Design, Construction and Performance Test of Mechanically Driven Aerial Lifting Platform



A thesis

By

Md. Mehedi Hasan BME1901017419

Md Kurban Ali BME1901017131

Arafat Sharker BME1901017398

S M Mobenur Rahman BME1901017407

Department Of Mechanical Engineering

SONARGAON UNIVERSITY (SU)

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Supervisor: Md. Ahatashamul Haque Khan Shuvo

Lecturer & Coordinator

DEPARTMENT OF MECHANICAL ENGINEERING
SONARGAON UNIVERSITY (SU)

In partial fulfillment of the requirements for the award of the degree

of

Bachelor of Science in Mechanical Engineering

SEPTEMBER 2022

Acknowledgments

First of all we are grateful to Almighty God for guiding us through the right path, giving strength and granting us this success.

We would like to express our appreciations to the many who have given of their time and consideration in helping us carry out this thesis.

Through this capstone project, I have learned many great things. I would not have thought possible a few years back.

We express deepest gratitude to our thesis supervisor Lecturer & Coordinator Md. Ahatashamul Haque Khan Shuvo for his helpful ideas, continuous support, valuable advices and suggestions throughout this study.

I believe that our creative brainstorming sessions formed a special professional bond that has progressed from a strict academic relationship to a friendship that will continue beyond graduation.

Special thanks to department of Mechanical Engineering, Sonargaon University and also thanks Dean, Faculty of Science & Engineering Prof. Dr. Md. Alamgir Hossain and Head of Department, Mechanical Engineering Md. Mostofa Hossain for continuous support and assistance.

Abstract

These results were used to design the next generation of aerial work platforms. This new design helps increase the safety, ergonomics and comfort for the user, the goal of this study was to apply the knowledge obtained from studying in the university and solve the substantial task of creating a design of the mechanical scissors lifting platform. Then to verify the validity of the theory the practice work was accomplished. The type of the platform and the design of the structure were selected. The selection of the material and calculations of the loads and stresses were per formed and explained. As the result of the work the 3D model of the lift using SolidWorks software was created. This thesis purpose is an in-depth study of human interaction with the current products that are out in the market while gathering data through a variety of ways, such as interviews with the users, observation of how they interact with the product, and surveys asking general questions about their interactions. A one-to-one scale ergonomics model is built to see how the used to examine the 5 percentile person and the 95 percentile person interact to understand the full-bodied interactions and the solution. For this purpose a research of literature and articles was made, that contain missing information of the theoretical part of the problem. The data was mainly taken from the internet, particularly from articles, digital copies of books and scientific works in a related field.

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Chapter 1

Introduction and Objective

1.1 Introduction

The structure of this thesis is planned as follows: in the first part, the theory is presented. It consists of several topics concerning overall of lifting tables of scissors type, things that are needed for the design, principles of working, technical characterization and others.

The first part is needed to give a general concept of the subject and after that comes the practical part which presents and explains how to perform the knowledge. It contains the 3D model of the lift, calculations of the load, several diagrams, charts, and stress calculations, which confirm the viability and validity of the theory part.

Such a thesis structure was chosen as the most appropriate and suitable for the chosen topic. It allows increasing knowledge by appealing to the literature and adding an individuality of the author by making him solve an actual practical problem using own approach.

The scissors elevator is an elevator with a system of levers and metal shaft on which the metal platform is capable of moving in the vertical plane. This is achieved by using of linked, folding supports in a crisscross pattern, called scissor mechanism.

The mechanical lift was chosen as a subject of the thesis because it is a perfect example of mechanical engineering field. This mechanism combines a result of several main fields of engineering and at the same time, it is simple and accessible for understanding. The construction and load distribution represent statics and strength of material subjects, the metal shaft knowledge of mechanical systems. Material science is important for selection

of a suitable material as well as knowledge of 3D modeling.

Also, scissors lift is an integral part of most of the workshops and building objects. The key advantage of lifts is that they even offer the best way to organize a technological and industrial process. Besides, almost all lifts give the possibility to change the place of their installation without much effort, which is important in the frequently changing conditions in the production process these days.

The need for the utilization of elevators is believably wide and it runs across workshops, factories, labs, fixing of billboards, residential commercial buildings to repair street lights, etc. Expanded and less efficient, the engineers may run into one or more problems while using.

1.2 Aims/Objectives of the study

- The project is aimed at designing and constructing a mechanical aerial lifting platform.
- Lift and lower workers and his working equipment with ease and in the most economical way.
- The lift is expected to work with minimal technical challenges and greater comfort due to its wide range of application.
- The device can easily be handled to the site to be used with universal swivel caster wheel and then operate by a driving shaft.
- Between the heights of lift (i.e. the maximum height) the device can be used in any height within this range and can be descend immediately in case of emergency.

Chapter 2

Literature Review

2.1 Background / History / Social Context

Being in the construction industry has many different jobs that one can do from masonry to building the first frame of a house, to putting up siding or plaster on the outside of a townhouse. A lot of these jobs, especially jobs that are done outdoors, are challenging to do and grueling on the body. For these workers, any sort of equipment is essential for them to use by helping them complete a task more quickly. For jobs that require reaching high areas, the three main pieces of equipment that are used are usually ladders, scaffolding, and aerial work platforms. "In 1951, Walter E. Thornton - Trump, nicknamed Ted, invented boom lifts to make working in high places easier [1]. This helped avoid the use of ladders and to reach areas that would be unreachable in reasonable means of a ladder. It gives the mobility of moving the machine anywhere with little setup time compared to scaffolding that would be needed to put around a whole exterior of a building to use.

"The global boom lift market is driven by growing demand for constructions across the geographies and various mega construction, particularly in regions like Asia pacific [2]. With the ever - growing demand for boom lifts for the construction industry, the safety of the user and others around the machine must be taken at the most seriously. Not to mention keeping the user in mind

and understanding how they interact with the device on and off, and how they move it around with or without impurities of their sight.

Even though construction workers can be viewed as high school dropouts or immigrants trying to make a stable income, these are the people that are shaping the infrastructure of the future, and they must have the equipment that is best suited to their needs.

2.2 Problem Definition

Construction is one of the most significant growing industries out there in the world today. It will always be a part of our daily life whether we see it or not. The people that are in this industry must work in many different conditions, areas, and machinery. One type of mechanism that is most used on the construction site is the aerial work platform (also known as a boom lift, aerial lift, and scissor lift). "An average of 26 construction workers die each year from using aerial lifts. This is 2 to 3 % of all construction deaths. On aerial lifts, the major causes are falls, electrocutions, and collapses or tip overs [3].The current use of these machines is to help reach higher altitudes and in areas of difficulty that with reasonable means such as ladders or scaffolding would be hard to get to. Not to mention lifting material to work with while in the air. There are many different areas of concern for workers up in the air while working and others working around them that can and needs to be addressed. The following thesis project will propose a solution regarding safety, ergonomics, and comfort for the workers utilizing the machine.

2.3 Investigative Approach Taken

To understand the key issues surrounding the use of aerial lifts among the users. The methods that are chosen helped enhanced problem recognition and will assist in the development of a solution for the workers on the aerial lift if not the lift itself. These methods of design research are stated below

and will be evaluated later in the report

- Literature reviews
- Information searches
- Analysis of existing solutions
- User Observation
- User Interviews
- Ergonomic Studies
- Activity Breakdown analysis

Some critical questions need to be answered to the given topic for a better understanding of the difficulties that are faced daily. Such questions are:

- How can we improve the overall quality of life while using the lift?
- What would the critical features of this lift include?
- How can the safety of using the machine improve?
- How long would the typical worker spend in the air?
- What are the ergonomics needs of the user?

2.4 Classification of lifting platforms

Aerial lifts fall into three main categories – scissor lifts, boom lifts and telehandlers. Although they may seem very similar, each one serves a unique purpose and is best suited for different jobs and environments.

2.4.1 Launching and unloading platform

To start something new it is needed to look at something that already exists. On the design elevators can be divided into the following main types: permanent and portable. The permanent elevators are: scissor raise platforms, track lifting platform, launching and unloading platforms [4].

An example is on Figure 2.4.1.



Figure 2.4.1 Launching and unloading platform

2.4.2 Mobile lifting platform

The portable elevators divided into: several mobile lifting platform, a couple of tractor - lift platforms, improved car lifting platform, AC - DC dual - use working out with a platform, self - elevating podium, crank type raise platform, foldable arm lift platform, packages cylinder lift platform, lightweight aluminum lift platform, working out with height from 1-30 m. array (Sinolifter.com 2011) An example is on Figure 3.2.

As the drive elevators divided into: electro - hydraulic, electromechanical, pneumatic hydraulic. As the lifting devices elevators divided into: chain, screw, telescopic, lever. As the picking - up devices elevators divided into: platform, frame, and console. Stationary elevators are established in a defined place, frequently without the special foundation on a flat surface of a floor and fastened by means of anchor bolts or special pins



Figure 2.4.2 Mobile lifting platform

If the elevator is telescopic then for his installation the special basement is required [5].

2.4.3 Electro - hydraulic drive lifting platform

The general view of the elevator is presented on Figure 3.3. The elevator with the electro - hydraulic drive is performed for placement on the floor. The elevator is intended for lifting objects with the weight of hundreds and thousands of kilo grams from the floor to the height of 1 meter.



Figure 2.4.3 General view of lift

There are two options for installing the lift on the floor or on the level with the floor. The standard is to place the remote control for the lift to the left at a distance of 1 m. If necessary, the location of the control panel at the other distance needed lengthening of the hydraulic drive.

The main technical capabilities [7]:

- The automatic device for blocking of mechanisms for safe work in any situation;
- The valves which are switching when hydraulic actuators are damaged,
- Valve for control of speed of lowering;
- The electro - hydraulic device for stopping the lowering in case of destruction of the basis of the elevator;
- Electrically the switched - on device for protection of legs of the user,
- The self - greased hinges.

The scissors lift has a table surface where the weight can be placed. The rising of a platform is carried out due to work of a hydraulic cylinder. The management of the elevator is carried out by the control panel which has four buttons: the main switch, lowering, rise, and blocking. As rising speed uniform and slow (an average 30 mm per second), physics behavior of the elevator corresponds to a static case (Garant-techservice.ru 2016).

The technical characteristics of the lift are shown in Table 3.1:

Loading capacity, kg	700
Height of rise, mm	1260
Rise time, sec.	40
Lowering time, sec.	40
Initial height, mm	125
Mass, kg	70
Power supply, volt	220 T

Table 2.4.1 Technical characteristic of the lift

On Figure 2.4.4 the main components of the lift are shown:

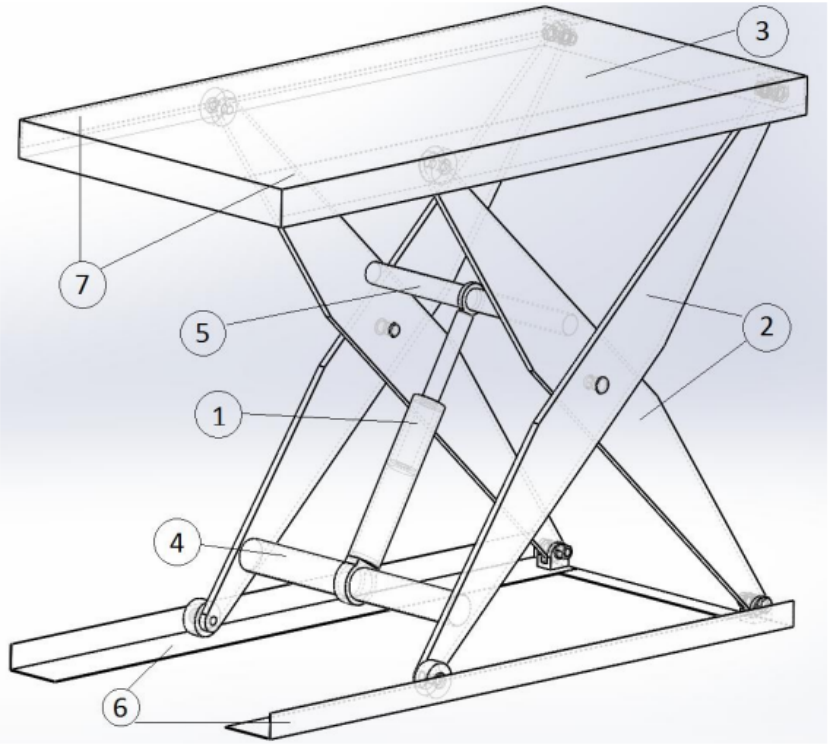


Figure 2.4.4 Main Components of hydraulic lifting platform

1. Hydraulic Cylinder
2. Leg
3. Table - top
4. Supporting tube 1
5. Supporting tube 2
6. Base plates
7. Top plates

Chapter 3

Methodology and Material selection

3.1 Mechanical Scissors Lift Methodology

The mechanical scissors lift is used for lifting materials especially on construction sites. This is one of the most recent advancement on scissors lift. There, the lift utilizes drive system connected to a load screw which constructs the X pattern on tightening and expands it on loosening. The lead screw actually does the work, since the applied force from the handle is converted to linear motion of the lift by help of the lead screw. A general knowledge however, regarding screws will reveal the loss due to friction in the screw threats. Therefore, the efficiency of this device is low due to losses in friction. Also, the power needed to drive the machine is manual, and much energy is expanded to achieve a desired result. Its suitability however, cannot be overemphasized as it can be used in almost every part of the country whether there is availability of electricity or not.

3.2 Material

Depending on a component and tasks that this component performs the selection of a certain material is founded. Different parts of the mechanism take different load and stress because they carry out different functions. It is important to use an individual approach to select a material for every part. It impacts on a total efficiency and benefit received from each detail and best properties which can give different materials. Thus, it is necessary to allocate

the main parts of a design and to explain features of each of them separately.

The main interest is made by the legs of the lift, the greatest part of loading is shared between them and they are a basic element of the assembly. It means that the material of which they are made has to be capable of maintaining this load. This part is subjected to a normal force which might cause buckling and shear force which cause bending, which possibly cause bending deformation or even braking of the part . Then such properties as strength, hardness, and stiff ness are needed. An appropriate material for these purposes is Mild Steel flat bar.

The second basic element of a design is the driving shaft. From the technical point of view, it acts as a bar with pinned ends. It is subjected to direct compressive force which leads to bending and buckling load in the rod. Also, there exists the internal pressure of the threads, which causes circumferential and longitudinal stresses all nuts thickness and threads. Thereby the nuts must have such properties as strength, toughness, ductility and hardness. An appropriate material is mild steel.

There are also such components as top plates and base plates. The top plates take the load caused by a weight of lifting goods. The main needed property here is strength and the selected material is mild steel L shape angular bar. The base plates are subjected to the weight of the load and scissors mechanism itself- shaft and legs, hence, hardness and stiffness are required. Mild steel is appropriate.

Chapter 4

Different Parts and their Specifications

4.1 Different Parts of Mechanically Driven Aerial Lifting Platform

1. L Shaped MS Angle
2. Flat Bar
3. Solid Round Bar (1 inch diameter)
4. Nut
5. Nut 3/8 inch.
6. Nut 1/2 inch
7. Nut 1 inch
8. Bolt
9. Bolt 3/8 inch.
10. Bolt 1/2 inch
11. Bolt 1 inch.
12. Washer
13. Washer 3/8 inch.
14. Washer 1/2 inch
15. Bearing
16. Universal Swivel Caster Wheels 2 inch

4.1.1 Bolts Dimension and Specifications



Figure 4.1.1 Bolt

SL. No	Bolt Size	Thread Diameter (C)	Threads per Inch (tpi)	Head depth max. (A)	Length (B)	Head (D	Material
1	3/8 inch	3/8 inch	16	0.234 inch.	2.5 inch	9/16 inch (spanner size)	Bright zinc plated
2	1/2 inch	1/2 inch	12	0.312 inch.	2 inch.	3/4 inch (spanner size)	Bright zinc plated.
3	1 inch	1 inch	8	0.609 inch.	1.8 inch.	1.5 inch (spanner size)	Bright zinc plated

Table 4.1.1 Bolts Dimension and Specifications

4.1.2 Nut Dimension and Specifications



Figure 4.1. 1Nut

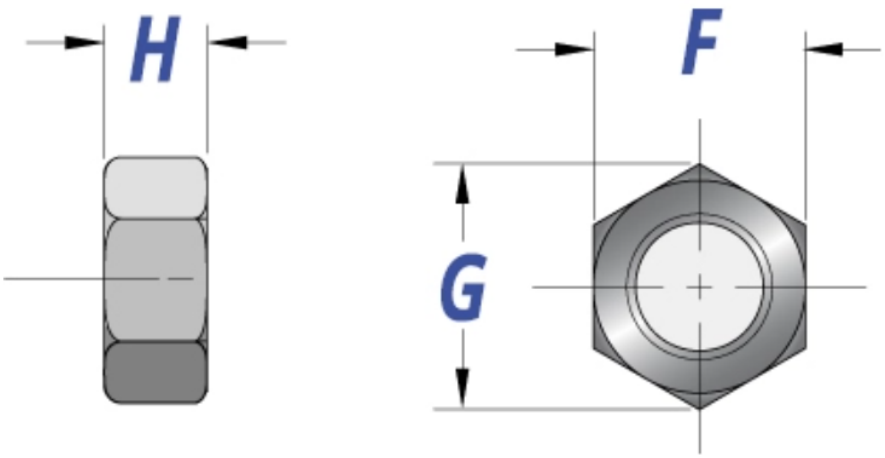


Figure 4.1.2.1 Nut Dimension

Sl. No.	Nut size	Width Across Flats (F)			Width Across Corners (G)		Thickness of Hex Nuts (H)		
		Basic	Max.	Min.	Max.	Min.	Basic	Max.	Min.
1	3/4 inch	9\16	0.562	0.551	0.65	0.628	21\64	0.337	0.32
2	1/2 inch	3\4	0.75	0.736	0.866	0.84	7\16	0.448	0.427
3	1 inch	1,1/2	1.5	1.45	1.732	1.653	55/4	0.887	0.831

Table 4.1.2 Nut Dimension and Specifications

4.1.3 Washer Dimension and Specification

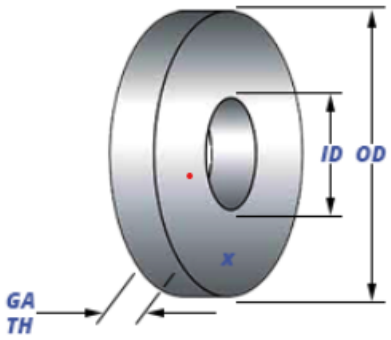


Figure 4.1. 2Washer

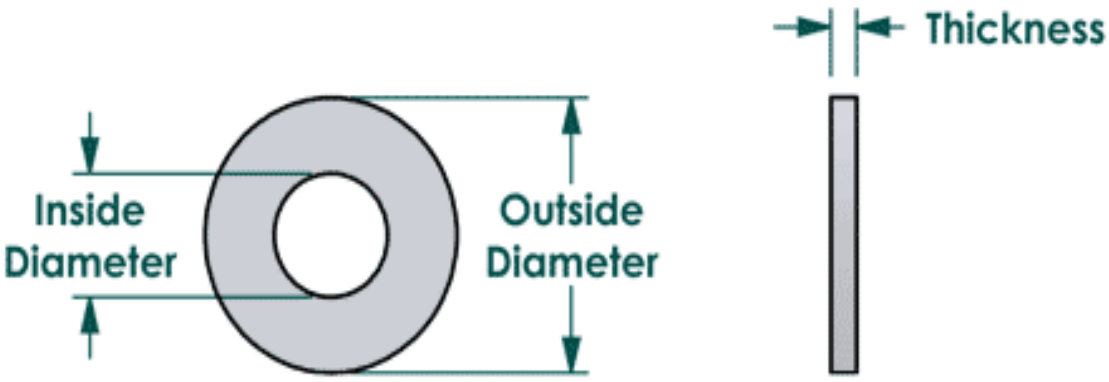


Figure 4.1. 3.1 Washer Dimension

Sl. No.	Washer size	Outside Diameter (OD)			Inside Diameter (ID)			Thickness (TH)	
		Normal	Max.	Min.	Normal	Max.	Min.	Max.	Min.
1	3/4 inch	13\16	0.827	0.805	13\32	0.419	0.401	0.08	0.051
2	1/2 inch	1\16	1.092	1.055	17\32	0.546	0.526	0.121	0.074

Table 4.1.3 Washer Dimension and Specifications

4.1.4 Bearing Specification





Figure 4.1.4 Bearing

1	Bearing Type	Ball Bearing
2	Brand Name	VXB
3	Compatible Lubricant Type	Grease
4	Item Weight	4.5 ounces
5	Material	Alloy Steel
6	Measurement System	Inch
7	Number of Items	1

8	Part Number	Z99R16

Table 4.1.4 Bearing Specification

4.1.5 Universal Swivel Caster Wheel Specification



Figure 4.1.5 Universal Swivel Caster Wheel

1	Type	Rotating Wheel
2	Bearing Type	Ball Bearing

3	Surface Treatment	Zinc Plated
4	Brake	With 2 Brake
5	Size	2 inch
6	Materia	Nylon
7	Color	Cream
8	Load capacity	150kg
9	Important	Screws Not Included In This Product

Table 4.1.5 Universal Swivel Caster Wheel Specifications

4.1.6 Driving Shaft Specifications





Figure 4.1.6 Driving Shaft

1	Color	Grey and Brown

2	Shape	Round
3	Speed	Multi Speed
4	Weight	200 kg
5	Material	Alloy Steel
6	Polishing	Powder Coated
7	Thickness	10-20 mm
8	Surface Finish	Polished
9	Model Name/Number	Sonalika
10	Surface Treatment	Induction Hardened

Table 4.1.6 Driving Shaft Specifications

4.1.7 Mild Steel Flat Bar Specification



Figure 4.1.7 Mild Steel Flat Bar

1	Thickness	15 mm
2	Single Piece Length	6 meter
3	Usage/Application	Construction
4	Grade	Fe 500
5	Material	Mild Steel

Table 4.1.7 Mild Steel Flat Bar Specifications

4.1.8 Mild Steel L Shape bar Specifications

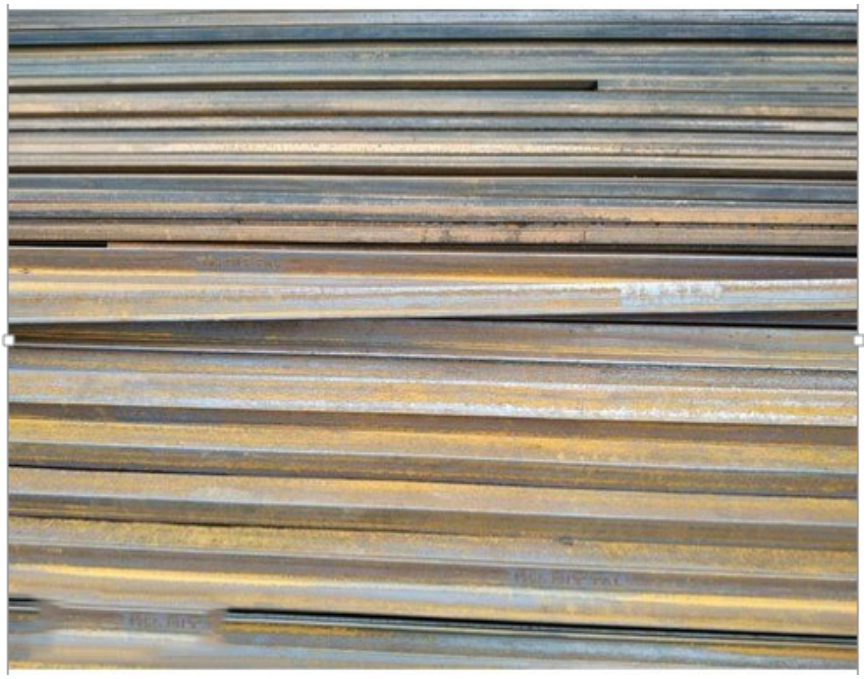


Figure 4.1.8 Mild Steel L Shape bar

1	Material	Mild Steel
2	Surface Finish	Galvanized
3	Size	Available In 25*25*3 30x30x3mm,34x34x4 mm,35x35x5mm,40x40x5/6mm,50 x50x5/6mm,65x65x5/6mm,75x75x 5/6 mm
4	Shape	L Shaped
5	Usage/Application	Construction
6	Unit Length	6 m
7	Technique	Hot Rolled
8	Tensile Strength	100-300Mpa

Table 4.1.8 Mild Steel L Shape bar Specification

4.2 Using Different Machine for making Aerial Lifting Platform and their Specifications

- Drill Machine
- Angle Grinder
- Arc Welding Machine
- Electric Spray Coloring Machine

4.2.1 Drilling Machine Specifications



Figure 4.2.1 Drilling Machine

1	Drilling Capacity in steel	19 mm
2	Drilling Capacity in C.I.	22 mm

3	Tapping Drilling Capacity in	16 mm
4	Spindle Travel	125 mm
5	No. o Spindle Speeds	8
6	Column Diameter	73.80 mm
7	Size o Square Table	270*270
8	Electric Motor	Phase, 1H.P., 1440RPM

Table 4.2.1 Drilling Machine Specifications

4.2.2 Angle Grinder Specifications



Figure 4.2.2 Angle Grinder

1	Continuous rating input	840W
2	Wheel Diameter	100 mm (4")
3	No Load Speed (RPM)	11,000
4	Vibration Level	Surface Grinding: 7.5 m/s²
5	Vibration K Factor	Surface Grinding: 1.5 m/s²
6	Sound Pressure Level	85 dB(A)
7	Sound Power Level	N/A dB(A)
8	Dimensions (L x W x H)	273x118x97 mm (10-3/4"x4-5/8"x3 -13/16")
9	Net weight	1.7 – 2.0 kg (3.7 – 4.5 lbs.)
10	Power supply cord	2.5 m (8.2 ft.)

Table 4.2.2 Angle Grinder Specifications

4.2.3 Electric ARC Welding Machine Specifications

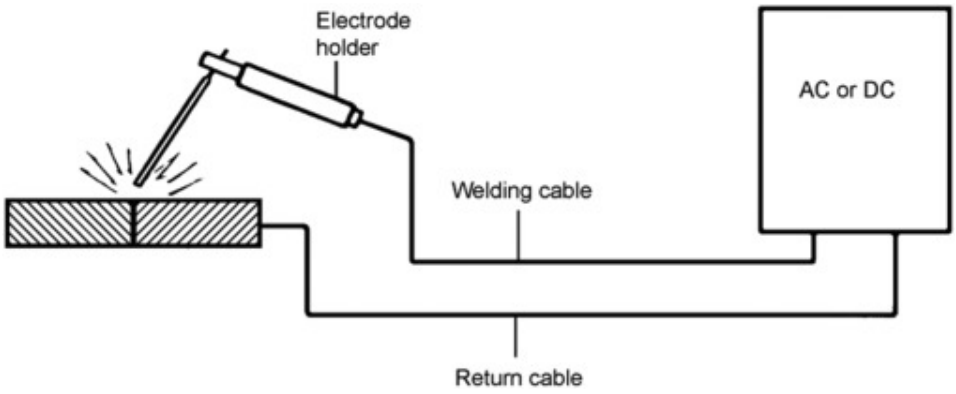


Figure 4.2.3 Electric ARC Welding process



Figure 4.2.3.1 Electric ARC Welding process

Table 4.2.3 Electric ARC Welding process

4.3Methodology

4.3.1 Make Base frame and platform:

At first cut 36-inch L shape angle bar and 18-inch L shape angle bar by angular grinder. Then joint 36-inch L shape angle bar and 18-inch L shape angle bar perpendicular by using electric arc welding. Again, follow same procedure to make joint. Now assemble two L shape joint by electric arc welding.



1	Fre	/60
2	Rat	.6
3	No-load Voltage (V)	
4	Output Current Range (A)	30-200
5	Current (Ampere)	500-600, >600
6	Motor Type	AC Motor
7	Welding Type	ARC Welder
8	Condition	Condition
9	Generator Compatible	Yes

Figure 4.3.1 Base frame and platform



Figure 4.3.1 Base frame and platform welding

4.3.2 Drilling Operation

First select drill point by using try-square and steel rule. Then mark punching by using punch and hammer.

Now install flat bar in drill machine. Now time of drilling operation.

Before drilling operation, we follow below mention different important issues:

• Know the location of start and stop switches or buttons and keep the drill press table free of tools and other materials.

• Use only properly sharpened drill bits, sockets, and chucks in good condition. Remove dull drill bits, battered tangs, or sockets from service.



Figure 4.3.2 Install L shape angle bar in Drill Machine

• Do not remove by hand metal or wood chips from the table or stock. Use brushes or other tools to properly remove chips.

• Do not attempt to oil the machine or adjust the work while the drill press is in motion.

• Do not insert a drill chuck key into the chuck until the power is shut off and the machine has come to a complete stop.

• All belts and pulleys must be guarded; if frayed belts or pulleys are observed, the drill press must be taken out of service and the belts or pulleys must be replaced.

• All stock must be properly secured with a vise or clamps prior to a machining process.



Figure 4.3.2.1 Drilling Operation

• If the stock slips in the vise or clamp, the operator must not attempt to hold the work with his/her hand or try to tighten the vise/clamp while the machine is in motion. Shutdown the power to the machine prior to re-tightening the loose stock.

• Use the correct speed and drill for the type of stock being machined.

• Use the appropriate bit for the stock being machined. Bits with feed screw or extremely long bits should not be used.

• The drill bit should be mounted the full depth and in the center of the chuck.

• Position the table and adjust the feed stroke eliminating the possibility of the bit striking the table.

• Feed the bit smoothly into the work. If the hole being drilled is deep, withdraw the bit frequently to remove shaving on the bit.

• Never attempt to remove a broken drill with a center punch or hammer.

• When an operator has finished working on the drill press, and before leaving the drill press for any reason, the power must be shut off and the machine

must come to a complete stop.

• When an operator observes an unsafe condition on the drill press, or stock that is being worked on, they must report it immediately to the Supervisor and the press will be taken out of service until the problem has been corrected.

We follow above mention important issues and completed 3/8-inch drill operation in three positions of one flat bar. Then attached and align eight flat bars. To keep proper alignment, we use temporary arc welding. Now drill operation done in three positions of all eight flat bars at a time.

Another drill operation done in L shape bar. Basement slide two drill operation and platform slide two drill operation.

4.3.3 Joint and welding

Joint two flat bars by 3/8-inch washer, nut, and bolt by using torque Wrench. Now joint circular pipe with two side scissors arms or leg by electric arc welding.



Figure 4.3.3 Scissor arm or leg joint by bolt, nut and washer.



Figure 4.3.4 Joint circular pipe by electric arc welding.

4.4 Driving mechanism

Shaft with thread 20-inch:

Thread was cut by using Lathe Machine by following procedure.

Threads can be cut on a cylindrical surface by forming or machining process Thread cutting by the machining process is done using a lathe. Threads of any pitch, shape and size can he cut on a lathe. The following figure shows the set -up of a lathe for thread cutting.

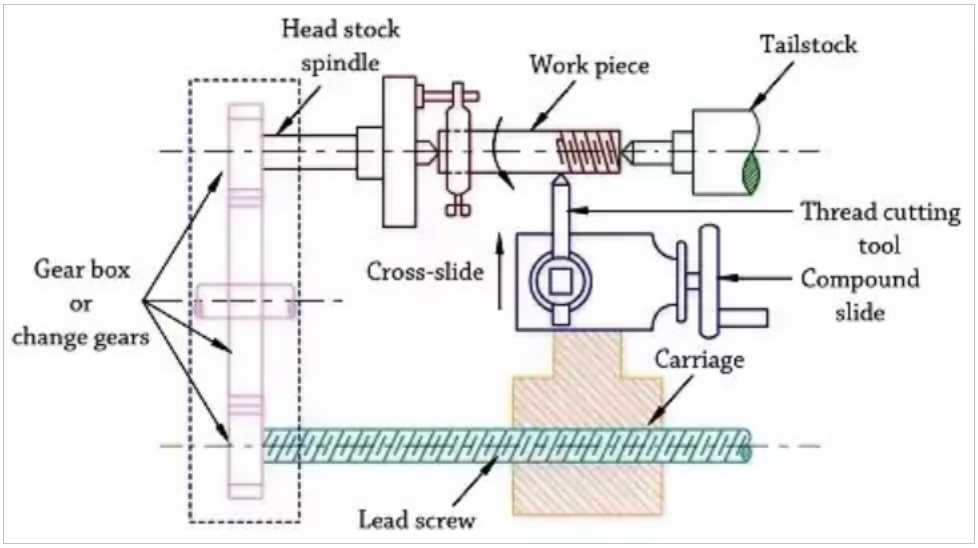


Figure 4.4 Set-up of a lathe for thread cutting.

Thread cutting operation is done on a lathe using a single-point tool called thread cutting tool. The workpiece is held between centers or in a chuck and the tool is held in tool post. For producing threads of pitch p mm, the tool must travel a distance equal to p [mm] as the workpiece makes one complete rotation. The definite relative rotary and linear motion between the workpiece and tool is achieved by locking or engaging the carriage with the lead screw through a screw and nut mechanism and fixing a gear ratio between the headstock spindle and lead screw. This is done by using change gear mechanism or gear box between the spindle and lead screw. To cut the threads, the tool is brought to the start of the workpiece and a small depth of cut is given to the tool using cross-slide. The carriage is engaged with the lead screw, the cut is made on the entire surface and at the end of the workpiece and carriage is disengaged. The tool is pulled out of the job and brought back to the starting position. The process is repeated until the full depth threads are obtained. The following relationship is used to determine the

gears/wheels required to generate threads of definite pitch.

All the lathes are provided with a set of change gears, usually having 20 to 120 teeth, with a variation of 5 teeth. In addition, a gear of 127 teeth is also provided which is known as translating gear. It is used in cutting metric threads. After the determination of above gearing ratio, the next step to follow is to multiply the numerator and denominator of the fraction by the same number to find out the number of teeth of the change gears.

Gear trains:

The following two types of gear trains are employed in cutting threads,

• Simple gear train

• Compound gear train

4.5 Installation of driving mechanism

1. Platform area below side of 18-inch L shape angle bar center position cut one inch bar by using grinding machine.



4.5.1: Figure 18-inch L shape angle bar center position cut

2. One inch diameter

washer joint with platform one inch cutting bar area by using electric arc welding.

Figure 4.5.2: One inch diameter washer joint with platform

3. Shaft proper area joint with one inch washer by using electric arc welding.



Figure 4.5.3: Shaft joint with one inch washer

4. Three-inch length flat bar center point makes one inch hole by using drill machine.



Figure 4.5.4: One inch hole of three-inch length flat bar

5. Shaft enter into hole of one inch washer of platform and three-inch length flat bar.



Figure 4.5.5: Shaft enter one inch washer and three-inch flat bar

6. After completed proper alignment of shaft joint the flat bar with platform that prat.



Figure 4.5.6: Shaft joint with L shape angle bar of platform

7. Two Scissor arms upper and lower position make 1/2-inch hole by using drill machine.



Figure 4.5.7: 1/2-inch hole of scissor arms upper and lower position

8. Two upper arms hole area joint by 1/2-inch nut, bolt and washer by using torque wrench.
9. Two upper arms hole area enter 1/2-inch bolt, washer and one inch diameter bearing.



Figure 4.5.8: Setting of bolt, washer and bearing

10. Cut the extra part of 1/2-inch nut by Angle Grinder and joint by using electric arc welding.



Figure 4.5.9: Joint of bolt, washer and bearing.

11. Enter two (one inch diameter) nuts in shaft thread.



Figure 4.5.10: Enter two nuts in shaft thread

12. Nuts with flat bar joint with L shaft angle bar by using electric arc welding.
13. After completed of driving mechanism work, we make lifting platform. Square bar and 3/8 inch flat bar joint with platform frame by electric arc welding.



Figure 4.5.11: Joint of two nuts, flat bar and L shape angle bar.

4.6 Driving Handle

Added handle with shaft by using electric arc welding.



Figure 4.6.1 Driving Handle

4.7 Operation of our project

- When we rotated handle clockwise that time lifting platform move up direction.

- When we rotated handle anti-clockwise that time lifting platform move down direction.



Figure 4.7.1 Clockwise direction & Anti-clockwise direction

Chapter 5

Calculations

The calculations of forces, stresses, and reactions of the structure play the most important role in the design because on the result of these calculations and its correctness depends stability, safety and successful work of the whole mechanism. The lifting table is a dynamic mechanism, but the speed of acting is relatively low, so this fact can be neglected and this system can be concerned as static. Then only two positions are needed to be considered, they are the initial position when the lift is lowered and just lying on the floor, and the highest position, when the mechanism lifted a weight on the highest possible distance.

5.1 Force acting on the metal shaft

5.1.1 Lowest position



Figure 5.1

Free body diagram for the initial position

While calculation it is important to understand the behavior of the structure. For this, the simplified picture is used to focus on the main acting forces. Here is the free body diagram on Figure 9.1

As it can be seen on Figure 9.1 , A and D are roller supports and B and C are pin supports , point O is also a pin joint between two legs of the lift . Force W is applied as the weight of the load and it is acting in the middle of the table, dimension "d" shows it. Also in the other plane which is not shown, the weight is supposed to be as well in the middle. When the force acting on the middle or shared over the table, it is transmitted equally to A and B supports. The " W_{legs} " is the load caused by a weight of the legs, it is also acting in the middle, but only in the initial position. Also, the total incoming forces must be equal to the total out coming, which means that whatever is happening inside the system the sum of reactions *Dy* and *Cy* would be equal to the weight. Then vertical reactions of D and C are half of the weight of the main load plus the weight of legs.

$$C_y = D_y = \frac{W + W_{legs}}{2}$$

EF from Figure 10.1 is the hydraulic cylinder and here it is acting like a truss. It is subjected a compression force, that means the cylinder acts with a certain force to the points E and F. On Figure 10.2 it can be seen how this force P is decom posed into a Y and X components according to the axes. And as a result:

$$Sin\beta = \frac{P_y}{P}$$

$$\Rightarrow P_y = P\, sin\beta$$

$$Cos\beta = \frac{P_x}{P}$$

$$\Rightarrow P_x = P\, cos\beta$$

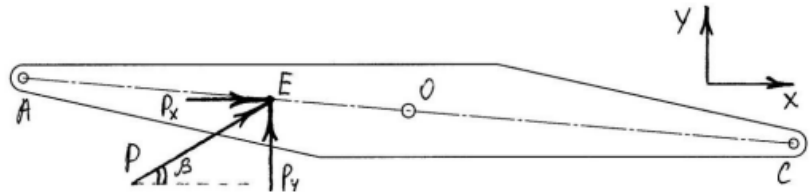
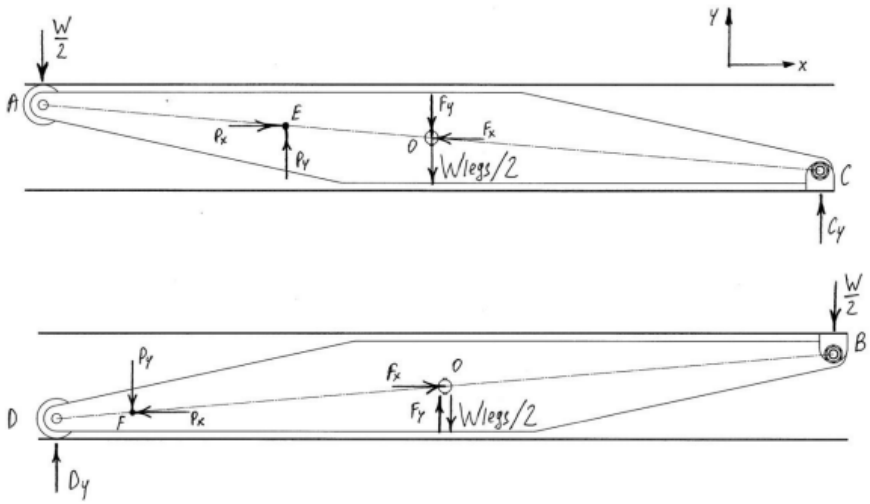


Figure 5.2 Force components at point E

Then the free body diagram is drawn for each leg separately on Figure 10.3. F_y and F_x are the components of F force acting on the pin, it is better to decom pose it right now because its value and direction are not known yet.



1Figure 5.3 Free body diagram for each of leg separately

Also, it is needed to get the projections of the dimensions of the leg which will be called "L" the dimension between E and O is called "a" The analogous result may be used for projection of CE, the dimension of which is " (L / 2 + a) " as shown on Figure 10.4.

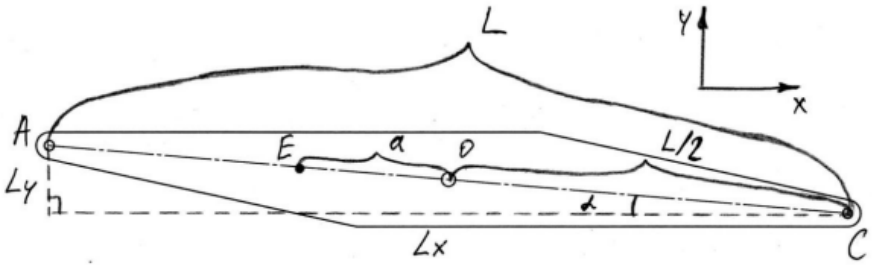


Figure 5.4 Projections of the leg

$Cos\alpha = \frac{L_x}{L} \Rightarrow L_x = L\ cos\alpha$

$Sin\alpha = \frac{L_y}{L} \Rightarrow L_y = L\ sin\ \alpha$

Then, using the diagram on Figure 9.3 it is needed to consider a balance of forces in Y and X directions and also the balance of moments created by the action of forces. It is done only for AC, but there will be an identical result on DB because dimensions are the same.

$\sum F_{OX} = 0$

$\Rightarrow P_X - F_X = 0$

$\Rightarrow P_X = F_X$

$F_X = P\ cos\beta$

$\sum F_{OY} = 0$

$\Rightarrow -\frac{W}{2} + P_Y - F_Y - \frac{W_{legs}}{2} + C_y = 0$

$\Rightarrow -\frac{W}{2} + P_Y - F_Y - \frac{W_{legs}}{2} + \frac{W + W_{legs}}{2} = 0$

$\Rightarrow P_Y = F_Y$

$F_y = P\ sin\beta$

Rotating around point C, CCW is positive direction:

$\sum M_C = 0$

$\Rightarrow \frac{W_{legs}}{2} . \frac{L}{2} cos\alpha + \frac{W}{2} L\ cos\alpha - P\ sin\beta (\frac{L}{2} + a) cos\alpha + F_y \frac{L}{2} cos\alpha - P\ cos\ \beta (\frac{L}{2} +$

$a) sin\alpha + F_x \frac{L}{2} sin\alpha = 0$

$\Rightarrow \frac{W_{legs}}{2} . \frac{L}{2} cos\alpha + \frac{W}{2} L\ cos\alpha - P\ sin\beta (\frac{L}{2} + a) cos\alpha + P\ sin\beta \frac{L}{2} cos\alpha - P\ cos\beta$

$(\frac{L}{2} + a)\sin\alpha + P\cos\beta\,\frac{L}{2}\sin\alpha = 0$

$\Rightarrow \frac{W_{legs}}{2} \cdot \frac{L}{2}\cos\alpha + \frac{W}{2} L\cos\alpha + P(-\sin\beta\,(\frac{L}{2} + a)\cos\alpha + \sin\beta\,\frac{L}{2}\cos\alpha - \cos\beta\,(\frac{L}{2} + a)\sin\alpha + \cos\beta\,\frac{L}{2}\sin\alpha) = 0$

$\Rightarrow \frac{W_{legs}}{2} \cdot \frac{L}{2}\cos\alpha + \frac{W}{2} L\cos\alpha + P(\sin\beta\cos\alpha(-(\frac{L}{2} + a) + \frac{L}{2}) + \cos\beta\sin\alpha\,(\frac{L}{2} - (\frac{L}{2} + a))) = 0$

$\Rightarrow \frac{W_{legs}}{2} \cdot \frac{L}{2}\cos\alpha + \frac{W}{2} L\cos\alpha + P(-a(\sin\beta\cos\alpha + \cos\beta\sin\alpha)) = 0$

Rule from geometry:

$\sin\beta\cos\alpha + \cos\beta\sin\alpha = \sin(\alpha + \beta)$

$\Rightarrow L\cos\alpha\,(\frac{W_{legs}}{4} + \frac{W}{2}) + P(-a\sin(\alpha + \beta)) = 0$

$$P = \frac{L\cos\alpha\,(\frac{W_{legs}}{4} + \frac{W}{2})}{a \cdot \sin(\alpha + \beta)}$$

$$P = \frac{L\cos\alpha\,(\frac{W_{legs}}{4} + \frac{W}{2})}{a \cdot \sin(\alpha + \beta)}$$

In this project, there was the following order of actions : first, based on the existing examples and approximate representation what has to be the elevator, rough 3D model was drawn , which can be seen on Figure 10.5, to get the needed measurements and numbers with which calculations can be done . Then in case if the model does not correspond to the necessary result it can be changed in an appropriate way.

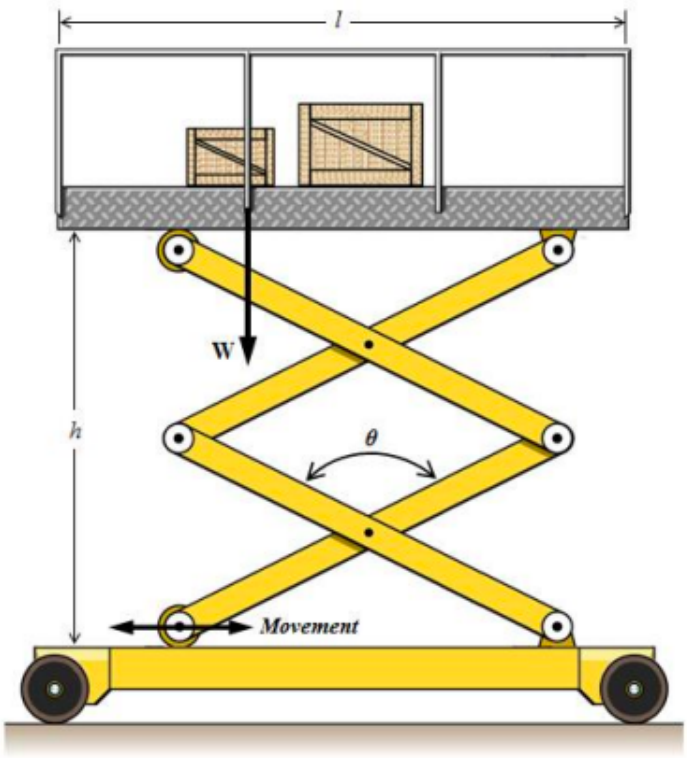


Figure 5.5 3D view of the lift

Having the 3D, the needed dimensions for further calculations can be obtained, which can be seen on Figure 5.6.



Figure 5.6 Dimensions in the lowest position

According to the design there are the following measurements:

Our Project	If Consider
L = 0.90 meters a = 0.33 meters Mass of the load is 100kg. Mass of the legs is 30 kg. Let, $\alpha = 5^{o}$ $\beta = 13\ ^{\circ}$	L = 2 meters a = 1 meters Mass of the load is 500kg. Mass of the legs is 100 kg. Let, $\alpha = 5^{o}$ $\beta = 13\ ^{\circ}$
$P = \frac{L cos\alpha \left(\frac{W_{legs}}{4} + \frac{W}{2}\right)}{a \,.\, sin(\alpha + \beta)}$ $P = \frac{0.90\ cos5^{o}\left(\frac{981}{2} + \frac{294.3}{4}\right)}{0.33 \,.\, sin\,(5^{o} + 13^{\circ})}$ $P = 4960\ N$	$P = \frac{L cos\alpha \left(\frac{W_{legs}}{4} + \frac{W}{2}\right)}{a \,.\, sin(\alpha + \beta)}$ $P = \frac{2^{*}\ cos5^{o}\left(\frac{490500}{2} + \frac{981}{4}\right)}{1 \,.\, sin\,(5^{o} + 13^{\circ})}$ $P = 1.58\ MN$

Table 5.1 lower side load calculation and compare

5.1.2 Highest position

On Figure 10.7 the free body diagram for the highest position of the lift is shown:



Figure 5.1.2.1 free body diagram for the highest position

d =.45 meters

AB= .35 meters

$\sum M_C = 0$

$\Rightarrow w.d + W_{legs}\left(\frac{AB}{2}\right) - D_y \,.\, AB = 0$

$\Rightarrow D_y = \frac{w \,.\, d + W_{legs}\left(\frac{AB}{2}\right)}{AB}$

$\Rightarrow D_y = 1.23\, w + 0.5 W_{legs}$

$\sum F_{OY} = 0$

$\Rightarrow D_y - C_y - W_{legs} - w = 0$

$\Rightarrow C_y = 1.23\,w + 0.5W_{legs} - W_{legs} - w$

$\Rightarrow C_y = .23w - 0.5\,W_{legs}$

According to the behavior of the legs: C_y = -B, and D_y = -A, for the free body diagrams of the legs in the highest position which is shown on Figure 10.8. Calculations are done only for AC, but there will be an identical result on DB because dimensions are the same.

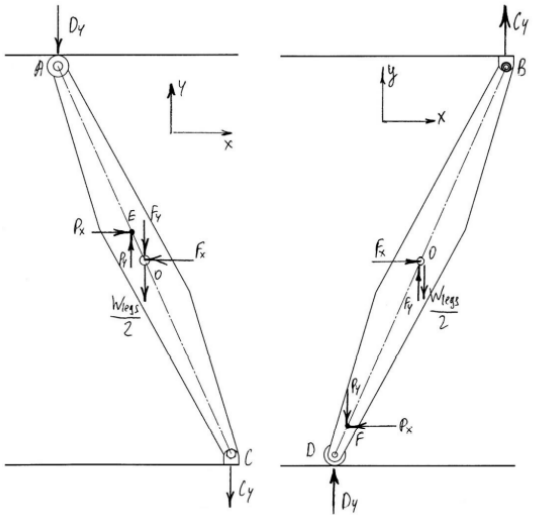


Figure 5.1.2.2 free body diagram of legs in highest position

$\sum F_{OX} = 0$

$\Rightarrow P_X - F_X = 0$

$\Rightarrow P_X = F_X$

$F_X = P\cos\beta$

$\sum F_{OY} = 0$

$$\Rightarrow -D_y + P_Y - F_Y - \frac{W_{legs}}{2} - C_y = 0$$

$$\Rightarrow F_Y = P_Y - D_y - \frac{W_{legs}}{2} - C_y$$

$$\Rightarrow F_Y = P_Y - 1.23\,w + 0.5W_{legs} - \frac{W_{legs}}{2} - .23w - 0.5\,W_{legs}$$

$\Rightarrow F_Y = P_Y - 1.46\,w - 0.5 W_{legs}$

$\Rightarrow F_Y = P \sin\beta - 1.46\,w - 0.5 W_{legs}$

$\sum M_C = 0$

$\Rightarrow \frac{W_{legs}}{2} \cdot \frac{L}{2} \cos\alpha + D_y L \cos\alpha - P \sin\beta \left(\frac{L}{2} + a\right) \cos\alpha + F_y \frac{L}{2} \cos\alpha - P \cos\beta \left(\frac{L}{2} + a\right) \sin\alpha + F_x \frac{L}{2} \sin\alpha = 0$

$\Rightarrow \frac{W_{legs}}{2} \cdot \frac{L}{2} \cos\alpha + 1.23w\, L \cos\alpha + 0.5 W_{legs}\, L \cos\alpha - P \sin\beta \left(\frac{L}{2} + a\right) \cos\alpha + P \sin\beta \frac{L}{2} \cos\alpha - 1.46w \frac{L}{2} \cos\alpha - 0.5 W_{legs} \frac{L}{2} \cos\alpha - P \cos\beta \left(\frac{L}{2} + a\right) \sin\alpha + P \cos\beta \frac{L}{2} \sin\alpha = 0$

$\Rightarrow 0.5 W_{legs}\, L \cos\alpha + 0.5w\, L \cos\alpha + P \left(-\sin\beta \frac{L}{2} \cos\alpha - \sin\beta . a . \cos\alpha + \sin\beta \frac{L}{2} \cos\alpha - \cos\beta \frac{L}{2} \sin\alpha - \cos\beta . a . \sin\alpha + \cos\beta \frac{L}{2} \sin\alpha\right) = 0$

$\Rightarrow 0.5 W_{legs}\, L \cos\alpha + 0.5w\, L \cos\alpha + P \left(-\sin\beta . a . \cos\alpha - \cos\beta . a . \sin\alpha\right) = 0$

$\Rightarrow 0.5 W_{legs}\, L \cos\alpha + 0.5w\, L \cos\alpha - P . a(\sin\beta \cos\alpha - \cos\beta \sin\alpha) = 0$

$\Rightarrow 0.5 L \cos\alpha (W_{legs} + w) - P . a(\sin\beta \cos\alpha - \cos\beta \sin\alpha) = 0$

$\Rightarrow \sin\beta \cos\alpha + \cos\beta \sin\alpha = \sin(\alpha + \beta)$

$\Rightarrow 0.5 L \cos\alpha (W_{legs} + w) - P . a \sin(\alpha + \beta) = 0$

$$P = \frac{L \cos\alpha \left(\frac{w}{2} + \frac{W_{legs}}{2}\right)}{a \sin(\alpha + \beta)}$$

The formula can be used for calculating the force in the cylinder in any position where reactions *Cy* and *Dy* are not the same, it means that any position except initial - lowest position, because in that position dimension between DC is the same dimension.

According to the design there are the following measurements:

Our Project	If Consider
L = 0.90 meters a = 0.11 meters Mass of the load is 100kg. Mass of the legs is 30 kg. $\alpha = 66^{o}$ $\beta = 72^{\circ}$	L = 2 meters a = 0.33 meters Mass of the load is 500kg. Mass of the legs is 100kg. $\alpha = 66^{o}$ $\beta = 72^{\circ}$
$P = \frac{L \cos\alpha \left(\frac{w}{2} + \frac{W_{legs}}{2}\right)}{a \sin(\alpha + \beta)}$ $P = \frac{0.90 \cos 66^{o} \left(\frac{294.3}{2} + \frac{981}{2}\right)}{0.11 \sin(72^{o}+66^{o})}$ $P = 1.4\ N$	$P = \frac{L \cos\alpha \left(\frac{w}{2} + \frac{W_{legs}}{2}\right)}{a \sin(\alpha + \beta)}$ $P = \frac{02 \cos 66^{o} \left(\frac{490500}{2} + \frac{981}{2}\right)}{0.33 \sin(72^{o}+66^{o})}$ $P = 405.33\ KN$

Table 5.2 upper side load calculation and compare

5.1.3 Driving Shaft load, different stress calculation

Reference book, Machine Design R.S. KHURMI J.K. GUPTA Chapter 11

Threads related different formula:

Initial tension in a bolt:

$Pi = 2840d$ N

Where,

P_i = Initial tension in a bolt, and

d = Nominal diameter of bolt, in mm.

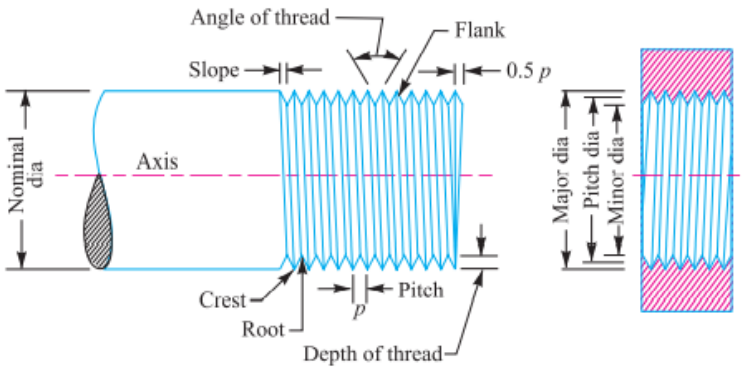


*Figure 2Figure 4.3. 1*Figure 5.2 Terms used in screw threads.

Stress area:

$$\text{Stress area} = \frac{\pi}{4} * \frac{(d_p + d_c)^2}{4}$$

Where,

d_p = Pitch diameter, and

d_c = Core or minor diameter.

Torsional shear stress:

$$\tau = \frac{16\ T}{\pi \times d_c^{\ 3}}$$

Where,

τ = Torsional shear stress,

T = Torque applied, and

d_c = Minor or core diameter of the thread.

Shear stress across the threads:

$$\tau_S = \frac{P}{\pi d_c \times b \times n}$$

Where,

τ_S = Shear stress across the threads

b = Width of the thread section at the root.

Compression or crushing stress on threads:

$$\sigma_c = \frac{P}{\pi d \times (d^2 - d_c^3) \times n}$$

Where,

d = Major diameter,

n = Number of threads in engagement.

Bending stress if the surfaces under the head or nut are not perfectly parallel to the bolt axis:

$$\sigma_b = \frac{x \,.E}{2l}$$

Where,

x = Difference in height between the extreme corners of the nut or head,

l = Length of the shank of the bolt, and

E = Young's modulus for the material of the bolt

Shearing load carried by the bolts:

$$P_s = \frac{\pi}{4} \times d^2 \times \tau \times n$$

Where,

P_s = Initial tension in a bolt

Driving Shaft different value of our project:

Our Project	If Consider
Major diameter = 24 mm = 0.024 m Pitch diameter d_p = 23 mm Core or Minor diameter d_c = 22 mm Pitch = 2 mm Width of the thread section at the root = 2 mm Number of threads in engagement n = 18*9 =162 Difference in height between the extreme corners of the nut or head x = 24.2 mm Length of the shank of the bolt l=0.45m Let, T = 25 N-m = 25000 N-mm	Major diameter = 240 mm = 0.24 m Pitch diameter d_p = 230 mm = 0.23 m Core or Minor diameter d_c = 0.22 m Pitch = 20 mm Width of the thread section at the root = 20 mm Number of threads in engagement n = 45 Difference in height between the extreme corners of the nut or head x = 240.2 mm = 0.2402 m Length of the shank of the bolt l = 1m Let,

E= 220 G-Pa	T = 25 N-m = 25000 N-mm E= 220 G-Pa
Initial tension in a bolt: *Pi = 2840d* N =2840*0.024 = 68.16 N	Initial tension in a bolt: *Pi = 2840d* N =2840*0.24 = 681.6 N
Stress area = $\frac{\pi}{4} * \frac{(d_p + d_c)^2}{4}$ $= \frac{\pi}{4} * \frac{(23+22)^2}{4}$ = 400 mm^2 = 0.0004 m^2	Stress area = $\frac{\pi}{4} * \frac{(d_p + d_c)^2}{4}$ $= \frac{\pi}{4} * \frac{(230+220)^2}{4}$ = 40000 mm^2 = 0.04 m^2
Torsional shear stress: $\tau = \frac{16\ T}{\pi \times d_c^3}$ $\tau = \frac{16 \times 25}{\pi \times 0.022^3}$ = 11957546 Pa =11.95 MPa	Torsional shear stress: $\tau = \frac{16\ T}{\pi \times d_c^3}$ $\tau = \frac{16 \times 25}{\pi \times 0.22^3}$ = 11957.546 Pa =119.5 KPa
Shear stress across the threads: $\tau_s = \frac{16\ T\ d_o}{\pi \times (d_o^4 - d_i^4)}$ $\tau_S = \frac{P}{\pi d_c \times b \times n}$ $\tau_S = \frac{68.16}{\pi \times 0.022 \times 0.002 \times 162}$	Shear stress across the threads: $\tau_s = \frac{16\ T\ d_o}{\pi \times (d_o^4 - d_i^4)}$ $\tau_S = \frac{P}{\pi d_c \times b \times n}$ $\tau_S = \frac{681.6}{\pi \times 0.22 \times 0.02 \times 45}$

=3044 Pa	= 1095 Pa
Average thread shear stress: $\tau_n = \frac{P}{\pi d \times b \times n}$ $\tau_n = \frac{68.16}{\pi \times 0.024 \times 0.002 \times 162}$ =2790 Pa	Average thread shear stress: $\tau_n = \frac{P}{\pi d \times b \times n}$ $\tau_n = \frac{681.6}{\pi \times 0.24 \times 0.02 \times 45}$ =1004 Pa
Compression or crushing stress on threads: $\sigma_c = \frac{P}{\pi d \times (d^2 - d_c^3) \times n}$ $\sigma_c = \frac{68.16}{\pi \times 0.024 \times (0.024^2 - 0.022^3) \times 162}$ =9870 Pa	Compression or crushing stress on threads: $\sigma_c = \frac{P}{\pi d \times (d^2 - d_c^3) \times n}$ $\sigma_c = \frac{681.6}{\pi \times 0.24 \times (0.24^2 - 0.22^3) \times 45}$ =2184 Pa
Bending stress if the surfaces under the head or nut are not perfectly parallel to the bolt axis: $\sigma_b = \frac{x \cdot E}{2l}$ $\sigma_b = \frac{0.0242 \times 220}{2 \times 0.457}$ =5.82 G-Pa	Bending stress if the surfaces under the head or nut are not perfectly parallel to the bolt axis: $\sigma_b = \frac{x \cdot E}{2l}$ $\sigma_b = \frac{0.242 \times 220}{2 \times 1}$ = 26.62 G-Pa
Shearing load carried by the bolts: $P_s = \frac{\pi}{4} \times d^2 \times \tau \times n$	Shearing load carried by the bolts: $P_s = \frac{\pi}{4} \times d^2 \times \tau \times n$

$P_s = \frac{\pi}{4} \times 0.024^2 \times 11.95 \times 162$ = 875 KN	$P_s = \frac{\pi}{4} \times 0.24^2 \times 119.5 \times 45$ = 244 KN

Table 5.2.1 Driving Shaft load, stress calculation and compare

5.1.4 Welding Shear stress and maximum shear stress calculation:

Reference book, Machine Design R.S. KHURMI J.K. GUPTA chapter 10

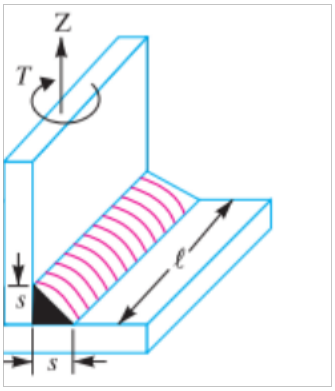


Fig. 5.11 Long fillet weld subjected to torsion.

Welding related different formula:

Shear stress:

$$\tau = \frac{T \times \frac{l}{2}}{t \times \frac{l^3}{6}}$$

Maximum shear stress:

$$\tau_{max} = \frac{3T}{0.707s \times l^2}$$

Where,

τ = Shear stress

τ_{max} = Maximum shear stress

T = Torque acting on the rod,

s = Size (or leg) of weld,

t = Throat thickness,

l= Length of welding

Welding different value of our project:

Our Project	If Consider
Length l = 70 mm =0.070 m Thickness = 5 mm = 0.005 m Fillet weld s = 2 mm =0.002 m Let, Permissible shear stress σ_t =55 MPa	Length l = 700 mm =0.70 m Thickness t = 50 mm = 0.05 m Fillet weld s = 20 mm =0.02 m Let, Permissible shear stress σ_t =55 MPa
Static load: $P = 0.707s \times l \times \sigma_t$ $P = 0.707 \times 0.002 \times 0.07 \times 55$ = 5444 N	Static load: $P = 0.707s \times l \times \sigma_t$ $P = 0.707 \times 0.02 \times 0.7 \times 55$ = 544.4 KN
Shear stress: $\tau = \frac{T \times \frac{l}{2}}{t \times \frac{l^3}{6}}$ $\tau = \frac{3T}{t \times l^2}$	Shear stress: $\tau = \frac{T \times \frac{l}{2}}{t \times \frac{l^3}{6}}$ $\tau = \frac{3T}{t \times l^2}$

$\tau = \frac{3\times 25}{0.005 \times 0.07^2}$ =3.06 MPa	$\tau = \frac{3\times 25}{0.05 \times 0.7^2}$ =3.06 G-Pa
Maximum shear stress: $\tau_{max} = \frac{3T}{0.707s \times l^2}$ $\tau_{max} = \frac{4.242\ T}{s \times l^2}$ $\tau_{max} = \frac{4.242\times 25}{0.002 \times 0.07^2}$ = 10.8 M-Pa	Maximum shear stress: $\tau_{max} = \frac{3T}{0.707s \times l^2}$ $\tau_{max} = \frac{4.242\ T}{s \times l^2}$ $\tau_{max} = \frac{4.242\times 25}{0.002 \times 0.07^2}$ = 10.8 M-Pa

Table 5.2.1 welding load, stress calculation and compare

5.1.5 Bolt shearing stress calculation:

Reference book, Machine Design R.S. KHURMI J.K. GUPTA chapter14

Our Project	If Consider
Bolt diameter d= 10 mm Let, T= 25 N-m	Bolt diameter d= 100 mm Let, T= 25 N-m

Stress:	Stress:
$\tau = \frac{16\ T}{\pi \times d^3}$	$\tau = \frac{16\ T}{\pi \times d^3}$
$\tau = \frac{16 \times 25}{\pi \times 0.01^3}$	$\tau = \frac{16 \times 25}{\pi \times 0.1^3}$
=127.4 MPa	=127.4 K-Pa

Table 5.2.2 bolt load, stress calculation and compare

5.1.6 Mechanical Advantage Calculation

Form our project data,

Pitch, h = p= 0.02m

Output load, W= 60 kg

Handle radius, l=200mm= 0.3m

Apply load, $F = \frac{W \times h}{s} = \frac{60 \times .002}{1.8} = 0.66$

$S = 2\pi l = 2\pi \times 0.20 = 1.25$

Mechanical Advantage $MA = \frac{load}{effort} = \frac{2\pi l}{p} = \frac{1.25}{.02} = 62.5$

5.2 Result:
Allowable Stress is-

Average thread shear stress =2790 Pa

Mechanical Advantage MA = 62.5

5.3 Advantage

Since the emergence in the light of different cultural achievements, the individual tries to maximize their use to facilitate the work. Only a century ago, the society did not have the opportunity even to dream about what is already

openly available at present. The rough labor is replaced by technology, for example lifting mechanisms. "A scissor lift elevator is a vertical transportation cab which is raised and lowered from underneath, somewhat like a traditional hydraulic elevator, except that instead of a hydraulic cylinder the extendable mechanism is a folding lattice of crisscrossed beams similar to a pantograph. The entire mechanism extends upward when pressure is applied to the lowest members. (Standards.phorio.com 2013).

People use a huge number of different lifts. The aim is also different, some are used in some situations while others are for a totally different environment. For example, there is an electro-hydraulic scissors elevator quite a small device allowing to lift hundreds of kilograms of freight on a height of tens of meters.

Thus , in particular , the hydraulic scissor hydraulic lift has been used successfully to electrical and other works on the heights of about 2-3 floors . Also, it allows making work at a greater height than tens of meters.

On Figure 5.1 below general examples of scissors elevators can be seen.



Figure 5.1 General examples (sv-e.com 2013).

Also, lifts of this type could also be applied to other conditions, such as daily loading and unloading work in warehouses. The scissor lift perfectly meets the needs for certain warehouse facilities, mainly because of the fact that above the lifting platform it has a lack of any mechanisms. This is complemented by access from all four sides, which gives the opportunity to use it for loading of objects on the top shelves of warehouse racks.

A distinctive feature of an electro- hydraulic scissor lift in comparison with other analogues is the low price due to the use of a relatively simple design. A special lifting platform is driven by a simple metal structure with levers that look like scissors connected with others in a long chain. As a lifting force is used electro hydraulic mechanism for driving a pair of scissors in motion (sv-e.com 2013).

In addition, a scissor lift is suitable for use in situations, where movement of other types of lifts is limited. This capability makes this type of lift particularly versatile and convenient. A platform with load is movable not only vertically, but also on the meter to the side, as is for example available on some models. This feature is highly convenient in situations in the workplace where there is no possibility to put the basis of lift exactly under the desired object (sv-e.com 2013).

5.4 Application

- ✓ Plants, venues and construction sites
- ✓ Equipment installation in complex environments
- ✓ Pipeline installation
- ✓ Decoration, cleaning and maintenance of building walls
- ✓ Manufacturing and maintenance of large equipment
- ✓ Supermarket and warehouse logistics

Chapter 6

Conclusion, Future Scope and Reference

6.1 Conclusion

The project was carried out successfully according to the project plan. The out-come of the mechanical scissors lift design meets the objective of the project. As a result, the project designed the mechanical drive parallelogram lift. The general section described the defining an aim, classification, purpose and technical characteristics of the lift, and the mechanism and operation principle of the designed lift.

In the design section, the lift calculation is done, where the forces acting in the driving shaft and emerging stresses in the system were calculated.

After completed this project, I have gained some skills and knowledge in this field. I have learnt many things in terms of utilizing engineering mechanisms in a proper manner. Finally, the experience I have obtained throughout this project will certainly help me to be a creative engineer in the future.

6.2 Future Scope

The design and construction of the hydraulic scissors lift is to lift up to a height of 1.5m and carrying capacity of less than 100kg (100 kilograms) with the available engineering materials. However, there is for academic purpose, a similar project for general carrying capacity with a selection of better engineering materials.

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