"Design And Development Of Wheelchair By The Application Of Chain Drive Mechanism"

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Abstract—over the past century there are about 50 million people which are physically handicapped, who want wheelchair but could not afford. Among these people most of them belong to rural area, who feels difficulty for taking education, employment, transportation in daily life cycle. If one lives in a developed country like United States, they have facility like elevators, public transportations, but for developing country there are rural areas in which people don't afford expensive wheelchairs. Most of the wheelchair available in market are either too expensive and are of poor technology. The aim is to modify the design, reduce the cost and to obtain better quality. Use of the lever is one of the ways to achieve the productivity, to reduce transportation time, and to get better user comfort. This project is intended to design and develop a wheelchair for handicapped which gives better load transmitting capacity, low maintenance and better performance index as compare to conventional wheelchair. If we analyze the conventional wheelchair, it contains poor technology and low user flexibility, less user comfort, there is social need of development in design of conventional wheelchair. Using data, we make calculation about power transmission, torque generating capacity, a normal wheelchair user can transmit about 40 km/hr velocity to wheels but due to poor technology they don't get mechanism to transmit torque into wheels. In our project we develop design which gives better performance and gives user better transportation experience.

I. Introduction

The aim of our project is to modify the wheelchair by the application of lever mechanism and chain drive in the basic design of wheelchair. As we knows, today there are in average 50 million people in world who are physically handicapped And millions of this people are the one who can't walk or need support to walk and can't afford the high-tech wheelchair. These are the people who need walking aids to perform even their basic routines. They have to be dependent on other people to travel .In developed countries there are various facilities provided to people by government and various organizations , whereas in underdeveloped countries they don't have any facilities , also some people can't afford to buy any aid.

Our main aim is to provide the wheelchair at low cost and effective too. The wheelchair we develop will be cheap, easily usable, easily manageable, and easily repairable. The lever and chain drive mechanism will give more output with less input. It can be use on all types of terrain without any problem. It is faster than a basic wheelchair and work efficient too. We plan to design and develop the wheelchair over the course of one year. By developing the wheelchair we will be able to help people who need's the wheelchair.

II. Literature Review

The basic rule of chain drive mechanism is to transmit power one shaft to another shaft at certain center distance with the help of sprockets and chain links.

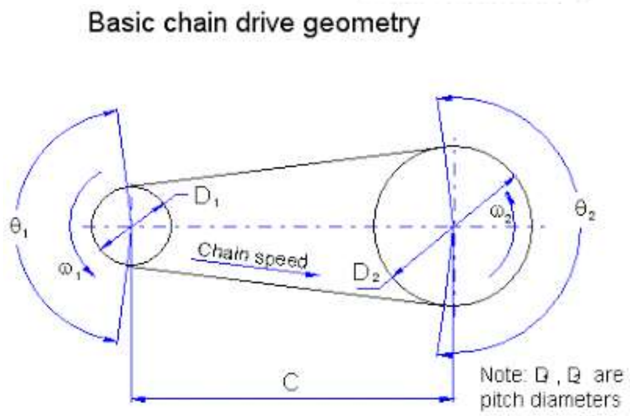


Fig 1

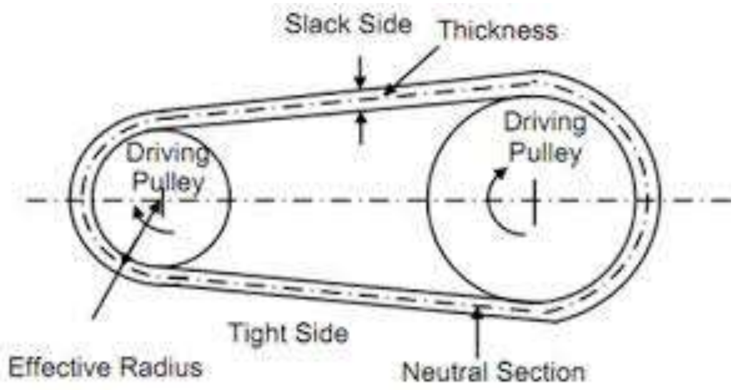


Fig 2

The basic rule of the lever is a rigid bar resting on a pivot which is used to move a heavy or firmly fixed load with one end when pressure is applied to the other end of the lever. In this case we are using second class of lever mechanism in our wheelchair.

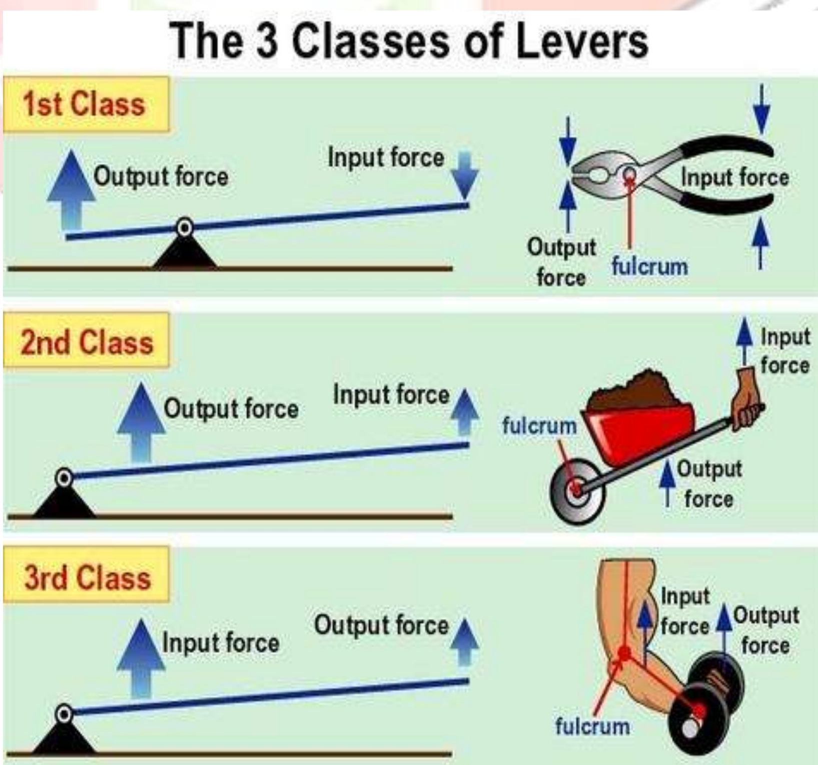
PRINCIPLE OF LEVER MECHANISM

For lifting an object by hands, it requires applying a force directly on the object. The Muscular strength must be facing upwards and intensity which is to be applied should be greater than the weight of the object. This is only possible only for lighter items which can be lifted by hands. The lever is a simple machine that changes the magnitude and direction of the force applied to move an object. It is used to minimize the effort required to lift the object. A lever is a rigid bar which moves around a supporting point which is called pivot or fulcrum. The object to be lifted is placed on the bar. When a force is correctly applied to the bar, it pivots about its fulcrum.

TYPES OF CHAIN DRIVE

- Roller chain
- Detachable chain
- Pintle chain
- Silent chain
- Leaf chain
- Laminated metal chain

In our wheelchair, we are using roller chain, due to more flexibility require.

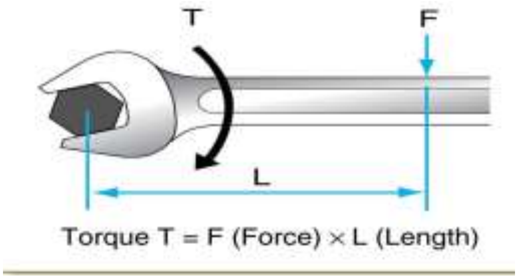


FEASIBILITY STUDY

Technical Feasibility

For Example,

From the design of the bicycle, we analyse that lever is the most important component which possibly increase efficiency. To generate high or low torque all we have to change is radius component of force because as all we know



All we need to change is short lever of bicycle should replace with long lever for getting more high torque due to high distance

So as we can relate:-

High torque: - user needs to effort at end of lever

Low torque: - user needs to effort below center of lever

$$\omega = \frac{\Delta\theta}{t}$$

ω — angular velocity
θ — angle (angular position)
t — time

High torque generates low rotational speed to the wheel

Low torque generates high rotational speed to the wheel

Economical Feasibility

Total Cost Estimation :-(Max 6000rs)

Chain Drive	- 1400rs
Lever	- 200rs
Two tires	- 200rs
Seat	- 200rs
Wheel chair frame	- 650rs
Machining and color	- 500rs
Front Wheel	- 350rs

Operational Feasibility

As we discuss in technical feasibility, for operational feasibility we actually apply the fundamentals:-

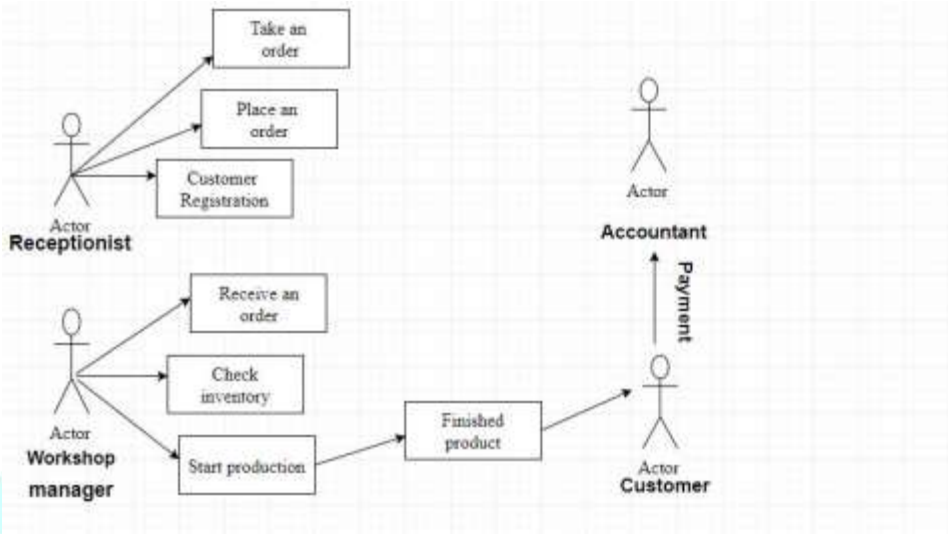
There is pair of lever which is directly connected with chain drive mechanism.

The force applied to lever by hands of user and it will further converted into torque which is transmitted from driving shaft to wheel by chain drive arrangement.

Through chain drive, Torque will transmit into axle of rear wheel; axle is directly connected with hub.
Hub is arrangement which contains ball bearing, torque will transmit into bearing, here bearing is use to reduce friction between shaft and wheel.
Through the hub torque will transmitted into rear wheel.

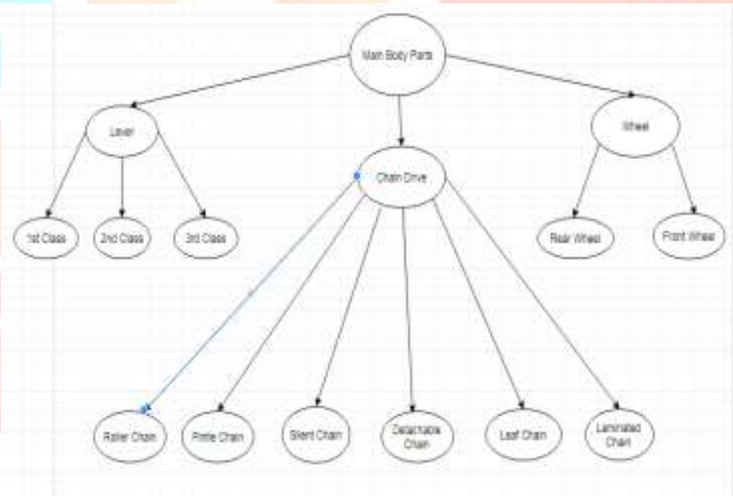
FUNCTIONS OF SYSTEM

Use Case Diagram

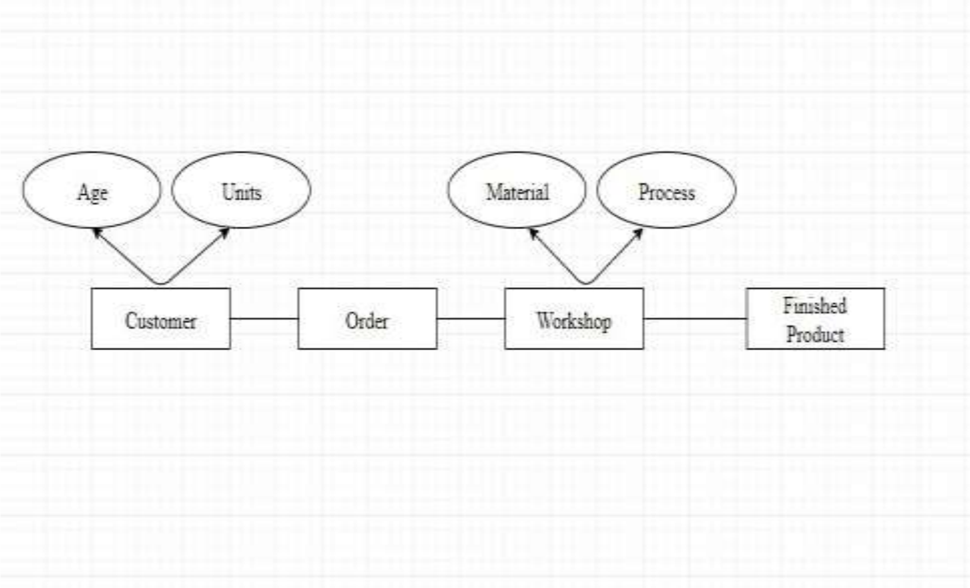


DATA MODELING

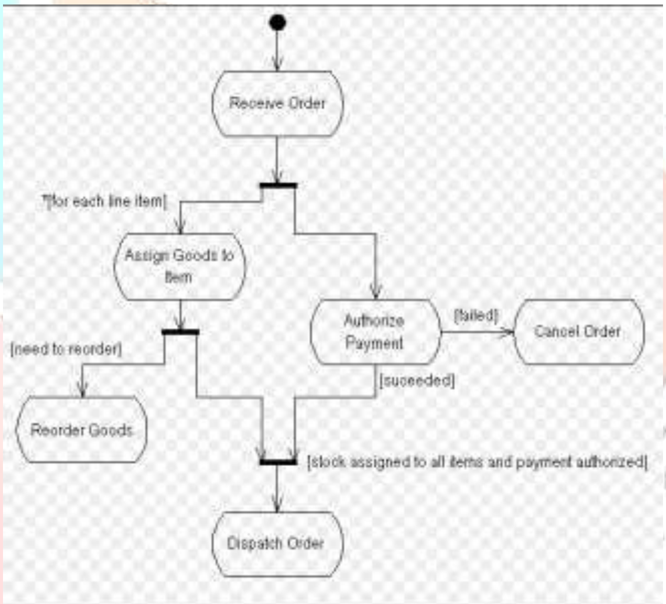
Class Diagram



E-R Diagram

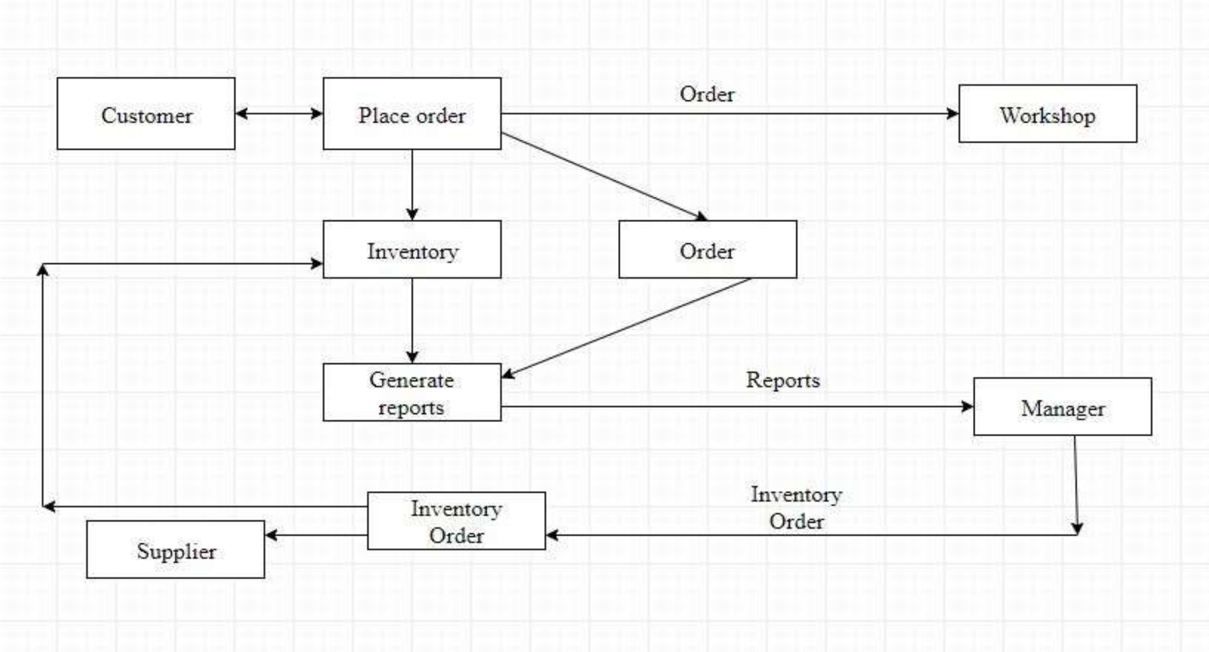


Activity Diagram



FUNCTIONAL AND BEHAVIORAL MODELING

Data Flow Diagram



IV. PHASES

PHASE 1 MATERIAL SELECTION

Material Data					
Sr. No.	**Material Property**	**Cold Rolled Steel ASTM A568**	**Carbon Fiber**	**Aluminum Alloy AISI 6063**	**Steel Alloy AISI 4340**
1	Ultimate Tensile Strength (MPa)	480	350	130	500
2	Machinability (%)	90	60	50	25
3	Hardness (BHN)	170	120	25	217
4	Cost (Kg)	70	600	192	105

Weightage point for Ultimate Tensile Strength is 5, Machinability is 4, Hardness is 3 and Cost is 2.

1. Calculation of weightage point for Cold rolled Steel ASTM A568

I. Point for Ultimate Tensile Strength 480 + 350 + 130 +

500 = 1460

There for Cold rolled Steel ASTM A568 the percentage strength is given by,

480 ÷ 1460 = 0.3287

Weightage for Strength is 5,

So, 0.3287 * 5 = 1.6435

II. Point for Machinability 90 + 60 + 50 +

25 = 225

There for Cold rolled Steel ASTM A568 the percentage Machinability is given by,
90 ÷ 225 = 0.4
Weightage for Machinability is 4,
So, 0.4 * 4 = 1.6

III. Point for Hardness

170 + 120 + 25 + 217 = 532

There for Cold rolled Steel ASTM A568 the percentage Hardness is given by,
170 ÷ 532 = 0.3195

Weightage for Hardness is 3,
So, 0.32 * 3 = 0.96

IV. Point for Cost

70 + 600 + 192 + 105 = 967

There for Cold rolled Steel ASTM A568 the percentage Cost is given by,

70 ÷ 967 = 0.07238

Weightage for Cost is 2,
So, 0.073 * 2 = 0.146

2. Calculation of weightage point for carbon fiber

I. Point for Ultimate Tensile Strength

480 + 350 + 130 + 500 = 1460
There for carbon fiber the percentage strength is given by,
350 ÷ 1460 = 0.2397

Weightage for Strength is 5,
So, 0.2397 * 5 = 1.1986

II. Point for Machinability

90 + 60 + 50 + 25 = 225
There for carbon fiber the percentage Machinability is given by, 60 ÷ 225 = 0.2666

Weightage for Machinability is 4,
So, 0.2666 * 4 = 1.066

III. Point for Hardness

170 + 120 + 25 + 217 = 532

There for carbon fiber the percentage Hardness is given by,
120 ÷ 532 = 0.2255

Weightage for Hardness is 3,
So, 0.2255 * 3 = 0.6765

IV. Point for Cost

70 + 600 + 192 + 105 = 967
Here for carbon fiber the percentage Cost is given by, 600 ÷ 967 = 0.6204

Weightage for Cost is 2,
So, 0.6204 * 2 = 1.2409

3. Calculation of Weightage point for Aluminum alloy AISI 6063

I. Point for Ultimate Tensile Strength 480 + 350 + 130 +

500 = 1460

There for Aluminum alloy AISI 6063 the percentage strength is given by,

130 ÷ 1460 = 0.08904

Weightage for Strength is 5,
So, 0.08904 * 5 = 0.4452

II. Point for Machinability 90 + 60 + 50 +

25 = 225

There for Aluminum alloy AISI 6063 the percentage Machinability is given by, 50 ÷ 225 = 0.2222

Weightage for Machinability is 4,
So, 0.2222 * 4 = 0.8888

III. Point for Hardness

170 + 120 + 25 + 217 = 532

There for Aluminum alloy AISI 6063 the percentage Hardness is given by,
25 ÷ 532 = 0.04699

Weightage for Hardness is 3,
So, 0.04699 * 3 = 0.1409

IV. Point for Cost

70 + 600 + 192 + 105 = 967

There for Aluminum alloy AISI 6063 the percentage Cost is given by,

192 ÷ 967 = 0.1985
Weightage for Cost is 2,
So, 0.1985 * 2 = 0.3971

4. Calculation of Weightage point for Steel alloy AISI 4043

I. **Point for Ultimate Tensile Strength** 480 + 350 + 130 +

500 = 1460

There for Steel alloy AISI 4043 the percentage strength is given by,

500 ÷ 1460 = 0.3424

Weightage for Strength is 5,
So, 0.3424 * 5 = 1.7123

II. **Point for Machinability** 90 + 60 + 50 +

25 = 225

There for Steel alloy AISI 4043 the percentage Machinability is given by, 25 ÷ 225 = 0.1111

Weightage for Machinability is 4,
So, 0.1111 * 4 = 0.4444

III. **Point for Hardness**

170 + 120 + 25 + 217 = 532

There for Steel alloy AISI 4043 the percentage Hardness is given by,
217 ÷ 532 = 0.4078

Weightage for Hardness is 3,
So, 0.4078 * 3 = 1.2236

IV. **Point for Cost**

70 + 600 + 192 + 105 = 967
There for Steel alloy AISI 4043 the percentage Cost is given by,
105 ÷ 967 = 0.1085
Weightage for Cost is 2,
So, 0.1085 * 2 = 0.2171

V RESULTS

Sr. No.	Material Property	Cold rolled Steel ASTM A568	Carbon Fiber	Aluminum Alloy AISI 6063	Steel Alloy AISI 4340
1	**Ultimate Tensile Strength(MPa)** **Percent** **Points**	0.3287 1.6437	0.2397 1.1986	0.08904 0.4452	0.3424 1.7123
2	**Machinability (%)** **Percent** **Points**	0.4 1.6	0.2666 1.066	0.2222 0.8888	0.1111 0.4444
3	**Hardness(BHN)** **Percent** **Points**	0.32 0.96	0.2255 0.6765	0.04699 0.1409	0.4078 1.2236

4	**Cost(Kg)** **Percent** **Points**	 0.073 0.146	 0.6204 1.2409	 0.1985 0.3971	 0.1085 0.2171
5	**Total Points**	**4.34**	**4.18**	**1.87**	**3.89**
	Rank	**1**	**2**	**4**	**3**

So, from the weightage method for material selection for the frame structure total points including all important parameters like Ultimate Tensile Strength, Machinability, Hardness and Cost. Material Cold Rolled Steel ASTM A568 is having highest total points. So, it would be appropriate material for the frame structure.

PHASE 2 SELECTION OF CHAINDRIVE

Step-1:- Selected motor available from market /Single Strand Roller Chain Standard chain forbicycle – 08 B (British Standard). So, pitch (p) is 12.7 mm shown in figure. __.
Step-2:- Took optimized gear ratio of 3:1
Step-3:- Opted No. of teeth onDriving Sprocket
z1 = 42
No. of teeth on Driven Sprocket
z2 = 14
Step-4:- Pitch Angle (α) = 360 / z

Front Sprocket = 8.57^0

Rear Sprocket = 25.71^0

Part	Specification
Chain Type	Single, 08 B Roller (British Standard)
Pitch	12.7 mm
Gear Ratio	3 : 1
No. of Teeth (Driving, Driven)	42 , 14
Diameter of Sprocket (Driving, Driven)	171.62 mm , 57.08 mm
Speed of Sprocket (Driving, Driven)	337 RPM, 1101 RPM

Transmission Drive Selection

PHASE 3 SELECTION OF BEARING

In market many roller bearings are available. So we required to choose bearing according to the below specification as per our requirement. In that we go through the bearing no-6202 standard bearing size and their different sizes of diameter.

1) Diameter I/D (d) = 15 mm
2) O/D= 35mm
3) Cr =1720 lbs
4) Cor =839 lbs
5) Fo = 13.2
6) Grease = 20.0
7) Oil = 24.0
8) W = 0.10 lbs

ACKNOWLEDGMENT

I Express My Cavernous Sense Of Obligation And Gratitude To My Guide Prof. KONDHIYA PANKITFor His Genuine And Constant Encouragement Throughout This Project Work. I Am Highly Obliged As My Honorable Guide Have Devoted His Valuable Time And Shared His Expertise Knowledge.

I Extend My Sincere Thanks To Our Chairman Mr. Pravinbhai Maniyar, Principal. Dr. Jayesh. V. Deskar, V. V. P. Engineering College, Rajkot And H.O.D. Dr. J. P. Mehta, Department Of Mechanical Engineering and Our Class Teacher Prof. Niraj R. Shingala For Providing Me Such An Opportunity To Do My Project Work.

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