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A Project Stage-II Report On Design and Development of Portable forklift

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Abstract

The present work is concerned with design and Manufacturing of a Portable forklift which can be used for various purpose in domestic as well as industrial places. Improvement in forklift is really needed to make it more efficient, user friendly, and practical to use, & most importantly high safety features.

The In-plant goods carrier system is user friendly as designed. The device finds greater use in the industrial lines for transport of the machined jobs, carrying goods internally in the fabrication plant. Forklift

is an industrial power truck used for lifting and transport materials. Through the steel fork under the load, the lifting and transportation have been done. At present, different kinds of forklift is available, according to the lifting weight of forklift is divided into small tonnage (0.5t) and (1t), middle tonnage (2t and 3t) and large tonnage (5t and above). INTRODUCTION

1.1 Introduction:

Now days due to heavy work load environment in the mechanical industrial lines workers are been depressed for carrying a heavy load, where the workers are prone to unhealthy conditions. Due to these factors some load carrying machines were developed in the recent past years. Like lift A forklift is a powered industrial truck used to lift and move materials over short distances. Forklifts are available at the market which requires more energy to operate, and cannot be used on the uneven surface.

Working in the mechanical workshops or any other large fabrication unit, where load is to carry (bars, plates, machined jobs etc.) from one unit of the factory to the other unit this device is useful. The total number of injuries per year (non-serious, serious, and fatal) is 96,785.

The purpose of this project is to modify the design of the forklift in terms of its functionality and also human factors considerations. In this project we are designing forklift up to 500kg of lifting capacity. In the process of obtaining a suitable design, the customer needs will be translating to the engineering characteristic to obtain the concepts that need to be modified and fabricated. Most people are familiar with the basic forklift (Manually operated) that is still included as standard equipment with newest automated forklifts.

Improvement in forklift is really needed to make it more efficient, user friendly, and practical to use, & most importantly high safety features.

The In-plant goods carrier system is user friendly as designed. The device finds greater use in the industrial lines for transport of the machined jobs, carrying goods internally in the fabrication plant. Forklift is an industrial power truck used for lifting and transport materials. Through the steel fork under the load, the lifting and transportation have been done. At present, different kinds of forklift is available, according to the lifting weight of forklift is divided into small tonnage (0.5t) and (1t), middle tonnage (2t and 3t) and large tonnage (5t and above).

Figure 1 Working Model

The purpose of this project is to encounter these problems. In this project we are using two types of lifting mechanism to lift the load. Assumptions made in designing a forklift, the total load is distributed among the forks for forklift (up to 100kg).

1.2 Problem Definition:

Humans have always needed to lift stuff, but haven't always known the means to do so effectively. Hoist were developed and used but we cannot use hoist to lift loads in few places. A hoist is just a system of chain and wenches on platform that could somewhat be moved. Hoist were great for lifting but not for much for moving from one place to another in few places. The platforms could get under lifted goods and then moved with a handle for transportation of machines in few places was our idea to minimize the labour work. Forklift help moves stuff that humans couldn't move easily.

To overcome this problem, we are using Forklift to find the solution on how to design a forklift using the simplest and cheapest way while it is energy saving. Although there were many ways to solve this problem, we recommend that the design of forklift system is the practical way when we considered all the factors and consequences especially about the analysis to develop this product. Hence, this report had been prepared to recommend the design of the forklift that is user friendly and easier to operate as do not required too much money to develop this product.

1.3 Scope and objective:

Scope

This project is about the designing and fabricating the forklift. The types of forklift that we used in this project are linear actuator operated forklift as it is more reliable and easy to operate. In order to develop new concept of the forklift design, we have done some survey by discussing with the forklift user. The scopes of project were on the designing 50kg maximum lifting capacity of forklift. To achieve our new design goals, we need to do some work on the existing forklift design and what kind of product transportation is using. Based on that work, we need to find what the shortcomings of existing designs are. The new design offers both new and improvised features, over what is currently available.

Objective

The main objective of this work is to minimize the human effort by improving the design of lift. To fulfill the requirement of industry, to reduce the cycle time and improving the productivity of plant.

The following objective will focus in this work: -

1. To study the various types of lifting mechanism.
2. To study the technical specification, critical dimensions and manufacturing process of various components of lift.

The design of lift will be analyzed by using analysis tool for validation.

2. LITURATURE SURVEY

Aashishkumar L Sharnangat, M. S. Tufail,(2017), he said that the development of robotic forklift intended to operate alongside human personnel, handling palletized materials within existing, busy, semi structured outdoor storage facilities. The robot operates in minimally-prepared, semi structured environments, in which the forklift handles variable palletized cargo using only local sensing, and transports it while interacting with other moving forklifts.

LiaiPan (2017) , a, Qiulei Dub As a kind of industrial handling forklifts, forklift plays an indispensable

role in people's life. Nowadays, in order to meet the needs of the people, the types of forklift are more and more. In this project, based on already the basic parameters of the push forward forklift tin the market, the working device of the forklift has been introduced.

Praveen raj (2016) he pointed out that in the modern world though there are many developments in the field of engineering. Development of lift simplifies the effort of carrying heavy loads over stairs, it is not possible to use lift in all places like schools, college's constructional areas. This paper aims at developing a mechanism for easy transportation of heavy loads over stairs. The main objective is to find an efficient and user friendly method of carrying various objects through stairs using minimum effort from the user and to also provide a smooth movement while climbing the stair. A stair climber is manufactured with tri lobed wheel frames at both sides of the climber and three wheels on each side are used in the tri lobed frame. The wheel assembly is rotated by a gear- motor mechanism where a direct current (DC) gear motor is used to provide the necessary power for rotation and a pinion- gear mesh is used for reducing the rotating speed of the wheel.

Mr. Ravi R. Mishra (2016), he modified in the first design, the power transmission to the single or double wheel trolley is useless to climb the stairs due to height factor of stairs creates huge obstacle on the way of forklift. Also, the design of the straight wheel frame became more complicated and was needed modified with its curve- spherical shape to give proper drive, which create more frictional force. For these reasons, three-wheel set on each side of forklift attached with frame was introduced to provide smooth power transmission in order to climb stairs without obstacles. Frame arrangement is suitable to transmit exact velocity ratio also. It provided higher efficiency and compact layout with reliable service

Kulkarni et al.(2016), he clearly pointed that, as per the survey more number of accidents happen due to more number of trolleys connected to a single tractor along with more load and it becomes difficult for the driver to control the tractor and its attachment trolleys. In this paper, they have designed a collapsible trolley that can be adjusted in size. So, to eliminate all the trolley related problems and reduce the cost, they have designed a simple trolley so that the work of two trolleys can be done in a single trolley. With this kind of design, it becomes easy for the drivers to drive the tractor and the trolley to the long distance safely.

Md. A. Hossain. Nafis (2013) , he studied a new horizon for the transportation of the loads over the stair. Most of the buildings of the country are structurally congested and unavailing of elevator facility so it is difficult and laborious to lift up heavy loads. The stair climbing Trolley can play an important role in those areas to lift loads over a short height, like libraries, hospital, and in construction area. The Trolley, which can move upper level through strain, or run in very rough and rocky surfaces, is called stair climbing Trolley.

VegimImeri (2015)[l], he studied the dynamic occurrences on forklift during lifting of loads proves to be difficult using physical experimentation and current measurement devices. Creating the forklift's multibody model and applying computer simulations is very use full method to study these occurrences, which helps to explain the reasons of heavy oscillations, failures and accidents of forklifts, and gives conclusions that can be useful for design considerations and safety. The aim is to see how dynamic forces, moments, speed and oscillations effect the forklift's construction and its stability during load lifting. To do this work we designed entire "virtual forklift" using model design and simulation application [3] and performed simulations in order to gain results. Main parameters that are influential on the dynamic behavior of forklift will be analyzed and will be searched for conclusions that can be useful for better understanding dynamics of forklift. This paper identifies a set of parameters that have influence in main forklift parts, and gives results with graphs and tables with values that are dynamic in nature, with high amplitudes and frequencies that effects directly in causes of material fatigue or failure.

Muthukumar K (2014),he pointed put, forklifts offer many benefits such as reducing manual material handling and enhancing productivity, there are factors that cause Musculoskeletal disorders (MSDs) to the forklift operators, such as severely twisted postures, prolonged sitting and exposure to vibration etc., ultimately leading to low productivity. The main objective of this study is to evaluate different make forklifts in a heavy equipment manufacturing industry (Voltas-diesel, Godrej-diesel, Doosan-diesel, Voltas-electrical and Macniell-electrical) and forklifts with different types of engine (diesel and electrically operated) based on subjective discomfort reported by the forklift operators using Corlett and Bishop's method of body mapping and Cornell Musculoskeletal Discomfort Questionnaire (CMDQ). Fourty four operators aged between 20-58 years driving five different make forklifts were the subjects. Operators working on Godrej diesel reported more discomfort while operators working on Voltas- electrical reported less discomfort. Operators working on diesel operated forklifts reported higher discomfort compared to electrically operated forklifts but the difference is small. Body part wise analysis revealed that the operators reported the highest level of discomfort at the lower back irrespective of the engine type.

Ben T Rails back (2014), he said, significant hazard related to the use of stand-up lift trucks, or stand-up forklifts, is the hazard of a lower limb crush injury or foot crush due to the opening across the rear of the operator compartment. According to one lift truck manufacturer's statistics, there have been over 500 accidents that resulted in an injury to the lower limb of the operator in the last 30 years that involved their stand-up lift trucks. [1] Other manufacturers have had similar accidents. The injuries have occurred to the lower limb of the operator due to the close proximity of the operator's lower limbs to the exterior of the lift truck, and the confined areas that stand-up lift trucks operate in. The operator's lower limb can become pinned and crushed between the moving lift and another fixed object such as a rack system, a column or another lift truck. Objects, such as a fork tine, can also intrude into the operator compartment, injuring the operator's lower extremities.

3. WORKING METHODOLOGY

3.1 Methodology

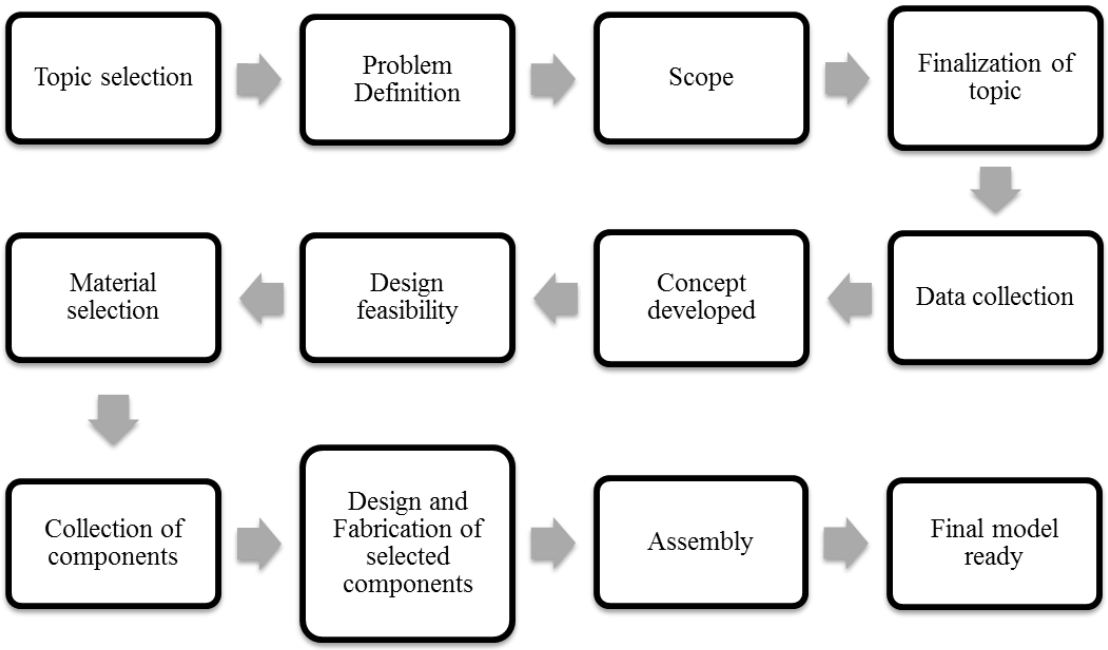


Figure 2 Flowchart of Work

1. Data collection regarding machine dimension and their weights.
2. Concept development.
3. Checking design feasibility
4. Checking of various stresses acting on the body due to axial load. Thus, the different parts of forklift are designed, manufactured as per dimensions.
5. Design in term of comfort.
6. Experimental calculations & Analysed using Analysis software for validation.

The above said work is planned in following phases.

Data Collection:

1. Forklift Introduction.
2. Deciding types of lifting mechanism.
3. Advantages & Disadvantages of forklift.
4. Research papers regarding forklift design, manufacturing & Analysis.
5. Technical specifications of forklift components, c channel, frame on welding machine.

Material Selection:

1. Design of each component and validation as per experimental results.
2. Selection of Steel Material and justification. Section selection, deciding modelling strategy, property definition.

Assembly of model in SOLIDWORKS:

1. Import each frame and pulley model in Software.
2. Meshing analysis in SOLIDWORKS.
3. Finding Stress, Strain analysis with our calculation.
4. Identifying critical sections.

Testing:

1. Theoretical analysis of forks & comparison.
2. Load testing.
3. Von-Mises Stress, Strain evaluation and calculations based upon testing calculation.

4. As per experimental calculation, plotting graphs (Load vs. Stress, Stress vs.).

3.2 Construction

Frame

The frame is usually made of mild steel. It is strong enough to withstand all types of loads in working condition. All other parts are fitted to the frame. Frame is helping the supporting of the various light load support. Frame shows the good aesthetic loop. every machine should have required the good frame design. Frame material should have high strength because frame balancing of other machine load. in ours project the frame showing important role. the vertical pulley and sprocket are mounted on vertical support of the frame. Main whole project assembly ours project mounted on frame. The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The Choice of material for engineering purposes depends upon the following factors:

1. Availability of the materials.
2. Suitability of materials for the working condition in service.
3. The cost of materials.
4. Physical and chemical properties of material.
5. Mechanical properties of material.

The mechanical properties of the metals are those, which are associated with the ability of the material to resist mechanical forces and load. We shall now discuss these properties as follows:

1. Strength: It is the ability of a material to resist the externally applied forces
2. Stress: Without breaking or yielding. The internal resistance offered by a part to an externally applied force is called stress.
3. Stiffness: It is the ability of material to resist deformation under stresses. The modules of elasticity of the measure of stiffness.
4. Elasticity: It is the property of a material to regain its original shape after deformation when the external forces are removed. This property is desirable for material used in tools and machines. It may be noted that steel is more elastic than rubber.

5. Plasticity: It is the property of a material, which retain the deformation produced under load permanently. This property of material is necessary for forging, in stamping images on coins and in ornamental work.
6. Ductility: It is the property of a material enabling it to be drawn into wire with the application of a tensile force. A ductile material must be both strong and plastic. The ductility is usually measured by the terms, percentage elongation and percent reduction in area. The ductile materials commonly used in engineering practice are mild steel, copper, aluminum, nickel, zinc, tin and lead.
7. Brittleness: It is the property of material opposite to ductile. It is the property of breaking of a material with little permanent distortion. Brittle materials when subjected to tensile loads snap off without giving any sensible elongation. Cast iron is a brittle material.
8. Malleability: It is a special case of ductility, which permits material to be rolled or hammered into thin sheets, a malleable material should be plastic but it is not essential to be so strong. The malleable materials commonly used in engineering practice are lead, soft steel, wrought iron, copper and aluminum.
9. Toughness: It is the property of a material to resist the fracture due to high impact loads like hammer blows. The toughness of the material decreases when it is heated. It is measured by the amount of absorbed after being stressed up to the point of fracture. This property is desirable in parts subjected to shock an impact loads.
10. Resilience: It is the property of a material to absorb energy and to resist rock and impact loads. It is measured by amount of energy absorbed per unit volume within elastic limit. This property is essential for spring material.
11. Creep: When a part is subjected to a constant stress at high temperature for long period of time, it will undergo a slow and permanent deformation called creep. This property is considered in designing internal combustion engines, boilers and turbines.
12. Hardness: It is a very important property of the metals and has a wide verity of meanings. It embraces many different properties such as resistance to wear scratching, deformation and mach inability etc. It also means the ability of the metal to cut another metal. The hardness is usually expressed in numbers, which are dependent on the method of making the test. The hardness of a metal may be determined by the following test.

a) Brinell hardness test
b) Rockwell hardness test
c) Vickers hardness (also called diamond pyramid) test and
d) Share scaleroscope.

The science of the metal is a specialized and although it overflows in to realms of knowledge it tends to shut away from the general reader. The knowledge of materials and their properties is of great significance for a design engineer. The machine elements should be made of such a material which has properties suitable for the conditions of operations. In addition to this a design engineer must be familiar with the manufacturing processes and the heat treatments have on the properties of the materials. In designing the various part of the machine it is necessary to know how the material will function in service. For this certain characteristics or mechanical properties mostly used in mechanical engineering practice are commonly determined from standard tensile tests. In engineering practice, the machine parts are subjected to various forces, which may be due to either one or more of the following.

- Energy transmitted
- Weight of machine
- Frictional resistance
- Inertia of reciprocating parts
- Change of temperature
- Lack of balance of moving parts

The selection of the materials depends upon the various types of stresses that are set up during operation. The material selected should with stand it. Another criteria for selection of metal depend upon the type of load because a machine part resist load more easily than a live load and live load more easily than a shock load.

Selection of the material depends upon factor of safety, which in turn depends upon the following factors.

- Reliabilities of properties
- Reliability of applied load
- The certainty as to exact mode of failure
- The extent of simplifying assumptions
- The extent of localized

- The extent of initial stresses set up during manufacturing
- The extent loss of life if failure occurs
- The extent of loss of property if failure occurs

Material used

- Mild steel

Reasons:

1. Mild steel is readily available in market.
2. It is economical to use.
3. It is available in standard sizes.
4. It has good mechanical properties i.e. it is easily machinable.
5. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure.
6. It has high tensile strength.
7. Low co-efficient of thermal expansion.

Properties of Mild Steel:

M.S. has a carbon content from 0.15% to 0.30%. They are easily wieldable thus can be hardened only. They are similar to wrought iron in properties. Both ultimate tensile and compressive strength of these steel increases with increasing carbon content. They can be easily gas welded or electric or arc welded. With increase in the carbon percentage weld ability decreases. Mild steel serve the purpose and was hence was selected because of the above purpose

Basic Frame:

The ms angles of material of mild steel are selected for the frame. The ms angles are cut into required size by cutting machine. The end of the ms angles cut into 90 degree(angle) to form rectangular frame. After cutting, the end of the ms angles is grinded so that it became smooth and convenient for welding. The ms angles are welded together to form a rectangular basic frame.

Figure 3 Milds steel angle

MS SHEET METAL:

These MS sheets and mild steel sheets confirm to various standards like ANSI, API, MSS, BS, DIN, JIS & IS standards. We can provide these ms sheets and mild steel sheets in different grades, thickness, length and weight as per the requirements. Sheet metal is metal formed by an industrial process into thin, flat pieces. Sheet metal is one of the fundamental forms used in metalworking, and it can be cut and bent into a variety of shapes. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin sheets are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate steel or "structural steel".

Sheet metal is available in flat pieces or coiled strips. The coils are formed by running a continuous sheet of metal through a roll slitter.

In most of the world, sheet metal thickness is consistently specified in millimeters. In the US, the thickness of sheet metal is commonly specified by a traditional, non-linear measure known as its gauge.

Table 1 sheet metal size selection

Guage	Thickness mm	Weight kg/sq.m

8	4	31.4
9	3.55	27.9
10	3.15	24.75
11	2.8	22
12	2.5	19
13	2.25	17.6
14	2	15.7
15	1.8	14.15
16	1.6	12.55
17	1.4	11
18	1.25	9.8
19	1.12	8.8
20	1	7.85
21	0.9	7.05
22	0.8	6.3
24	0.63	4.95
26	0.5	3.9
28	0.4	3.15

Linear actuator:

A linear actuator is an actuator that creates motion in a straight line, in contrast to the

circular motion of a conventional electric motor. Linear actuators are used in machine tools and industrial machinery, in computer peripherals such as disk drives and printers, in valves and dampers, and in many other places where linear motion is required. Hydraulic or pneumatic cylinders inherently produce linear motion. Many other mechanisms are used to generate linear motion from a rotating motor.

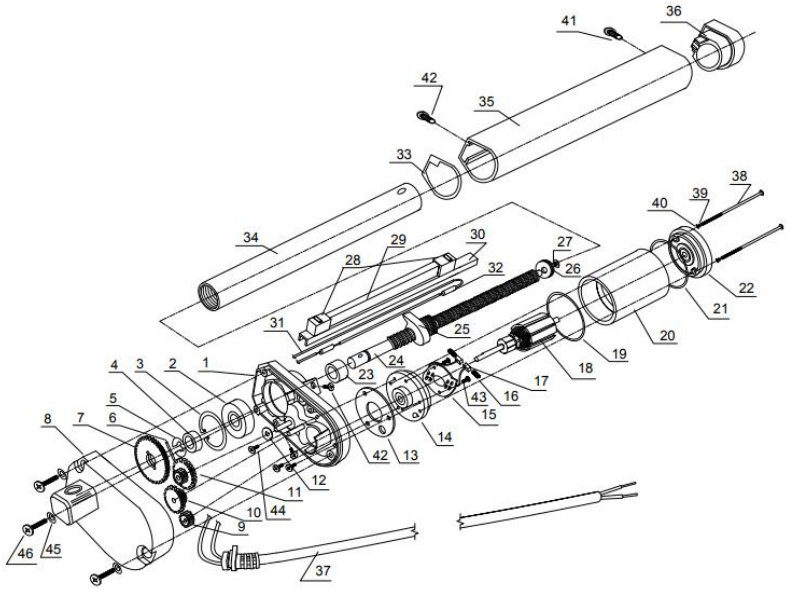


Figure 4 Electric Linear Actuator Parts

Item	Description	Qty
1	Actuator base	1
2	Shaft Bearing	1
3	Shaft Bearing Lock	1
4	Shaft Base Spacer	1
5	Shaft Base Spacer Lock	1
6	Shaft Gear Wheel Holder	1
7	Shaft Gear Wheel	1
8	Base Cover with Mounting Support	1
9	Electric Motor Gear Wheel	1
10	Small Intermediate Gear Wheel	1
11	Medium Intermediate Gear Wheel	1
12	Teflon Washer	1
13	Electric Motor Base Washer	1
14	Electric Motor Base	1
15	Brush Holder PCB	1
16	Electric Motor Brush	2
17	Electric Motor Brush Spring	2
18	Electric Motor Rotor	1
19	Motor Enclosure Bottom Washer	1
20	Electric Motor Encloser with Stator	1
21	Motor Enclosure Top Washer	1
22	Electric Motor Cap with Rotor Bearing	1
23	Shaft Spacer	1

Item	Description	Qty
24	Treaded Shaft Drive / Lead Screw	1
25	Shaft Base with Limit Switches Arm	1
26	Shaft Drive End Support	1
27	Shaft Drive End Support Screw	1
28	Limit Switch	2
29	Limit Switches Spacer	1
30	Limit Switches Base	1
31	Limit Switches Wiring	1
32	Diode	2
33	Shaft Encloser Bottom Washer	1
34	Shaft with Mounting Hole	1
35	Shaft Encloser	1
36	Shaft Enclosure Top Cap	1
37	Power Cable	1
38	Motor Enclosure Screw	2
39	Motor Screw Spring Washer	2
40	Motor Screw Washer	2
41	Shaft Eclosure Top Cap Screw	1
42	Shaft Enclosure Base Screw	3
43	Brush Holder PCB Screw	2
44	Motor Base Screw	3
45	Base Cover Washer	3
46	Base Cover Screw	3

Inside a linear actuator is a number of different components, all of which work together to form the movements that are needed from the equipment. While electric screw actuators were specifically designed to have fewer moving parts, both to reduce the potential for breakdowns

and maintenance, and also to make the actuators lighter and easier to use, there are many parts that are integral to its overall functioning.

Motor:

The motor is what makes the motion possible, and what interacts with the other parts of an electric linear actuator. The most common type of motor is a 12v DC motor, but for stronger or weaker actuators, this can be switched to a different format. The motor provides the movement. The motor is also subject to what is called the duty cycle of the actuator, the length of time it can operate before needing to rest.

Figure 5 Gear Motor

Gears – The gears are what attaches the motor to the lead screw, and allow them to move freely.

Figure 6 Gears

DC brushes:

DC brushes bring current into the actuator by conveying it between stationary wires within the equipment.

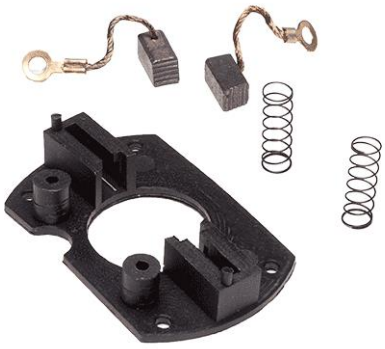


Figure 7 DC Brushez

Cylinder:

The cylinder is the part of the actuator which contains the motion created by the motor. It does not move but contains the parts that do move.

Lead screw:

lead screw actuators are the most common form of electric actuator. The lead screw is attached inside the cylinder, and it is this part of the actuator that actually turns the rotational motion into linear motion. The lead screw travels up and down the cylinder, creating the motion which is needed.

Figure 8 Lead Screw

Limit switch:

A limit switch is incorporated into most (although definitely not all) models of the electric actuator, and acts as a means of limiting the movement of the actuator. When the limit switch is triggered, then all movement stops.

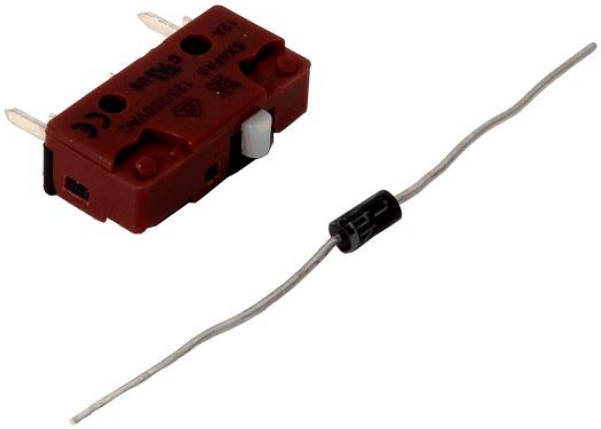


Figure 9 Limit Switch

The motor provides the actual movement, to be changed into linear energy by the lead screw running up and down the cylinder, with a limit switch set to keep things from moving too far. The rotor and stator assemblies of the linear actuator both come into play at this point, as the primary and secondary workings of the motor. The stator assembly (as the primary workings) is hit with voltage first, which then gets turned into a current to be shunted into the rotor assembly (the secondary workings). The two workings together create a field, which is ultimately what causes motion. Once this motion has been created within the motor, it moves into the cylinder, where it turned into the linear motion through interaction with the limit switch.

The gears are what actively turns the cylinder, which is how the linear motion is created. DC brushes are used within the motor to help convey the electric current between it and the lead screw

Spray paint can:

Spray paint, also known as aerosol paint, is paint that's stored in a pressurized container and dispensed using a valve to release a mixture of paint and a propellant, usually pressurized gas or compressed air. The result is a fine, even mist that is easily applied to a variety of surfaces. Spray painting is one of three primary methods for paint application besides using a paintbrush or a roller, and is generally quicker, cleaner, and easier to achieve a uniform coat.
Spray paint started becoming a steadfast friend to do-it-yourselfers when American artist Francis Davis Millet developed an oil and lead mixture that could be sprayed to speed up preparations for the Chicago World's Fair. But it was Edward Seymour who thought to use an aerosol spray to dispense paint. In 1949, he demonstrated a new aluminum paint designed for finishing radiators on a large scale quickly. Aerosol spray cans had been around since Norwegian engineer Eric Rotheim invented the first one in 1931, and Seymour was simply piggybacking on this innovation as a way to showcase his own product [source: Harris]. But he was so intrigued by this new method of paint delivery that he directed his company, Seymour of Sycamore, to dedicate considerable resources to exploring its potential [source: Seymour of Sycamore].

Figure 10 spray can

Around the same time Seymour was working on his contributions to spray paint, Krylon and

Crown Holdings Inc. were each developing new can designs that eventually gave rise to the metal cylinders we use today [source: Sattler]. They were smaller, lighter, cleaner and applied an even coat faster than a brush or roller could, making those small paint projects around the house a lot more manageable. And once the manufacturing industry discovered its benefits, spray paint went from a resourceful and useful invention to a full-blown industrial boon.

Today, spray paint comes in enamels, stains, flats and glossies, and there are varieties designed for virtually any surface, including wood, metal, glass, plastic and masonry. In other words, if it can be painted, there's probably a spray paint that can do the job.

The various machining operations conducted after material selection are as follows:

PROCESS SHEET:

Following operations were while fabricate the project

Cutting: -

Cutting is the separation or opening of a physical object, into two or more portions, through the application of an acutely directed force.

Implements commonly used for cutting are the knife and saw, or in medicine and science the scalpel and microtome. However, any sufficiently sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force. Even liquids can be used to cut things when applied with sufficient force (see water jet cutter).

The material as our required size. The machine used for this operation is power chop saw. A power chop saw, also known as a drop saw, is a power tool used to make a quick, accurate crosscut in a work piece at a selected angle. Common uses include framing operations and the cutting of moulding. Most chop saws are relatively small and portable, with common blade sizes ranging from eight to twelve inches.

Figure 11 Cutting Operation

The chop saw makes cuts by pulling a spinning circular saw blade down onto a work piece in

a short, controlled motion. The work piece is typically held against a fence, which provides a precise cutting angle between the plane of the blade and the plane of the longest work piece edge. In standard position, this angle is fixed at 90°. A primary distinguishing feature of the mitre saw is the mitre index that allows the angle of the blade to be changed relative to the fence. While most mitre saws enable precise one-degree incremental changes to the mitre index, many also provide "stops" that allow the miter index to be quickly set to common angles (such as 15°, 22.5°, 30°, and 45°).

Welding: -

Welding is a ((fabrication or sculptural ((process that joins materials, usually metals or thermoplastics, by using high heat to melt the parts together and allowing them to cool causing fusion. Welding is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal.

In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that, based on weld configuration (butt, full penetration, fillet, etc.), can be stronger than the base material (parent metal). Pressure may also be used in conjunction with heat, or by itself, to produce a weld. Welding also requires a form of shield to protect the filler metals or melted metals from being contaminated or oxidized.

Square pipes of different lengths to make frame. The machine used for this operation is electric arc welding. Electrical arc welding is the procedure used to join two metal parts, taking advantage of the heat developed by the electric arc that forms between an electrode (metal filler) and the material to be welded. The welding arc may be powered by an alternating current generator machine (welder). This welding machine is basically a single-phase static transformer Suitable for melting RUTILE (sliding) acid electrodes. Alkaline electrodes may also be melted by alternating current.

Figure 12 Welding operation

The welding current is continuously regulated (magnetic dispersion) by turning the hand wheel on the outside of the machine, which makes it possible to select the current value, indicated on a special graded scale, with the utmost precision. To prevent the service capacities from being exceeded, all of our machines are fitted with an automatic overload protection which cuts of the power supply (intermittent use) in the event of an overload. The operator must then wait for a few minutes before returning to work. This welding machine must be used only for the purpose described in this manual. Read the entire contents of this manual before installing, using or servicing the equipment, paying special attention to the chapter on safety precautions. Contact your distributor if you do not fully understand these instructions. The time required for this operation is 120 minutes.

Drilling: -

Drilling is a cutting process that uses a drill bit to cut a hole of circular ((cross-section in solid materials. The drill bit is usually a rotary ((cutting tool, often multi-point. The bit is pressed against the work-piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work-piece, cutting off chips (swarf) from the hole as it is drilled.

In ((rock drilling, the hole is usually not made through a circular cutting motion, though the bit is usually rotated. Instead, the hole is usually made by hammering a drill bit into the hole with quickly repeated short movements. The hammering action can be performed from outside the hole ((top-hammer drill) or within the hole (down-the-hole drill, DTH). Drills used for horizontal drilling are called drifter drills.

In rare cases, specially-shaped bits are used to cut holes of non-circular cross-section; a ((square cross-section is possible.

Figure 13 Drilling Operation

Drilled holes are characterized by their sharp edge on the entrance side and the presence of ((burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks.

Drilling may affect the mechanical properties of the work piece by creating low residual stresses around the hole opening and a very thin layer of highly ((stressed and disturbed material on the newly formed surface. This causes the work piece to become more susceptible to corrosion and crack propagation at the stressed surface. A finish operation may be done to avoid these detrimental conditions. For ((fluted drill bits, any chips are removed via the flutes. Chips may form long spirals or small flakes, depending on the material, and process parameters. The type of chips formed can be an indicator of the machinability of the material, with long chips

suggesting good material machinability.

Figure 14 Drilling Tool

Finishing: -

Finishing is a broad range of industrial processes that alter the surface of a manufactured item to achieve a certain property. Finishing processes may be employed to: improve appearance, adhesion or wettability, solder ability, corrosion resistance, tarnish resistance, chemical resistance, wear resistance, hardness, modify electrical conductivity, remove burrs and other surface flaws, and control the surface friction. In limited cases some of these techniques can be used to restore original dimensions to salvage or repair an item.

An unfinished surface is often called mill finish.

The edges with grinder using grinding wheel. The machine used for this operation is hand grinder. An angle grinder, also known as a side grinder or disc grinder, is a handheld power tool used for cutting, grinding and polishing. Angle grinders can be powered by an electric motor, petrol engine or compressed air.

The motor drives a geared head at a right-angle on which is mounted an abrasive disc or a thinner cut-off disc, either of which can be replaced when worn. Angle grinders typically

have an adjustable guard and a side-handle for two-handed operation. Certain angle grinders, depending on their speed range, can be use*d* as sanders, employing a sanding disc with a backing pad or disc. The backing system is typically made of hard plastic, phenolic resin, or medium-hard rubber depending on the amount of flexibility desired. The time required for this operation is 20 minutes.

Figure 15 Finishing Operation

Polishing: -

Polishing is the process of creating a smooth and shiny surface by rubbing it or using a chemical action, leaving a surface with a significant specular reflection (still limited by the

index of refraction of the material according to the Fresnel equations.) In some materials (such as metals, glasses, black or transparent stones), polishing is also able to reduce diffuse reflection to minimal values. When an unpolished surface is magnified thousands of times, it usually looks like mountains and valleys. By repeated abrasion, those "mountains" are worn down until they are flat or just small "hills." The process of polishing with abrasives starts with coarse ones and graduates to fine ones.

The welded joints with hand grinder using grinding wheel. The machine used for this operation is hand grinder. With refinement, grinding becomes polishing, either in preparing metal surfaces for subsequent buffing or in the actual preparation of a surface finish, such as a No. 4 polish in which the grit lines are clearly visible. Generally speaking, those operations which serve mainly to remove metal rapidly are considered as grinding, while those in which the emphasis is centered on attaining smoothness are classified as polishing. Grinding employs the coarser grits as a rule while most polishing operations are conducted with grits of 80 and finer. If polishing is required, start with as fine a grit as possible to reduce finishing steps. There is a wide range of grinding and polishing tools on the market and advice is available from ASSDA members to assist in particular applications. Polishing operations are conducted with the abrasive mounted either on made-up shaped wheels or belts which provide a resilient backing. The base material may be in either a smooth rolled or a previously ground condition. If the former, the starting grit size may be selected in a range of 80 to 100. If the latter, the initial grit should be one of sufficient coarseness to remove or smooth out any residual cutting lines or other surface imperfections left over from grinding. In either case, the treatment with the initial grit should be continued until a good, clean, uniform, blemish-free surface texture is obtained. The initial grit size to use on a pre-ground surface may be set at about 20 numbers finer than the last grit used in grinding, and changed, if necessary, after inspection. Upon completion of the initial stage of polishing, wheels or belts are changed to provide finer grits. Polishing speeds are generally somewhat higher than those used in grinding. A typical speed for wheel operation is 2500 meters per minute. The time required for this operation is 20 minutes.

Figure 16 Polishing Operation

Turning:

Turning is a metal cutting process for producing a cylindrical surface with a single point tool. The work piece is rotated on a spindle and the cutting tool is fed into it radially, axially or both. Producing surfaces perpendicular to the work piece axis is called facing. Producing surfaces using both radial and axial feeds is called profiling.

A *lathe* is a machine tool which spins a block or cylinder of material so that when abrasive, cutting, or deformation tools are applied to the work piece, it can be shaped to produce an object which has rotational symmetry about an axis of rotation. Examples of objects that can be produced on a lathe include candlestick holders, table legs, bowls, baseball bats, crankshafts, camshafts, and bearing mounts. Lathes have three main components:

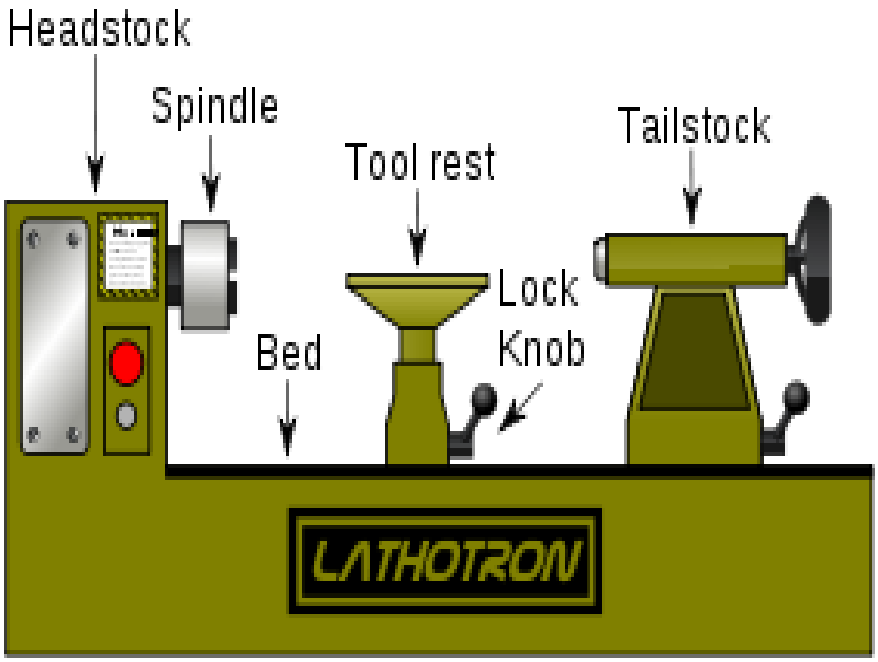


Figure 17 Lathe

Headstock:

The headstock's spindle secures the work piece with a chuck, whose jaws (usually three or four) are tightened around the piece. The spindle rotates at high speed, providing the energy to cut the material. While historic lathes were powered by belts from the ceiling, modern examples uses electric motors. The work piece extends out of the spindle along the axis of rotation above the flat bed.

Carriage:

The carriage is a platform that can be moved, precisely and independently, horizontally parallel and perpendicular to the axis of rotation. A hardened cutting tool is held at the desired height (usually the middle of the work piece) by the tool post. The carriage is then moved around the rotating work piece, and the cutting tool gradually shaves material from the work piece.

Tailstock:

The tailstock can be slid along the axis of rotation and then locked in place as necessary. It may hold centers to further secure the work piece, or cutting tools driven into the end of the work piece.

Safety Precautions:

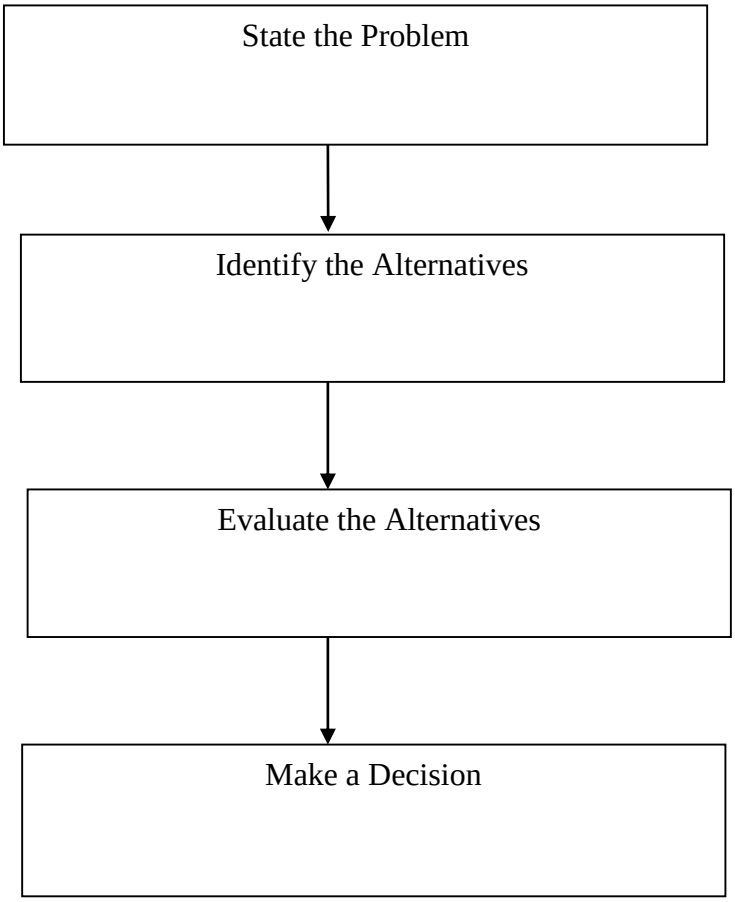
The following points should be considered for the safe operation of machine

and to avoid accidents: -

- All the parts of the machine should be checked to be in perfect alignment.
- All the nuts and bolts should be perfectly tightened.
- The operating switch should be located at convenient distance from the operator so as to control the machine easily.
- The inspection and maintenance of the machine should be done from time to time.

3.3 Decision Making Process

No methodology is available for material and method selection except decision making in multi attribute environment. Material selection is vital and crucial activity in any industry nowadays. This substantially reduces the risk of wrong material or method selection.



3.4 Project Pan

Following fig explains the steps for experiment. The process flow mentioned above will be considered to meet the goal of research work.

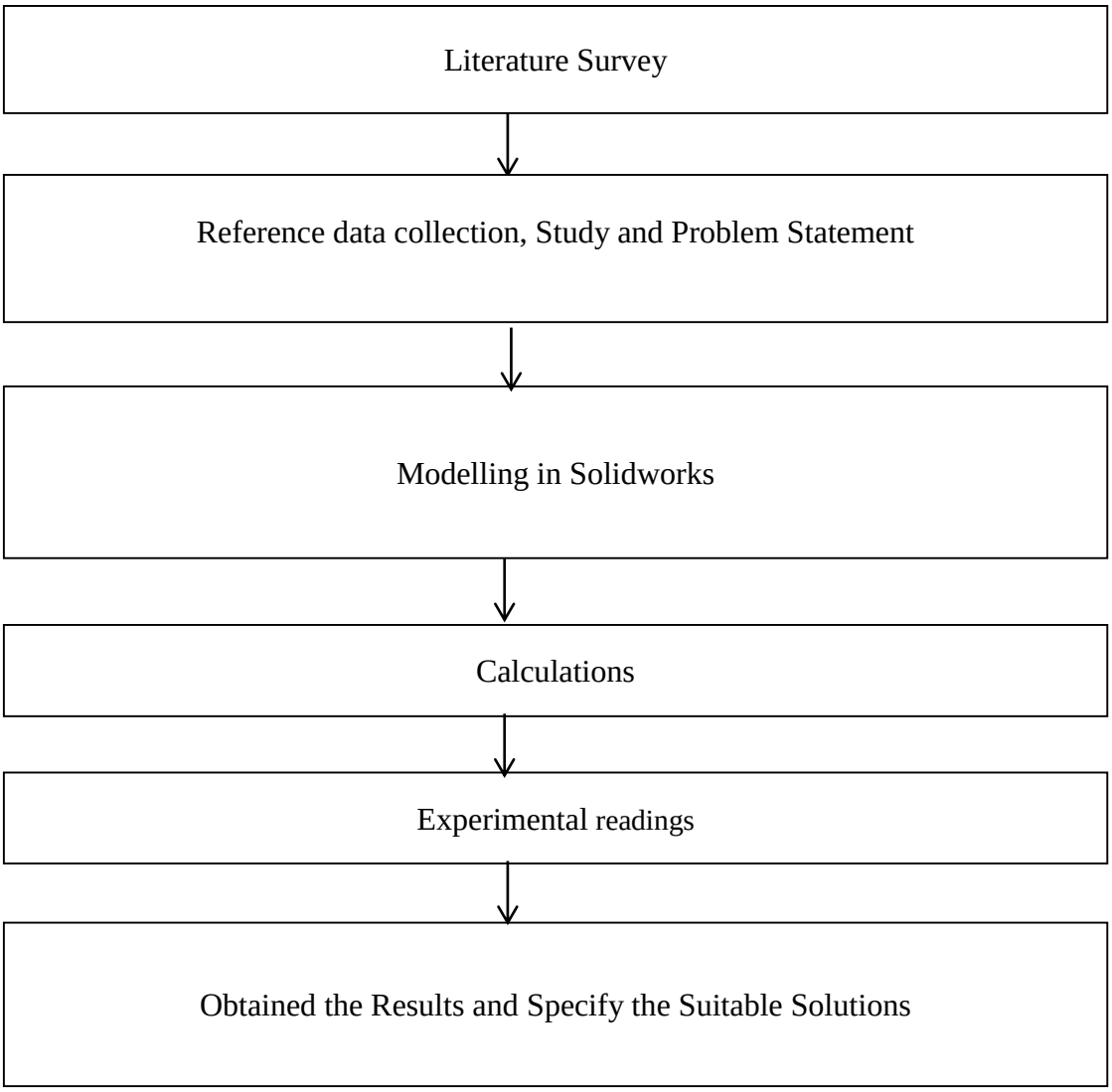


Figure 19 Steps of Execution

3.5 CAD drawing

Procedure

- The entire model has been designed with the help of designing software solid works.
- With the help of colour feature the colours are given to the entire model.

Figure- Cad model of the assembled project is designed on Solidworks 2018 software

SOLID MODELING

The entire model has been designed with the help of designing software solid works.

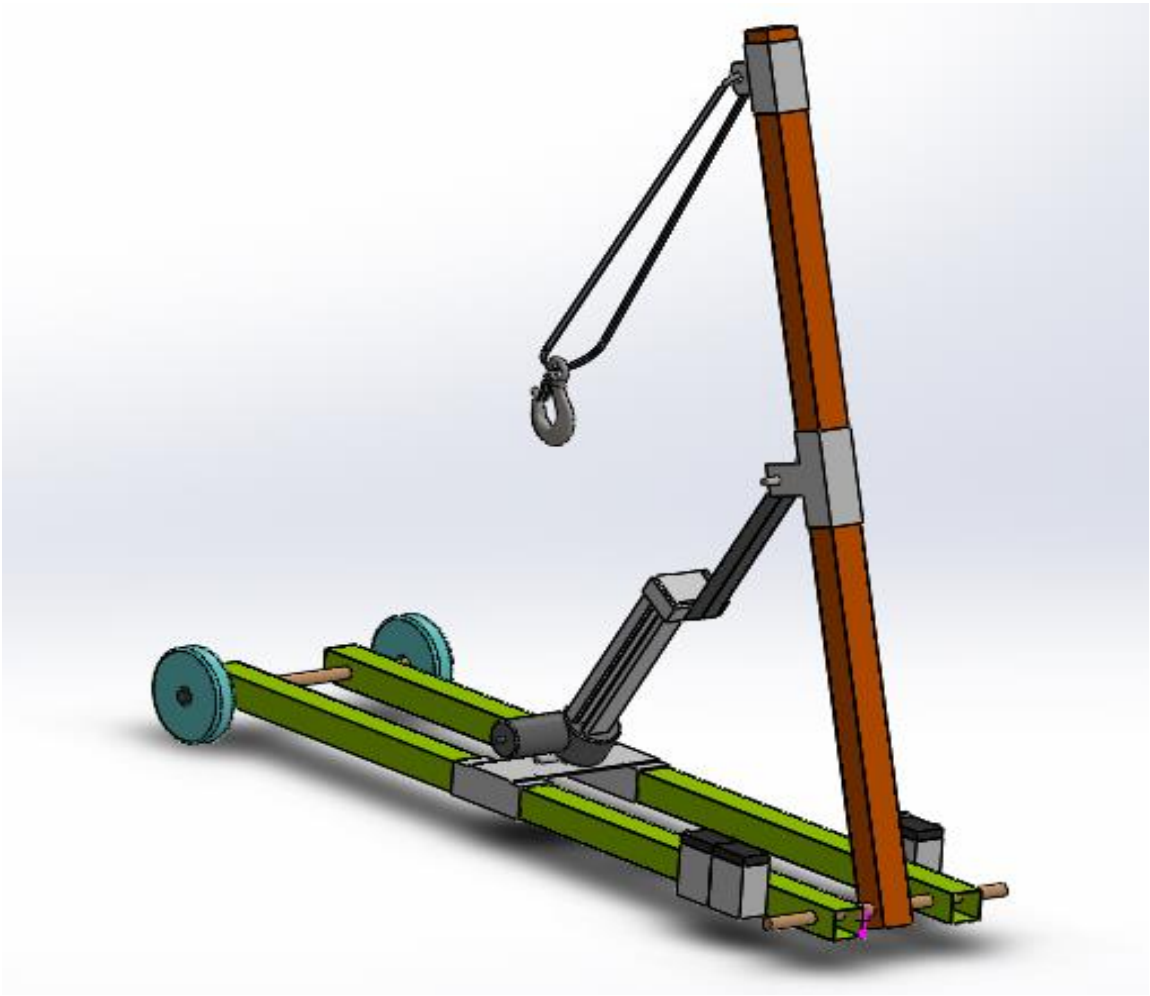


Figure 20 Isometric front view

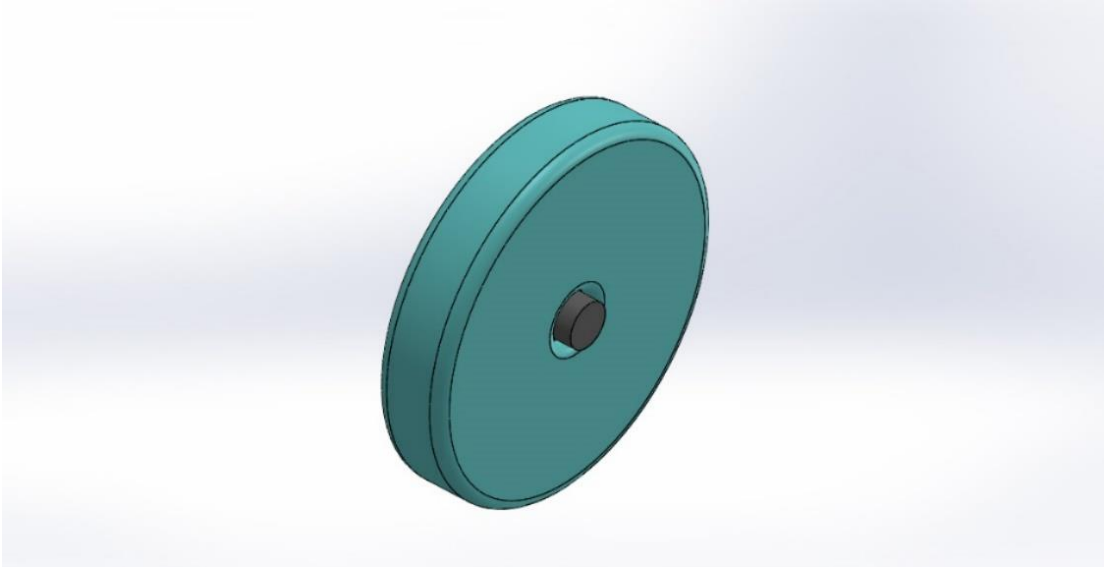


Figure 21 Wheel

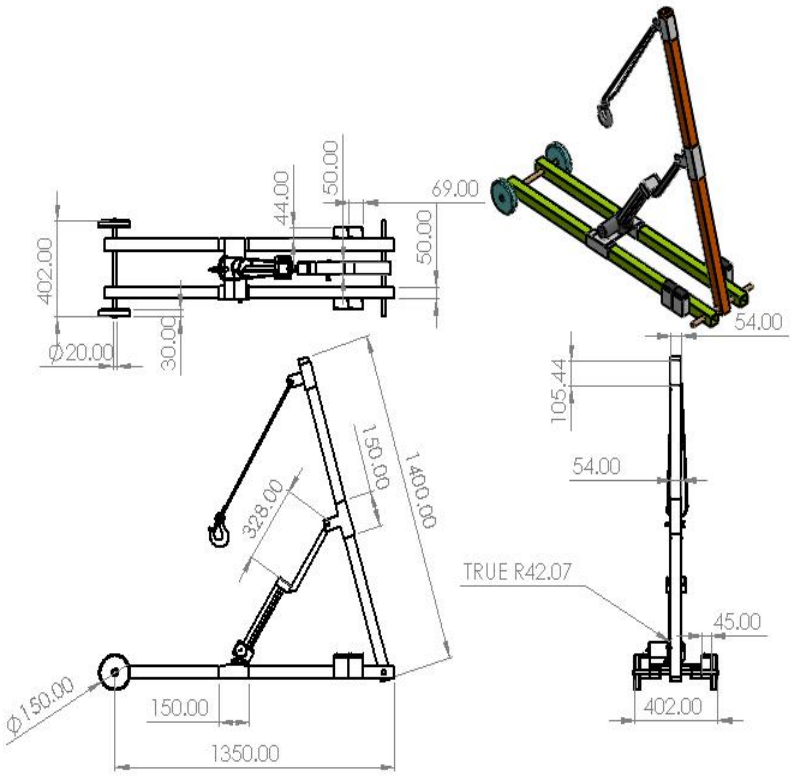


Figure 22 drafting

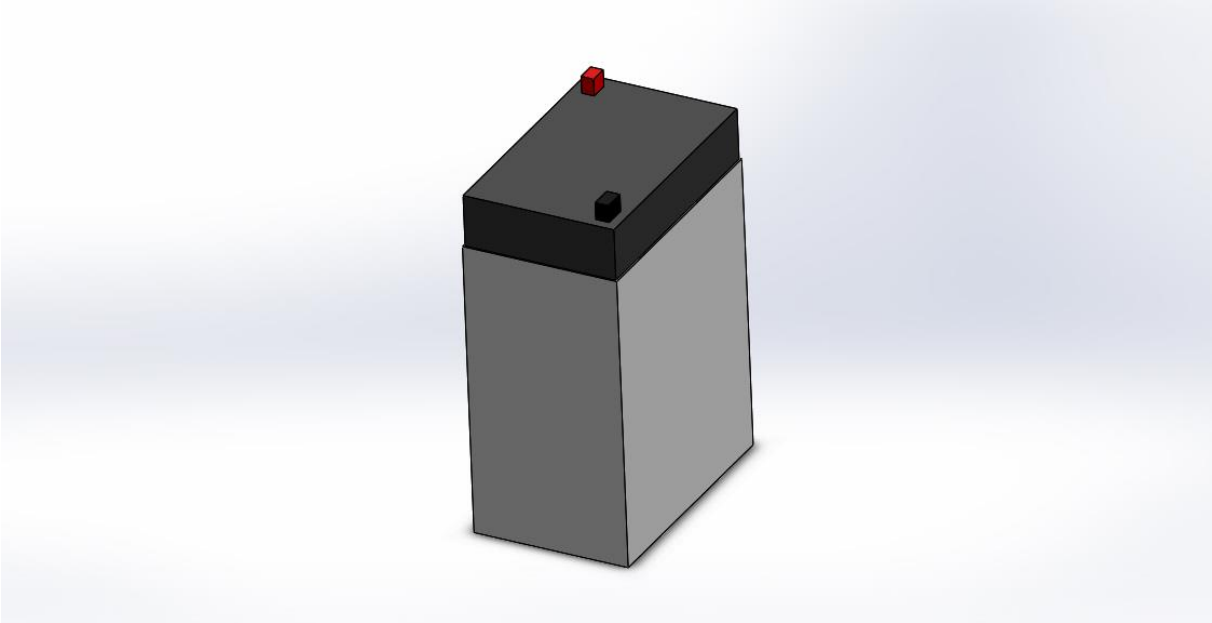


Figure 23 Battery 6V

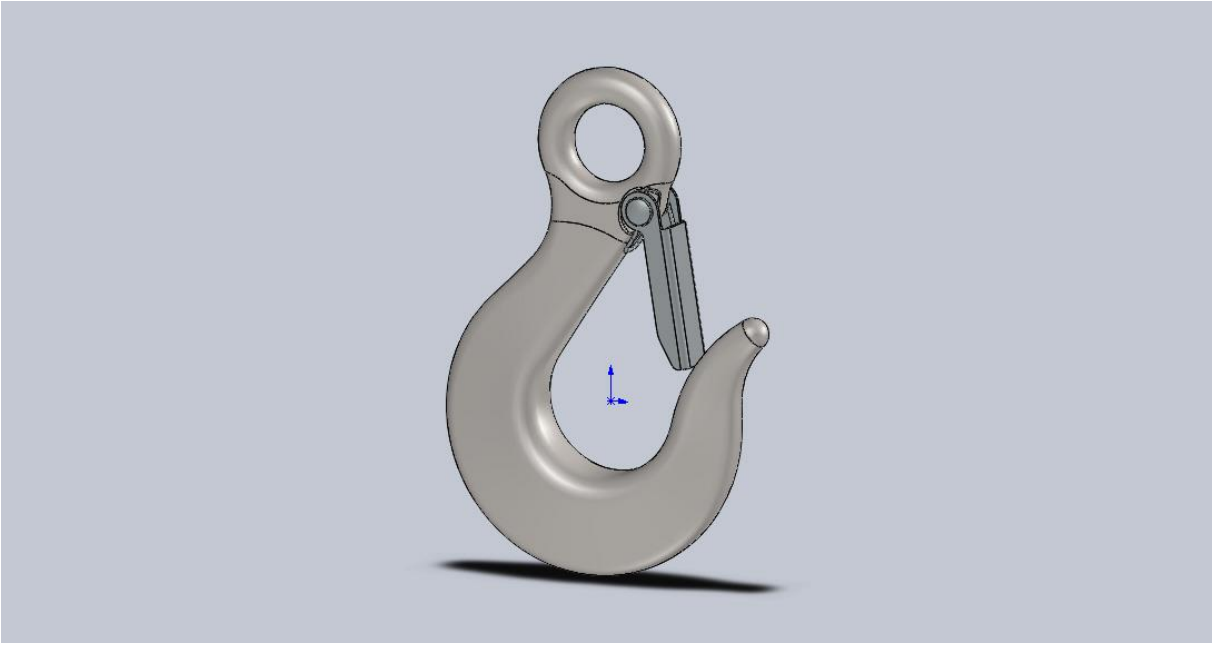


Figure 24 Eye Hook

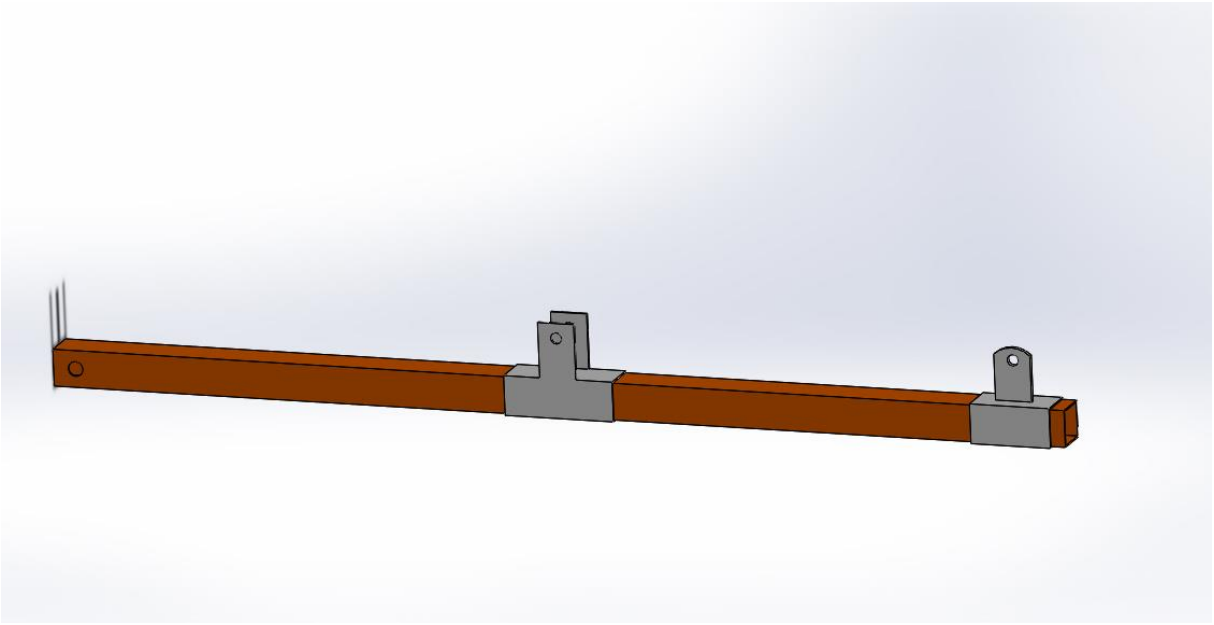


Figure 25 Upper Arm

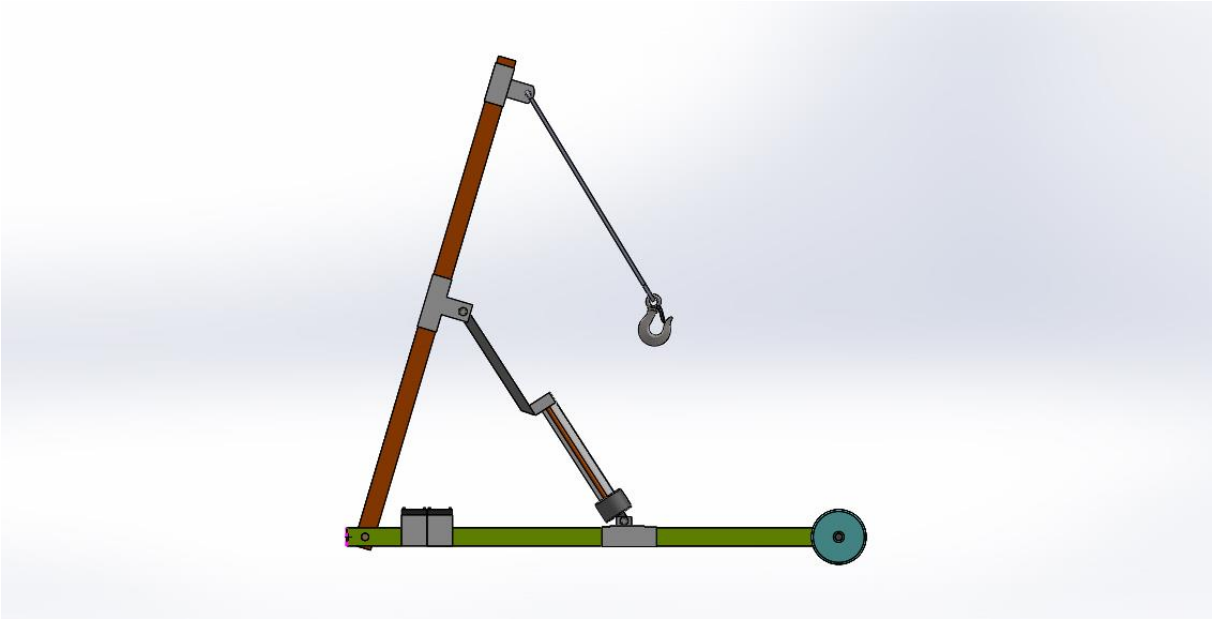


Figure 26 Side View

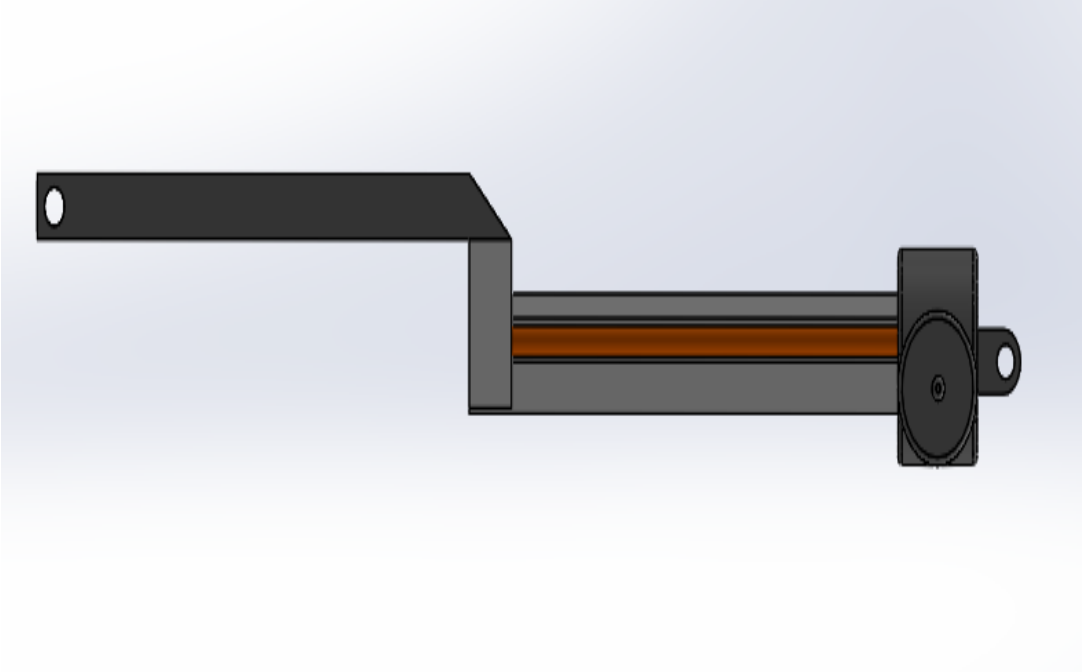


Figure 27 Linear Actuator

Figure 28 Shaft 20mm

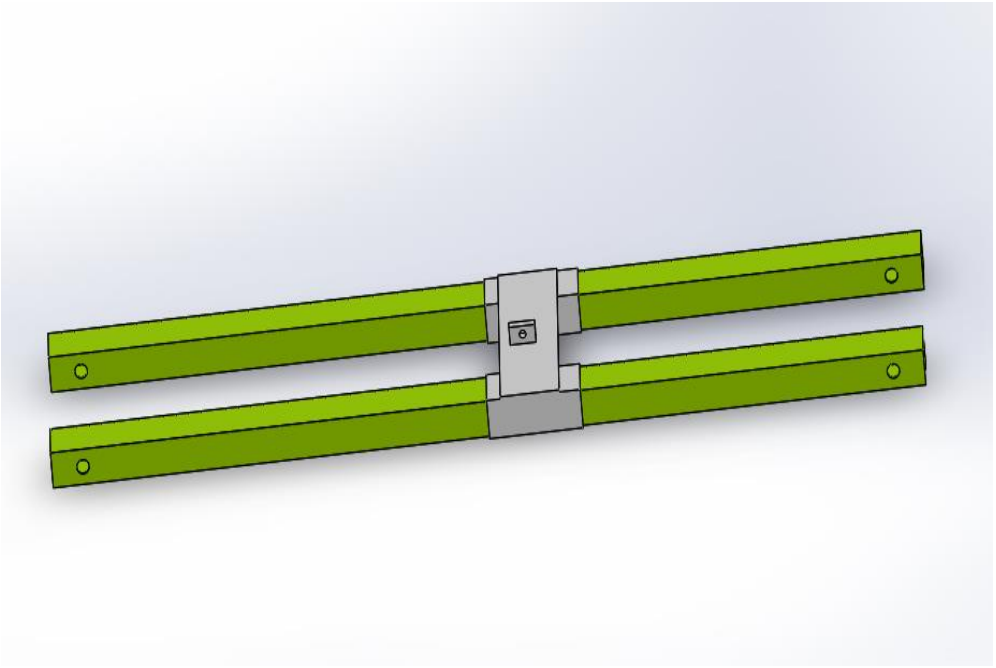
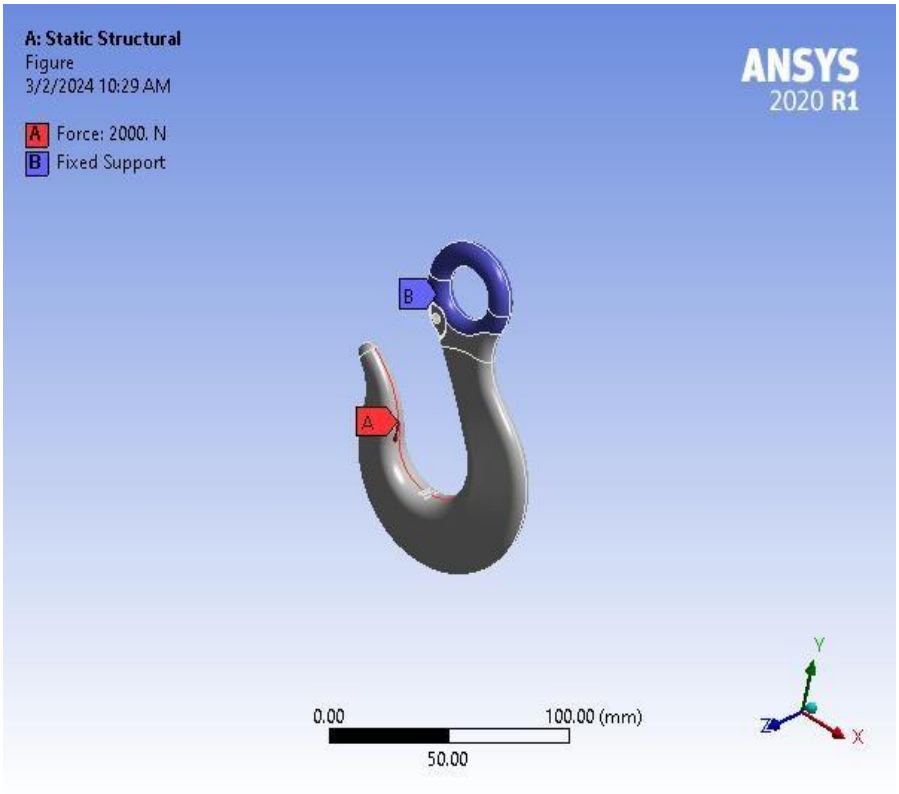
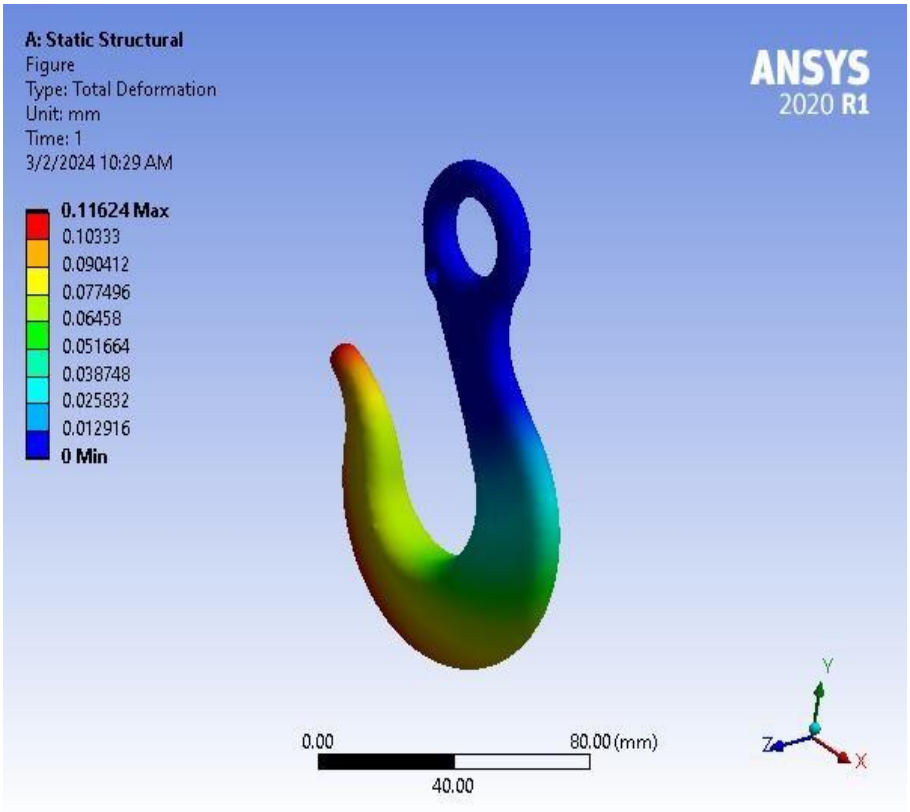
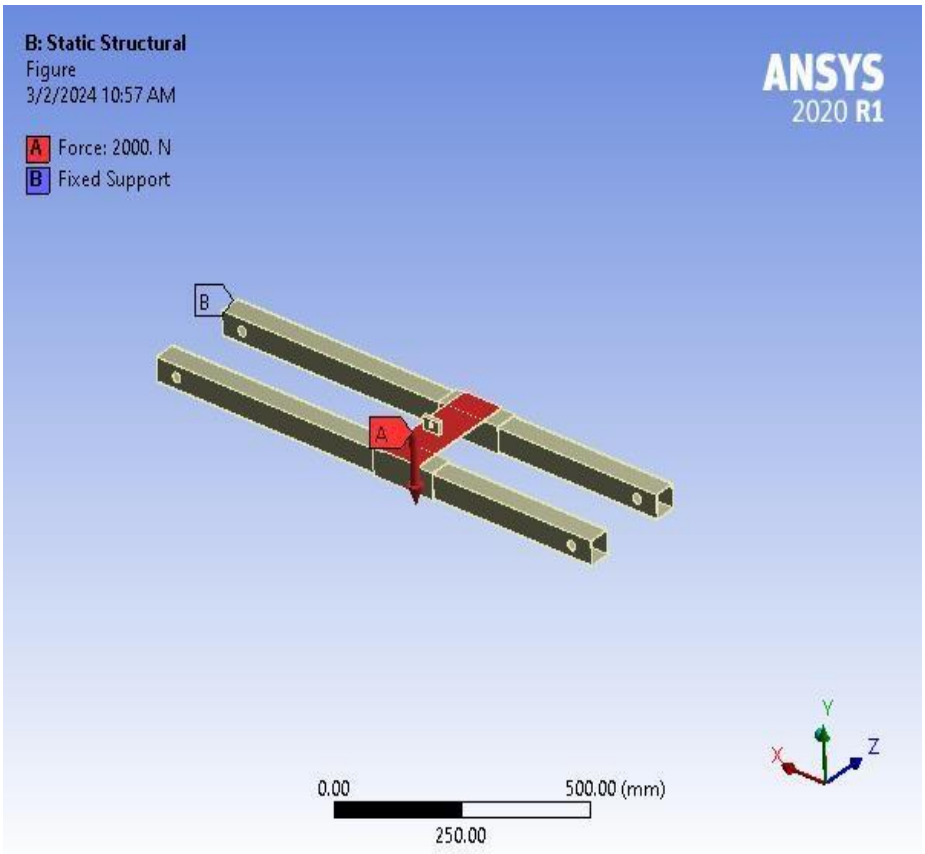


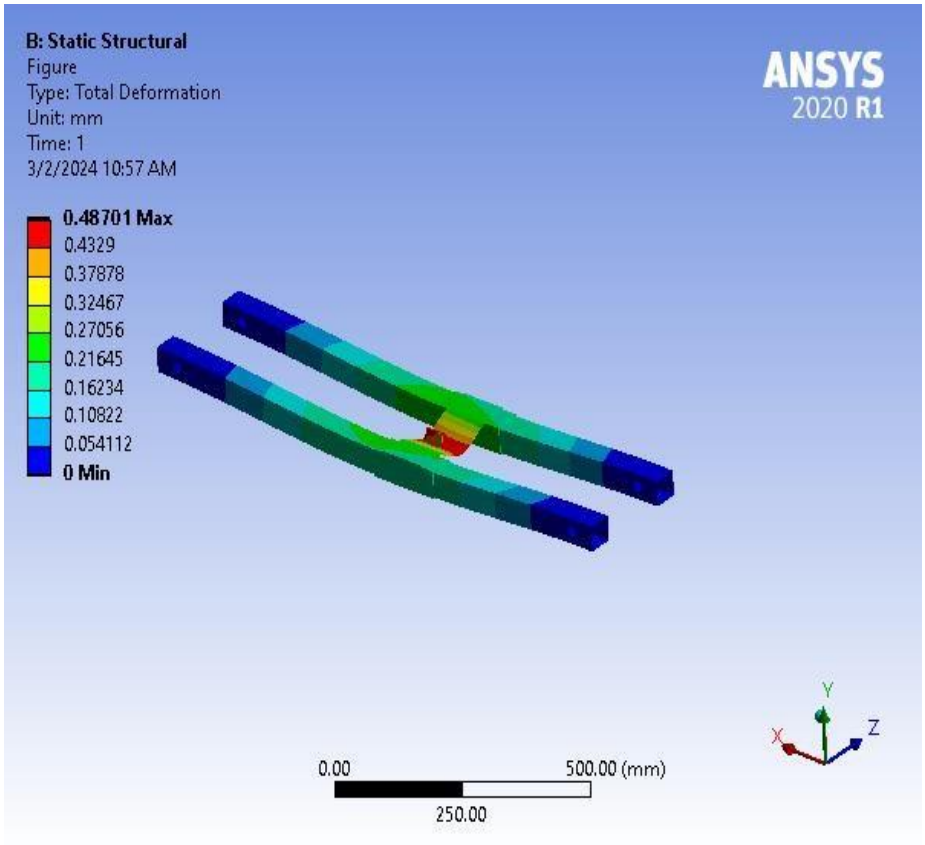
Figure 29 Lower Arm

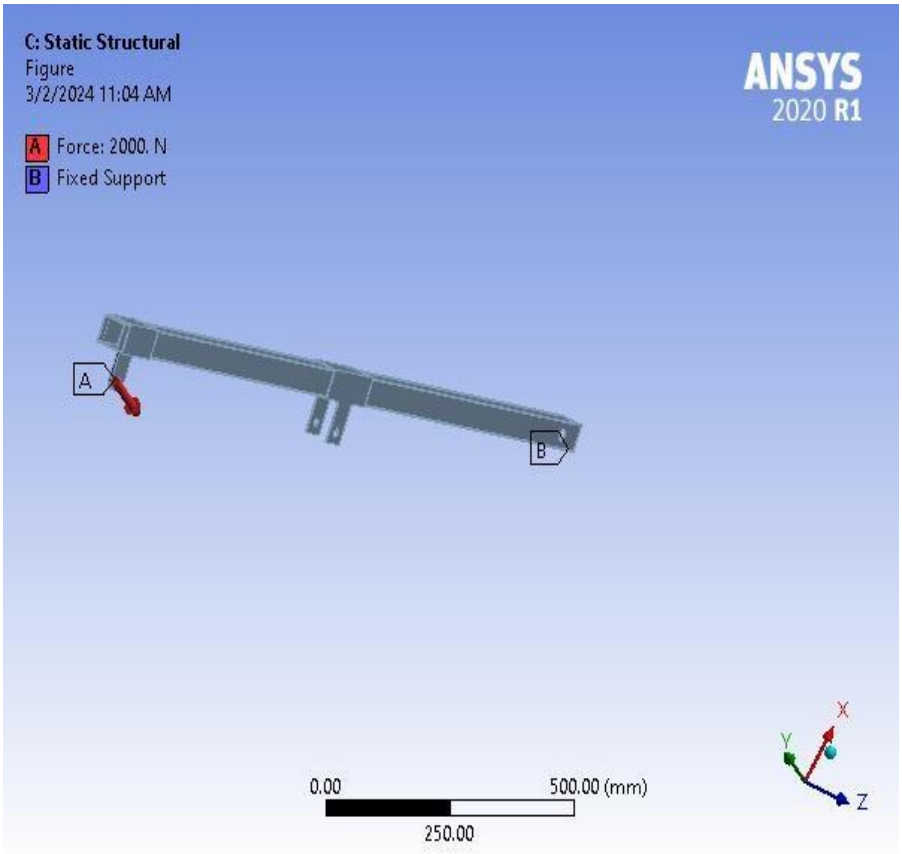
3.6 ANSYS Report






B: Static Structural
Figure
3/2/2024 10:57 AM
A Force: 2000. N
B Fixed Support
ANSYS
2020 R1
B
A
Y
X
Z
0.00
500.00 (mm)
250.00


B: Static Structural
Figure
Type: Total Deformation
Unit: mm
Time: 1
3/2/2024 10:57 AM
0.48701 Max
0.4329
0.37878
0.32467
0.27056
0.21645
0.16234
0.10822
0.054112
0 Min
ANSYS
2020 R1
Y
X
Z
0.00
500.00 (mm)
250.00


C: Static Structural
Figure
3/2/2024 11:04 AM
A Force: 2000. N
B Fixed Support
ANSYS
2020 R1
A
B
0.00
500.00 (mm)
250.00
X
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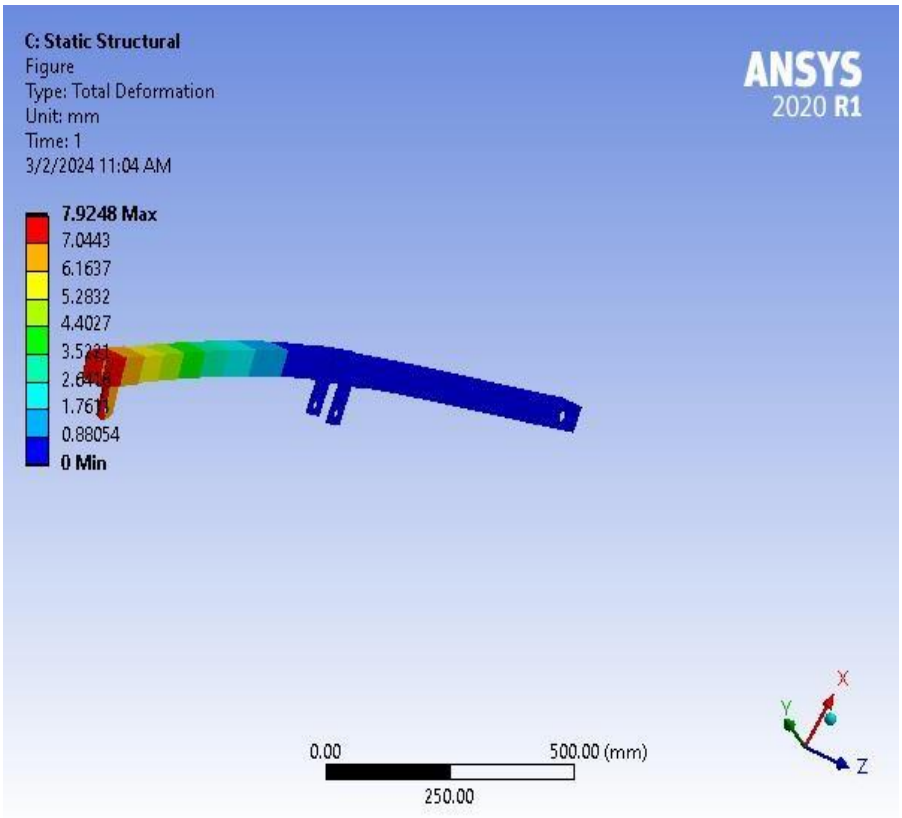
Z


C: Static Structural
Figure
Type: Total Deformation
Unit: mm
Time: 1
3/2/2024 11:04 AM
7.9248 Max
7.0443
6.1637
5.2832
4.4027
3.5221
2.6416
1.761
0.88054
0 Min
ANSYS
2020 R1
0.00
500.00 (mm)
250.00
X
Y
Z

3.7 Calculations

EN 10083 C45 steel carbon steel

C45 steel sheet Physio-chemical testing items for products of the plant include tensile test ,hardness test ,impact test ,flattening test ,and chemical composition analysis, etc .C20,C45 steel pipes are manufactured by cold drawn process.

C45 is a medium carbon steel is used when greater strength and hardness is desired than in the "as rolled" condition. Extreme size accuracy, straightness and concentricity combine to minimize wear in high speed applications. Turned, ground and polished.

Soft Annealing

Heat to 680-710oC, cool slowly in furnace. This will produce a maximum Brinell hardness of 207.

Normalizing
Normalizing temperature: 840-880oC/air.

Hardening
Harden from a temperature of 820-860oC followed by water or oil quenching.

Tempering
Tempering temperature: 550-660oC/air.

C45 steel plate, EN 10083 C45 steel plate, under EN 10083 standard, we can regard C45 steel plate as high carbon steel.

C45 steel plate is one mainly of high carbon steel, EN 10083 C45 steel plate is for quenching and tempering. Technical delivery conditions for non-alloy steels, these steels are for general engineering purposes

	Comparison of steel grades

C45 EN 10083-2 Number:1.0503	JIS G 4051	S 45 C
	DIN 17200	C 45
	NFA 33-101	AF65-C 45
	UNI 7846	C 45
	BS 970	070 M 46
	UNE 36011	C 45 k
	SAE J 403-AISI	1042/1045

Table 2 steel grades

Chemical Composition of EN C45 steel

Grade	C(%)min-max	Si(%)min-max	Mn(%)min-max	P(%)max	S(%)max	Cr(%)min-max
C45	0.42-0.50	0.15-0.35	0.50-0.80	0.025	0.025	0.20-0.40

Table 3 Chemical Composition

Mechanical Properties of EN C45 steel

Grade	Condition	Yield Strength R°(Mpa)	Tensile Strength Rm (Mpa)	Elongation A5(%)	Hardness HRC	Quenching Temperature (°C)	Bendability	Nominal Thickness,t 1.95mm≤t≤10.0mm	
								Rolled	Annealed
C45	Rolled Annealed Water-quenched Oil quenched	460 330	750 540 2270 1980	18 30	58 55	820 860	Min.recommended Bending radius (≤90°)	2.0×t	1.0×t

Table 4 Mechanical Properties of EN C45 steel

Properties of steel C45 (1.0503) Properties of steel C45 (1.0503)

Weld ability: Due to the medium-high carbon content it can be welded with some precautions.

Hardenability: It has a low hardenability in water or oil; fit for surface hardening that gives this steel grade a high hardness of the hardened shell.

Product Information

ITEMS INFO

SPECIFICATION FOR OPTION:

Round bar	Diameter: 4mm~800mm or as required
Steel plate	Thick:8mm~300mm, Width:100mm~2300mm
Angle bar	Size:3mm*20mm*20mm~12mm*800mm*800mm
Square bar	Size: 4mm*4mm~100mm*100mm
	Width:10mm~2000mm
Hexagonal	Size: 4mm~800mm
Length: 2m,4m,5.8m,6m,11.8m,12m or as required	

MECHANICAL PROPERTY:

Annealing	Forging	Tempering and Hardening	Normalization
Subcritical annealing:	1100~850	Tempering: 550~660	840~880
650~700		Hardening : 820~860 water	
Isothermal annealing:			
820~860			

CHEMICAL COMPOSITION:

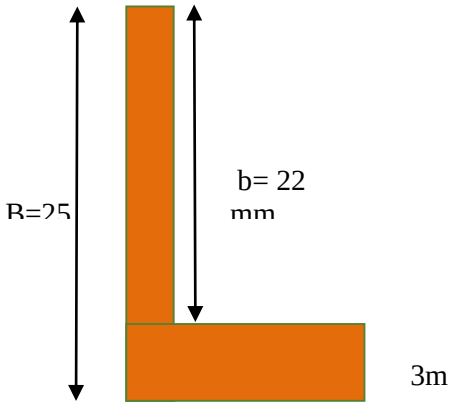
NO.	C	Mn	Si	Cr	Cu	Ni	P	S
Aisi 1045	0.43~0.50	0.6~0.9	0.10~0.60				≤0.040	≤ 0.050
DIN1.1191	0.42~0.48	0.6~0.9	0.15~0.35	≤0.15	≤0.3	≤0.2		
JIS S45C	0.42~0.50	0.5~0.8	≤0.40	≤0.40		≤ 0.4		
C45	0.42-0.50	0.5~0.8	0.4~0.8				≤0.035	≤0.035
GB45	0.42~0.50	0.5~0.8	0.17~0.37	≤0.25	≤0.25	≤0.3	≤0.035	≤0.035
EN8	0.42~0.48	0.6~0.9	0.15~0.35	≤0.20	≤0.30	≤0.20	≤0.030	≤0.030

CCSI CCS INDUSTRIAL CORP. CE SGS

Figure 30 Properties of steel C45

Why Mild Steel C-45 is selected in our project.

1. Easily available in all sections.
2. Welding ability
3. Machinability
4. Cuttingability
5. Cheapest in all other metals.



Material = C 45 (mild steel)

Take fos 2

25

$\sigma_t = \sigma_b = 540/fos = 270\ N/mm^2$

$\sigma_s = 0.5\ \sigma_t$

$= 0.5 \times 270$

$= 135\ N/mm^2$

Let the total weight (P) of our machine be 40 kg, now this 40 kg weight is kept on four angles, so it may fail under bending.

P = 40 kg.

P = 40 x 9.8 = 392 N.

L = 610 mm.

M = WL/4 = 392 × 610/4

= 59780 N-mm

$Z= B^3/6 – b^4/(6 \times B)$

$Z= 25^3/6-22^4/(6\times25)$

$Z= 1042\ mm^3$

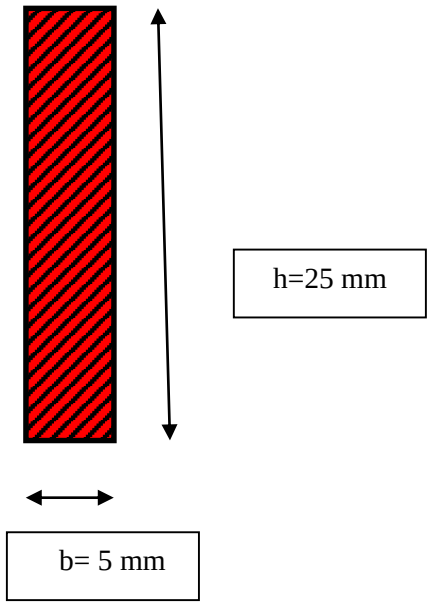
$= M/Z = 59780/1042 = 57.37\ N/mm^2$

As induced bending stress is less than allowable bending stress design is safe.

Design of transverse fillet welded joint.

Figure wielding

Hence, selecting weld rod size = 3.2mm



Area of Weld = 0.707 x Weld Size x L

= 0.707 x 3.2 x 25

= 56.56 mm^2

Force exerted = ---N

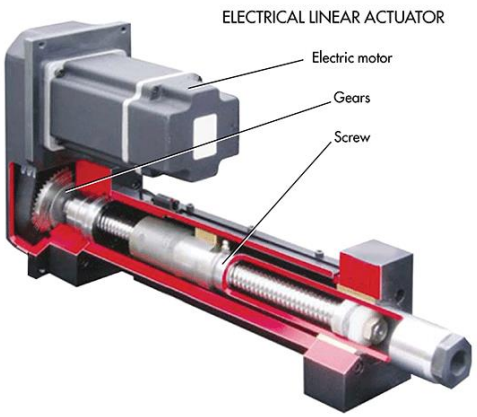
Stress induced = Force Exerted / Area of Weld

21 = F / 56.56

F= 1187.76 N = 121.07 kg

Maximum Allowable Stress for Welded Joints = 21 N/mm^2

Electric Actuator Motor:



This simple electrical actuator system will ensure consistent operation in both directions. It will also give you added features such as end of stroke limit switches, mid stroke

protection and manual override operation in case of power failure. Optional features such as analog or digital position feedback and adjustable end of stroke limit switches are also available. Another advantage is that a system like this is easy to integrate with other control systems normally found in industrial systems or forklifts such as PLC's, micro-controllers, computers or simple relay-based systems.

The linear actuator we will purchase will be of 150 lbs = 68 kg

Square pipe of 50x50 section is used as a column, we will check for its bending load.

Let the maximum load applied by linear actuator be 68 kg
So, load on column is = 68 kg = 680 N

W = 680 N

M = W L / 4 = 680 X 1400/ 4 =238000 N-mm

$Z = B^3 – b^3 / 6 = 50^3 - 46^3 / 6 = 4610.6\ mm^3$

$\sigma_b = M / Z$

$\sigma_b = 238000 / 4610.6 = 51.62\ N/mm^2$

$\sigma_{b\ INDUCED} < \sigma_{b\ ALLOWED}$

$36.14\ N/mm^2 < 270\ N/mm^2$
Hence our design is safe.

Design of bolt: - shearing

Bolt is to be fastened tightly also it may fail under shearing load when we rotate the arm. Std nominal diameter of bolt is 5.8 mm. From table in design data book, diameter corresponding to M 6 bolt is 5.2 mm
Let us check the strength: -

$\sigma_s = 90\ N/mm^2$

Also,

$P = \Pi /4\ dc^2 x\ \sigma\ shear$

$$90 = \frac{P}{3.14/4 \times (5.2)^2}$$

$P = 90 \times 21.23 = 1911.3\ N = 198\ kg$

The single M6 bolt can sustain 198 kg load under shearing and which is far more than 68 kg, so nut is safe.

Working

The project is made by using the raw material mentioned above, the main raw material of project is mild steel linear actuator battery shaft will and hook project work when the manual operator switch on the linear actuator as soon as the linear actuator motor switch on it rotates the gear inside it and forces the lead screw to push the linear actuator the linear actuator which is the upper arm of the Forklift the upper arm of Forklift is connected to Chain and hook the operator operating the linear actuator holds the shaft on his hand in the middle one and of linear actuator is connected to hook other and is to lower body where the total weight of a machine is gone to the floor it is operated on 24 volt lead acid dry battery the electrical energy of battery is converted into mechanical energy by using linear actuator the linear actuator which is the upper arm and weight is lifted the capacity of whole machine is around 50 kg.

3.8 Cost estimation

Cost estimation may be defined as the process of forecasting the expenses that must be incurred to manufacture a product. These expenses take into a consideration all expenditure involved in a design and manufacturing with all related services facilities such as pattern making, tool, making as well as a portion of the general administrative and selling costs.

PURPOSE OF COST ESTIMATING:

1. To determine the selling price of a product for a quotation or contract so as to ensure a reasonable profit to the company.
2. Check the quotation supplied by vendors.
3. Determine the most economical process or material to manufacture the product.
4. To determine standards of production performance that may be used to control the cost.

BASICALLY, THE BUDGET ESTIMATION IS OF TWO TYRES:

1. material cost
2. Machining cost

MATERIAL COST ESTIMATION:

Material cost estimation gives the total amount required to collect the raw material which has to be processed or fabricated to desired size and functioning of the components.

These materials are divided into two categories.

1. Material for fabrication:

In this the material in obtained in raw condition and is manufactured or processed to finished size for proper functioning of the component.

1. Standard purchased parts:

This includes the parts which was readily available in the market like Allen screws etc. A list is forecast by the estimation stating the quality, size and standard parts, the weight of raw material and cost per kg. For the fabricated parts.

RAW MATERIAL & STANDARD MATERIAL

Table 5 Raw Material Cost

SR NO	PART NAME	MAT	QTY	COST
1	SQUARE PIPE	MS	20 KG	1200
2	LINEAR ACTUATOR	STD	1 NOS	6000
3	SHAFT DIA 20 MM	MS	10 KG	700
4	CHAIN	SS	1 SET	900
5	BATTERY	STD	4 NOS	1600
6	SHEET METAL	MS	1 SQM	100
7	WHEEL	STD	2 NOS	300
8	NUT BOLT WASHER M 10	MS	20 NOS	275
9	HOOK	CI	1 NOS	600
10	MISCELLINOUS	-	-	1000
			TOTAL	12675

3.9 Plan of execution:

Table 6 Plan of Work/Timeline

Months/ Activity	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
A											
B											
C											
D											
E											
F											
G											
H											
I											
J											

Activities

- A= Topic finalization
- B= Literature Review
- C= Formulation of Problem
- D= Parametric analysis
- E=Development of CAD models of system
- F= Purchasing of components
- G= Manufacturing
- H= Assembly and Testing
- I= Results and Conclusion
- J= Report Writing

3.10 Project and flow chart:

From the flow chart, this project started with the objective of the project. The objective of the project must follow the title. The objective must fulfill the title Then follow up with design review about folding table and then study a lot of investigation about folding table. This is including study about several of stage, type of stage, types of material which suitable to make a stage. These tasks have been done through study on internet, books and others resources. After all information had been collected and gathered, the project continued with the design process. All the knowledge and lessons had been applied to make a suitable design for the project. After several design sketched, design consideration has been made and one of the designs have been chosen by using Pugh's concept selection. The solid modeling and engineering drawing by using solid works software the fabrication process progress use drawing as a reference. The process consist fabrication to all parts that have been designed by the dimension using various type of manufacturing process. The manufacturing process includes welding, drilling, bending, cutting and etc. During the fabrication process, if there have error occur, such as fabrication error, so the process needs to modification the process needs to go back to the previous step and the process flow again, until no error occur the process can have been continued smoothly until the final product finished. Then, the draft report needs to be submitted to the supervisor for double checking if there had an error.

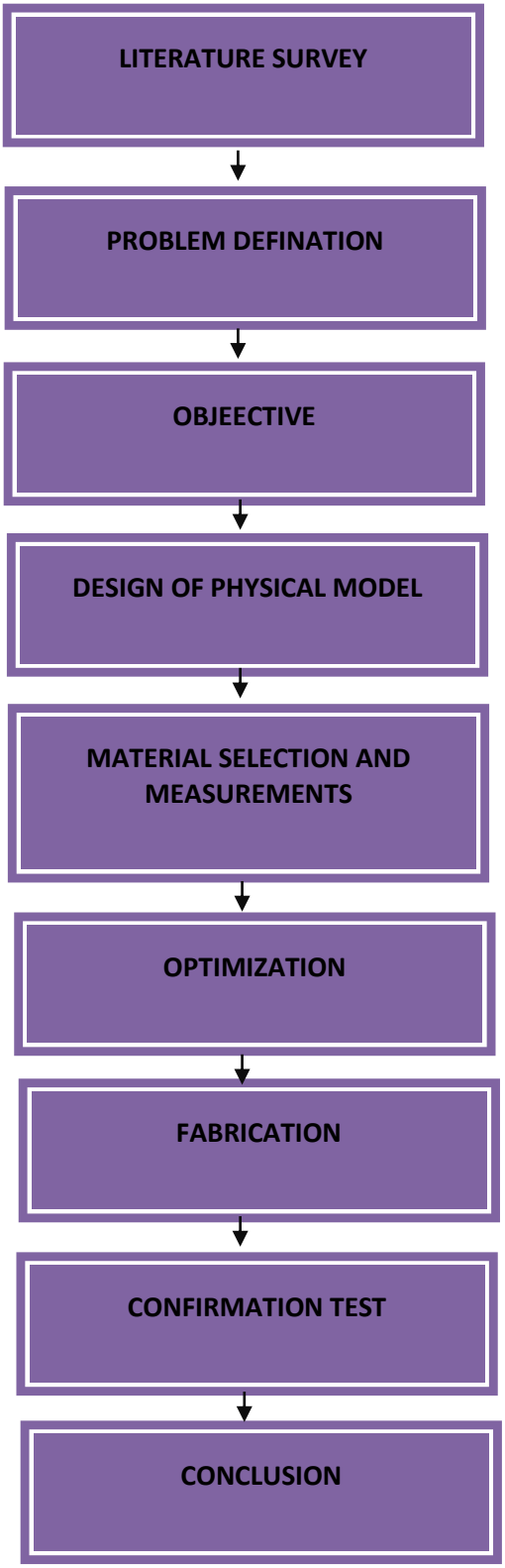


Figure 31 flow chart

4. RESULTS AND DISCUSSION

The overall system was evaluated by performing an end-to-end pick and place task. The objectives of the test are to verify performance and reliability of the Portable forklift systems, and demonstrate the implementation. The forklift was tasked with navigating to a bay containing a load, picking it up, then placing it in another bay. The test was conducted in an loading dock. The test was conducted as follows:

1. The forklift begins at one end of the loading dock, with a view of at least one localizing tag so the forklift is able to obtain a position.
2. Upon pressing switch, the forklift begins moving hook in upward direction.
3. After lifting load, we moved the forklift to the drop-off area and successfully unloaded the load.

In initial tests, the forklift was able to reliably operate under control using manual command. In current form, the forklift successfully delivers reliable, functional autonomous hardware and a fully functional stack to enable further research in specific areas of autonomy.

CONCLUSION

This project will helpful for small scale industrialists as it is easy to operate with less cost and indirectly it will save the labor cost. Savings resulting from the use of this machine will make it pay for itself with in short period of time& it can be a great companion in any field dealing with rusted and unused metals. Researchers have done tremendous work in the area of trolley design with greater reliability, protection and robust design also design was adequate and costs reduced. Trolleys used in many areas like in hot rolled product handling, grain feeding trolley, in casting industries, shopping malls etc., much more work is still needed to make use of trolleys in different areas.

Future Research includes research on forklift's weight change and stability during the turning and speeding up process, and developing a shifting counterweight automatically adjust the balance of the forklift.

5. REFERANCES

1. Mr. V.B.Bhandari, "Design of machine element", Tata Mc- Graw Hill Publication, 3rd Edition 2010.
2. Mr. P.S.Gill, "Design Data Book", 3rd Edition.P. S. Thakare, P. G. Mehar, Dr. A. V. Vanalkarand Dr. C. C. Handa, "Productivity Analysis of Manually Operated and Power Operated Sheet Bending Machine: A Comparative Study",International Journal of Engineering Research and Applications (IJERA), ISSN: 2248-9622, Vol. 2,Issue 2, Mar-Apr 2012, PP.111-114.
3. Failure of Forklift Forks, Juan M. Massone and Roberto E. Boeri, Engineering Failure Analysis 17 (2010) 1062–1068.
4. Michael G. Kay, Material Handling Equipment (McGraw-Hill, 2nd Edition, 2012).
5. P. Jey Praveen Raj, P. M. Mohamed Fuge, R. Paul Caleb, G. Natarajan**,** Design and Fabrication of Stair Climbing Trolley, International Journal for Scientific Research and Development,*6(2)*, 2016, 50 - 53.
6. S. R. Kulkarni, T. S. Vandali, and S. A. Goudadi, Prototype of Collapsible Trolley, International Journal for Scientific Research and Development, 4(5), 2016, 18 - 25.

7. Chan F., 2002, Design of material handling equipment selection system: an integration of expert system with analytic hierarchy process approach. Integrated Manufacturing Systems, 13, 58-68.
8. Mulik Shriniwas, Salunkhe Rohit, Shaikh Shahrukh, Waghmode Dada, and Swipnil Gaikwad (2016), Advance material handling trolley using tri-wheel mechanism, International Journal of Recent Research in Civil and Mechanical Engineering, ISSN 2393-8471, Vol. 2, Issue 2, pp: (160-165).M. Young, The Technical Writer's Handbook. Mill Valley, CA: University Science, 1989.
9. Roshan Alaspure, Chaitali Barmase, Snehal Chambhare, Manish Mandhre, and Prof. Yogesh G. Joshi (2016), Fabrication of Stair Climbing Wheel Mechanism: Alternate for lifting goods, International Research Journal of Engineering and Technology, e-ISSN: 2395 -0056, Volume: 03 Issue: 05, pp: (553-555).
10. Hsueh-Er,C.,"Stair-climbingforklift,2008,"Patent No. US2008164665 (A1)", Jan 24.
11. Vegim Imeri, 2013, Studying dynamic effects on warehouse forklift during forward movement with full loading, 16th International Research / Expert Conference, TMT 2012.
12. Swagat Kelkar, 2015, Virtual Stability of Forklift Truck in CAD. International Journal of Research in Aeronautical and Mechanical Engineering. February 2015 Vol 3, Issue 2 ISSN 2321-3051.
13. Ben T Railsback, 2014, Stand-Up Forklift Egress Times as a Function of Operator Compartment Guarding. International Mechanical Engineering Congress and Exposition. November 2014. Vol 14, Issue 7.
14. Muthukumar K, Sankaranarayanasamy, and A.K. Ganguli. (2014). "Analysis of Frequency, Intensity, and Interference of Discomfort in Computerized Numeric Control Machine Operations," Human Factors and Ergonomics in Manufacturing & Service Industries, 24 (2), pp.131-138.
15. Swagat Kelkar, 2015, Virtual Stability of Forklift Truck in CAD. International Journal of Research in Aeronautical and Mechanical Engineering. February 2015 Vol 3, Issue 2 ISSN 2321-3051.