A Dissertation on

DESIGN AND FABRICATION OF HAND OPERATED FORKLIFT

Submitted By

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C E R T I F I C A T E

This is to certify that **Mr. Pranay Gangurde, Mr. Manik Sharma, Mr. Kishor Bhosale, Mr. Prajwal Charde,** have successfully completed project entitled **" Design and Fabrication of Hand Operated Forklift"** under my supervision, In the practical fullfillment of Bachelor of Engineering-Mechanical Engineering of University of Pune.

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We are feeling very humble in expressing my gratitude. It'll be unfair to bind the precious help and support which we got from many people in few words. But words are the sole media of expressing one's feelings and my feeling of gratitude is absolutely beyond thesewords. It might be my pride to take this opportunity to say the thanks. Firstly, we would thankour beloved guide **Dr. Sachin Jambhale**, for his valuable guidance, patience and support. He was always there to force us a touch forward to get the work done properly and on time. He has always given us freedom to try to do mini project work and the chance to work under his Supervision.

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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.

As it was intended, the in-plant products transporter system is user-friendly. The device finds greater use inthe industrial lines for transport of the machined jobs, carrying goods internally in thefabrication plant. An industrial power truck called a forklift is used to lift and move items. Lifting and transporting of the cargo have been completed using the steel fork underneath. At present,different kinds of forklift is available, according to the lifting weight of forklift is divided intosmall tonnage (0.5t) and (1t), middle tonnage (2t and 3t) and large tonnage (5t and above).

Chapter 1

Introduction

Now days thanks to heavy work load environment in the mechanical industry workers are been depressed for carrying a heavy load, where the workers are susceptible to unhealthy conditions. thanks to these factors some load carrying machines were developed in the recent past years. A powered industrial truck that is used to lift and transport things over short distances can be compared to a forklift. Forklifts are available at the market which needs more energy to operate, and cannot be used on the uneven surface.

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

The aim of this project is to modify the design of the forklift in terms of its functionality and taking human factors considerations. during this project we are designing forklift up to 50kg of lifting capacity. within the process of obtaining a suitable design, the customer needs are going to be translating to the engineering characteristic to obtain the concepts that need to be modified and fabricated. most of the people are familiar with the basic forklift (manually operated) that is still included as standard equipment with newest automated forklifts.

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

As it was intended, the in-plant products transporter system is user-friendly. The device finds greater use within the industrial lines for transport of the machined jobs, carrying goods internally within the fabrication plant. An industrial power truck called a forklift is used to lift and move items. Through the steel fork under the load, the lifting and transportation are done. at the present, different sorts of forklift is available, consistent with the lifting weight of forklift is divided into small tonnage (0.5t) and (1t), middle tonnage (2t and 3t) and enormous tonnage (5t and above).

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

1.1 Problem Definition:

Humans have always needed to lift things, but they haven't always had the skills to do it safely. 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. Hoistwere great for lifting but not for much for moving from one place to another in few places. Theplatforms could get under lifted goods and then moved with a handle for transportation of machines in few places was our idea to minimize the labor work. Forklift help moves stuff that humans could not 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 designof the forklift that is user friendly and easier to operate as do not required too much money to develop this product.

Scope and objective:

1.2 Scope

This project is about the designing and fabricating the forklift. the sort of forklift that we used in this project is linear actuator operated forklift as it is more reliable to operate. so asto develop new concept of the forklift design, we've done some survey by discussing with the forklift user. The scopes of project were on the designing 50kg maximum lifting capacity of forklift. to realize our new design goals, we'd like to do some work on the existing forklift design and what kind of product transportation is using. supported that work, we'd like to find what the shortcomings of existing designs are. The new design offers both new and improvisedfeatures, over what's currently available.

1.3 Objectives

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.

Following are the objectives: -

- To minimize the human effort.
- To make it compact in size as compared to the forklift that we used in the industries.
- To cut down the time and effort needed to lift, carry and transport.

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

Chapter 2

Literature Survey

Various Types of research studies by different authors are:

Aashish Kumar L Sharnangat et al. [1] demonstrated that robotic forklift intended to operate alongside mortal labor force, handling palletized accoutrements within being, busy, semi structured out-of-door storehouse installations. The robot operates in minimally- prepared, semi structured surroundings, in which the forklift handles variable palletized weight using only original seeing, and transports it while interacting with other moving forklifts.

LiaiPan et al. [2] explained that a sort of industrial handling forklifts, forklift plays an important role in people's life. Nowadays, so as to meet the needs of the people, the kinds of forklift are more and more. during this project, supported already the basic parameters of the push forward forklift tin the market, the working device of the forklift has been introduced.

Praveen raj et al. [3] demonstrated that, it can be said that engineering has undergone several advancements in the current world. Although the development of lifts made it easier to transport large objects upstairs, not all locations, such as schools and college construction zones, allow the use of lifts. This study intends to provide a system for simple transportation of big goods up and down staircases. Finding a practical and user-friendly way to carry various goods up and down stairs while requiring the user to exert the least amount of effort possible is the major goal. Tri lobed wheel frames are utilized in the construction of stair climbers on both sides of the climber, with three wheels on each side. That is the wheel assembly.

Mr. Ravi R. Mishra et al. [4] demonstrated within the first design, the installation transmission to the single- or double-wheel trolley is useless to climb the stairs due to height factor of stairs creates huge handicap on the way of forklift. Also, the planning of the straight wheel frame came more complicated and was demanded modified with its wind- globular shape to give proper drive, which produce further frictional force. For these reasons, three- wheel assail each side of forklift attached with frame was introduced to give smooth power transmission in order to climb stairs without obstacles. Frame arrangement is suitable to transmit exact haste rate also. It handed advanced effectiveness and compact layout with dependable service.

Kulkarni et al. [5] studied that, as per the check more number of accidents be due to further number of trolleys connected to a single tractor along with further cargo and it becomes delicate for the motorist to control the tractor and its attachment trolleys. In this paper, they've designed a collapsible trolley that can be acclimated in size. So, to exclude all the trolley related problems and reduce the cost, they've 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 motorists to drive the tractor and the trolley to the long distance safely.

Md. A. Hossain. Nafis et al. [6] explained for the purpose of moving the loads over the stair, it was decided on a replacement horizon. Most of the buildings of the country are structurally congested and unavailing of elevator facility so it's difficult and laborious to lift up heavy loads. The stair climbing Trolley can play a crucial role in those areas to lift loads over a short height, like libraries, hospital, and in construction area. The Trolley, which may move upper level through strain, or run in very rough and rocky surfaces, is named stair climbing Trolley.

VegimImeri et al. [7] demonstrated the dynamic circumstances on forklift during lifting of loads proves to be delicate using physical trial and current dimension bias. Creating the forklift's multibody model and applying computer simulations is extremely use full system to study these circumstances, which helps to interpret the reasons of heavy oscillations, failures and accidents of forklifts, and provides conclusions that can be useful for design considerations and safety. The end is to work out how dynamic forces, moments, speed and oscillations prompt the forklift's construction and its stability during cargo lifting. to try to to this work, we designed entire "virtual forklift" using model design and simulation operation and performed simulations in order to gain results. Main parameters that are influential on the dynamic gesture of forklift are going to be anatomized and will be searched for conclusions that can be useful for better understanding dynamics of forklift. This paper identifies a group of parameters that have influence in main forklift corridor, and provides results with graphs and tables with values that are dynamic in nature, with high confines and frequentness that goods directly in causes of fabric fatigue or failure.

Muthukumar K et al. [8] explained that, forklifts offer many benefits like reducing manual material handling and enhancing productivity, there are factors that cause Musculoskeletal disorders (MSDs) to the forklift operators, like severely twisted postures, prolonged sitting and exposure to vibration etc., ultimately resulting in low productivity. the most 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 MacNeil-electrical) and forklifts with differing types of engines (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). Forty four operators aged between 20-58 years driving five different make forklifts were the themes. Operators performing on Godrej diesel reported more discomfort while operators working on Voltas- electrical reported less discomfort. Operators performing on diesel operated forklifts reported higher discomfort compared to electrically operated forklifts but the difference is small. 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 et al. [9] demonstrated significant hazard related to the use of stage- up lift exchanges, or stand- up forklifts, is the hazard of a lower branch crush injury or bottom crush due to the opening across the reverse of the driver cube. According to one lift truck manufacturer's statistics, there have been over 500 accidents that redounded in an injury to the lower branch of the driver in the last 30 times that involved their stage- up lift exchanges. Other manufacturers have had analogous accidents. The injuries have passed to the lower branch of the driver due to the close propinquity of the driver's lower branches to the surface of the lift truck, and the confined areas that stand- up lift exchanges operate in. The driver's lower branch can come projected and crushed between the moving lift and another fixed object similar as a rack system, a column or another lift truck. Objects, similar as a chopstick apex, can also intrude into the driver cube, injuring the driver's lower extremities.

Swagat Kelkar et al. [10] demonstrated that forklifts are used for material movement from one place to a different. the end of the study was to find out the effective system for stability testing of the artificial forklift truck with the help of CAD model of the forklift. The forklift should be stable alongside and longitudinal axis while moving with and without cargo on plain ground also as on pitches specified. These styles of stability testing and their values in several conditions are specified in IS4357. This paper focuses on procedure for stability testing of forklift in CAD before factual manufacturing of the truck.

Chapter 3

Methodology

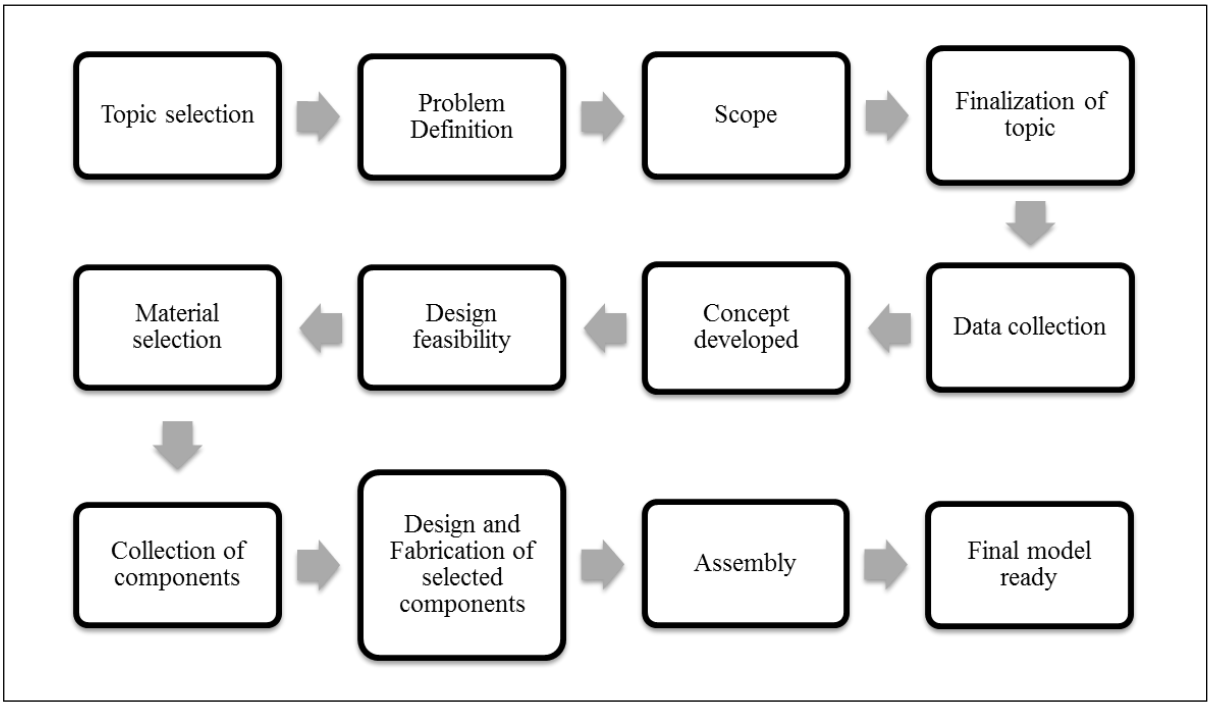


Figure 1 Flowchart of Work

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 & Analyzed using Analysis software for validation.

The above said work is planned in following phases.

Data Collection:

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

Material Selection:

- ➢ Design of each component as per requirement.
- ➢ Selection of Steel Material and justification. Section selection, deciding modelling strategy, property definition.

Assembly of model in SOLIDWORKS:

- ➢ Import each frame and pulley model in Software.
- ➢ Meshing analysis in SOLIDWORKS.
- ➢ Finding Stress, Strain analysis with our calculation.
- ➢ Identifying critical sections.

Testing:

- ➢ Theoretical analysis of forks & comparison.
- ➢ Load testing.
- ➢ Von-Mises Stress, Strain evaluation and calculations based upon testing calculation.
- ➢ As per experimental calculation, plotting graphs (Load vs. Stress, Stress vs.).

3.1 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.

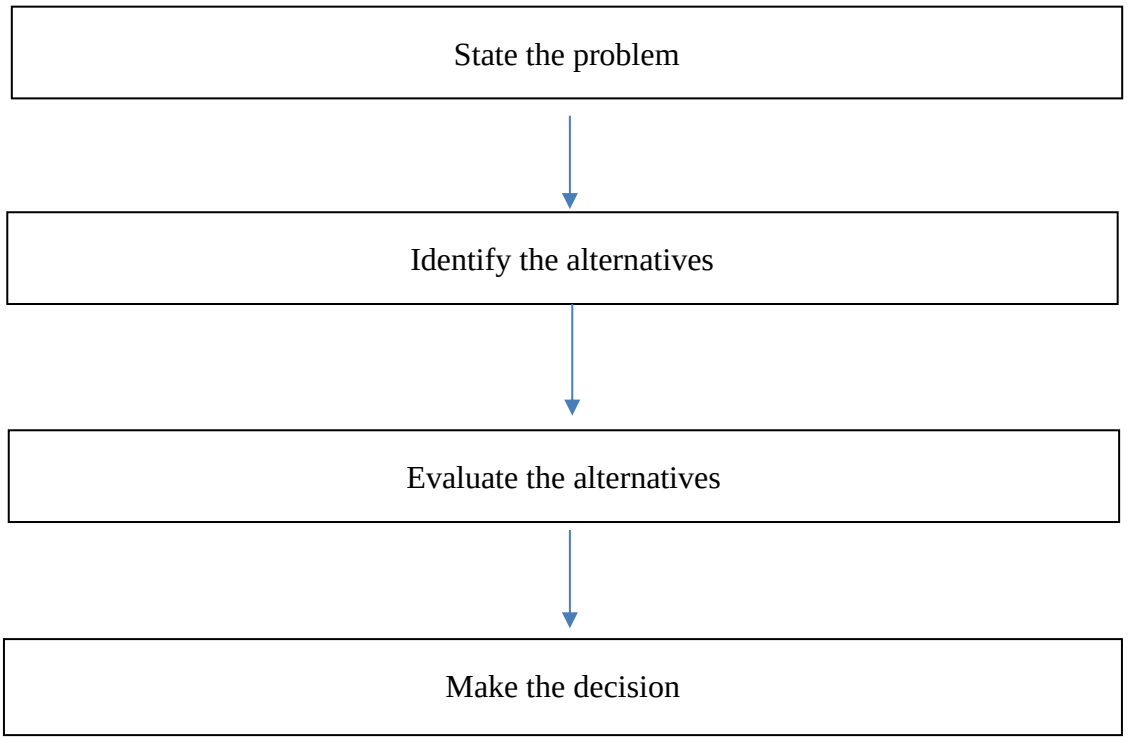


Figure 2 Decision making process

3.2 Project Plan

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

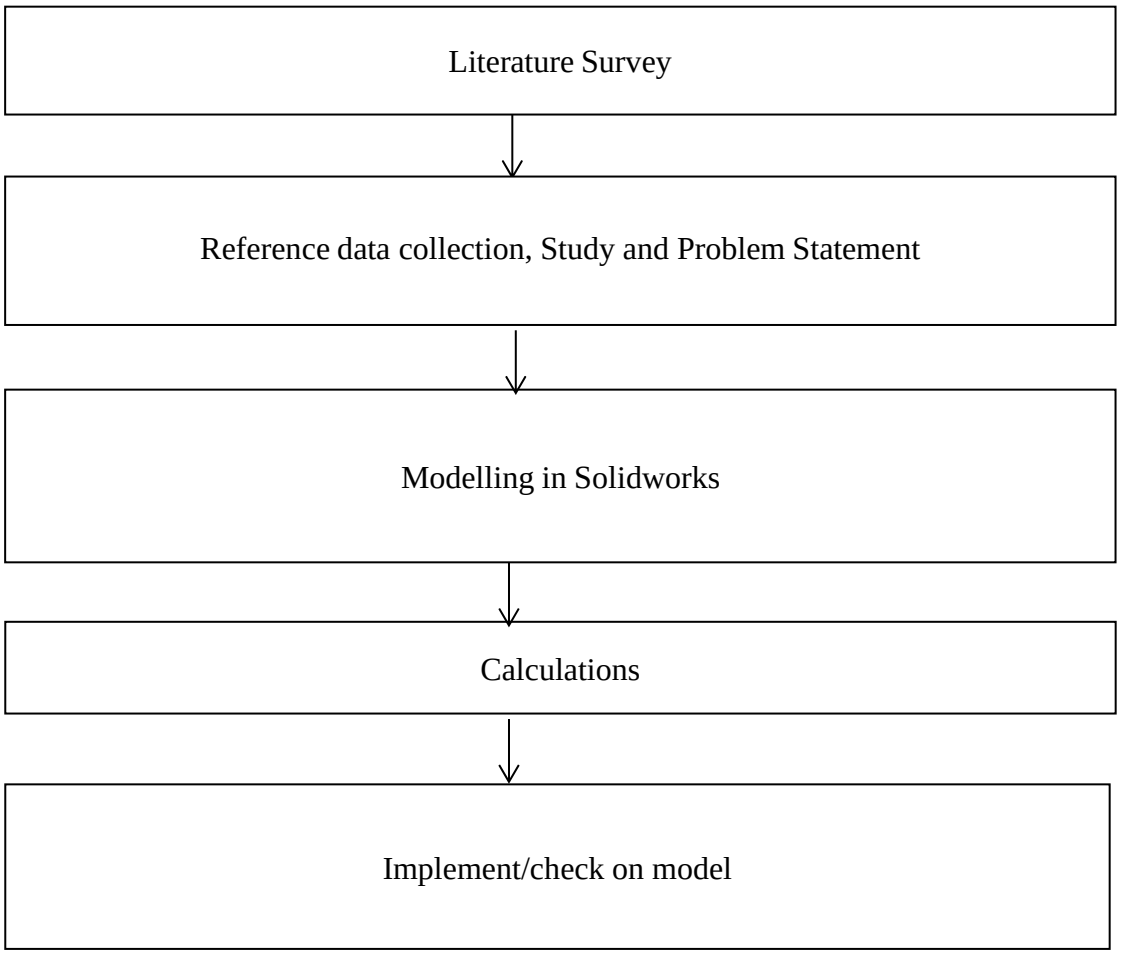


Figure 3 Steps of Execution

3.3 WORKING

The project that we are planning to build will made by using the raw material mentioned above,the main raw material of project is mild steel, linear actuator, battery, shaft, wheel and hook. The project works, when the manual operator switches on the linear actuator as soon as the linear actuator motor switch is on it rotates the gear inside it and forces the lead screw to push the linear actuator, the linear actuator pushes 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. One end of linear actuator is connected to hook another end is to lower body, where the total weight of a machine is transmitted 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 gives power to the upper arm and weight lifting capacity of the machine is around 50 kg.

3.4 Plan of execution:

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

Figure 4 Plan of execution

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

Chapter 4

CAD design and Calculations

4.1 Procedure

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

In This Figure- CAD model of the assembled project is designed on Solidworks software

SOLID MODELING

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

Figure 5 Isometric front view

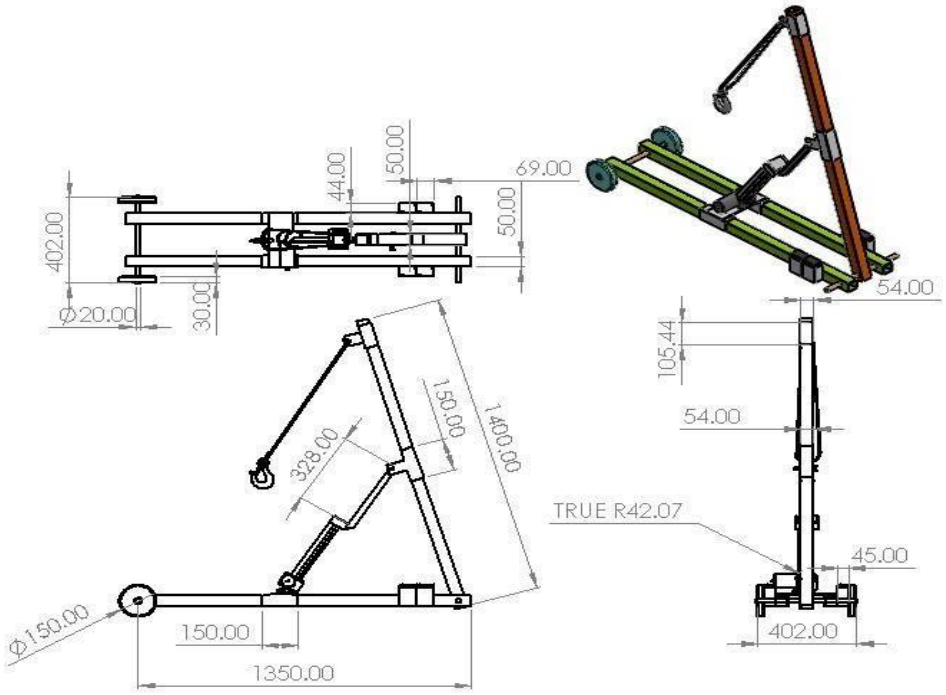


Figure 6 Drafting

Fig.7.a(Top view)

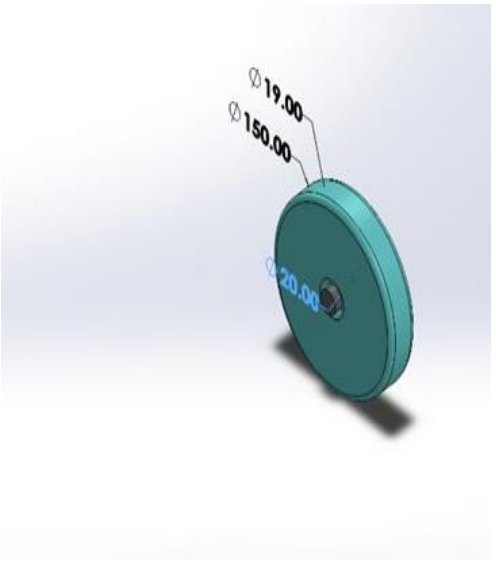


Fig.7.b(Drafting)

Figure 7 Wheel

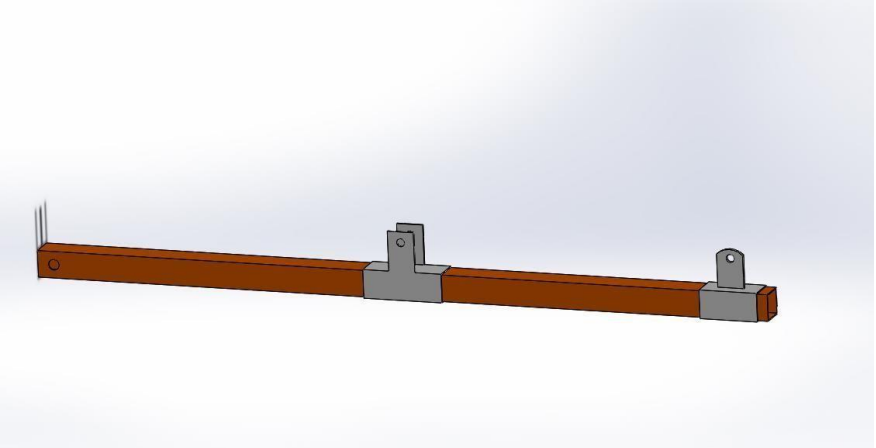


Fig.8.a(Side View)

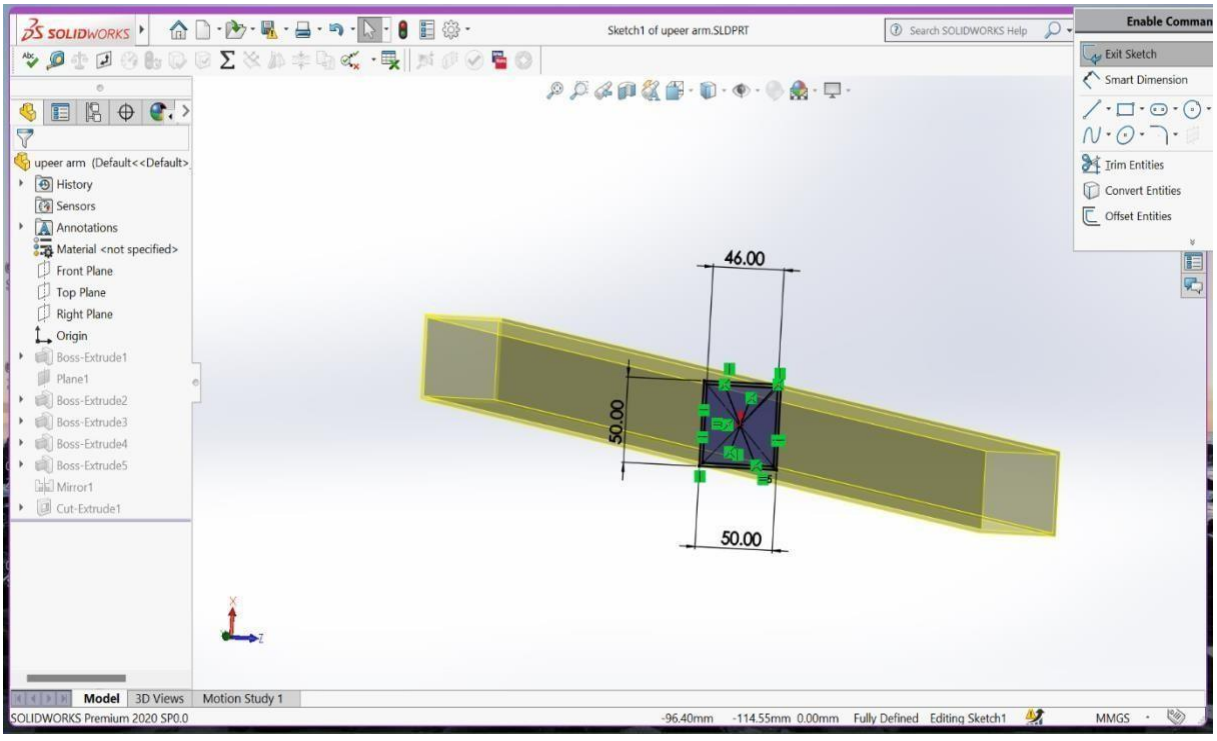


Fig.8.b(Drafting)

Figure 8 Upper Arm

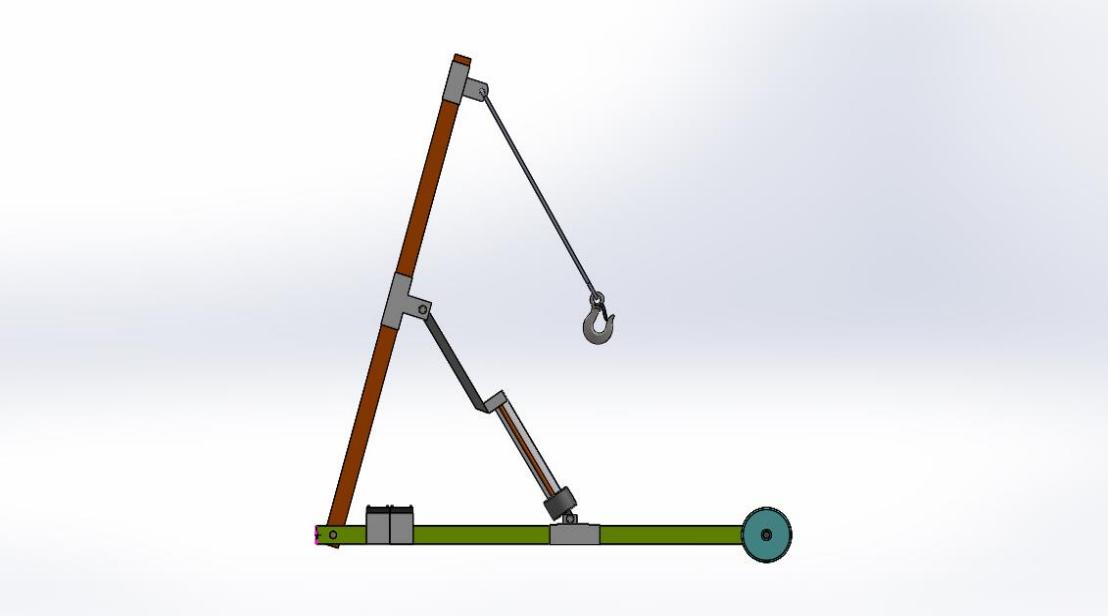


Figure 9 Side View

Fig.10.a(Front view)

Fig.10.b(Top view)

Figure 10 Linear Actuator

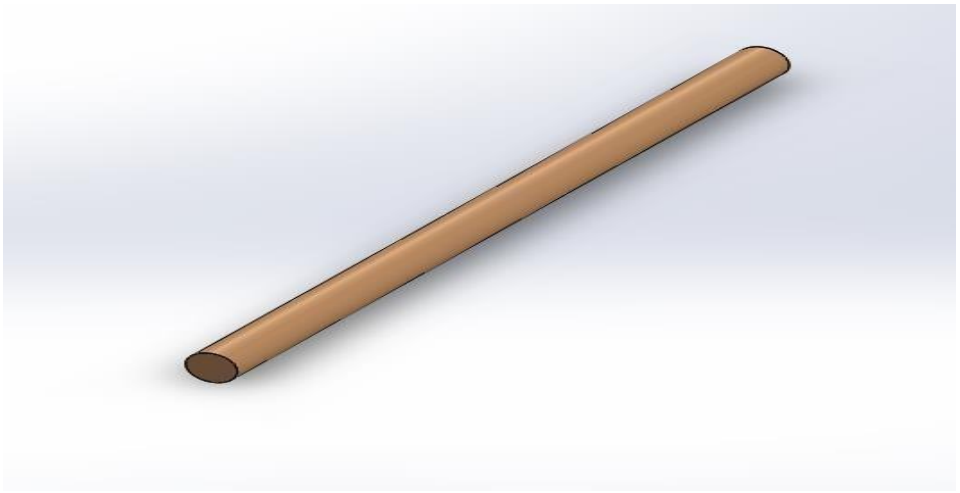


Figure 11 Shaft 20mm

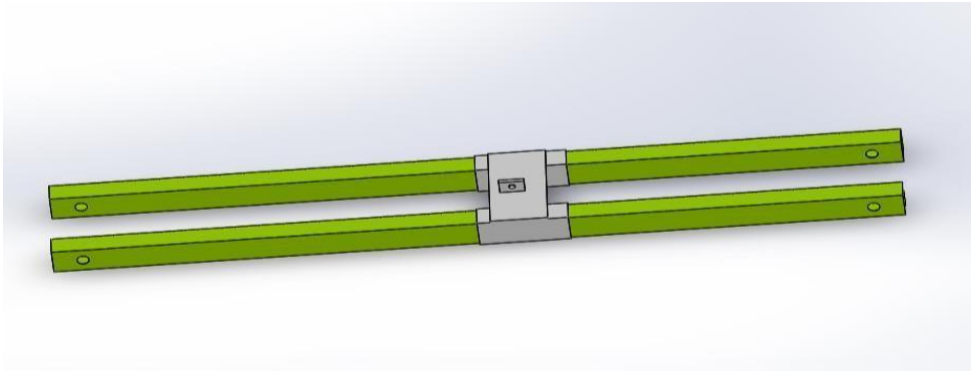


Fig.12.a(Top view)

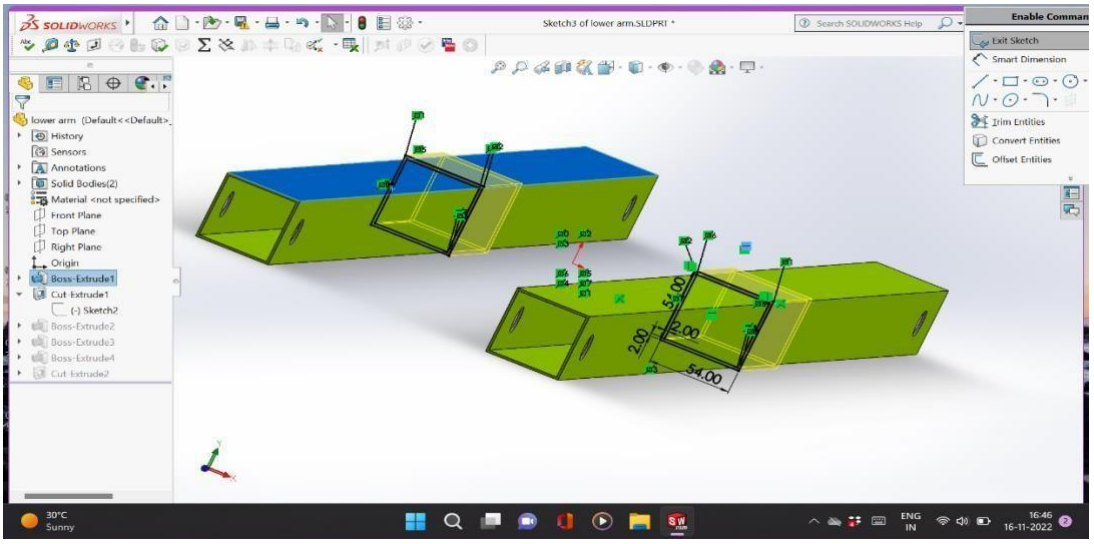


Fig.12.b(Drafting)

Figure 12 Lower Arm

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 sword is used when lesser strength and hardness is asked than in the as rolled condition. Extreme size delicacy, straightness and concentricity combine to minimize wear and tear in highspeed operations. Turned, ground and polished.

Soft Annealing

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

Normalizing

Normalizing temperature: 840-880°C/air.

Hardening

Harden from a temperature of 820-860°C followed by water or oil quenching.

Tempering

Tempering temperature: 550-660°C /air.

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

C45 sword plate is one substantially of high carbon sword, EN 10083 C45 sword plate is for quenching and tempering. Specialized delivery conditions for non-amalgamated non amalgamated brands, these brands are for general engineering purposes.

Table 1 Comparison of steel

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

4.3.1Chemical Composition of EN C45 steel [11]

Table 2 Chemical Composition

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

4.3.2 Mechanical Properties of EN C45 steel [11]

Table 3 Mechanical Properties

Grade	Condition	Yield Strength R°(Mpa)	Tensile Strength Rm (Mpa)	Elon-gation A5(%)	Hardness HRC	Quenching Temperature (℃)	Benda-bility	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.re co-mmended Bending radius (≤90°)	2.0*t	1.00*t

Properties of steel C45

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

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

Quenching: Rapid cooling, as by immersion in oil or water, of a metal object from the high temperature at which it has been shaped.

4.2 Calculations

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

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

Material = C 45 (mild steel)

Take fos 2

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

$\sigma_s = 0.5\ \sigma_t$

$= 0.5 \times 270$

$= 135\ N/mm^2$

Force Analysis:

Reaction force at pt. C

$R_C = W + W_{hook}$

$= 50 + 1$

$= 51kg$

$= 51 \times 9.81 \sim 510\ N$

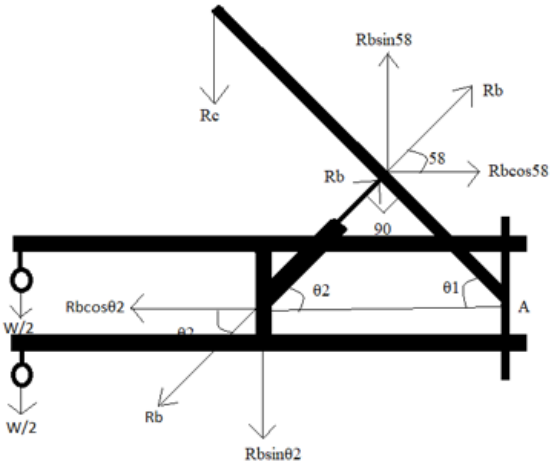
Reaction at pt. D,

$\theta_2 = 58^\circ$

By resolving forces,

$W = R_B \sin\theta_2 = 680 \times \sin(58^\circ)$

$W = 576.67$



Free Body Diagram

Figure 13

Reaction on each wheel,

$= W/2 = 576.67/2$

$= 288.33$

In triangle ADB,

$\theta_B = 90^\circ$

$\theta_D = 58^\circ$

therefore, $\theta_A = 32^\circ$

Reaction force at point B,

By resolving in y-direction,

$R_B \sin\theta = 680 \sin(58^\circ)$

$= 576.67$

Bending stress: It is the normal stress that an object encounters when it is subjected to a large load at a particular pt. that causes the object to bend and become fatigued.

$\sigma = MY/I$

as we know that,

$M = WL/4$

and

$Y = h/2$

$I = bh^3/12$

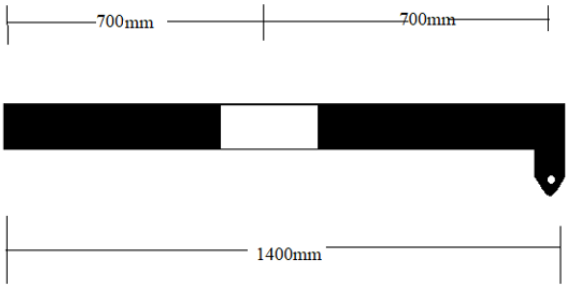


Figure 14 Fbd of rod

$$\sigma_b = MY/I$$

$$= \frac{\frac{WL \times h}{8}}{\frac{bh^3}{12}}$$

$$= \frac{3WL}{2bh^3}$$

$$= \frac{1.5 \times 680 \times 1.4}{0.05 \times 0.05 \times 0.05}$$

$$= 1.14\ N/m^2$$

For Deflection/Deformation: It is a measure of how much an object is stretched.

$\delta_B = F L^3 / (3 EI)$

were,

δ_B = maximum deflection in B

E = modulus of elasticity

I = moment of Inertia

$\delta_B = \frac{680 \times 700 \times 700 \times 700}{3 \times 21 \times 10^4 \times 10416.60}$

$= 3.58mm$

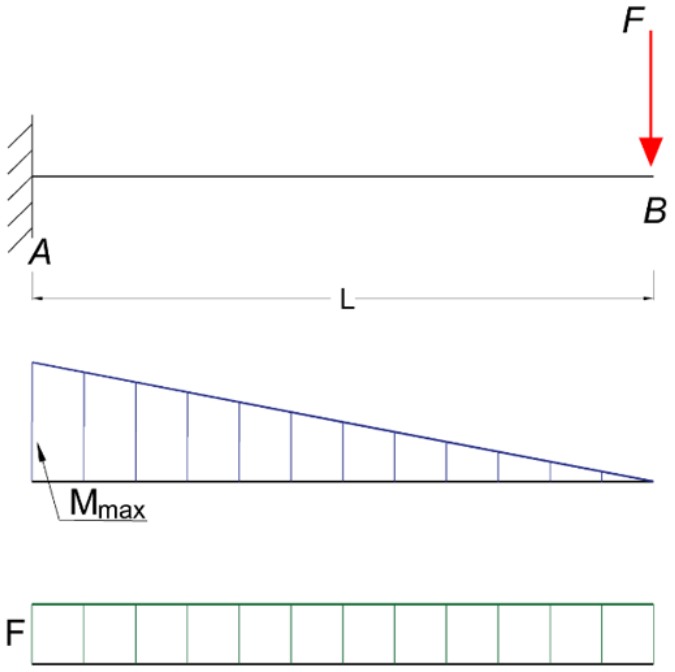


Figure 15 BMD

- **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

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

$\sigma_b = M / Z$

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

σ_b INDUCED < σ_b ALLOWED

$51.62\ N/mm^2 < 270N/mm^2$

Hence our design is safe.

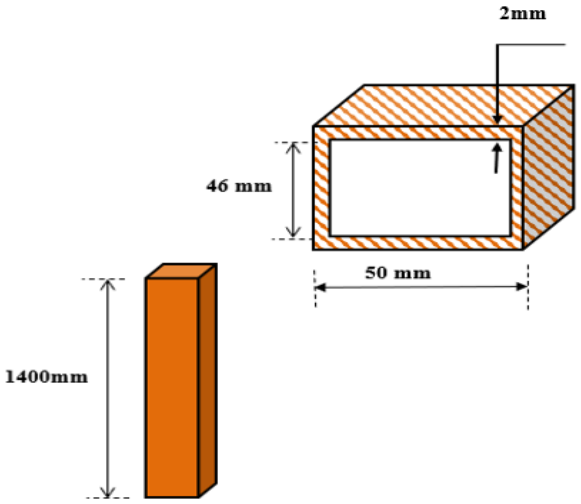
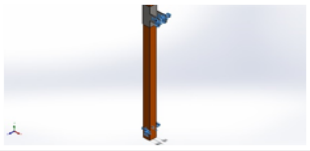


Figure 16 Dimensions of pipe

4.3 Analysis

Loads and Fixtures

Fixture name	Fixture Image	Fixture Details
Fixed-1		Entities: 4 face(s) Type: Fixed Geometry

Resultant Forces

Components	X	Y	Z	Resultant
Reaction force(N)	-680.266	0.507595	0.415913	680.266
Reaction Moment(N.m)	0	0	0	0

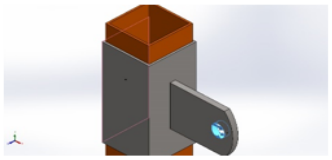
Load name	Load Image	Load Details
Force-1		Entities: 1 face(s) Reference: Face< 1 > Type: Apply force Values: ---, ---, -,680 N

Figure 17 Load and Fixture

Study Results

Name	Type	Min	Max
Stress1	VON: von Mises Stress	3.092e+04N/m^2 Node: 9134	1.359e+08N/m^2 Node: 12849

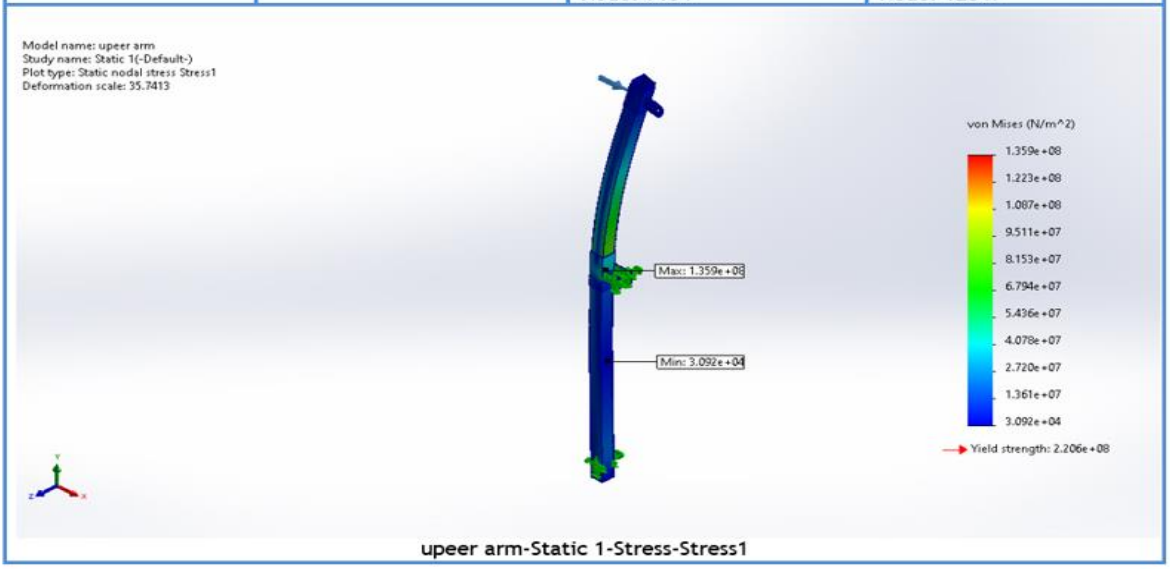


Figure 18 Analysis of stress

Here we check about stress and it is maximum at center.

Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.000e+00mm Node: 33	5.040e+00mm Node: 43

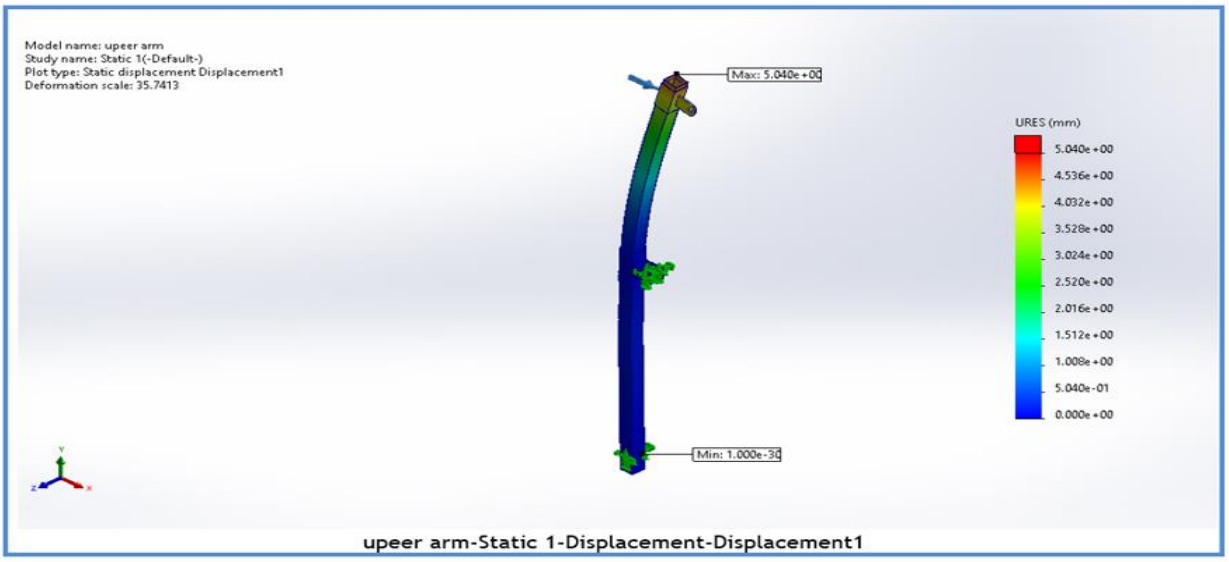


Figure 19 Analysis of displacement

Here we check displacement it is maximum at top and in below Diagram we check about fos it is minimum at center.

Name	Type	Min	Max
Factor of Safety1	Automatic	1.624e+00 Node: 12849	7.134e+03 Node: 9134

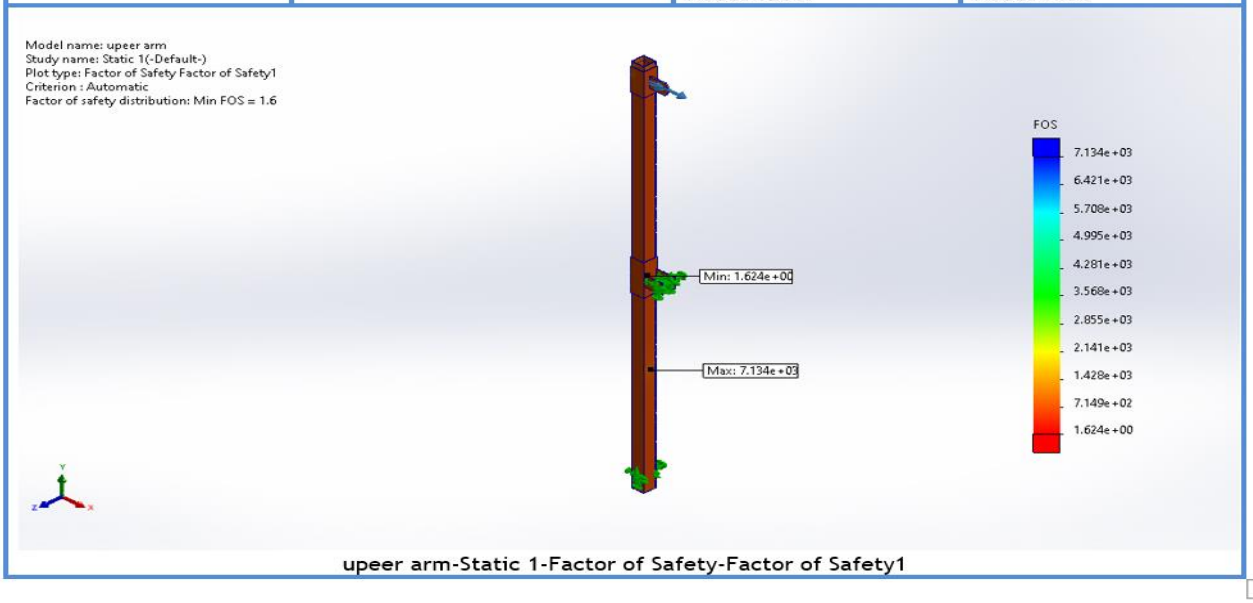


Figure 20 Factor of safety

Chapter 5

Components and manufacturing operations

5.1 Components

5.1.1. Battery

A battery is a source of electric power consisting of one or more electrochemical cells with external connections for powering electrical devices.

Specifications:

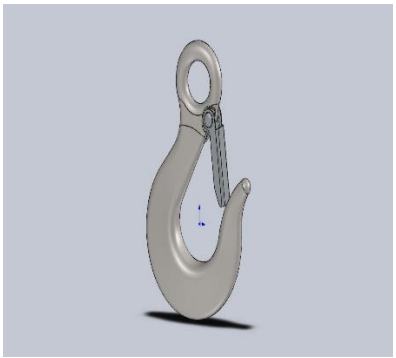
- Material: Plastic
- Color: White
- Pieces: 1
- Voltage: 24V
- Current: 5 Amp
- Power: 60 watts
- Safety instructions: charge fully before use. Do not short circuit.

Figure 21 (6V 4 Battery)

5.1.2. Hook and Wheel

A lifting hook is a device for grabbing and lifting loads by means of a device such as a hoist or crane.

A circular frame or disk arranged to revolve on an axis, as on or in vehicles or machinery.



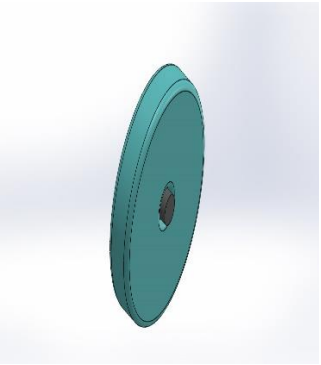


Figure 22 Hook and Wheel

5.1.3. ELECTRIC ACTUATOR MOTOR:

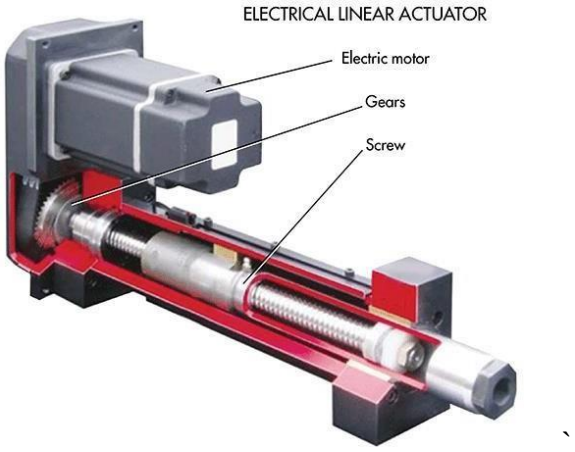


Figure 23 Electric actuator motor

This straightforward electrical actuator system will provide reliable movement in all directions. It will also give you added features such as end of stroke limit switches, mid stroke protection and manual override operation just in case of power failure. Optional features like analog or digital position feedback and adjustable end of stroke limit switches are also available. Another advantage is that a system like this is often easy to integrate with other control systems normally found in industrial systems or vehicles such as PLC's, micro-controllers, computers, or basic systems based on relays We will buy a linear actuator that weighs 150 lbs. or 68 kg.

5.2 Manufacturing Operations:

5.2.1 Cutting Machine : -

Cold saws are saws that slash through many kinds of metal, including sheet metal, using a circular saw blade. The movement that occurs during cutting, which prevents both the metal and the blade from getting too heated, is what gives the saw its name. A cold saw is often a stationary form of saw machine rather than a portable type of saw. It is driven by electricity.

High-speed steel is frequently utilized to make the circular saw blades that are used with cold saws. Such steel blades are resistant to wear even when used frequently. As a result, it is possible to finish several cutting tasks before the blade needs to be changed. When using the saws to cut through thicker portions of metal, high speed steel blades are extremely helpful. A cold saw may also include a blade with a tungsten carbide tip in addition to high-speed steel blades. This kind of blade structure also aids in resistance to deterioration. One significant distinction is that tungsten-tipped blades can occasionally be re-sharpened, increasing the life of the blade.

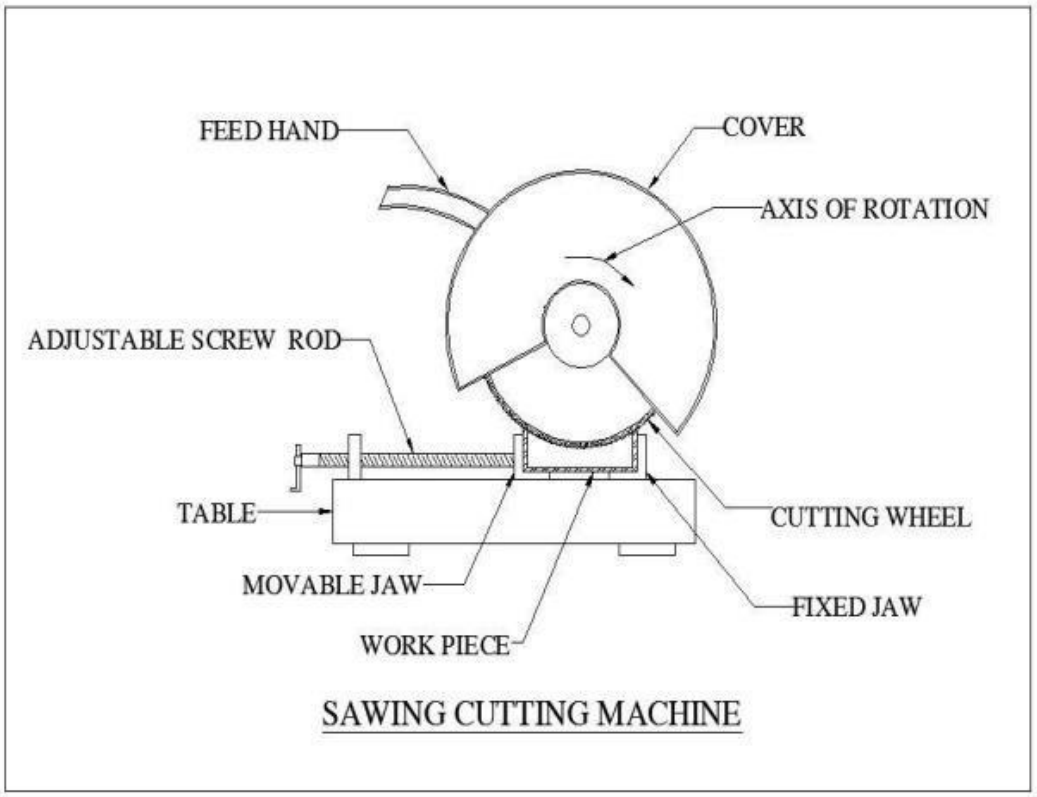


Figure 24 Cutting machine

5.2.2. Turning: -

The most frequent machining operation on a lathe is turning. A cutting tool removes material from the outside diameter of a spinning workpiece during the turning process. Turning's primary goal is to reduce the workpiece's diameter to the appropriate size. Rough and final turning operations are the two different kinds.

By removing the most material in the quickest amount of time, rough turning operations strive to process a piece to within a set thickness while disregarding precision and surface polish. Finish turning results in a workpiece with final exact dimensions and a smooth surface finish.

The turned pieces' exterior diameters may vary between different portions. Step, taper, chamfer, and contour are only a few topological features that might be present where two surfaces with differing diameters meet. Multiple passes at a shallow radial depth of cut might be required to achieve these features.

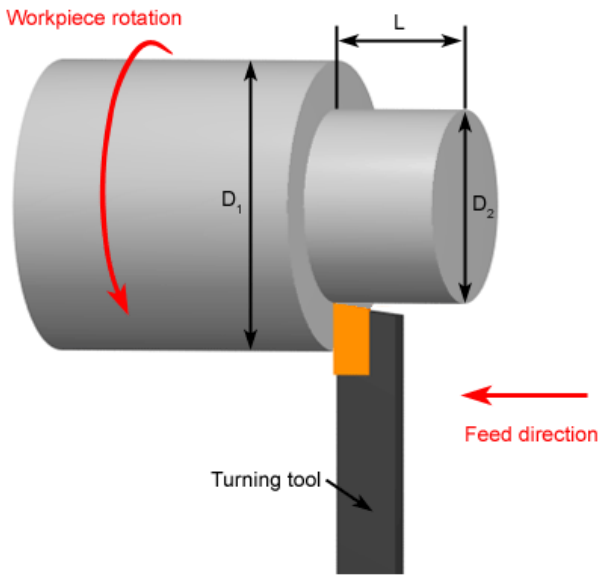


Figure 25 Turning

5.2.3. Drilling: -

Drilling is a cutting procedure that creates or enlarges circular holes in solid materials using a drill bit. The drill bit is a multipoint, rotary cutting instrument. The bit is rotated at speeds ranging from hundreds to thousands of revolutions per minute while being forced against the work piece. Through cutting out chips (swarf) from the hole as it is being drilled, this presses the cutting edge against the work piece.

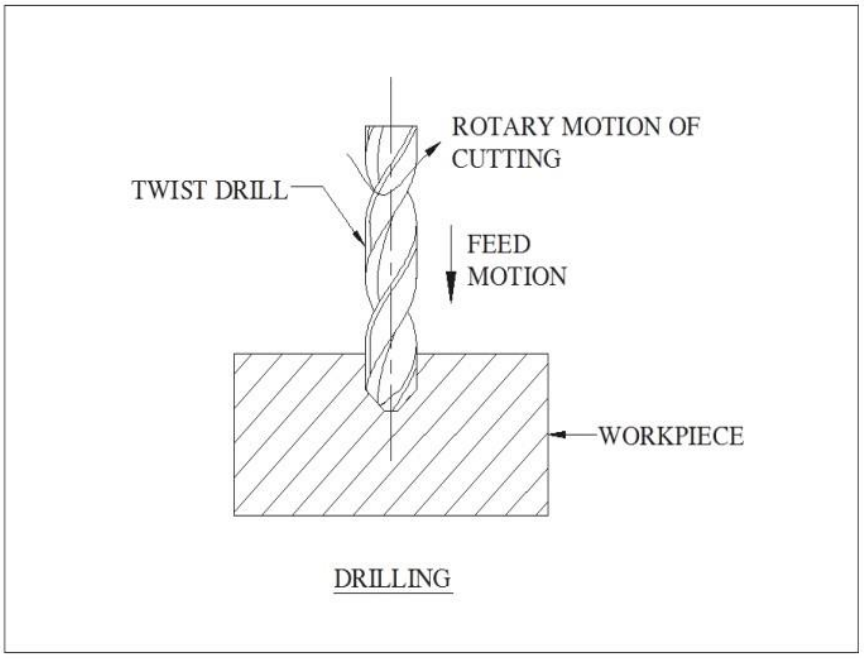


Figure 26 Drilling

The geometry of the typical twist drill bit is intricate; it features curved cutting teeth around its cylindrical surface in addition to straight cutting teeth at the bottom that perform the majority of the metal cutting. As the hole is being machined, the flutes—grooves made by the helical teeth—help force the chips out of the hole.

The drill tip's velocity is obviously zero, hence this part of the tool is unable to accomplish much cutting. Therefore, before using the drill, it is typical to create a small hole in the material known as a center-hole. Center-drills, specialized drills used to create center-holes, offer a reliable method for aligning the drill bit with the location of the hole's center. There are hundreds of various drill shapes and sizes; here, we will only focus on a few introductory drill facts.

5.2.4. Welding: -

Permanent joints can be made through welding. It is employed in the creation of shipbuilding, general repair work, tanks, furniture, aircraft frames, railway wagons, machine frames and ship bodies. Only a handful of the welding techniques that rely on heating with an electric arc are discussed here, beginning with the first type of welding known as simple arc welding, also known as shielded metal arc welding (SMAW) or stick welding. In this procedure, electricity is supplied to an electrode holder that holds an electrode that is typically coated with a mixture of chemicals or flux by an electrical machine, which may be DC or AC but is typically AC these days. In order to provide a return channel for the current, an earth cable joins the work piece to the welding machine. The electrode tip is tapped (or "struck") against the work piece to start the weld, which creates an electric arc. The molten pool created by the high temperature generated (approximately 6000oC) almost immediately creates the joint as the electrode's end continues to melt into the pool. While moving the electrode along the joint, the operator must keep the distance between the electrode tip and the work piece under control.

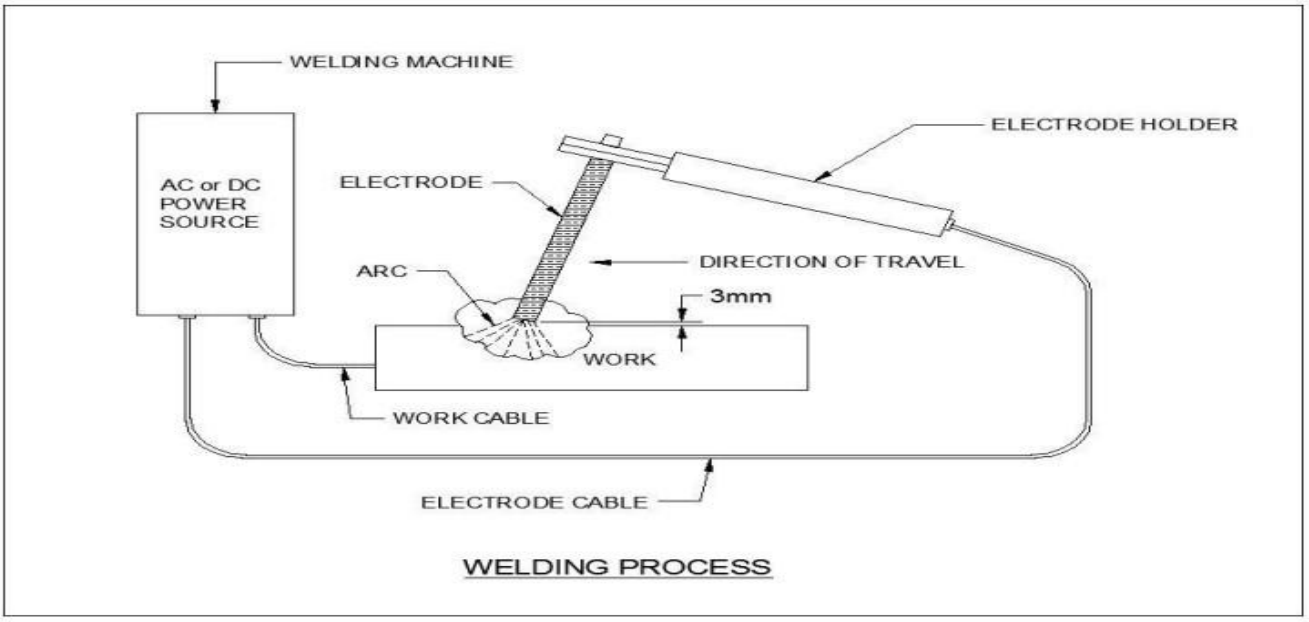


Figure 27 Welding

Chapter 6
Testing and validation

6.1 Testing

Figure 28 Testing

6.2 Validation

Table 26 Validation

Serial no.	Weight to be applied (kg)	Weight Lifted (Yes/No)
1.	8	Yes
2.	20	Yes
3.	25	Yes
4.	53	Yes

Chapter 7

Conclusion and Bill of Materials

7.1 Photos of Forklift

Fig 29.a(Side view)

Fig 29.b(Top view)

Figure 29 View of Forklift

7.2 Bill of Materials

Table 5 Bill of material

Sr No.	Part Name	Material Quantity	Cost
1.	Square pipe	20 kg	1200
2.	Linear Actuator	1	4000
3.	Shaft	1	600
4.	Chain	1 Set	500
5.	Battery	4	1600
6.	Sheet Metal	1	100
7.	Wheel	2	300
8.	Nut Bolt Washer	10	275
9.	Hook	1	400
10.	Miscellaneous	____	1000
	Total		9975

7.3 Conclusions

- Savings performing from the application of this machine will make it pay for itself with in short period of time and it can be a great companion in any field dealing with rusted and unused essence.
- The event of mechanical forklift assures the ergonomically comfort to the driver or worker and to reduces time needed for homemade lifting and running.
- It is capable of lifting 68kg weight which ensures to reduce human efforts.
- Different weights are applied to see the maximum ability of the forklift and it is qualified in every test of testing.
- We conclude that, our design will helpful for little scale diligence as it’s easy to operate with lower cost and laterally it'll save the labor cost.

REFERENCES

1. Aashish Kumar L Sharnangat. Design of Wireless Operated (On RFID) Forklift in Warehouse. *The International Journal of Engineering and Science (IJES)*, *2*(4), 64-67.
2. Liai Pan, Yanli Wu, Design research on working device of 3 tons balanced and internal combustion forklift, OJME 2017
3. 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.
4. Mishra, M. R. R., & Waghmare, N. A. (2013). Design and fabrication of stair climbing hand truck. International Journal of Emerging Trends in Engineering and Development, 5(3), 296-310.
5. 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.
6. Md. A. Hossain. Nafis, Linda, R. I., & Akhtar, S. (2010). Design and manufacturing of a stair climbing vehicle. In International conference on industrial engineering and operations management Dhaka, Bangladesh.
7. VegimImeri, 2013, Studying dynamic effects on warehouse forklift during forward movement with full loading, 16th International Research / Expert Conference, TMT 2012.
8. 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.
9. 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.
10. 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.
11. https://www.alloysteelplates.com/c45-plates