Visvesvaraya Technological University

Belgavi – 590014

A project Report on

"DESIGN AND FABRICATION OF SELF POWERED HYDRAULLIC SYSTEM FOR WALKING REHABILITATION"

In partial fulfillment of requirements for VIII Semester in Bachelor of Engineering in Mechanical Engineering

Submitted by

NIKHIL PATOLE

Under the guidance of

Prof. S.B. ANGADI

Department of Mechanical Engineering

KLE Dr. M S Sheshgiri

College of Engineering and Technology,

Belgavi – 590014

2014 – 2015

Visvesvaraya Technological University, Belgavi

Department of Mechanical Engineering

KLE Dr. M S Sheshgiri

College of Engineering and Technology, Udyambag

Belgavi – 590014

Certificate

Certified that the project entitled "**DESIGN AND FABRICATION OF SELF POWERED HYDRAULIC SYSTEM FOR WALKING REHABILITATION**", is a work carried out in fulfillment of requirement for VIII Semester in **Bachelor of Engineering** in Mechanical Engineering of the **Visvesvaraya Technological University, Belgavi**, during the year **2014 - 2015**. It is certified that all corrections / suggestions indicated for Internal Assessment have been incorporated in the report deposited in the department library. The project has been approved as it satisfies the academic requirements in respect of project work prescribed for the said Degree.

ABSTRACT

The hydraulically powered walking mechanism helps in framing a better aid for limb movement for those individuals with disabilities in either of their legs without using any external source of power. The primary objective of this mechanism is that it should withstand the human loads, be flexible to the movements and also be able to mingle with the amputated part in the similar manner as that of the natural limb. The said mechanism is developed based on hydraulics principles which avoid wear and tear of the material and the friction within it. Hydraulic fluid used in this mechanism helps in attaining the natural limb function. The 3D model has been created using solid edge modeling software.

The main objective of the project is to develop a walking mechanism that is more flexible, economical, efficient and can be easily manufactured. The dimensions considered for modeling the mechanism are taken based on the size of the amputated or effected leg.

Table of Contents

List of Figures

Fig.7.15 Assembled model

Table 8.1 Costing

Chapter 1

INTRODUCTION

In orthopedic medicine, prosthesis, prosthetic, or prosthetic limb is an artificial device extension that replaces a missing body part. It is the science of using mechanical devices with human muscle, skeleton, and nervous system to assist or enhance motor control lost by trauma, disease or defect.

Prosthesis are typically used to replace parts lost by injury (traumatic) or missing from birth (congenital) or to supplement defective body parts.

The usage of 'Hydraulics' in designing exoskeletons for human limbs has been increased in recent years, because of the reliability it provides considering to other mechanisms. Hydraulic joints have more flexibility, life and also ease of utility. It provides friction less motion in the mechanism developed, which improves the life of structure. Wear and tear of the parts used can be easily avoided. The structure designed resembles human limb in function. Various components are designed and assembled. This work involves development of a design which plays the same role as that of original limb.

1.1 LITERATURE SURVEY

Prosthetics have been mentioned throughout history. The Egyptians were early pioneers of the idea, as shown by the wooden toe found on a body from the New Kingdom. Roman bronze crowns have also been found, but their use could have been more aesthetic than medical.

In medicine, prosthesis (from Greek *prósthesis*, "addition, application, attachment") is an artificial device that replaces a missing body part, which may be lost through trauma, disease, or congenital conditions. Prosthetic amputee rehabilitation is primarily coordinated by a prosthetist and an inter-disciplinary team of health care professionals including physiatrists, surgeons, physical therapists, and occupational therapists.

A person's prosthesis should be designed and assembled according to the patient's appearance and functional needs. For instance, a patient may need a transradial prosthesis, but need to choose between an aesthetic functional device, a myoelectric device, a body-powered device, or an activity specific device. The patient's future goals and economical capabilities may help them choose between one or more devices.

Lower extremity prostheses provide replacements at varying levels of amputation. These include hip disarticulation, transfemoral prosthesis, knee disarticulation, transtibial prosthesis, Syme's amputation, foot, partial foot, and toe. The two main subcategories of lower extremity prosthetic devices are trans-tibial (any amputation transecting the tibia bone or a congenital anomaly resulting in a tibial deficiency) and trans-femoral (any amputation transecting the femur bone or a congenital anomaly resulting in a femoral deficiency).

Transfemoral prosthesis is an artificial limb that replaces a leg missing above the knee. Transfemoral amputees can have a very difficult time regaining normal movement. In general, a transfemoral amputee must use approximately 80% more energy to walk than a person with two whole legs. This is due to the complexities in movement associated with the knee. In newer and more improved designs, hydraulics, carbon fiber, mechanical linkages, motors, computer microprocessors, and innovative combinations of these technologies are employed to give more control to the user. In the prosthetic industry a trans-femoral prosthetic leg is often referred to as an "AK" or above the knee prosthesis.

A transtibial prosthesis is an artificial limb that replaces a leg missing below the knee. Transtibial amputees are usually able to regain normal movement more readily than someone with a transfemoral amputation, due in large part to retaining the knee, which allows for easier movement. Lower extremity prosthetics describes artificially replaced limbs located at the hip level or lower. In the prosthetic industry a trans-tibial prosthetic leg is often referred to as a "BK" or below the knee prosthesis

To design an artificial knee which resembles that of original knee first one has to understand function of knee joint in human body.

The knee joint joins the thigh with the leg and consists of two articulations, one between the femur and tibia, and one between the femur and patella. It is the largest joint in the human body and is very complicated. The knee in human body permits flexion and extension as well as a slight medial and lateral rotation. Since in humans the knee supports nearly the whole weight of the body it plays an important role in humans to walk and run.

The function of the knee is to provide stability and flexibility to the lower leg while walking, running, and stair climbing, rising from a seated position. It moves in bending, straightening, and rotation.

The figure below shows gait cycle of right leg in normal human. Stance phase is a period where leg will be in free position where forces acting will be negligible on knee. Swing phase is a period where walk will depend on controls of knee mechanism. In initiation phase force will be applied on toe which in turn acts on knee used to swing about axis of knee. Many prosthetic mechanisms developed to date do not provide all of above mentioned functions but can be flexible for walking as normal human.

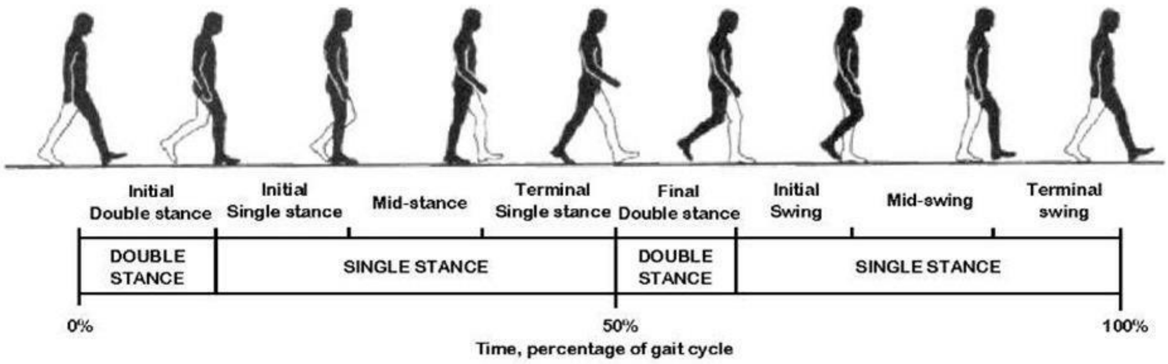

Fig.1.1

In the present scenario, one of the most common prosthetic limb available is the Jaipur foot. Designed in and named after Jaipur, India, the prosthetic leg was designed to be inexpensive, water-resistant, and quick to fit and manufacture. The Jaipur Foot is made of polyurethane, which at the time was the new material used in the production of the prostheses. The material increases the durability and the convenience of use. Now the government of India supports Bhagwan Mahavir Viklang Sahyata Samiti with financial aid to carry out the work done by the organization. The Jaipur Foot has helped many people to overcome their leg disability. The idea of the Jaipur Foot was conceived by Ram Chander Sharma under the guidance of Dr. P.K. Sethi, who was then the head of the Department of Orthopedics at Sawai ManSingh Medical College in Jaipur, India.

The Jaipur Foot is superior to its SACH (Solid Ankle Cushion Heel) counterpart in certain ways, mainly in the range of movements it offers. The articulation at the 'ankle' allows not only inversion-eversion movements but also dorsiflexion (essential for squatting, standing up from prone position, etc.) and a shorter keel helps achieve this. Also, the materials used at the foot-end are waterproof and moderately mimic a real foot.

These features help a physically-challenged person assimilate more easily in a semi-urban or rural setup in the Indian subcontinent and other developing countries.

Fig.1.2

The Jaipur Foot distinguishes itself from other artificial feet by not having a central keel, thus permitting mobility in all planes despite being non-articulated. The dorsiflexion at the ankle, a special feature of the foot, addresses the cultural and lifestyle needs of Oriental people; however, this positively influences the performance of amputees even in Western societies.

Chapter2

COMPONENTS

1. Hydraulic cylinders
2. Hose pipes
3. Hydraulic ports
4. Hydraulic seals
5. Supporting frame (skeleton)
6. Cylinder clamping plates
7. Fasteners

2.1 HYDRAULIC CYLINDERS

Cylinders are used to convert fluid power into mechanical motion. A cylinder consists of a cylindrical body, closures at each end, movable piston, and a rod attached to the piston.

When fluid pressure acts on the piston, the pressure is transmitted to the piston rod, resulting in linear motion. The piston rod thrust force developed by the fluid pressure acting on the piston is easily determined by multiplying the line pressure by the piston area.

FORCE = PRESSURE x AREA or F = PA

2.2 TYPES OF CYLINDERS

Standard cylinders have been designed to meet the wide range of applications. The following types of cylinders provide an overview of what is available.

2.2.1. **SINGLE ACTING CYLINDER**

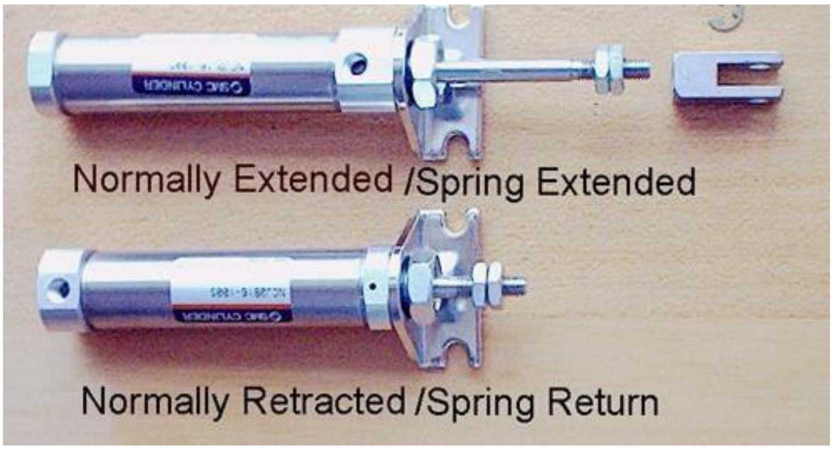

Fig.2.2.1

The single-acting cylinder is pressurized at one end only, with the opposite end vented to atmosphere through a breather filter (air cylinder) or vented to a reservoir (hydraulic cylinder). The return stroke of the cylinder is accomplished by some external means.

2.2.2. **DOUBLE ACTING CYLINDER**

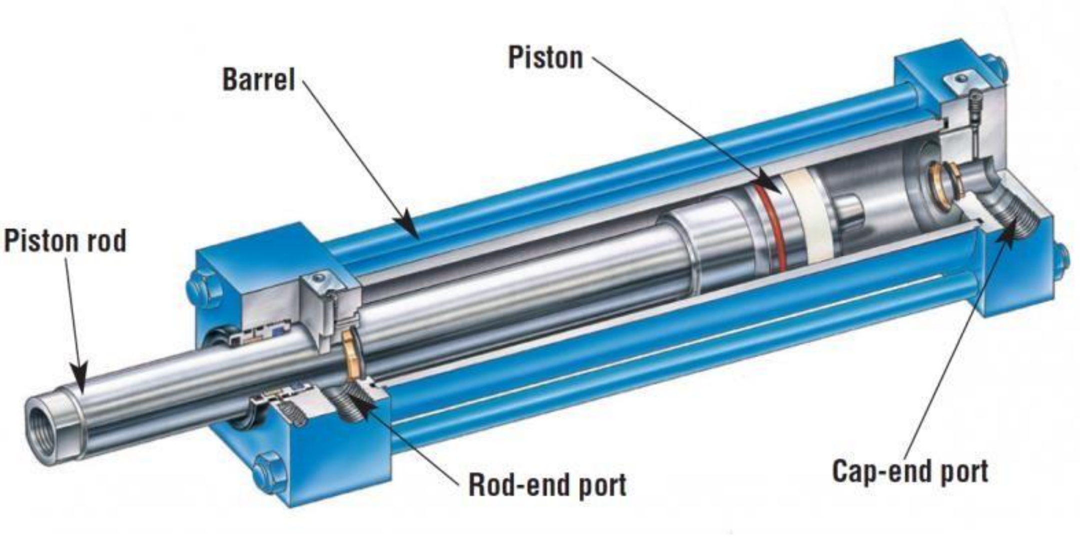

Fig.2.2.2

The most familiar double acting cylinder is the single rod end. This type of cylinder provides power in both directions, with a pressure port at either end. Single rod end cylinders exert greater forces when extending than when retracting, since the piston area on the blind end is larger than the piston area on the rod end (due to the area covered by the piston rod).

2.2.3. **SPRING RETURN CYLINDER**

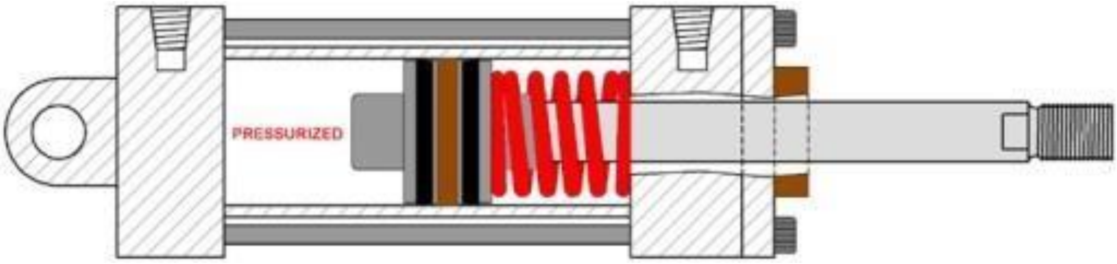

Fig.2.2.3

The spring return cylinder is normally considered a single acting cylinder. The operation of this type of cylinder is the same as a single acting cylinder, except that a spring is used to accomplish the return stroke.

2.2.4. DOUBLE ROD END CYLINDER

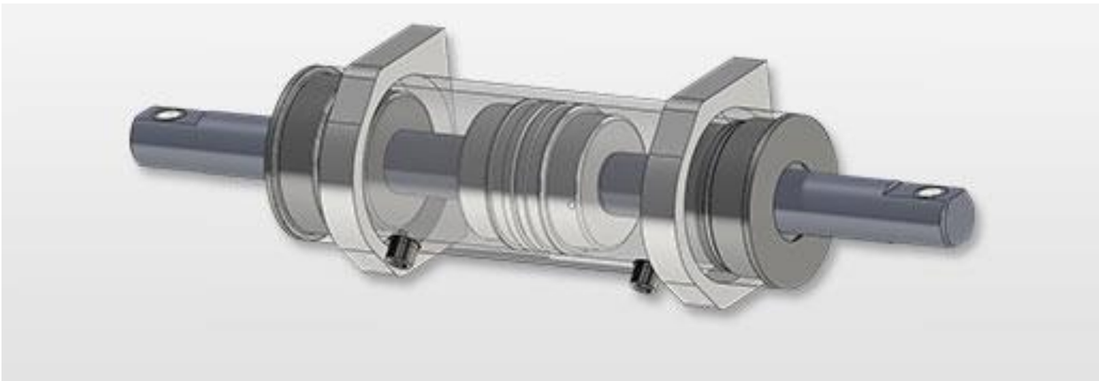

Fig.2.2.4

The double rod end cylinder is used when it is necessary for the cylinder to exert equal force and operate at equal speed in both directions. It also can be used to operate limit valves or switches.

2.3 CYLINDER LOADING

Cylinders perform a wide variety of applications and are often used in place of larger, more expensive mechanical systems. One such application is when a cylinder is used to move a high friction sliding load. Some examples of this are: machine slides, pallet shuttle systems on automated machinery, milling machine tables and grinder tables.

There are a number of things to consider when sizing a cylinder for a sliding load application. These include the unit weight (load), lubrication and required speed. For applications where there is light lubrication, the cylinder should provide a thrust force capable of moving a load equal to 50% to 75% actual load. Once in motion a thrust force capable of moving 20% of the actual load weight is adequate.

2.4 ROD BUCKLING

Correct rod size selection is an important factor in sizing a cylinder for an application. If the piston rod diameter is too small in relation to the load column, failure or rod buckling is likely to occur.

The standard rod for each bore size should be sufficient to carry the maximum tension force that the cylinder is capable of producing. It is in compression applications that the column strength needs to be considered. For proper rod size selection in compression applications.

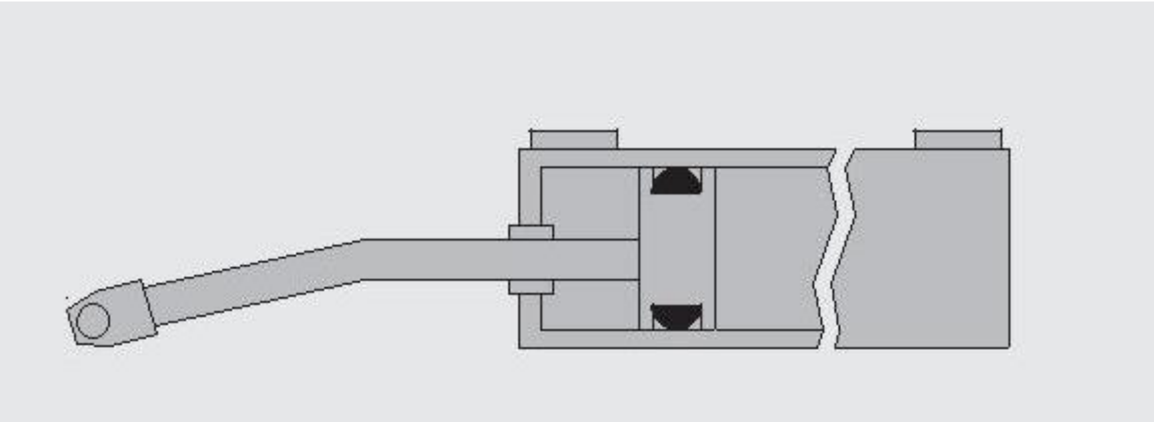

Fig.2.4

2.5 HOSE PIPES

Fig.2.5

A hose is a flexible hollow tube designed to carry fluids from one location to another. Hoses are also sometimes called pipes (the word pipe usually refers to a rigid tube, whereas a hose is usually a flexible one), or more generally tubing. The shape of the hose is usually cylindrical (having a circular cross section).

Hose design is based on a combination of application and performance. Common factors Size, Pressure Rating, Weight, Length, Straight hose or and Chemical Compatibility.

Hoses are made from one or a combination of many different materials. Applications mostly use nylon, polyurethane, polyethylene, PVC, or synthetic or natural rubbers, based on the environment and pressure rating needed. In recent years, hoses can also be manufactured from special grades of polyethylene (LDPE and especially LLDPE). Other hose materials include PTFE (Teflon),stainless steel and other metals.

2.6 HYDRAULIC PORTS

Fig.2.6

A port is used in pipe plumbing systems to connect straight pipe or tubing sections, to adapt to different sizes or shapes, and for other purposes, such as regulating or measuring fluid flow. The term plumbing is generally used to describe conveyance of water, gas, or liquid waste in ordinary domestic or commercial environments, whereas piping is often used to describe high-performance (e.g. high pressure, high flow, high temperature, hazardous materials) conveyance of fluids in specialized applications. The term tubing is sometimes used for lighter-weight piping, especially types that are flexible enough to be supplied in coiled form.

2.7 HYDRAULIC SEALS

Fig.2.7

A hydraulic seal is a relatively soft, non-metallic ring, captured in a groove or fixed in a combination of rings, forming a seal assembly, to block or separate fluid in reciprocating motion applications. Hydraulic seals are vital in machinery. Their use is critical in providing a way for fluid power to be converted to linear motion.

Hydraulic seals can be made from a variety of materials such as polyurethane, rubber or PTFE. The type of material is determined by the specific operating conditions or limits due to fluid type, pressure, fluid chemical compatibility or temperature.

2.8 SUPPORTING FRAME

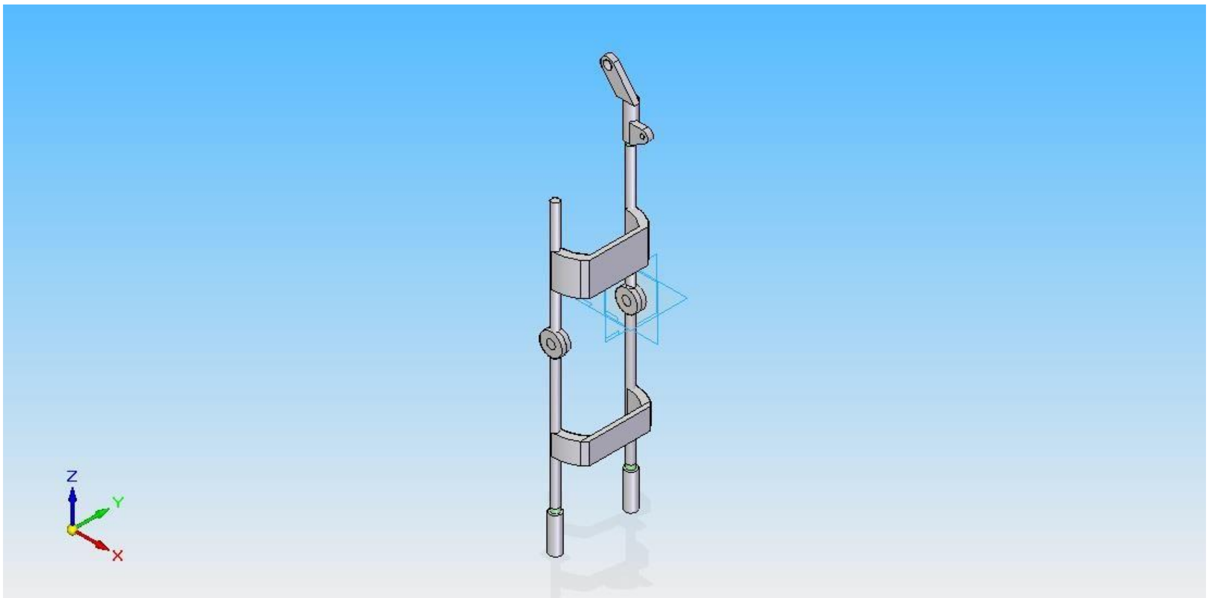

Fig.2.8

The frame of the self-operated hydraulic system supports the entire structure and behaves as a skeleton for the mechanism and would be preferably made out of aluminium. It houses three cylinders which are clamped to it using fasteners. A hinge is provided in the structure of the frame which resembles the movement of a human knee.

Chapter 3

HYDRAULIC FLUIDS

Hydraulic fluids, also called hydraulic liquids, are the medium by which power is transferred in hydraulic machinery. Common hydraulic fluids are based on waste, mineral oil or water.

The primary function of a hydraulic fluid is to convey power. In use, however, there are other important functions of hydraulic fluid such as protection of the hydraulic machine components.

The table below lists the major functions of a hydraulic fluid and the properties of a fluid that affect its ability to perform that function:

Function	Property
Medium for power transfer and control	• Non compressible (high bulk modulus) • Fast air release • Low foaming tendency • Low volatility
Medium for heat transfer	• Good thermal capacity and conductivity
Sealing Medium	• Adequate viscosity and viscosity index • Shear stability
Lubricant	• Viscosity for film maintenance • Low temperature fluidity • Thermal and oxidative stability • Hydrolytic stability / water tolerance • Cleanliness and filterability • Demulsibility • Antiwear characteristics • Corrosion control
Pump efficiency	• Proper viscosity to minimize internal leakage • High viscosity index
Special function	• Fire resistance • Friction modifications

	• Radiation resistance
Environmental impact	• Low toxicity when new or decomposed

Table 3

3.1 TYPES OF HYDRAULIC FLUIDS

3.1.1 PETROLEUM BASED FLUIDS

Mineral oils or the petroleum based oils are the most commonly used hydraulic fluids. Basically they are possess most of the desirable characteristics, they are easily available and are economical. In addition, they offer the best lubrication ability; least corrosion problems are compatible with most seal materials. The only major disadvantage of these fluids is their flammability. They pose hazards, mainly from the leakages, in high temperature environments like industries, engines, and so on.

3.1.2 EMULSIONS

Emulsions are the mixtures of the two fluids, which do not chemically react with other.

(a) Oil-water

This emulsion has water as the main phase, while small droplets of oil are dispersed in it. Generally, the oil dilution is limited to about 5%, hence it exhibits the characteristics of water. It is highly fire resistant, incompressible, and has good cooling properties.

(b) Water-in-oil emulsions

Water-in-oil emulsions also called invert emulsions, are basically oil based in which small droplets of water are dispersed throughout the oil phase. They are the most popular hydraulic fluids. They exhibit more of a oil like characteristics; hence it has good viscosity and lubrication properties. The commonly used emulsion has a dilution of 60% and 40% water.

3.1.3 WATER GLYCOL

Water-Glycol is another non-flammable fluid commonly used in aircraft hydraulic systems. They generally have low lubrication ability as compared to mineral oils, and are not suitable for high temperature applications. They have water and glycol in the ratio of 1:1.

Because of their aqueous nature and presence of air, they are prone to oxidation and related problems. They need to be added with oxidation inhibitors.

3.1.4 SYNTHETIC FLUIDS

Synthetic fluid, based on phosphate easter, is another popular fire-resistant hydraulic fluid. These are suitable for high temperature applications, since they exhibit good viscosity and lubrication characteristics. They are not suitable for low temperature applications. In fact they require heaters in the tanks to preheat the fluid to operating temperatures.

Chapter 4

WORKING PRINCIPLE AND MECHANISM

4.1 PRINICIPLE

This system is called as self-operated because there is no external source to drive it. The energy required is very less and is derived from the effort that a person puts to lift the leg. A person's weight is equally distributed on both the legs. But during walking, it is not so. The leg which is on the ground takes up the entire load of the body and this depends on two factors:

1. Strength of that leg
2. Balance

If we concentrate on balancing, we assume that one leg has perfect strength and takes the entire body weight. When a person tries to walk, he not only lifts one leg but also leans his body a little forward. Due to this, the leg taking up the load is now restricted to throw the entire weight forward and the load acting on the leg slowly decreases. Once, the lifted leg touches the ground and the former leg is lifted, the same is experienced by this leg too.

Now focusing on balancing, when one leg is taking up entire load and with no movement the amount of energy required to push a person forward is very less and this is how balancing is distributed.

Here the force exerted by the person while folding his leg is the energy that drives the mechanism. This energy is effectively utilized and is transmitted to other leg by means of hydraulics and thus, it provides aid for walking disabilities.

4.2 MECHANISM

This system consists of three cylinders of different sizes, one which is mounted on the normal leg is called driver cylinder and the other two mounted on the frame are called driven cylinders. The volume of driver cylinder is equal to the sum of the volume of the driven cylinders. The cross sectional areas of all the three cylinders are same, hence the operating speeds of the cylinders are same.

When the person folds the normal leg, the driver cylinder is compressed as it is attached to the leg. The fluid from this cylinder enters the other two cylinders. As stroke is restricted, there is fixed displacement and hence there is no requirement of valves. Due to this these cylinders expand & give the powered leg the required movement. When the normal leg is straightened, the driver cylinder expands & the driven cylinders retract and the powered leg goes back to its original position. When driven cylinders are in the extended position, they give a push to extend the person forward.

Chapter 5
DESGIN OF COMPONENTS

5.1 FRAME CALCULATION

Material: Aluminium

Density, ρ= 2700 kg/m^3

Load= P = 100 kg (Human weight + additional weight)

Young's modulus, E= 67.5GPa

Length of rod, L = 400mm =0.4m

Factor of safety, F O S= 3

Working Stress, $\sigma = \frac{\sigma y}{fos}$

Yield stress = σ_y = 150 MPa

σ =150/3 = 50MPa

$\sigma = \frac{P}{A}$

Area, $A = \frac{\pi}{4} d^2$

$d = \sqrt{\frac{4P}{\pi\sigma}}$

d =$\sqrt{\frac{4 * 100 * 9.81}{\pi * 50 * 10^3}}$

d = 4.99 x 10^{-3}m

d = 6 x 10^{-3}m

Taking diameter of the rod as 10mm

As bending load acts on the frame due to the cylinder exerts a force, therefore, taking the diameter of the rod as 16mm.

So, **d= 16mm**

5.2 BUCKLING LOAD CALCULATION

Euler's Formula

$$F = \frac{\pi^2 EI}{L^2}$$

Moment of Inertia, $I = \frac{\pi}{64} d^4$

$$I = \frac{\pi}{64} * 0.016^4$$

I= 3.217 x 10^{-9} mm^4

$$F = \frac{\pi^2 * 67.5 * 10^9 * 3.217 * 10^{-9}}{0.4^2}$$

F = 13394 N

Or **F = 1365 kg**

5.3 WEIGHT CALCULATION OF ALUMINIUM COMPONENTS

RODS

d= 16mm =0.016m

L= 400mm =0.4m

ρ =2700 kg/m^3

$$A = \frac{\pi}{4} d^2$$

$$A = \frac{\pi}{4} * 0.016^2$$

A=2.01*10^{-4} m^2

Volume of outer rods

V_o= 2AL

$V_o = 2 \times 2.01 \times 10^{-4} \times 0.4$

$V_o = 1.6 \times 10^{-4}\ m^3$

5.4 NUT CALCULATION

Outer dia. of nut= $d_{n,o}$= 25mm

Inner dia. of nut= $d_{n,i}$= 16mm

l= 80mm

Area of nut= $A_n = \frac{\pi}{4}(25^2 - 16^2)$

$= 289.81\ mm^2$

$= 2.898 \times 10^{-4} m^2$

Volume of nut= $V_n = A_n \times l$

$V_n = 2.898 \times 10^{-4} \times 0.08$

$V_n = 2.3184 \times 10^{-5}\ m^3$

5.5 WEIGHT OF HINGE

$D_{B,o}$ = 40mm $D_{B,i}$ =

16mm Thickness, t =

20mm

Volume of hinge, V_h= Area of hinge x thickness

$V_h = \frac{\pi}{4}(?^2 - ?^2) * ?$

$V_h = \frac{\pi}{4}(0.025^2 - 0.016^2) * 0.02$

$V_h = 5.79 \times 10^{-6}$ m^3

5.6 TOTAL WEIGHT OF ALUMINIUM COMPONENTS

$V = V_{�} + V_{�} + V_h$

$V = 1.6 \times 10^{-4} + 2.3184 \times 10^{-5} + 5.79 \times 10^{-6}$

$V = 1.89 \times 10^{-4}\ m^3$

Therefore, weight of frame= W= Volume x Density

W= $1.89 \times 10^{-4} \times 2700$

W= 0.51 kg

DESIGN OF CYLINDERS

5.7 PISTON ROD CALCULATION

Material: Cast Iron

Strength: 40 MPa

Loading capacity of piston rod

$\sigma = \frac{�}{A}$

Where, σ =stress

A =area, ($A = \frac{\pi}{4} �^2$)

$$40 = \frac{F}{\frac{\pi * (20^2)}{4}}$$

$$[illegible] = \frac{\pi}{4} 20^2 * 40$$

F=12566.37 N

(1kgF = 9.81N)

$$[illegible] = \frac{12566.37}{9.81}$$

F=1280.9 kg

F=1.28 Tonnes

5.8 MAXIMUM INTERNAL PRESSURE OF BARREL

$$P[illegible] = \frac{[illegible]}{[illegible]}$$

F= 1000kg (Maximum load of the system)

F= 1000 x 9.81

F= 9810N

$$P = \frac{9810}{\frac{\pi}{4} * 20^2}$$

P=31.2MPa

5.9 CALCULATING THICKNESS OF BARREL

Lame’s Equation

$$[illegible] = \frac{[illegible]}{[illegible]^2} - [illegible]$$

Where, σ_r =Radial stress

$$\sigma_c = \frac{b}{r^2} + a$$

Where, σ_c=Circumferential stress

Internal design $\quad d_i$=30 mm

r_i =15 mm

Barrel material is Aluminium

σ_y =90 MPa

σ_c at inner radius = 90 MPa

$$90 = \frac{b}{15^2} + a$$

σ_r at inner radius =31

$$31 = \frac{b}{15^2} - a$$

Solving

$$90 = \frac{b}{15^2} + a$$

$$-31 = \frac{b}{15^2} - a$$

....

$$121 = 2b/r^2$$

b = 13612.5

Substituting above equations

$$a = \frac{b}{15^2} - 31$$

$$= \frac{13612.5}{15^2} - 31$$

� $= 29.5$

Now,

At outer radius

$$[illegible] = \frac{13612.5}{[illegible]^2} - 29.5$$

$$0 = \frac{13612.5}{r_o^2} - 29.5$$

$$\frac{13612.5}{r_o^2} = 29.5$$

$$r_o^2 = 461.4$$

r_o =21.48mm

Thickness = $r_o - r$

=21.48 – 15

t=6.4mm

5.10 BUCKLING OF PISTON ROD

Bore = 30 mm

Operating pressure = 31.2 MPa

Length = 125 mm

$P_{[illegible]} = [illegible]$

= 2*31.2*π/4*30^2

= 44107.9/2

$P_{[illegible]}$ = 22053.95 MPa

$$[illegible] = \frac{64 * [illegible]^2 * P_{[illegible]}}{[illegible]^2 * [illegible] * [illegible]}$$

d =13.4m

Chapter 6

FABRICATION

COMPONENTS	MATERIAL	PROCESS INVOLVED
CYLINDERS	ALUMINIUM	BORING, FACING, TAPPING, TURNING, DRILLING, MILLING
FRAME	ALUMINIUM	TURNING, TAPPING
CLAMPING PLATES (type 1)	ALUMINIUM	DRILLING
CLAMPING PLATES (type 2)	STAINLESS STEEL	DRILLING

Table 6

6.1 MATERIAL USED – ALUMINIUM

Aluminium is a silvery white, soft, nonmagnetic, ductile metal. Aluminium is the third most abundant element (after oxygen andsilicon), and the most abundant metal in the Earth's crust. It makes up about 8% by weight of the Earth's solid surface. Aluminium metal is so chemically reactive that native specimens are rare and limited to extreme reducing environments.

Aluminium is remarkable for the metal's low density and for its ability to resist corrosion due to the phenomenon of passivation. Structural components made from aluminium and its alloys are vital to the aerospace industry and are important in other areas oftransportation and structural materials. The most useful compounds of aluminium, at least on a weight basis, are the oxides andsulfates.

Aluminium is a relatively soft, durable, lightweight, ductile and malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. It is nonmagnetic and does not easily ignite. A fresh film of aluminium serves as a good reflector (approximately 92%) of visible light and an excellent reflector (as much as 98%) of medium and far infrared radiation. The yield strength of pure aluminium is 7–11 MPa, while aluminium alloys have yield strengths ranging from 200 MPa to 600 MPa.

Aluminium has about one-third the density and stiffness of steel. It is easily machined, cast, drawn and extruded.

Aluminium atoms are arranged in a face-centered cubic (fcc) structure. Aluminium has a stacking-fault energy of approximately 200 mJ/m^2.

Properties of aluminium:

Light metal	Aluminium is extremely light weight about 1/3 of that of copper or steel. Excellent for use in the transportation industry, due to its lightweight, this may help reduce costs.
Excellent Strength	Aluminium has excellent strength to weight ratio making it ideal for use in situations where high strength and low weight are required.
Corrosion resistance	Aluminium corrosion resistance makes it a good choice of material for use in the construction and buildings industry. It is the natural oxide coating on aluminium that gives its corrosive resistance. Anodising or powder coating can further protect the aluminium, which also provides decorative finish.

Chapter 7

DRAWINGS AND COMPONENT FIGURES

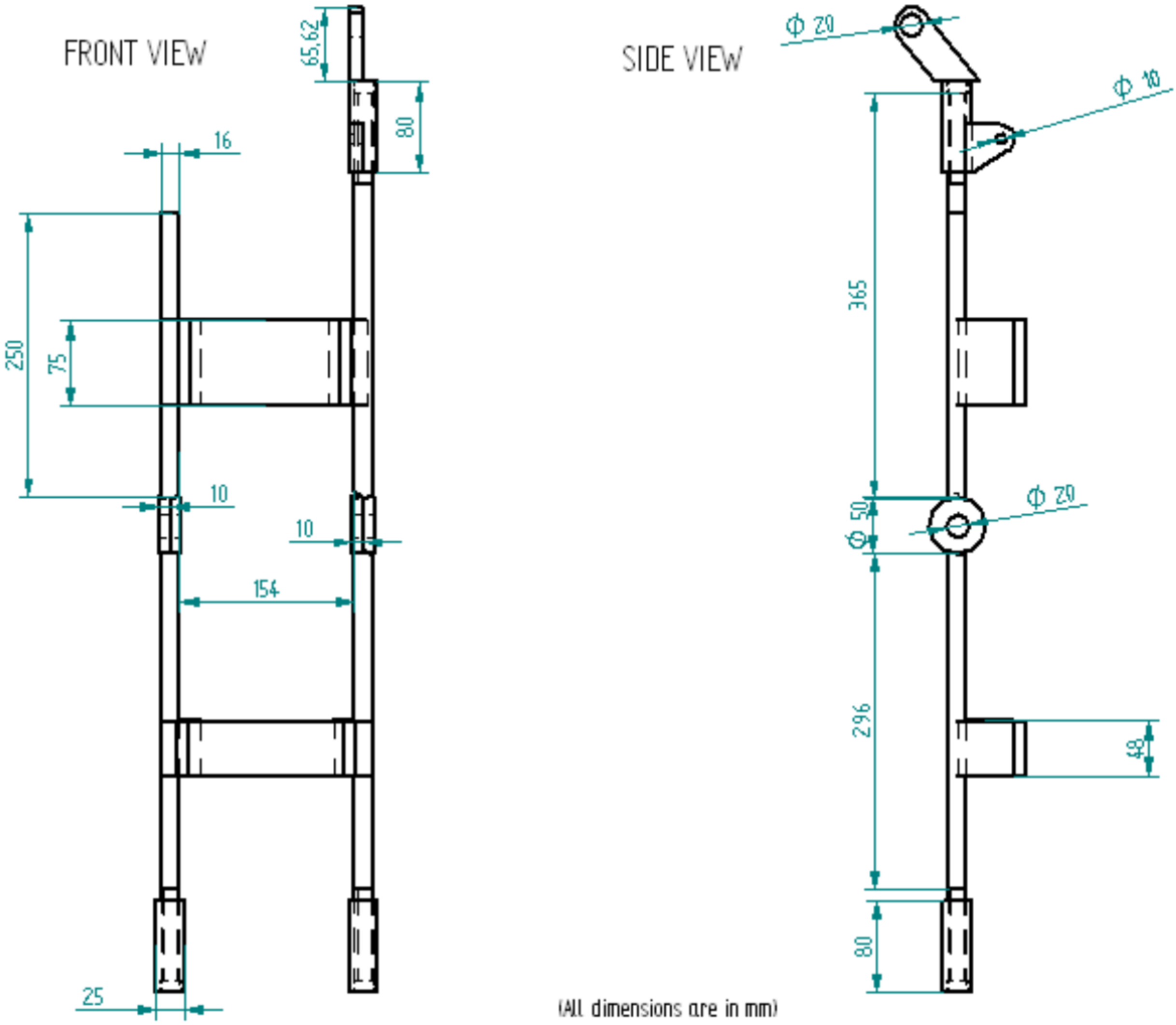

Fig.7.1 (CAD model of the frame)

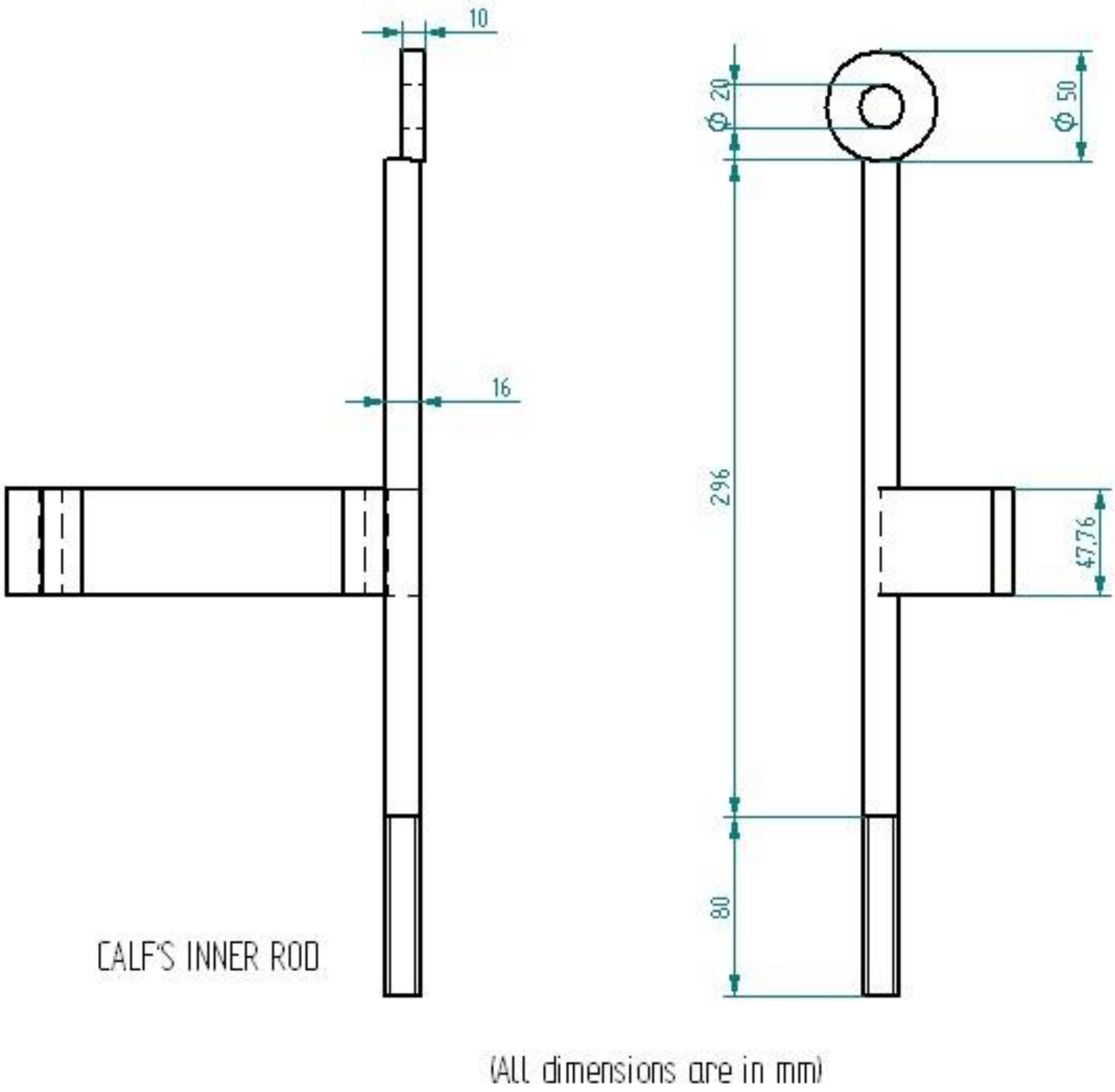

Fig.7.2 (Rods used in the frame)

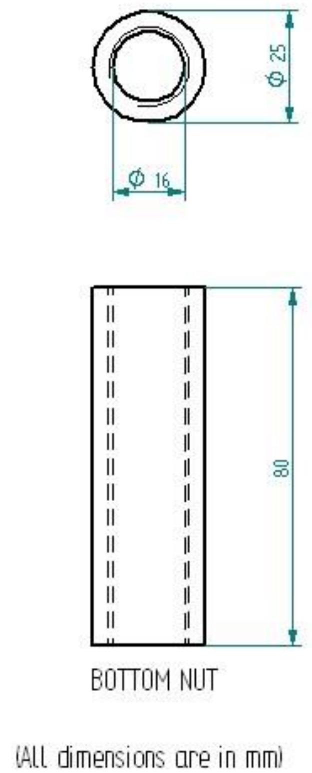

Fig.7.3 (Length adjustment nut)

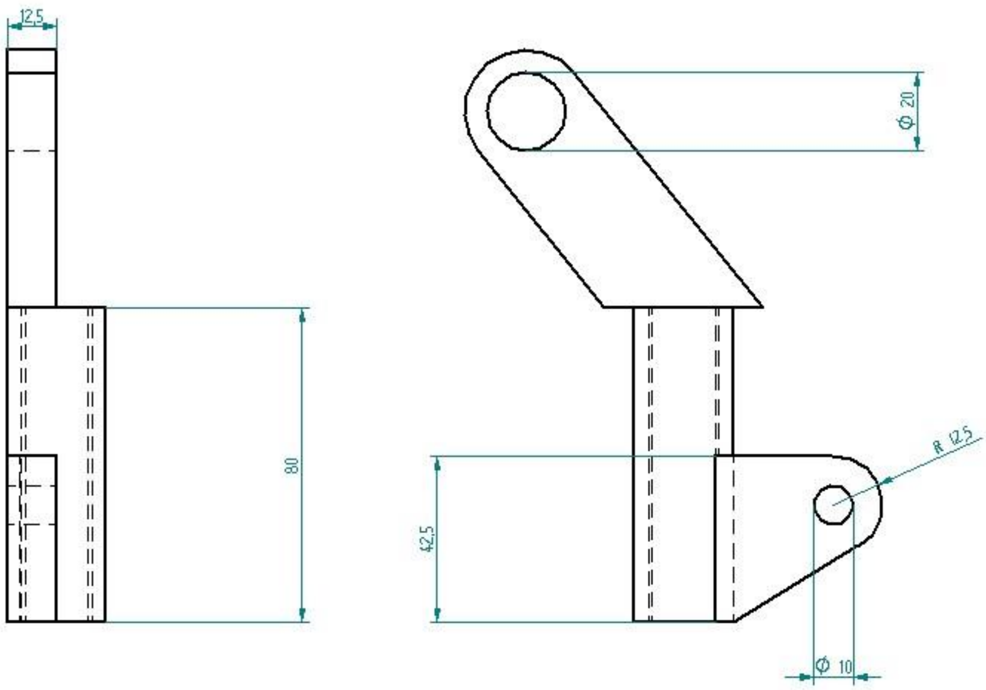

Fig.7.4 (Thigh mounting plate)

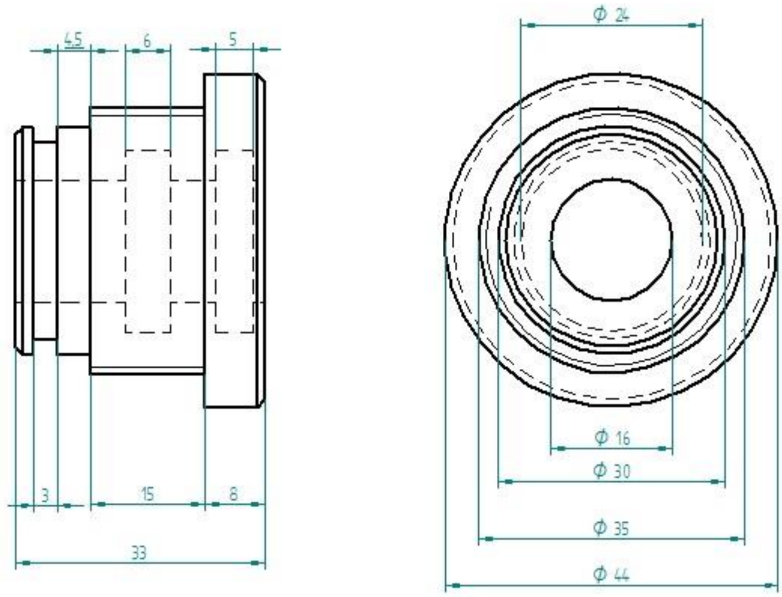

Fig.7.5 (Nut drawing)

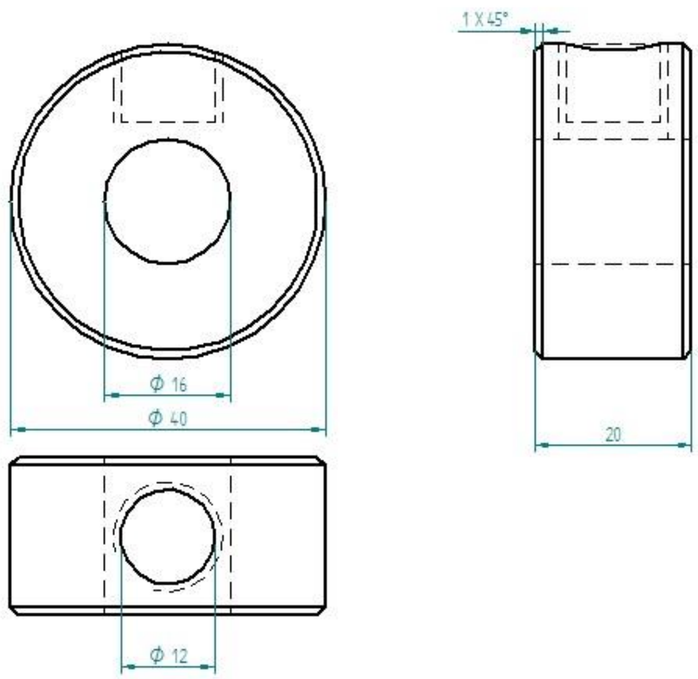

Fig.7.6 (Plate drawing)

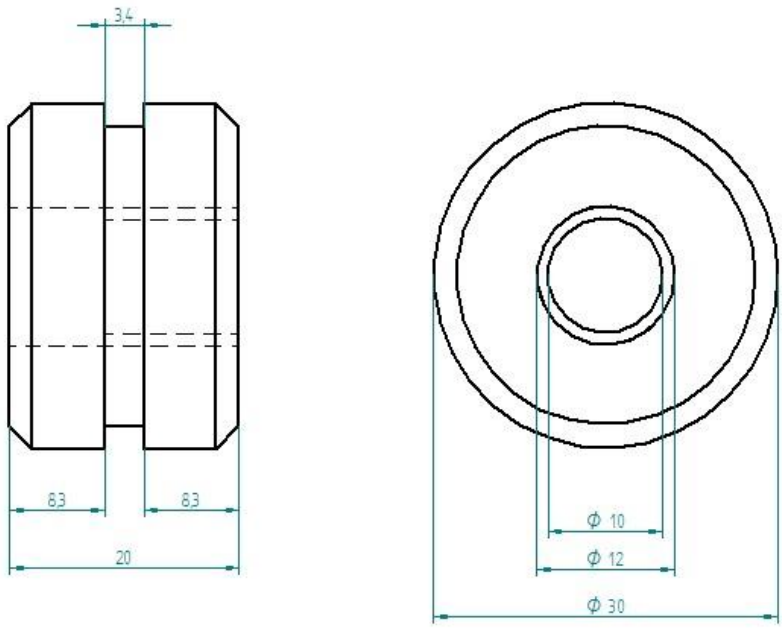

Fig.7.7 (Piston drawing)

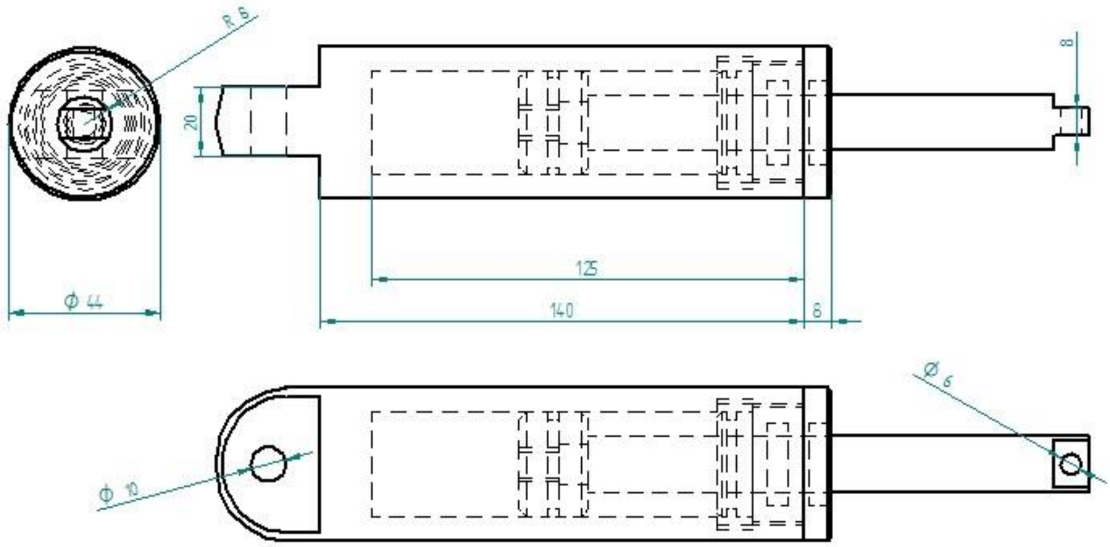

Fig.7.8 (Cylinder drawing)

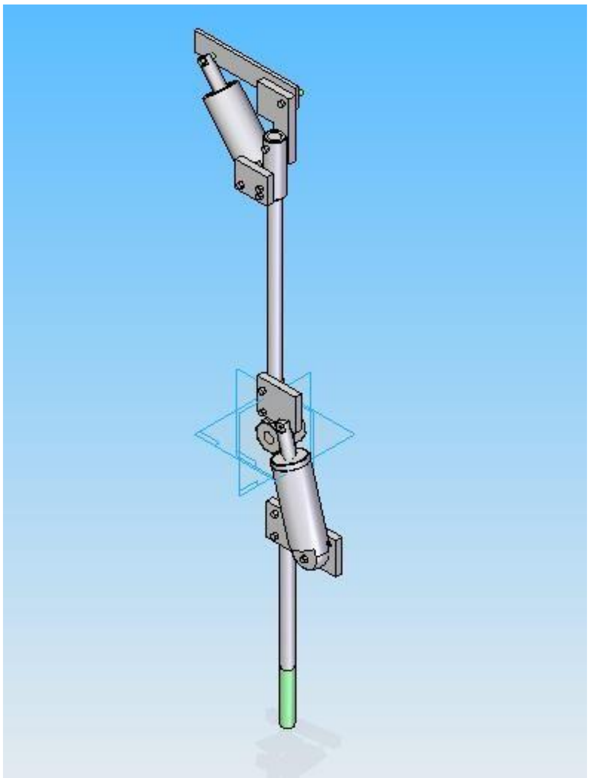

Fig.7.9 (CAD model)

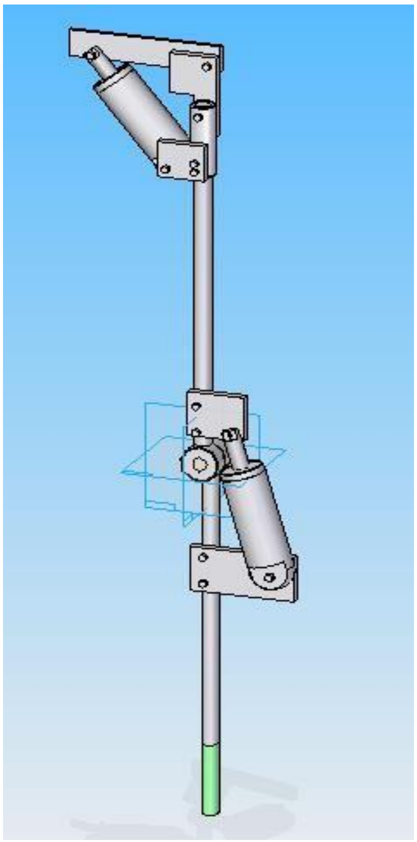

Fig.7.10 (CAD model)

Fig.7.11 (Driver cylinder)

Fig.7.12 (Driven cylinders)

Fig.7.13

Fig.7.14 (Hydraulic connections)

Fig.7.15 (Assembled model)

Chapter 8

ADVANTAGES

1. No external power source to drive the system.

2. Limited stroke, hence no requirement of directional control valves.

3. Operating speed is same as flowing fluid, between the cylinders does not pass through valves and cross-sectional area of cylinders is same.

4. A person with a disabled leg or a person without a leg can also use this system.

5. Economical compared to externally powered systems.

6. Several sizes and configurations can be incorporated.

7. Requires minimal maintenance.

8.1 COSTING

COMPONENTS	QUANTITY	PRICE (Rs /-)
CYLINDERS	3	5000
FRAME	1	1900
HOSE PIPES	1	1600
PORTS	8	390
HARNESS BELT	1	430
CYLINDER SEALS	12	650
FASTENERS	62	120
MACHINING	-	1000
OTHERS	-	600
TOTAL	**-**	**11690**

Table 8.1

CONCLUSION

The project titled "DESIGN AND FABRICATION OF SELF POWERED HYDRAULLIC SYSTEM FOR WALKING REHABILITATION" explains the design and manufacturing of the mechanism involved, basic application of which is to provide aid to disabled person. This project gives us detailed information about the various factors that we have taken into account before designing and selecting different components, which form a part of the equipment. It also gives the details of assembly. Considered design specifications include the slenderness of the leg and the shape of the walking gait. Proportions of the linkage are estimated utilizing measures of the human leg. Solid Edge software package is used to design the mechanism. Finally the project highlights the major advantages of the Self powered hydraulic system.

REFERENCES

TEXT BOOKS

1. R.S.Khurmi & J.K.Gupta – Machine Design – Eurasia publishing house New Delhi, 14th Edition, 2008.
2. Design data hand book by K. Mahadevan and K. Balaveera Reddy, 3rd edition, 1987, CBS Publishers.
3. Design data hand book by H. G. Patil, I. K. International publishing house Pvt. Ltd.