DESIGN, ANALYSIS AND MANUFACTURING OF SINGLE AXLE HAND HELD ENGINE POWERED PLOUGH FOR AGRICULTUAL PURPOSES IN HILLY AREAS

A thesis

Presented to

SCHOOL OF MECHANICAL AND MANUFACTURING ENGINEERING

Department of Mechanical Engineering

NUST

ISLAMABAD, PAKISTAN

In Partial Fulfillment

of the Requirements for the Degree

Bachelors Mechanical Engineering

By

Ali Azfar	11-BE-ME-NUST-SMME-86
Ahmad Hassan Kamal	11-BE-ME-NUST-SMME-08
Zia Shahid	11-BE-ME-NUST-SMME-83
Abdul Rafay	10-BE-ME-NUST-SMME-02

2015

Keywords: plough two wheel tractor single axle diesel engine

EXAMIANTION COMMITTEE

We hereby recommend that the dissertation prepared under our supervision by:

1. ALI AZFAR 11-BE-ME-NUST-SMME-86
2. AHMAD HASSAN KAMAL 11-BE-ME-NUST-SMME-08
3. ZIA SHAHID 11-BE-ME-NUST-SMME-83
4. ABDUL-RAFAY 10-BE-ME-NUST-SMME-02

Titled: "DESIGN, ANALYSIS AND MANUFACTURING OF SINGLE AXLE HAND HELD ENGINE POWERED PLOUGH FOR AGRICULTUAL PURPOSES IN HILLY AREAS" be accepted in partial fulfillment of the requirements for the award of Bachelors Mechanical Engineering degree with (___ grade).

Committee Member: Dr. Sami ur Rehman Lecturer Department of Mechanical Engineering	____________________ Dated:
Committee Member: Engr. Muhammad Adnan Hanif Lecturer Department of Mechanical Engineering	____________________ Dated:
Supervisor: Engr. Muhammad Naweed Hassan Department of Design and Manufacturing Engineering	____________________ Dated:

______________________ ___________

(Head of Department) (Date)

COUNTERSIGNED

Dated: ________________ _________________________

(Dean / Principal)

ABSTRACT

Single axle walking tractors have been introduced recently in the country by international NGOs and the use of these tractors is increasing as the labor-saving and efficiency has been demanded. These tractors have good efficiency but their maintenance is a problem for the user as these tractors are manufactured by foreign companies in a complex design and complicated mechanisms are used, plus the spare parts are not available in Pakistan. The aim of project was to design analyze and manufacture a two wheel walking tractor using the simple mechanism and with the parts that are easily available in country, other main targets of project are low cost, easy mobility, efficiency and durability. The project involves comparison of selected models of walking tractors and assessment of their design to optimize power required from engine and the mechanism used in power transfer from engine to wheels. Diameter of wheel shafts and their material properties are evaluated by applying concepts of mechanics of material and machine design. Belts sizes, sizes of the pulleys, static and dynamic forces in bearings were calculated. Traction force is determined by both theoretical and experimental methods. Stress Analysis of the frame was done to determine the frame strength and effect of loading. Factor of safety is also considered where required.

PREFACE

This thesis is the result of final year project in the fields of manufacturing, design and analysis. The research has been supervised by Engr. Muhammad Naweed Hassan, Department of Design and Manufacturing Engineering. I could not have accomplished this research without the help of others. First, I want to thank Engr. Muhammad Naweed Hassan for his support. Though our discussions weren't that frequent and easy, they helped us to find a proper path in our research. Further, I want to thank Librarian Waseem Akhtar for passing on the FYP thesis of past graduates on topic "Design and Fabrication of an Autoclave".

We offer our humblest and sincerest words of thanks Almighty Allah who bestowed upon us the potential and ability to contribute in already exciting ocean of design and manufacturing techniques.

Being mechanical engineers it's our work to contribute in designing and manufacturing sectors and to introduce a new idea for the people of Pakistan. Mechanical Engineering underpins improvements in human welfare, through technologies which it develops for health, food production. Advance technologies are also important in solving problems created by human activity. Engineering allows us to move forward through incremental improvements in technology, adapted for particular needs and situations

ACKNOWLEDGMENTS

All the praises are for the almighty, Allah who bestowed us with the ability and potential to complete this thesis. We also pay our gratitude to the Almighty for enabling us to complete this report. We are thankful to our Creator Allah Subhana-Watala to have guided us throughout this project at every step and for every new thought which you setup in our minds to improve it. Indeed we could had done nothing without your priceless help and guidance.

Words are very few to express enormous humble obligations to our affectionate Parents for their prayers and strong determination to enable us to achieve this project objective.

We take this opportunity to record our deep sense of gratitude and appreciation to our supervisor, Engr. M. Naweed Hassan, Department of Design and Manufacturing Engineering, for his constant encouragement, inspiring guidance with his Wisdom and for his help throughout our project and thesis work.

We also appreciate the cordial co-operation from all my concern co-advisors for providing us requisite information and knowledge for compilation of our complete work.

ORIGINALITY REPORT

Declaration

I certify that this research work titled "DESIGN, ANALYSIS AND MANUFACTURING OF SINGLE AXLE HAND HELD ENGINE POWERED PLOUGH FOR AGRICULTUAL PURPOSES IN HILLY AREAS" is our own work. The work has not been presented elsewhere for assessment. The material that has been used from other sources it has been properly acknowledged / referred.

`

Signature of Students

ALI AZFAR	2011-BE-ME-NUST-SMME-86
AHMAD HASSAN KAMAL	2011-BE-ME-NUST-SMME-08
ZIA SHAHID	2011-BE-ME-NUST-SMME-83
ABDUL-RAFAY	2010-BE-ME-NUST-SMME-02

COPYRIGHT

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

FOS Factor of Safety

USS Ultimate Shear stress

UTS Ultimate Tensile Stress

PTO Power Take Off

Hp Horse Power

3D Three Dimensional

CHAPTER 1

This chapter introduced the project, its title, the aims and objectives of the project as well as the organization of the report.

Organization of the report

In chapter two the review of literature is presented. It summarizes the existing knowledge in the area of the project while referring to significant publications (books, research papers) in the area of the research work.

The literature review is followed by description of research methodology and design approach.

The next chapter presents the outcomes of the project, the assessment of the outcomes and comparison against existing similar works.

The final chapter provide comprehensive conclusion of the project and future recommendations.

INTRODUCTION

Agriculture in Pakistan has a significant history. As Per the world agriculture statistics, Pakistan is the one of the world's largest producer of many fresh fruits and vegetables, select fibrous crops also. A report from 2008 claimed Pakistan's population is growing faster than its ability to produce rice and wheat. Other recent studies claim Pakistan can easily feed its growing population, plus produce wheat and rice for global exports, if it can raise its farm productivity.

So in order to rise its productivity more machines must be implemented, to help small scale farmers two wheel tractors are introduced. It is a power tool used to prepare the land for agricultural purpose.

Single axle hand held tractor is a ploughing machine designed for preparing land by breaking the soil with the help of blades suitable for sowing seeds (without overturning of the soil).

Nowadays, utilization of engines powered machinery has been increased in agriculture applications because of simple structure and high efficient for this type of implement.

Single axle walking tractors have been introduced recently in the country by international NGOs and the use of these tractors is increasing as the labor-saving and efficiency has been demanded. These tractors have good efficiency but their maintenance is a problem for the user as these tractors are manufactured by foreign companies in a complex design and complicated mechanisms are used, plus the spare parts are not available in Pakistan. The aim of project was to design analysis and manufacture a two wheel walking tractor using the simple mechanisms and with the parts that are easily available in country, other main targets of project are low cost, easy mobility, efficiency and durability.

IMPACT ON ECONOMY

Pakistan is basically an agricultural country and it's almost 70% of the economy is based on agriculture. Agriculture accounts for nearly 20 per cent of Pakistan’s national income (GDP) and employs 44 percent of its workforce (Economic Survey Govt. of Pakistan, 2005). Agriculture also supplies raw material to Pakistan’s Industries, notably textile industry the largest industrial sub-sector of the economy. The number of total tractors in KPK. 24,269 (Census of Agricultural Machinery, 2004). Available tractor are larger in size and cannot perform in hilly areas in KPK. That’s why the tractors figure is very low in KPK as compared to other provinces. Small tractors are highly needed in these areas.

KPK is sheltering a population of more than 20 million people. The major portion of this population i.e. about 83% is dwelling in rural areas putting a tremendous pressure on land resources. To cater for the livelihood needs of this mammoth population, the province possesses 10.17 million hectares of land. However, the cultivable area is 2.75 million hectare. . Out of cultivable area only 1.8 million hectare is cultivated where as 1.08 million hectare is cultivable waste. This scenario resulted in a situation where 94% farms are now below the range of 12.5 acres.

CHAPTER 2

LITERATURE REVIEW

An engine power plough is a specialized mechanical tool used to Plough the land by a series of blades which are used to swirl up the earth. Blades are drawn as an attachment behind either a two-wheel tractor or four-wheel tractor. Small, two wheel tractors are used in domestic gardens. In addition, small tractors have been used to clean the exterior of oilfield pipes and to prepare the ground for road construction.

Single axle tractors have become world famous for preparation of seedbed in fields. Nowadays, utilization of two wheel tractors has been increased in agricultural applications because of simple structure and high efficiency for this type of tillage implements.

By taking advantage of rear mounted clevis hook, the primary and secondary tillage applications could be conjugated in one stage.

While coming on to the working of the hand held tractor, it is typically propelled forward (via 5-15 horsepower petrol engine) by the powered wheels, they may also have small transport wheel(s). To keep the machine from moving forward too fast, an adjustable controller which alters the speed of engine is fixed on the handle.

The slower a tractor moves forward, the more soil plough can be obtained. The operator can control the amount of friction/braking action by raising and lowering the handlebars of the blades

STUDIES ON AVAILABLE SMALL TRACTORS

Before going in to the design of a new engine power two wheel tractor we had a thorough study on presently available hand held tractors and then also learn about the its advantages and disadvantages. Some of the two wheel tractors that we gone through are

- Huiyou DF-12
- Agria 3600
- Dahaihsi 121

Huiyou DF-12

Engine	S195, 1 cylinder, Horizontal, 4 cycle, 12hp / 2000 rpm
Speed	1.4 / 2.5 / 4.1 / 5.3 / 9.4 / 15.3 km/h : forward 1.1 / 3.8 km/h : reverse
Gear	6 forward : 2 reverse
Weight	500 kg
Starting method	Hand crank

Table 1: Specifications of Huiyou DF-12

Figure 1: Huiyou DF-12

AGRIA 3600

Engine	Robin EH17 1-cylinder-4-stroke-petrol engine 4.0 kW (6.0 DIN-PS)
Speeds	F: 0-6 km/h; B: 0-4 km/h
	Forward: 1.3; 2.4 and 7.0 km/h, Backward: 2.1 and 3.6 km/h
Gears	Pinion shift gearbox 4-shifts, 2 forward / 2 backward
	Step less hydrostatic traction drive with one-disk dry clutch
Handle bar	adjustable in height and lateral without tools, vibration-cushioned
	turn able by 180°
Steering	single wheel steering
Standard Equipment	Hand launching
Weight	560 kg

Table 2: Specifications agria 3600

Figure 2: Agria 3600

DAHAIHSI 121

Engine	Engine ZS1100N, 12hp
Speed	Forward: 1.4, 2.5, 4.1, 5.3, 9.4, 15.3 Reverse: 1.0, 3.8
Gear	6 forward, 2 reverse
Weight	350 kg
Staring method	Hand Crank

Table 3: Specifications dahaihsi 121

Figure 3: Dahaihsi 121

CHAPTER 3

METHODOLOGY

Machine design is creation of plans for machine to perform the desired functions. The machine may be entirely new in concept of performing new type of work or it may perform more economically work that can be done by existing machine. It may be an improvement or enlargement of an existing machine for better economy and capability. Machine design is defined as the use of scientific principles, technical information and imagination in the description of a machine or a mechanical system to perform specific function with maximum economy and efficiency. This definition of machine design contains following important features:

A design uses principles of basic and engineering sciences such as physics, mathematics, statics and dynamics, thermodynamics and heat transfer, vibration and fluid mechanics. Some of the examples of these principles are Newton's law of motion, Carnot cycle, and internal combustion engine formulas for finding power fuel consumption etc.

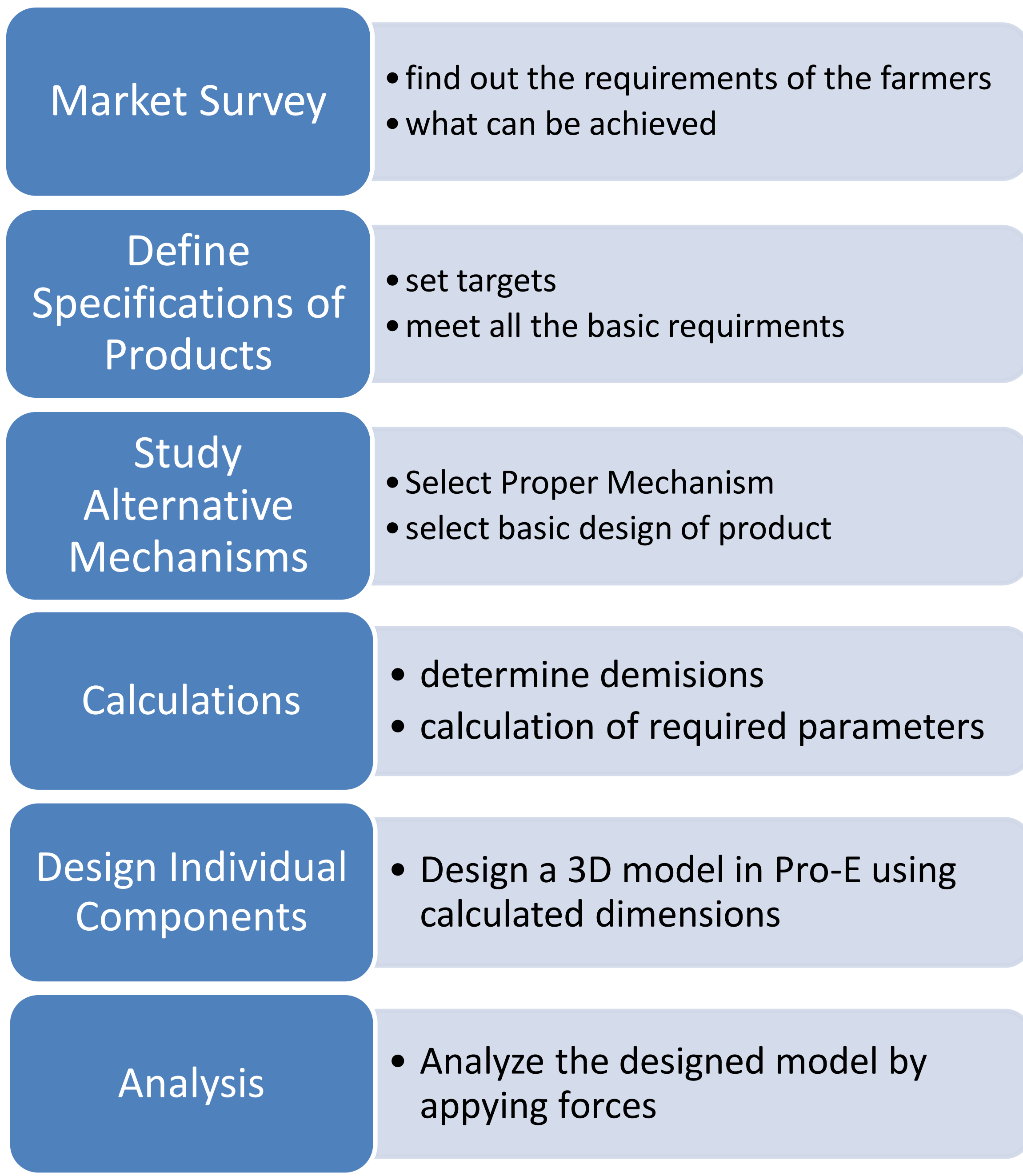
The designer has technical information of the basic elements of a machine. These elements include fastening devices, chain, belt and gear drives, bearings, oil seals and gaskets, springs, shaft, keys, couplings and so on. A machine is a combination of these basic elements. The designer knows the relative advantages and disadvantages of these basic elements and their suitability in a particular application.

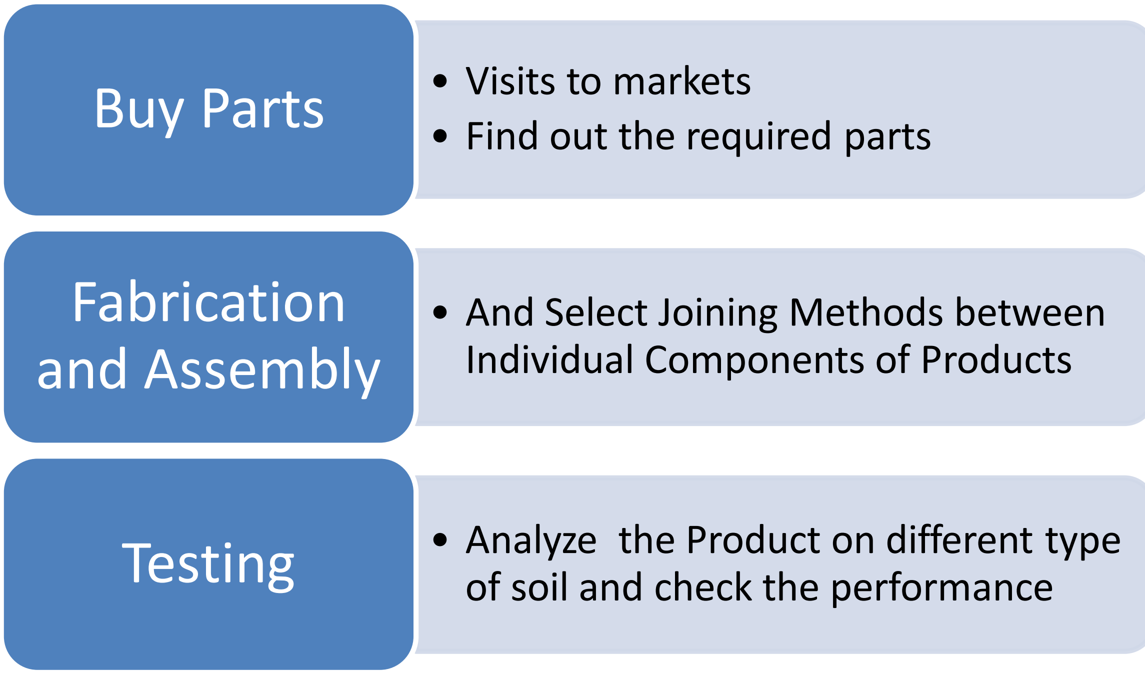
The designer uses his skill and imagination to produce a configuration which is a combination of these basic elements. However, these combinations are unique and different in different situations. This intellectual part of selection of proper configuration is creative in nature.

The final outcome of design process consists of description of the machine. The description is in the form of drawing of assembling and individual components

A design is created to satisfy a recognized need of the customer. The need may be perform a specific function with maximum economy and efficiency.

Machine design establishes and designs solutions and pertinent structures for problems not solved before and provided new solution to problems that have previously been solved in different way.




Buy Parts
Visits to markets
Find out the required parts
Fabrication and Assembly
And Select Joining Methods between Individual Components of Products
Testing
Analyze the Product on different type of soil and check the performance

CHAPTER 4

CALCULATIONS AND RESULTS

Tractor Static Calculations to find RPM on wheel

Experimental:

Force required for 1 inch deep and 1.5 inch wide cut = 250 N

And for 4 inch deep having same width = 1000 N/shank

Practical:

Draft force for hard Soil = 200 N/m

Work rate = 0.2 hector/hr

Tractor Speed = 2.02 km/hr= 0.5611m/s

Implement width $= \frac{11.8 \text{ x } 0.2}{3}$ = 0.8 m

Tyre Radius= 16.00 in = 0.406 m

RPM (Tire) = 13.2

Soil resistance = Iw x depth x draft force = 0.8 x 10 x 200 = 1608 N

Required drawbar power $= \frac{1608 \text{ x } 3}{3600}$ = 1.34 kW

Power Take off (PTO) = 1.35 x soil condition factor

PTO = 1.35 x 1.5 = 2.01 kW = 2.69 hp

Considering efficiency:

Power = $\frac{\text{force x velocity}}{\text{efficiency}} = \frac{3000 \text{ x } 0.5611}{0.85}$ = 1980 W = 2.65 hp

$F = U_k$ x N => $N = \frac{F}{Uk}$

$N_{th} =$ 2550 N

N_{exp} = 1370 N

For wheel:

T = r x F

T_{th} = 0.406 x 1608 = 652.84 Nm

T_{exp} = 0.406 x 3000 = 1218 Nm

Torque required at Engine:

T_{th} = 652.84/77 = 8.47 Nm

T_{exp} = 1218/77 = 15.81 Nm

Required Diameter for Shaft:

$T_{th,wheel}$ = 652.84 Nm

Properties of iron:

UTS = 350 MPa

USS = 0.6 x UTS = 210 MPa

$T_{th} = \frac{\pi}{16}$ x tmax x d^3= 652.84 = $\frac{\pi}{16}$ x 210 x d^3

d_{th} = 24.02 mm

$T_{exp} = \frac{\pi}{16}$ x tmax x d^3= 856.5 = $\frac{\pi}{16}$ x 210 x d^3

d_{exp} = 29.57 mm

Factor of safety (FOS) is considered here as this part have the extreme loads and FOS is taken as 1.5, new values of diameters become: 4

d_{th} = 24.02 x 1.5 = 36.03 mm

d_{exp} = 29.57 x 1.5 = 44.35 mm

We use the wheel shaft of medium carbon alloy steel with diameter of 40 mm

Gear ratio is achieved as

1:3 reduction at first pulley

1:1 to 1:3.15 at gear box

1:2 at second pulley

And at end on differential 1:4

Plough Rate:

Area ploughed per hour = 2000 m x 0.92 m = 1840 m^2/hour = 0.184 hectors/ hour

Weld Calculations:

Weld #1

P= t x l x r$_{t = t \times r \times \frac{F}{\pi r . r} = \frac{Ft}{\pi r}}$

F= force applied for welding

t= thickness of tube

r = radius of tube

P= force generated due to welding

P (standard) MPa	Bear electrode		Coated electrode	
	Steady load	Fatigue load	Steady load	Fatigue load
tension	90	35	110	55
Compression	100	35	125	55
Shear	50	21	70	35

Stress conc. factor

Reinforces butt weld = 1.2

Bear Electrode

	Steady load(MN)	Fatigue load(MN)
Tension	1231	479.09
Compression	1368.84	479.09
Shear	752.95	287.49

Coated electrode

	Steady load(MN)	Fatigue load(MN)
Tension	1505.72	752.86
Compression	1711.04	752.86
Shear	958.3	479.15

Weld # 2

Circular fillet welt subjected to torsion:

d= diameter of rod

r= radius of road

T= torque acting on rod

s= size of weld

t= throat thickness

J= polar moment of inertia of weld section

J= $\frac{\pi td.d.d}{4}$ = $\pi/4$ x 0.7x 10^{-2} x (0.8x $10^{-3})^3$

J= 3.87 x 10^{-3}

$\tau = Tr/J = Td/7.74 \times 10^{-3}$

$\tau = 114.987\ T$

Torsion for experiment:

$\tau = 114.987 \times 16.33 = 1.88$ kNm

Torsion for theoretical:

$\tau = 114.987 \times 8.73 = 1.003$ kNm

Max. Shear occurs at

$\tau = 6 \sin 45 = 0.7075$

$\tau_{max} = 2.83 x 16.33 x 1/\pi x 0.8 x 10^{-2} x 0.89^2$

$\tau_{max} = 2.32$ kNm

Circular fillet weld subjected to bending moment:

d= diameter of rod

M= bending moment acting on rod

S= size

t= thickness of throat

z= section modulus of weld section

$z = \pi d.d.t/4$

$\sigma_b = M/z = M/(\pi d.d.t/4) = 4M/\pi td^2$

$\sigma_b = 4M/\pi x 0.7 x 10^{-2} x (0.89)^2 = 229.63M$

Moment experimental:

$\sigma_b = 229.63 x 16.33 = 3.74\ kN/m^2$

Moment theoretical:

$\sigma_b = 229.63 \times 8.73 = 2 kN/m^2$

$t = S \sin 45 = 0.707 \times S = 0.707\ (0.8 \times 10^{-2}) = 5.656 \times 10^{-3}$

$\sigma_{b,max} = 5.66\ M/\pi x S x d^2 = 5.66x1x6.33/\pi x0.8x10^{-2}x0.7921$

$\sigma_{b,max} = 4.643 kNm/m^2$

Young modulus for iron

$Y = 210x10^9\ N/m^2$

$Y = \sigma/\epsilon$

$\epsilon = \sigma_b/Y = 17.80x\ 10^{-9}$ (experimental)

$\epsilon = \sigma_b/Y = 17.80x\ 10^{-9}$ (theoretical)

$\epsilon = \sigma_{b,max}/Y = 22.09\ x\ 10^{-9}$(experimental)

$\epsilon = \sigma_{b,max}/Y = 11.80x\ 10^{-9}$(theoretical)

SHAFT CALCULATIONS

Shaft material = iron

Diameter = 41.4mm (calculated)

Diameter = 40.0mm (used)

Cross sectional Area = A

$A_{cal} = \pi\ x\ (41.4x10^{-3})^2/4 = 1.34x\ 10^{-3}\ m^2$

$A_{used} = \pi\ x\ (40.0x10^{-3})^2/4 = 1.257x\ 10^{-3}\ m^2$

Area moment of inertia

Calculated:

$I_{xx} = \pi\ x\ (41.4\ x\ 10^{-3})^4/64 = 2.31x\ 10^{-6}\ I_{yy} = 2.31x10^{-6}$

Used:

$I_{xx} = \pi\ x\ (40.0\ x\ 10^{-3})^4/64 = 2.01x\ 10^{-6}\ I_{yy} = 2.01x10^{-6}$

Section modulus:

Calculated:

$S_{yy} = I_{yy}$ x2/d = 2 x2.31x10^{-6}/41.4x10^{-3} = 1.125x 10^{-4}

$S_{xx} = I_{xx}$ x2/d = 2 x2.31x10^{-6}/41.4x10^{-3} = 1.125x 10^{-4}

Used:

$S_{yy} = I_{yy}$ x2/d = 2 x2.31x10^{-6}/40.0x10^{-3} = 97x 10^{-5}

$S_{xx} = I_{xx}$ x2/d = 2 x2.31x10^{-6}/40.0x10^{-3} = 97x 10^{-5}

Center of gravity:

Calculated (mm)	Used (mm)
X=20.7	X= 20
Y=20.7	Y=20

Mass:

M=ρ A l

l= 2.3cm

ρ(medium carbon) = 7.15 g/cm^3

ρ(low carbon) = 7.05 g/cm^3

ρ(iron) = 7.87 g/cm^3

ρ(high carbon) = 7.25 g/cm^3

Mass(kg)	Calculated	Used
Medium carbon	2.221	2.067
Low carbon	2.18	2.04
Iron	2.44	2.27
High carbon	2.24	2.1

Radius of gyration:

$r_x = (I_{xx}/A)^{0.5}$; $r_y = (I_{yy}/A)^{0.5}$

Calculated:

$r_x = 0.0414$

$r_y = 0.0414$

Used:

$r_x = 0.0399$

$r_y = 0.0399$

Polar moment of inertia:

$J = I_{xx} + I_{yy}$

$J_{cal} = 4.62 \times 10^{-6}$

$J_{used} = 4.02 \times 10^{-6}$

Gear box designing:

$F_r = F_t \tan \Theta$

P =Tn/63000

T= torque

n= RPM

P= power

$\omega_b/\omega_a = T_a/T_b$

$166.66/500 = T_a/T_b$

$T_a/T_b = 0.333$

As $v = r\omega$

Let $V_a = V_b$

$\omega_a/\omega_b = r_b/r_a$

$500/166.66 = r_b/r_a$

$r_b/r_a = 3$

<u>V belts Calculation:</u>

Vbelt power capacity:

$P=P_o \times z \times k_l \times k_o / k_t$

$I = D_2/D_1 = 3$

$z = 3$

If $i > 1.88$ then $k_i = 1.15$

Small pulley diameter:

$De = Ki\ D_1$

$De = 1.15 \times 4 = 4.6$ inch

Belt length:

Axis distance = A

$D2 + D1 \geq A \geq D2 + D1\ /2$

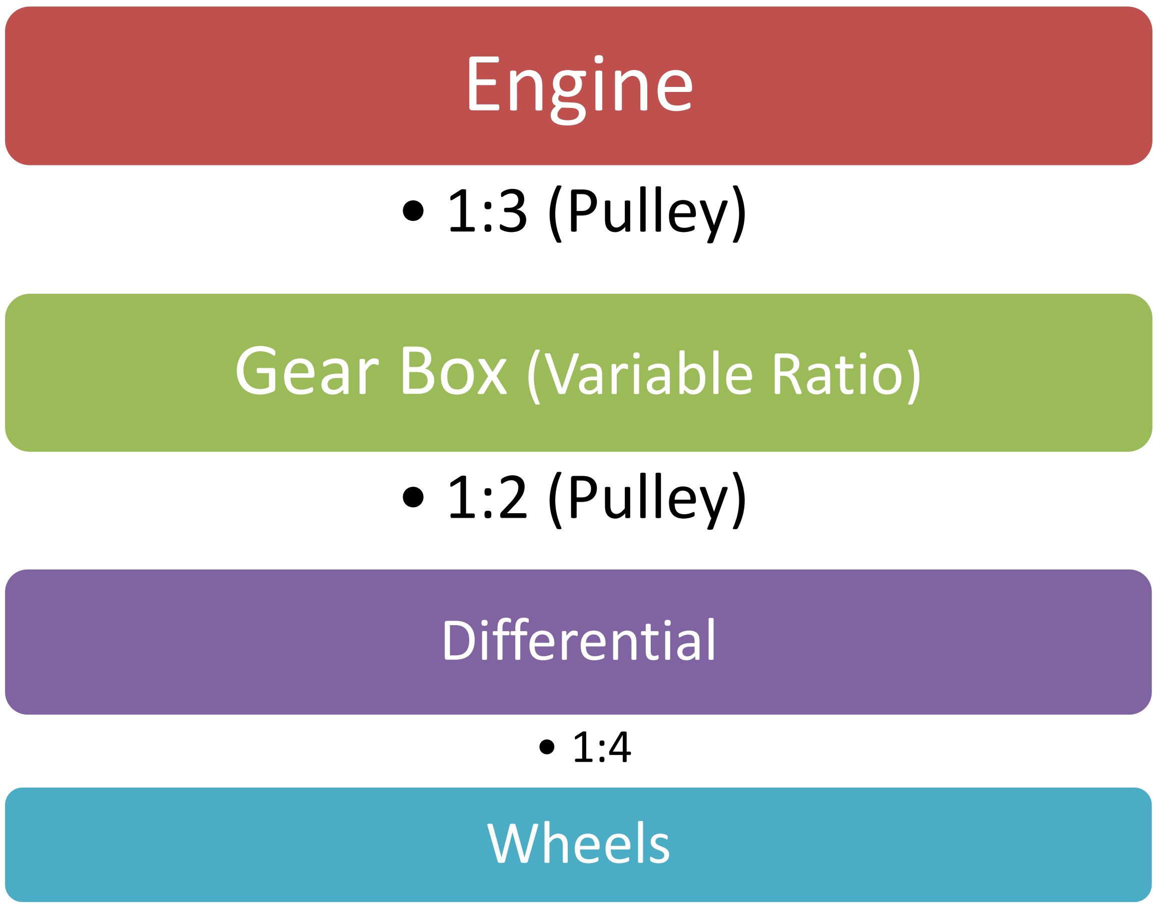
$812.8 \geq A \geq 253.2$

A=533mm = 21 inch

CHAPTER 5

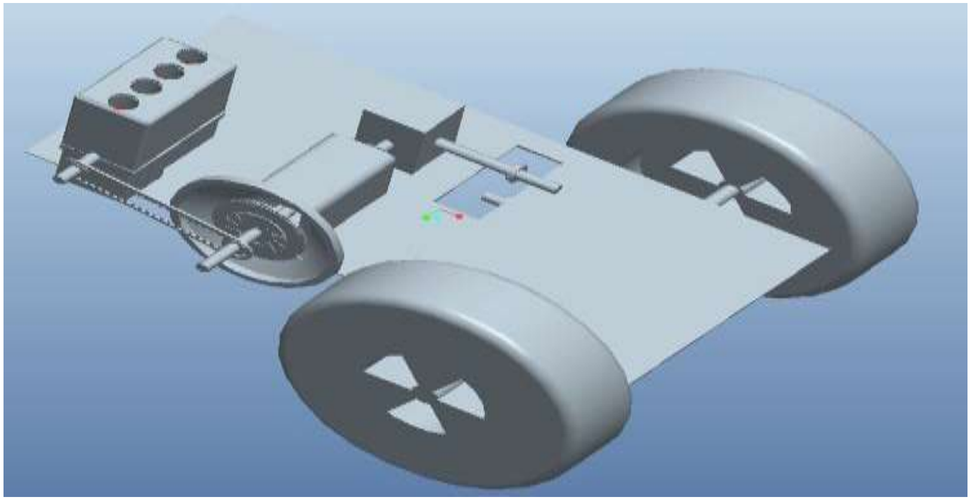
DESIGN

SCHEMATIC DIAGRAM



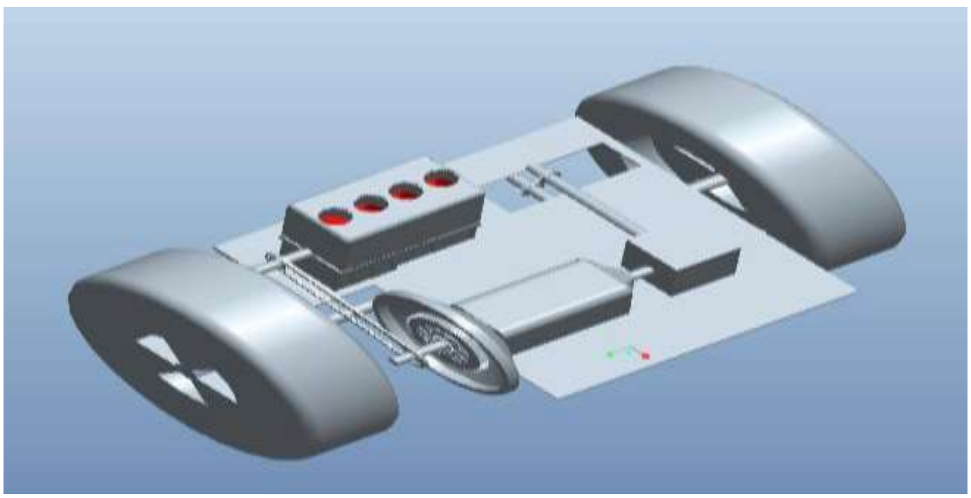
Different designs were under consideration, some of which are given below.

First design:



Weight wasn't properly balanced and the configuration was complex. In this configuration we have to use both gear reducer and converter which results in increased cost. That's why this design wasn't selected.

Second Design:



The speed achieved by this design was lower than our required speed, that's why this design was also rejected.

After 1-2 more design configurations, and with the guidance of Prof. Sir Sami, we achieved our final design which is given below along with the rough fabricated design.

Third Design:

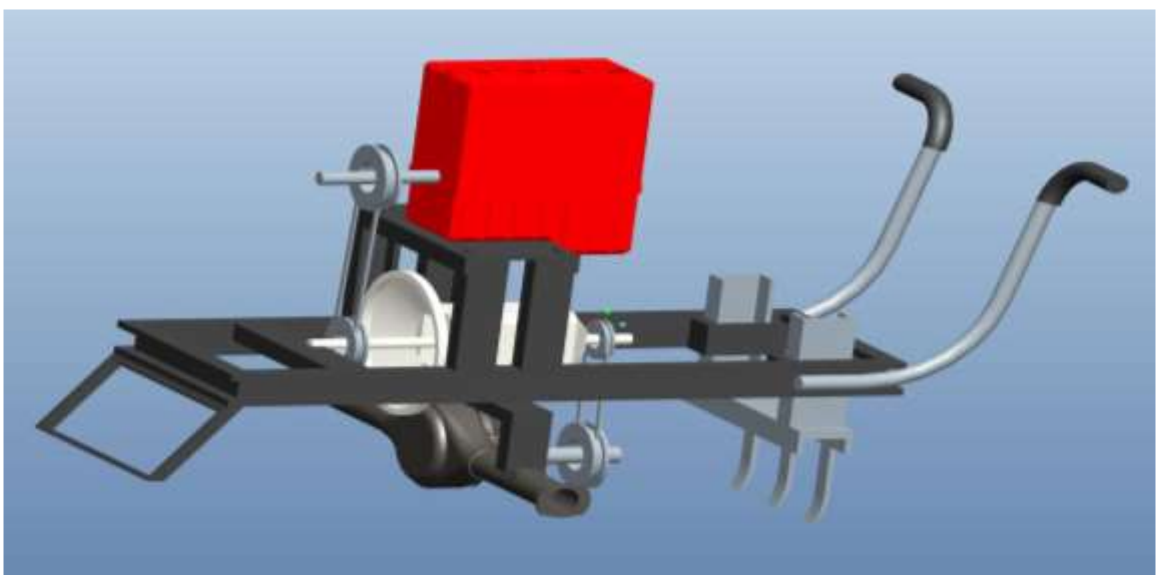


Figure 4: Pro-E Design

CHAPTER 6

MAIN PARTS

1. DIFFERENTIAL

Different differential axle assemblies were under consideration .e.g. differentials of QINGQI rickshaw, Sazgar Rickshaw, jeep M151 and differential of Suzuki Potohar jeep

We selected differential of Potohar jeep based on following factors:

- Lower cost
- Small size
- Easy to modify
- High strength and can be used in hilly area.
- High differential gear ratio

Rear differential axle assembly was used, considering the requirements of our project we had to decrease the width of our differential. Three configurations were studied for this purpose.

1. Cutting differential housing and axle shafts.

   We did not go for this configuration, if we cut axle half shaft we had to weld it to join shortened shaft, because this shaft is in extreme loading conditions during operation, all stresses would be generated across the weld, which the weld might not withstand.

2. Suzuki Mehran car tans-axle differential system configuration.

   Mehran car differential system was considered in which shock absorber was replaced by frame supports, in this way we can avoid cutting of differential. The issue was the compromise on the stability and strength of machine. Also the gears and shafts will be over stressed during operation and also it will not can't achieve the required speed at tires.

3. Potohar Jeep differential system Configuration

   Potohar Jeep rear differential axle assembly was selected in which the differential gear was offset from the center (as shown in picture). So we cut the longer side of the housing of axle. This configuration used only one cut on housing and thus we avoided cut on the axle shaft of differential. From this configurations we succeeded in our purpose of high strength

Following is the picture of the cutting operation of differential axle housing.

2. FRAME

Standards followed are ASTM A6/A6M - Dimensions and Static parameters

ASTM, C 3x5

C-Section frame C 3 x 5 of 5 mm thickness was used taking in consideration of the dimensions, forces and weight of different parts like gear box and engine. Different frame designs were analyzed according to the forces acting on the frame using Ansys . I beam and C beam of structural steel are almost equal in tension, compression, shear and both can be used for fabrication of Frame.

Parameter	Symbol	Value
Flange-flange inner face height	H	2.7 inch
Width	B	1.5 inch
Flange thickness	h	0.159 inch
Web thickness	b	0.258 inch
Length	L	60 inch
Density	p	0.283 lb/in^3

Channel Beam Properties:

Parameter	Symbol	Value
Cross section area	A	7.572 cm^2
Mass	M	9.039 kg
Second moment of area	I_{xx}	582276.438 mm^4
Second moment of area	I_{yy}	84281.461
Section modulus	S_{xx}	15191.695 mm^3

Minimum section modulus	S_{yy}	2966.359 mm^3
Radius of gyration	r_x	27.731 mm
Radius of gyration	r_y	10.55 mm
CoG distance in x direction	x_{cog}	9.688 mm
CoG distance in y direction	y_{cog}	38.329 mm

HOT ROLLED CARBON CHANNEL STEEL SS400

. Its properties are given below

Modulus of Elasticity	210,000 N/mm^2
Shear modulus	81,000 N/mm^2
Poisson's ratio	0.3
Coefficient of thermal expansion	12 x 10-6/°C

3. TYRE

Three different types of tires were under consideration

Tires of china made hand held tractors

Tires of Pajero jeep (due to easy availability in market)

We used Good year tire American made of size 9.5-16 tires. The specifications of the selected tires are given below:

Rim Diameter	9.5
Tire Outer Diameter	16
Tire Pressure	50 bar
Tire type	6 ply
Friction coefficient	0.6
Rolling Resistance Coefficient	0.040

- This type of tire can be used in hilly areas as it can run on sloppy tracks.
- Very less chance of slippage
- High ground Clearance to avoid collision between differential and stones in fields.

4. PULLEY

1^{st} set Pulley ratio = 1:3

2^{nd} set Pulley ratio = 1:2

Pulley Number	Pulley Diameter
1.	4
2.	12
3.	4
4.	8

OPERATIONS:

- Pulleys were checked for dynamic balancing on lathe machine.

- Boring was done on pulleys 2
- Facing was done on pulleys number 2, 3, 4
- Tapering was done on pulley 2

Driven side of the gear box contains splines, in order to connect the pulley to the gear box we also needed splines on the shaft that is connected to the pulley.

In order to solve this problem, we took a metal plate of 15mm. Facing was done on the metal plate to decrease its length & diameter. Four holes were drilled in the plate & pulley to join the plate with the pulley with the help of bolts. The universal joint shaft was cut and the piece with the splines was connected to the plate with the help of the brass welding.

Brass welding was done because other welds can't be used on Degi Loha (words commonly used in market) and steel.

Degi Loha: The iron containing small amounts of sand.

Iron vs. Degi Loha Pulleys:

The iron heats up very rapidly and can cause damage to the belt, whereas the Degi Loha is a bad conductor of heat and doesn't heat up.

5. ENGINE

During survey different engines came under our consideration. There are 2 types of engines.

1. Diesel Engine
2. Petrol Engine

Comparison between diesel engine and petrol engine:

Parameter/ factors	Diesel Engine	Petrol Engine
Torque	High	Low
RPM	Low	High
Availability of fuel in hilly areas	Easy	Difficult
Weight	Greater	Less
Stroke length (compression ratio)	High	Low
Maintenance Cost	Low	high

We used Diesel Engine, because we needed more torque at low rpm, which the petrol engine can't provide.

Engines come in two configurations (according to the radiator)

1. With built in radiator
2. Without built in radiator

We used the engine without radiator due to limited resources.

In accordance with the starting of engine they come in two configurations.

1. Self-Start
2. Hand Crank

We used hand crank engine.
Following are the specifications of our used engine

Model	R175a
Fuel	Diesel
Max RPM	2200
Hp	7.0
Engine Oil Grade (summer)	HC-11
Engine Oil Grade (winter)	HC-8
Tank Fuel Capacity	6 liters
Water Tank Capacity	6 liters
Mileage (operation)	0.86 liters/hour

6. HANDLE

For handle purposes we took a pipe and bend it on Pipe bending machine, then we welded the Yamaha 100 handle upon it.

The vibrations produced at the driver end were huge and it was very difficult to handle the tractor for the user. To reduce the vibrations at the handle, we used handle bar grip.

7. BELTS

Double V type belts were used to minimize deflection in belts.

To vary the belt span, the engine can be displaced along an axis parallel axis of differential.

Belts on 1st set of pulleys	B-54
Belts on 2nd set of pulleys	B-39

Chain vs. Belt

	Belt	Chain
Maintenance	low	High
Life	high	low
Moving components	No	Links, Pins and rollers
Cost	Low	High
Noise	low	High
Vibration damping	high	Low
Lubrication	No	Yes
efficiency	Low	high
Loop	Continuous, Can't be separated	Discontinuous, Can be separated

Considering these factors, we used belts for our tractor.

8. BEARINGS

3 Bearing were used in our tractor.

2 bearing were used inside the gearbox to support the shaft. The number of these ball bearings are NTN 6208ZC3

200 = light bearing series

Internal bore = X*5= 08*5 = 40mm

Z= Shield on one side

C3= Radial Clearance greater than normal

IS: 3824 standards were followed in the calculations of the static and the dynamic loading of the bearing.

3[rd] bearing used was the journal bearing UC-207-20.

When the shaft runs without the journal bearing the gear box tilts to the back side at a certain angle and thus causes the deflection in the belts. In order to avoid that effect the journal bearing was used. Below is the diagram of the journal bearing.

Inside the gear box, a clutch bearing was also placed.

9. GEAR BOX

During market survey, different gear boxes were under consideration for the project.

1. Suzuki Mehran
2. Suzuki Bolan
3. Suzuki pickup

We used gear box of Suzuki pick up; other two were rejected because of these reasons

1. Mehran gear box was rejected as it was not compatible with the design because it was transaxle.
2. Gear box of Suzuki bolan was rejected because clutch plates were not fitting in the covering of the gearbox and we had to design a new covering for the gearbox.
3. These both issues were resolved in the Suzuki pick up gearbox.

To close the one end of the gear box and to support the input shaft on which pulley is mounted as well to support the clutch system we devised this setup after research and calculations.

Cutted the metal plate in required shape corresponding of gear box front. Then weld a pipe with it having internal diameter of 80 mm (after lathe operations) on one side and mounted two bearings and their detail is given in bearing section. After drilling operations, plate was bolted on gear box front.

Clutch mechanism:

Clutch mechanism which we used is Diaphragm spring type single plate friction clutch with throughout bearing for its operation.

10. COVERING

To protect from dust and considering the safety, the tractor was covered with the sheet metal of 19 gauge. Main operations on covering are cutting, drilling, bending and spot welding. Drawing are given in 2Ddiagram section at the end.

11. BREAKING AND TURNING

Differential brake system:

A brake system specially designed in which operation depends on the difference between RPM of two tires.

In our tractor, we use differential brake system. both tires have separate brakes , when one brake is pressed the tire connected with that brake slowdown and other tire speed up , this produces the turning effect.

12. ADJUSTABLE SHANK

Height of blades can be varied , as the method for connecting attachment to the machine is through nut and bolts, three drills were made at different heights to vary height between blades and ground.

CHAPTER 7

ANALYSIS

Following analysis was done on Ansys and the results were refined after increasing the number of the nodes at the point of the stresses.

a) Static Structural Analysis
   1. Maximum Principle Elastic Strain Analysis
   2. Maximum Principle Stress Analysis
   3. Maximum shear elastic strain analysis
   4. Minimum Principle Elastic Strain Analysis
   5. Minimum Principle Stress Analysis
   6. Total Deformation Analysis

b) Transient Structural Analysis
   1) Maximum Principle Elastic Strain Analysis
   2) Maximum Principle Stress Analysis
   3) Minimum Principle Elastic Strain Analysis
   4) Minimum Principle Stress Analysis
   5) Total Deformation Analysis

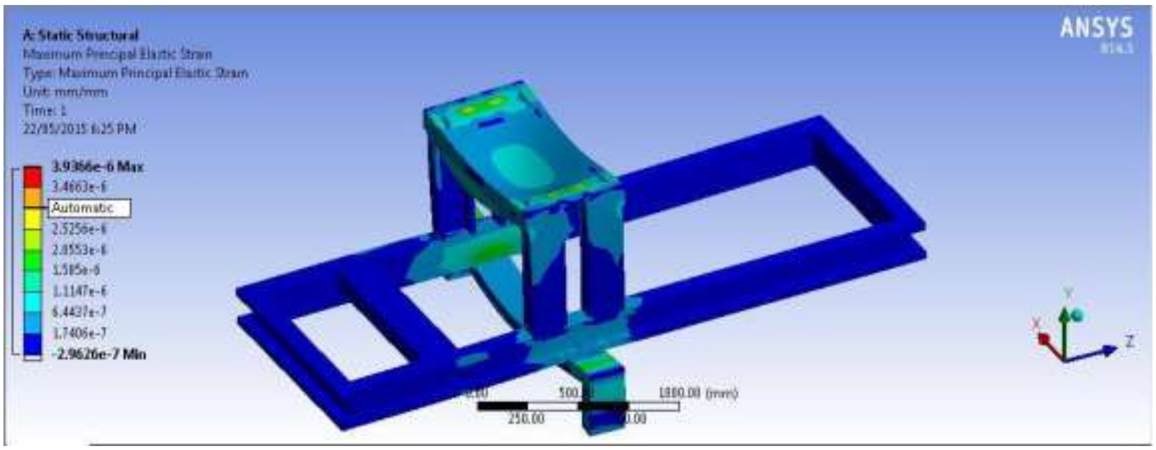
c) Nodal Analysis

d) Shaft Analysis

To study the dynamic properties of frame under vibrational excitation is called Modal analysis.

The results of these analyses are attached below:

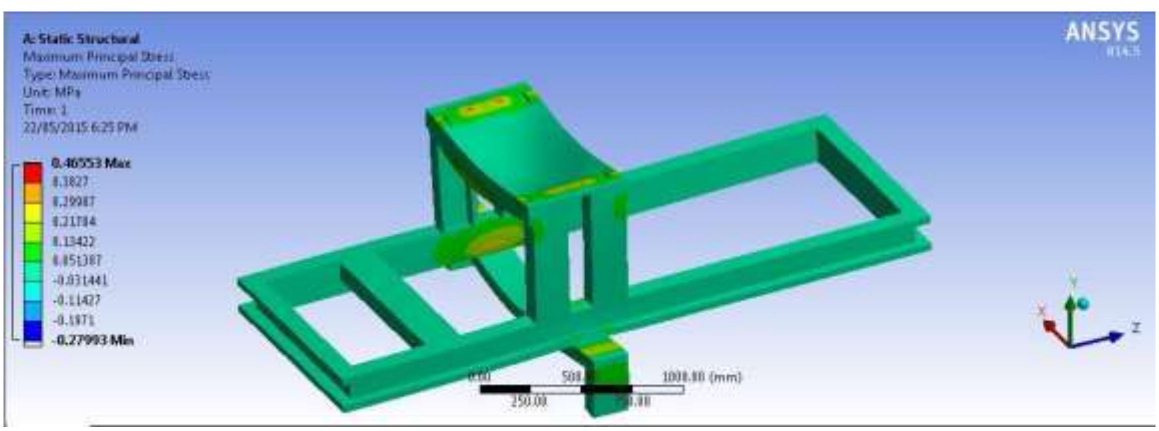
A.1.



Maximum value: 3.9366e-06 mm/mm

Minimum Value: -2.9626e-07 mm/mm

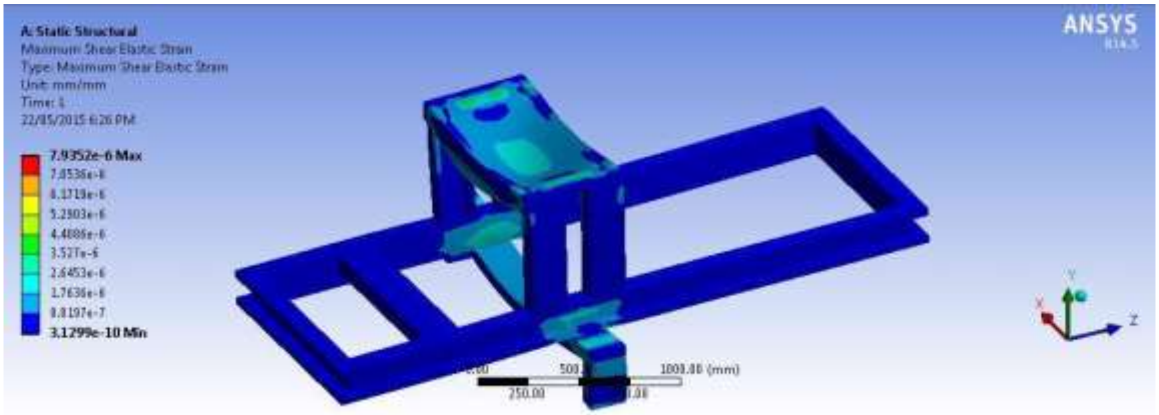
A.2.



Maximum value: 0.46553 MPa

Minimum Value: -0.2799 MPa

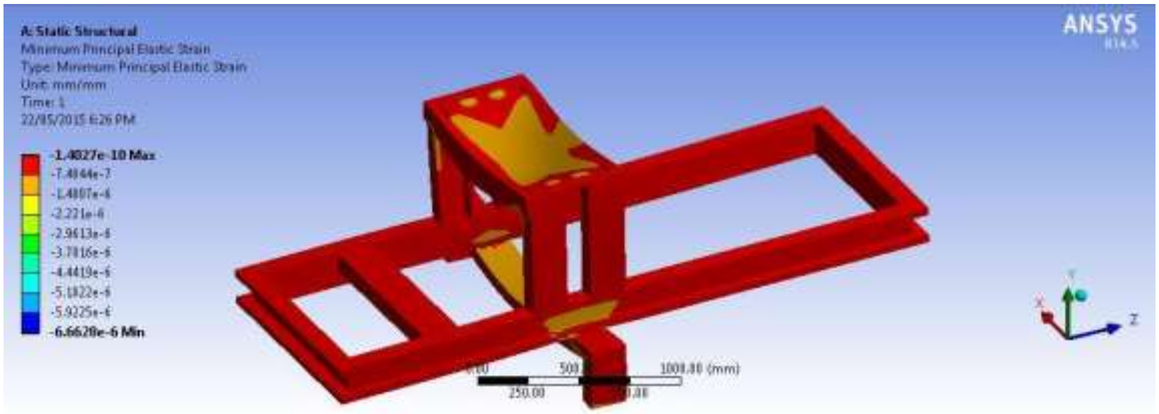
A.3.



Maximum value: 7.9352e-06 mm/mm

Minimum Value: 3.1299e-10 mm/mm

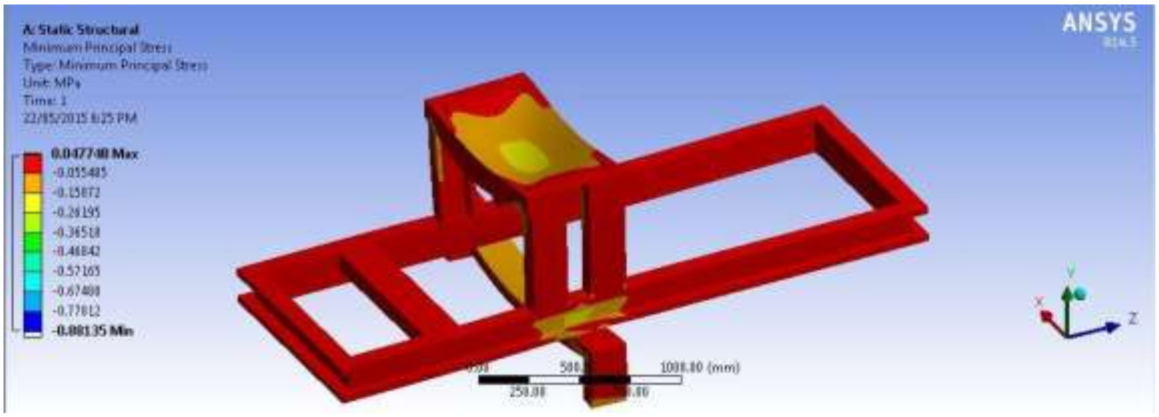
A.4.



Maximum value: -1.4027e-10 mm/mm

Minimum Value: -6.6628e-06 mm/mm

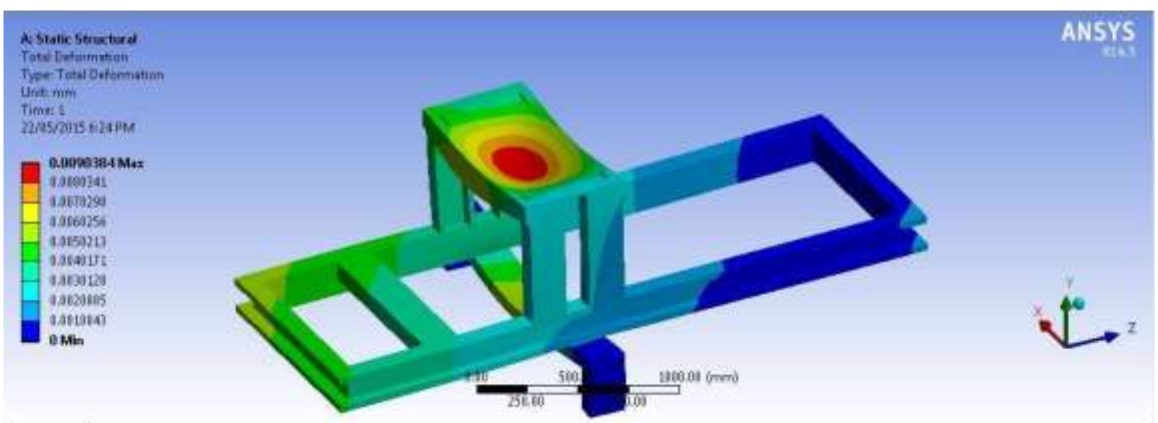
A.5.



Maximum value: 0.047748 MPa

Minimum Value: -0.88135 MPa

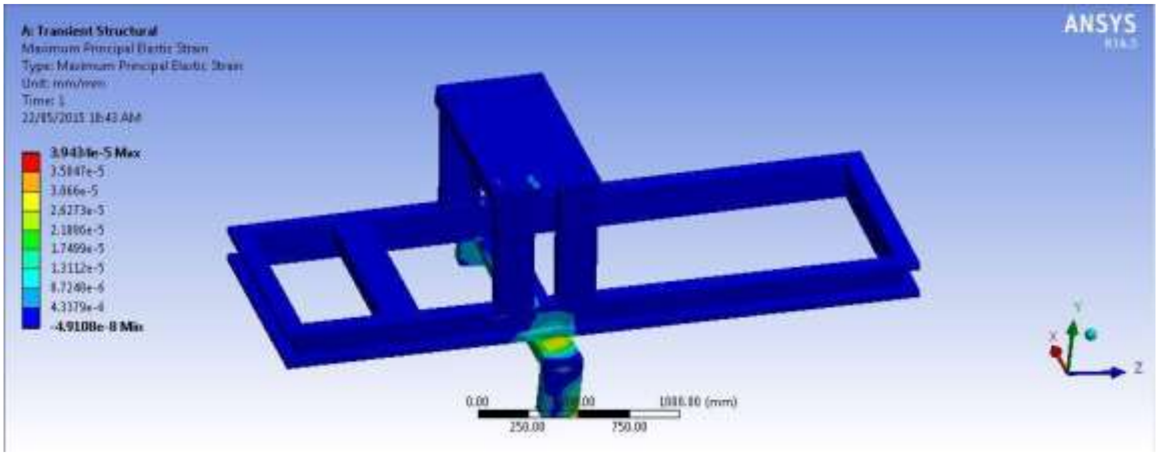
A.6.



Maximum value: 0.0090384 mm

Minimum Value: 0 mm

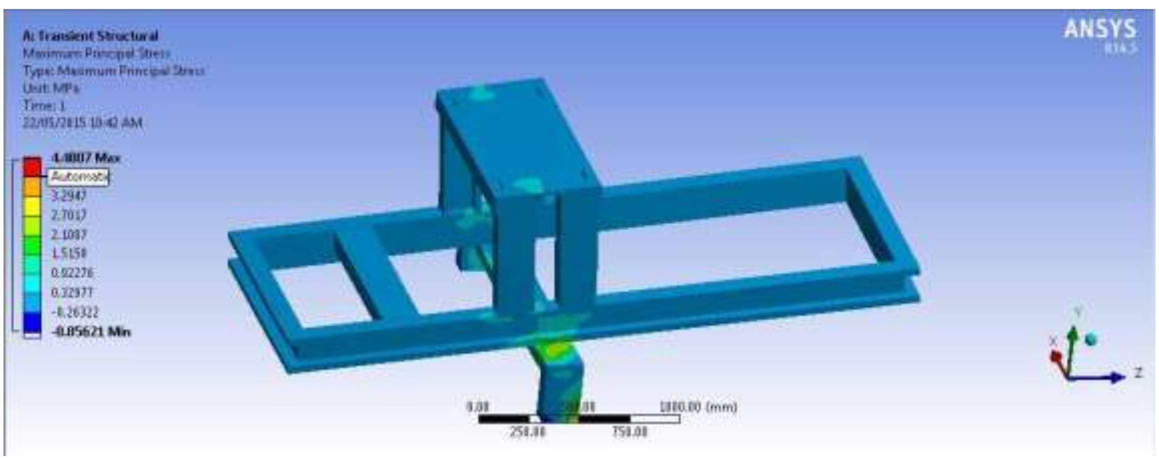
B.1.



Maximum value: 3.943e-05 mm/mm

Minimum Value: -4.9108e-08 mm/mm

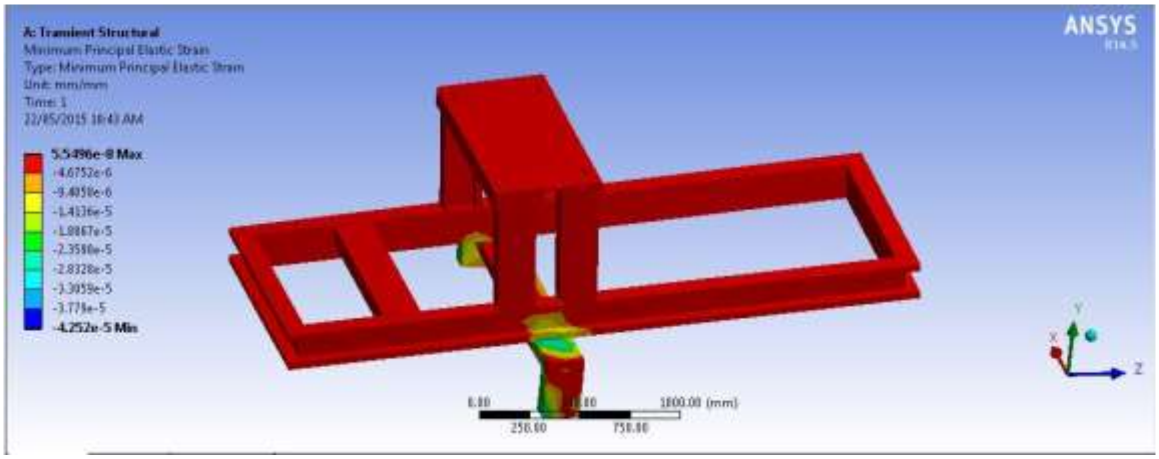
B.2.



Maximum value: 4.4807 MPa

Minimum Value: -0.85621 Mpa

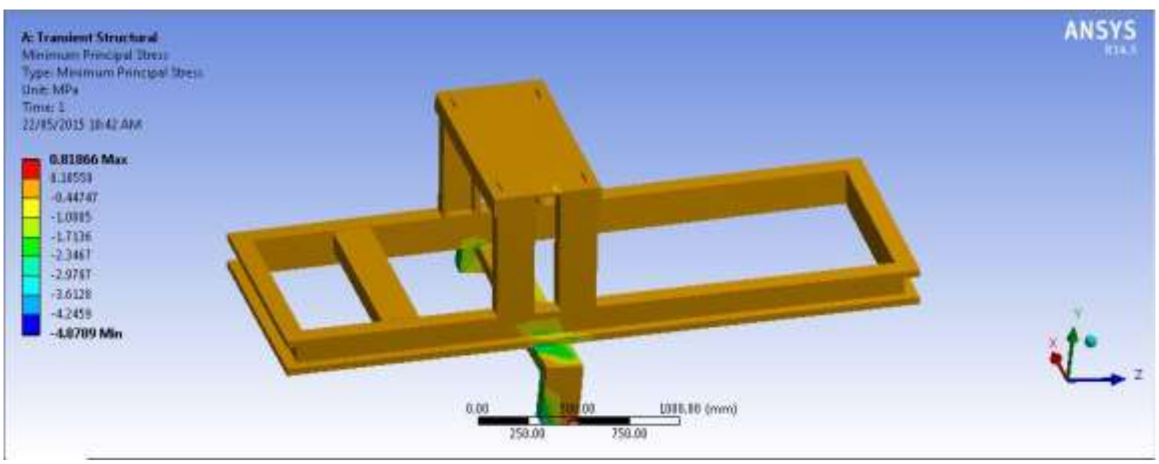
B.3.



Maximum value: 5.5496e-08 mm/mm

Minimum Value: -4.252e-05 mm/mm

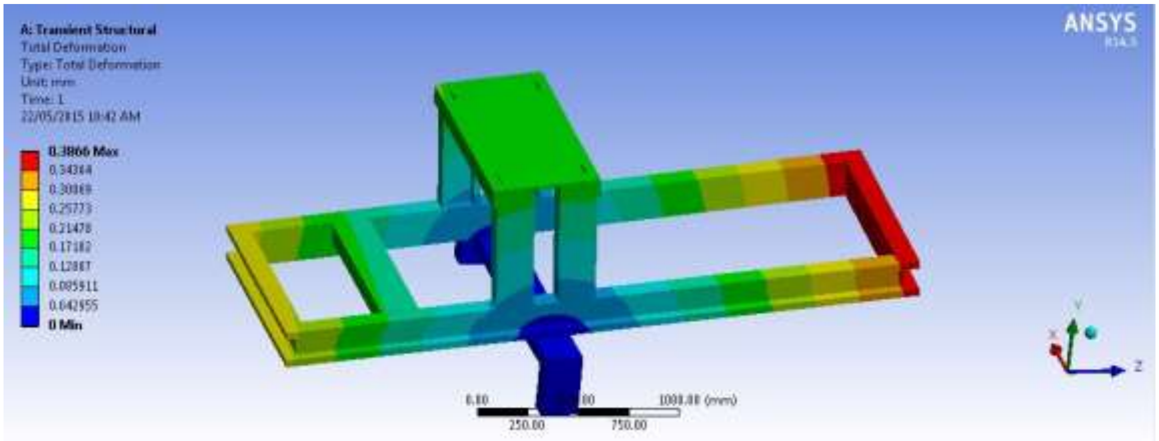
B.4.



Maximum value: 0.81866 Mpa

Minimum Value: -4.8789 MPa

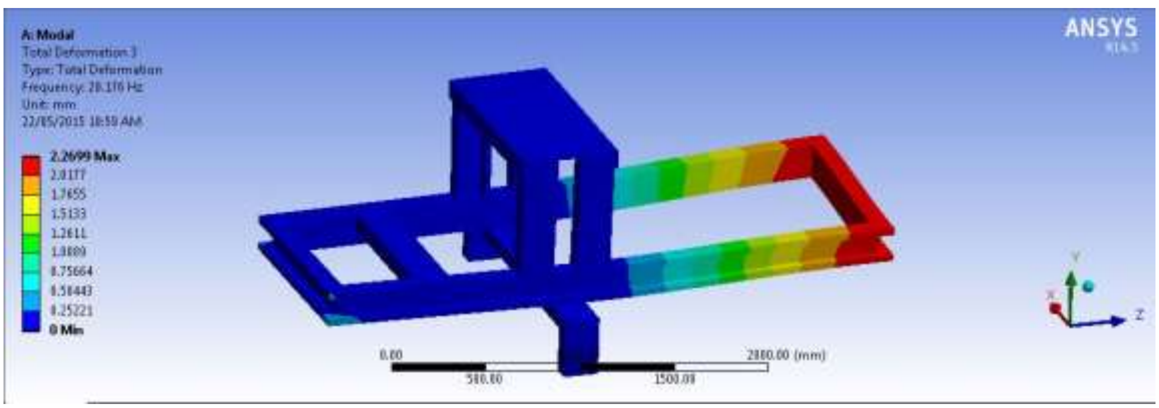
B.5.



Maximum value: 0.3866 mm

Minimum Value: 0.0 mm

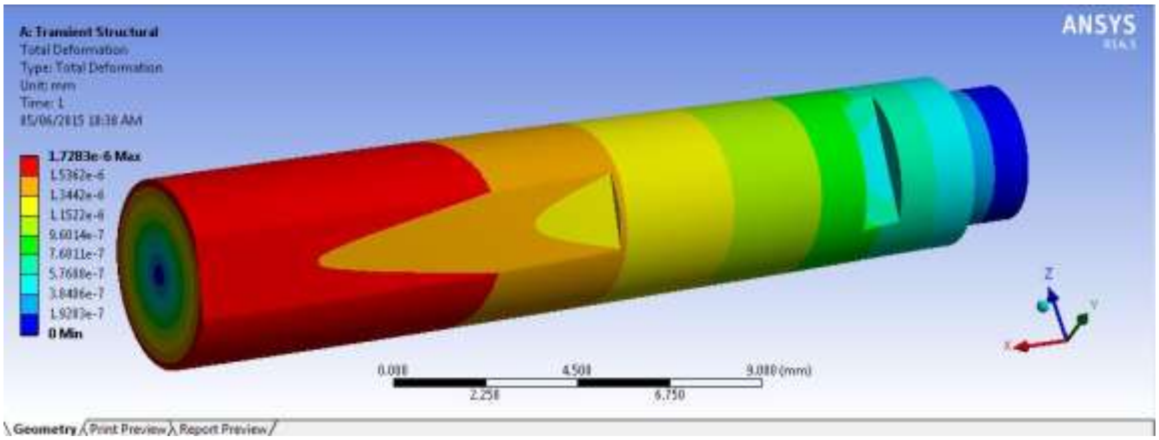
C.1.



Frequency: 20.176 Hz

Deformation: 2.2699mm

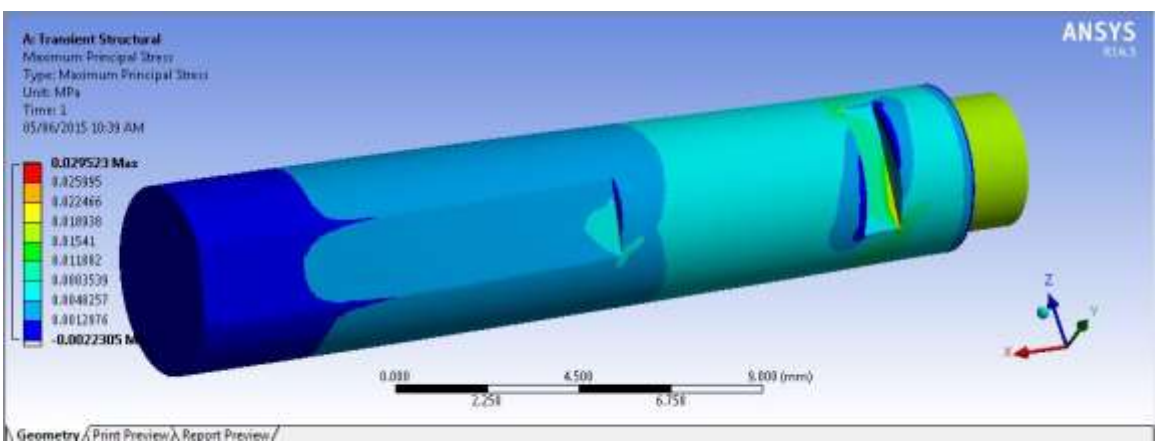
D.1.



Maximum Value: 1.7283e-6 mm

Minimum Value: 0.000000 mm

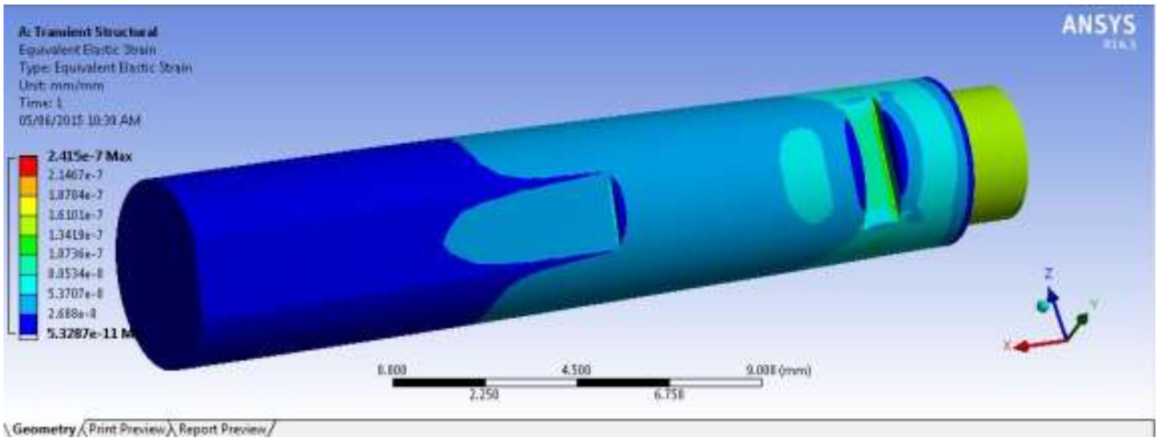
D.2.



Maximum Value: 0.029523 MPa

Minimum Value: -0.0022305 MPa

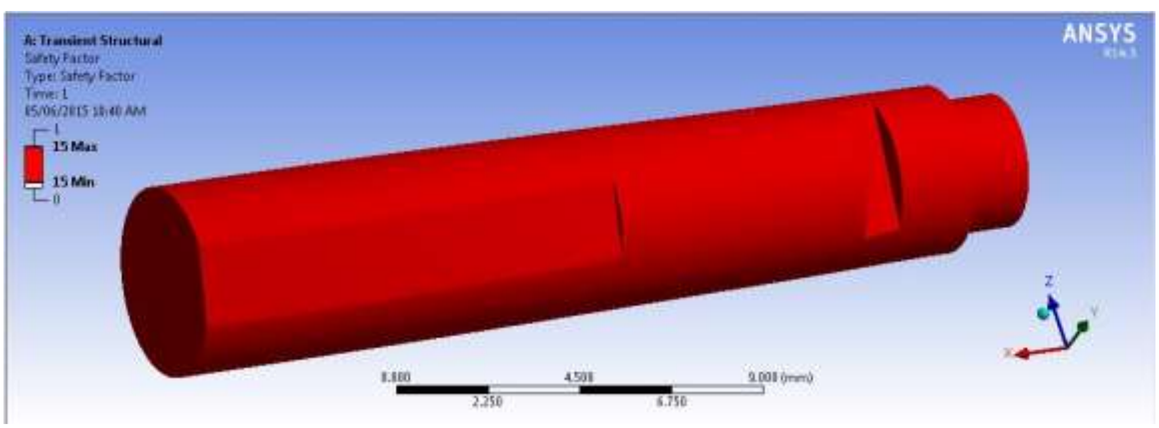
D.3.



Maximum Value: 0.029523 MPa

Minimum Value: -0.0022305 MPa

D.4.



FOS (Max/Min) = 15

CHAPTER 8

MANUFACTURING OPERATIONS

Main operations involved in fabrication are:

- Cutting tube and I sections
- Welding
- Drilling
- Grinding
- Bending
- Facing
- Tapering

Welding

Welding > electric arc welding > consumable electrode > shielded metal arc welding

We used J421-E6013 type rods for the welding of rear axle differential housing.

Chemical Composition of Deposited Metal (%)

Chemical composition	C	Mn	Si	S	P
Guarantee value	≤0.12	0.3~0.6	≤0.35	≤0.035	≤0.040

Mechanical Properties of Deposited Metal

Test Item	R_m(MPa)	R_{eL}(Mpa)	A (%)	KV_2(J)	KV_2(J)
Guarantee value	≥420	≥330	≥17	-(normal temperature)	-(0°C)
General result	460~540	≥340	18~26	50~80	≥47

Feature

- **Stable arc**
- **Lower spatter**
- **Smooth bead and appearance**
- **Lower smoke**

Product specifications and testing results

OPERATION TESTING

We successfully tested our two wheel engine powered plough by running the product up to 4 inch deep cutting.

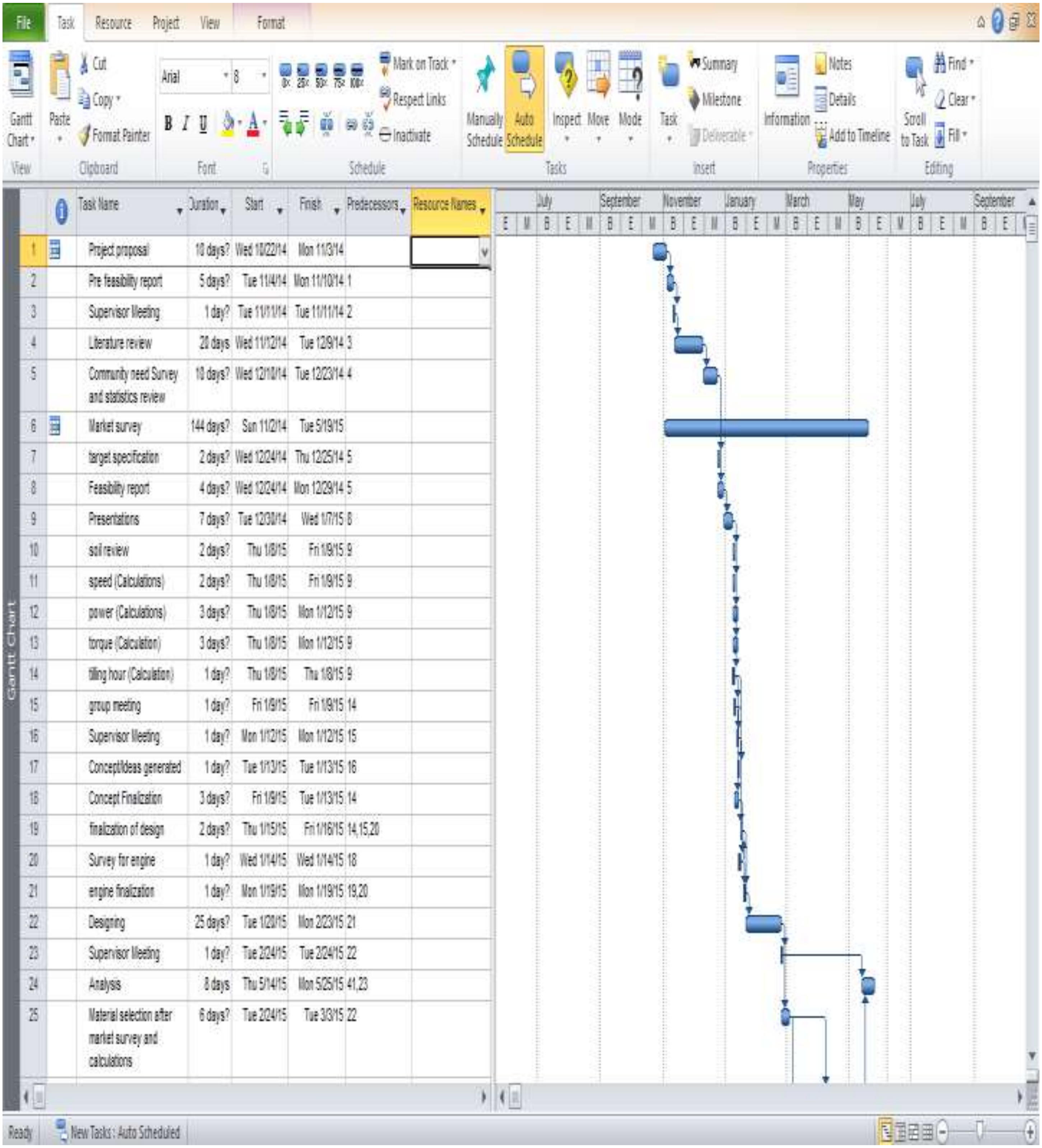
SPECIFICATIONS

Engine	Diesel engine R175a, 7 hp
Gears	Forward 4, 1 Reverse
Start	Hand Crank
Turn	Turn able
Clutch Type	Pressure Plate type
Weight	160 kg

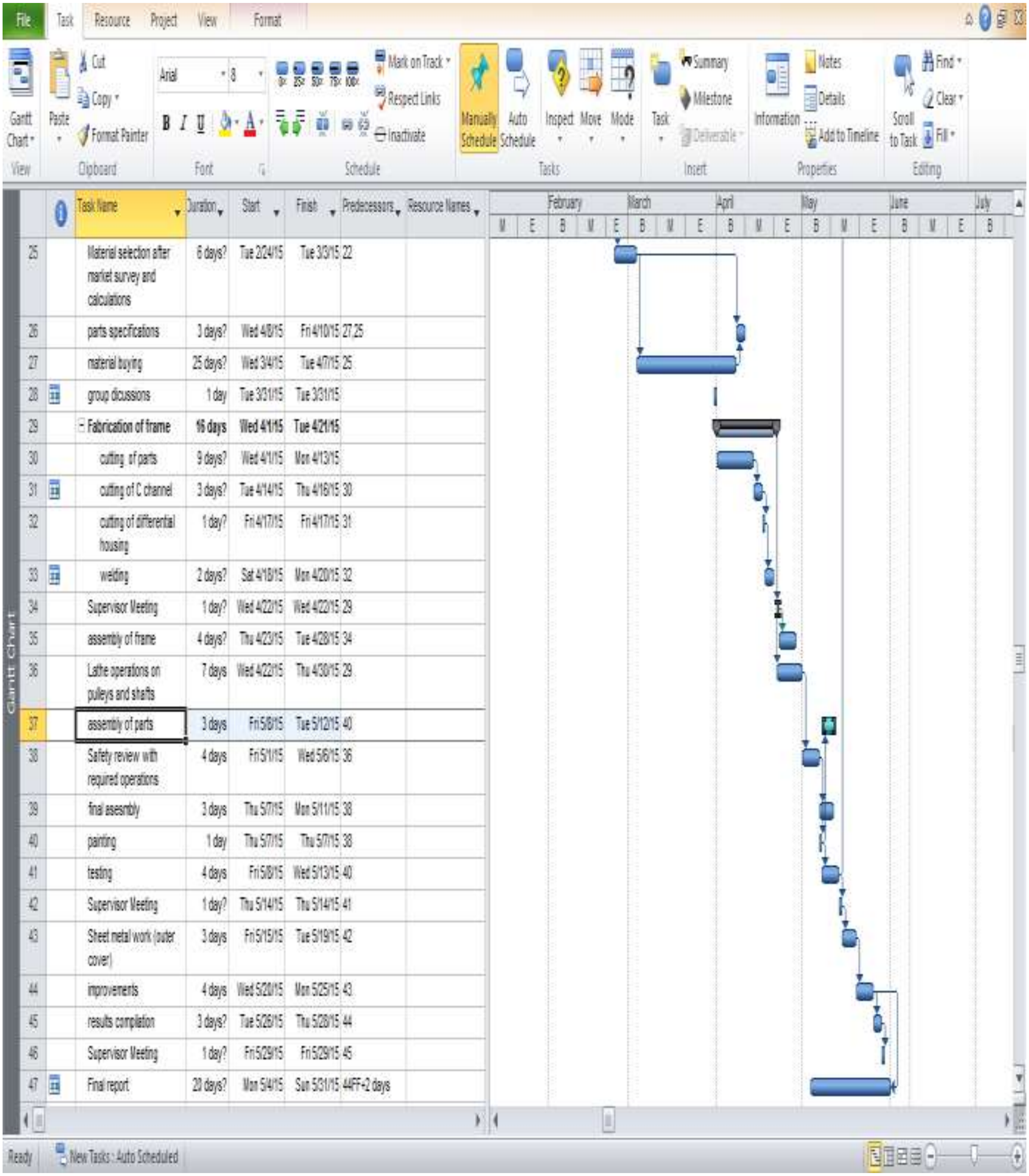
Gantt Chart

MS Project:

- Software was acquired through School of Mechanical and Manufacturing Engineering, NUST
- Software was installed using key provided by them
- Schedule that was actually made and used by Us While fabrication of this project
- Activity names, duration, start date and finish date was provided to us through PMO.
- All activities were enlisted
- Duration of every activity along with start and finish date was entered.
- Relationships between different activities were developed on our own.
- Task which was completed in two different steps were split using split task command.
- Task having any lag or lead on its predecessor activity was given in predecessor tab e.g. 13FS-3 days mean finish to start relation with its predecessor activity which is 13th activity on the list and having lag of -3 days or lead of 3 days.



	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	Project proposal	10 days?	Wed 10/22/14	Mon 11/3/14		
2	Pre feasibility report	5 days?	Tue 11/4/14	Mon 11/10/14	1	
3	Supervisor Meeting	1 day?	Tue 11/11/14	Tue 11/11/14	2	
4	Literature review	20 days	Wed 11/12/14	Tue 12/9/14	3	
5	Community need Survey and statistics review	10 days?	Wed 12/10/14	Tue 12/23/14	4	
6	Market survey	144 days?	Sun 11/2/14	Tue 5/19/15		
7	target specification	2 days?	Wed 12/24/14	Thu 12/25/14	5	
8	Feasibility report	4 days?	Wed 12/24/14	Mon 12/29/14	5	
9	Presentations	7 days?	Tue 12/30/14	Wed 1/7/15	8	
10	soil review	2 days?	Thu 1/8/15	Fri 1/9/15	9	
11	speed (Calculations)	2 days?	Thu 1/8/15	Fri 1/9/15	9	
12	power (Calculations)	3 days?	Thu 1/8/15	Mon 1/12/15	9	
13	torque (Calculation)	3 days?	Thu 1/8/15	Mon 1/12/15	9	
14	tilling hour (Calculation)	1 day?	Thu 1/8/15	Thu 1/8/15	9	
15	group meeting	1 day?	Fri 1/9/15	Fri 1/9/15	14	
16	Supervisor Meeting	1 day?	Mon 1/12/15	Mon 1/12/15	15	
17	ConceptIdeas generated	1 day?	Tue 1/13/15	Tue 1/13/15	16	
18	Concept Finalization	3 days?	Fri 1/9/15	Tue 1/13/15	14	
19	finalization of design	2 days?	Thu 1/15/15	Fri 1/16/15	14,15,20	
20	Survey for engine	1 day?	Wed 1/14/15	Wed 1/14/15	18	
21	engine finalization	1 day?	Mon 1/19/15	Mon 1/19/15	19,20	
22	Designing	25 days?	Tue 1/20/15	Mon 2/23/15	21	
23	Supervisor Meeting	1 day?	Tue 2/24/15	Tue 2/24/15	22	
24	Analysis	8 days	Thu 5/14/15	Mon 5/25/15	41,23	
25	Material selection after market survey and calculations	6 days?	Tue 2/24/15	Tue 3/3/15	22	



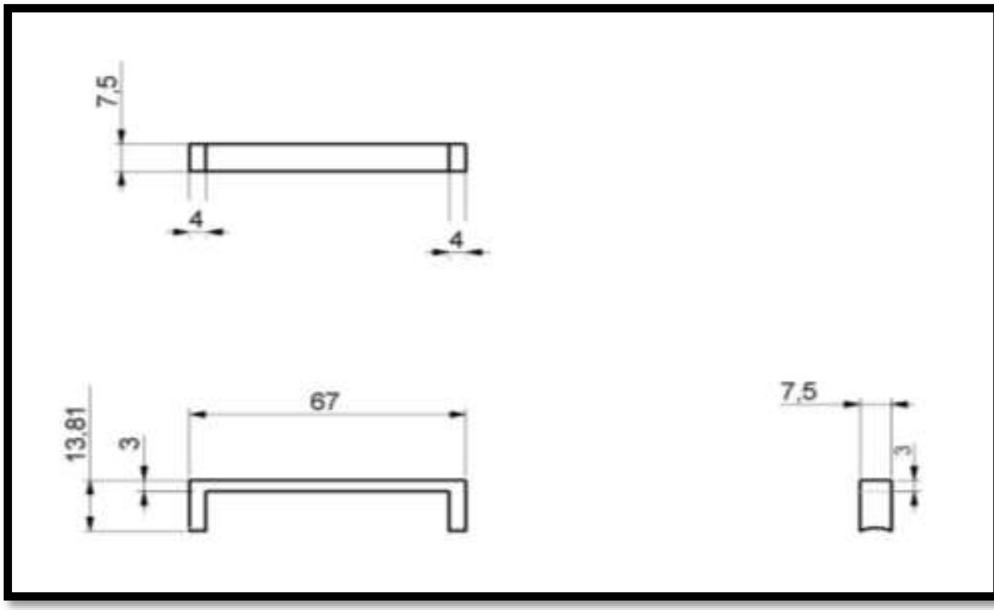
ID	Task Name	Duration	Start	Finish	Predecessors	Resource Names
25	Material selection after market survey and calculations	6 days?	Tue 2/24/15	Tue 3/3/15	22	
26	parts specifications	3 days?	Wed 4/8/15	Fri 4/10/15	27,25	
27	material buying	25 days?	Wed 3/4/15	Tue 4/7/15	25	
28	group discussions	1 day	Tue 3/31/15	Tue 3/31/15		
29	**Fabrication of frame**	**16 days**	**Wed 4/1/15**	**Tue 4/21/15**		
30	cutting of parts	9 days?	Wed 4/1/15	Mon 4/13/15		
31	cutting of C channel	3 days?	Tue 4/14/15	Thu 4/16/15	30	
32	cutting of differential housing	1 day?	Fri 4/17/15	Fri 4/17/15	31	
33	welding	2 days?	Sat 4/18/15	Mon 4/20/15	32	
34	Supervisor Meeting	1 day?	Wed 4/22/15	Wed 4/22/15	29	
35	assembly of frame	4 days?	Thu 4/23/15	Tue 4/28/15	34	
36	Lathe operations on pulleys and shafts	7 days	Wed 4/22/15	Thu 4/30/15	29	
37	assembly of parts	3 days	Fri 5/8/15	Tue 5/12/15	40	
38	Safety review with required operations	4 days	Fri 5/1/15	Wed 5/6/15	36	
39	final assembly	3 days	Thu 5/7/15	Mon 5/11/15	38	
40	painting	1 day	Thu 5/7/15	Thu 5/7/15	38	
41	testing	4 days	Fri 5/8/15	Wed 5/13/15	40	
42	Supervisor Meeting	1 day?	Thu 5/14/15	Thu 5/14/15	41	
43	Sheet metal work (outer cover)	3 days	Fri 5/15/15	Tue 5/19/15	42	
44	improvements	4 days	Wed 5/20/15	Mon 5/25/15	43	
45	results compilation	3 days?	Tue 5/26/15	Thu 5/28/15	44	
46	Supervisor Meeting	1 day?	Fri 5/29/15	Fri 5/29/15	45	
47	Final report	20 days?	Mon 5/4/15	Sun 5/31/15	44FF+2 days	

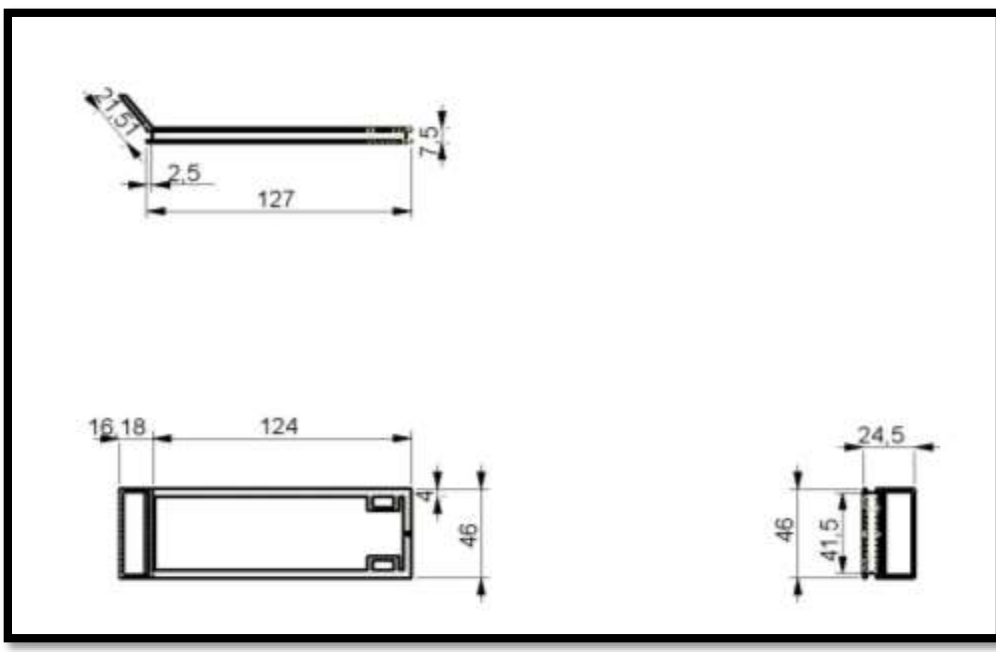
CHAPTER 9

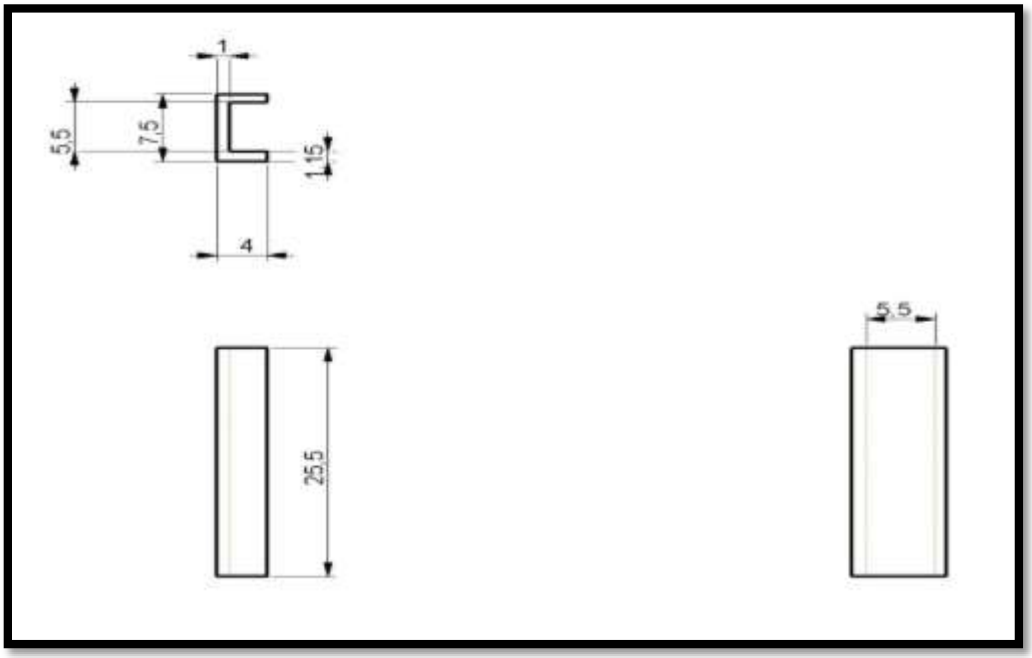
2D DRAWING

The 2-D drawings of the different objects are given below:

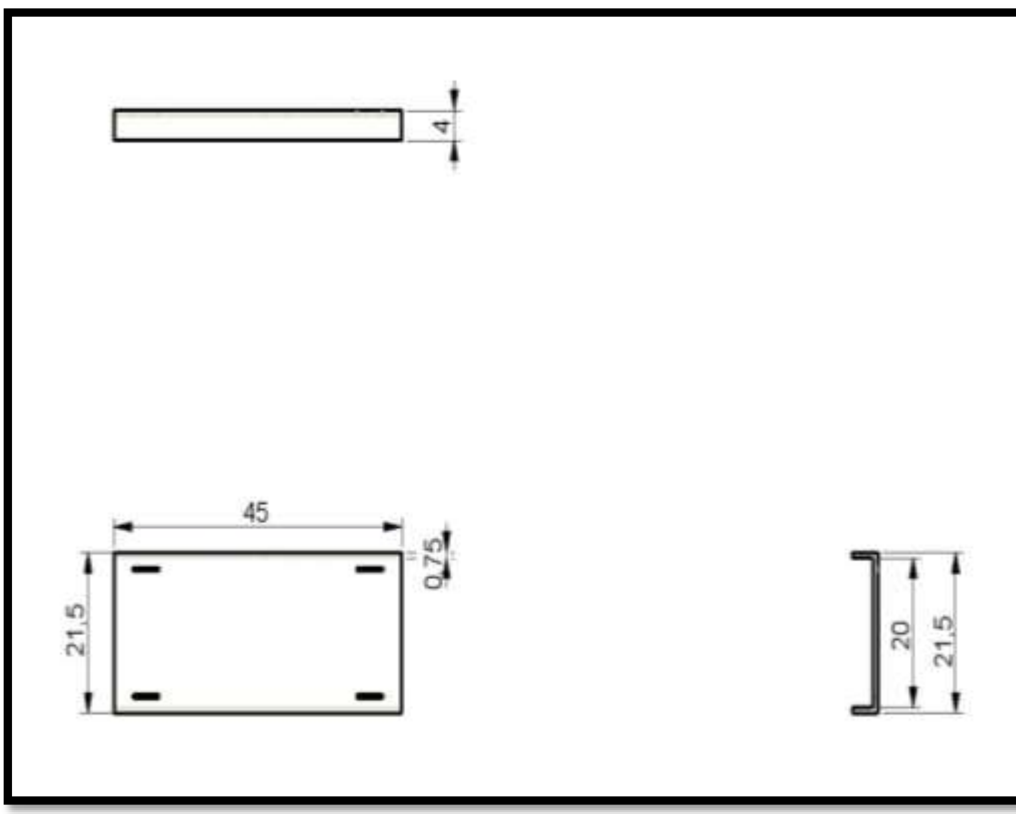
1) Frame Diagrams



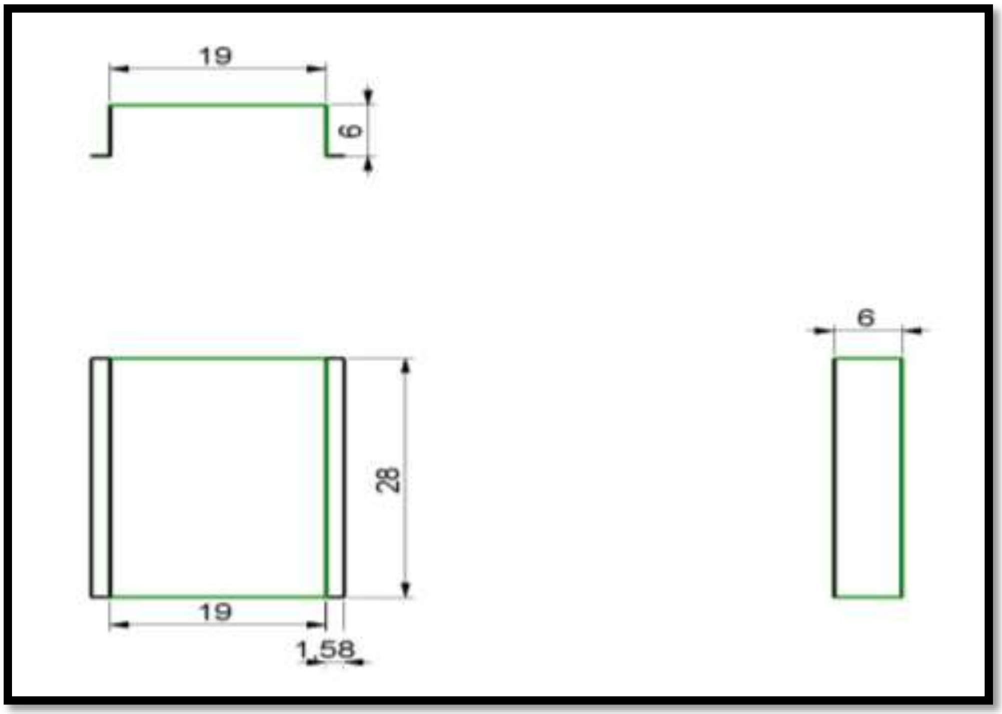


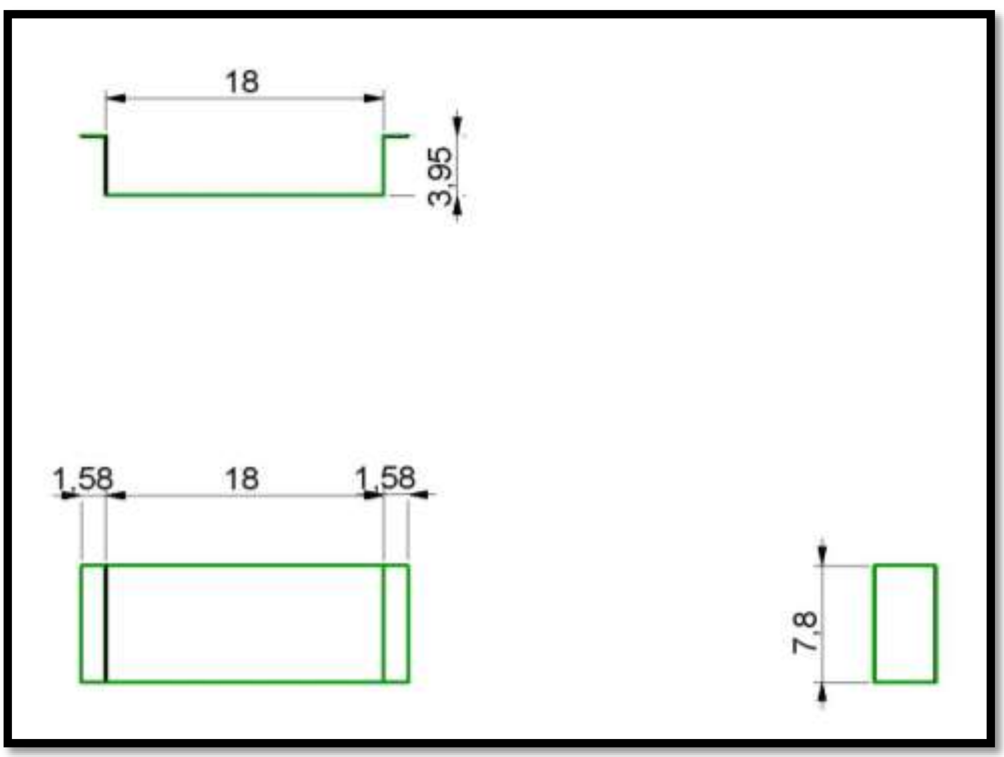


2) **Engine Plate**



3) Sheet Metal





CHAPTER 10

COMPARISON WITH IMPORTED TRACTORS

Parameters	Imported	Our plough project
Weight (kg)	350-560	160
Cost (PKR)	2-4 lac	1 lac
Maintenance	High	Low
Availability of spare parts	Not easily available	Easily available

CHAPTER 11

CONCLUSION AND RECOMMENDATION

Recommendations

Gear box:

Gear box could be used which is smaller in size, gears can be design of proper ratios which are required. Use of gear with proper gear ratios will also remove the one or may be both of pulley reduction steps

Engine:

To reduce weight petrol engines can be used as petrol engines are very smaller and lighter as compared to diesel engine. Plus the petrol engines produce less noise and vibrations

Radiator:

If the machine is used on heavy duty a radiator could be used for cooling of engine.

Double Clevis Bracket

Double clevis bracket welded at back side if the user wants to attach cart or some other appliance can use this hook.

Conclusion

Making two wheel tractor was not an easy task. Product will have a positive impact in the agriculture and manufacturing industry is not an easy task. During product development there were many factors which were under considerations including material selection and market survey for making cheapest and viable strong product. We achieved most of the goals that we had set when we started our project. There is always room for improvement, and we believe that certain modifications can make our two wheel tractor more users friendly

OVERALL PRODUCT

WORK CITED

[1] N. Kumar, "Erosion," *Wear*.

[2] Q. Huang, "Cavitation Erosion and Particle Profile," *Wear*, vol. 2, no. I, pp. 676-682, 2000.

[3] P. Mehdi, "Fluid Flow," *Nature*, vol. 2, no. 2, pp. 881-890, 2003.

[4] Pakistan Economic Survey. 2004-05. Govt. of Pakistan, Finance Div. Econ. Advisory Wing, Islamabad, pp.9/15

[5] www.wikipedia.com

[6] http://www.agria.de/en-gb/products/Einachser/agria-3600/index.html