Palestine Polytechnic University

College of Engineering

Development Of Transportation System For Dates Industry

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Mechanical Engineering

Developement Of Transportation System For Dates Industry

By the guidance of our supervisor , and by the acceptance of all members in the testing committee, this project is delivered to Mechanical Engineering Department in the college of engineering and technology , to be as a fulfillment of the requirement of the department for the Bachelor's degree of Mechanical Eng. / Automotive Engineering .

Supervisor signature

Dr. Arafat

Testing committee sigaature

14/2/2019

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The head of department signature

Dedication (Arabic)

إلى السنبلة الذهبيّة في بِلادي وبيّارات البرتقال ...إلى كرومِ العِنَب وغصن الزيتون ...ودَم الشهداء ودَمعة الأطفال.... إلى رغيف الطابون وريح الزَعتر .....إلى (فِلسطين) تِلك التي صَنعتني كَي أكونَ هُنا.

إلى الشموع التي احترقت لتصنع لنا غدا أفضل ..... (شهداء الحرية).

إلى القابعين خلف القضبان لننعم بطعم الحرية.... (أسرانا البواسل).

إلى ملاكي في الحياة...الى معنى الحب والى معنى الحنان والتفاني.... الى بسمة الحياة وسر الوجود...الى من كان دعائها سر نجاحي وحنانها بلسم جراحي الى أغلي الحبايب... (امي الحبيبة)

الى من كلله الله بالهيبة والوقار.... الى من علمني العطاء بدون انتظار.... الى من احمل اسمه بكل افتخار. ارجو من الله ان يمد في عمرك لترى ثمارا قد حان قطافها بعد طول انتظار وستبقى كلماتك نجوم اهتدي بها اليوم وفي الغد والى الابد... (والدي العزيز)

إلى من تحلو بالإخاء وتميزوا بالوفاء والعطاء إلى ينابيع الصدق الصافي.....(أصدقائي).

إلى الذين أجدهم معي في السراء والضراء .... (أقاربي الأعزاء) .

إلى من سرنا سوياً ونحن نشق الطريق معاَ نحو النجاح والإبداع إلى... (زميلاتي وزملائي)

إلى أولئك الذين يحملون على كاهلهم بناء جيل المستقبل.... (أساتذتنا الكرام).

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Abstract

Traditional means of transportations, such as forklifts and manual labor used in warehouses, is considered one of the problems that seek solution because these means causes waste of time and money, inconvenience, breakdowns, expensive materials in addition to risks to the workers and the product itself. Finding a solution is very important especially to the owner of commercial establishments and warehouses.

Thus, this project aims at designing a transportation system of the stock within the warehouses easily and accurately in a way that saves time, efforts, cost, and reduces congestion and inconvenience.

Proposed Design is a trailer suitable for hauling fruit bins or the like, pivotally connected to hitch and supported by an axle assembly, which includes an offset cross shaft.a

An hydraulically actuated cam assembly rotates the cross shaft so that the rear end of the trailer can be lowered to the ground for easy loading and unloading without raising the forward end.

A date transfer system has been designed to transfer the date product between the production and manufacturing stages, replacing the traditional transport system (forklifts). This system provides 62% of the time required to complete the transport.

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Chapter 1 Introduction

1.1 Overview

The process of storing and transporting goods within the warehouses is one of the most important things that are taken into consideration. There are several factors affecting the choice of means of transportation. These factors are (mass, Physical & chemical) properties of the transported body, in addition to the nature of the passages it will be transferred through.

Based on this, the goods are commonly handled manually by labors in the case of lightweight bodies that have regular shape and not fragile. However, chemical or explosive material is not eligible for manual transportation.

If the body to be transported is irregular or heavy and transferred for long distances, a transportation system should be taken into consideration

The transportation system should be suitable for the characteristics of the transferee body. It should provide comfort, maintenance of the means of transport at the lowest cost, as well as the availability of technicians with the ability to deal with the maintenance of this system.

1.2 Importance of the project:

The date sector in Palestine is witnessing a development in production and employment of labor, and a breakthrough for new markets and self-sufficiency, a sector that deserves attention, it is the next oil of Palestine, and will increase the rates of gross national income.
This sector embraces about 370 thousand palm trees, which requires more labor, which reached in this sector to about 6,200 workers and employees, and is expected to increase the number in the coming years from 12 thousand workers to 17 thousand workers .
The production of dates from the Palestinian territories in the year 2017 to 17 thousand tons, while production is expected to rise in 2018 to 20 thousand tons

The method of choosing a transportation system is very important, and it is one of the problems faced by the owner of big business or plant. Therefore, there should be a developed transportation system for handling products within the warehouses so as to save time, efforts, cost, and to ensure the easy movement and accurate mobility.

1.3 Projectobjectives:

This project aim to provide the required integrated system for the transfer of product boxes and the transition between the production stages using an integrated system that ensures saving time effort, annual cost and reduce congestion.

1.4Motivation

The motivation behind this project is the need for a method or system that transfers the date's boxes between the stages of production going through, as the provision of such means and systems in factories and facilities provides many advantages such as saving time, effort, comfort and reducing the percent error during the transfer process. However, it is worthy to mention that many factory owners and plants hesitate to use such systems.

1.5 Project layout

The project is a trailer suitable for hauling fruit bins or the like, pivotally connected to a hitch and supported by an axle assembly, which includes an offset cross shaft as in Figure 1.1. An hydraulically actuated cam assembly rotates the cross shaft so that the rear end of the trailer can be lowered to the ground for easy loading and unloading without raising the forward end. The trailer also has a stop mechanism on its rear end, which is actuates by the same cam assembly, which rotates the axle, to automatically place it in operative position when the trailer is raised .

Figure 1.1 : The proposed project

1.6 Time plan:

The table 1.1 and table 1.2 shows the time plan in first and second semester :

Table 1.1 Schedule Time-first semester

Task\Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Visit the factory and study the work site																
State of the art																
General study of the plant																
Writing and documentation																
Draw the project through an engineering drawing program																
Design of the system																

Table 1.2 Schedule Time-Second semester

Task/Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
We went to visit the company																
Draw the prototype through an engineering drawing program																
Build the outer shape of the prototype																
Design of the system And buy the required Component																
Building the prototype and assembly																
Writing and documentation																

1.7Parts list and budget:

The table 1.3 shows the parts of machine and price of each one and total cost of all project.

Table 1.3 Total cost

Tools & Device	Items	Item Price(Nis)	Total Price (Nis)
Steel	1	500	500
Tires	2	75	150
Contactors& circuit breaker	2	40	80
Switches &lamps &Power panel	1	280	280
gear of motor & shaft &lathe	1	500	500
Selector 5/3	1	250	250
.Intermediate jacks	2	175	350
Chain	1	90	90
pneumatic tube	1	100	100
Industrial cost			1200
Selector 5/2	1	150	150
Power supply	1	100	100
Bearings	6	-	250
main jacks	1	130	130
Electrical motor	1	300	300
Throttles of the pneumatic jacks	6	-	80
Total	4510 NIS		

CHAPTER 2

State of the art

2.1Introduction

2.2 Counterbalance Forklift Truck

2.3 The Three-Wheel Counterbalance Forklift

2.4 Narrow Aisle Trucks

2.5Conveyor system using three-level converters

2.6 Rail transport system

2.7 Bin Trailer (shuttle)

Chapter 2 State of the art

2.1 Introduction

By looking at the various means of transportation used in warehouses, companies, workplaces and considering the scientific papers related to these types of transport. This chapter will contain some of the means of transportation currently used. Studies and experiences of these means, an explanation of what distinguishes the idea of our project from these means and highlight the advantages and disadvantages of them.

2.2 Counterbalance Forklift Truck

This is the proper name of the traditional forklift, which everyone is familiar with it's called a counterbalance forklift because the load that's being carried in the front is counterbalanced by a heavy weight mounted on the back of the vehicle as in Figure2.1 . The forks are often attached to a mast that can raise the load several feet up off the ground. This makes it easier to move the load, in addition to some masts are high enough that the load can be place on the second level of a shelving system [1].

Forklift counterbalance trucks can power by gas power, diesel or electric batteries. They are often using in warehouses, construction sites, and other shipping/storage facilities [1].

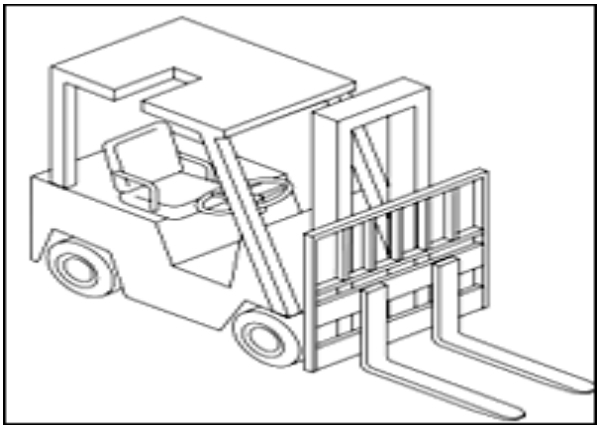


Figure 2.1: Counterbalance Forklift [1]

2.3The Three-Wheel Counterbalance Forklift

This type of forklift is very similar to the standard counterbalance forklift with one exception: it features a third wheel located in the middle of the back part of the forklift. This gives the vehicle much more maneuverability as shown in Figure 2.2. While standard counterbalance forklifts need a good amount of space to make turns, a three-wheel forklift can actually spin in a very tight circle.

Three-wheeled counterbalance forklifts are manly used in warehouses and loading docks where there is not much room for maneuvering or turning [1].

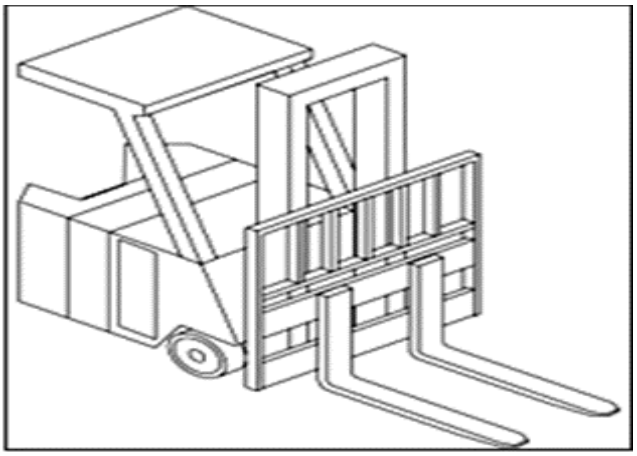


Figure 2.2: The Three-Wheel Counterbalance

2.4 Narrow Aisle Trucks:

Narrow-aisle trucks are design to work in areas narrower than 12 feet (144 inches). While they provide more storage space, narrow aisle storage systems require reach trucks and order pickers to operate in much narrower aisle widths as in Figure2.3.

Narrow-aisle trucks use electric motors. They work in aisles 8 to 9 1/2 feet wide. They come mostly as stand-up riders. This configuration helps increase productivity and operator comfort.

Reach trucks use a pantograph that lets the operator extend or retract the load without moving the lift truck [2].

Figure 2.3: Narrow Aisle Trucks [2]

2.5Conveyor system using three-level converters

This paper presents a very new drive system. Eight 2500 kW motors are driven by three-level inverters with GTOs as in Figure 2.4. A three-level active front end (AFE) is use at the input side of each inverter. A GTO chopper is use to provide controlled electrical braking in case of line loss. The paper presents the requirements and alternatives for the drive system and the control strategies for

the converters and the belt. A novel application of the selective harmonic elimination method is use to reduce the input current harmonics. Special attention is dedicates to the interaction with the electrical network. The most relevant features of the system are: (i) fusels operation; (ii) adjustable power factor; (iii) reduced input current harmonics; and (iv) smooth transition between motoring and regenerating modes and 15 MW of regenerated power with more than six months of successful operation [3].

Figure 2.4: Conveyor System [3]

2.6 Rail transport system:

The rail transport system may generally be an elevated rail system that may be located along existing transportation right of ways such as roads, railroads, rivers, etc. as in Figure 2.5. While the system is generally structured for elevated roadways, it may also have surface or ground level elements. The system uses rail sections and rail switch sections having two load rail elements to carry automobile carrier cars and passenger cars. Guide rails are attaches to the load rail elements by upstanding guide rail supports [4].

Figure 2.5: Rail transport system [4]

2.7 Bin Trailer (shuttle):

The invention is a trailer suitable for hauling fruit bins or the like, pivotally connected to a hitch and supported by an axle assembly, which includes an offset cross shaft as in Figure 2.6. An hydraulically actuated cam assembly rotates the cross shaft so that the rear end of the trailer can be lowered to the ground for easy loading and unloading without raising the forward end. The trailer also has a stop mechanism on its rear end, which is actuates by the same cam assembly, which rotates the axle, to automatically place it in operative position when the trailer is raised [5].

Figure 2.6: Bin Trailer [5]

By considering the previous studies on the different types of forklifts, tankers and railways, and the transport characteristics, types, advantages and disadvantages, we conclude that the best transport system is the bin trailer (shuttle)system. In this project, we are going to study and develop this system.

CHAPTER 3

General study of the plant

3.1 Introduction

3.2 Dates production phases

3.3 Sterilization stage

3.4 Cooling and storage stage

3.5 Sorting and packaging

3.6 Storage of finished products

Chapter 3 General study of the plant

3.1 Introduction

Many factories in Palestine face serious problems in the system of transporting products within factories , which cause wasting money. Some of them run in certain seasons as they depend on agriculture, such factories have limited period to fulfill the work, which means putting on too much efforts and paying high cost. The problem of efforts and money is very important to be studied.

Factories of this type are located in Jericho, the most important plants depends on palm trees, where the season ranges from three months to four months. In this period, the plant needs to double the effort to obtain the final product.

3.2 Dates production phases

It was observed through the study of constraintsof these plants specialized in the field of dates a problem in the transfer of dates boxes after the harvest where dates pass in more than one stage and the place is subject to several operations . First, sorting the dates according to the farm of origin. Second, transferring the date boxes to the sterilization and drying stores. Third, transferring the date boxes to the cooling refrigerators. Then, transfer the date's boxes to the packaging stage and form the product in the final form. Finally, the dates are stored in finished product refrigerating. The transport problem depends on the forklifts. Every single time box passes through all the stages, requiring at least 6-10 minutes, which is relatively long compare to the number of boxes.

The following Figure3.1 explains the date's production phases:

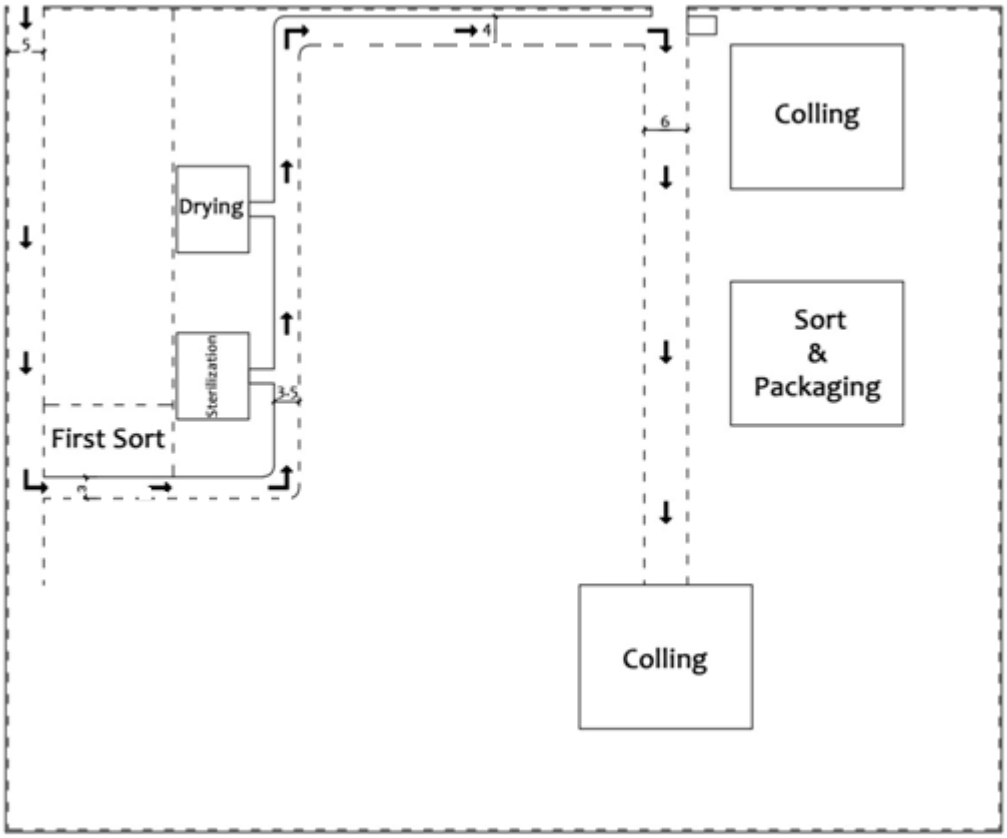


Figure 3.1: Production stages

*Appendix II

3.2.1 Sort stage

It is the first stage in which the dates are pass immediately after harvesting. The dates are sorted by the harvested farm, then sorted into the drying and sterilization rooms according to the dates as shown in the following Figure 3.2. The humid content is transferred to the drying rooms and the dry ones are transferred to the sterilization rooms. In addition, they are placed for a specified period to reduce humidity, taking into account weight before and after.

Figure 3.2:First sort stage

3.2.2 Drying stage

Wet dates are transferred after the initial screening stage to the drying rooms where the dates are placed in this room under a temperature suitable for a specified period as shown in Figure 3.3.

Figure 3.3: Drying stage

3.3 Sterilization stage

The date sterilization unit is an important part of the date processing and processing plant. It has a great role in sterilization of dates and killing all insects, larvae and outstanding eggs before starting washing, cleaning and packing operations as shown in Figure 3.4.

Figure 3.4: Sterilization stage

3.4 Cooling and storage stage:

The storage period is divides into two types:

.1. Temporary storage

.2. Long-term storage

Both types need to reduce the temperature of refrigerated materials in the beginning and then determine the optimum grades for each storage according to the specifications of the material.

Food In the case of dates needs to gradually reduce the temperature until it is not separated Peel the pulp and then determines the optimum degree of storage asshown in Figure 3.5.

Figure 3.5: Cooling and storage stage

3.5 Sorting and packaging

At this stage, dates are sorted by size into many sizes, large, medium and small. This stage is characterized by accurate and effective classification of date grains with the use of laser as illustrated as shown in Figure 3.6. Then packing dates taking into account the weight measured by electronic balance.

Figure 3.6: Sorting and packaging

3.6 Storage of finished products:

After finishing the packaging phase and obtaining the final product, the product is transferred to the refrigerators and stored in it according to the appropriate conditions for keeping the product.

CHAPTER 4

Proposed Design

Part 1:Full Scale Trailer:

4.1 Introduction

4.2 Design Description

4.3 Movement description

4.4 Design Requirements

4.5 Calculation design for the full scale

4.6 Design results

Part 2: Prototype:

4.7 Calculation design for the prototype

Part 1

Full Scale Trailer:

Chapter 4 Proposed Design

Part 1:Full Scale of bin Trailer

4.1 Introduction

This projects aim to provide the required integratedsystem for the transfer of product boxes, and the transition between the production stages using an integrated system that ensures saving time effort, annual cost and reduce congestion.

The proposed design is a trailer suitable for transfer dates bins or the like, pivotally connected to a hitch and supported by an axle assembly, which includes an offset cross shaft. hydraulically actuated cam assembly rotates the cross shaft so that the rear end of the trailer can be lowered to the ground for easy loading and unloading without raising the forward end. The trailer also has a stop mechanism on its rear end, which is actuated by the same cam assembly, which rotates the axle, to automatically place it in operative position when the trailer is raised

4.2 Design Description

The preliminary concept sketch for the trailer design is included and labeled assince all that is needed is a trailer that can carry bins that are designed for being lifted by forked machines, the trailer design will contain two long rails, similar to forklift forks. To fit five bins, the length of the rails must be 6.5 m on the basis of the number of boxes and the length of each box as it goes along with the length of the trailerand this accommodates all of the bins and leaves a small amount of rail as in Figure 4.1

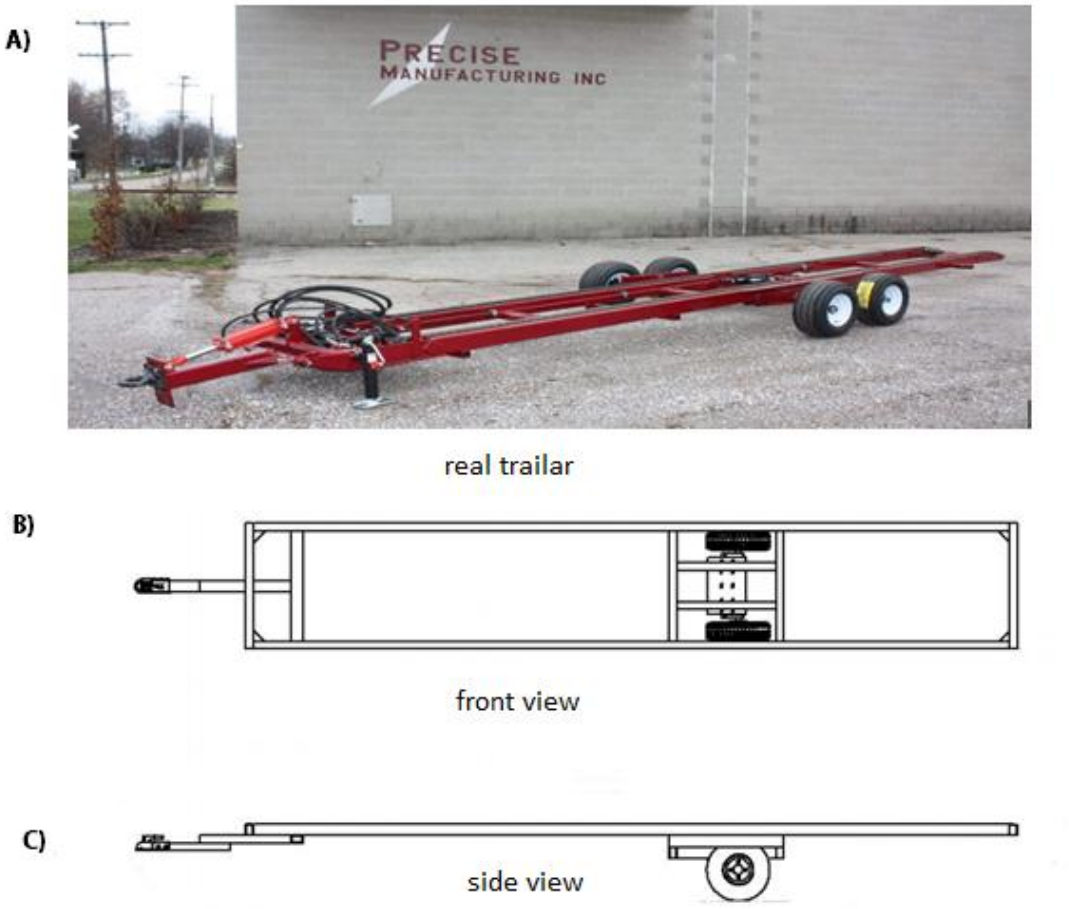


Figure 4.1: Bin Trailer

4.3 Movement description:

4.3.1 Loading process:

Date boxes are loaded on the trailer such that the hydraulic jack lefts the trailer in a specific angle, this angle allows the trailers back to slide under the box that make pushing the box easier using the chain as in Figure4.2.

4.3.2 Unloading process:

The hydraulic jack lefts the trailer from the front, and while unloading boxes the chain stops working and the tractor pulls the trailer then takes it away from under the boxes as in Figure4.2.

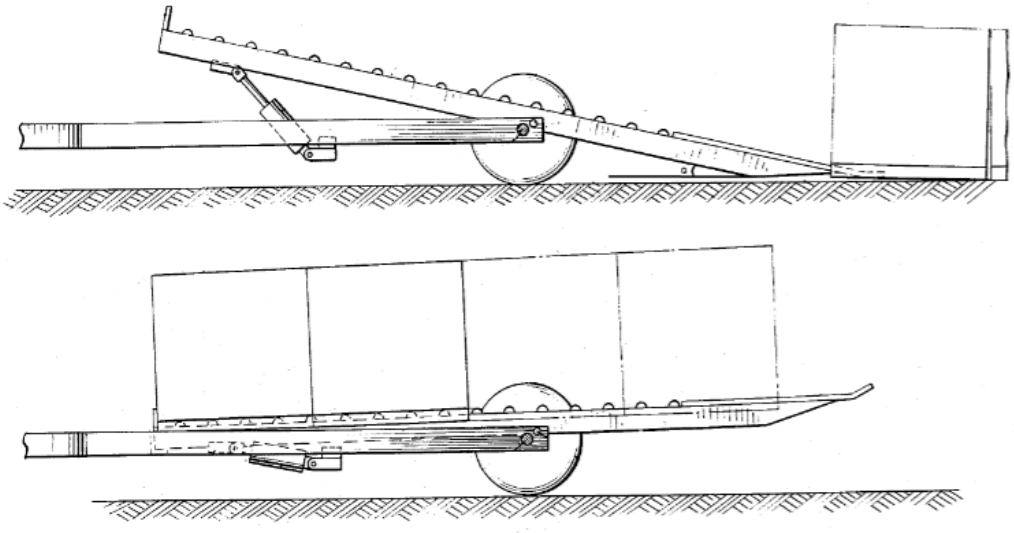


Figure 4.2: loading and uploading process

4.4 Design Requirements:

The design requirements for the device are as follows:

- The device must be a trailer.
- The device must be able to carry a total of 5 bins with a total combined length of 6.5 m.
- The device must be able to interface with Tractor.
- The device must be able to carry a total of distributed load 7.7 KN/m spread evenly over its length.
- The device will be able to travel for all stages under full load.

4.5 Calculation design for full scale of trailer:

4.5.1 Calculation Bin Trailer:

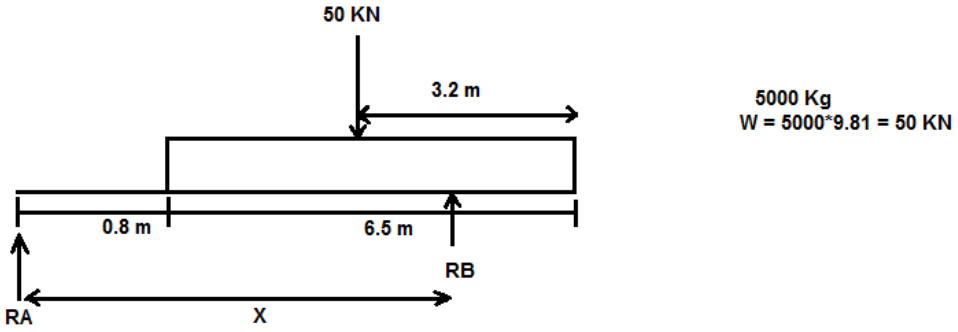


Figure 4.3 Free body diagram Bin Trailer

From figure 4.3

Position of tires on trailer that give the tail hitch coupling

(10-15) % of the distributed load.

$$(10+15)/2 = 12.5\ \%$$

RA = 50 * 12.5/100 = 6.25KN

ΣFy= 0 (4.1)

RA + RB = 50

RB + 6.25 =50

►RB = 43.75KN.

Through the figure 4.3

$\Sigma M_A = 0$ (4.2)

(0.8+3.25)*50 – RB*X = 0

► X = 4.6 m.

Calculate angle loading and uploading

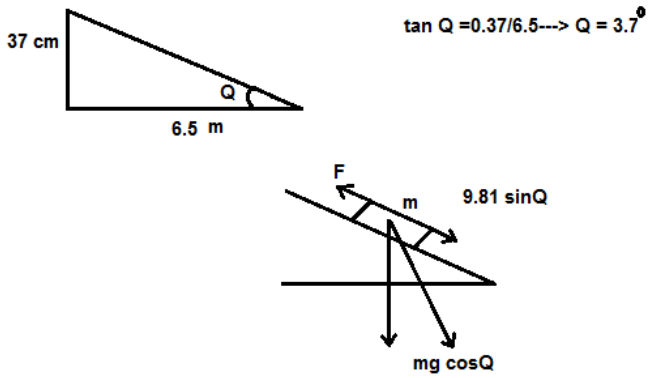


Figure 4.4: Free body diagram Bin Trailer

From figure 4.4:

In the case of constant speed there is no acceleration:

$\Sigma F_X = 0$ (4.3)

F – mg sinQ – (Friction coefficientbetween steel and wood) mg cosQ = m*ax

F – (1)9.81 sin (3.7) –(1) 0.6 * 9.81 cos (3.7) = m*ax

►F = 0.57 + 5.9 = 6.47 KN (The force needed to draw one box of one ton)

► :Find acceleration speed

$V^2 = v1^2 + 2*a*\Delta x$ (4.4)

1 m/s = 0 +2*a*(1) ► a =0.5 m/s^2

In case of speed and acceleration at the beginning of movement:

$\sum Fx = m * ax$ *(4.5)*

F – mg sinQ – (Friction coefficient between steel and wood) mg cosQ = m*ax

F – (1)9.81*sin (3.7) – (1)0.6 * 9.81*cos (3.7) =1*0.5

►F_{max} *=7KN* *(* The force needed to draw one box of 5 ton)

The force needed to draw 5 boxes :

Fmax = 5 * F = 35 KN

P = F_{max} **V (4.6)

*=35*1* ►*=35KW*

1HP = P/0.746 ►= *47 HP*

4.5.2 Bearing calculation:

► For 4 wheels:

,F = 43.75 KN FB: Load on 4 wheel

►For one Wheel: (Fr)

= 43.75/4 = 10.9375 KN.

Assume the speed of trailer will be 20 Km/ h

V = 20000m/60min =333.33 m/min.

V = w * r (4.7)

► w = v/r = 333.33/0.35 = 952.38 ≈ 1000 rev/min. W = 1000 rpm

FD = Fr * a_f (4.8)

= 10.9375 * 1.2 = 13.125 KN.

XD = (LD_h * 60 *W) /10^6 (4.9)

► LD_h = 25000h

=1500

C_{10} = $1500^{1/3.3}$ * F_D (4.10)

= $1500^{1/3.3}$ *13.12

= 120.379 → (02-90mm) Roller Bearing

Let C_{10}^* = 142 C_0 = 100

FD: design radial load (KN)

af: Application factor

XD: life ratio

LD: desired life (hours)

C10: catalog design

4.5.3 Deflection calculation:

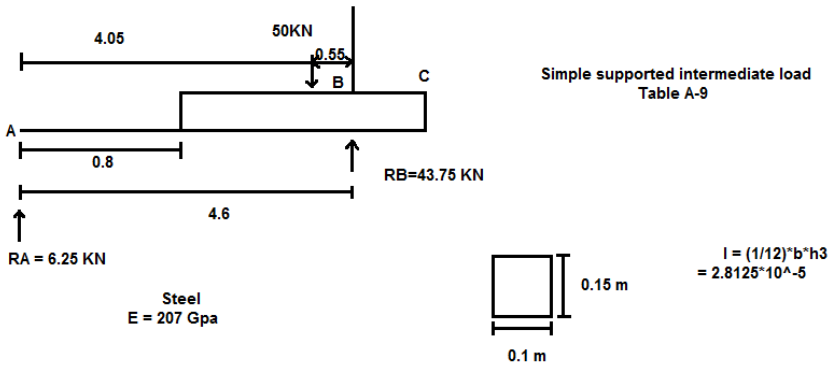


Figure 4.5 Free body diagram Bin Trailer

From figure 4.5:

(4.05m) the distance between the front and middle of the trailer.

(0.55m) the distance between the middle of the trailer and the location of the wheels.

(4.6m) Distance between the location of the diameter and the location of the wheel in the trailer, the distance at which the deformation occurs.

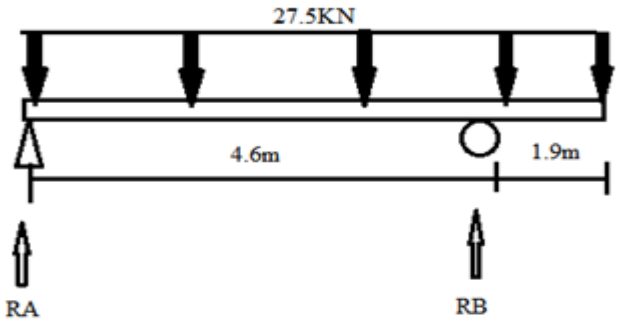
$* (x^2 = (f_F * b * x)/ (6 * E * I * L) Y_{Ac} - b^2 - L^2)$ (4.11)

@ $x = 2.3mY_{Max}$

$= \frac{50KN * 0.55 * 2.3}{6 * 207 * 0.28125 * 4.6} * (2.3^2 + 0.55^2 - 4.6^2). Y_{Ac}$

= 6.12 mm.

4.5.4 Bending , shear and stress :



$$\sum Fy = 0$$

*RA + RB = 27.5 * (4.6 + 1.9)*

RA + RB = 178.75 KN.m

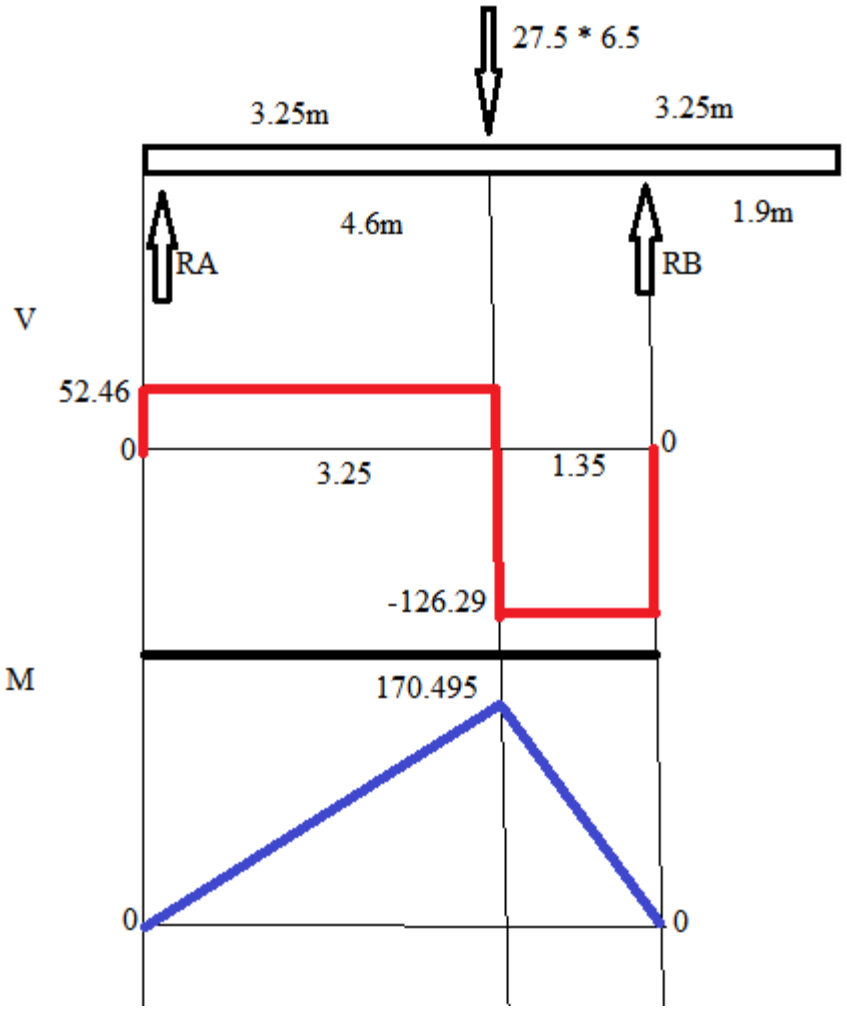
We calculated one section where we replaced half the total load with half the weight of the structure.

$$\sum M@A = 0$$

RB (4.6) – 178.5 ((4.6+1.9)/2) = 0

RB = 126.29 KN.m

RA = 52.46 KN.m



Bending moment = 170.495 KN.m

Shear = 126.29 KN

Stress = M * c / I

= (170.495 *10^3) * (0.15/2) / 2.8125 * 10^-5

= 454.65 MPa

4.6 Design results

- The power of hydraulic motor required to drag the bin equal 10hp
- The type of bearing in wheels is roller bearing (02-90mm) number 4
- Needed the two chains, the length of this equal 14 m, permission to change the length.

Part 2

Prototype proposed design

4.7 Calculation design for the prototype:

The position of the wheels.

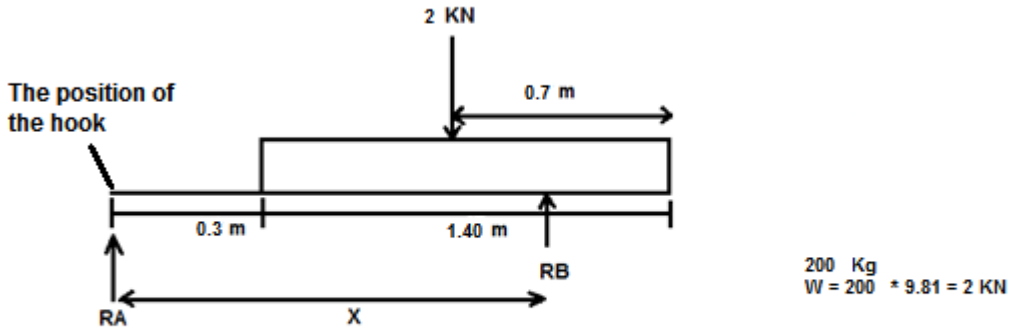


Figure 4.6: Free body diagrams for Bin Trailer Prototype

From figure 4.6:

The Position of tires on prototype that gives the tail hitch coupling (10-15) % of the distributed load.

$(10 + 15)/2 = 12.5\%$

$\Sigma F_y = 0 \quad (4.12)$

$R_A = 2 * 12.5 = 0.25$

$\Sigma F_y = R_A + R_B = 2\,KN$

$R_B + 0.25 = 2 \blacktriangleright R_B = 1.75\,KN$

Calculation of the position of tire from length of the trailer

$\Sigma M_A = 0 \quad (4.13)$

$\Sigma M_A = 2 * (0.3 + 0.7) - R_B(x) = 0$

$x = 1.14\,m$

As shown in figure 4.7 a free body diagram for prototype :

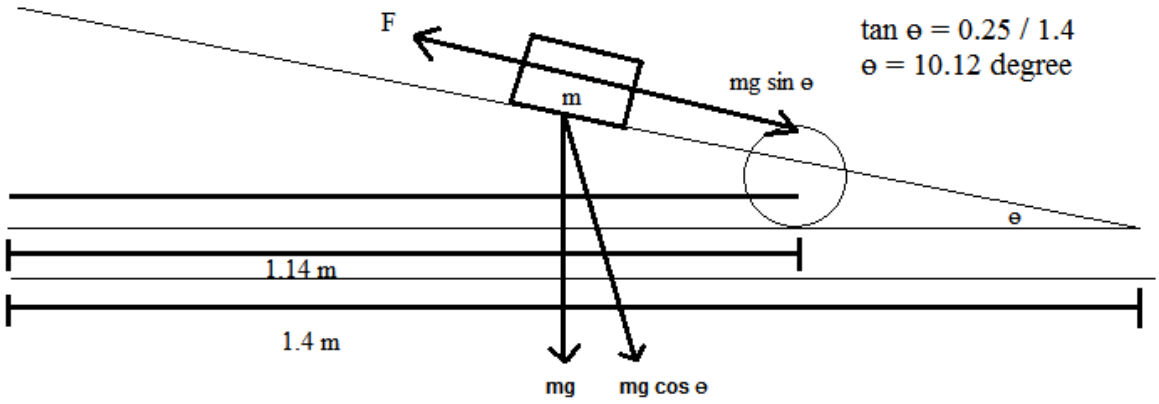


Figure 4.7: Free body diagram for Prototype

In the case of constant speed there is no acceleration:

$\Sigma F_X = 0 \quad (4.3)$

F – mg sinQ – (Friction coefficientbetween steel and wood) mg cosQ = m*ax

F – (0.1)9.81 sin (10.12) –(0.1) 0.6 * 9.81 cos (10.12) = m*ax = 0

►F = 0.749 KN (The force needed to draw one box of 100 Kg)

►:Find acceleration speed

$V^2 = v1^2 + 2*a*\Delta x$ (4.4)

1 m/s = 0 +2*a*(1) ► a =0.5 m/s^2

In case of speed and acceleration at the beginning of movement:

$\sum Fx = m * ax$ *(4.5)*

F – mg sinQ – (Friction coefficient between steel and wood) mg cosQ = m*ax

F – (0.1)9.81*sin (10.12) –(0.1) 0.6 * 9.81*cos (10.12) =0.1*0.5

►F_{max} *= 0.8 KN* *(* The force needed to draw two box of 200 Kg)

The force needed to draw 2 boxes :

Fmax = 2* F = 1.6 KN

$P = F_{max} * V$ (4.6)

*=1.6*1* ►*=1.6KW*

1HP = P/0.746 ►*= 2.14 HP*

4.7.1Deflection Calculation

The deflection occurs at the weakest point in the middle of the trailer.

As shown in figure 4.8:

$$Y_{max} @ x = 0.57\ m$$

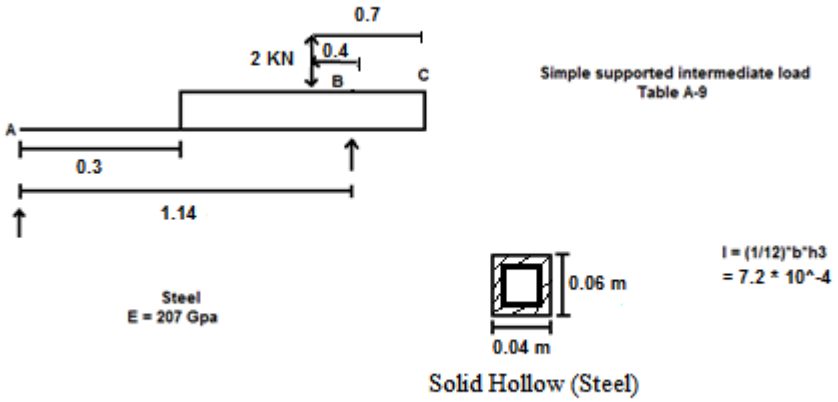


Figure 4.8: Free body diagram for Prototype

$$Y_{AC} = (f_F * b * x) / (6 * E * I * L) * (x^2 + b^2 - L^2) \quad (4.17)$$

$$Y_{max} @ x = 0.57\ m$$

$$Y_{AC} = (2 * 0.4 * 0.57) / (6 * 207 * 10^9 * 7.2 * 10^{-4} * 1.14) * (0.57^2 + 0.4^2 - 1.14^2)$$

$$Y_{AC} = 3.6\ mm$$

4.7.2 Calculation design for intermediate jacks

The figure 4.9 shows free body diagram for prototype trailer to calculate the location and strength of the pneumatic jacks .

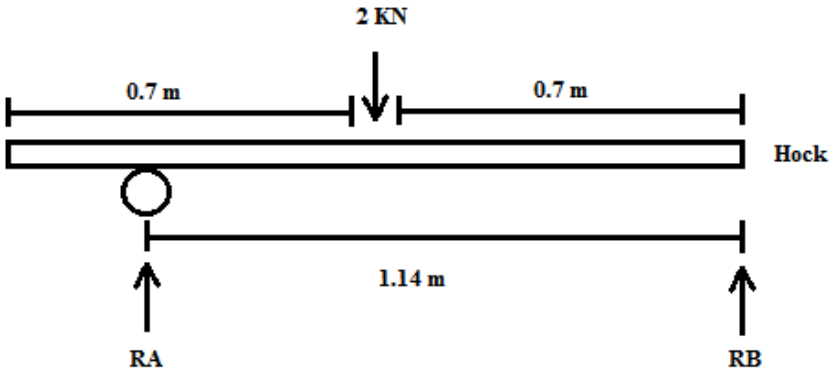


Figure 4.9: Free body diagram for prototype trailer

As shown in figure 4.9:

$$\sum M_B = 0 \qquad (4.18)$$

$$2 * 0.7 - R_A * 1.14 = 0$$
$$R_A = 1.4 / 1.14 = 1.228\ KN$$
$$R_A + R_B = 2\ KN$$
$$1.228 + R_B = 2\ KN$$
$$R_B = 0.772\ KN$$

$$R_A + R_B = w$$
$$R_A + R_B = 2\ KN$$

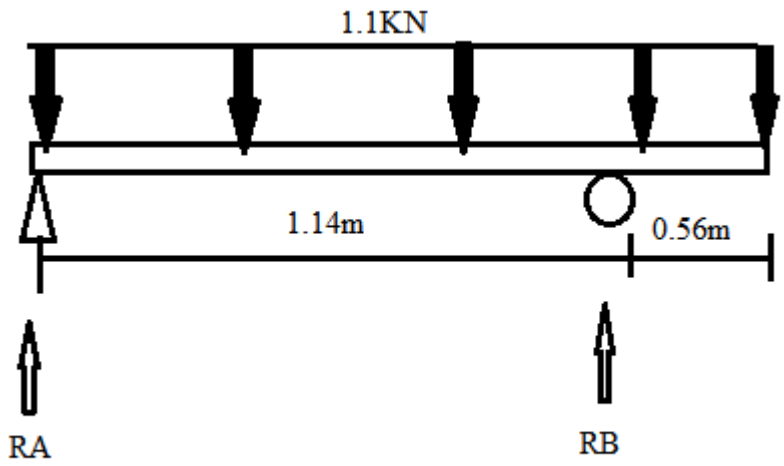
According to the position of the jacks in the trailer it loads (20 - 25)% from the total load.

$$0.25 * 2\ KN$$
= 0.5 KN = F (Force for the intermediate two jacks).
The force for each jack = 0.5 / 2 = 0.25 KN

$$P = F / A \qquad (4.19)$$
$$A = F / P$$
$$A = 0.25 * 10^3 / 12 * 10^5$$
$$A = (\pi / 4) * d^2$$
$$d = \sqrt{(4 * A)/\pi}$$
$$d = 1.6\ \text{cm}$$

1.6 is the required diameter for the jack

7.4.3 Bending , shear and stress :



$$\sum Fy = 0$$

RA + RB = 1.1 (1.14 + 0.56)*

RA + RB = 1.87KN.m

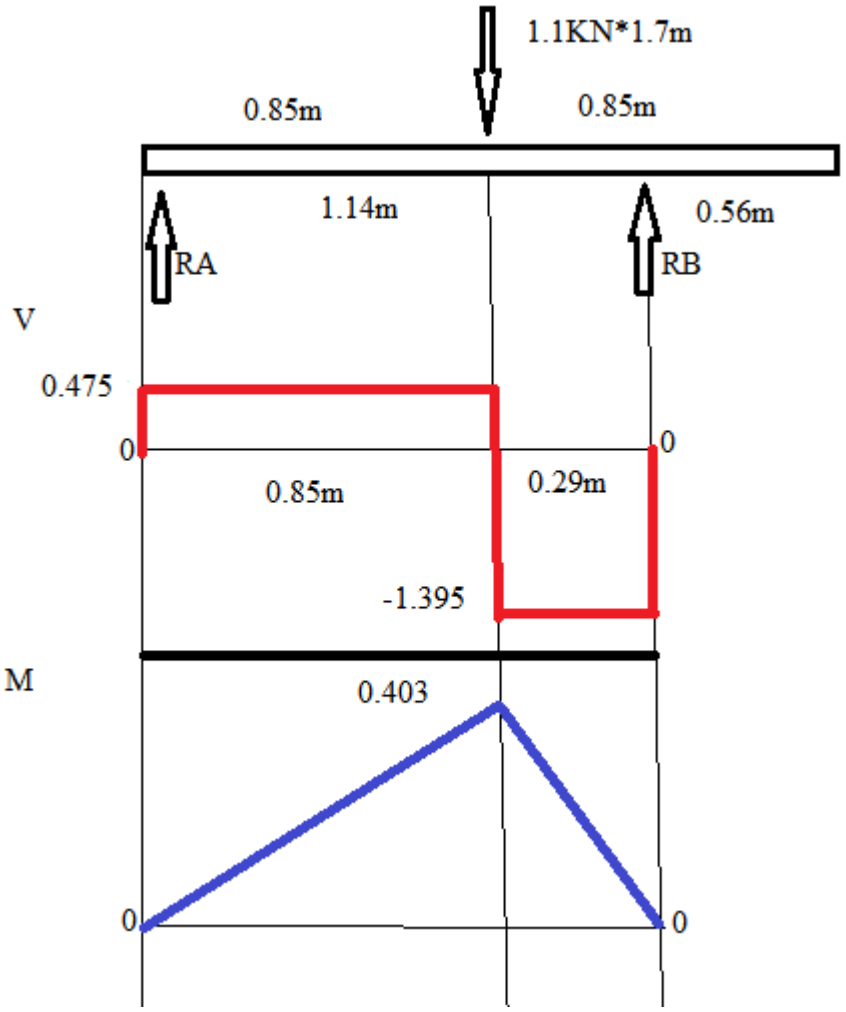
We calculated one section where we replaced half the total load with half the weight of the structure.

$$\sum M@A = 0$$

RB (1.14) – 1.87((1.14+0.56)/2) = 0

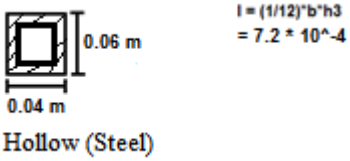
RB = 1.39 KN.m

RA = 0.745 KN.m



Bending moment = 0.403 KN.m

Shear = 1.395 KN



I = (1/12)*b*h3
= 7.2 * 10^-4

Stress = M * c / I

= (0.403 *10^3) * (0.06/2) / 7.2 * 10^-4

= 0.016791 MP

CHAPTER 5

Bin Trailer Prototyping

5.1 Introduction

5.2 Prototype Overview

5.3 Movement Description

5.4 The Prototype Design Calculations

5.5 Pneumatic Cycle when the system running

Chapter 5 Bin Trailer Prototyping

5.1 Introduction

Early in this autumn the project team visited the company *.During the visit we make a discussion with the production engineer about using the bin trailer (shuttle) as the best transport system for the factory. At the end of the discussion we decided to start implementing the bin trailer since it is the most appropriate choice based on the company operation terms and situation. The trailer can upload any alternative product that not exceeds the weight, height and width of the studied product in this study which is dates e.g. apples, fruits.

A prototype of a full scale bin trailer will be built to illustrate the concept.

5.2Prototype Overview

The **Prototype** is a miniature model of the bin trailer built to illustrate the processes. This prototype will show the main idea of the full scale bin trailer with its full functionality starting from loading, unloading and transporting goods easily and smoothly.

This prototype will use a pneumatic actuator system instead of hydraulic system.

5.2.1Prototype Components

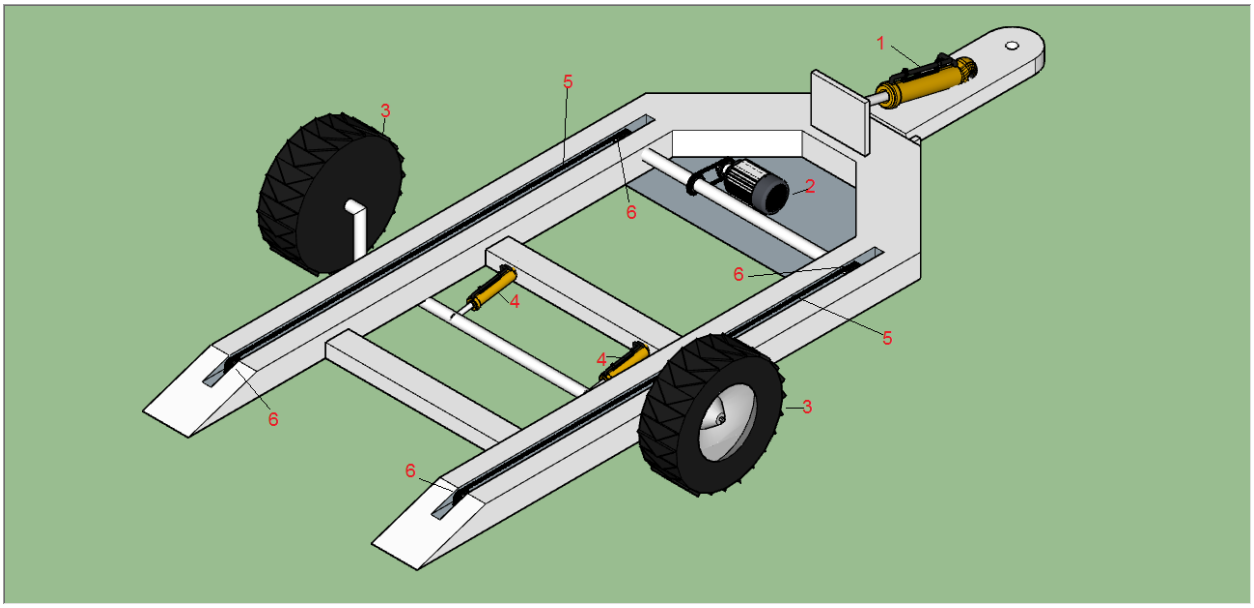


Figure 5.1: Top view for the prototype

Table 5.1 Prototype Components

1.	The main jack for unloading and loading the trailer (Pneumatic Actuator). The Pneumatic Actuator jack lefts the trailer in a specific angle, this angle allows the trailers back to slide under the box that make pushing the box easier.
2	The electric motor 1 horsepower. Figure 5.5 The electric motor used to move the chains clockwise and counter clockwise.
3	Two wheels R25 Two wheels used to move and raise the trailed. For full scale of trailer we will use for wheels.
4	Two jacks for the wheels (Pneumatic Actuator), one jack for each wheel, Figure 5.6 The jacks used to push the rode to the front.

5	Two Chains The chains used to assists the load to move to the front or back according to movement direction.
6	Six bearings for the chains, 2 at the front and 4 for the rear. Figure 5.7 The bearing used to install the chain.

In the stopping state the trailer stay in a full horizontal state, all actuators components in the trailer are not running and the pneumatic sources are in off state and the electrical source is off the side view for the trailer as shown in figure 5.2 and the rear view as shown in figure 5.3.

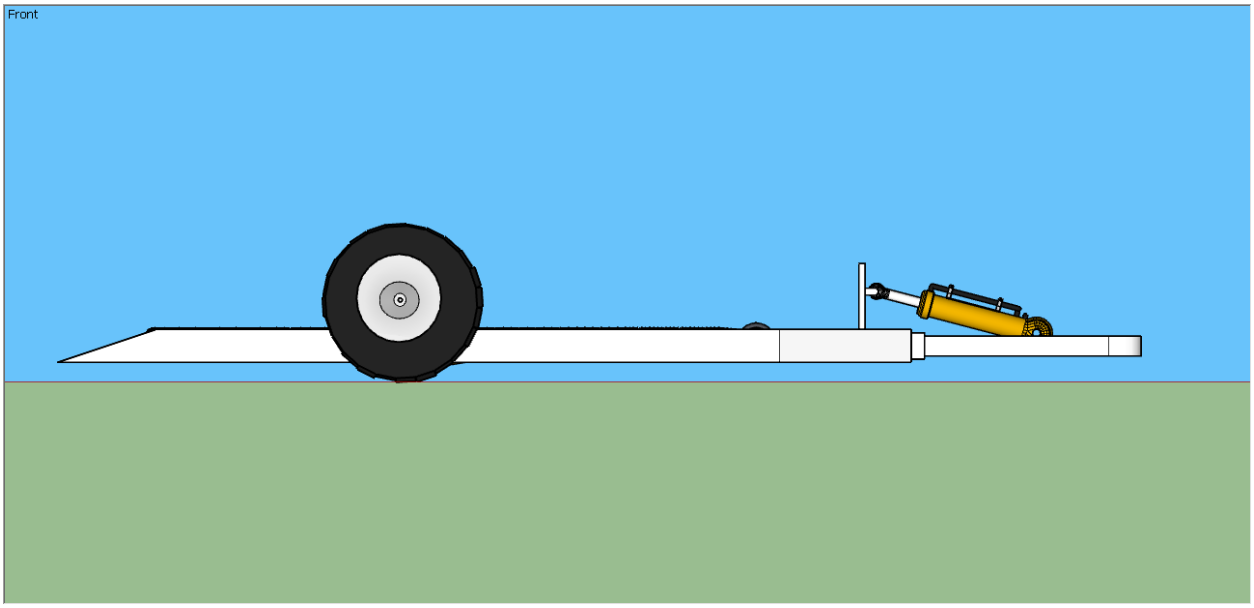


Figure 5.2: Side View ready to loading

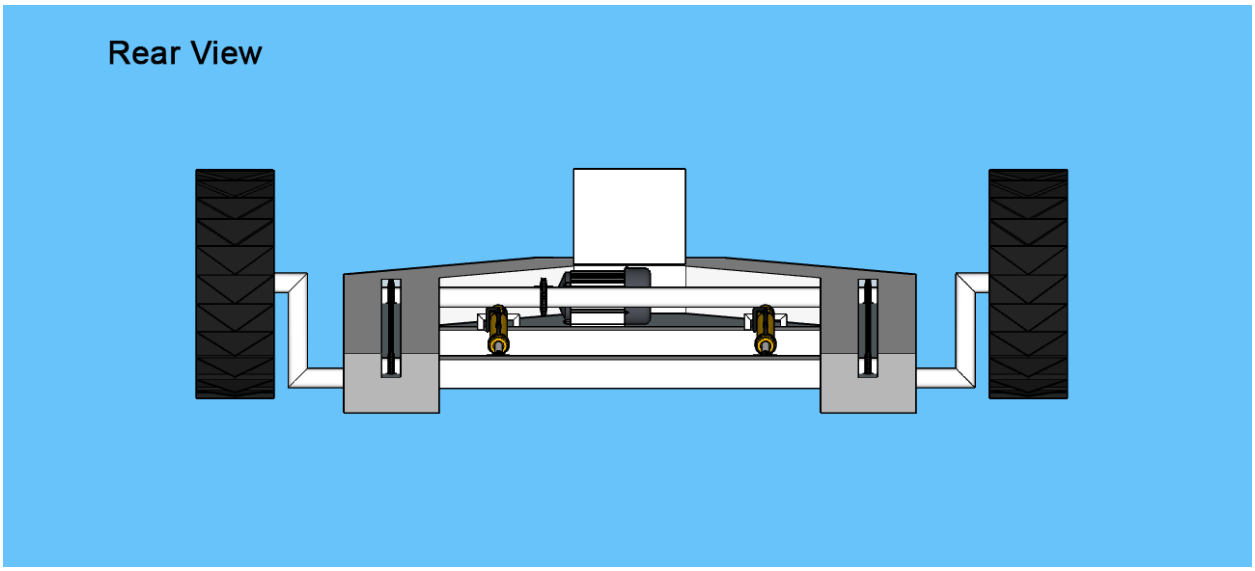


Figure 5.3: Rear view

In the start raising all actuators components in the trailer are running and the pneumatic sources are on state and the electrical source is on. The main jack in the trailer raise the trailer to slide under the load easily and the level for the trailer is raise for 10 degrees state, as shown in figure 5.4.

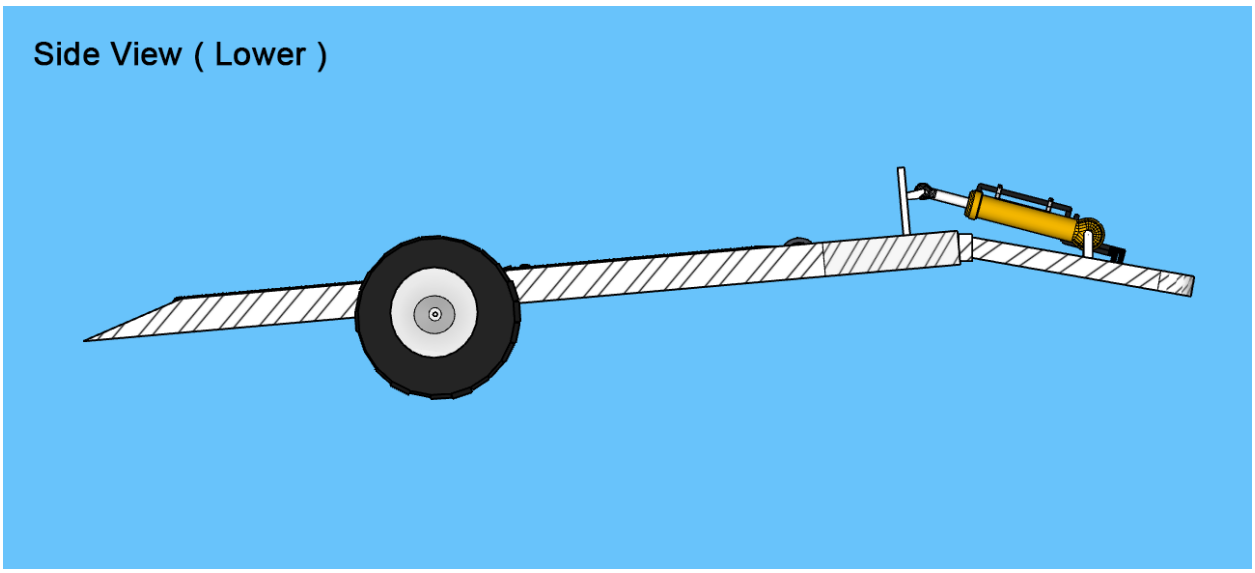


Figure 5.4: Side view start rising

The following figure for the electric motor when it powered on the motor will start moving the chain which going to move the rode that will move the bearings for the main chains, as shown in figure 5.5 and figure 5.6.

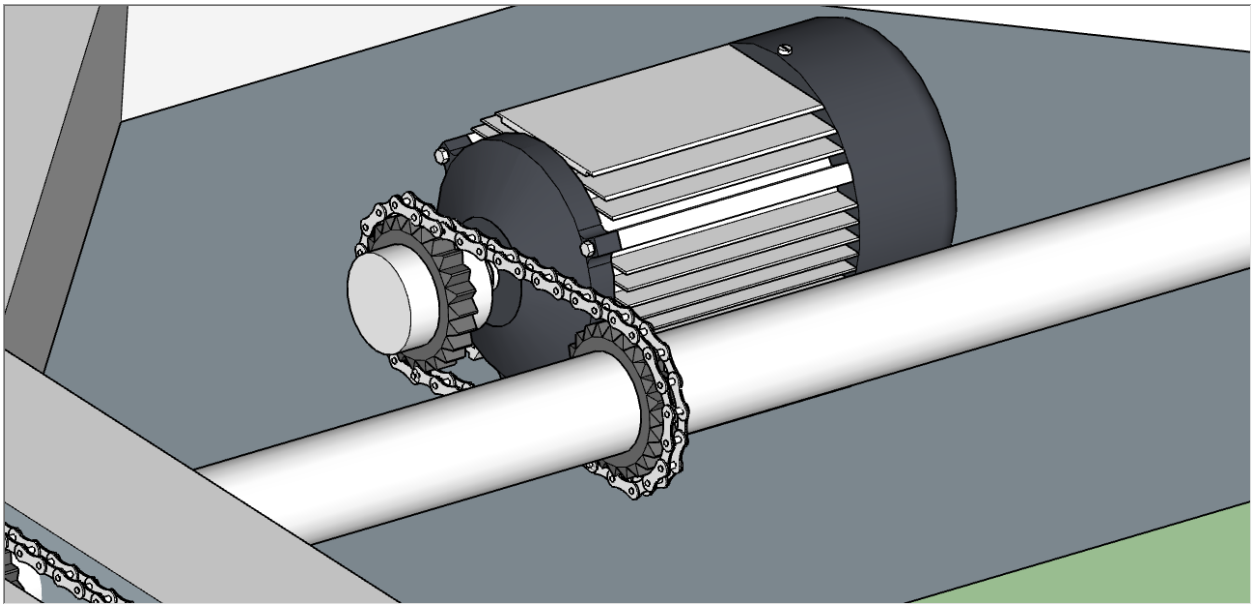


Figure 5.5:the Electric motor

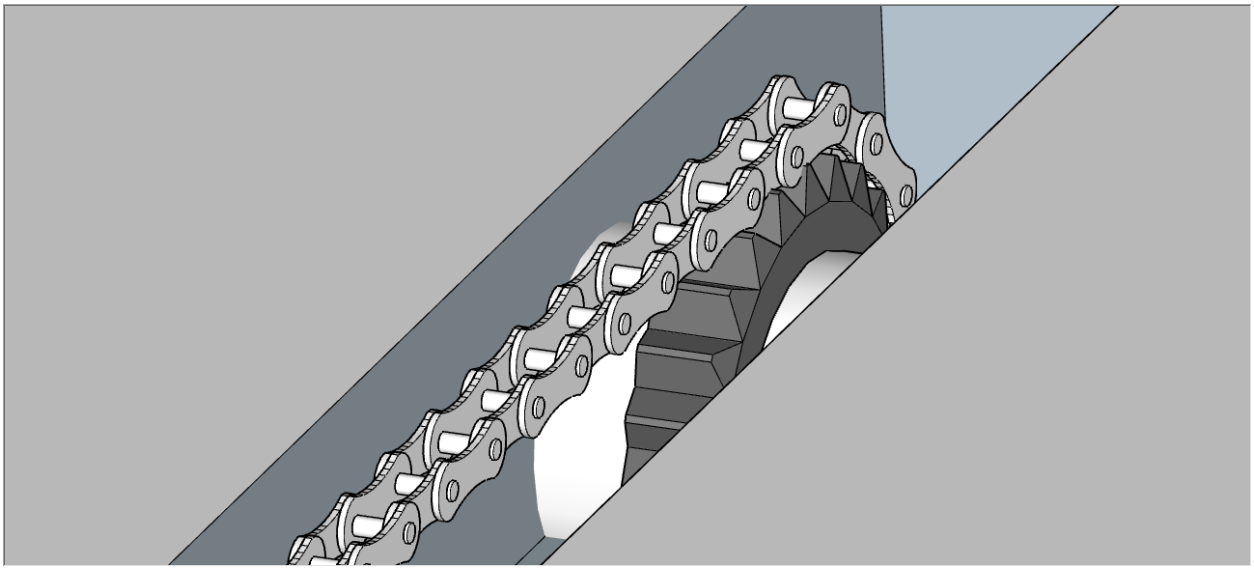


Figure 5.6:the bearing for the chain

The following figure 5.7 for the pneumatic jacks are used to push the intermediate rode which is connected to the wheels in the front, so the level of the trailer and the joint connected to the wheels will go lower.

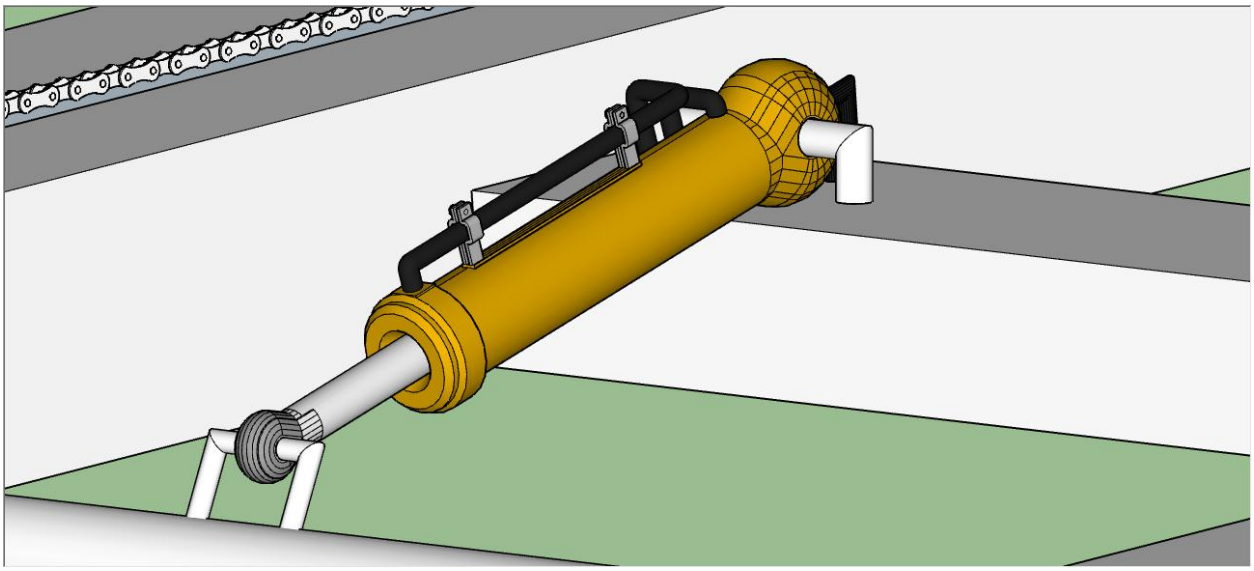


Figure 5.7 The jack for the wheels (Pneumatic Actuator)

5.3Movement Description

5.3.1Loading process

The trailer is connected with the power source. The pneumatic jack is used to raise the trailer with 10 degrees angle, asshown number 1 in Figure 5.1. The pneumatic jacks are used to push the intermediate rode which is connected to the wheels in the front, so the level of the trailer and the joint connected to the wheels will go lower, as shown in number 4 in Figure 5.1. After the level of the trailer goes lower, the cargo is loaded so the front of the trailer goes under the cargo; meanwhile, the electric motor becomes ready to move the chains clockwise to the back of the trailer to attach the cargo on the trailer. After loading the cargo the main pneumatic jack returns the trailer in its horizontal level. The pneumatic jacks pull the rode to return the wheels to its natural status, as shown in number 4 in Figure 5.1.

5.3.2Unloading process

The pneumatic jack is used to raise the trailer with 10 degrees angle, shown as number 1 in Figure 5.1. The pneumatic jacks are used to push the rode which is connected to the front wheels, so the level of the trailer and the joint connected to the wheels will go lower, shown as number 4 in Figure 5.1. After the level of the trailer goes lower, the cargo is ready to be unloadedand the electric motor moves the chains counter clockwise so the trailer is moved and the cargo is left after unloading the cargo the main pneumatic jack returns the trailer to its horizontal level. The pneumatic jacks pull the rode to return the wheels to their natural status, shown as number 4 in Figure 5.1.

5.6 Pneumatic Cycle when the system is running

The pneumatic source pumps the air to the selectors, the selector 5/2 gives the air to intermediate jacks who connected to the wheels and the selector 5/3 gives the air to the main jack. The air that pumped to the jacks through a throttling operators so it helps the trailer to rise gradually. The selector 5/2 takes the signal from the control unit to run the intermediate jacks at the same time this signal is cut off the intermediate jacks return to its off state. The exhaust port in the selector 5/3 is closed, the selector takes the signal from the control unit to run the main jack so the main jack raises and down gradually.as shown in figure 5.8,5.9

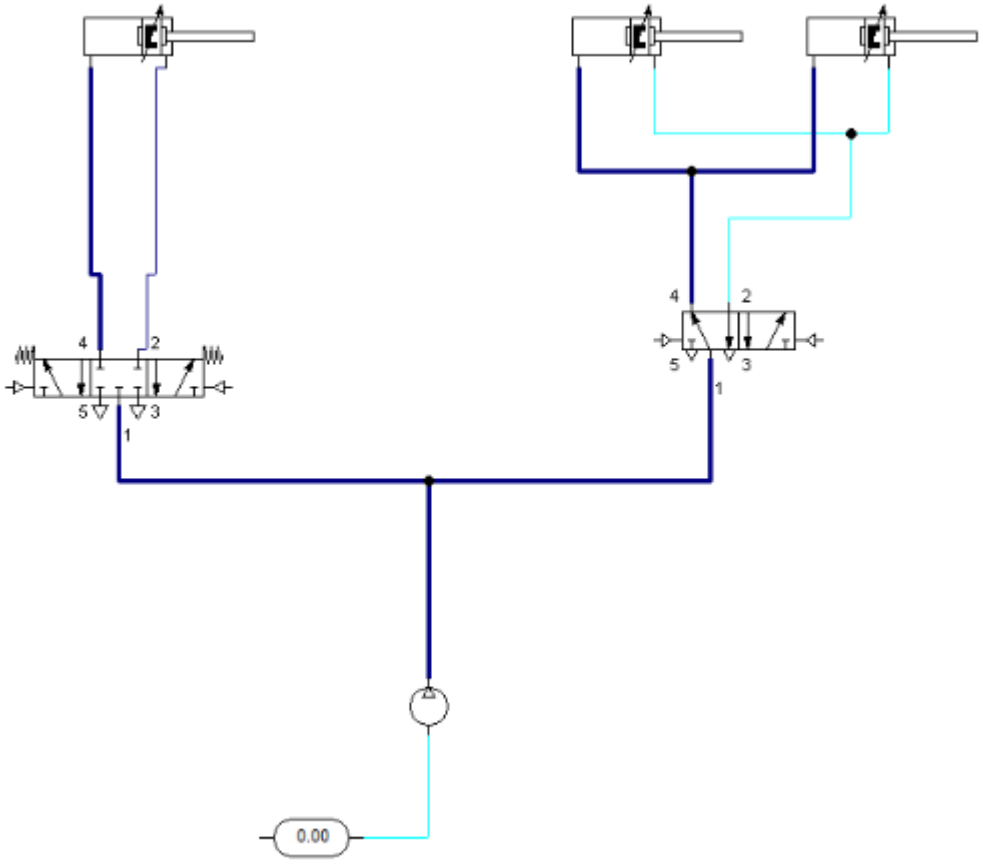


Figure 5.8: The Pneumatic Cycle while running

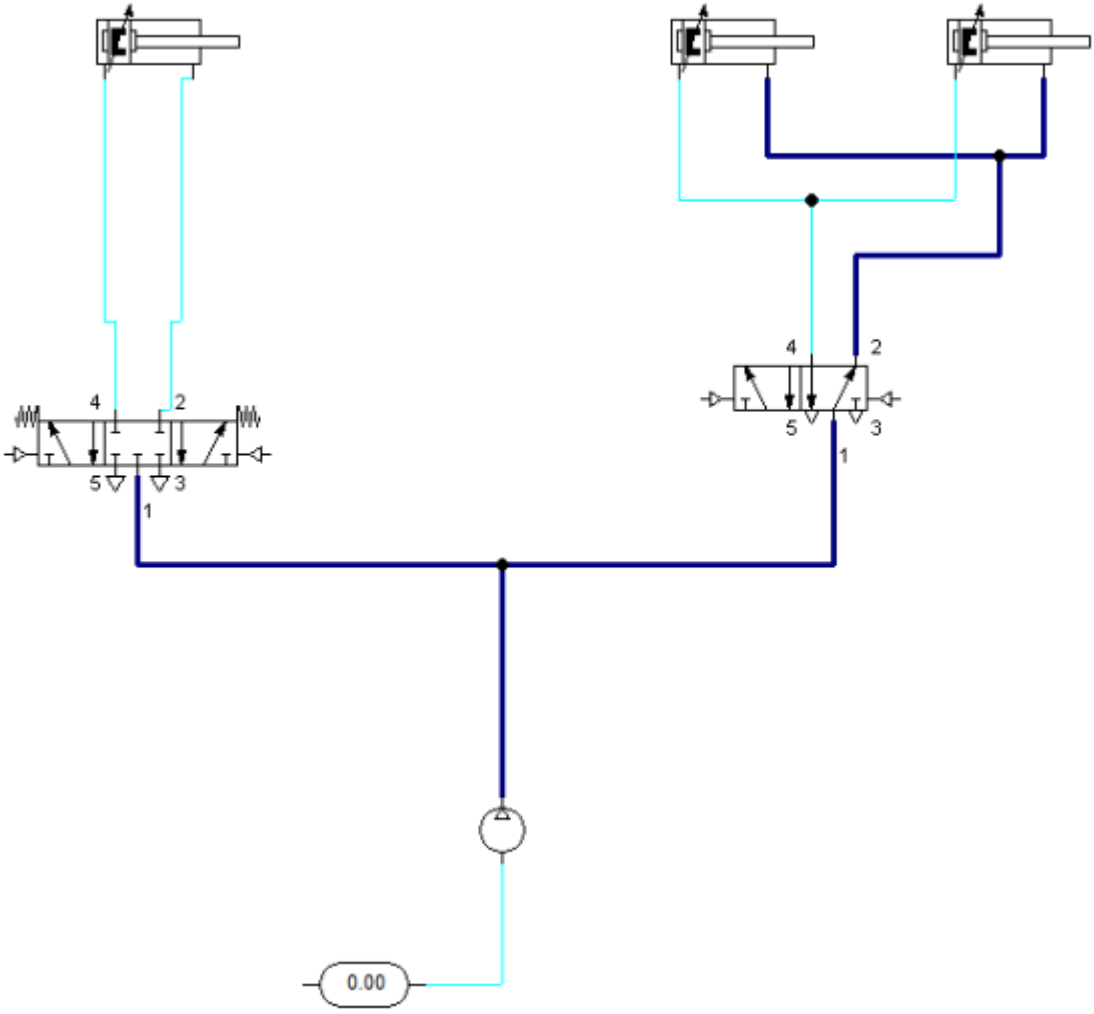


Figure 5.9: The Pneumatic Cycle while stopping

This section shows the power circuit and control circuit with graphs of electrical parts:

5.4Circuit of power.

The prototype needs to be connected to 3 phase alternative power source to the motor through a circuit Breaker which disconnects the circuit if any electrical short occurs. In addition to the circuit breaker a 3 phase overload switch which disconnects the circuit from any increasing load. Two contactors are used to control the movement direction of the motor clockwise and counter clockwiseas shown in figure 5.10 .

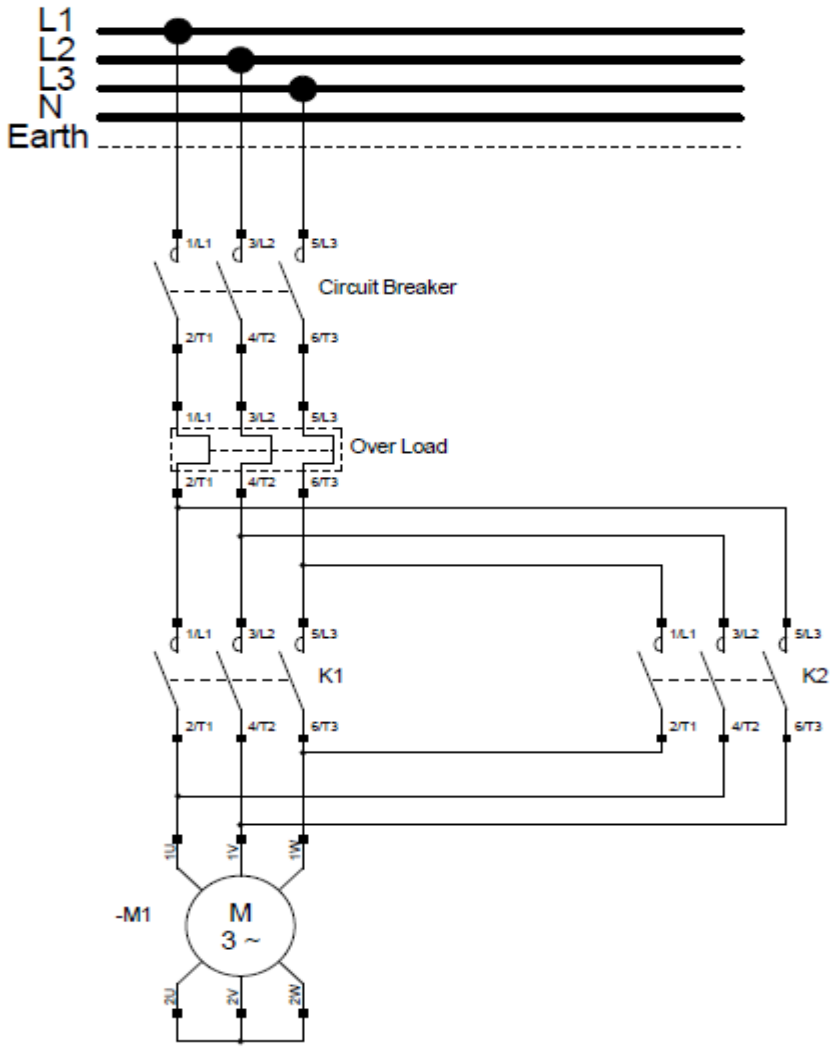


Figure 5.10 Electrical charts for the power circuit

5.5Circuit of Control

The prototype as shown in figure 5.11 needs to be connected to

- One phase alternative power source to the jacks through a circuit Breaker which disconnects the circuit if any electrical short occurs on control circuit.
- An emergency switch which disconnects the current on the power and control circuit manually when any urgent occurs.
- Two switches are used to operate the contactor which is connected to the motor. An automatically limit switch is connected to switch off the motor if the trailer completely loaded.
- A switch to control the 5/2 selector which disconnects the signal from the intermediate jacks.
- Two push buttons to control the movement of the main jack by 5/3 selector.

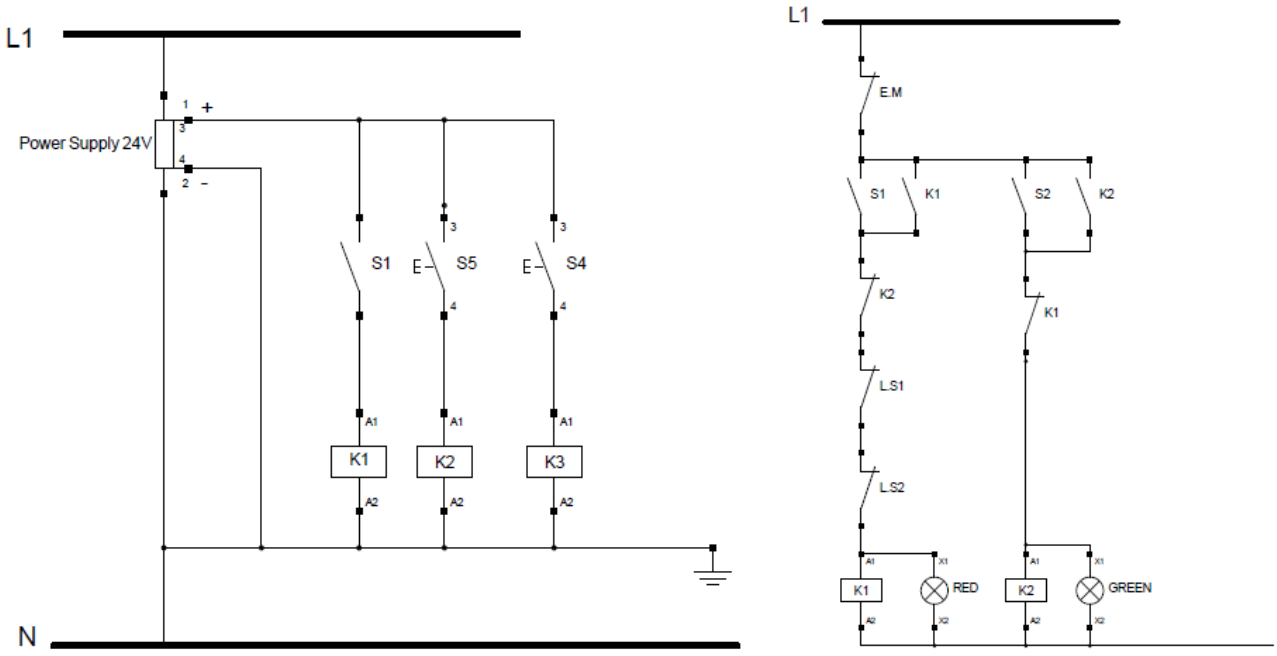


Figure 5.11: Electrical Chart for Control Circuit

CHAPTER 6

Experimental Work

6.1 Introduction

6.2 Building process steps

6.3 Conclusion

6.4 Recommendations

Chapter 6 Experimental Work

6.1 Introduction

Building a trailer prototype from scratch will require welding skills, an aptitude for electrical knowledge to install taillights, so the team decides to gather the pieces and contract with an expert with this work.

The team gathersthe components for trailer prototype. (Steel, Tires, Selectors, pneumatic Jacks, Chains, Bearings, electrical motor, Contactors, circuits)

The building process starts after purchasing the components.

6.2PrototypeBuilding

1. Construct the trailer frame.

   The frame consists of 4 steel iron rails, 2 for the sides, and 2 for the front and middle. Depending on the established length of the trailer prototype, the sides might be longer than the front and middle, as shown in figure 6.1.

   Weld the angle iron railstogether for the bed frame. Assure the corners are squared.

Figure 6.1 Trailer Frame

2. Attach the tires.

Use a pneumatic jack to rise up the frame. Block all 4 corners to keep it elevated. Weld the rods to thetiresto the frame, as shown in figure 6.2

.

Figure 6.2 Tires

3. Weld the hook to the frame, as shown in figure 6.3.

Figure 6.3 Hook

4. Attach the pneumatic jacks and the motor by the chins by the bearings, as show in figure 6.4.

Figure 6.4 Jacks and Motor

5. Assembly of the parts (Steel, Tires, Selectors, pneumatic Jacks, Chains, Bearings, electrical motor, Contactors, circuits),as shown in figure6.5.

6. Route electrical wires from the motor to the control circuit and attach the selectors to control the jacks,as shown in figure6.6.

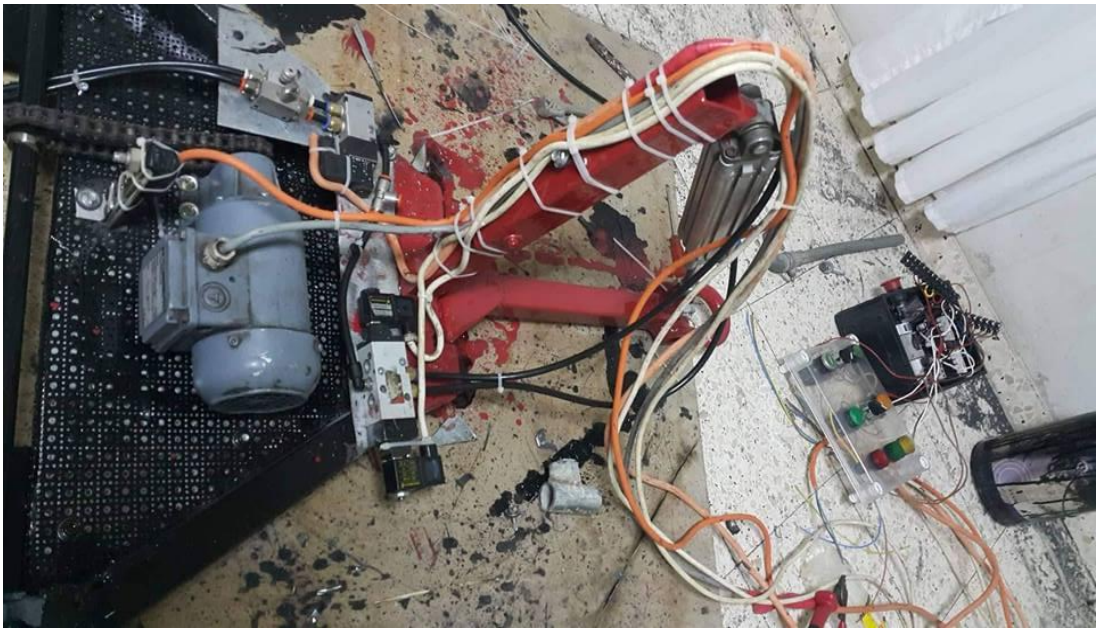


Figure 6.5 Electrical Wires

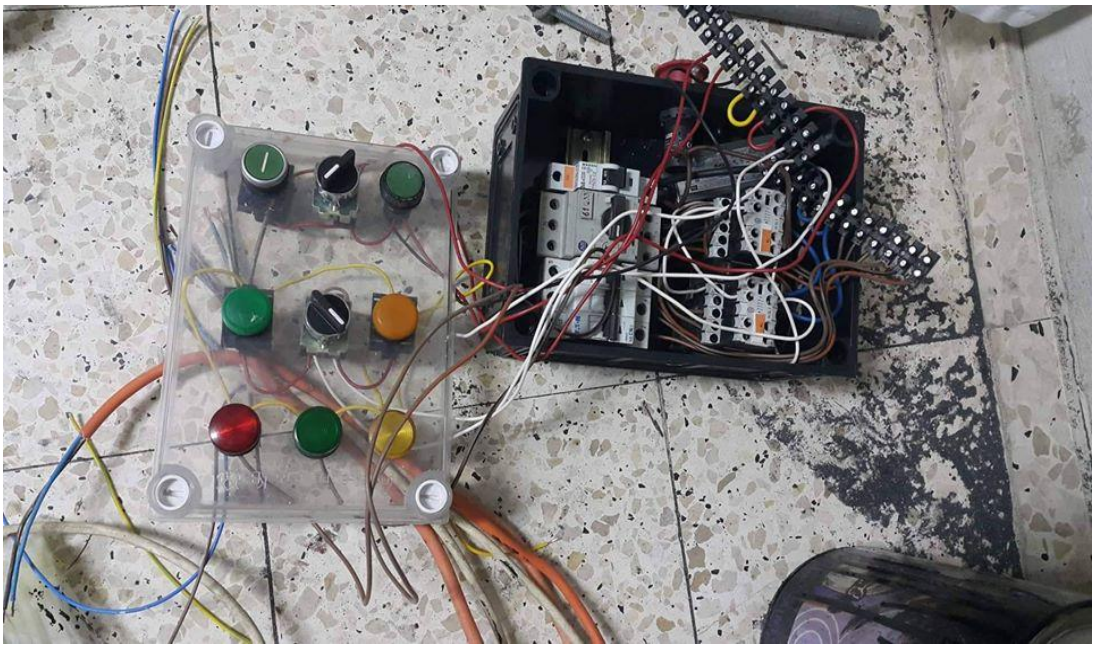


Figure 6.6 Control and Power circuit

7. Attach a signal lights.

8. The figure 6.7,6.8,6.9 shows the machine in working :

figure 6. 7: lifting down

figure 6. 8:Transport operation

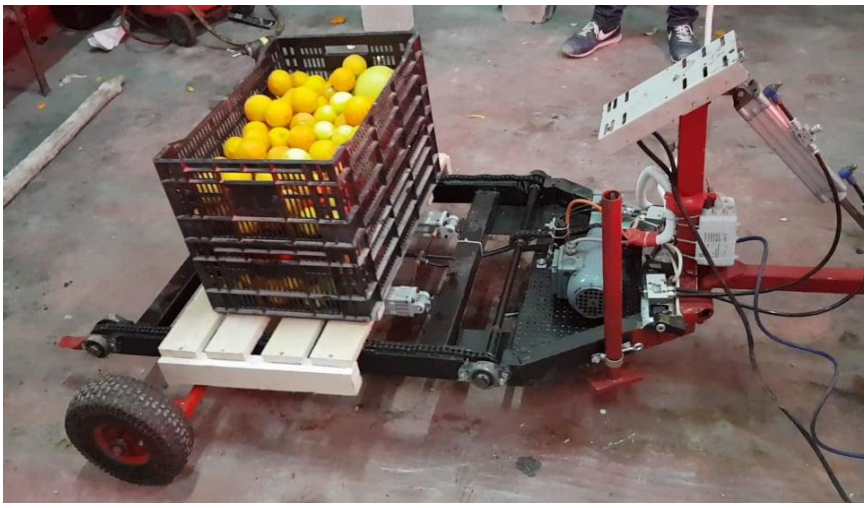


figure 6. 9:Lifting up

9. Finish the prototype , as show in figure 6.10 , 6.11 :

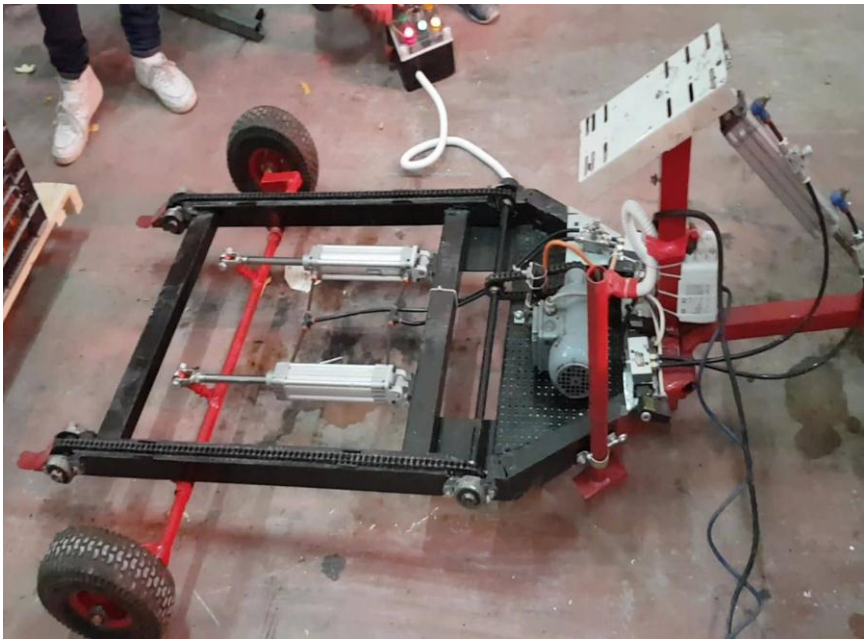


Figure 6.10: The final shape of prototype

Figure 6.11:the final shape of prototype

6.3 Conclusion

The design of this trailer was carefully thought and documented throughout the entire process it went through. From the basic idea all the way, special consideration and care had given. This trailer is of a very simple design while also being comparably cheaper to other very similar trailers. This product fills all the requirements of a bin trailer without sacrificing strength and durability.

The quality of this orchard bin trailer shows from not only the man hours spent meticulously reviewing the scenarios and operating conditions it will be in, but also the time spent choosing proper materials and careful documentation and modeling .

Time has been saved as the trailer moves 5 boxes together between the manufacturing stages and takes 20 to 25 minutes compared to the forklifts that transport one box, which takes 8 minutes .

6.4 Recommendations :

A rigid body was used in the design between the wheels and the chassis of the trailer , resulting in vibrations and thus affect the safety of the product. And we recommend the use of damper between the wheels and the trailer structure to maintain the product and not damage it .

Appendix I

Company Visit Report

A. Date & Location

Date of Visit: 8th September 2018	Location of Visit: Al-Nakheel Company, Jericho
Objectives of the visit: • Figure out production process • Define transportation problem • Discuss Bin Trailer solution	Methodology: • Factory departments' visit • Production Engineer meeting • Production Engineer Discussion

B. Delegation

Name	**Title**	**Organization**
TamerNassar	Graduation Project team member	Polytechnic University
BahaaAdwan	Graduation Project team member	Polytechnic University
RamiBaradia	Graduation Project team member	Polytechnic University
Eng. Nader Eseed	Production Engineer	Al-Nakheel Company

C. Main Findings:

Objective 1: Figure out production Process

Al- Nakheel Company works on date's field, its production process starts from harvest to the final product. Eng. Nader explained the production process stages for us, which continues from Augustus to March,

Production Process Stages:

1. Harvest, The crop comes from the farms in boxes and these boxes are mounted on the trestle is about 2.5 meters high and weighs 400 kilos, it moved by power source.

2. The crop weighed and given a number then moved to refrigerators by conventional forklifts

3. The crop moved to the sorting stage. The soft, dry and damaged crop sorted using machines and labor. It moved forklifts.

4. The dry crop moved to sterilization stage and the soft moved to drying stage according to the product status. It moved forklifts.

5. The crop moved to the refrigerators and waits for manufacturing arrangement, It moved forklifts.

6. The crop moved to manufacturing and packaging stage. It moved forklifts.

7. Finally, the final product moved to refrigerators. It moved forklifts.

Objective 2: Define transportation problem

The crop transportation inside the factory needs to move the product from stage to another uses a conventional forklifts, this is a traditional movement way which makes a rush in movement tracks.

Product Movement

1. Entrance

2. To Weighting

3. To Refrigerators

4. To Sorting

5. Sterilization and drying stage track

6. Move to Refrigerators

The Refrigerators

7. The product moves from the refrigerators to Production stage, then storage refrigerators.

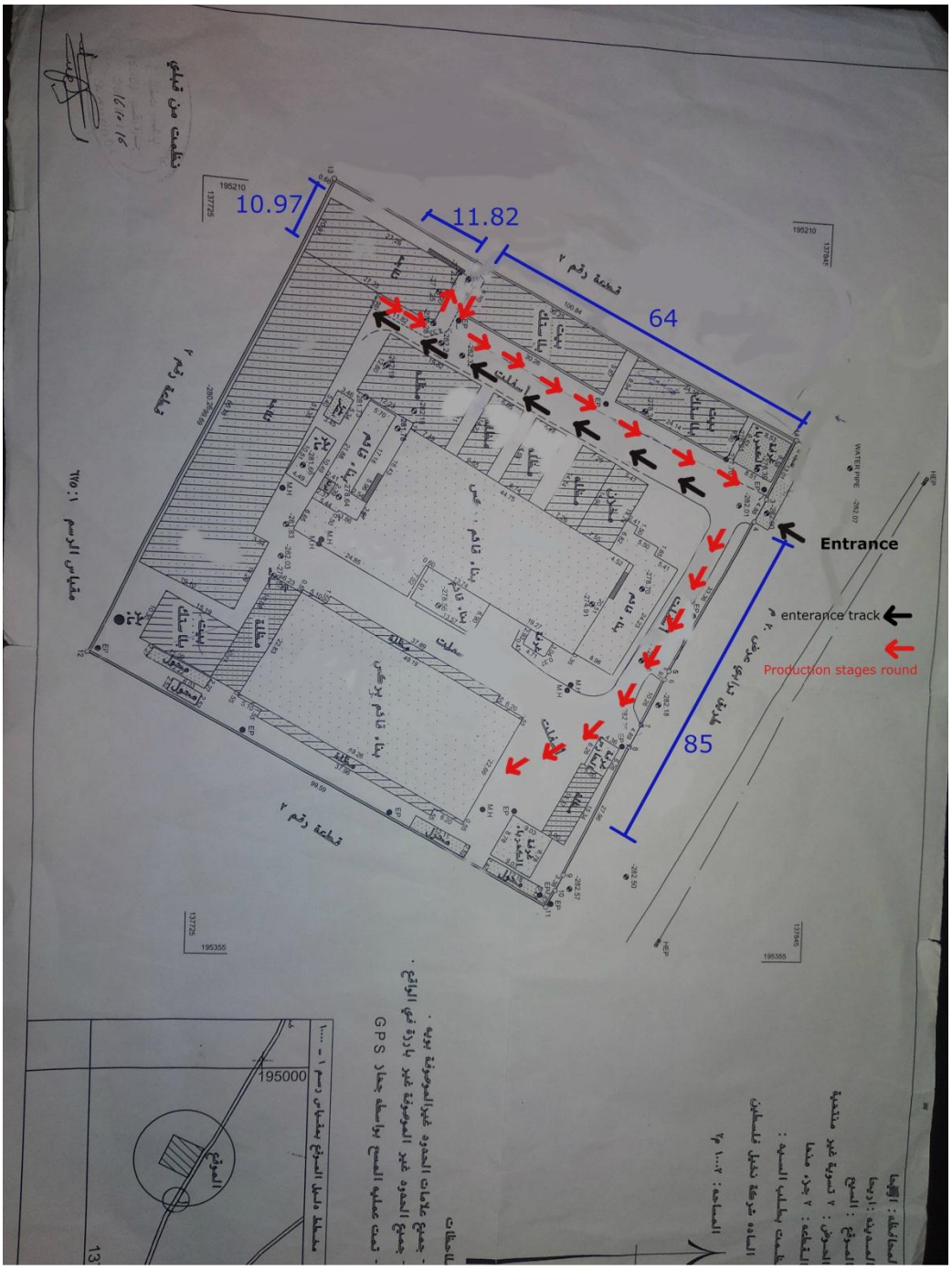
By following the movement stages you can notice that the traditional way waists time and effort, according to the production engineer the movement for the product from a to z needs approximately 10 minutes using the traditional transportation forklifts in addition to the large number of forklifts, so the problem can be summarized by, the rush on moving tracks inside the factory starting from the entrance to the production stage.

Objective 3: Discuss Bin Trailer solution

During the visit we discussed using Bin Trailer (shuttle) as the best transport system for the factory. Bin Trailer Solution was chosen as the most appropriate option for transportation problem in the factory which mentioned in the introduction for Development of transportation system for dates industry project.

Appendix II

Site Plan



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