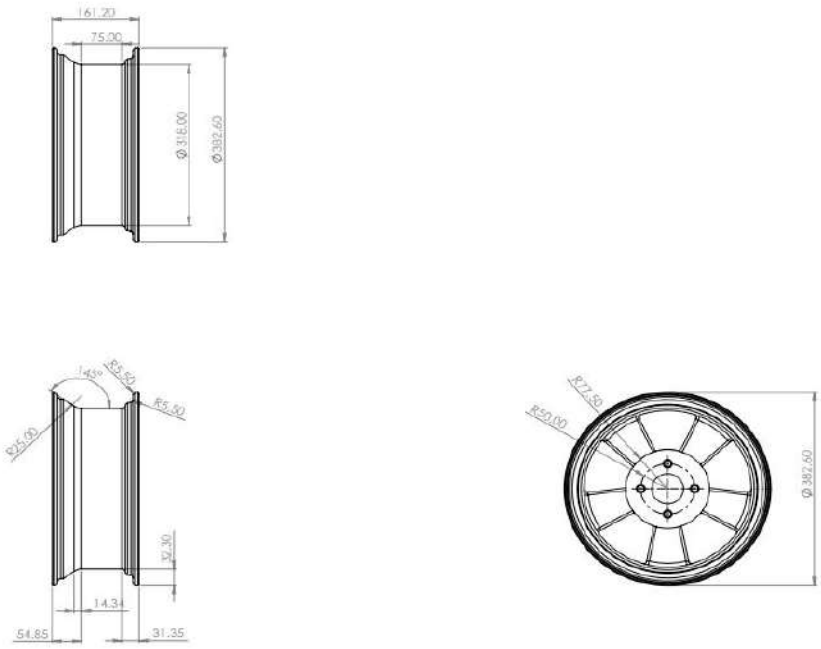


Figure 7 Rims

Stubs Axle:

A stub axle is an axle that is connected to an assembly that mounts on one side of a trailer. It does not go all the way across the trailer like a typical straight axle does. Stub axles allows the trolley to travel on rough patches without disturbing its load. Stub axles are fitted in the hub assembly.

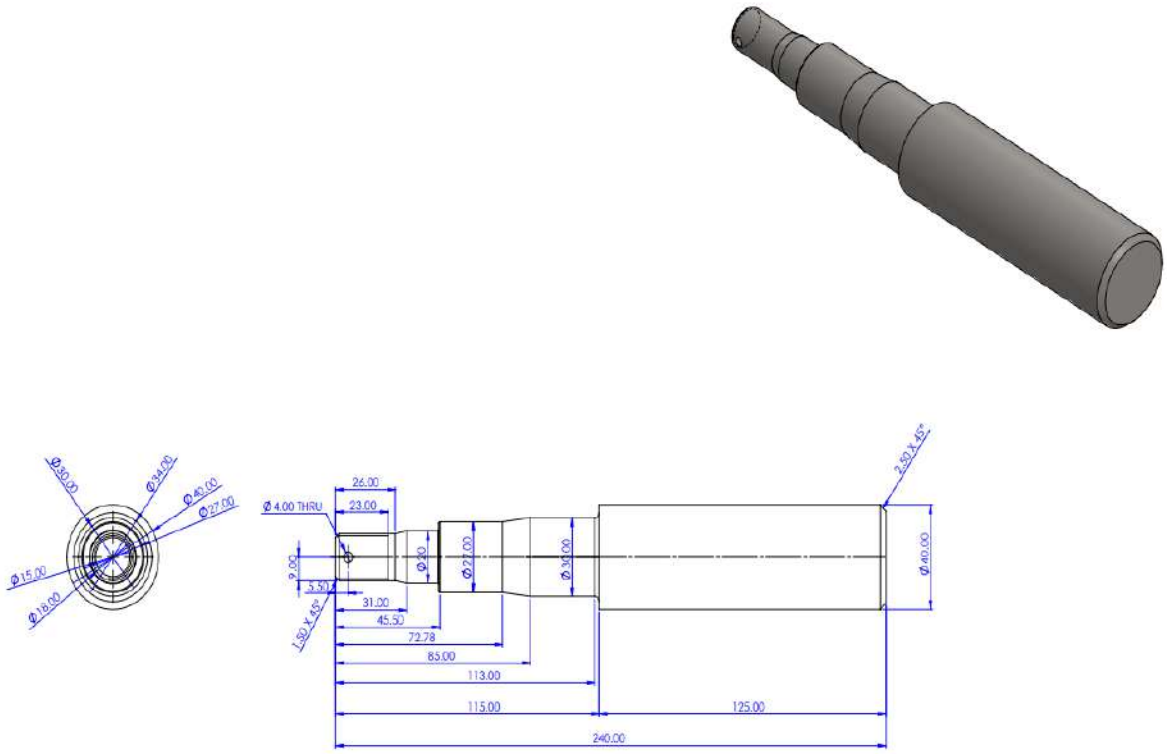


Figure 8 Stub Axle

Wheel Plate:

Tires of the towed vehicle are placed on the wheel plates. The dimensions of the wheel plate are always bigger so that within a certain range every tire can fit on the wheel plate. Our design is made for hatchbacks an sedans.

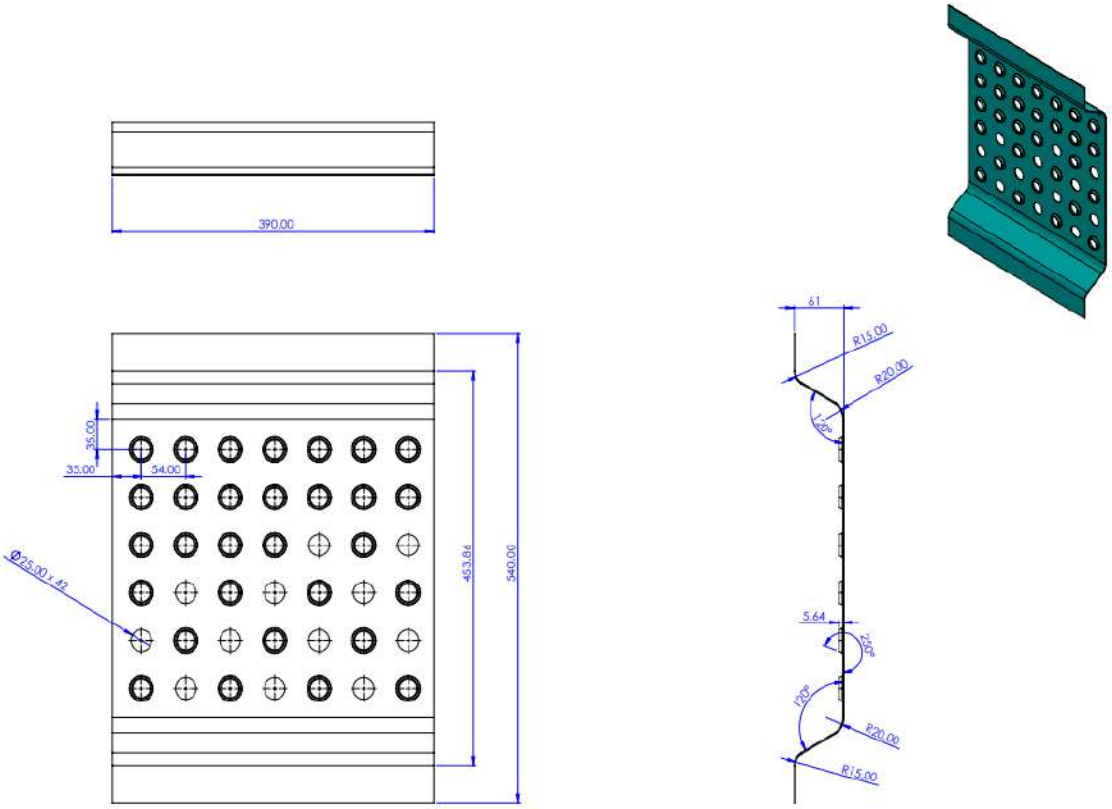


Figure 9 Wheel Plate

Drawbar:

Drawbar is one of the most important parts in a tow trolley because it deals with the strength of the tow trolley also the steering of the tow trolley. In our design we have chosen the composite drawbar because it is a variation of the single drawbar design with supports to both strengthen the drawbar and provide support. This style enables the drawbar to be slightly longer as well as not so heavy a section of steel. Composite drawbars give the benefits of good clearance to the tow vehicle.

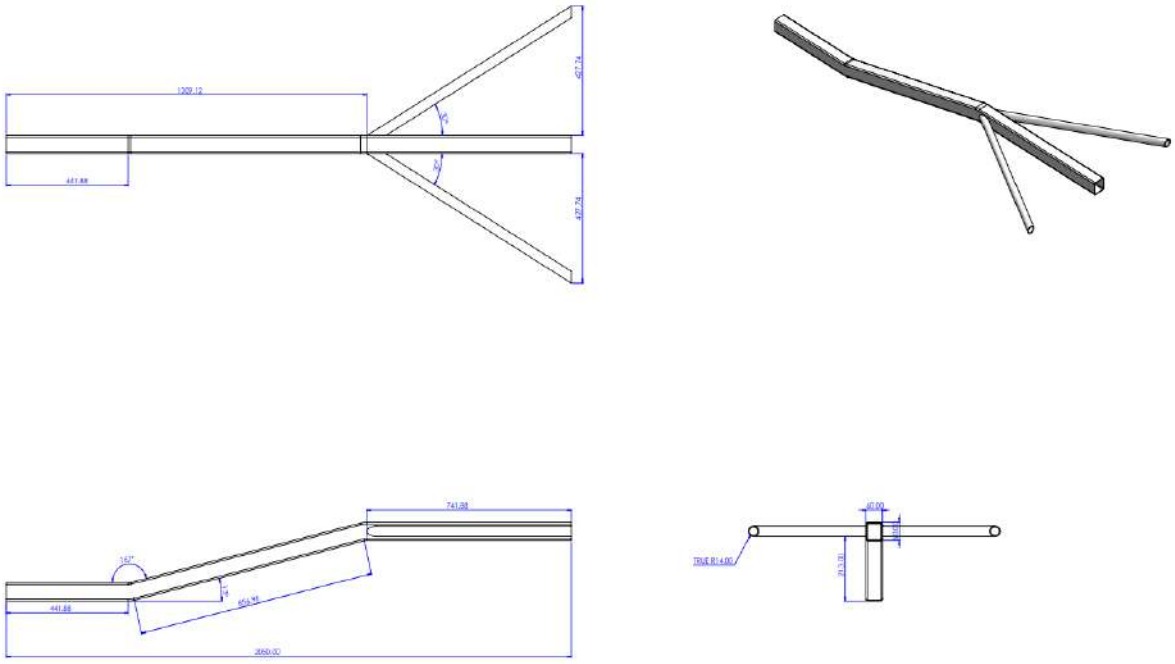


Figure 10 Drawbar

Axle Beam:

An axle is a rod or shaft that connects a pair of wheels to propel them and retain the position of the wheels to one another.

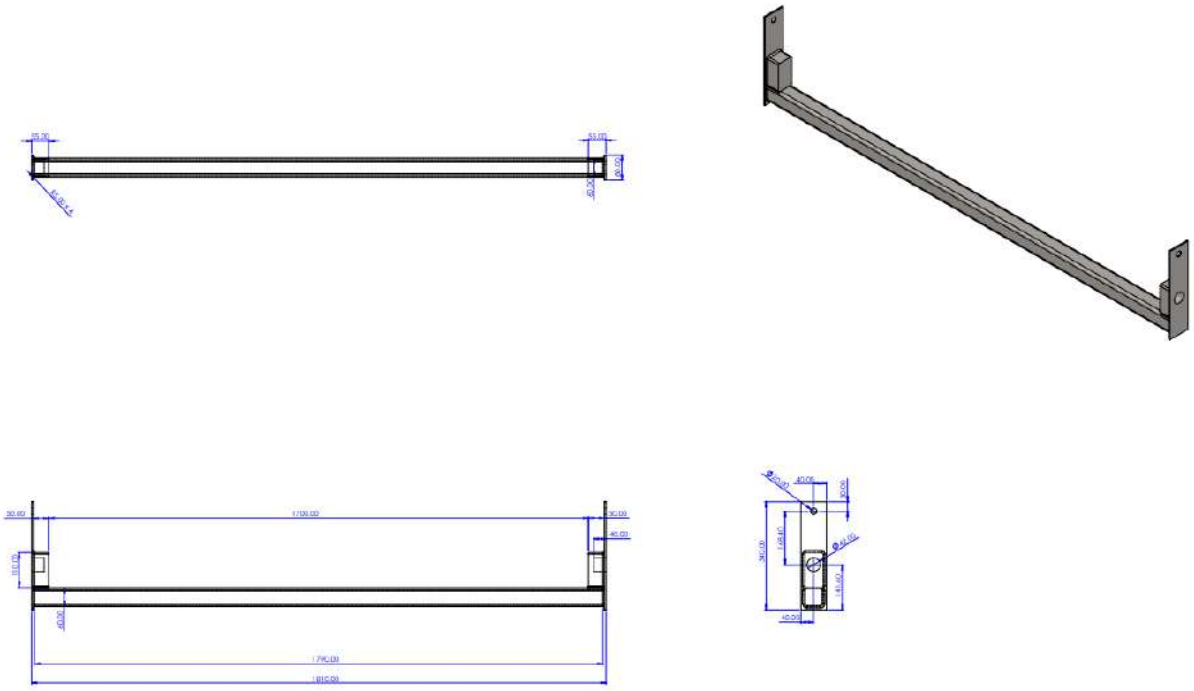


Figure 11 Axle Beam Assembly

Center Frame:

Center frame is the main assembly point of the tow trolley. All the components such as wheel plate and axle are placed on the basis of this frame.

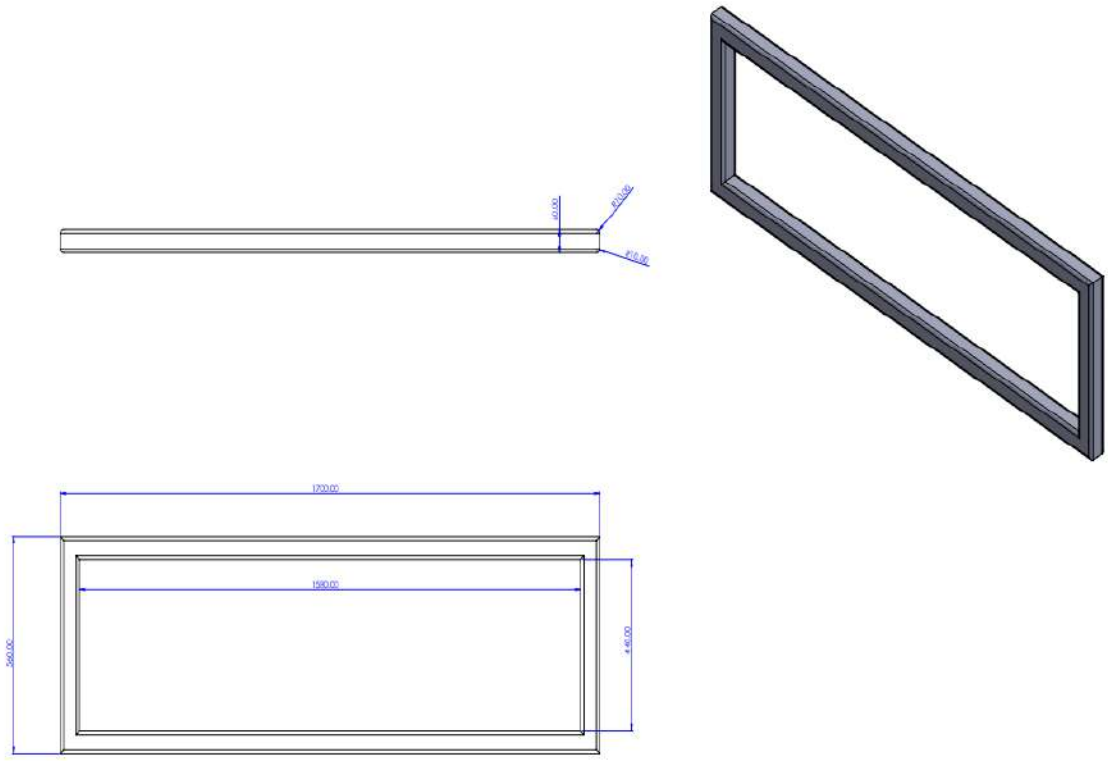


Figure 12 Center Frame

Wheel Strap Hook:

After the wheels are placed on the wheel plate it should be made sure that the wheels remain locked in there place and because of this we use a wheel strap hook at the front of wheel plate so that we can place the straps along the wheel and lock the wheel.

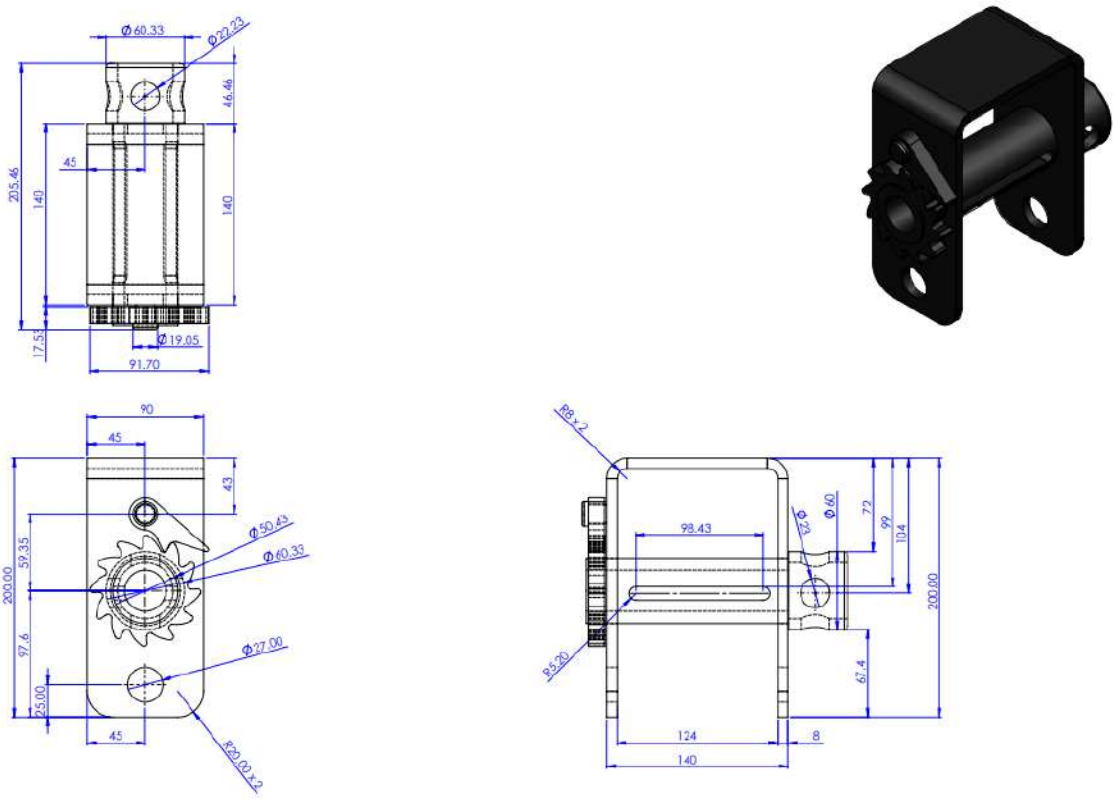


Figure 13 Wheel Strap Hook

Hitch:

The part that connects the tow trolley to the trailer vehicle is known as hitch.

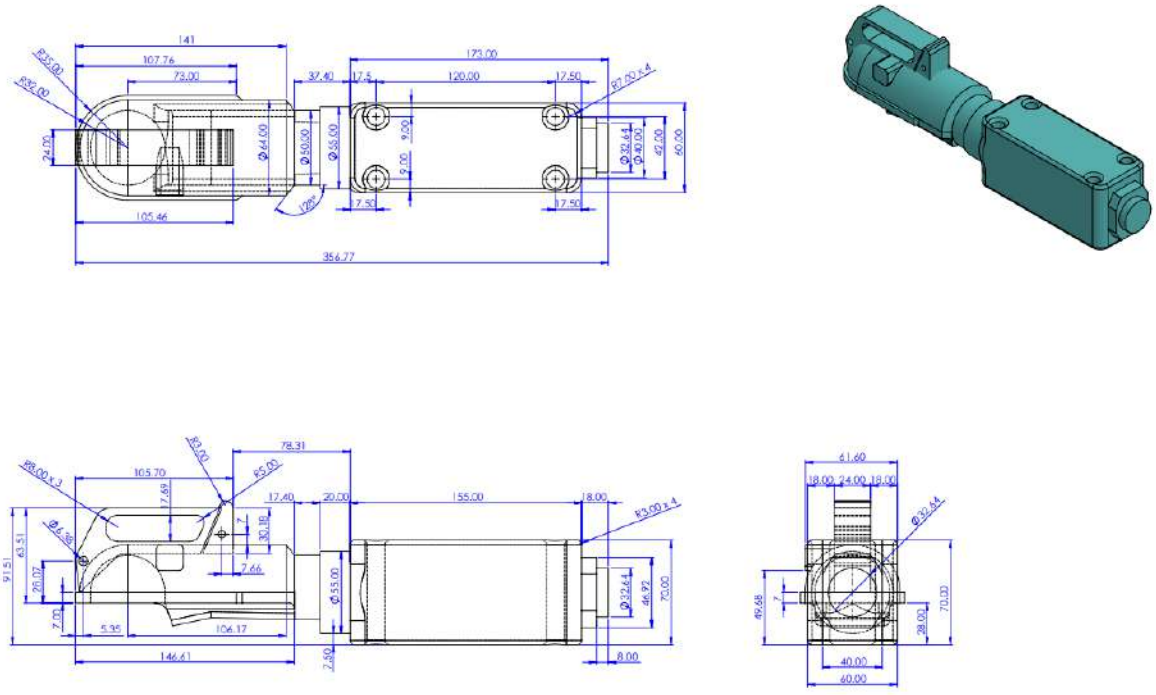


Figure 14 Hitch

Ansys Analysis

In the beginning we must define the static structural properties. In our case, the main frame of the tow trolley had a fixed support because the main form is fitted such that it gets support from the wheels. The main force is applied on the wheel plates such that the load of a vehicle is 500kg that is equally distributed in half because both the tires will have equal weight. Hence, the weight is equally distributed on both wheel plates. Then we have the results of these forces acting on the wheel plate as shown below.

250KG = 2550N

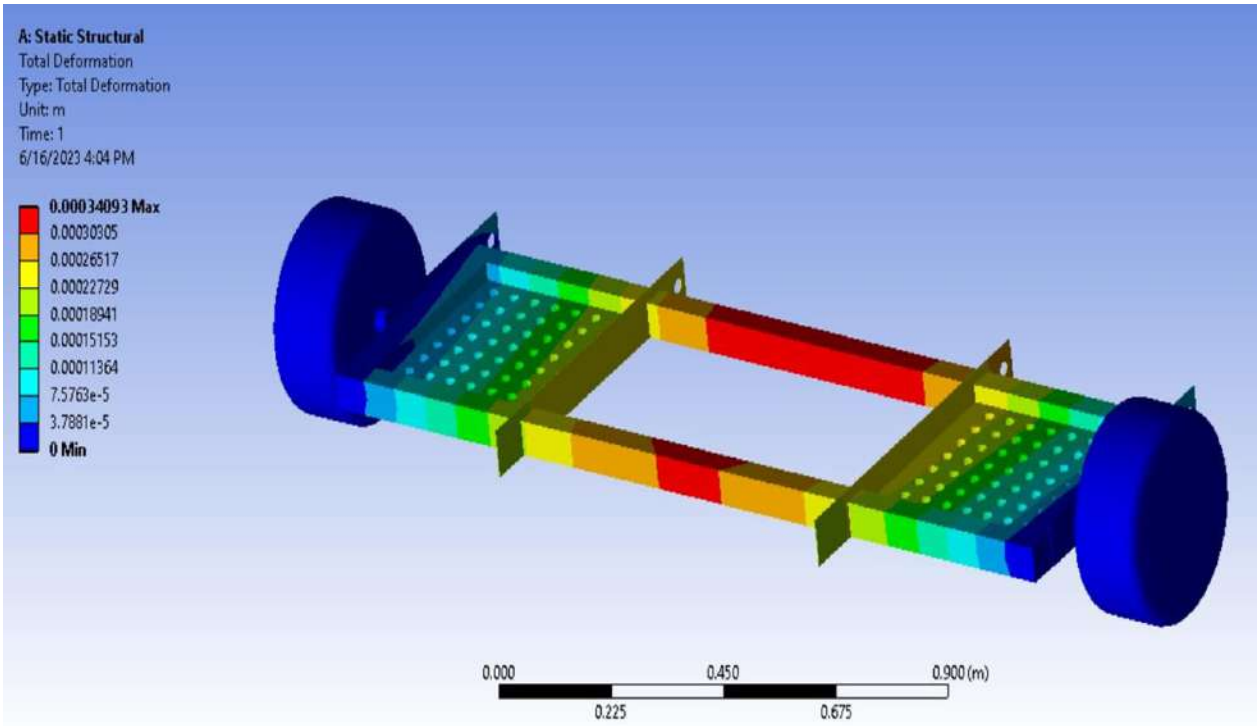


Figure 15 Ansys

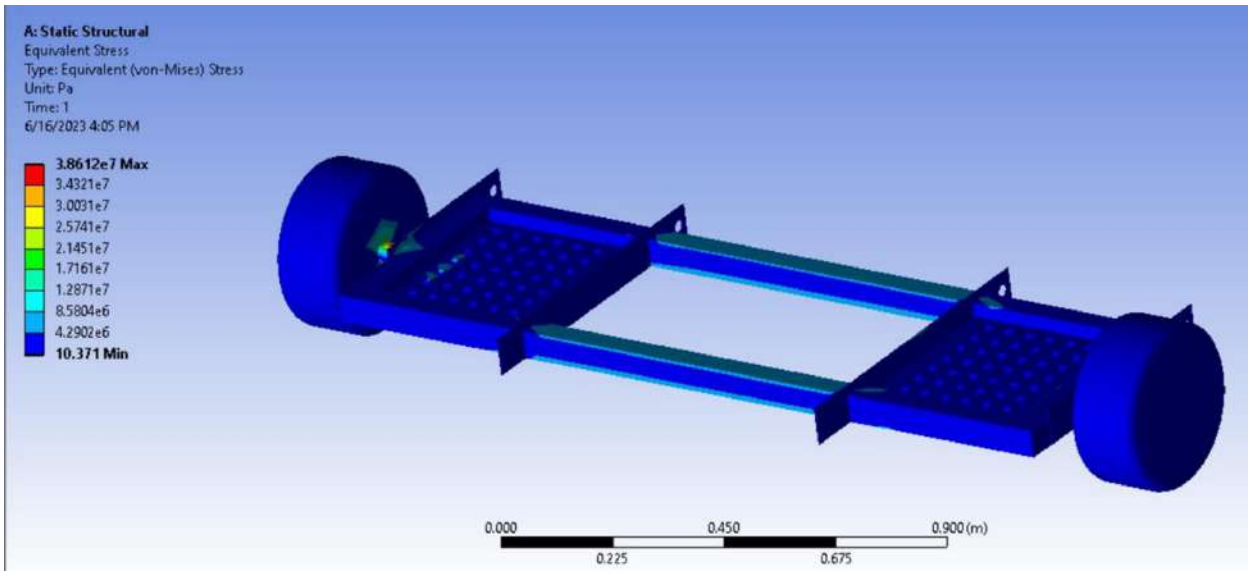


Figure 16 Ansys

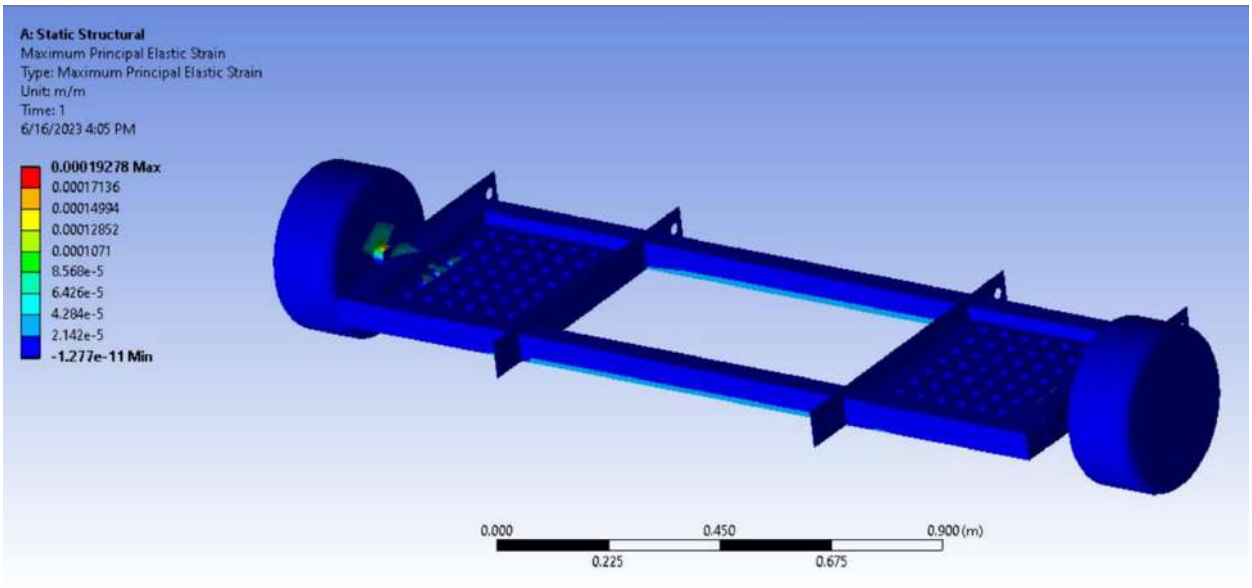
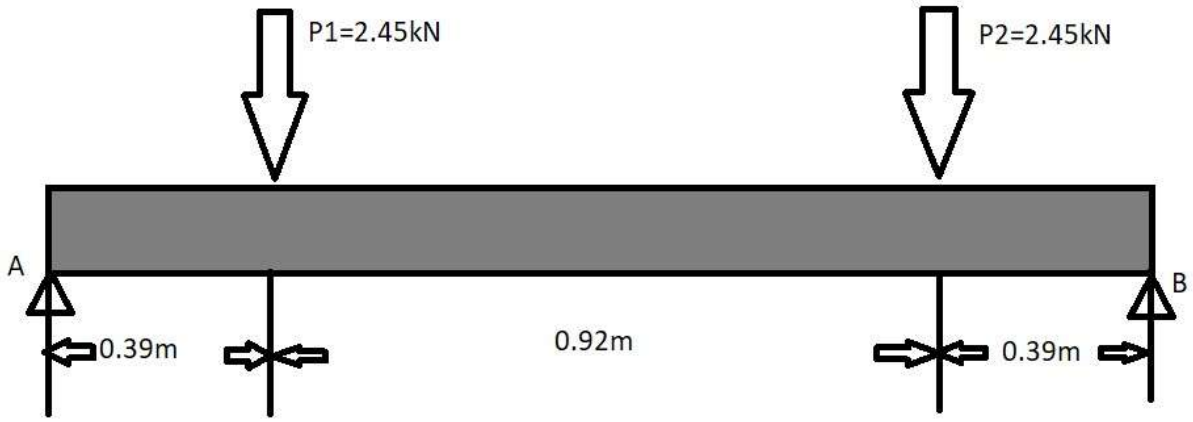


Figure 17 Ansys

CALCULATIONS

Design Calculations (Equal Loads)



$$\sum F_y = 0$$

$$R_A + R_B = 2.45kN + 2.45kN$$

$$R_A + R_B = 4.9kN \quad \ldots eq(1)$$

$$\sum M_A = 0$$

$$R_B(1.7m) = (2.45kN)(1.31m) + (2.45kN)(0.39m)$$

$$R_B(1.7m) = 3.20 + 0.95$$

$$R_B(1.7m) = 4.15kN.m$$

$$R_B = \frac{4.15}{1.7}$$

$$R_B = 2.45kN$$

$$Putting\ R_B in\ eq(1)$$

$$R_A = 4.9 - 2.45$$

$$R_A = 2.45kN$$

$$M_{MAX} = Pa$$

$$M_{MAX} = (2.45)(0.39)$$

$$M_{MAX} = 0.995kN$$

$$M_{MAX} = 0.995 \times FOS$$

$$M_{MAX} = 0.995 \times 1.5$$

$$M_{MAX} = 1.5kN$$

$$\sigma_Y = \frac{MY}{I}$$

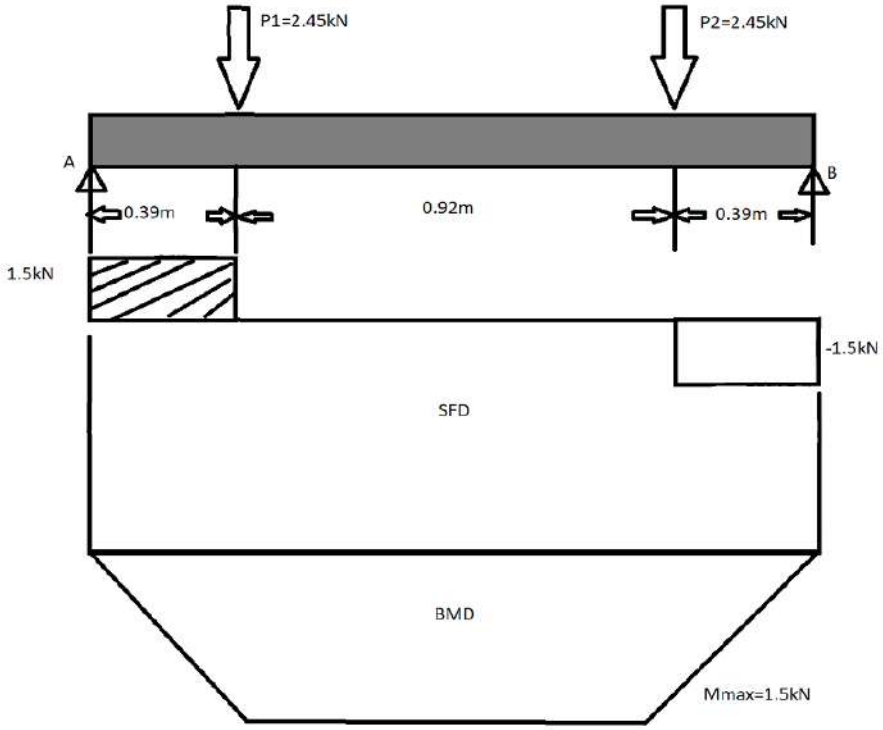
$$\sigma_Y = \frac{M \times \frac{h}{3}}{\frac{6h^3}{12}}$$

$$\sigma_Y = \frac{6M}{bh^2}$$

$$250MPa = \frac{6(1.5)}{0.06h^2}$$

$$h = 0.025m$$

$$h = 25mm$$



Design Calculations (Unequal Loads):

$$\sum F_y = 0$$

$$R_A + R_B = 0.5kN + 3.4kN$$

$$R_A + R_B = 4.9kN \quad \ldots . eq(1)$$

$$\sum M_A = 0$$

$$R_B(1.7m) = (3.4kN)(1.31m) + (0.5kN)(0.39m)$$

$$R_B = 3.50kN$$

$$Putting\ R_B in\ eq(1)$$

$$R_A = 4.9 - 3.50$$

$$R_A = 1.4kN$$

$$M_{MAX} = Pa$$

$$M_{MAX} = (4.4)(0.39)$$

$$M_{MAX} = 1.716kN$$

$$\sigma_Y = \frac{MY}{I}$$

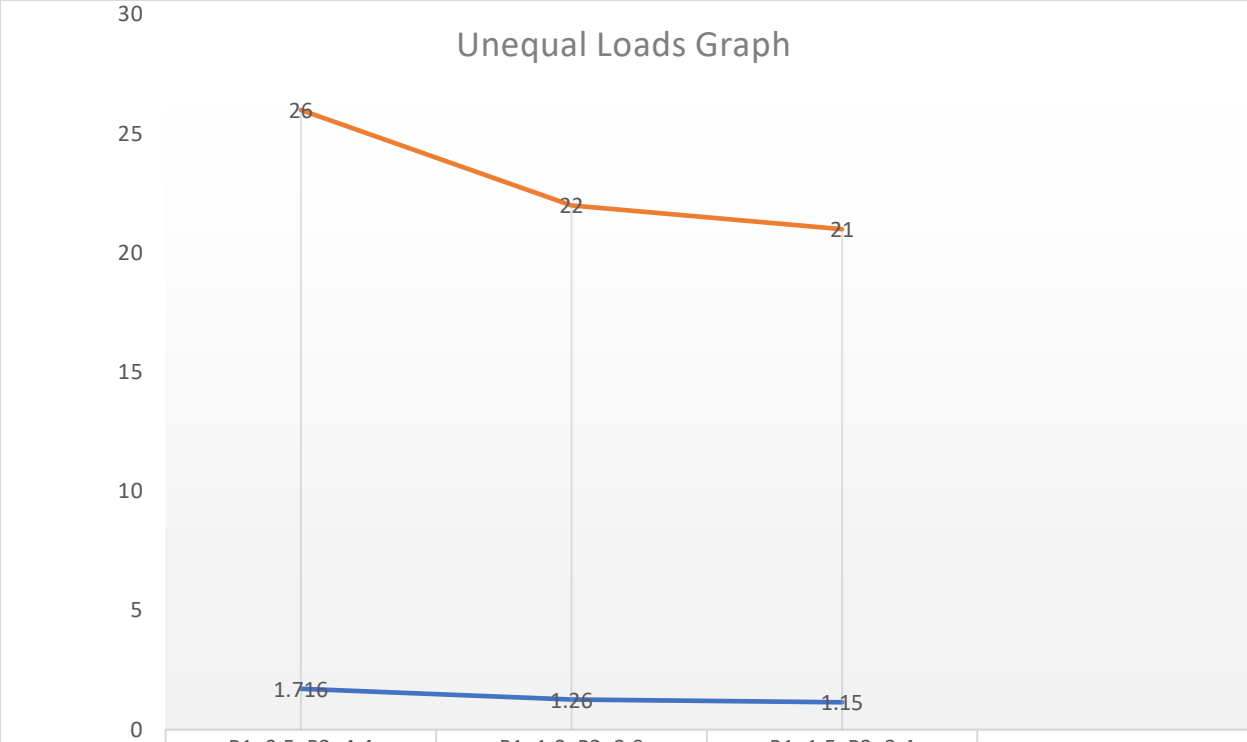
$$\sigma_Y = \frac{M \times \frac{h}{3}}{\frac{6h^3}{12}}$$

$$\sigma_Y = \frac{6M}{bh^2}$$

$$250MPa = \frac{6(1.716)}{0.06h^2}$$

$$h = 0.026m$$

$$h = 26mm$$



	P1=0.5, P2=4.4	P1=1.0, P2=3.9	P1=1.5, P2=3.4	
Mmax	1.716	1.26	1.15	
h	26	22	21	

CHAPTER FOUR: FABRICATION

This project is mainly manufactured with mild steel pipes and sheets. Major components such as wheel plate and drawbar were welded with the centre frame. Electric arc welding was used as it was easily available and efficient to use. Basically, in this chapter we have described each and every step and material used to manufacture this project.

Components Manufactured

There were several components that were manufactured because they are simply not available in the market secondly these components are manufactured according to the design of the project so there can be variations in results and efficiencies if one does not manufacture according the certain requirements and demands of the project. Some components required specific angles that were obtained through bending machine.

List of components manufactured:

1. Centre/Supporting frame
2. Wheel Plate
3. Centre Plate
4. Drawbar
5. Plate separators
6. Supports for Battery and motor

List of components purchased:

1. 12V Battery
2. 24V Motor
3. Axle Gear
4. Tires
5. Rims
6. Nose Wheel
7. Remote and circuit

Centre Frame:

Centre frame consists of 4 mild steel square pipes that are welded together. The frame is a rectangular support for the wheel plates. The length of the frame is 1700mm and the width of the frame is 560mm. We used square pipes of size 2 ½ inches (60 x 60 mm). They were welded together using electric arc welding (EAW) as it was the most convenient and better for strength.

Figure 18 Steel Pipes

This is how the main frame looks like after welding. The material used for the central frame was chosen because if its strength and secondly the size of the pipes allowed it to be easily welded and worked on.

Figure 19 Centre Frame

Wheel Plate and Centre Plate:

For wheel plates we used pieces of mild steel sheet. The bends on the wheel plate were given through a bending and press machine. The desired angle was achieved by placing the part of the sheet where we wanted the bend and then the ram strikes on the sheet causing the sheet to bend at that angle. Then the wheel plate was welded on the centre frame at the left and right sides of the main frame. In the same way we prepared the centre sheet.

Figure 20 Wheel Plate

Figure 21 Centre Sheet

The purpose of centre sheet is to place our necessary items such as hydraulic jack on the centre sheet hence its eliminates any external carrying of the hydraulic jack as it can be placed on the centre sheet. The centre sheet has a length of 780mm and width of 540mm.

Drawbar:

Drawbar is manufactured from MS steel pipes. Total length of the drawbar is 2070mm and thickness of the drawbar is (60x60) mm or 2 ½ inches. Angle provided due to adjust according to the bumper of the vehicle. The drawbar is welded to the centre of the supporting frame. It also has two supporting rods welded with the main drawbar pipe for additional strength and load capacity for the drawbar.

Figure 22 Drawbar

Components Purchased:

Wheels:

We have purchased the tires of the size of 20inch as per our ground clearance needs and secondly, we needed to place those tires in this trolley that sustain the weight of the towed vehicle and doesn't affect the efficiency of the tow trolley. The wheels were joined each by the other simple axles as they are simply a connection of steel rod connected with the hub of the wheel.

Figure 23 Wheels

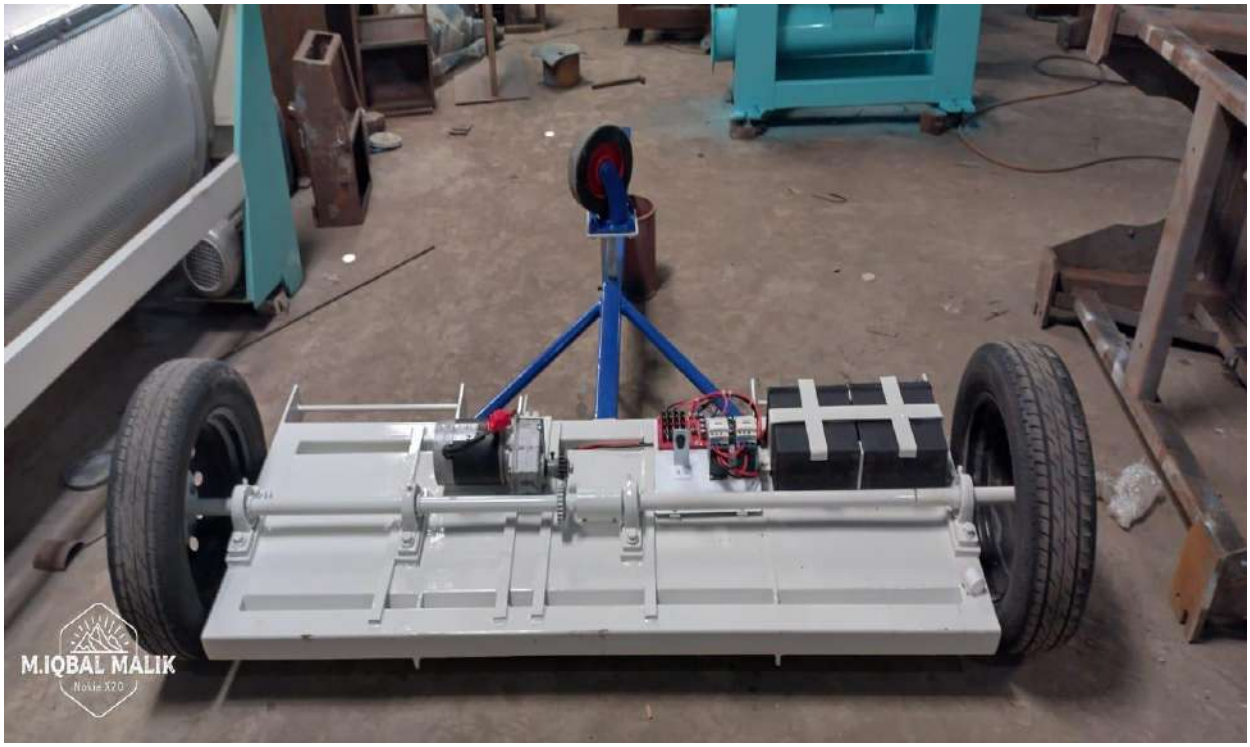


Figure 24 Axles

In this picture, we can see that there is a simple connection between the wheels. This fulfills our project's objective which is to keep this project simple and efficient enough that it can perform its task without any problem.

Nose Wheel:

A nose wheel is attached with drawbar such that it allows easy maneuvering of the tow trolley. The nose wheel is also attached with a rod that includes several holes so that we can adjust the position of the nose wheel according to the height we desire and also according to the bumper of the car through which we can form a connection between the drawbar and bumper of the towing vehicle. The size of the nose wheel is 8inch and it can perform a 360degree of rotation allowing easy turning of the trolley.

Figure 25 Nose wheel

Motor and Battery:

A 24V DC gear motor is used to allow the self-propelling of the tow trolley. This motor was used because a heavy battery can withstand the load of 400-500kgs while allowing a speed of 10-20km/h. It has a maximum ampere of 5.5A while on this load. The power of this motor is 500watt.This motor has 50rpms while sustaining the load secondly, we also have a variable included that can be adjust the rpms according to our requirements. We have chosen DC motor for our tow trolley as this allows us to control its speed and output range. DC motor smoothly handles heavy loads while keeping the power output and speed of the motor constant. One of the main reasons due to which we chose DC motor over AC motor is the cost efficiency of DC motor. The main purpose of our project is to design and manufacture a tow trolley which is not expensive and also its performance is satisfactory which led us to buying this gear motor. This motor was easy to pair with our axle gear as seen in fig 29. The gears are in contact in each other causing a smooth and steady power output which is quite essential for our project keeping in mind the variable speeds required in our tow trolley with respect to the weight of the towed vehicle.

Figure 26 DC motor

Figure 27 Battery

This is our battery used in this tow trolley to power the motor. This a maintenance free battery. Dimensions of this battery is (l=237mm, w=128mm and h=224mm). This battery can have a capacity of 45A. Daewoo Battery dl-60 is a Lead-Acid battery. These specialized batteries are designed to be fully compatible to Pakistani environment and manufactured using most advanced technology. Daewoo battery for Automotive is already charged and filled with good quality electrolyte (which is important as it impacts the battery life) by the manufacturer, making it ready-to-use as soon it is plugged in the car or another purpose. We have placed two placed 12V batteries in this tow trolley because our DC gear motor is of 24V hence a single 12V will make the motor underperform and cause slow speeds of motor that conflicts our objective of this tow trolley.

Complete Assembly of Self Propelling:

We have created such an assembly of our self-propelling mechanism that it allows easy changing of any faulty component and also allows to fully adjust if we want to move our tow trolley manually by pulling the drawbar or by use of the motor allowing automatic movement of this tow trolley.

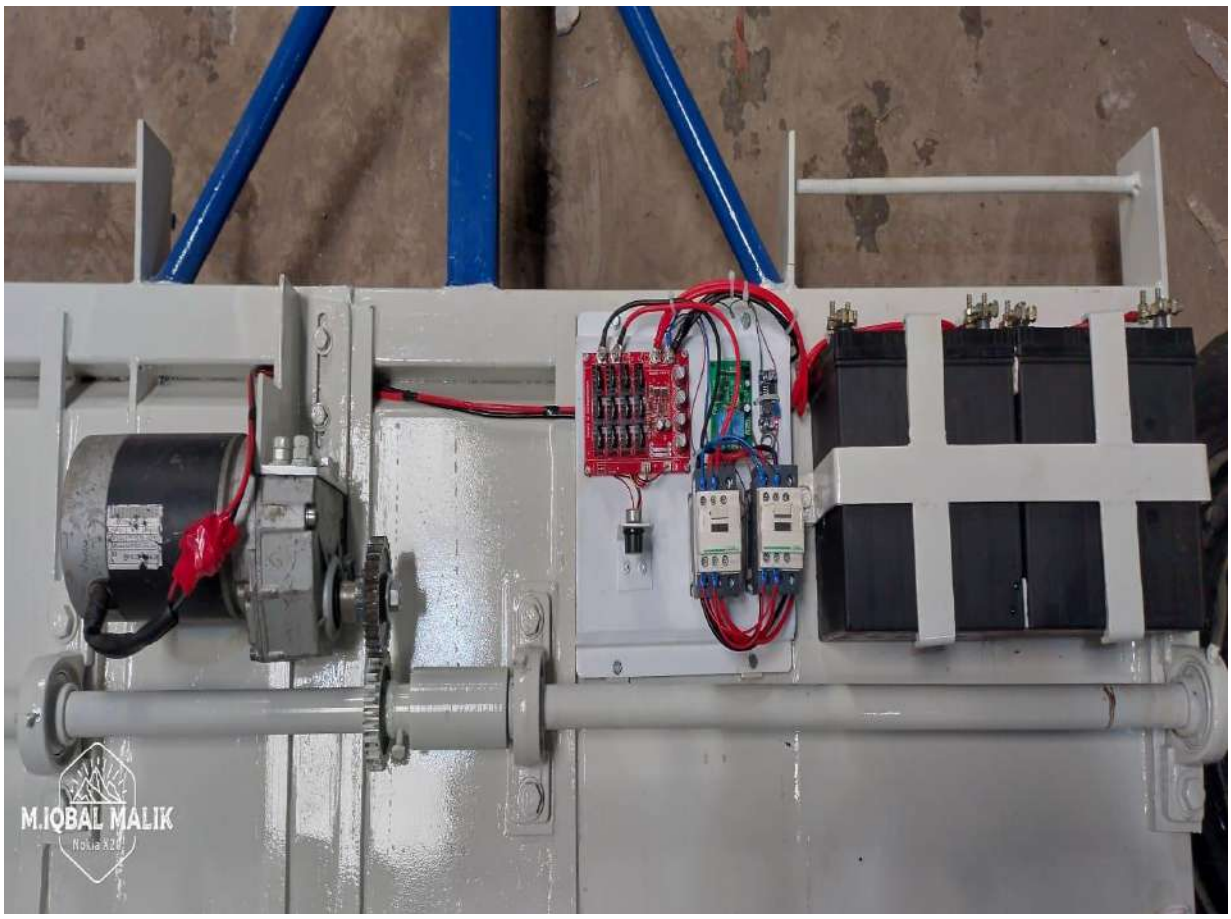


Figure 28 Motor and Battery Assembly

Here we have placed a sliding mechanism for the motor that helps switch between manual or automatic movement of the tow trolley. For automatic movement the gear on the motor is joined with the gear of the axle hence with the power of motor we can rotate our wheels without any external means. If we want to switch to manual movement of the tow trolley then we have to simply open the nuts of the sliding plate attached with the motor which disengages the both gears and this allows only the axle gear to move and we can move the tow trolley by just pulling the drawbar. The batteries are placed horizontally due to the minimum ground clearance required for this tow trolley and if we place the batteries vertically then our ground clearance will be very less that is quite dangerous keeping in mind the roads of Pakistan.

Remote:

We have used a simple car key and connected with a circuit that allows simple and easy to use remote for the movement of tow trolley.

Figure 29 Remote

Here is the remote used for the movement of the tow trolley and working of the motor. This allows a simple forward and backward movement through the buttons C and A respectively. The buttons D and B control the power output and rpms of the motor allowing easy increase or decrease in the motor power output and ultimately the speed of the tow trolley.

Welding:

We chose welding over riveting due to several factors but the main reason was the strength of the pipes.
Riveting is a semi-permanent and non-thermal joining method that involves using a mechanical fastener/rivet to join sheet metal parts. Riveting involves drilling a hole in the two sheet metal parts you want to join together and installing a rivet.
The disadvantages of riveting were:

- High overall cost.
- Increase in overall weight.
- Due to holes, plates become weak.
- Corrosion can occur in the riveted area leading to an increase in maintenance cost.

Welding is a thermal process used in joining two similar or dissimilar metal parts. It is a permanent process that involves aligning the metal, melting the metal parts, and cooling them to allow the parts to form rigid joints.
In welding, we used electric arc welding because it has numerous advantages such as:

- Versatile and works well on metal that's dirty
- Low Cost as compared to riveting
- High welding speed

Cost:

After a thorough market survey these were the lowest cost possible with better material quality.
Square mild steel pipes (6100mm) ----- 8000 Rs
Electric Arc welding ----- 2000 Rs
Wheel plate (540mm × 360mm) ----- 3000 Rs
Centre plate (780mm × 540mm) ----- 2000 Rs
Drawbar (60 × 60mm) ----- 7500 Rs
Axle Rod ----- 3000 Rs
Tires and Rim ----- 9000 Rs
Batteries ----- 22000 Rs
Motor ----- 18000 Rs
Remote and circuit ----- 6000 Rs

CHAPTER FIVE: DISCUSSIONS

Here we will discuss all the data we have calculated throughout of research and designing of this project. This also includes any changes to our designing and implantation of the data into manufacturing this project. There were several factors that caused changes in our designing and manufacturing of the project.

Towing Of Vehicle:

Towing of the vehicle is done by aligning the wheels of the vehicle with the wheel plate of the tow trolley. Then the car is driven and wheels of the vehicle are placed on the wheel plate through a ramp given at the start of wheel plate of the tow trolley which allows easy towing of the vehicle however in our problem we stated that if the vehicle is completely broken down and the vehicle cannot move my itself so it requires an additional support to place the wheels of the car on the wheel plates. Hence, we removed the ramps and now the wheels of the vehicle will be placed manually through a jack which can be either hydraulic jack or air jack as these are readily available at any workshop and also are easy to use for the user. By removing the ramps, our cost was slightly decreased and there was a less component to work upon in assembly of the project. However, there is a hassle lifting both the wheels of the vehicle through a jack and then placing the wheel plates under the wheels of the vehicle and then removing the jacks.

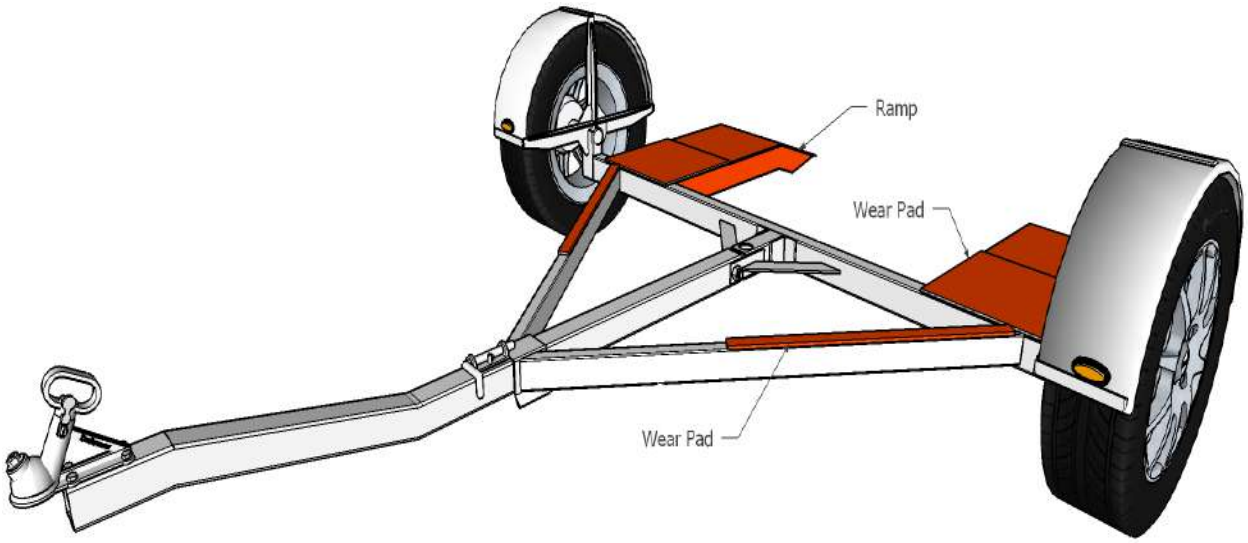


Figure 30 Ramps

Ground Clearance:

Our tow trolley has a ground clearance of 13 inches where as most tow trollies manufactured in USA and Canada have a ground clearance of 8 inches. Our tow trolley has higher ground clearance due to the self-propelling feature which allows the tow trolley to move on its own with the help the help of DC gear motor and batteries through a wireless remote. The whole assembly of self-propelling has multiple components including 2 batteries that consume a lot of space in the downward direction which in case of other countries would have been fine but in case of Pakistan the ground should be enough to allow the tow trolley to have enough ground clearance that it can easily pass through any bump or speed breaker.

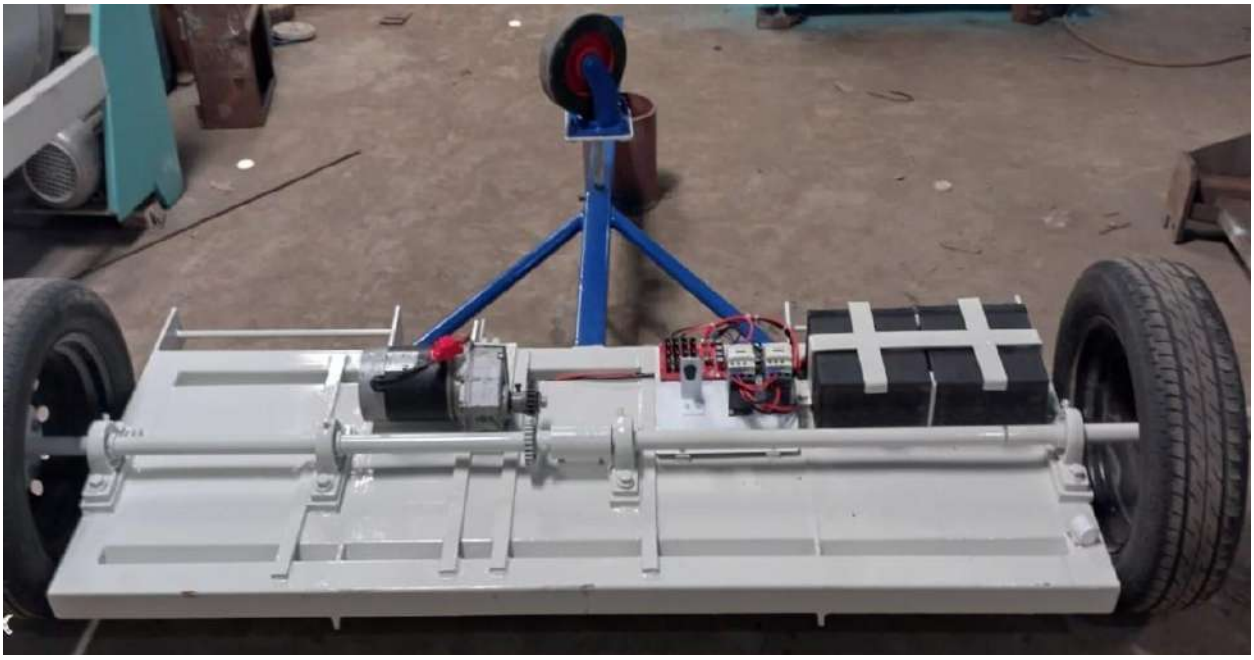


Figure 31 Ground Clearance

Nose Wheel:

Again, keeping in view, the roads of Pakistan, the nose wheel is added to ensure efficient maneuvering of the tow trolley in even tight roads and secondly if the tow trolley is to be travelled on its own then a nose wheel can add an advantage of support to the weight on the drawbar so the drawbar doesn't lift up when weight of the wheels of the vehicle is are placed on the wheel plate of the tow trolley.

Load Capacity:

Tow trollies are basically used for those vehicles that are small size or have less weight as compared to SUVs or jeeps. They aren't made for big vehicles and secondly, they are made for shorter distances as the wear and tear of the towed vehicle has also kept in mind while designing and manufacturing of this tow trolley.

Our project is capable of towing vehicles up to 1200kg which ranges from 600cc cars to 1500cc so statistically these are the range of majority cars present in Pakistan. This project can also be called as prototype as it cannot withstand weight more than 1200kgs. As compared to other tow trollies they can withstand weight up to 2000kgs as they are designed according to big vehicles and jeeps.

CHAPTER SIX: CONCLUSION AND FUTURE DIRECTION

In conclusion, Tow trolley is basically used to tow any vehicle for shorter distances as it cannot tow any vehicle for longer distances due to the rear wheel wear and tear of the towed vehicle. Multiple calculations were performed to check the load bearing capacity of this tow trolley and it can bear loads of vehicles weighing up to 1200kgs. We also added the self-propelling feature that allows the tow trolley to move itself for shorter distances for example if a workshop is present in a 1km radius then we don't need any external vehicle to be attached with the tow trolley and we can transport the vehicle through its self-propelling feature.

There were many limitations such as we cannot design this trolley for vehicles exceeding the weight of 1200kgs as there were reasons such as increase in the cost and also in Pakistan mostly there are hatchback vehicles that have less than 1200kgs weight.

Secondly, the batteries should be dry batteries because we used acid batteries that can cause an issue of leakage of acid because we placed the batteries in horizontal position. We could not place the batteries in vertical position due to less ground clearance hence if we made the tow trolley higher it could cause damage to the towed vehicle and could also increase its wear and tear.

In future multiple things can be improved such as steering mechanism of the tow trolley as there should be a way that there should be a steering that allows side ways movement also as currently there is only front and backwards movement.

Secondly, the tow trolley should be developed for long distances to provide more efficiency to the tow trolley by increasing the efficiency of the motor and battery and somehow reducing the safety concerns of the towed vehicle and its wear and tear.

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