Research based Project

“DEVELOPMENT OF HANDY GROOVE CUTTER FOR MORE THAN 5MM THICK PLATES OF STRUCTURAL MATERIALS”

A PROJECT REPORT

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In fulfillment for the award of the degree
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In

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GOVERNMENT ENGINEERING COLLEGE
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CERTIFICATE

Date: 20/04/2020

This is to certify that the Project entitled **"DEVLOPMENT OF HANDY GROOVE CUTTER FOR MORE THAN 5MM THICK PLATES OF STRUCTURAL MATERIALS"** have been carried out by PRAJAPATI RAVIKUMAR (160610119042), PRAJAPATI PRAVIN (160610119041), DARJI HARSHIL (160610119010) and GURJAR SAMAYKUMAR (160610119012) under my guidance in fulfillment of the degree of Bachelor of Engineering in MECHANICAL ENGINEERING (8^{th} Semester) of Government Engineering Collage, Palanpur during the academic year 2019-20.

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ACKNOWLEDGEMENT

The completion of our project was not an easy task for us. The project is manufacturing based project and huge manufacturing and material knowledge required. In accomplishing this goal many personals gave the helping hand for us. We would like to appreciate their guidance and encouragement.

First of all, we would like to thank our Guide Prof. **A. D. Patel**, of Mechanical Engineering Department who is the supervisor of the project, gave us a fabulous help and guidance in the whole period of the project. It is a pleasure to mention **Dr. J.A. VADHER**, Head of the Mechanical Engineering Department who gave us tremendous help by providing necessary guidance for our final year projects.

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ABSTRACT

Many cutting heavy and portable machines are available for through cutting. Which discrete the two parts. But for partial wider cut in width direction which creates Groove is only done by laser cutting machines, gas cutting machines, plasma cutting machines or other machining operations. These all are founded machines. For precision, many industries are using milling operation for groove cutting which is very costly.

Main objective of this project is to develop a handy groove cutter to cut groove of variety of sizes to reduce a cost, time and labor work. This cutter will be capable to cut a groove in more than 5 mm thick plates in single pass.

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INTRODUCTION

1.1 INTRODUCTION

In many industries and Fabrication workshop there are many advanced groove cutting machines are used like Milling machine, LASER cutting machine, Gas cutting machine, water jet machining etc. these machines are very costly and heavy in weight. these all machines can be capable to cut very accurately. These all are founded machines.so it is time consuming for locating and fixing for small work piece or a job. So, it is not much better machining process for industries and fabricators. A grove cutting is used as per the different application like cutting a groove for welding assembly, building structure, joints etc. so it necessary to cut a small accurate groove in very less effort, less labor work and less time for a precise and rapid production or job work.

1.2 PROBLEM STATEMENT

Many cutting heavy and portable machines are available for through cutting. Which discrete the two parts. But for partial wider cut in width direction which creates Groove is only done by laser cutting machines, gas cutting machines, plasma cutting machines or other machining operations. For a small groove in bulky work piece in above machines is very time consuming and non-reliable

To cut a groove more than 5mm width is a main task of this project work. Many cutting methods are available for through cutting the thick plates. Handy cutter to cut such groove in single pass is main need of this project.

1.3 OBJECTIVE

Main objective of this project is to develop a handy groove cutter to cut groove of variety of sizes to reduce a cost, time and labor work. This cutter will be capable to cut a groove in more than 5 mm thick plates in single pass.

- Making A Handy Groove Cutter To Cut Various Size Of Groove
- Easy To Move
- Reduce The Cost of operation
- Capable To Groove More Than 5mm Thick Plate
- Less cost of cutter

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LITERATURE REVIEW

2.1 INTRODUCTION

Aim of our project is to develop a handy groove cutter to cut groove of variety of sizes to reduce a cost, time and labor work. This cutter will be capable to cut a groove in more than 5 mm thick plates in single pass.

So, for literature review we refer more than 40 journals and international papers from different sources like ASME, ScienceDirect, ArcelorMittal and SAAB company's website. Mostly used structural material at industrial level is A514 Grade B steel.

❖ **PROPERTIES AND GUIDELINE FOR A514 GRADE B MATERIAL**

(information form ArcelorMittal and SAAB company's website)

➢ ASTM A514 Grade B
(High-Yield-Strength, Quenched and Tempered Alloy Steel Plate)

2.2 GENERAL PRODUCT DESCRIPTION

ASTM A514 Grade B is a quenched and tempered alloy steel plate for structural applications requiring high yield strength combined with good formability and toughness. A514 Grade B has a minimum yield strength of 100 ksi [690 MPa] and may be ordered with supplemental Charpy V-notch impact test requirements.

APPLICATIONS: Typical applications for A514 Grade B include transport trailers, construction equipment, crane booms, mobile man-lifts, agricultural equipment, heavy vehicle frames and chassis, and welded bridge structural members.

DIMENSIONS AVAILABLE:

- Thickness: 0.1875” – 1.25” (4.8 mm – 31.8 mm)
- Width: 72” - 102” (1,829mm – 2,591 mm)
- Length: 240” - 600” (6.10m – 15.2 m)

Standard plate thicknesses available (96” wide x 240” pattern size) include 3/16”, ¼”, 3/8”, ½”, ¾”, 1” and 1-1/4” (4.8, 6.4, 9.5, 12.7, 19.0, 25.4 and 31.8 mm). Please inquire for other sizes.

➢ MECHANICAL PROPERTIES

- **Tensile Test** is performed in the transverse direction according to ASTM A6 requirements. The minimum values are tabulated below:

0.2% YS ksi [MPa], min.	UTS ksi [MPa]	Elongation in 2” [50 mm], min. %	Reduction of Area, min. %	Brinell Hardness*
100 [690]	110 to 130 [760 to 895]	16	35	235 to 293

➢ CHEMICAL COMPOSITION

Meets chemical requirements of ASTM A514 Grade B, as shown below (wt % ladle analysis):

	C	Mn	P	S	Si	Cr	Mo	V	Ti	B	CEV Typ.	CET Typ.
Min.	0.12	0.70	-	-	0.20	0.40	0.15	0.03	0.01	0.0005	0.51	0.42
Max.	0.21	1.00	0.035	0.008*	0.35	0.65	0.25	0.08	0.08	0.005		

➢ FORMABILITY PROPERTIES

A514 Grade B material exhibits good cold forming characteristics. Shear burrs and heat-affected zones of thermal cut edges on or near the bend axis as well as sharp corners on edges and on gas cut or punched holes located on or adjacent to the bend axis should be removed by grinding prior cold forming.

Thickness (in. [mm])	Bend axis perpendicular to rolling direction. Inside radius, R, (min.)	Bend axis perpendicular to rolling direction. Die width, W.	Bend axis parallel to rolling direction. Inside radius, R (min.)	Bend axis parallel to rolling direction. Die width, W
0.1875 – 0.75 [4.8 – 19]	1.75t	7t	2.625t	9t
>0.75 – 1.00 [>19 – 25.4]	2.25t	8t	3.375t	10t
>1.00 – 1.25 [>25.4-31.8]	4.5t	12t	6.75t	16t

➢ WELDABILITY

Welding of A514 Grade B shall be performed in accordance with the applicable welding code. In the absence of a specified welding code, the following suggested minimum preheat and interpass temperatures and welding consumables are provided. Special welding consumables and welding procedures may be required to avoid detrimental effects on the mechanical properties of the base metal. Low hydrogen practices are strongly recommended, including the removal of surface moisture. A514 Grade B may be susceptible to reheat cracking in the heat-affected zone of welds during stress relieving or postweld heat treatment. As a result, SSAB recommends that a qualified welding engineer consider this potential before stress relieving weldments of this product.

Welding Process	Thickness (in. [mm])	Minimum Preheat and Interpass Temperature (°F [°C])	Consumables
Shielded Metal Arc (SMAW)	Up to ¾ [19]	50 [10]	AWS E10015-X, E10016-X, E10018-X, E10018-M
Shielded Metal Arc (SMAW)	>¾ – 1.25 [19 –31.8]	150 [65]	AWS E10015-X, E10016-X, E10018-X, E10018-M
Gas Metal Arc (GMAW)	Up to ¾ [19]	50 [10]	AWS ER110S-XXX-XX
Gas Metal Arc (GMAW)	>¾ – 1.25 [19 –31.8]	150 [65]	AWS ER110S-XXX-XX
Submerged Arc (SAW)	Up to ¾ [19]	50 [10]	AWS F11XX-EXXX-XX, F11XXECXXX-XX
Submerged Arc (SAW)	>¾ – 1.25 [19 –31.8]	150 [65]	AWS F11XX-EXXX-XX, F11XXECXXX-XX
Flux Cored Arc (FCAW)	Up to ¾ [19]	50 [10]	AWS E11XTX-X, E11XTX-XM

2.3 PATENTS SEARCHED BY US RELATED TO THE PROJECT

1) (CN109551050) Large-scale pressure container wall welding groove cutting equipment with adjustable cutter By Zhao Deli
2) (US20050191141) Groove cutting tool By Nomoto Nobutoshi; Oshima Shin; Takahashi Naohisa
3) (JP4327397B2) Slotting cutter and a cutting insert for use therein By Willy Astrom
4) (KR20050011021) Device for separating cutting groove of metal plate by wedge in cutting metal plate by circular saw blade BY Lee Han Keun
5) (CN109570596) Dovetail groove milling cutter BY Li Dongqi; Wu Shiping; Zhang Fenghua; Gan Weihua; Zhang Xinlan

2.4 RESEARCH PAPERS SEARCHED BY US RELATED TO THE PROJECT

- Development of a Twister Machine for Groove Cutting by, Yoshihiro Yamaguchi

Aim of Development - Streamlining of Edge Preparation Process

high cutting performance of the Twister machine in the plate thickness range widely used in the production of construction machinery, achieving a speed several times that by gas cutting and about 2 to 3 times the speed by a 6-kW laser beam cutting machine

- Study on Burr Formation at the Top Edge in Rectangular Groove Cutting; Wen Jun Deng, Zi Chun Xie, Ping Lin, and Tong Kui Xu

Burrs are one of the most serious obstacles to precision manufacturing and manufacturing process automation, Burrs are formed in various machining process as a result of plastic deformation due to plasticity during mechanical manufacturing process and have been defined as undesirable projections of material beyond the edge of a work piece.

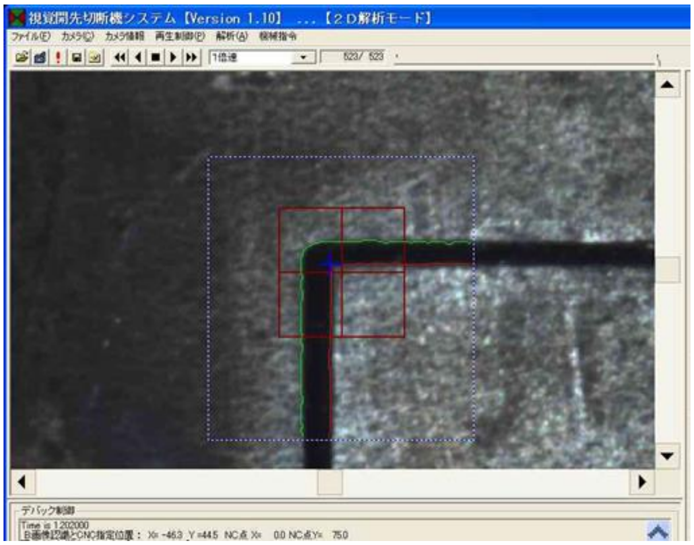


Fig. Image Prepared by CCD camera

(charge coupled device camera)

The machine automatically moves to the photographing points and photographs after performing cutting in Pass 1 as fig. The photographed images are translated into binary values and edge points are extracted by image processing Position mis- alignment can be calculated by comparing a position without position misalignment and the actual edge point position.

3

RESEARCH GAP

According to the literature review we identify the types of methods & problems for cutting a groove related to the particular application.so that we have many conclusions of literature review & Ideas for modification of design and cutting process.

Many cutting heavy and portable machines are available for through cutting. But for partial wider cut in width direction which creates Groove is only done by laser cutting machines, gas cutting machines, plasma cutting machines or other machining operations. These all are founded machines. For precision, many industries are using milling operation for groove cutting which is very costly. Some fabricators are doing by drilling multiple holes line by line as per size of groove, finally they are hammering and filling to finish the groove. But this method is not feasible all time.

So as per current literature review, it is needed to develop a *"handy groove cutter"* which cut a groove with single pass.

3.1 CURRENT CONVENTIONAL METHODS FOR CUTTING A GROOVE

For cutting a groove in a more than 5mm thick metal plate by handy manually There is no any Cutter is Available for cutting a direct groove in metal plate. So, all the fabricators and tool operators are using the different methods for cutting a groove

Fabricators & cutting Operators following these conventional methods:

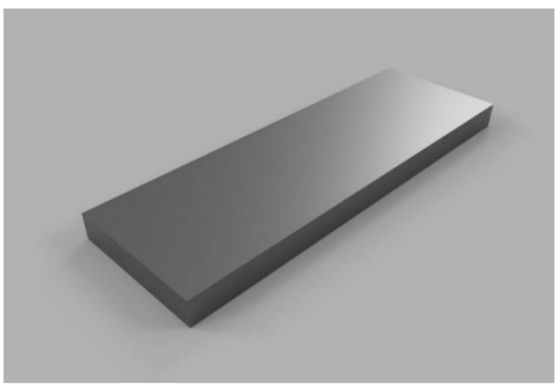


Figure 1: Thick Metal Plate

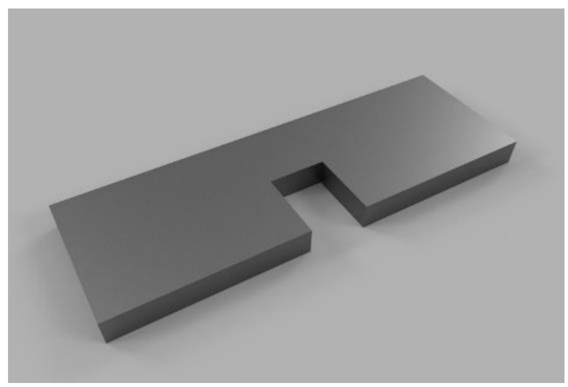


Figure 2: Cutting A Groove in Plate

As per the fig.1 thick metal plate of A514 grade B is shown and fig.2 is the plate with cutting groove as shown in figure.

METHOD 1: BY CUTTING MORE THAN TWO SLOTS

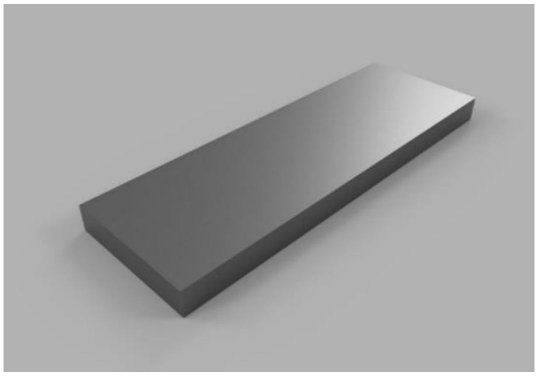


Figure 3: Thick Metal Plate

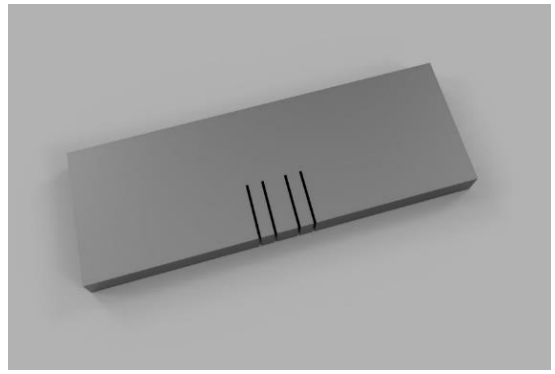


Figure 4: Many cutting slots

- Operator first cut the whole groove in many parts as shown in figure according to the length of the groove.
- Then by using the drilling tool at the end of the cut they doing drilling operation and remove the chips and doing the finishing operation
- So, it is very time consuming and very less accurate method.

➢ **LIMITATIONS:**

- POOR FINISHING
- OVER CUTTING
- TIME CONSUMING

Figure 5: Manual grooved bolck

➢ METHOD 2: BY USING GAS WELDING

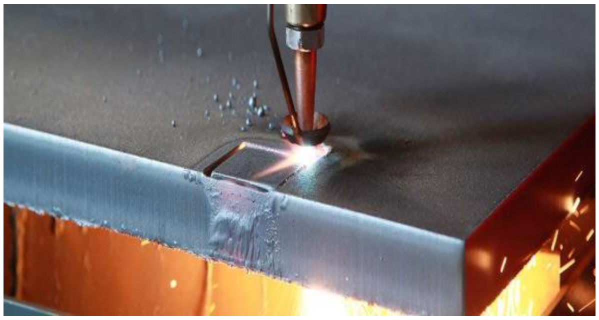


Figure 6(A): Gas grooving method in plate

Figure 6(B): Gas grooving method in plate

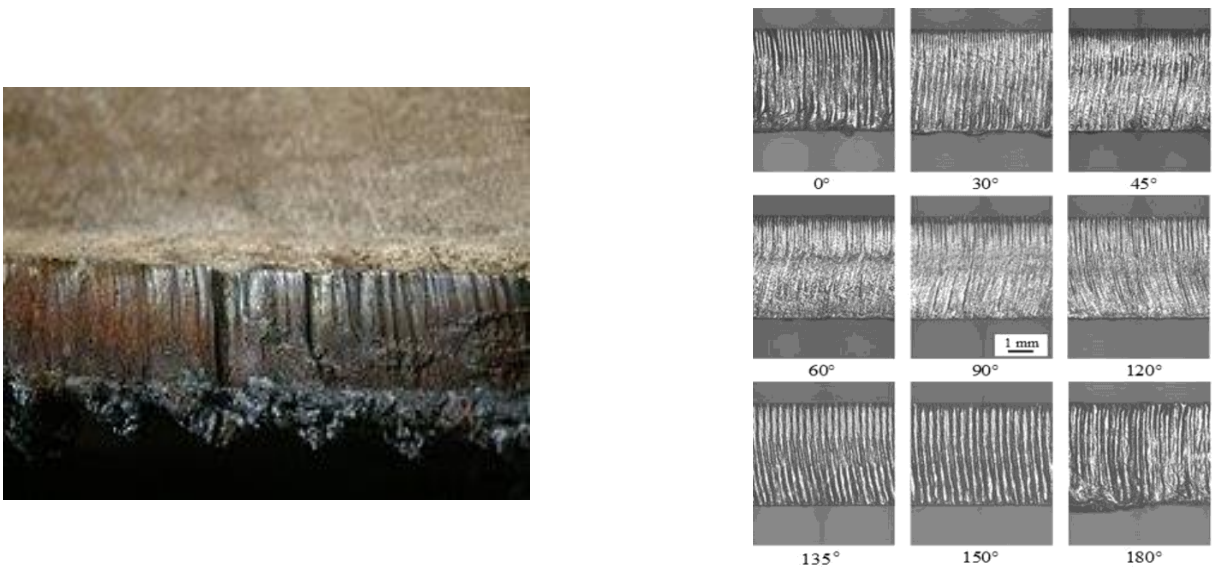


Figure 7: Gas cutting effect on grooving in plate

➢ LIMITATIONS OF GAS CUTTING

- Very skilled worker is required
- Heavy equipment
- Risk of blast
- Poor surface finish

➢ METHOD 3: USING LASER CUTTING

Figure 8: Laser cutting machine

- Huge machine
- Very costly
- Highly skilled worker requires

OTHER METHODS USED FOR CUTTING A GROOVE

- Punching Machine
- Plasma arc cutting
- water jet cutting
- abrasive jet cutting

➢ For collecting the more information, we visited the fabrication shop and discussed with the fabricator about this problem and we get many information about the cutting a groove.

➢ Site visit photographs:

Figure 9: Metal working photographs

3.2 VISITED SITES FOR RESEARCH

- New Panchal iron steel working
  Mr. Akshaybhai Panchal
  Aeroma Circle, Palanpur
  Banasnkantha, Gujarat

- Mr. Mahesh Mistry
  Machine Tool Retailer in Tharad
  Banasnkantha, Gujarat

- New Panchal iron steel working
  Mr. Kamleshbhai Panchal, Chadotar
  Banasnkantha, Gujarat

4

DESIGN OF GRINDING CUTTING MACHINE

After prior literature review and research gap we had gone through brainstorming between our team and guide. So that we finalized design of grinding cutting machine as per our requirement for this project.

In designing grinding cutting machine first of all we had made wire frame model. This wireframe model is designed in Autodesk AutoCAD Mechanical which computer aided design software used for design and FEA analysis.

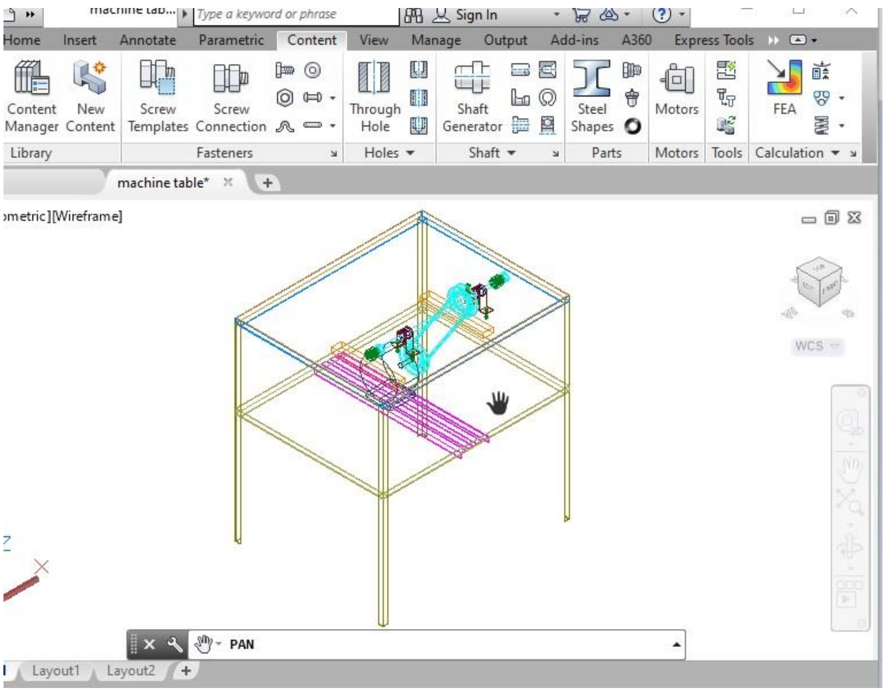
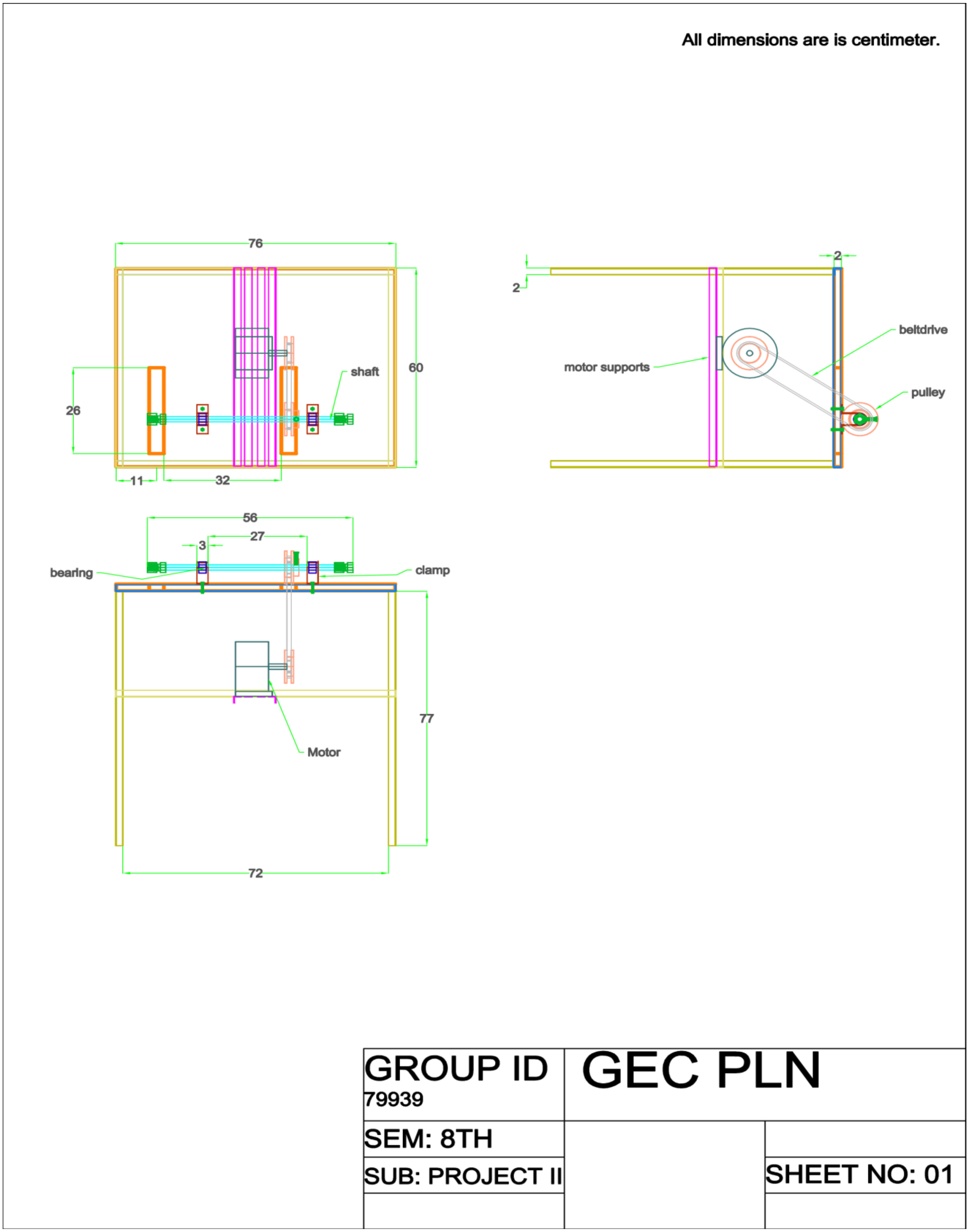


Figure 10: Wireframe model of grinding cutting machine

4.1 2D Drawing Sheet Of Grinding Cutting Machine



4.2 SOLID MODELING OF GRINDING CUTTING MACHINE

We prepared solid model of grinding cutting machine using dimension taken from 2D drawing sheet. After that 3d solid model is made in different layers with different parts used in grinding cutting machine.

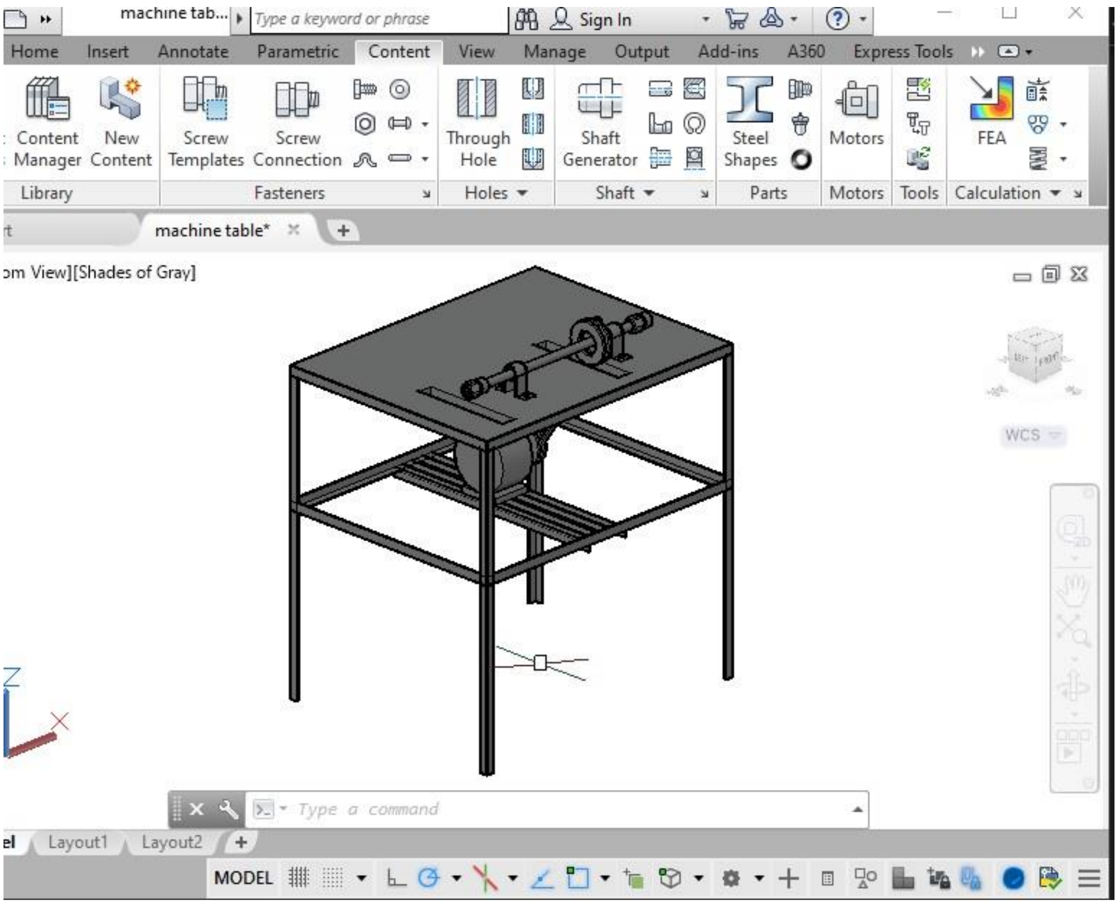
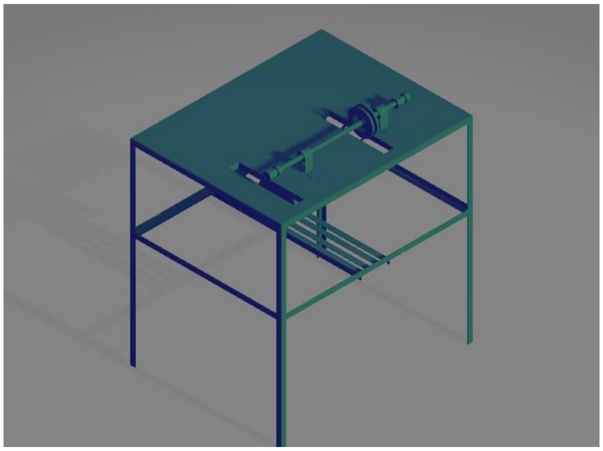
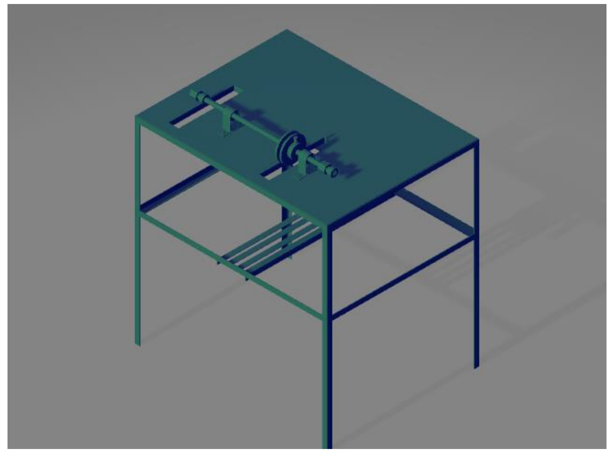


Figure 11: 3D Solid model of grinding cutting setup in shade of gray

After making solid model we also made its viewing more interesting using 3D Viewer app of microsoft corporartion. We had given different lighting effect and viewing angle for making better visualization of 3d solid model. Exported images from 3D Viewer are shown as below.

4.2.1 Isometric View of Solid Model of Grinding Cutting Machine

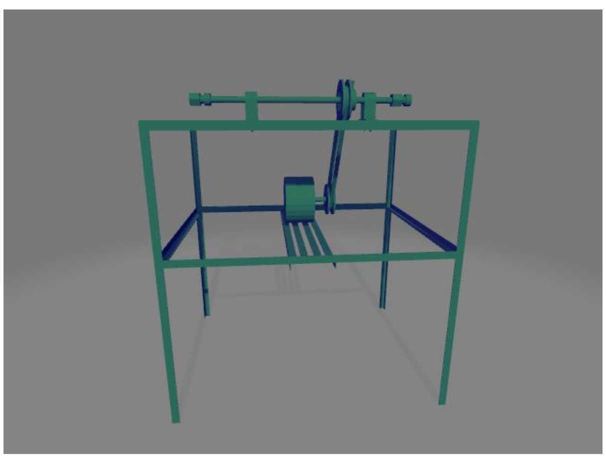


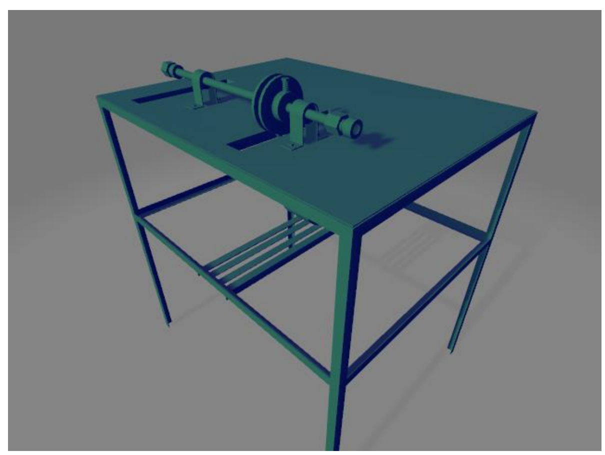


Isometric left view   Isometric right view

Figure 12: Isometric view of solid model of grinding cutting machine

4.2.2 Perspective View of Solid Model of Grinding Cutting Machine





2 different perspective viewing angle

Figure 13: Perspective view of solid model of grinding cutting machine

4.3 Rendering of Solid Model of Grinding Cutting Machine

Rendering gives real life view to solid model. We had done rendering through inbuilt render engine in Autodesk AutoCAD Mechanical Cad software. In rendering we have first given the materials identities to different parts of solid model and then we had done rendering using inbuilt render engine in Autodesk AutoCAD Mechanical Cad software.

Figure 14: Rendered image of grinding cutting machine

Rendering gives realistic look to 3D model and we also made rendering of solid model of grinding cutting machine from different viewing angles which are shown in below images.

4.3.1 Rendered Images of Grinding Cutting Machine From Different Viewing Angle

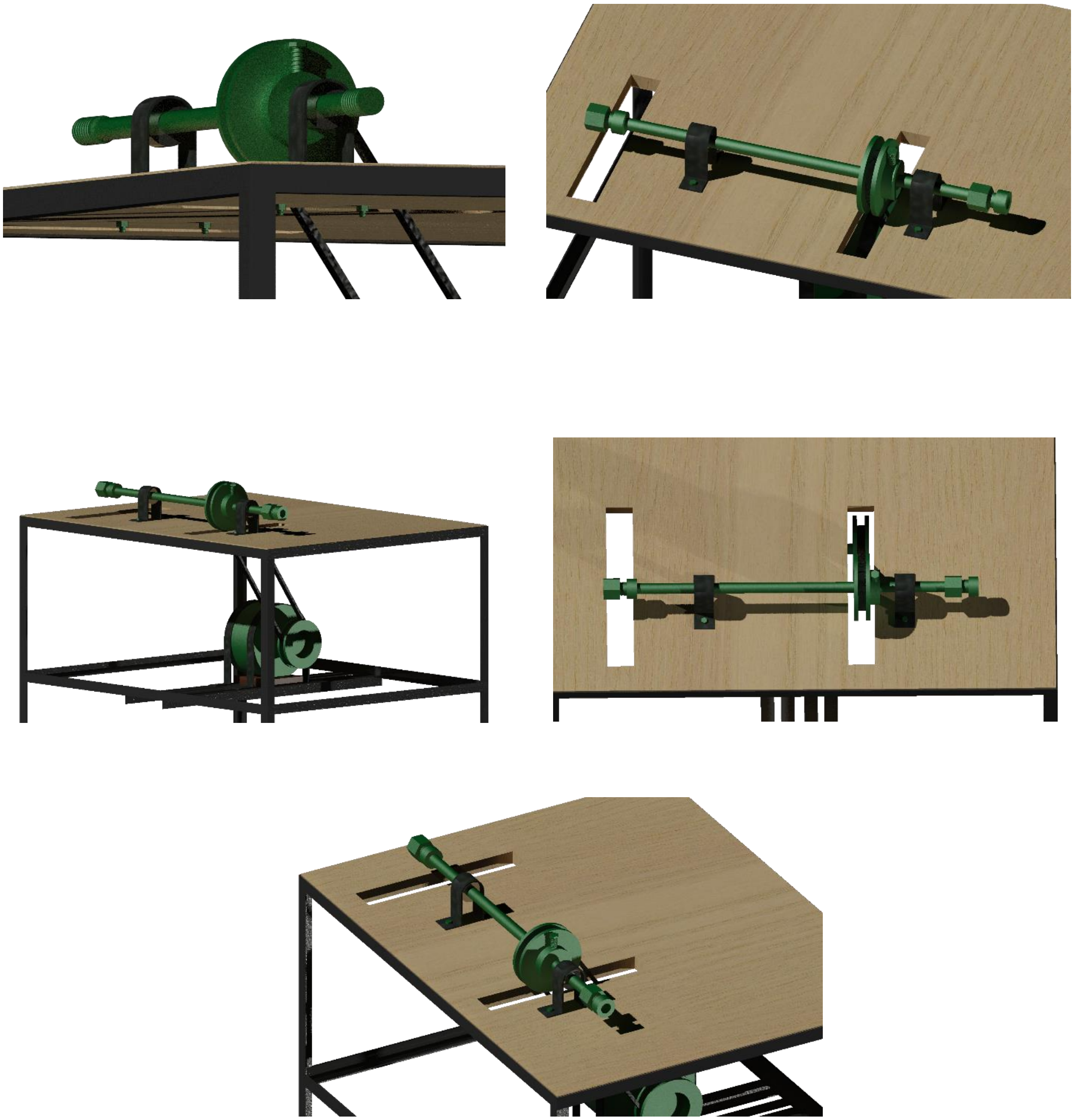


Figure 15: Rendered images from different viewing angle

5

METHODOLOGY

5.1 ATTAINABLE METHODS FOR THIS PROJECT BASED ON OUR LITERATURE REVIEW

- Arranging Multiple Grinding Cutters On Single Shaft
- Arranging Multiple HSS Cutters On Single Shaft
- High density abrasive grinding wheel
- Fixing Milling Cutter On Shaft Of Electric Cutter
- Side Drilling By Drilling Machine
- Gas Cutting Operation
- LASER Cutting
- Punching Operation

5.2 SELECTED METHODS FOR THIS PROJECT

- Arranging Multiple HSS Cutters On Single Shaft
- High density abrasive grinding wheel

5.3 High Density Abrasive Grinding Wheel

Figure 16: Groove cutting by grinding wheel tool

High density abrasive grinding wheel is taken for the experiment. For a metal cutting. The high-density abrasive grinding wheel not reliable due to the very much time consumption, very low cutting rate, time taken for the work done is more so heating is more which cause the defects in the work piece also in grinding wheel.

So, by our experiment on high density abrasive grinding wheel method is not reliable.

5.4 Arranging Multiple Grinding Cutters On Single Shaft

As the photographs shows we arrange the multiple HSS cutters on the single shaft.

Here the arrangement is (1.5+1.5+3) mm

Figure 17: Groove cutting by multiple cutter

5.4.1 COMBINATIONS OF DIFFERENT TYPES CUTTER

1. combination type one cutter:
    - Thickness of cuter: 1.2mm, 1.5mm, 3mm

      Example: photographs in multiple plate groove cutting by one cutter

cutter thickness = 1.2mm

Figure 18: Combination type one cutter

2. **combination type two cutter:**
    - Thickness of cuter: (1.2+1.2) mm, (1.5+1.5) mm, (3+3) mm, (1.5+3) mm

      Example: photographs in multiple plate groove cutting by two cutters

cutter thickness= (3+3) mm, (1.2+1.2) mm, (1.5+1.5) mm

Figure 19: Groove cutting by combination type two cutter

3. combination type three cutter:

   - Thickness of cuter: (1.5+1.5+3) mm, (3+3+1.5) mm

   Example: photographs in multiple plate groove cutting by three cutters

cutter thickness= (1.5+1.5+3)mm

Figure 20: Groove cutting by combination type three cutter

5.5 Cooling Arrangement While Cutting

Figure 21: Work piece plate on cooling arrangement

- Here we provide the water for the cooling purpose by pipeline.
- It reduces the cutting temperature and reduce the effect of distortion in plate due to heat.

5.6 MEASUREMENT OF MOTOR'S AND SHAFT'S RPM

Figure 22: RPM Measurement

As per tachometer reading the electric motor has average 2600 Revolution per minute.

5.7 WORKPIECE MATERIAL USED FOR CUTTING GROOVES

PERFORMED GROOVE CUTTING STEPS IN PLATES:

- PVC plate

  We cut the groove first time in PVC plate with high density abrasive grinding wheel on our designed grinding cutting machine. And we got following result as shown in below photographs.

Figure 23: Grooved PVC plate

- Aluminium plate

Next, we had taken aluminum plate for checking the groove cutting by density abrasive grinding wheel.

Figure 24: Grooved aluminum plate

Aluminum is harder than PVC plate so it takes more time for grooving and from this experiment of cutting groove by density abrasive grinding wheel in harder material than aluminum it takes more time than usual grinding cutting by grinding cutter.

- Iron plate and blocks

Figure 25: Different size grooves in iron plate and blocks

FINALISED MATERIAL USED FOR GROOVE CUTTING:

After going through literature review and research gap we had decided to use (1) Recycled Steel and (2) Magnetic steel. This material is selected based on information is got from visited sites which are fabricators and metal workers.

5.8 Preparation Of Workpiece And Pre-Setting the Metal Job Dimensions

First of all, we had bought metal plates available in different sizes. After that, we have decided the dimension for cutting grooves in thick metal plates. We had cut all plates as per our requirement on our designed grinding cutting setup by our self.


Figure 26: Removing burrs on metal workpiece and prepration of workpiece.

5.8.1 The Metal Job Work Plate Dimensions

Pre- Setted dimensions of multiple thickness of plates are as in below figures.

A. Thickness of Plate= 2mm

Figure 27(a): Workpiece plate of 2mm thickness

Length of plate: 750 mm

Thickness of plate: 2mm

Width of plate: 80mm

B. Thickness of Plate= 3mm

Figure 27(b): Workpiece plate of 3mm thickness

Length of plate: 600 mm

Thickness of plate: 3mm

Width of plate: 60mm

C. Thickness of Plate= 5mm

Figure 27(c): Workpiece plate of 5mm thickness

Length of plate: 510 mm

Thickness of plate: 5mm

Width of plate: 55mm

D. Thickness of Plate= 6mm

Figure 27(d): Workpiece plate of 6mm thickness

Length of plate: 510 mm

Thickness of plate: 5mm

Width of plate: 55mm

6

MEASUREMENT, CALCULATION AND RESULT

6.1 GROOVE MEASUREMENT BY VERNIER SCALE

Formula:

Final reading (Groove size) **=** Main scale + (Vernier scale * Least count)

- We have used Vernier which has Vernier's Least count= 0.02 mm

6.2 CALCULATION EXAMPLES

(A) <u>For 2mm thick plate</u>

(1) Cutter thickness = 1.2 mm

Groove size = 1 + (9 * 0.02)

= 1.2 mm

(2) Cutter thickness = 1.5 mm

Groove size = 2 + (0 * 0.02)

= 2 mm

(3) Cutter thickness = 3 mm

Groove size = 4 + (3.2 * 0.02)

= 4.1 mm

(4) Combination of two cutters = (1.2+1.2) mm

Groove size = 4+ (2.2 * 0.02)

= 4.0 mm

(5) Combination of two cutters = (1.5+1.5) mm

Groove size = 5 + (1 * 0.02)

= 5.0 mm

(6) Combination of two cutter = (1.5+3) mm

Groove size = 6 + (6 * 0.02)

= 6.1 mm

(7) Combination of two cutter = (3+3) mm

Groove size = 7 + (3.3 * 0.02)

= 7.1 mm

(B) <u>For 3 mm thick plate</u>

(1) Cutter thickness = 1.2 mm

Groove size = 1 + (9 * 0.02)

= 1.2 mm

(2) Cutter thickness = 1.5 mm

Groove size = 2 + (9.4 * 0.02)

= 2.2 mm

(3) Cutter thickness = 3 mm

Groove size = 4 + (0 * 0.02)

= 4.0

(4) Combination of two cutters = (1.2+1.2) mm

Groove size = 4+ (0 * 0.02)

= 4.0 mm

(5) Combination of two cutters = (1.5+1.5) mm

Groove size = 5 + (0 * 0.02)

= 5.0 mm

(6) Combination of two cutter = (1.5+3) mm

Groove size = 6 + (6.8 * 0.02)

= 6.1 mm

(7) Combination of two cutter = (3+3) mm

Groove size = 7 + (3.3 * 0.02)

= 7.1 mm

6.3 RESULT TABLE

Setup: Grinding Cutting Machine

Specifications:

1. Motor RPM: 2600
2. Motor HP: 1 HP
3. Cutters used: 1.2mm, 1.5mm, 3mm

Result table:

Cutter thickness (mm)	Groove size	
	For 2mm thick plate	For 3mm thick plate
1.2	1.2	1.2
1.5	2	2.2
3	4.1	4
Combination type 1_two cutters		
1.2+1.2	4	4
1.5+1.5	5	5
1.5+3	6.1	6.1
3+3	7.1	7.1
Combination type 2_three cutters		
1.5+1.5+3	8.1	8.2
3+3+1.5	9.1	9.1
Combination type 3_four cutters		
1.5+1.5+3+3	11.1	11.1

7

APPLICATION BASED WORKING

After performing various groove cutting operation and getting final result table from various configuration of grinding cutters, we had then decided to use our handy grinding cutting machine for application-based metal job working. We had decided to make a structure by our self. We had made structure with our designed machine setup which is also useful to fabricators and metal workers whom we were met at the time of site visit to their workshops for searching research gap.

7.1 PRE-SET METAL JOB WORK PLATE DIMENSIONS

- For a metal Base Plate:
    - Length of plate: 750 mm
    - Thickness of plate: 6mm
    - Width of plate: 50mm
    - Thickness of groove: 8mm
    - Length of groove: 25mm

- **For a metal block:**
    - No. of metal blocks: 4
    - Length of plate: 200 mm
    - Thickness of plate: 6mm
    - Width of plate: 50mm
    - Thickness of groove: 8mm
    - Length of groove: 25mm

7.2 Finalized Groove Cutting Method

In this method multiple cutters are mounted parallel on single shaft. Cutting a groove by a arranging a multiple Grinding cutter on a single shaft is very effective method. By this method groove is easily done and there is no problem of a much heating and vibration also the groove is accurate. so, due to the reliability of this method we will adopt this method for making a model.

7.3 Photographs of metal job Structure

- Metal base plate and blocks

Figure 28: metal base plate 750 mm

Figure 29: 4 metal blocks each of 200 mm

Figure 30: Metal job structure

8

CONCLUSION

This project introduces a handy groove cutter for a fabricators and industries so, this system can be efficiently used anywhere whether it is outdoor or indoor. it will help the workers to cut the groove in any bulky or small size work piece very easily.in a heavy or bulky model for the small groove in other machines is time consuming for fixing and clamping but in this case by the handy groove cutter it can be easily cut by the groove in any position and no need for fixing and clamping so in very less time the work is prepared. So, it is time consuming and very less costly compared to the costly machines. The operation cost of machines is very less compared to other machines like LASER cutting machine, gas cutting, plasma arc cutting. This project reduces the initial cost of the products and increase in the production rate.

9

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6. ScienceDirect database
   www.sciencedirect.com
7. National digital library of India
   www.ndl.iitkgp.ac.in
8. World intellectual property organization for patents
   https://patentscope.wipo.com

9.2 SOFTWARE USED

All softwares used under student licence for this project.

1. Autodesk Fusion 360
2. Autodesk AutoCAD Mechanical
3. 3D Viewer App by Microsoft corporation.

GOVERNMENT ENGINEERING COLLEGE PALANPUR
MECHANICAL ENGINEERING DEPARTMENT
B.E. SEMESTER VIII - PROJECT-II (2181909)

INTERNAL EVALUTION (20) 2019-20

Sr. No.	Criteria / Enrolment No.	Innovativeness / Creativity (4)	Review of Literature / Related Studies (4)	Selection of Proper Tools / Techniques (4)	Content and Presentation (4)	Question and Answers (4)	Total (20)
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2	150610119042	2.6	2.6	2.6	2.6	2.6	13.0
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7	160610119005	3.8	3.8	3.8	3.8	3.8	19.0
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9	160610119007	3.8	3.8	3.8	3.8	3.8	19.0
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11	160610119010	3.8	3.8	3.8	3.8	3.8	19.0
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21	160610119023	3.8	3.8	3.8	3.8	3.8	19.0
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24	160610119026	3.8	3.8	3.8	3.8	3.8	19.0
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30	160610119035	3.8	3.8	3.8	3.8	3.8	19.0
31	160610119036	3.8	3.8	3.8	3.8	3.8	19.0

Handy

32	160610119038	3.4	3.4	3.4	3.4	3.4	17.0
33	160610119039	3.8	3.8	3.8	3.8	3.8	19.0
34	160610119040	3.8	3.8	3.8	3.8	3.8	19.0
35	160610119041	3.8	3.8	3.8	3.8	3.8	19.0
36	160610119042	3.8	3.8	3.8	3.8	3.8	19.0
37	160610119043	3.8	3.8	3.8	3.8	3.8	19.0
38	160610119044	3.8	3.8	3.8	3.8	3.8	19.0
39	160610119045	3.8	3.8	3.8	3.8	3.8	19.0
40	160610119046	3.8	3.8	3.8	3.8	3.8	19.0
41	160610119047	3.4	3.4	3.4	3.4	3.4	17.0
42	160610119048	3.8	3.8	3.8	3.8	3.8	19.0
43	160610119049	3.8	3.8	3.8	3.8	3.8	19.0
44	160610119050	3.8	3.8	3.8	3.8	3.8	19.0
45	160610119051	3.8	3.8	3.8	3.8	3.8	19.0
46	160610119052	3.8	3.8	3.8	3.8	3.8	19.0
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51	160610119057	3.8	3.8	3.8	3.8	3.8	19.0
52	160610119058	3.8	3.8	3.8	3.8	3.8	19.0
53	160610119059	3.8	3.8	3.8	3.8	3.8	19.0
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55	160610119061	3.0	3.0	3.0	3.0	3.0	15.0
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63	170613119009	3.8	3.8	3.8	3.8	3.8	19.0
64	170613119010	3.4	3.4	3.4	3.4	3.4	17.0
65	170613119012	3.4	3.4	3.4	3.4	3.4	17.0
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67	170613119014	3.8	3.8	3.8	3.8	3.8	19.0
68	170613119016	3.4	3.4	3.4	3.4	3.4	17.0

“DESIGN &DEVELOPMENT OF ELECTRO-CHEMICAL DISOLUTION MACHINE”

A PROJECT REPORT

Submitted by

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In fulfillment for the award of the degree
Of

BACHELOR OF ENGINEERING
In

MECHANICAL ENGINEERING

GOVERNMENT ENGIEERING COLLEGE

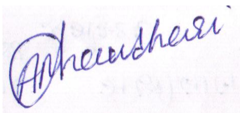
PALANPUR

Gujarat Technological University, Ahmedabad
APRIL 2019

CERTIFICATE

Date: 20/04/2020

This is to certify that the Project entitled **"DESIGN AND DEVELOPMENTOF ELECTRO CHEMICAL DISOLUTION MACHINE"** have been carried out by BAROT BHAVIK P.(160613119001),DHOKE SWAPNIL M.(140613119004),RAMI DHRUMIT S.(160613119013),TAILYSAHU KARTIK J.(150613119011) and SANDHI AAKIB S.(160610119014) under my guidance in fulfilment of the degree of Bachelor of Engineering in MECHANICAL ENGINEERING (8th Semester) of Gujarat Technological University, Ahmedabad during the academic year 2018-2019.



GUIDE

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DEPARTMENT

HEAD OF DEPARTMENT

Dr. J.A.VADHER

MECHANICAL ENGINEERING

DEPARTMENT

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It is a matter of great pleasure and privilege to have this Project report entitled: **"DESIGN AND DEVELOPMENTOF ELECTRO CHEMICAL DISOLUTION MACHINE"** With a deep sense of gratitude, we wish to express sincere thanks to our honourable guide **Prof. A.R.CHAUDHARY** (Mechanical Engineering Department, Government Engineering College, Palanpur). We are fortunate to be given the opportunity of working under him. In spite of a tight schedule, he always found time for our difficulties and patiently answered to all our queries. It is a pleasure to mention **Dr. K.B.JUDAL** Principal of our college and **Dr. J.A.VADHER** Head of the Mechanical Engineering Department who gave us tremendous help by providing necessary guidance for our final year projects.

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ABSTRACT

The Electrochemical Machining (ECM) is a non-traditional machining (NTM) process belonging to Electrochemical category. ECM is opposite of electrochemical or galvanic coating or deposition process. Thus ECM can be thought of a controlled anodic dissolution at atomic level of the work piece that is electrically conductive by a shaped tool due to flow of high current at relatively low potential difference through an electrolyte which is quite often water based neutral salt solution.

KEYWORDS:

ELECTROLYTE, TOOL, PUMPS, FILTRATION AND STORAGE TANKS,COLLET

TABLE OF CONTENT

1

INTRODUCTION

1.1 INTRODUCTION

The process of metal removal by electro chemical dissolution was known as long back as 1780 AD but it is only over the last couple of decades that this method has been used to advantage. It is also known as contactless electrochemical forming process. The noteworthy feature of electrolysis is that electrical energy is used to produce a chemical reaction, therefore, the machining process based on this principle is known as Electrochemical machining (ECM). This process works on the principle of of Faraday's laws of electrolysis.

Michael Faraday discovered that if the two electrodes are placed in a bath containing a conductive liquid and DC potential (5-25V) is applied across them, metal can be depleted from the anode and plated on the cathode. This principle was in use for long time. ECM is the reverse of the electroplating.

ECM can be thought of a controlled anodic dissolution at atomic level of the work piece that is electrically conductive by a shaped tool due to flow of high current at relatively low potential difference through an electrolyte which is quite often water based neutral salt solution. In ECM, Electrolyte is so chosen that there is no plating on tool and shape of tool remains unchanged. If the close gap (0.1 to 0.2mm) is maintained between tool and work, the machined surface takes the replica of tool shape.

1.2 PROBLEM:

In small manufacturing companies it is hard for them to buy fully automatic ECM machines so we are making a mechanism which can help them and which is easy to use and it can done surface finish and it is very economic.

1.3 OBJECTIVE:

Reduce cost for surface finish of metal rods and it can simply give good surface finishing for various sizes metal rods with the use of ECM Process. We are want to increase the surface roughness and surface finish by small amount of cost and by using unconvensional process.

1.4 APPLICATION

- Improve Surface Roughnace
- Improve MRR

2

COMPONENTS

2.1 Components of Electro Chemical Disolution Machine

Different components are:

1. Copper Electrode
2. Aluminium Ring
3. Electric Motor
4. Pump
5. Collet
6. Base Frame
7. Flow Control Valve

Main components of the system

- Copper Electrode
- Flow Controll valve
- Aluminium Ring
- Electrolyte
- Motor and Pump

2.2 Power Supply System

During ECM, a high value of direct current (may be as high as 40000 A) and a low value of electric potential (in range of 5-25 V) across IEG(Interelectrode gap) is desirable. The highest current density achieved so far is around 20,000 A/cm2. Hence , with the help of a rectifier and a transformer, three phase AC is converted to a low voltage, high current DC. Silicon controlled rectifier (SCRs) are used both for rectification as well as for voltage regulation because of their rapid response to the changes in the process load and their compactness. Voltage regulation of ± 1% is adequate

Non Traditional Machining Processes S5MEComplied by: Jagadeesha T, Assistant Professor, National Institute of Technology, Calicut. Page 5 for most of the precision ECM works. However, lack of process control, equipment failure, operator's error, and similar other reasons may result in sparking between tool and work. The electrical circuitry detects these events and power is cut off (using the device like SCRs) within 10 micro seconds to prevent the severe damage to the tool and work. In case of precision works even a small damage to an electrode is not acceptable. It may be minimized by using a bank of SCRs placed across the DC input to ECM machine.

Fig.2.1 DC Power Supply

2.3 Electrolyte supply and Cleaning system:

The electrolyte supply and cleaning system consisting of a pump, filter, pipings, control valves, heating or cooling coils, pressure gauges, and a storage tank (or reservoir). Electrolyte supply ports may be made in the tool, work or fixture, depending upon the requirement of the mode of electrolyte flow. Small inter electrode gap, usually smaller than 1mm, should be maintained for achieving High MRR and high accuracy. For this purpose, smooth flow of electrolyte should be maintained and any blockade of such a small gap by particles carried by electrolyte, should be avoided. Hence, electrolyte cleanliness is imperative. It is normally done with the help of filters made of SS steel, Monel or any other anticorrosive material.

It should be ensured that the piping system does not introduce any foreign material like corroded particles, scale or pieces of broken seal material. Piping system is therefore made of SS steel, Glass fibre reinforced plastic (GFRP), plastic lined MS or similar other anti corrosive material. The required minimum capacity of electrolyte tank is 500 gallons for each 10000 A of current. ECM is supposed to machine different metals and alloys at optimum machining conditions and with varying requirements of accuracy, surface texture, etc. Under such situations, a single tank system is not recommended because of loss of time and wastage of electrolyte during drilling cleaning, mixing or filling of new electrolyte in the tank. It results in higher cost and poor accuracy of electro chemically machined surface and also poor control of operating conditions. More than one tank therefore, can be used and their number would depend upon the range of electrolytes needed to meet the work load.

2.3.1 PUMP:

Single or multi-stage centrifugal pumps are used on ECM equipment. A minimum flow rate 15 litres/ min per 1000 A electrolyzing current is generally required. A pressure of 5-30 kg/cm2 meets most of the requirements.

Fig. 2 Pump

2.3.2 Pipe

The Pipe are use to connect the Electrolight tank to Pump and also to connect pump to Electrode. The main work of Pipe is to flow require amount of Electrolight to Electrode with help of Pump. We used Flexible pipe instant of any pipe due to reduce lossees in Pressure .

Fig.3 Pipe

2.3.3 Flow Control Valve

Flow control valve is used to regulate the flow of Electrolite

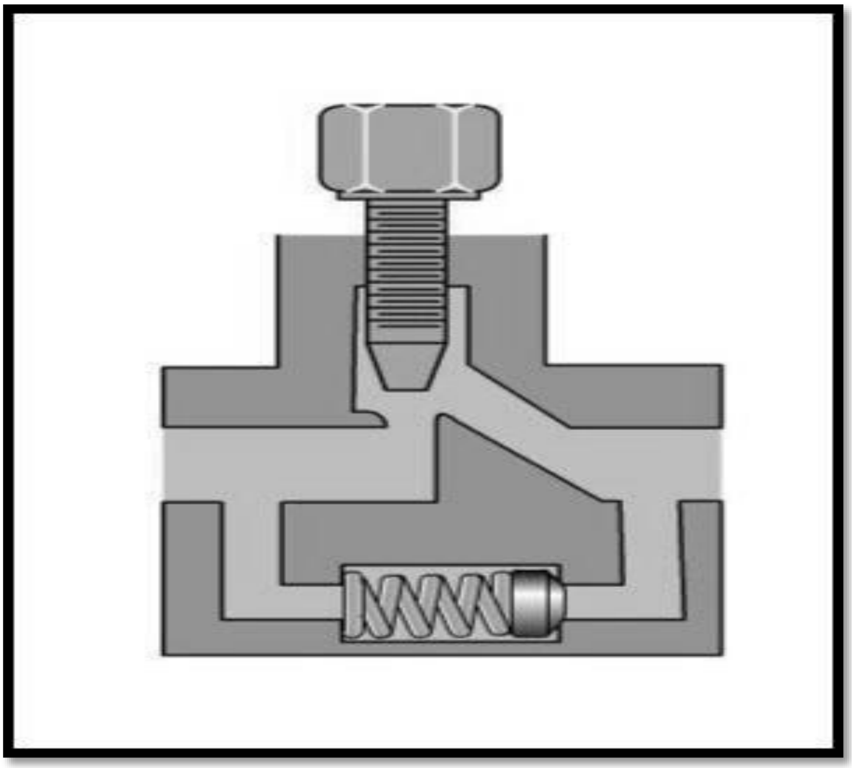

Fig 2.4: Flow Control Valve

2.3.3 Base Reservoir

There are main Three thank we have to use in our Project .First one is to Store the electrolyte, Second one as a working Tank where our Operation id Done in actual, and Third one as a extra tank where our worked Electrolyte is Store. Here We used three tank because this is a chemical Process so here we can not use one Electrolyte at many time so we have to use more than one tank. We use MS as a tank material because any other material can com[pose with this electrolyte which is not feasible for our Project point of view.

Tank Dimension and Material are given below,

1) Working Tank –

L*B*H = 700*300*400

2)Storage Tank –

Storage tank are used for store the require amount of Electrolyte during Operation .As we know the material of Tank are MS.

L*B*H=500*210*300

.

2.4 Tool and Tool Feed system

Use of anti corrosive material for tools and fixtures is important because they are required for a long period of time to operate in the corrosive environment of electrolyte. High thermal conductivity and high thermal conductivity are main requirements. Easy machining of tool material is equally important because dimensional accuracy and surface finish of the tool directly affect the work piece accuracy and surface finish. Aluminum, Brass, Bronze, copper, carbon, stainless steel and monel are a few of the material used for this purpose. Further, those areas on the tool where ECM action is not required, should be insulated. For example, lack of insulation on the sides of die sinking tool causes unwanted machining of work and results in a loss of accuracy of the machined work piece. Use of non – corrosive and electrically non conducting material for making fixtures is recommended. Also, the fixtures and tools should be rigid enough to avoid vibration or deflection under the high hydraulic forces to which they are subjected

2.4 Work piece and work holding system

Only electrically conductive material can be machined by this process, The chemical properties of anode (work) material largely govern the material removal rate (MRR). Work holding devices are made of electrically non conductive materials having good thermal stability, and low moisture absorption properties, For Example, graphite fibres reinforced plastics, plastics, Perspex,etc., are the materials used for fabricating the work holding device.

3

WORKING PRINCIPLE

The following figure shows general layout for the machine.

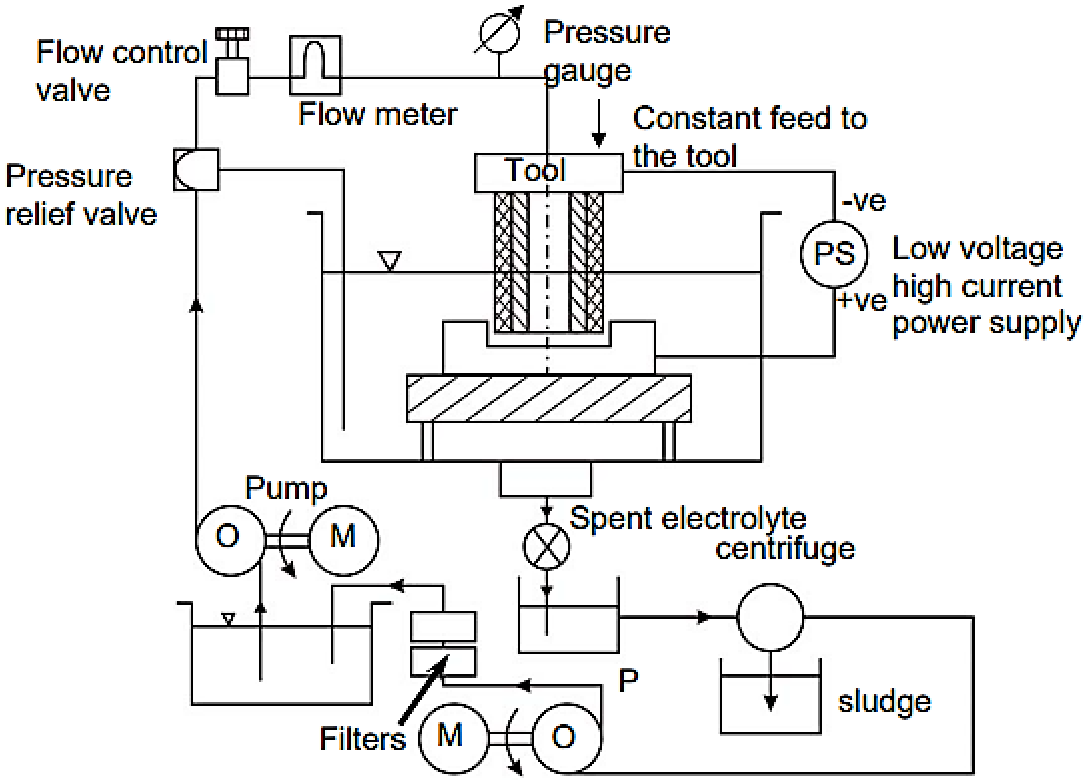

Figure 4.1: General Layout

The electrochemical machining system has the following modules:

- Power supply
- Electrolyte filtration and delivery system
- Tool feed system
- Working tank

Electrochemical Machining (ECM) is a non-traditional machining (NTM) process belonging to Electrochemical category. ECM is opposite of electrochemical or galvanic coating or deposition process. Thus ECM can be thought of a controlled anodic dissolution at atomic level of the work piece that is electrically conductive by a shaped tool due to flow of high current at relatively low potential difference through an electrolyte which is quite often water based neutral salt solution. Fig. 1 schematically shows the basic principle of ECM.

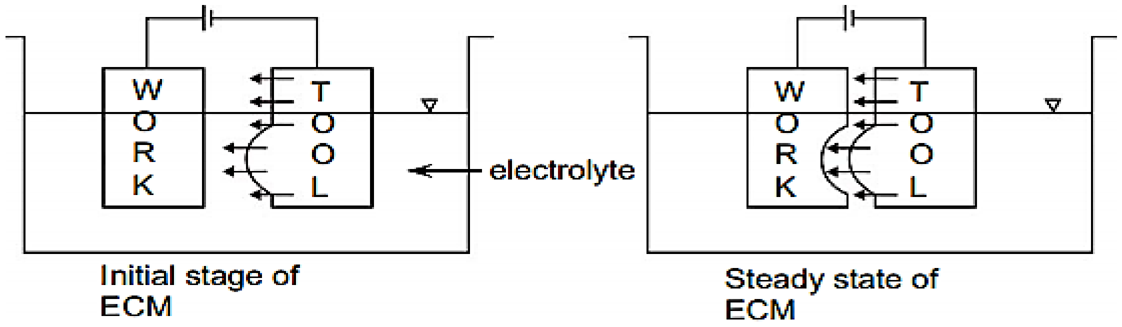

Fig. 1 Schematic principle of Electro Chemical Machining (ECM)

- **Chemistry of Process.**

During ECM, there will be reactions occurring at the electrodes i.e. at the anode or work piece and at the cathode or the tool along with within the electrolyte.

Let us take an example of machining of low carbon steel which is primarily a ferrous alloy mainly containing iron. For electrochemical machining of steel, generally a neutral salt solution of sodium chloride (NaCl) is taken as the electrolyte. The electrolyte and water undergoes ionic dissociation as shown below as potential difference is applied

$$NaCl \leftrightarrow Na^+ + Cl^-$$

$$H_2O \leftrightarrow H^+ + (OH)^-$$

As the potential difference is applied between the work piece (anode) and the tool (cathode), the positive ions move towards the tool and negative ions move towards the work piece. Thus the hydrogen ions will take away electrons from the cathode (tool) and from hydrogen gas as

$$2H^+ + 2e^- = H_2 \uparrow \text{at cathode}$$

Similarly, the iron atoms will come out of the anode (work piece) as:

$$Fe = Fe^{++} + 2e^-$$

Within the electrolyte iron ions would combine with chloride ions to form iron chloride and similarly sodium ions would combine with hydroxyl ions to form sodium hydroxide

$$Na^+ + OH^- = NaOH$$

In practice FeCl2 and Fe(OH)2 would form and get precipitated in the form of sludge. In this manner it can be noted that the work piece gets gradually machined and gets precipitated as the sludge. Moreover there is not coating on the tool, only hydrogen gas evolves at the tool or cathode. Fig. 2 depicts the electro-chemical reactions schematically. As the material removal takes place due to atomic level dissociation, the machined surface is of excellent surface finish and stress free

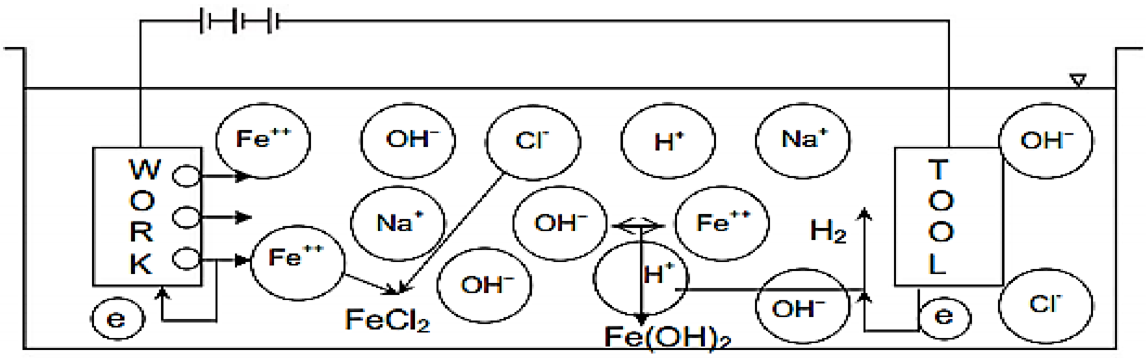

Fig. 2 Schematic representation of electro-chemical reactions

Summary of cathode and anode reaction is given below

Cathode Reaction

Na+ + e- = Na

Na+H20 = Na(OH)+H+

2H++2e- =H2 ↑

It shows that there is no deposition on tool but only gas is formed, whereas, in cathode in machining an iron.

Anode Reaction

Iron (Fe) ↔ Fe++ + 2e-

Fe++ +2cl-↔ Fecl2

Fe++ +2(OH)-↔ Fe(OH)

Fecl2 +2(OH)-↔ Fe(OH)2 +2cl-

It shows that metal (work piece) i.e. Fe goes into solution and hence machined to produce reaction products as iron chloride and iron-hydroxide as a precipate. Interesting part is that the removal is an atom by atom, resulting in higher surface finish with stress and crack free surface, and independent of the hardness of work material. Smaller the interlectrode gap(IEG) the gap, greater will be the current flow because resistance decreases and higher will be rate of metal removal from the anode. Higher current density, in small spacing(usually about 0.5mm or less) , promotes rapid generation of reaction products.

The voltage is required to be applied for the electrochemical reaction to proceed at a steady state. That voltage or potential difference is around 2 to 30 V. The applied potential difference, however, also overcomes the following resistances or potential drops.

They are:

• The electrode potential

• The activation over potential

• Ohmic potential drop

• Concentration over potential

• Ohmic resistance of electrolyte

Fig. 3 shows the total potential drop in ECM cell.

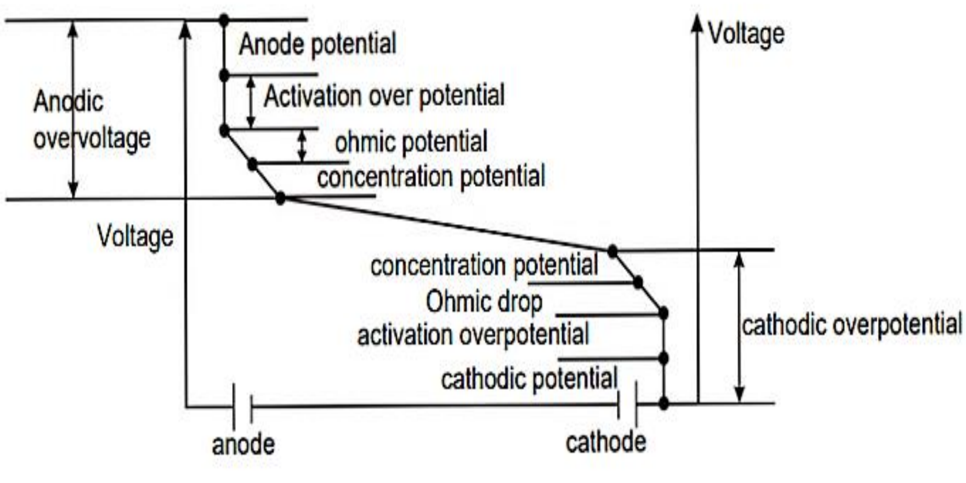

Fig. 3 Total potential drop in ECM cell

- **Process Parameter**

- Tool -Copper, brass or steel
- Power supply- 2-35 DC volt
- Current -50-40,000 amp 7
- Material removal rate- 1600 mm3/min
- Specific power consumption- 7w/mm3/min
- Electrolytic solution -NaCl and NaNO3 solution
- Accuracy and surface finish -0.02 mm, 0.4µm
- Feed Rate -0.5 mm/min to 15 mm/min
- Overcut- 0.2 mm to 3 mm
- Surface roughness-Ra 0.2 to 1.5 µm

4

DESIGN CONSIDERATION

4.1Design Procedure

4.1.1Material Selection

To prepare any machine part, the type of material should be properly selected, considering design and safety .The selection of material for engineering application is given by the following factors:-

1) Availability of materials
2) Suitability of the material for the required components.
3) Cost of the materials.

The machine is basically made up of mild steel. The reasons for the selection are Mild steel is readily available in market .It is economical to use and is available in standard sizes. It has good mechanical properties i.e. it is easily machinable. It has moderate factor of safety, because factor of safety results in unnecessary wastage of material and heavy selection. Low factor of safety results in unnecessary risk of failure. It has high tensile strength. Low coefficient of thermal expansion. The materials of the sheets to be cut are taken as aluminium and plastic as they are replacing many metals in the present scenario because of their distinguished properties and features.

4.1.1Metal removal rate Calculation

During ECM, metal from the anode (or work piece) is removed atom by atom by removing negative electrical charges that bind the surface atoms to their neighbors. The ionized atoms are then positively charged and can be attracted away from the work piece by an electric field. In an electrolytic cell (ECM cell) material removal rate is governed by Faraday’s law of electrolysis.

The amount of chemical change produced by an electric current (or the amount of substance deposited or dissolved) is proportional to the quantity of electric charges passed through electrolyte.

$$W \propto Q$$

The amount of different substances deposited or dissolved by the same quantity of electricity are proportional to their Electro chemical equivalent weights.(ECE)

$$W \propto ECE;$$

$$ECE = M/v$$

Where M is the atomic weight and v is the valency.

These laws can be expressed in mathematical form as follows:

MRR

$$W = 1/F(ECE).Q$$

$$MRR = 1/F(M/v)I\ t$$

Where F is the faraday’s constant=96500 coulombs =26.8amp-hr, Q is the charge (0coloumb), I the current (ampere) and t is the dissolution period. This equation is based on number of simplified assumption and does not account for the effect of some of significant process variables, namely, changes in valency of electrochemical EC dissolution during the operation, gas evolution and bubble formation, electrolyte electrical conductivity and temperature variation along the electrolyte fow path, over potential m presence of passivation film etc. Passivity arises as a result of chemical and electro chemical behavior of metals which results in the formation of protective film on their surfaces. Further, dissolution of iron in Nacl solution, depending upon the machining conditions, may be either in the form of ferrous hydroxide or ferric hydroxide. Mode of dissolution during machining if alloys, is still more difficult to know. The preferential valency mode of dissolution has been found to depend upon the electrolyte flow rate, IEG and length of electrolyte flow path.

4.2 Specifications

1. Base Reservoir

Quantity: 1

Total Length: 700mm

Total Width : 300 mm

Total Height : 400 mm

Material : MS

2. FCV Valve:

    Quantity: 1

    Operation: Manual

    Type: Hand Lever, Detent Type

    Number of Ports: 2

3. Pneumatic Pipe

    Quantity: 2000mm

    Diameter: 5mm

    Thickness: 0.3mm

4. Fixing Bolts-

    Quantity: 5

    Length: 25mm

    Size: M6

5. Aluminium Ring -

    Quantity: 1

    Diameter: 150mm

    Material: Aluminium AL6061

6. Copper Electrode :

    Quantity: 1

    L*B*H: 30*30*6

    Material: Copper

4.3 CONSTRUCTION

Raw Material Used

1. Mild Steel Plates for base frame.
2. Copper for Electrode.
3. Aluminium 6061 for Ring.

Machines & Tools Used

1. Cutting Machine.
2. Sensitive Drilling Machine.
3. Horizontal Milling Machine.
4. .EDM
5. Table Grinder.
6. VMC
7. Surface Grinding Machine.

4.4 DRAWINGS

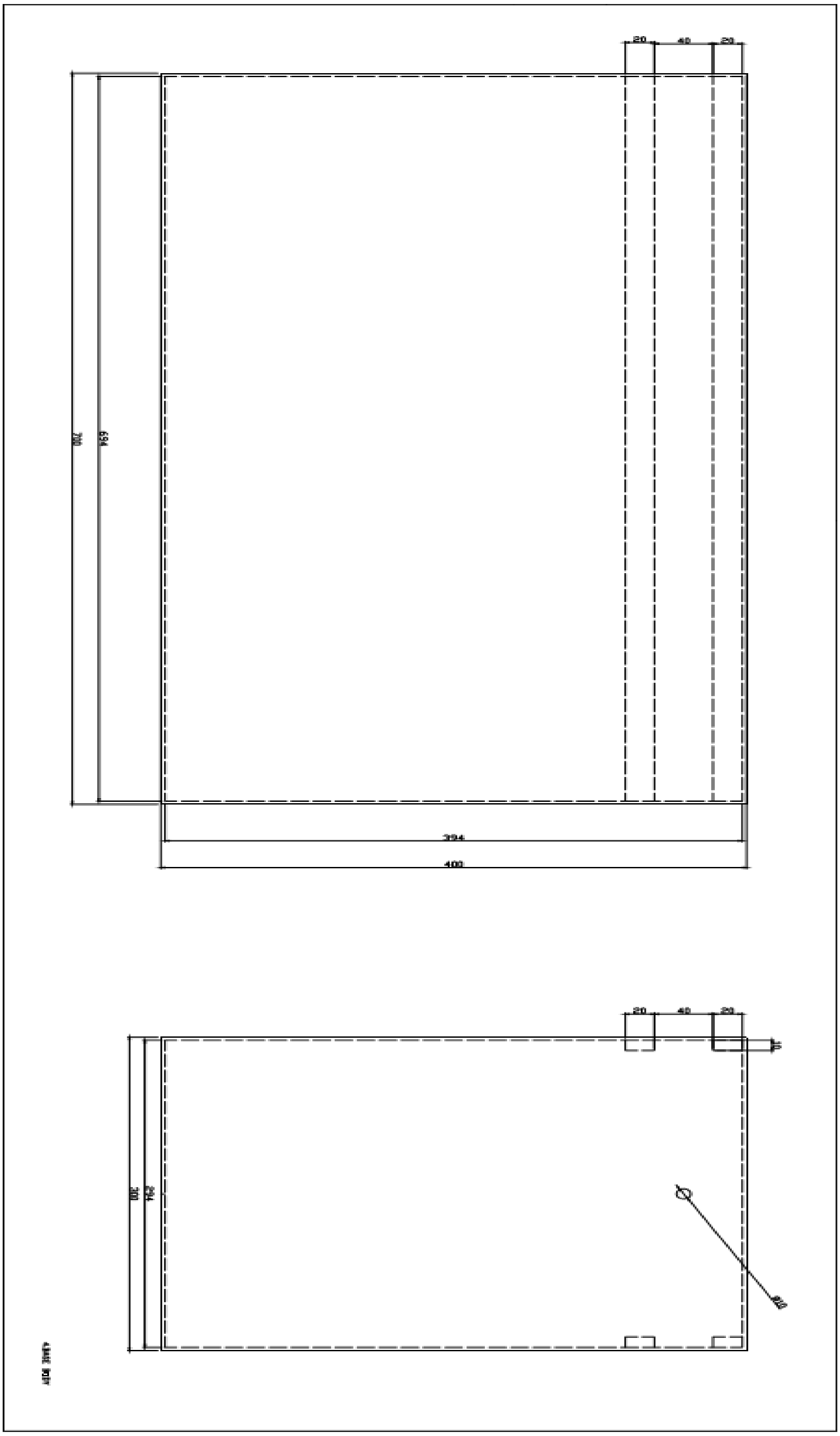

Fig 4.1: Base Frame Drawing

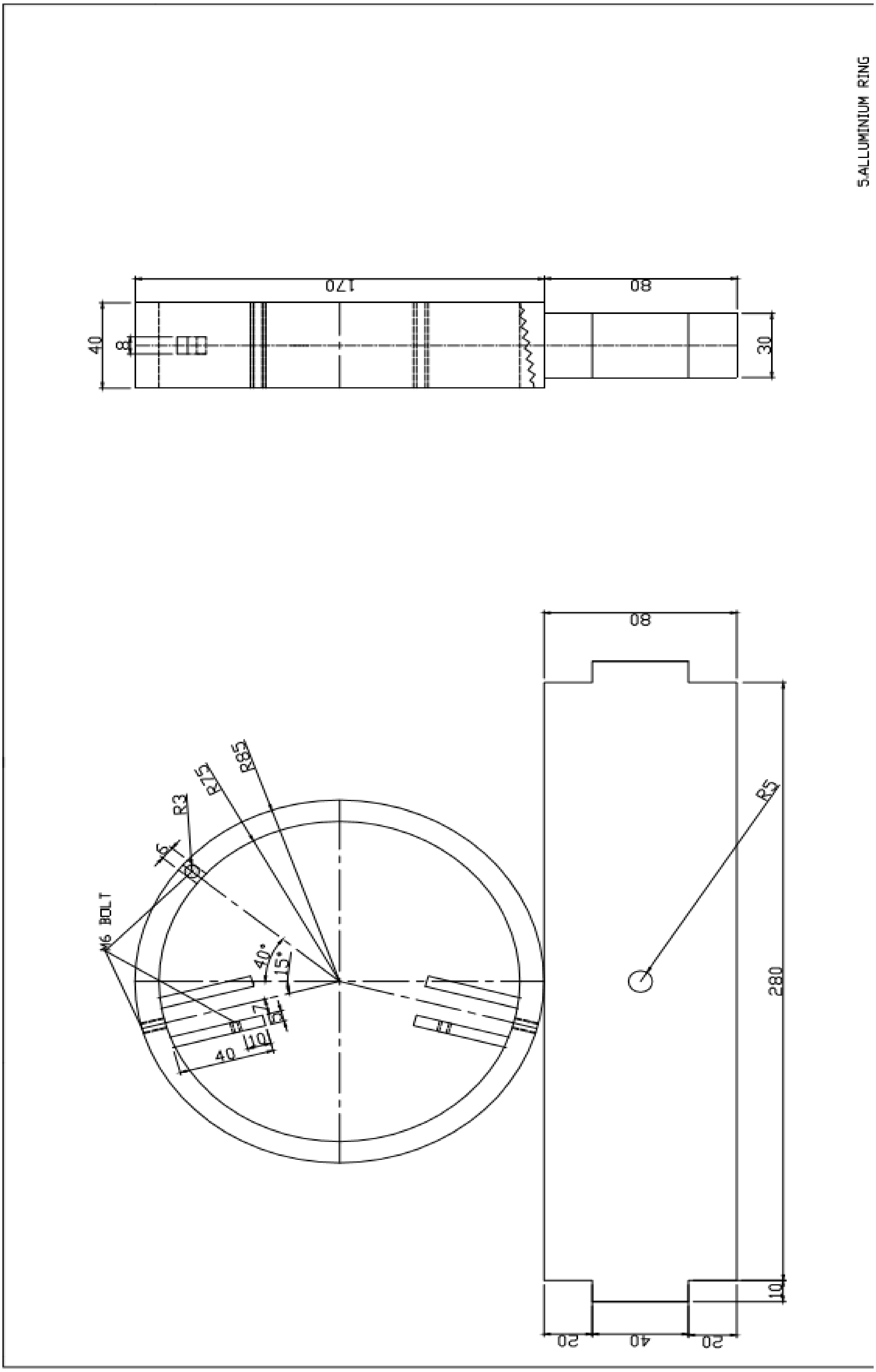

Fig 4.2: Aluminium Ring Drawing

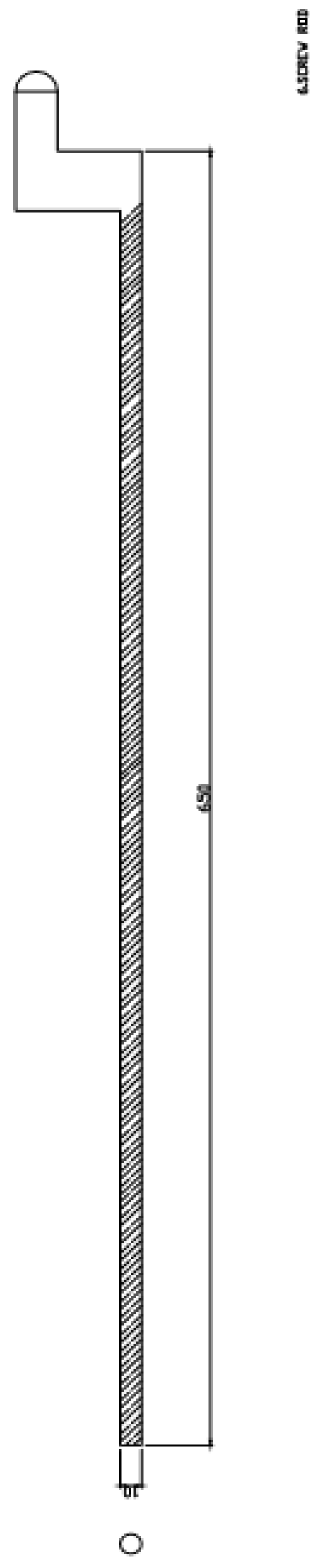

Fig 4.3: MS rod Drawing

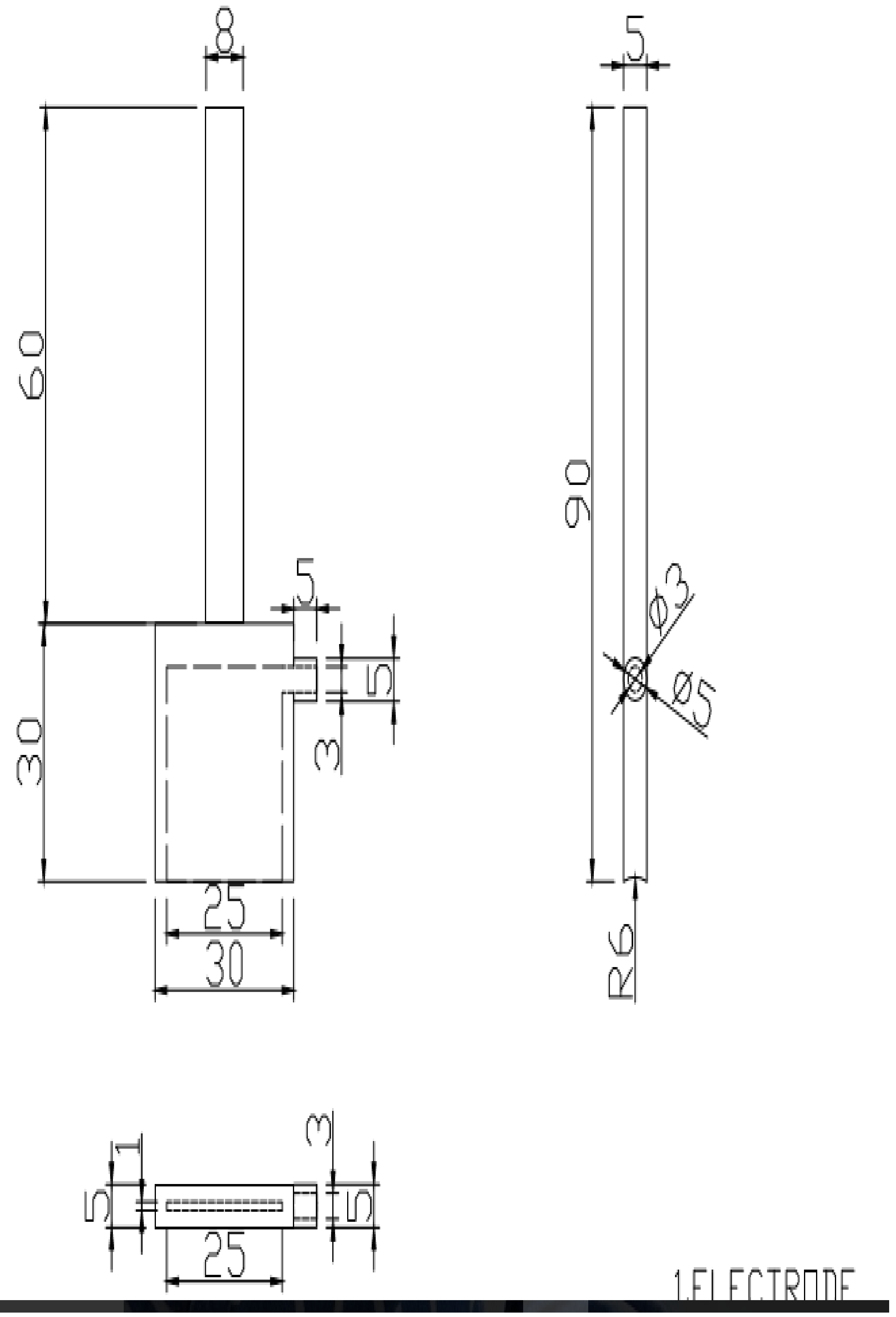

Fig 4.4: Electrode Drawing

4.8 PROCESS SHEET

Sr. No.	Part Name	Material	Quantity	Process	Equipment
1	Frame	Mild Steel	1	Cutting	Cutting machine
				Grinding	Table Grinder
				Welding	Electric arc welding machine
				Grinding	Hand grinder
				Paint	Hand brush
2	Electrode	copper	1	Milling	EDM machine
3	Aluminium Ring	AL6061	1	Cutting	VMC
				Grinding	Table grinder
				Drilling	Sensitive drilling machine
				Welding	Electric arc welding machine
4	Connecting Rod	Mild steel	3	Cutting	Cutting Machine
				Grinding	Table Grinder
				Threding	Lathe Machine

Table 5.2: Process Sheet

4.9 COST SHEET

SR NO	PART NAME	MATERIAL COST	MANUFACTURING COST	TOTAL COST
01	Copper Electrode	280	1600	1880
02	Aluminium Ring	2440	3500	5940
03	Pipe with FCV	600	-	600
04	AC/DC Convertor	4484	-	4484
05	Chuck	1400	-	1400
06	Wire	60	-	60
07	Base Frame	5500	2000	7500
08	ELECTROLYTE	800	-	800
09	MOTOR	1200	-	1200
10	PUMP	500	-	500
11	SCREW	60	-	60
-	-	-	-	-
	TOTAL			**=24424 rs**

5

ADVANTAGES, DISADVANTAGES AND APPLICATIONS

5.1 ADVANTAGES

ECM offers impressive and long lasting advantages.

1.ECM can machine highly complicated and curved surfaces in a single pass.

2.A single tool can be used to machine a large number of pieces without any loss in its shape and size. Theoretically tool life is high

3.Machinability of the work material is independent of its physical and mechanical properties. The process is capable of machining metals and alloys irrespective of their strength and hardness.

4.Machined surfaces are stress and burr free having good surface finish 5.It yields low scrap, almost automatic operation, low overall machining time, and reduced inventory expenses.

6.There is no thermal damage and burr free surface can be produced.

5.2 DISADVANTAGES

1. High capital cost of equipment
2. Design and tooling system is complex
3. Hydrogen libration at the tool surface may cause hydrogen embrittlement of the surface.
4. Spark damage may become sometimes problematic
5. Fatigue properties of the machined surface may reduce as compared to conventional techniques (by 20%)
6. Non conductive material cannot be machined.
7. Blind holes cannot be machined in solid block in one stage
8. Corrosion and rust of ECM machine can be hazard
9. Space and floor area requirement are also higher than for conventional machining methods.

Some additional problems related to machine tool requirements such as power supply, electrolyte handling and tool feed servo systems.

5.3 APPLICATIONS

1.ECM can be used to make disc for turbine rotor blades made up of HSTR alloys
2.ECM can be used for slotting very thin walled collets
3.ECM can be used for copying of internal and external surfaces, cutting of curvilinear slots, machining of intricate patterns, production of long curved profiles, machining of gears and

chain sprockets, production of integrally bladed nozzle for use in diesel locomotives, production of satellite rings and connecting rods, machining of thin large diameter diaphragms.

4.ECM principle has be employed for performing a number of machining operations namely, turning, treplaning, broaching, grinding, fine hole drilling, die sinking, piercing, deburring,plunge cutting etc.

5.ECM can also be used to generate internal profile of internal cams.

5

CONCLUSION

Now we know that machine is very cheap as compared to hydraulic sheet metal cutting machine. The finishing of the workpiece is very good. This machine is advantageous to small industries as they cannot afford the expensive machine.

This project introduces a study develops surface roughness models for two different parameters namely voltage and feed rate for ECM process of mild steel as work piece and copper as tool material using response surface method . The second-order response models have been developed with analysis of variance . From the above experiment and graph it is seen that surface roughness is minimum at the optimal value of voltage and feed. As we increase the voltage and feed rate surface roughness also increases .Hence an optimum value of voltage i.e. 7.5v and feed rate of 0.2 mm/min is most suitable and significant for the minimum value of surface roughness and good quality of the work piece

6

FUTURE SCOPE

1. It will be helpful for small industries who can not effort heavy machine

2. The Finishing of the work piece is good and it desirable for manufacturing companies.

Therefore in future there are measure such a large amount of modifications that we will create to survive the large global world of competition.

7

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GOVERNMENT ENGINEERING COLLEGE PALANPUR
MECHANICAL ENGINEERING DEPARTMENT
B.E. SEMESTER VIII - PROJECT-II (2181909)

INTERNAL EVALUTION (20) 2019-20

Sr. No.	Criteria Enrolment No.	Innovativeness / Creativity (4)	Review of Literature / Related Studies (4)	Selection of Proper Tools / Techniques (4)	Content and Presentation (4)	Question and Answers (4)	Total (20)
1	150610119015	3.8	3.8	3.8	3.8	3.8	19.0
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65	170613119012	3.4	3.4	3.4	3.4	3.4	17.0
66	170613119013	3.8	3.8	3.8	3.8	3.8	19.0
67	170613119014	3.8	3.8	3.8	3.8	3.8	19.0
68	170613119016	3.4	3.4	3.4	3.4	3.4	17.0

Society Based Project

"*DEVELOPMENT OF INTELLIGENT WHEELCHAIR*"

A PROJECT REPORT

Submitted by

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NAI NITIN C.	(150613119005)
RANAVASIYA MEHUL B.	(150613119010)
RAVAL VIJAY S.	(150613119011)
THAKOR AJITSINH U.	(130610119059)

In fulfillment for the award of the degree
Of

BACHELOR OF ENGINEERING
In

MECHANICAL ENGINEERING

GOVERNMENT ENGIEERING COLLEGE

PALANPUR

Gujarat Technological University, Ahmedabad

APRIL 2018

CERTIFICATE

Date: 23/04/2018

This is to certify that the Project entitled ***"DEVELOPMENT OF INTELLIGENT WHEELCHAIR"*** have been carried out by CHELANI KULDIP K.(150613119001),NAI NITIN C.(150613119005),RANAVASIYA MEHUL B.(150613119010),RAVAL VIJAY S.(150613119011) and THAKOR AJITSINH U.(130610119059) under my guidance in fulfillment of the degree of Bachelor of Engineering in MECHANICAL ENGINEERING (8th Semester) of Gujarat Technological University, Ahmadabad during the academic year 2017-18.

GUIDE

PROF. N. A. PATEL

MECHANICAL ENGINEERING DEPARTMENT

HEAD OF DEPARTMENT

DR. J.A.VADHER

MECHANICAL ENGINEERING DEPARTMENT

ACKNOWLEDGEMENT

The working on this project is not an easy task for us. The project is manufacturing based project and huge manufacturing and material knowledge is required. In accomplishing this goal many personals gave the helping hand for us. We would like to appreciate their guidance and encouragement.

First of all we would like to thank our Guide **Prof. N. A. Patel**, of Mechanical Engineering Department who is the supervisor of the project, gave us a fabulous help and Guidance. It is a pleasure to mention **Dr. K.B.JUDAL** Principal of our college and **DR.J.A.VADHER**, Head of the Mechanical Engineering Department who gave us tremendous help by providing necessary guidance.

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ABSTRACT

How far we think about the people who are handicapped by birth, old age people and some accidental cases seen helpless. All the wheelchairs in the market till market till now are not useful for the people whose limbs are not working. They are not involved in the national progress and not only this they are burden for others. The people who have his kind of disability are not able to perform their everyday actions. Due to dependence on others, a person loses their confidence and desire to live their life independently. With the help of this wheelchair they become able to be a bit independent. This research paper introduces the design and implementation of a novel hands free control system for intelligent wheel chair. This is achievement for those whose limbs are not working and who are blind because it works with the movement of head. It's a god's gift for them because independent in some field. Basically my achievement is their happiness. Novel hands-free control system follow by accelerometer wheelchair and it works on real time basis.

TABLE OF CONTENT

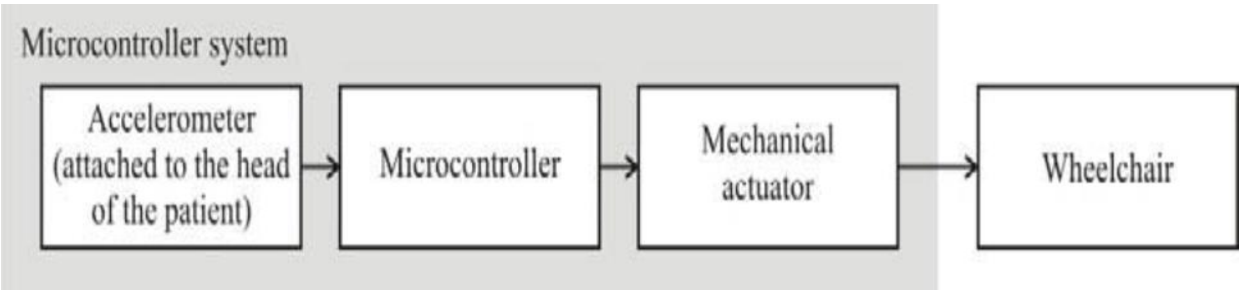
LIST OF FIGURES

1

INTRODUCTION

Most of us do not know about this but there is a type of disability in person who are not able to use any of their limbs. This kind of disability is called quadriplegia and the person with this disability is called quadriplegics.There are several reason for this kind of disability and decreased motion i.e. stoke, high blood pressure ,degenerative disease of bones and joints and cases of paralysis and birth defect. Sometimes it is also due to accidents and age. The persons with disability are not able to perform their daily activities. According to the level of disability a person can get his ability of movement by using medical equipments. Many types of wheelchairs are in market currently most of them work with joystick driven. But they are not up to the mark for elderly people. Some hands free are also introduced with work by the movement of head, eye tracking, eye blinding etc. But they also affected by the noise and light around the person. By the noise and light around the person, By the use of eye tracking and blinking the eye sight also affect. Two medical devices with electronic system are introduced to improve the ability of the person inside and outside conditions.

Block diagram



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1.1 PROBLEM STATEMENT

"Comfort" is main aspect of people. Most of us do not know about the type of disability in person who is not able to use any of their limbs. This kind of disability is called quadriplegia and the person with this disability is called quadriplegics .There are several reason for this kind of disability and decreased motion i.e. stoke, high blood pressure ,degenerative disease of bones and joints and cases of paralysis and birth defect. Sometimes it is also due to accidents and age.

To overcome these problems the thought of developing this project come for the paralyzed persons and some accidental cases persons.

We have surveyed in our society about this project they had given us lots of positive response about this project. They have said that the main advantage of this project is easy to operate and very less physical effort. Paralyzed or handicapped person can move with our project and successfully solved this purpose without any difficulty.

So, a thought of taking responsibility of society came our project "*DEVELOPMENT OF INTELLIGENT WHELCHAIR"*

1.2 OBJECTIVE OF PROJECT

The main object of this project is to make a wheelchair for the persons who are suffered from disability of movement which will consist a totally automated system for easy movement.we are making real product of intelligent wheelchair driven by accelerometer.

Fig 1.1 Ordinary Wheelchair

1.3 SCOPE OF PROJECT

We are inspired from the paralyzed person in society which are suffering from disability of movement. In this developed smart powered wheelchair we provide the accelerometer which is mounted on the head to recognize the movement of the head. The movement of head like forward, backward, right and left done to move the wheelchair respectively the direction. Now the microcontroller read the command of accelerometer to give command to the mechanical actuators to work as per the given command.

The mechanical actuators like DC geared motor will rotate the tire of the wheelchair. It also includes the stop function of the wheelchair.

1.4 WHEELCHAIR

A wheelchair is chair with wheels, designed to help the disabled individuals. .

- **TYPES OF MANUAL WHEELCHAIR**

Manual wheelchair classification is done based on the use and type of material used. Travel, airport, pediatric and stainless steel wheelchairs are the commonly used wheelchairs in hospitals.

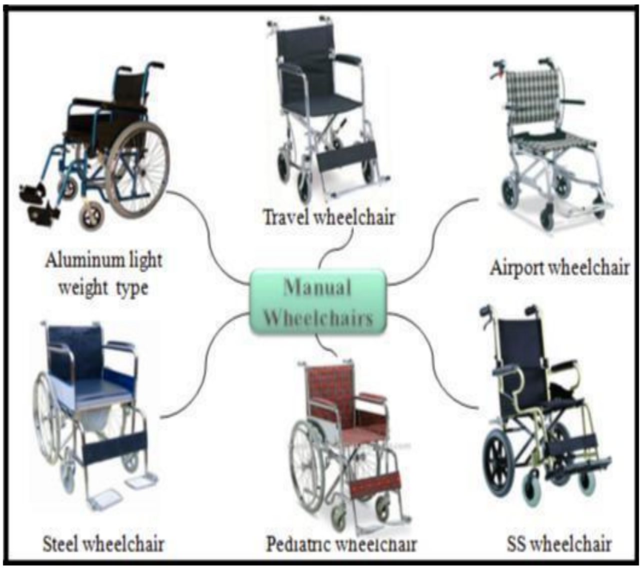


Fig.1.2 Manual wheelchairs

- **TYPES OF SPORTS WHEELCHAIRS**

Entertainments like sports and games are the part of human life. Human who are physically challenged will have the entertainment through these kinds of wheelchairs.

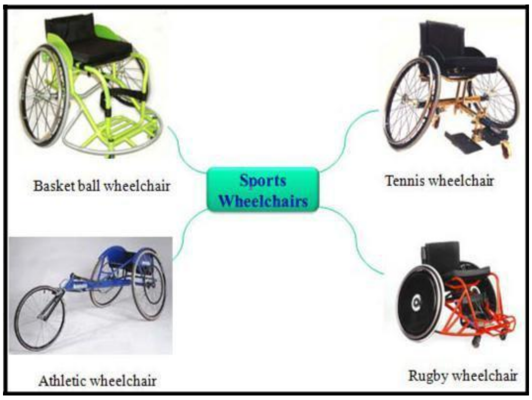


Fig.1.3 Sports wheelchairs

- **ELECTRIC WHEELCHAIRS**

Electric wheelchairs are the commonly used indoor mobility devices. The specialty of these kinds of devices is for their design especially because of the custom design. The design can be done according to the user's convenience.

Fig.1.4 Electrical wheelchair

1.5 APPLICATION

- For paralyzed persons
- For person without limbs.

2

LITERATURE REVIEW

2.1 INTRODUCTION

For chosen are of automation design and development, it is aimed to change manually operated wheelchair movement by using intelligent wheelchair movement. In order to refer work more than 60 journals and international paper from different sources like Emerald, IEEE and ASME have been reviewed. In addition to this some of the industrial articles and web sites of the companies which are making mobility aids for hospitals and much other use have also been reviewed.

This literature review is classified according to the area of work which we have planned to achieve the soul aim of this project. They are,

Wheelchairs

Caster Wheel

Anthropometric Consideration

2.2 STRUCTURE OF WHEELCHAIR

Generally the ordinary wheelchair which is used by the paralyzed people are available in the market. This ordinary wheelchair is totally manually operated wheelchair. It consists of wheels, casters, armrests, footrests, backrest, brakes and a seat.

Fig.2.1 Structure of Ordinary Wheelchair

2.3 <u>RESEARCH PAPERS:</u>

1. Smart wheelchairs

Richard C. Simpson

"**Department of Rehabilitation Science and Technology, University of Pittsburgh, Pittsburgh, PA**"

Several studies have shown that both children and adults benefit substantially from access to a means of independent mobility. While the needs of many individuals with disabilities can be satisfied with traditional manual or powered wheelchairs , a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. To accommodate this population, researchers have used technologies originally developed for mobile robots to create "smart wheelchairs." Smart wheelchairs have been the subject of research since the early 1980s and have been developed on four continents. This article presents a summary of the current state of the art and directions for future research.While the needs of many individuals with disabilities can be satisfied with traditional manual or powered wheelchairs, a segment of the disabled community finds it difficult or impossible to use wheelchairs independently. This population includes, but is not limited to, individuals with low vision, visual field reduction, spasticity, tremors, or cognitive deficits. These individuals often lack independent mobility and rely on a caregiver to push them in a manual wheelchair. There are several barriers that must be overcome before smart wheelchairs can become widely used. A significant technical issue is the cost versus accuracy trade-off that must be made with existing sensors. Until an inexpensive sensor is developed that can detect obstacles and drop-offs over a wide range of operating conditions and surface materials, liability concerns will limit smart wheelchairs to indoor environments. Another technical issue is the lack of a standard communication protocol for wheelchair input devices (e.g., joystick, pneumatic switches) and wheelchair motor controllers. There have been several efforts to develop a standard protocol (e.g., Multiple Master Multiple Slave [45]), but none has been adopted by industry. A standard protocol would greatly simplify the task of interfacing smart wheelchair technology with the underlying wheelchair. Even if these technical barriers are overcome (and I believe they will be), issues of clinical acceptance and reimbursement still remain. Third-party payers are unlikely to reimburse clients for the expense of smart wheelchairs until they have been proven to be efficacious, if not cost-effective. Unfortunately, the evidence needed to prove efficacy will not exist until Sufficient numbers of smart wheelchairs have been prescribed.

This will not be possible without adequate numbers of clinicians and wheelchair technicians who have training and expertise in the use of smart wheelchair technology. Smart wheelchairs are expensive and complicated, so the familiarization and training effort will require the extensive resources and infrastructure that only the major wheelchair manufacturers (e.g., Per Mobil, Invacare, Pride Mobility, Sunrise Medical) possess. This is not to imply, however, that smart wheelchair technology cannot be commercialized. Smart wheelchair technology is ready, today, for use in indoor environments that have been modified to prevent access to drop-offs. These modifications can take the form of baby gates, doors in front of stairwells, and ramps placed over single steps. The first smart wheelchair that is commercially successful in North America is likely to be marketed as a device that can be operated independently indoors, but must be controlled by an attendant outdoors or in unmodified indoor environments. However, as sensor technology improves, the environments in which smart wheelchairs can safely operate will continue to expand.

2. Smart wheelchair

Snehlata Yadav, Poonam Sheoran

"**International Journal of Innovative and Emerging Research in Engineering**"

This article presents a summary of current state of smart wheelchairs. An assistive technology known as wheelchair is used to deal with loss of mobility for the patients who are not able to walk normally due to some injury or some other age related walking disabilities (permanent or under treatment). There is a vast development in the field of wheelchairs. Researchers are going on to develop reliable, low cost and easy to use devices. Out of all the methodologies, HCI (Human Computer Interface) and HMI (Human Machine Interface) are the latest and most effective techniques [5]. In user interface systems both bio-signals and non-bio-signals are used as a medium of control. Bio-signal based devices mainly use bio-signals like EEG, EOG or EMG as control signals. The advantage of using bio-signal approach is that when patients become completely paralyzed, the only resource available to them then is bio-signals. Non bio-signal based devices provide 100% accuracy and require less training for patients but the usage of these devices is limited to patients with partial or complete flexibility in their body parts. A handicapped person with locomotive disabilities needs a wheelchair to perform functions that require him or her to move around. He can do so manually by pushing the wheelchair with his hands. However, many individuals have weak upper limbs or find the manual mode of operating too tiring. Hence, it is desirable to provide them with a motorized smart wheelchair that can be controlled by bio-signal & non bio-signal approach.

Since the motorized wheelchair can move at a fair speed with minimum efforts. There are different types of wheelchairs available now days which are discussed below. This paper presents a summary of current state-of-the-art smart wheelchairs various techniques are available to operate and control the wheel mechanism of wheelchair. Some of operating techniques of wheelchairs have been explained here. This information is gathered to promote awareness of status of existing types of smart powered wheelchair so that the improvement can be incorporated into it.

3. Head Gesture Based Wheelchair Movement Control for Disabled Person

Pei Jia and Huosheng H. Hu, Tao Lu and Kui Yuan

"Department of Computer Science, University of Essex, Colchester, UK"

This paper presents a novel hands-free control system for intelligent wheelchairs (IWs) based on visual recognition of head gestures. A robust head gesture-based interface (HGI), is designed for head gesture recognition of the Robo Chair user. The recognized gestures are used to generate motion control commands to the low-level DSP motion controller so that it can control the motion of the Robo Chair according to the user's intention. Ad boost face detection algorithm and Cam shift object tracking algorithm are combined in our system to achieve accurate face detection, tracking and gesture recognition in real time. It is intended to be used as a human-friendly interface for elderly and disabled people to operate our intelligent wheelchair using their head gestures rather than their hands. This paper describes the design and implementation of a novel hands-free control system for IWs. The developed system provides enhanced mobility for the elderly and disabled people who have very restricted limb movements or severe handicaps. A robust HGI, is designed for vision-based head gesture recognition of the Robo Chair user. The recognized gestures are used to generate motion control commands so that the RoboChair can be controlled according to the user's intention. To avoid unnecessary movements caused by the user looking around randomly, our HGI is focused on the central position of the wheelchair to identify useful head gestures. Our future research will be focused on some extensive experiments and evaluation of our HGI in both indoor and outdoor environments where cluttered background changing lighting conditions, sunshine and shadows may bring complications to head gesture recognition.

4. Developing Intelligent Wheelchairs for the Handicapped

Takashi Gomi and Ann Griffith

"**Applied AI Systems, Inc. (AAI) 340 March Road, Suite 600 Kanata, Ontario, CANADA**"

A brief survey of research in the development of autonomy in wheelchairs is presented and AAI's R&D to build a series of intelligent autonomous wheelchairs is discussed. A standardized autonomy management system that can be installed on readily available power chairs which have been wellengineered over the years has been developed and tested. A behavior-based approach was use to establish sufficient on-board autonomy at minimal cost and material usage, while achieving high efficiency, sufficient safety, transparency in appearance, and extend ability. So far, the add on system has been installed and tried on two common power wheelchair models. Initial results are highly encouraging. The chairs are adapted, computer-controlled power wheelchairs which can be driven by a number of methods such as switches, joysticks, laptop computers, and voice-output. The mechanical, electronic and software design are modular to simplify the addition of new functions, reduce the cost of individualized systems and create a system. Since there are no modes and behaviors are combined transparent to the user, an explicit subsystem the Observer was up to report to the user what the system is doing. The Observer responds and reports its perceptions to the user via a speech synthesizer or input device. Two prototype autonomous wheelchairs based on commercially available motorized wheelchairs have been built using behavior-based AI. The initial prototyping went very rapidly and the size vehicles operating in the real world environment implemented using conventional AI and robotics methodologies. One of the chairs is now capable of travelling to its indoor destinations using landmark-based navigation. The performance of the prototypes indicates there is a cautious possibility today to build a functional intelligent wheelchair that is practical and helpful to people with certain types and degrees of handicap.

2.4 CASTER WHEEL:

Vibration is one of the most interesting topics in the field of vibrations and is the science prevailing caster wheel shimmy. Self-excited vibration is characterized by vibration that is produced by the motion of the system like wheelchair speed.

Fig.2.2 Caster wheel

It can be observed that in most of the cheapest wheelchairs, the design of the casters makes use of a sliding frictional damper in the spindle support to improve the characteristics. Understanding the theory of damping for the casters show how shimmy prevention works in ultra-light and powered wheelchairs.

2.5 ANTHROPOMETRIC CONSIDERATION:

Primary consideration should be given for comfort, so that people can sit for long time without feeling any physical discomfort. Considering the suitable materials for seat surface, frame and can make a comfortable seating for the design. Without considering the ergonomics and application can make a diverse effect to the user. Seat cushions are so important in the design of wheelchair. A wheelchair or stretcher design without cushion is not recommended for the hospital purposes. A stretcher or wheelchair design without cushion may create spinal cord injuries to the patients.

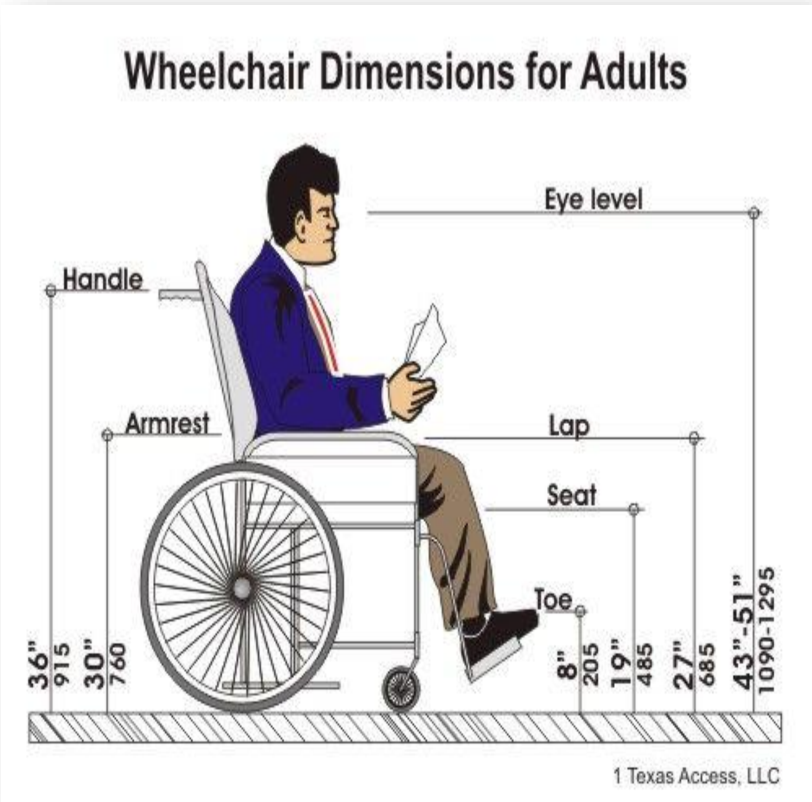


Fig.2.3 Anthropometric consideration for wheelchair

3

DESIGN CONSIDERATION

3.1. INTRODUCTION

Smart powered wheelchair needs some specified design consideration. Forces, internal forces, tripping angle, internal moments, stresses and bending stresses are needed to taken into account. Here some are described below:

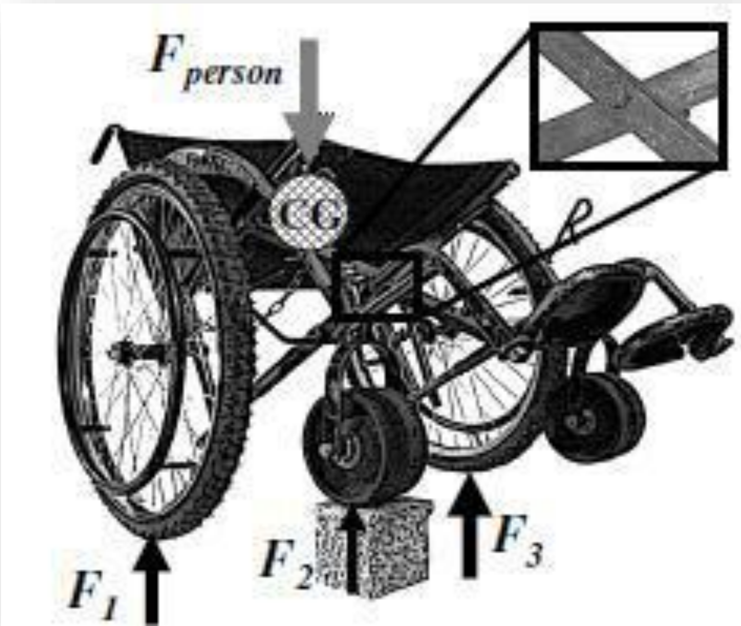


Fig. 3.1 Forces acting on wheelchair

3.2 DESIGN CRITERION

- **MECHANICAL PRINCIPLES OF WHEELCHAIR**

A free body diagram (FBD) is a visual representation of the forces acting on an object. You have already seen FBD sin the previous examples. As in the case of stationary objects, like the orange and wrench example, there are forces acting on them to balance the force of gravity pulling them to the ground.

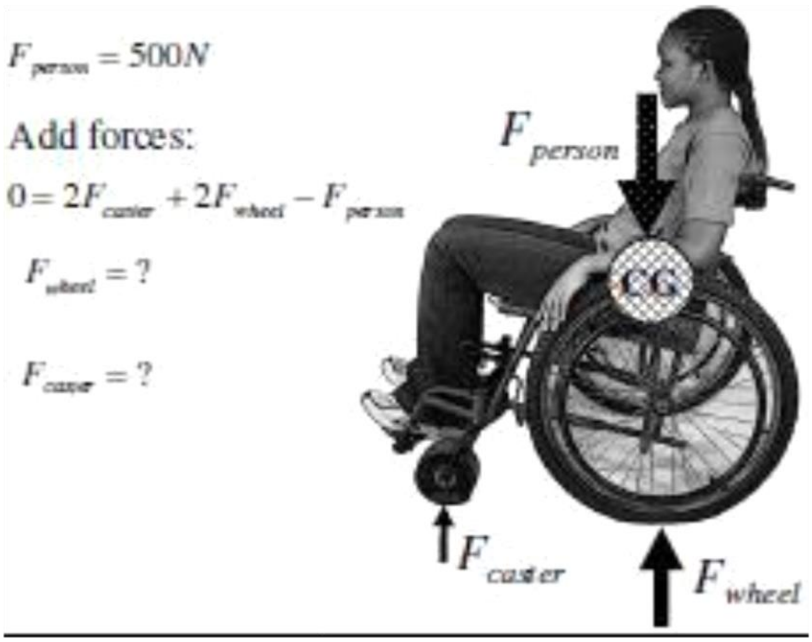


Fig. 3.2 Forces calculation

➢ DESIGN CALCULATIONS:

Gross weight = 120kg
Wheel size =10 cm (diameter)
= 5 cm=0.05m (radius)

Speed = 2km/h

1) Linear distance travelled (in one revolution):

$=2\pi r$

$= 2\pi*0.05$

= 0.3141 m

2) Speed = 0.315 m/s

3) RPM = 1130.97/ (0.314*60)

N = 60.03 rpm

4) **Power Calculation :**

P=[Mass in kg * (acc. gravity) * (velocity in m/s) *Rr] + [Air density * Cd *(Area in M^2)]

= [120 *9.81* 0.314 * 0.1] + [0.6465 * 0.88 * 0.612 * 0.030]

P = 36.97 watt

5) **Torque Calculation:**

Efficiency= [Power output / power input]

Power output = Efficiency * power input

= 0.80 * 36.97

=29.57 watt

Power output = T*ω

T = power output / ω

= 29.57 / 6.28

T = 4.70 N*m

- Now we are able to select the DC geared motor whose torque is 4.70 N*m.

6) **Battery size:**

Speed=1.130 km/h

Power comes out=36.97 watt at 1.130kmph

1 hour --→1.130 km/h power consumption

= 36.97 watt

= 36.97/1.130

= 32.71 Ah/km

Ah used per Km = 32.71/12v

= 2.72Ah/km

- **From the above calculation we can use the battery of 12 V.**

We have to multiply it in Km

= 2.72*2*1.25(20% less left after drive)

= 6.8 AH

- If we use Lipo battery ,

= 6.8 Ah * 1.05 (constant)

= 7.14 Ah battery required

✓ **We selected the 12V and 7.5Ah battery.**

3.3 HEAD MOTION RECOGNITION ALGORITHM

Since a set of possible motions in this case is very small, the number of available commands is also very limited. Thus, the control system that we propose allows the user to give only four different commands: “forward”, “backward”, “left” and “right”. This means that the set of motions to be,recognized has only four members. The implemented algorithm relies greatly on this fact. The meaning of each of the commands is relative and depends on the present wheelchair state, Fig. 2. Namely, we define six different wheelchair states: “state of still”, “moving forward – 1st gear”, “moving forward – 2^{nd} gear”, “moving backward”, “rotating left” and “rotating right”. If the wheelchair is in the “state of still”, the command “forward” will put it in the state “moving forward – 1st gear”, and the command “backward” will put it in the state “moving backward”. On the other hand, if the wheelchair is in the state “moving forward – 1st gear”, the command “forward” will put it in the state “moving forward – 2nd gear”, and the command “backward” will put it in the state “state of still”, i.e. stop the wheelchair. Analogously, if the wheelchair are in the state “moving backward”, the command “forward” will stop it. Head motion recognition is based on the force measurements yielded by an accelerometer attached to the head. As mentioned, there are only four members of the motion set, which represent head leaned in four possible directions. This means that the algorithm needs to estimate when the head is leaned in one of the four directions. In other words, it is sufficient to read only the accelerometer data of two axes: in this case, x and y. The position of the accelerometer and the axes are defined in Fig. 3. The thresholds are accelerometer output values that the user defined at system startup. These represent the angles in all four directions by which the head needs to be leaned in order to issue a command to the system. These thresholds define borders of a region in three-dimensional space (Fig. 4) and the algorithm operation is based on estimating the head position relative to this region.

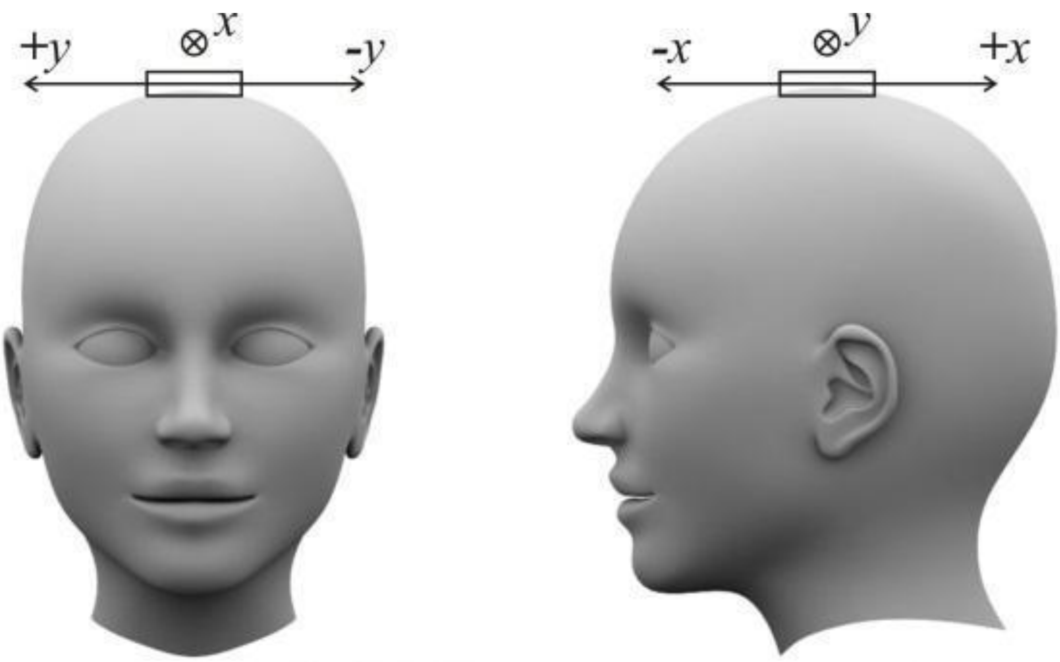


Fig.3.3 The position of the accelerometer relative to direction

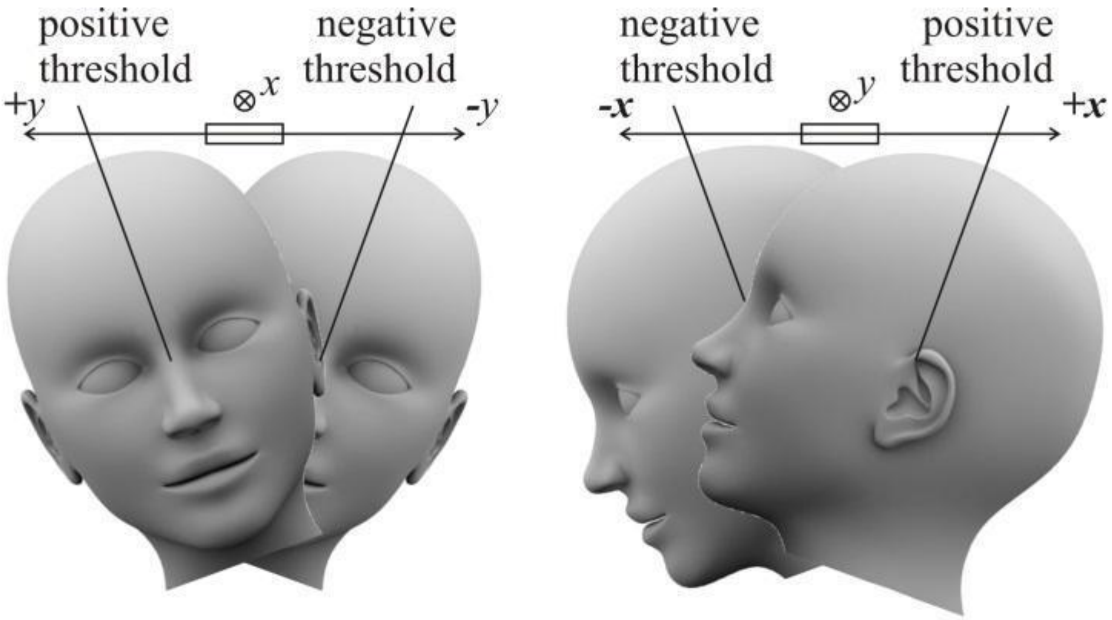


Fig.3.4 An example of threshold setting

The algorithm is implemented through several steps of operation. The motion data processing is done online, i.e. the command is estimated while the user moves the head. The algorithm description that follows assumes that microcontroller has read the current result of the accelerometer measurements. In the following paragraphs, the algorithm operation is described. Eliminating gravity component. When in gravitational field, the accelerometer shows acceleration of the Earth's gravity (except if it is in free fall). Thus, in order to get the actual state of the accelerometer, gravitational component has to be removed. In this case, this is done in two steps. First, on startup, the gravity is measured. Because of this, it is required that the patient remains calm for the first period after turning on the system. The end of this period is signalized by the diode B5 (Fig. 9). Then, after every measurement, that amount is subtracted from the accelerometer output signal. Thus, the gravitational component of acceleration is eliminated in correspondence the position and attitude of the control unit attached to the patient's head. Reading and filtering of the accelerometer output. Output voltage changes, which appear as a result of head motion not intended to issue a command lead to errors.

Namely, the system can wrongly recognize and start executing an unwanted command. Such changes are sudden, so they can be removed using a low-pass filter. In this case, the filter is software implemented to remove the high frequency changes in the accelerometer signal. Threshold setting. Since this is a system intended for patients with severe disabilities, it has to be as adjustable as possible. Because of this, the threshold setting according to patient's possibilities is enabled. The thresholds are set up upon start-up. After corresponding signalization, the patient moves the head first in +x direction, and then in +y direction. Axes and directions are defined relative to the position and attitude of the control unit attached to the head of the patient. In Fig. 3, the axes and directions are shown. As it can be seen, the x axis change resembles the head movement forward-backward and the y axis change resembles the head movement left-right. In this context, positive movements are backward and right, respectively.

In Fig. 4, an example of threshold setting is shown. This operation can be done during system operation. The threshold setting operation is started by pressing the C0 pushbutton (Fig. 9) and holding it until the patient moves the head in the corresponding position, relative to the +x axis. When the button is released, the system memorizes the threshold and turns on the B6 (Fig. 9) diode. This means that the procedure for setting the +y axis threshold can commence. Now, the pushbutton C1 (Fig. 9) needs to be pressed and held until the patient moves the head in the corresponding position, relative to the +y axis. Issuing commands. Every command consists of three consecutive motions.

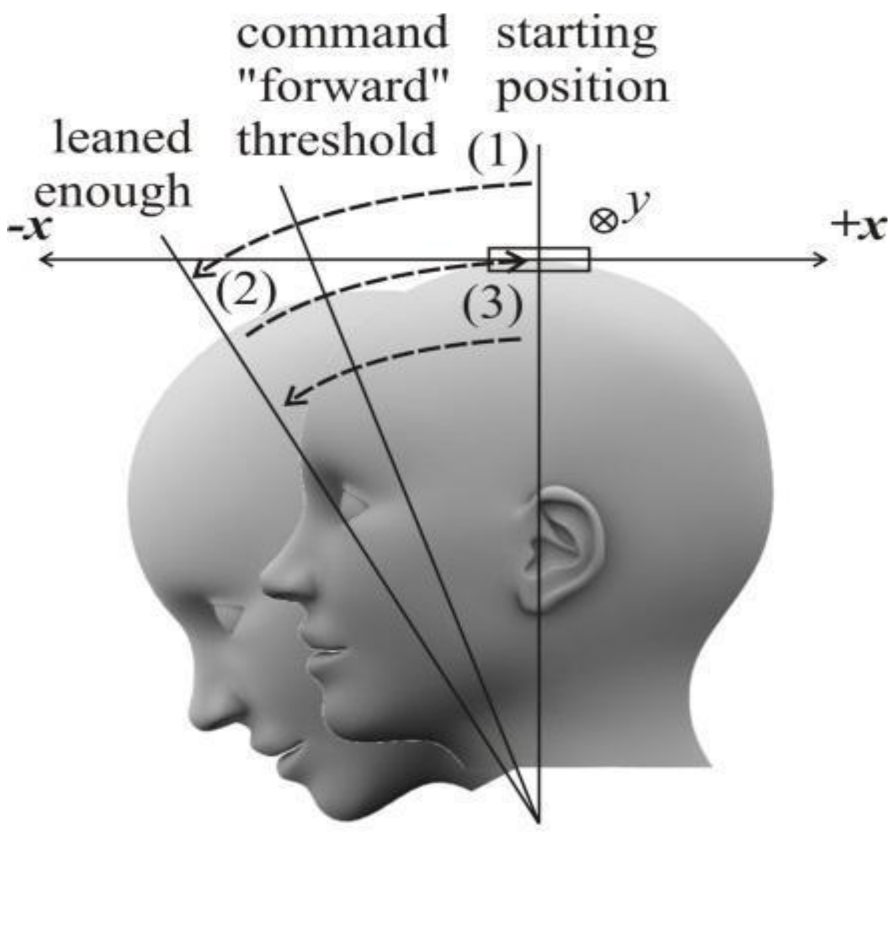


Fig.3.5 An example of issuing a command – forward

4. FABRICATION:

4.1. INTRODUCTION

Smart powered wheelchair is fabricated according to the design consideration which has been discussed in the previous chapter. This chapter includes the detailed fabrication of parts along with raw material, manufacturing processand functional roll of that part.

4.2. Intelligent wheelchair components:

• ARDUINO microcontroller	• Bush
• The battery.	• Wooden sheet
• Accelerometer/Tilt Sensor	• Angle section plate
• Motor Driver IC	• Ordinary chair
• DC Geared Motor.	• Switch
• Tyre	• Metal sheet cover

❖ **ARDUINO microcontroller**

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller and a piece of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code to the physical board.

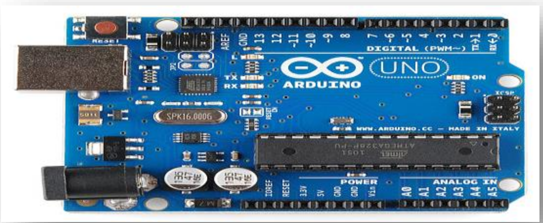


Fig.4.1 ARDUINO MICROCONTROLLER

Arduino is an open source computer hardware and software company, project, and user community that designs and manufactures single board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The project's products are distributed as open-source hardware and software, which are licensed under the GNU Lesser General Public License or the General Public License permitting the manufacture of Arduino boards and software distribution by anyone.

Arduino board designs use a variety of microprocessors and controllers. The microcontrollers are typically programmed using a dialect of features from the programming languages C and C++. In addition to using traditional compiler toolchains, the Arduino project provides an integrated development environment based on the Processing language project.

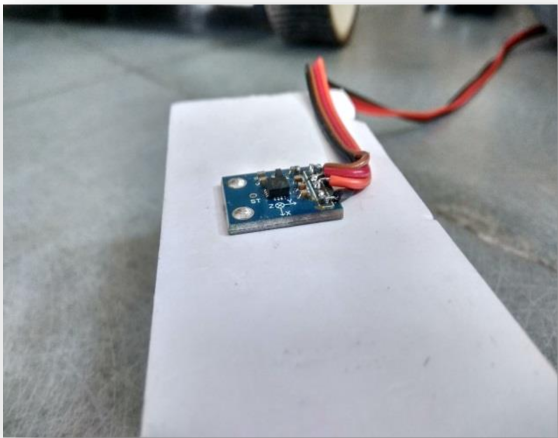
- ❖ **The Battery (Dry Cell)**

The common battery (dry cell) is a device that changes chemical energy to electrical energy. Dry cells are widely used in toys, flashlights, portable radios, cameras, hearing aids, and other devices in common use. A battery consists of an outer case made of zinc (the negative electrode), a carbon rod in the center of the cell (the positive electrode), and the space between them is filled with an electrolyte paste. In operation the electrolyte, consisting of ground carbon, Manganese dioxide, Sal ammoniac, and zinc chloride, causes the electrons to flow and produce electricity.

Fig 4.2 THE BATTERY

❖ Axis Accelerometer

3-axis accelerometer to now have an on-board 3.3V regulator - making it a perfect choice for interfacing with a 5V microcontroller such as the . This breakout comes with 3 analog outputs for X, Y and Z axis breakout board. The ADXL335 is the latest and greatest from Analog Devices, known for their exceptional quality MEMS devices. The VCC takes up to 5V in and regulates it to 3.3V with an output pin. The analog outputs are ratiometric: that means that 0g measurement output is always at half of the 3.3V output (1.65V), -3g is at 0v and 3g is at 3.3V with full scaling in between. Fully assembled and tested. The XYZ filter capacitors are 0.1uF for a 50 Hz bandwidth.



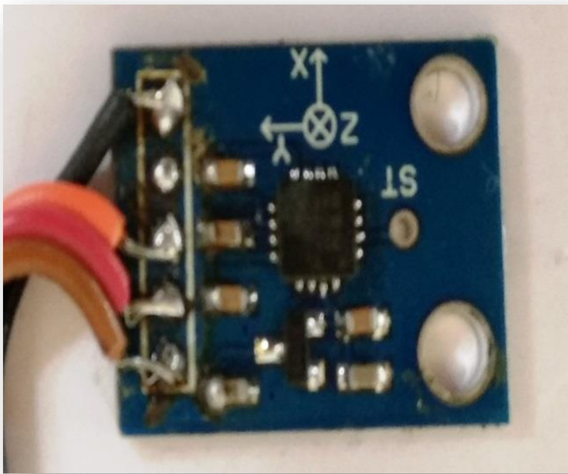


Fig.4.3 AXIS ACCELEROMETER SENSOR

Features:

- 3-axis sensing.
- Excellent temperature stability.
- BW adjustment with a single capacitor per axis.

Specifications

- Parameter Value
- Operating Voltage +5v dc regulated
- Operating temperature -55c to +125c

Pin Details

- gnd Power supply ground
- +5v Power supply input
- x x-axis value
- y y-axis value
- z z-axis value.

- **<u>MOTOR DRIVER IC :</u>**

Fig.4.4 motor driver IC

MOTOR DRIVER IC is the one type of driver which drives and control the actuators (dc geared motor) by getting asignal from arduino microcontroller which is connected with accelerometer sensor.

❖ DC GEARED MOTOR

A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to anydesirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. This Insight will explore all the minor and major details that make the gear head and hence the working ofgeared DC motor.

➢ EXTERNAL-STRUCTURE:

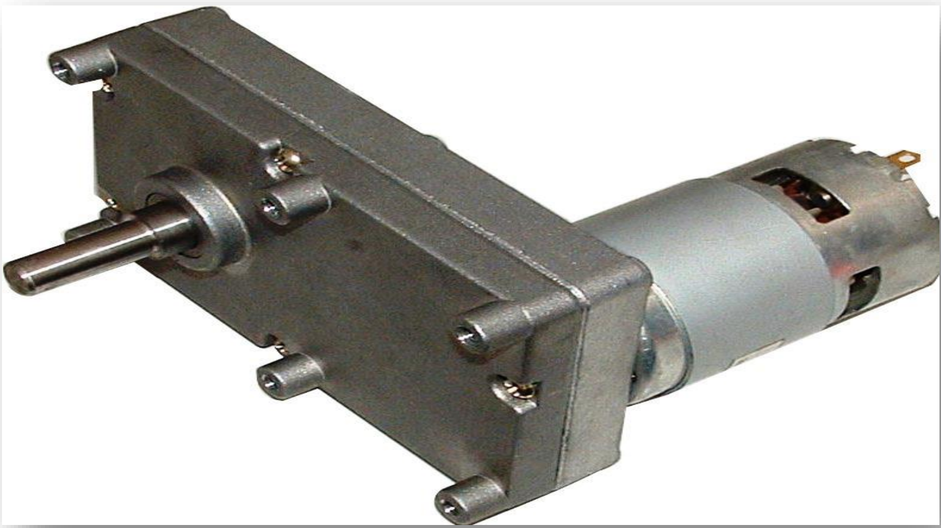


Fig.4.5 DC GEARED MOTOR

At the first sight, the external structure of a DC geared motor looks as a straight expansion over the simple DC ones The lateral view of the motor shows the outer protrudes of the gear head. A nut is placed near the shaft which helps in mounting the motor to the other parts of the assembly.The lateral view of the motor shows the outer protrudes of the gear head. A nut is placed near the shaft which helps in mounting the motor to the other parts of the assembly.

➢ **INTERNAL-STRUCTURE:**

Fig.4.6 INTERNAL STRUCTURE

The gear assembly is set up on two metallic cylinders whose working can be called as similar to that of an axle. A total of three gears combine on these two cylinders to form the bottom gear assembly out of which two gears share the same axle while one gear comes in between them and takes a separate axle.

The gears are basically in form of a small sprocket but since they are not connected by a chain, they can be termed as duplex gears in terms of a second cog arrangement coaxially over the base. Among the three gears, two are exactly same while the third one is bigger in terms of the number of teeth at the upper layer of the duplex gear. The third gear is connected to the gear at the upper portion of the gear head.

- **<u>TYRE AND BUSH ASSEMBLY:</u>**


Fig.4.7 TYRE AND BUSH ASSEMBLY

Tyres are designed to support the wait of the wheelchair, transmit traction, torque and breaking forces to the floor and maintain and change the direction of travel .inner bushes are used to connect the outer diameter of the shaft to the inner diameter of the wheel, which transmits the power of the motor to the tyre.

- **<u>ANGLE SECTION PLATE (2NOS)</u>**

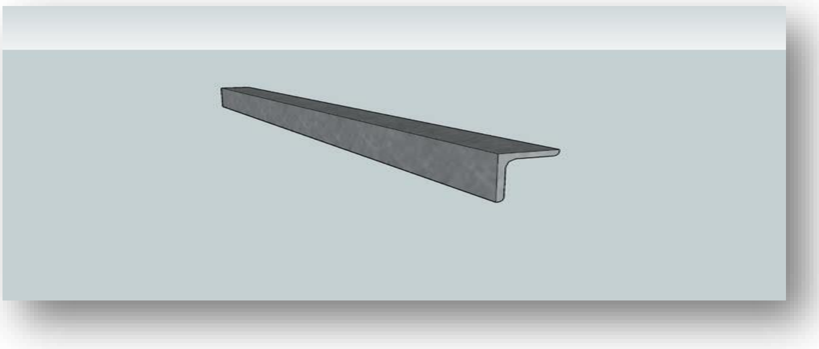


Fig.4.8 ANGLE SECTION PLATE

Angle section plate is used to carry the whole load of wheelchair and transmit that load to the tyres .it is also used to support and fix the DC geared motor to the base .by using the two angle section plate we can support enough load of wheelchair.

- **WOODEN SHEET :**

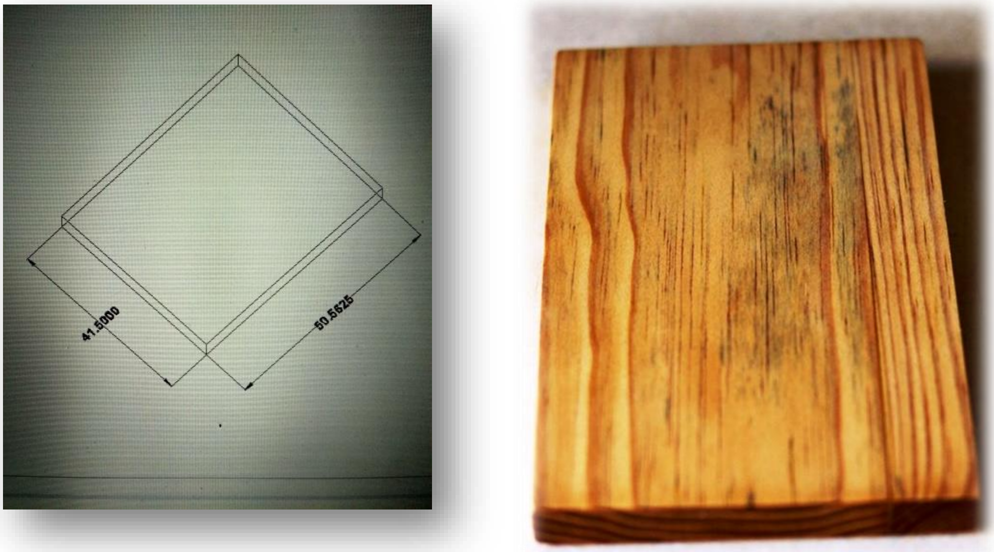


Fig.4.9 Wooden Sheet

Wooden sheet is used as the perfect capable base of the whole wheelchair which transfers the whole load of the wheelchair to the angle section plate which is connected with the tyres through DC geared motor.

- **METAL SHEET COVER :**

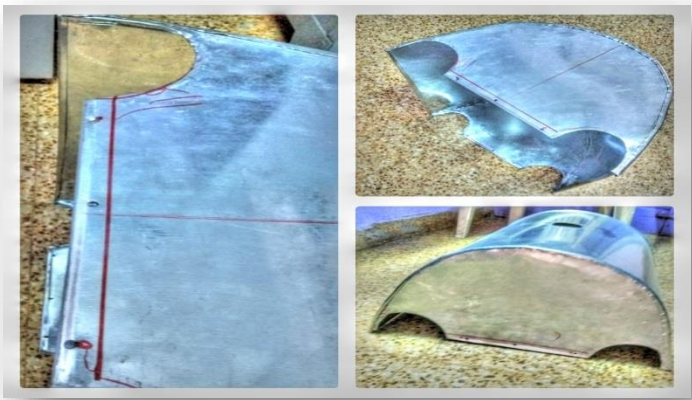


Fig.4.10 METAL SHEET COVER

A metal sheet cover is used to protect the wheelchair wiring and internal structure and internal parts of the wheelchair.

5

CONCLUSION

This project introduces a automated wheel chair for physically handicapped persons for their independent movement. It will able to navigate in indoor and outdoor environment. It is a reactive system and does not require mapping or planning. Interaction between user and wheelchair is investigated. We implemented 2 dimension head movement for good control. This shows a novel hands-free control system for intelligent wheelchair based on visual recognition of head gestures. So, this is an extremely useful system for user having restricted limb movements caused by some diseases such as Parkinson's diseases and quadriplegics. We can use this wheelchair for the person whose only one sense is working that is their mind and their body does not respond to any machine which may be due to any reason i.e. by birth or accidental case this wheelchair is good gift for them.

6

FUTURE SCOPE

The goals of this project were purposely kept within what was believed to be attainable within the allotted timeline. As such, many improvements can be made upon this initial design. That being said, it is felt that this design represents a functioning miniature scale model which could be replicated to a much larger scale.

- Automatically recharging the battery using alternator during movement of the the wheelchair.

- Various security systems for the patient can be impended which can alarm the nearby people if when required.

- Also by using voice recognition system, this project can be implanted.

7

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GOVERNMENT ENGINEERING COLLEGE PALANPUR
MECHANICAL ENGINEERING DEPARTMENT
B.E. SEMESTER VIII - PROJECT-II (2181909)

INTERNAL EVALUTION (20) 2017-18

Sr. No.	Criteria Enrolment No.	Innovativeness / Creativity (4)	Review of Literature / Related Studies (4)	Selection of Proper Tools / Techniques (4)	Content and Presentation (4)	Question and Answers (4)	Total (20)
1	130610119030	3.4	3.4	3.4	3.4	3.4	17.0
2	130610119052	3.4	3.4	3.4	3.4	3.4	17.0
3	130610119059	3.8	3.8	3.8	3.8	3.8	19.0
4	140610119001	3.8	3.8	3.8	3.8	3.8	19.0
5	140610119002	3.4	3.4	3.4	3.4	3.4	17.0
6	140610119003	3.8	3.8	3.8	3.8	3.8	19.0
7	140610119004	3.8	3.8	3.8	3.8	3.8	19.0
8	140610119005	3.8	3.8	3.8	3.8	3.8	19.0
9	140610119006	3.8	3.8	3.8	3.8	3.8	19.0
10	140610119008	3.8	3.8	3.8	3.8	3.8	19.0
11	140610119009	3.4	3.4	3.4	3.4	3.4	17.0
12	140610119010	3.8	3.8	3.8	3.8	3.8	19.0
13	140610119011	3.0	3.0	3.0	3.0	3.0	15.0
14	140610119012	3.8	3.8	3.8	3.8	3.8	19.0
15	140610119013	3.8	3.8	3.8	3.8	3.8	19.0
16	140610119015	3.8	3.8	3.8	3.8	3.8	19.0
17	140610119016	3.8	3.8	3.8	3.8	3.8	19.0
18	140610119017	3.8	3.8	3.8	3.8	3.8	19.0
19	140610119018	3.4	3.4	3.4	3.4	3.4	17.0
20	140610119019	3.8	3.8	3.8	3.8	3.8	19.0
21	140610119020	3.8	3.8	3.8	3.8	3.8	19.0
22	140610119021	3.4	3.4	3.4	3.4	3.4	17.0
23	140610119022	3.8	3.8	3.8	3.8	3.8	19.0
24	140610119023	3.0	3.0	3.0	3.0	3.0	15.0
25	140610119024	3.8	3.8	3.8	3.8	3.8	19.0
26	140610119025	3.8	3.8	3.8	3.8	3.8	19.0
27	140610119026	3.8	3.8	3.8	3.8	3.8	19.0
28	140610119027	3.4	3.4	3.4	3.4	3.4	17.0
29	140610119030	3.0	3.0	3.0	3.0	3.0	15.0
30	140610119031	3.4	3.4	3.4	3.4	3.4	17.0
31	140610119032	3.4	3.4	3.4	3.4	3.4	17.0

32	140610119033	3.8	3.8	3.8	3.8	3.8	19.0
33	140610119034	3.0	3.0	3.0	3.0	3.0	15.0
34	140610119035	3.8	3.8	3.8	3.8	3.8	19.0
35	140610119036	3.8	3.8	3.8	3.8	3.8	19.0
36	140610119037	3.0	3.0	3.0	3.0	3.0	15.0
37	140610119038	3.0	3.0	3.0	3.0	3.0	15.0
38	140610119039	3.8	3.8	3.8	3.8	3.8	19.0
39	140610119040	3.4	3.4	3.4	3.4	3.4	17.0
40	140610119041	3.4	3.4	3.4	3.4	3.4	17.0
41	140610119042	3.4	3.4	3.4	3.4	3.4	17.0
42	140610119043	3.8	3.8	3.8	3.8	3.8	19.0
43	140610119044	3.4	3.4	3.4	3.4	3.4	17.0
44	140610119045	3.4	3.4	3.4	3.4	3.4	17.0
45	140610119046	3.4	3.4	3.4	3.4	3.4	17.0
46	140610119047	3.8	3.8	3.8	3.8	3.8	19.0
47	140610119048	3.4	3.4	3.4	3.4	3.4	17.0
48	140610119049	3.8	3.8	3.8	3.8	3.8	19.0
49	140610119050	3.8	3.8	3.8	3.8	3.8	19.0
50	140610119051	3.8	3.8	3.8	3.8	3.8	19.0
51	140610119052	3.0	3.0	3.0	3.0	3.0	15.0
52	140610119053	3.8	3.8	3.8	3.8	3.8	19.0
53	140610119054	3.4	3.4	3.4	3.4	3.4	17.0
54	140610119055	3.4	3.4	3.4	3.4	3.4	17.0
55	140610119056	3.4	3.4	3.4	3.4	3.4	17.0
56	140610119059	3.4	3.4	3.4	3.4	3.4	17.0
57	140610119062	3.8	3.8	3.8	3.8	3.8	19.0
58	140610119063	3.8	3.8	3.8	3.8	3.8	19.0
59	150613119001	3.8	3.8	3.8	3.8	3.8	19.0
60	150613119003	3.8	3.8	3.8	3.8	3.8	19.0
61	150613119005	3.8	3.8	3.8	3.8	3.8	19.0
62	150613119006	3.8	3.8	3.8	3.8	3.8	19.0
63	150613119007	3.8	3.8	3.8	3.8	3.8	19.0
64	150613119008	3.0	3.0	3.0	3.0	3.0	15.0
65	150613119010	3.8	3.8	3.8	3.8	3.8	19.0
66	150613119011	3.8	3.8	3.8	3.8	3.8	19.0
67	150613119012	3.8	3.8	3.8	3.8	3.8	19.0

Application Based Project

"DESING AND DEVELOPMENT OF SHOCK ABSORBING WHEEL WITH INTEGRAL SUSPENSION"

A PROJECT REPORT

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In fulfilment for the award of the degree of

BACHELOR OF ENGINEERING

In

MECHANICAL ENGINEERING

GOVERNMENT ENGINEERING COLLEGE

PALANPUR

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMADABAD

OCTOBER 2017

CERTIFICATE

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Date: 23/11/2017

This is to certify that the Project entitled "**DESING AND DEVELOPMENT OF SHOCK ABSORBING WHEEL WITH INTEGRAL SUSPENSION**" have been carried out by CHAUDHARY DIPAK (140610119005), DHARAVA KETUL (140610119012), MEVADA RAVI (140610119022) and PATEL DARSHAN (140610119035) under my guidance in fulfilment of the degree of Bachelor of Engineering in MECHANICAL ENGINEERING (7^{th} Semester) of Government Engineering Collage, Palanpur during the academic year 2015-16.

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The completion of our project was not an easy task for us. The project was bit different from other software based projects and a huge hardware and electronic knowledge were required. In accomplishing this goal many personals gave the helping hand for us. We would like to appreciate their guidance and encouragement since without their support the project would not have been a success.

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Our team was together as a family, sharing all the happiness, hardships and even the personal matters, during the last several months. Each member contributed maximum to make this a success. We would like to thank all other colleagues that were not mentioned here for their great support provided.

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ABSTRACT

Recently, there is an increasing interest on bicycle riding for recreation or fitness purpose. Bicycles are also accepted as urban transportation due to the consciousness of environmental protection. For a more comfortable riding experience, many bicycles are equipped with a suspension system.

Bicycle suspension systems have been designed to improve bicycle comfort and handling by dissipating terrain-induced energy. However, they may also dissipate the cyclist's energy through small oscillatory movements, often termed 'bobbing', that are generated by the pedaling movements. This phenomenon is a major concern for competitive cyclists engaged in events where most of the time is spent climbing, e.g. off-road cross-country races and also concern to handicap people who can get better ride on wheelchair.

The aim is to design, analyze and fabricate a wheel of a cycle with tangential suspension system in the wheel itself. It is done so by introducing spring like material. Thus, the spokes of the cycle are replaced by leaf spring of variable length which can be varied according to the given conditions. The leaf springs are attached to the hub which can dislocate from its center and hence can be termed as "Floating hub". The leaf springs are attached to the rim at the other end where the length of the spring can be adjusted.

The spring system between the hub and the rim of the wheel provides suspension that continuously adjusts to uneven terrain and provide cushioning to rider from abnormalities in the road. This wheels are designed such that the suspension system is integrated within wheel for higher shock-absorbing performance and better comfort.

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INTRODUCTION

1.1 INTRODUCTION

In today's world, Bicycles are the most favorite choice when it comes to causes like health, pollution, and environment. Several researches have been done in order to make the ride comfortable. Different types of cycles have been developed for various applications like Commuter Bikes, Mountain Bike, and Racing bike. Now a days wire spoke wheels are mostly used. Today's wire spoke wheels can carry more than a hundred times their own weight. In off-road bicycling, skilled riders often jump from high obstacles, subjecting their wheels to forces of more than a quarter ton. Constant and better comfort throughout can be achieved by making certain simple necessary changes in the regular design of the front wheel suspension system. So, we are going to introduce changes in conventional wheel by applying a tangential suspension system in the wheel itself to get comfortable riding.

1.2 PROBLEM STATEMENT

In conventional wire spoke wheels spokes can loosen from hitting bumps hard or from landings following jumps. If tapping or clicking sounds coming from a wheel, wheel should reach for spoke wrench and start jiggling to find the loose spoke. If we are tightening one spoke without considering the effect of tension, or pull, on spokes at the opposite side of the rim then tension pulls that portion of wheel rim towards the hub, loosening spokes on the opposite side of the wheel. If you don't tighten the nut enough, the tension from the opposite spokes remains greater -- and the spoke nut loosens again as the rider continues to ride.

Spoke lengths are specific to the diameter of a wheel rim. A dent at one portion of a wheel rim can shorten the distance between the wheel and the hub. As a result, the spoke in the area of the dent is too long to be tightened. It's rare that riding on rough terrain can impact a rim in a way that causes it to twist, but it can happen. Dents are relatively easy to spot. A twisted rim might be out of true by as little as two mm, which is difficult to notice, but is enough to affect the specific length of spokes. Attempting to tighten excessively loose spokes can strip the threaded end or the threads in a spoke nut.

1.3 HISTORY OF BICYCLE WHEEL

The wheel is the most crucial element of the bicycle: it allows the rider to roll over the ground with great speed and efficiency. Historians believe the wheel originated in Mesopotamia sometime around 3,500 BC. While the Sumerians did not pedal their way through ancient Mesopotamia, animal-powered wheeled chariots and carts helped haul goods and people for thousands of years. During the industrial revolution in the 19th century, advances in materials and engineering made it possible to use the wheel effectively in human-powered machines. The modern bicycle, complete with a steel frame, a chain drive, steel wheels and spokes, and pneumatic tires, would emerge in the late 1800s.

While the use of the wheel was widespread in ancient times, it did have limitations. The resistance to the motion of a wheel can vary tremendously depending on the surface on which it is traveling. A rough road is much harder to roll over than a smooth one. The Romans were aware of this and developed a massive network of paved roads. While this may have been the first time in history that roads were improved to facilitate the wheel, it certainly wasn't the last. In the United States in the 1890s, cyclists successfully lobbied for improvements in roads nationwide, and with cycling the nation's most popular sport at the time, legislators listened.

When most people think about early bicycles, the high-wheelers of the late 1800s come to mind. These early models had names such as the "Ordinary" or "Extraordinary." In England, these bicycles were also known as "penny farthings" because the large and small wheels were reminiscent of the large one-penny coin and the smaller farthing coin.

The pedals were attached directly to the front wheel of the high-wheelers. The larger the front wheel on an "Ordinary," the farther the cyclist would travel with each turn of the pedals. Exploratorium Senior Scientist Paul Doherty explained, "Every time the pedals would go around once, that whole giant front wheel would go around once. So, for one cycle of the bicyclist's legs he might go 140 inches (3.556 meters), a tremendous distance forward." This made pedaling up hills quite difficult, but allowed for great speed on the flats. High-wheeled bicycles were designed for speed, not for safety.

The safety bicycle that was developed in the 1880s closely resembles the bicycles of today. The rider is suspended on a metal frame between two wheels of equal size. A chain drive mechanism connects the pedals to the rear wheel. The stability and comfort of the design was superior to the high-wheelers, and so earned the "safety" its name.

Even the earliest bicycles used spokes of one sort or another. In fact, even in ancient times many chariots and animal-drawn carts used spokes. A spoked wheel can be made as strong as a solid one and have only a fraction of the weight. While early spoked wheels were almost always made out of wood, the bicycle wheels and spokes of today are made out steel or aluminum or occasionally more exotic materials such as carbon composite or ceramics.

Minimizing the weight of the wheels is extremely important in bicycle design. Why does weight matter? Each time you push the pedals, you have to accelerate the weight of the wheel both forward and around its center. In other words, the wheel undergoes angular and straight motion simultaneously. You can see this when you ride--the front tire of your bicycle rotates while it moves forward along with you and the bike.

There are many different ways to spoke a bicycle wheel. Most bicycles have tangential spokes, meaning that the spokes do not connect from the hub to the rim in a straight line, but at an angle. There are many different patterns of tangential spokes. Occasionally bicycles will have completely radial spokes. These spokes go straight from the hub to the rim of the tire. Wheels typically have tangential spokes. The way in which the wheels are spoked determines how they will perform.

The pneumatic (or air-filled) rubber tire is something we take for granted today. Almost every type of bicycle wheel has a pneumatic tire on its rim. The development of the pneumatic tire was an important landmark in the development of the modern bicycle. Prior to its invention in 1888 by John Boyd Dunlop, bicycling was a bumpy and somewhat uncomfortable experience. Tires were made out of leather (and later solid rubber) attached to a wood or metal rim. The air-filled tire brought with it a smooth, comfortable, and stable ride. It's no surprise that it also helped make bicycling more popular.

1.4 OBJECTIVE

The basic objective is to remove extra material as possible without compromising the strength of the wheel as this supports the weight of the vehicle and install system which can give comfort to rider while riding.

1.5 MOTIVATION OF PROJECT

One day we saw mother pushing her child in a buggy. The front wheels hit a slight kerb and the child jolted forward because of the impact. We thought why a wheel couldn’t have suspension inside it, so it would soften an impact from any direction.

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2

LITERATURE REVIEW

2.1 INTRODUCTION

Aim of our project is to change conventional wheel spoke by using advance engineering. In order to refer previous work more than 50 journals and international paper from different sources have been reviewed. In addition to this some of the industrial articles and web sites of the companies which are making bicycle tires have also been reviewed. So, here we have surveyed a list of various wheel manufacturing based journals and projects which are very interesting to learn. The following projects based on wheel manufacturing we surveyed would give better idea about the shock absorbing systems in wheel and materials of leaf spring strips practically.

A book by Gulur Siddaramanna, Shiva Sankar and SambagamVijayarangan named "Mono Composite Leaf Spring for Light Weight Vehicle – Design, End Joint Analysis and Testing". A single leaf with variable thickness and width for constant cross sectional area of unidirectional glass fiber reinforced plastic (GFRP) with similar mechanical and geometrical properties to the multi leaf spring was designed, fabricated (hand-layup technique) and tested. Computer algorithm using C-language has been used for the design of constant cross-section leaf spring. The results showed that a spring width decreases hyperbolically and thickness increases linearly from the spring eyes towards the axle seat. The finite element results using ANSYS software showing stresses and deflections were verified with analytical and experimental results. Compared to the steel spring, the composite spring has stresses that are much lower, the natural frequency is higher and the spring weight is nearly 85 % lower with bonded end joint and with complete eye unit.

Mr. TharigondaNiranjanBabu, Mr. P. Bhaskar and Mr. S. Moulali's book "Design and Analysis of Leaf Spring with Composite materials". The introduction of composite materials has made it possible to reduce the weight of the leaf spring without any reduction in load carrying capacity and stiffness. Leaf spring is modelled in CATIA V5R20 software and it is imported in ANSYS 12.0. The conventional composite leaf springs were analyzed under similar conditions using ANSYS software and the results are presented. Deflection of composite leaf spring is less as compared to steel leaf spring with the same loading condition. Weight and cost are also less in composite leaf spring as compared to steel leaf spring with the same parameters. Conventional steel leaf spring is also found to be 5.5 times heavier then Jute EGlass/Epoxy leaf spring. Material saving of 71.4 % is achieved by replacing Jute EGlass/ epoxy in place of steel for fabricating the leaf spring.

"Design and Analysis of a Leaf Spring for automobile suspension system- A Review" by Baviskar A. C., Bhamre V. G., Sarode S. S. Composite materials have more elastic strain energy storage capacity and high strength to weight ratio as compared with those of steel. Therefore, it is concluded that composite leaf spring is an effective replacement for the existing steel leaf spring in automobile. E-glass epoxy is better than using Mild-steel as though stresses are little bit higher than mild steel, E-glass epoxy is having good yield strength value. The prior cracking in the spring was extensive enough to reduce the strength of the spring to the point where normal dirt road forces were adequate to produce rupture. The weight of the leaf spring is reduced considerably about 85 % by replacing steel leaf spring with composite leaf spring.

"Loop wheels: because sometimes it's good to reinvent the wheel." Loop wheels are a new type of bicycle wheel that have been designed to make cycling more comfortable. Loop wheels feature a spring system between the hub and the rim of the wheel which provides suspension – cushioning the rider from bumps and potholes in the road. The spring configuration allows for the torque to be transferred smoothly between the hub and the rim. Front and rear Loop-wheels have different spring rates. A front and rear loop-wheel can be used together as a set, or you can use a single loop-wheel alongside a conventional spoked wheel. Loop-wheels provide suspension on a bike which has none, or can be fitted in addition to suspension forks to give a smoother, more comfortable ride.

2.2 TYPES OF WHEEL

There are three main types of bike tires. Each of these tires has its own peculiar characteristic features.

1. Tubular Wheel
2. Clinchers Wheel
3. Tubeless Wheel

1. Tubular Wheel

Tubular tires are structurally similar to clinchers in the sense that they also have inner tubes. However, they are stitched into a completely enclosed casing that would be glued to the rims. We must pay serious attention to the gluing of the inner tubes to the rims, or else it may be too dangerous to ride with such tires. Tubular tires are the lightest type of wheel and tire integrated equipment: This is why they are set apart for fast races such as cyclocross races. The low tire pressures in them make it possible to run over sharp objects and not get punctured.

2. Clincher Wheel

Almost ninety percent (90%) of the cyclists use clinchers (tubes or inner tubes) because of their great usefulness. Clinchers are very cheap affordable. It is the most popular type of bike tires, there are more manufacturers of clinchers than any other type of bike tires. Clinchers are very reliable and can be used consistently without experiencing any kinds of headache, if used properly and well taken care of.

3. Tubeless Wheel

Tubeless tires do not have tubes inside the tires, but depend mainly on the tires and rims producing an airtight chamber that will be strong enough, when pumped, to sustain the weight on the bike. The tire casings are harder than the other types of tires; hence, they are less susceptible to pinch flat. They don’t even have tubes that could be punctured. They are used mostly for races. But tubeless wheels are more costlier than tubed wheels.

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2.3 STUDY OF EXISTING SYSTEM

The first bicycle wheels followed the traditions of carriage building: a wooden hub, a fixed steel axle (the bearings were located in the fork ends), wooden spokes and a shrink fitted iron tire. A typical modern wheel has a metal hub, wire tension spokes and a metal or carbon fiber rim which holds a pneumatic rubber tire.

Recently using wheels contain following main parts:

1. Hub
2. Axle
3. Rim
4. Spoke
5. Rubber Tire

2.3.1 HUB

A hub is the center part of a bicycle wheel. It consists of an axle, bearings and a hub shell. The hub shell typically has two machined metal flanges to which spokes can be attached. Hub shells can be one-piece with press-in cartridge or free bearings or, in the case of older designs, the flanges may be affixed to a separate hub shell.

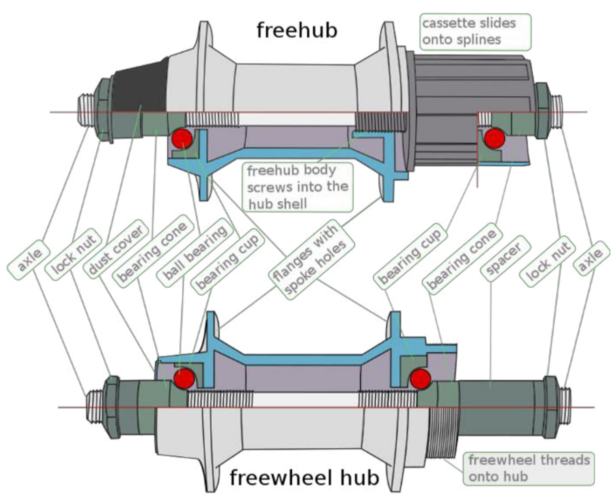


Figure 1: Wheel Hub

2.3.2 AXLE

The axle is attached to dropouts on the fork or the frame. There are accessories that can be attach to axle:

1. Quick release mechanism
2. Nut
3. Bolt
4. Thru axle
5. Female axle

1. Quick release mechanism

A lever and skewer that pass through a hollow axle designed to allow for installation and removal of the wheel without any tools (found on most modern road bikes and some mountain bikes).

2. Nut

The axle is threaded and protrudes past the sides of the fork/frame. (Often found on track, fixed gear, single speed, BMX and inexpensive bikes)

3. Bolt

The axle has a hole with threads cut into it and a bolt can be screwed into those threads. (Found on some single speed hubs, Cannondale Lefty hubs)

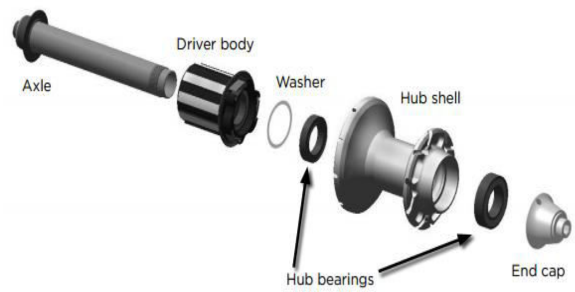
4. Thru axle

A removable axle with a threaded end that is inserted through a hole in one fork leg, through the hub, and then screwed into the other fork leg. Some axles have integrated cam levers that compress axle elements against the fork leg to lock it in place, while others rely on pinch bolts on the fork leg to secure it. Diameters for front thru axles include 20 mm, 15 mm, 12 mm, and 9 mm. Rear axles typically have diameters of 10 or 12 mm. Most thru axles are found on mountain bikes, although increasingly disc-braked cyclocross and road bikes are using them. Thru axles repeatably locate the wheel in the fork or frame, which is important to prevent misalignment of brake rotors when using disc brakes. Unlike other axle systems (except Lefty), the thru axle is specific to the fork or frame, not the hub. Hubs/wheels do not include axles, and the axle is generally supplied with the fork or frame. Adapters are usually available to convert wheels suitable for a larger thru axle to a smaller diameter, and to standard 9mm quick releases. This allows a degree of re-use of wheels between frames with different axle specifications.

5. **Female axle**

Hollow center axle, typically 14, 15, 17, or 20 mm in diameter made of chromoly and aluminum, with two bolts thread into on either side. This design can be much stronger than traditional axles, which are commonly only 8 mm, 9 mm, 9.5 mm, or 10 mm in diameter.

Modern bicycles have adopted standard axle spacing: the hubs of front wheels are generally 100 mm wide fork spacing, road wheels with free hubs generally have a 130 mm wide rear wheel hub. Mountain bikes have adopted a 135 mm rear hub width, which allows clearance to mount a brake disc on the hub or to decrease the wheel dish for a more durable wheel. Free ride and downhill are available with both 142 and 150 mm spacing.



(A) Axle Used on Wheel (B) Axle Assembled with Hub

Figure 2:(A) Axle Used in Wheel; (B) Axle Assembled with Hub

2.3.3 RIM

The rim is commonly a metal extrusion that is butted into itself to form a hoop, though may also be a structure of carbon fiber composite, and was historically made of wood. Some wheels use both an aerodynamic carbon hoop bonded to an aluminum rim on which to mount conventional bicycle tires.

Metallic bicycle rims are now normally made of aluminum alloy, although until the 1980s most bicycle rims - with the exception of those used on racing bicycles - were made of steel and thermoplastic.

Rims designed for use with rim brakes provide a smooth parallel braking surface, while rims meant for use with disc brakes or hub brakes sometimes lack this surface. The Westwood pattern rim was one of the first rim designs, and rod-actuated brakes, which press against the inside surface of the rim were designed for this rim. These rims cannot be used with caliper rim brakes.

Table 1: Rim Options for Rim Brakes

Brand & Model	Material	External Width	Height	Shape	Tubeless Compatible	Weight (g)	Hole Drillings Available
CBK CA50C-25 *[1]	Alu/Carbon	25	50	U	No	590	16-32
DT Swiss R460	Alu'	23	23	U	Yes	460	24-32
DT Swiss RR511	Alu'	21.5	32	U	Yes	530	20-32
Flo 30	Alu'	26	30	U	Yes	570	20-32
H Plus Son Archeype	Alu'	23	25	V	No	470	20-36
Halo Carbaura A	Alu/Carbon	23	38	U	Yes	535	20-24
HED Belgium Plus	Alu'	25	24	V	Yes	465	20-32
Kinlin XR-22	Alu'	24	22	V	Yes	440	20-32
Kinlin XR-31T / BHS C31w / Halo Devaura	Alu'	24	31	V	Yes	485	16-36
Mavic CXP Pro *[2]	Alu'	19	24	V	No	470	32
Pacenti Forza	Alu'	25	26	U	Yes	460	20-32

The cross-section of a rim can have a wide range of geometry, each optimized for particular performance goals. Aerodynamics, mass and inertia, stiffness, durability, tubeless tire compatibility, brake compatibility, and cost are all considerations. If the part of the cross-section of the rim is hollow where the spokes attached, as in the Sprint rim pictured, it is described as box-section or double-wall to distinguish it from single-wall rims such as the Westwood rim pictured. The double wall can make the rim stiffer. Triple-wall rims have additional reinforcement inside the box-section.

There is three types of bicycle rim' cross-section:

1. **Westwood rim:**

   This rim is fitted to vintage roadster bicycles with rod/ stirrup brakes, today being used in contemporary "drum brake" traditional utility bicycles.

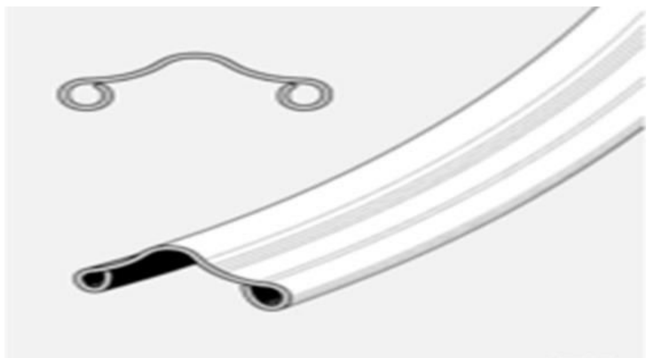


Figure 3: Westwood Rim

2. **Endrick Rim:**

   This rim is fitted to sports bicycles from the 1930s, 40s and 50s, forerunner of modern-day rim brakes.

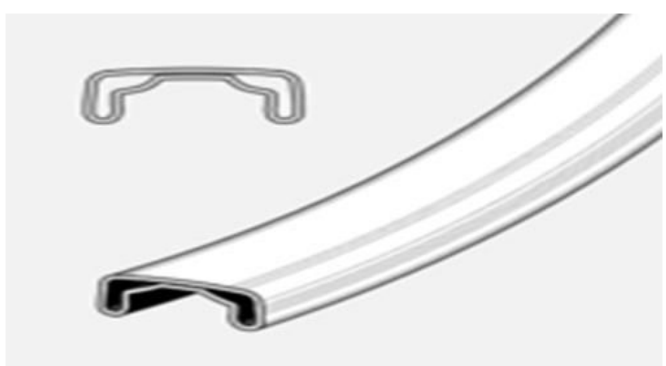


Figure 4: Endrick Rim

3. **Sprint Rim:**

   This rim is referred for tubular tires.

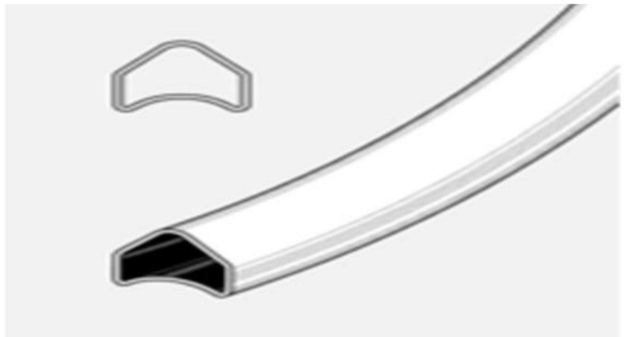


Figure 5: Sprint Rim

2.2.4 SPOKE

The rim is connected to the hub by several spokes under tension. Original bicycle wheels used wooden spokes that could be loaded only in compression, modern bicycle wheels almost exclusively use spokes that can only be loaded in tension. There are a few companies making wheels with spokes that are used in both compression and tension.

One end of each spoke is threaded for a specialized nut, called a nipple, which is used to connect the spoke to the rim and adjust the tension in the spoke. This is normally at the rim end. The hub end normally has a 90 degree bend to pass through the spoke hole in the hub, and a head so it does not slip through the hole.

Double-butted spokes have reduced thickness over the center section and are lighter, more elastic, and more aerodynamic than spokes of uniform thickness. Single-butted spokes are thicker at the hub and then taper to a thinner section all the way to the threads at the rim. Triple-butted spokes also exist and are thickest at the hub, thinner at the threaded end, and thinnest in the middle.

Apart from tubeless wheels, which do not need them, tubed bicycle wheels require rim tapes or strips, a flexible but tough liner strip (usually rubber or woven nylon or similar material) attached to the inner circumference of the wheel to cover the ends of the nipples. Otherwise, the nipple ends wear a hole in the tube causing a flat tire.

In 2007, Mavic introduced their R-Sys, a new bicycle spoke technology that allows the spokes to be loaded in both tension and compression. This technology is promised to allow for fewer spokes, lower wheel weight and inertia, increased wheel stiffness, with no loss of durability. However, in 2009 Mavic recalled R-Sys front wheels due to spoke failures leading to collapse of the entire wheel.

The spokes on the vast majority of modern bicycle wheels are steel or stainless steel. Stainless steel spokes are favored by most manufacturers and riders for their durability, stiffness, damage tolerance, and ease of maintenance. Spokes are also available in titanium, aluminum, or carbon fiber.

Figure 6: Spokes

2.2.5 RUBBER TIRE

Bicycle tires provide an important source of suspension, generate the lateral forces necessary for balancing and turning, and generate the longitudinal forces necessary for propulsion and braking. They are the second largest source, after air drag, of power consumption on a level road. The modern detachable pneumatic bicycle tire contributed to the popularity and eventual dominance of the safety bicycle.

2.4 LOAD EFFECT DUE TO PAVEMENTS

Every moving wheel induces dynamic deflections which alternately causes tensile and compressive stresses in the road structure. The damage that vehicles do to a road structure depends greatly on the magnitude of the axle loads. This is reflected in the system used for determination of design loading, where the damaging effect of an axle loading follows an exponential function which was derived from the road test and resulted in the following equivalency formula:

$$Load\ Equivalency\ Factor = \frac{Actual\ axle\ load}{Standard\ axle\ load}$$

The relative damage to a pavement is the number of repetitions of a load that will result in pavement failure and increases very rapidly with increasing axle loads. This means, if the axle load is doubled the damage will not be merely doubled but will be increased twenty fold (because the damage increases exponentially).

This relationship indicates, for example, that an axle carrying, twice the legal load has 22 times the damaging effect of a legal axle load. In addition to axle load the damaging effect from traffic has been found, amongst others, to depend upon the following factors:

- Axle type and spacing
- Wheel type
- Uneven load distribution on dual tries
- Tire pressure

2.5 ROAD CONDITION IN INDIA

The roads in our villages, towns and cities are bumpy and are not traffic-worthy. In villages there are ups and downs on the streets or roads and if it is dark one may stumble. The Panchayats, municipalities and corporations are not particular in laying good roads, in mending them.

Road construction quality and maintenance have a direct impact on ride quality in vehicles. In jurisdictions where all roads are relatively smooth, the passengers are undisturbed already and the vehicle can be optimized for a higher degree of handling. In most industrialized countries like, as well as in many developing countries like India, pavement condition is scanned on road network.

Here in India roads are in bad shape. The suburbs of the towns and the cities have bad roads with the result that there is traffic bottleneck. After rainy session bog potholes on road and uneven terrain occur. Therefore, riding after rainy session is very uncomfortable. Sometimes accidents are caused as the roads are in bad shape. In the middle of the road there may be a pothole where water may be stagnant, and to avoid the pothole, a car going straight may suddenly swerve to the left or to the right. The vehicle coming behind may dash on it resulting in an accident.

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3

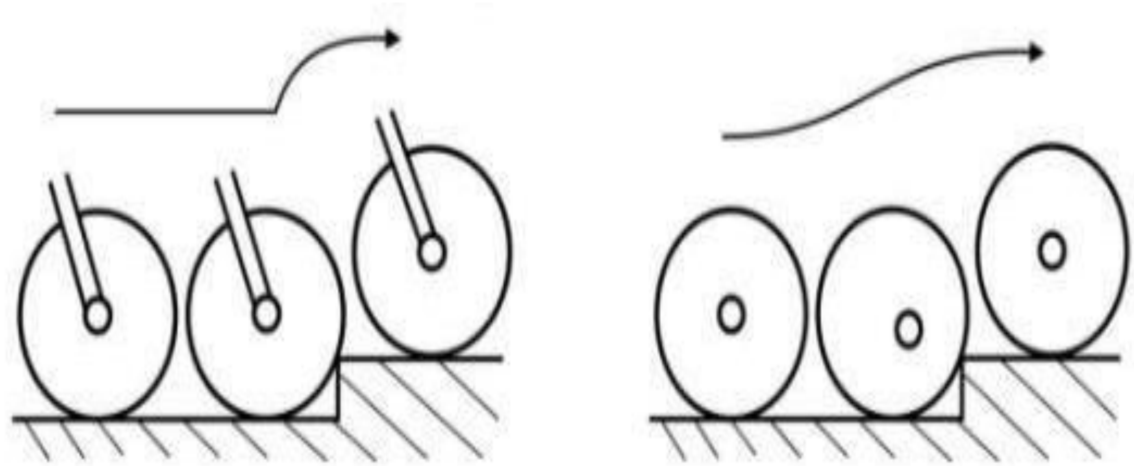
DESIGN CONSIDERATION

3.1 INTRODUCTION

Although the origin of the wheel may be obscure, its invention as a load carrying device marked the advent of machinery. Today the wheel is an essential part of most machines in the form of gears, pulleys, cams, sprockets, bearings, and other rotating devices. However, it is still most conspicuous as a load carrier; and, from a technical perspective, the bicycle wheel stands out as one of the most elegant of these

The wire-spoked bicycle wheel was introduced more than a century ago to replace wooden wheels with thick, rigid spokes. Tensioning the wires made these wheels possible, and with them came the lightweight bicycle that we know today. Wire spokes not only reduced weight but also improved durability. Today's wire wheels can carry more than a hundred times their own weight. In off-road bicycling, skilled riders often jump from high obstacles, subjecting their wheels to forces of more than a quarter ton. Although the bicycle is the world's most common vehicle, few people understand how its wheels achieve their unusual strength. Constant and better comfort throughout can be achieved by making certain simple necessary changes in the regular design of the front wheel suspension system. The significant change is introduction of a tangential suspension system in the wheel itself. This ensures that it absorbs shocks from all the directions.

All the shocks, coming in travel through the center that is the hub. In regular design the hub is fixed with rigid spokes joining it to the rim and hence, practically takes no part in providing suspension. Here, understanding the importance of hub, it has been given the ability to move and recoil back to its original position. This floating hub has the ability to move not by resting on fixed spokes of that of a regular bicycle. Here, the fixed spokes of the bicycle is replaced with spring like material that has damping ability. It is known that a leaf spring is a simple form of spring commonly used for the suspension in wheeled vehicles. A spring made of a number of strips of metal curved slightly upwards and clamped together one above the other. Here instead of clamping the springs together, they are used individually.



(A) (B)

Figure 7: (A) Normal Wheel Design; (B) Modified Wheel Design

3.2 DESIGN CRITERION

The main target was to achieve the desired deflections in the suspension for a particular weight of driver. Considering the application EN45 material is selected for leaf. The thickness of the leaf is determined by assuming it to be a cantilever beam and designing it for bending failure and the design was then analyzed in Ansys software. The stiffness of the leaf can be changed by simply shifting the mounting positions of the leaf at the wheel's end. By changing the effective length of the leaf we can change the stiffness and hence control the hub travel. The wheel was designed considering the impact forces coming from the ground and lateral forces while cornering. Iterations were done to find the number of leaves to be used by checking the stresses and nature of deformation for 3 and 4 leaves only. Using more number of leaves will lead to unnecessary increase in weight. The analysis was done on Ansys v15.0 software to check the stresses and deformation in the system. A custom hub is designed to accommodate all the leaves with the help of nut and bolts.

Dimension of cross section of the leaf is to be determined. The width of the leaf material was kept as 35mm as it cannot be more than the width of the wheel. Considering front impact case, using impulse momentum theorem,

F*t = m*v

Time of impact, t=0.5 sec

Mass of cycle including rider, m= 100 kg

Max. Velocity, v=30kmph= 8.3 m/s

F= 1660 N

For determining the thickness of the Leaf, let us consider it as a cantilevered beam.

Bending Stress is given by

S_b= 400 MPa

W= 1660 N

L= 350mm

B= 35mm

From above equation, we get thickness of leaf, t=2.913 ~ 3mm.

3.3 PROCEDURE FOR ANSYS ANALYSIS

Static analysis is used to determine the displacements stresses, stains and forces in structures or components due to loads that act on the component. Steady loading in response conditions are assumed. The kinds of loading that can be applied in a static analysis include externally applied forces and pressures, steady state inertial forces such as gravity or rotational velocity imposed (non-zero) displacements, temperatures (for thermal strain). A static analysis can be either linear or nonlinear. Work we consider linear static analysis.

The procedure for static analysis consists of these main steps:

1. Building the model
2. Obtaining the solution
3. Reviewing the results.

3.3.1 MATERIAL PROPERTIES OF MATERIALS:

Table 2: Properties of EN44 & EN8

Properties	**EN44**	**EN8**
Density	7850 kg/m^3	7820 kg/m^3
Young's Modulus	205 GPa	205 GPa
Tensile Strength	800 MPa	680 MPa
Bending Strength	450MPa	420MPa
Poission's Ratio	0.33	0.3

3.3.2 ANALYSIS OF LEAF

The Leaf was designed in Catia V5R20. The material used for Leaf is EN45 as it possess the properties like high elasticity and higher fatigue strength.

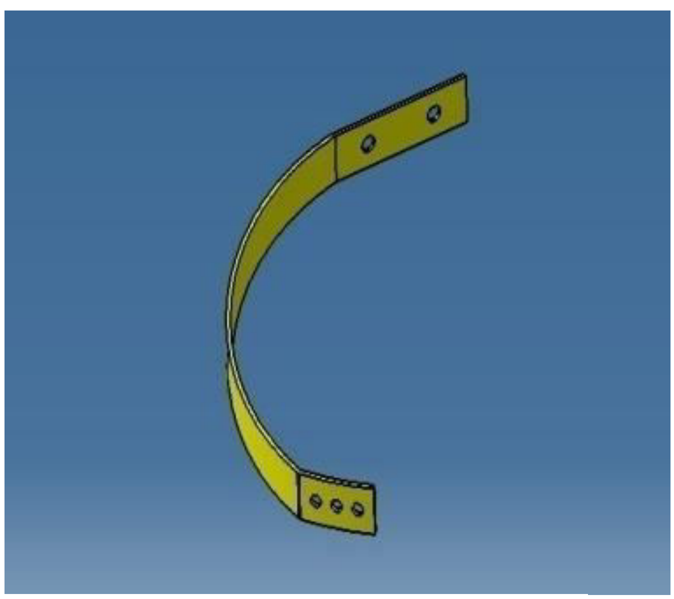


Figure 8: CAD Model of Leaf

Static structural analysis is done to find the safety of the leaf under impact. For analysis of leaf it was assumed as a cantilever, the end which is attached to hub was constrained and the force due to impact was applied on the other end.

3.3.3 ANALYSIS OF HUB

A custom hub is designed to accommodate the leaf springs. Material used for hub is EN8 as it has the properties of high strength and hardness. Structural analysis is done, taking into consideration the forces acting on the hub.

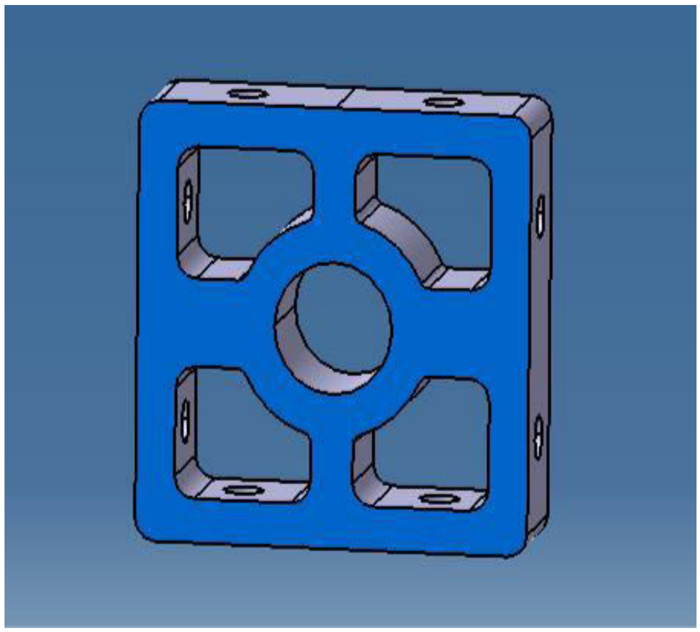


Figure 9: CAD Model Hub

Table 3: Results of analysis of Hub

Object Name	Total Deformation	Equivalent Stress
Minimum	0. mm	0.13633 MPa
Maximum	7.3358e-003 mm	25.42 MPa

3.3.4 IMPACT FORCE ANALYSIS

Steady state structural analysis is performed to check the safety of the design. Using impulse momentum principle, force was calculated when the cycle hits a rigid wall with a velocity of 30kmph. The force obtained was 1660 N.

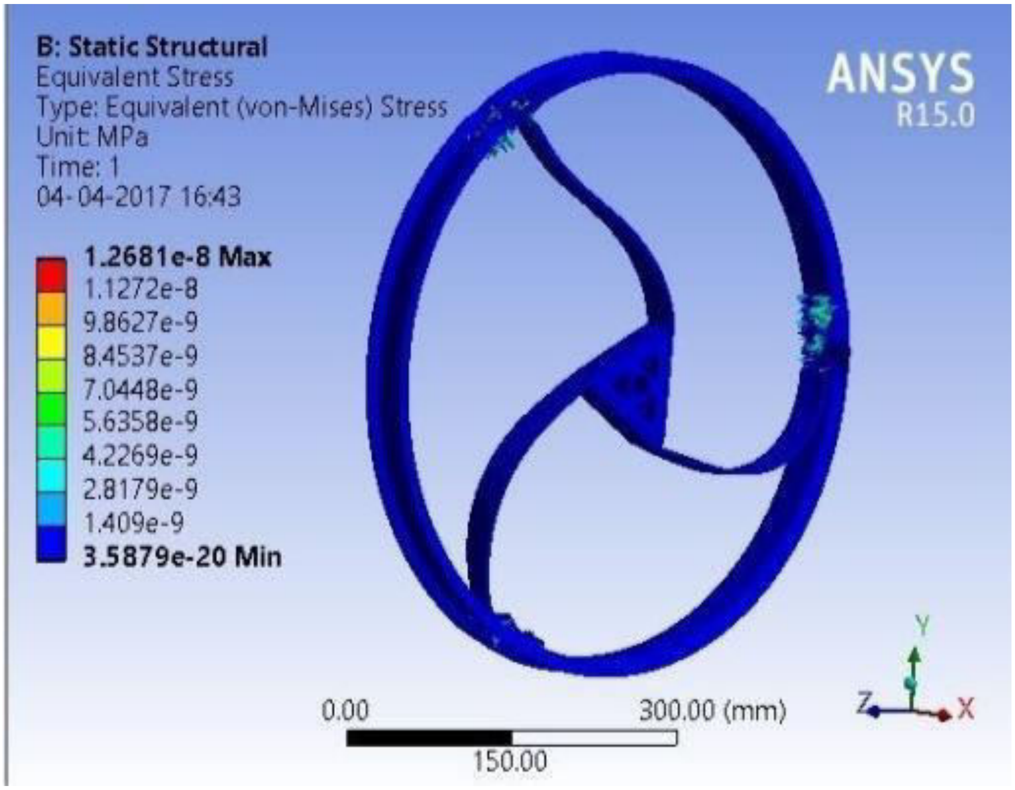


Figure 10: Stress Distribution in Impact Forces for 3 Leaf

Table 4: Result of Analysis of 3 Leaf Wheel for Front Impact

Object Name	Total Deformation	Equivalent Stress
Minimum	0. mm	0.11642MPa
Maximum	12.1 mm	676.44MPa

Table 5: Stress Distribution in Impact Forces for 4 Leaf

Object Name	Total Deformation	Equivalent Stress
Minimum	0. mm	0.11642 MPa
Maximum	9.45 mm	535.3 MPa

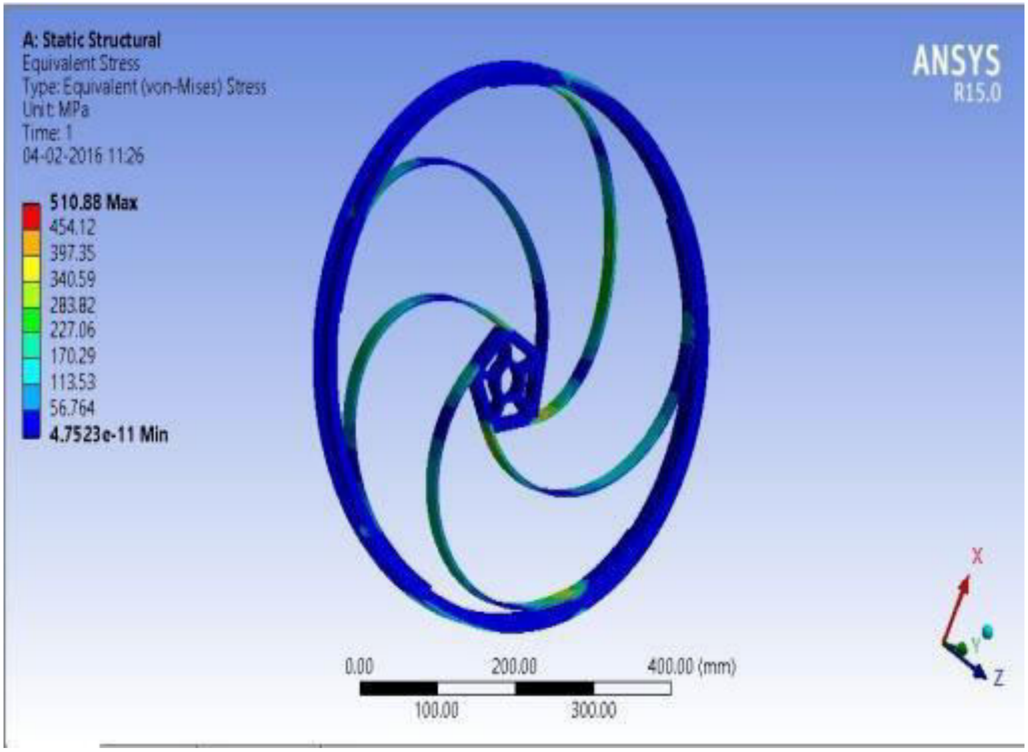


Figure 11: Stress Distribution in Impact Forces for 5 Leaf

Table 6: Result of analysis of 5 leaf wheel for front impact

Object Name	Total Deformation	Equivalent Stress
Minimum	0. mm	4.7523e-011MPa
Maximum	4.78 mm	510.88 Pa

3.3.5 LATERAL FORCE ANALYSIS

It is important to check the safety of design in cornering conditions, the system must remain stable while taking any sharp turn. The wheel is constrained and lateral force was applied at the center of the hub in the lateral direction.

Force was calculated for condition where cycle takes a turn of radius 2m at a velocity of 30kmph. 1400 N force was applied at the center of the hub in the lateral direction. The main consideration was to have least deflection in the lateral direction which will determine the stability of the system while cornering.

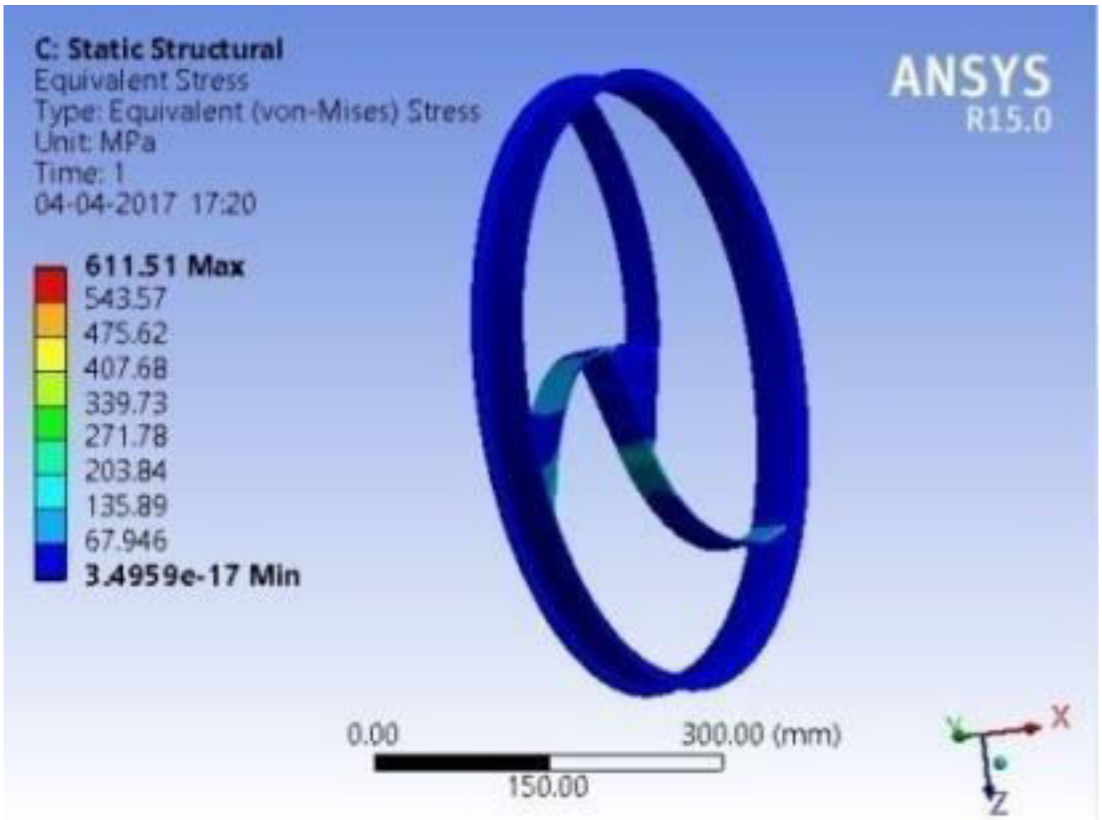


Figure 12 Stress Distribution in Lateral Forces for 3 Leaf

Table 7: Result of analysis of 5 leaf wheel for front impact

Object Name	Total Deformation	Equivalent Stress
Minimum	0. mm	8.1233e-009MPa
Maximum	2.5813 mm	611.51 MPa

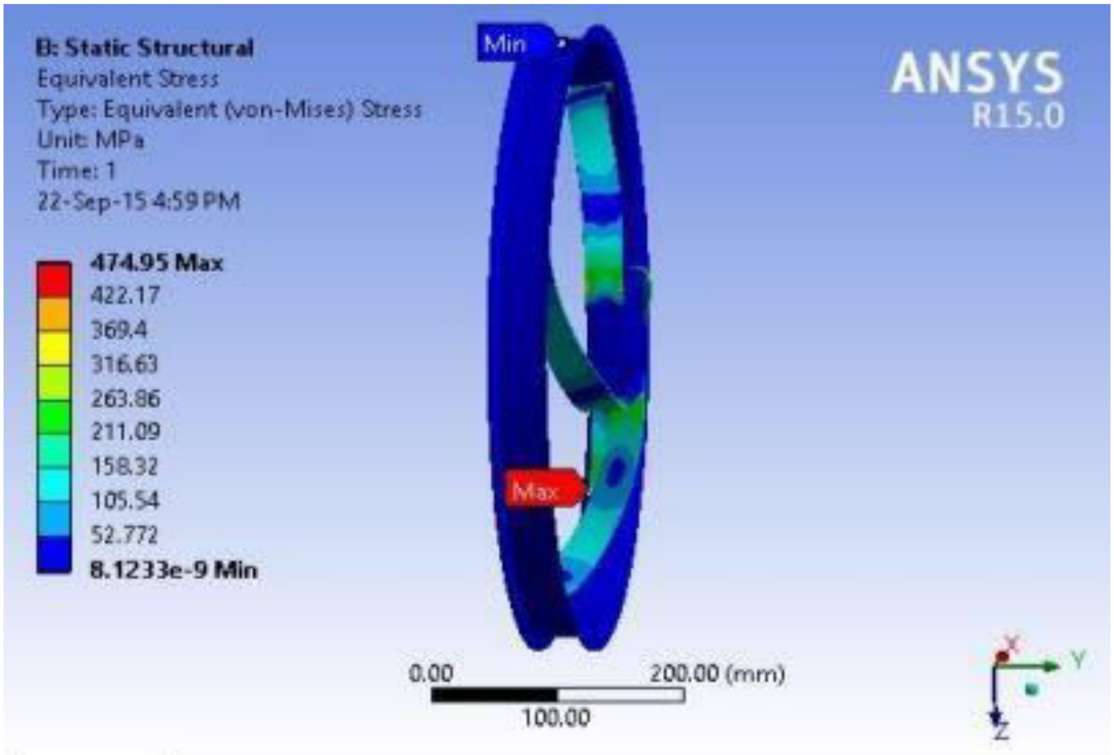


Figure 13 Stress Distribution in Lateral Forces for 4 Leaf

Table 8: Results of Analysis of 4 Leaf Wheel for Lateral Forces

Object Name	Total Deformation	Equivalent Stress
Minimum	0. mm	8.1233e-009MPa
Maximum	3.24 mm	475 MPa

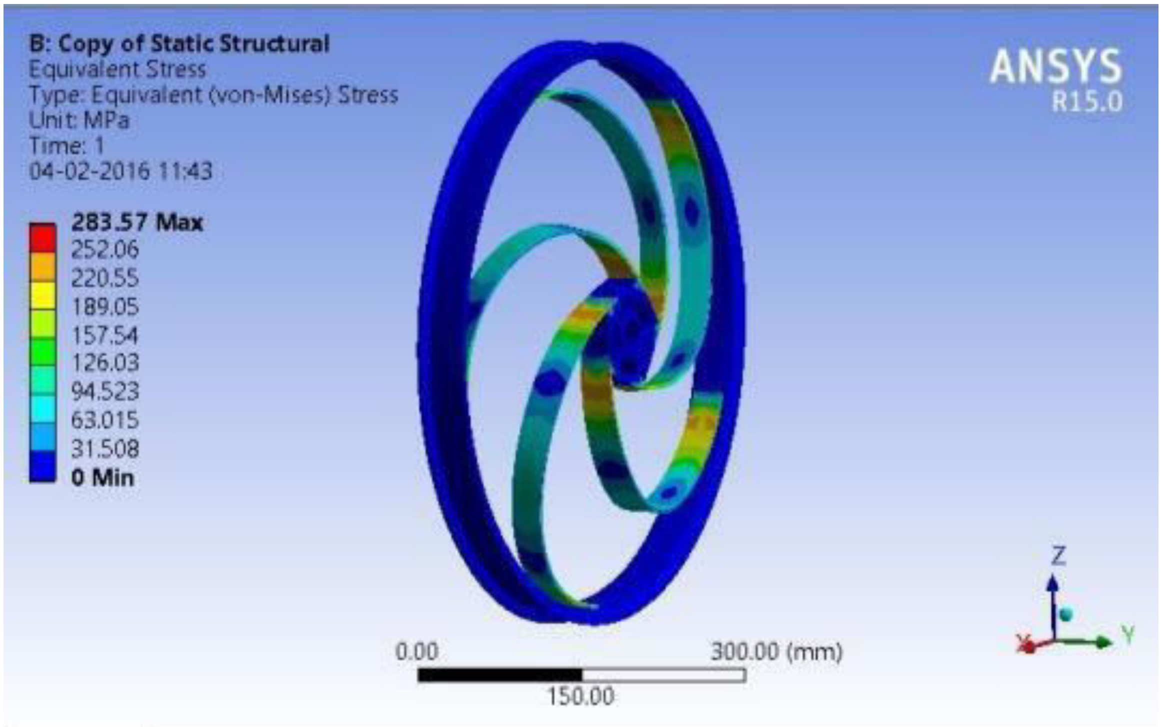


Figure 14: Stress in Lateral Forces for 5 Leaf

Table 9: Results of Analysis of 5 Leaf Wheel for Lateral Forces

Object Name	Total Deformation	Equivalent Stress
Minimum	0. mm	8.1233e-009MPa
Maximum	2.08 mm	283.57 MPa

3.4 Selecting an Optimum Design

Before selecting an optimum design it is important to consider all the other parameters like weight of design, manufacturing feasibility, nature of deformation and cost. It is necessary that the weight should be less and the manufacturing should be simple and easy to reduce the overall cost of the product.

The nature of deformation should be in desired way so that whenever any impact comes the stability of the wheel is maintained at the same time the shock should be absorbed and it should regain its original shape as soon as the wheel crosses the disturbance

After comparing all the results and considering other parameters following conclusions are made:

Table 9: Comparison between 3, 4& 5 Leaf Wheel

Parameter	**3 Leaf**	**4 Leaf**	**5 Leaf**
Equi. Stress	676.4 MPa	535.5 MPa	510.4MPa
Total Deformation	12.1 mm	9.4 mm	4.38 mm
Weight	3.95 kg	4.75 kg	6.25 lg

3.4 COMPARISON OF DIFFERENT PARAMETERS

We analyzed the designs for 3, 4 and normal wheel for different loading conditions taking 800N, 1200N and 1600N forces. We represented this data in graphical form for better analysis.

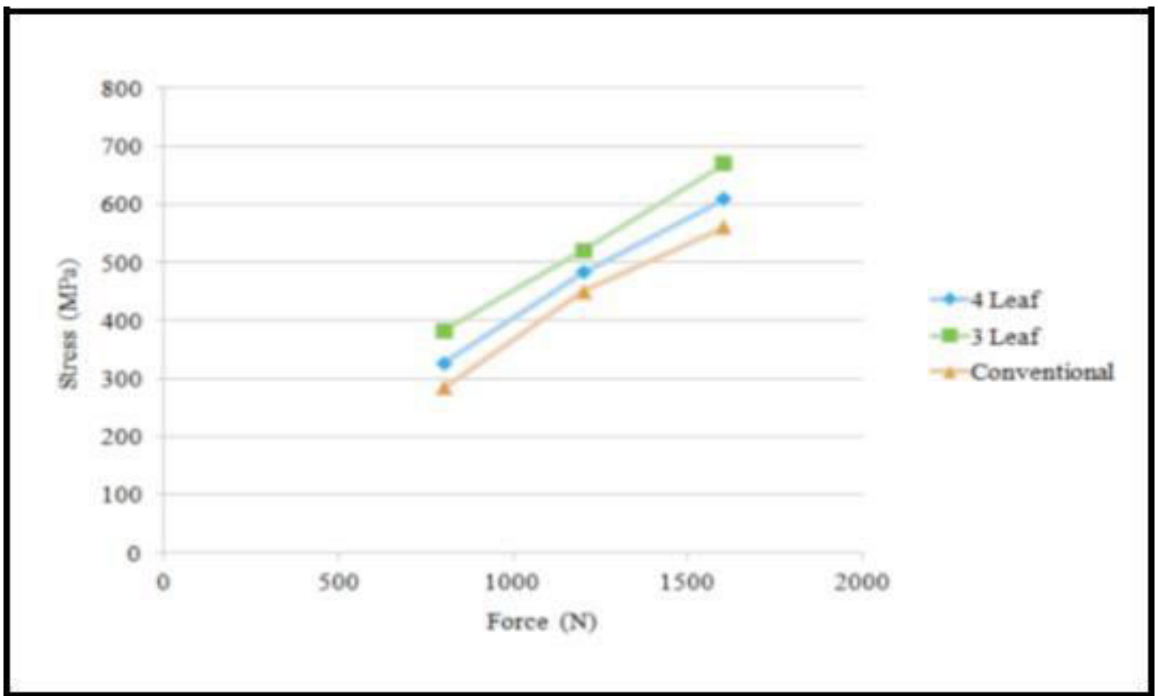


Figure 15: Graph 1- Stress vs. Load for Impact Condition

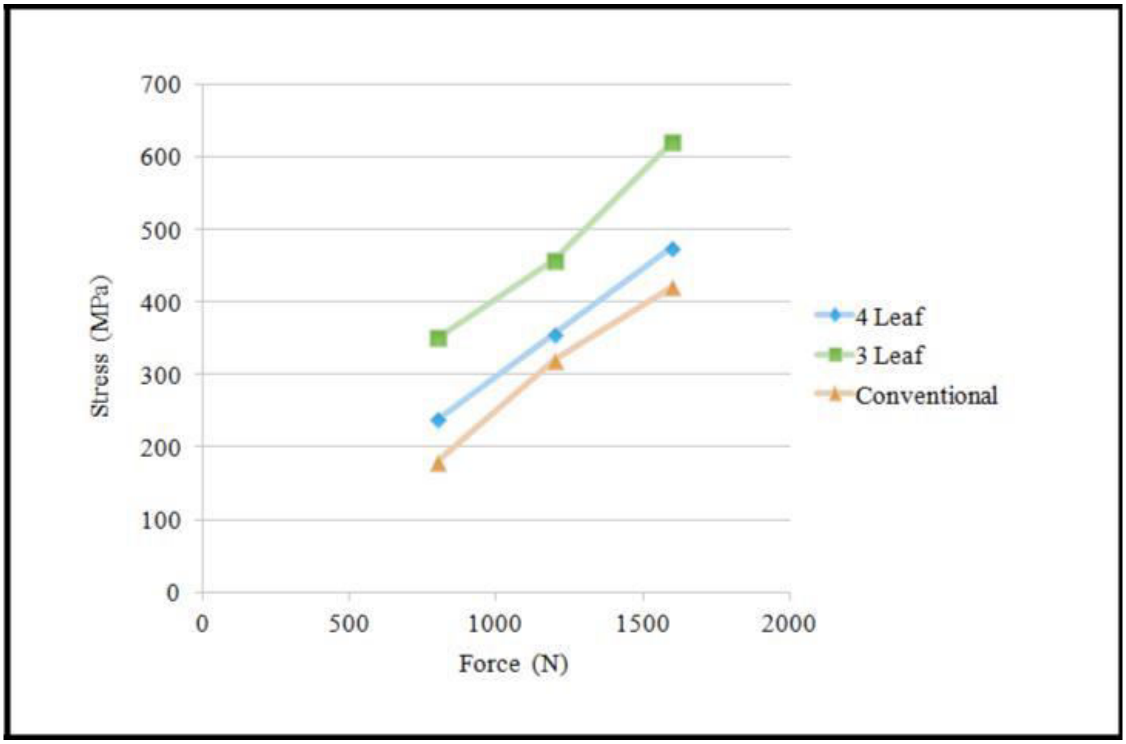


Figure 16: Graph 2- Stress vs. Load for Lateral force Condition

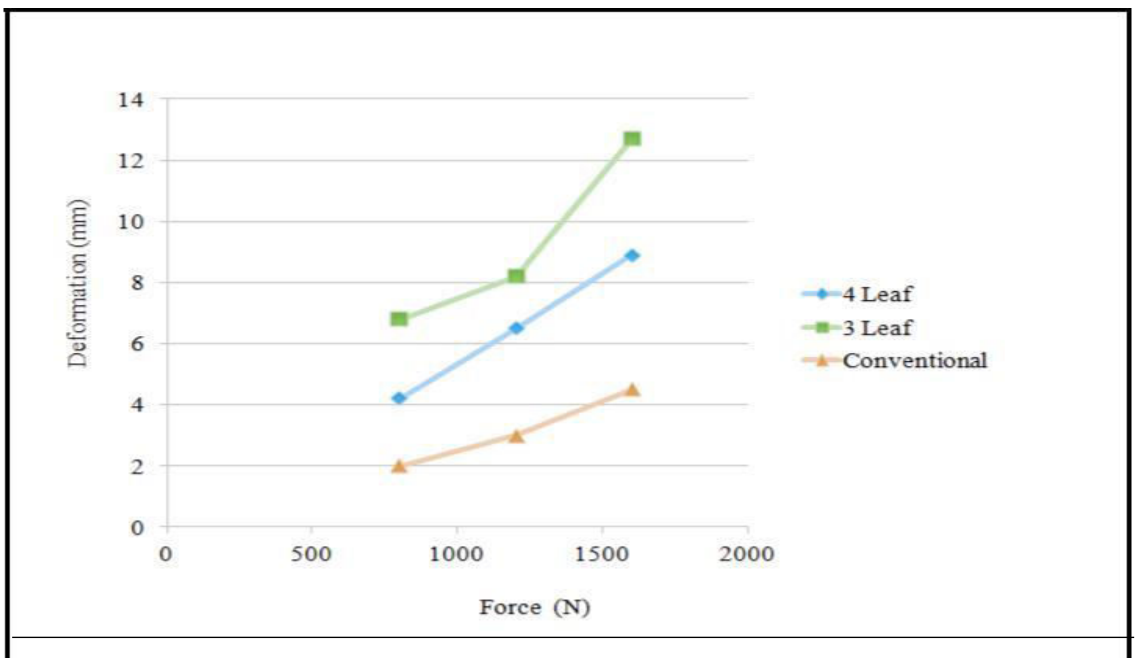


Figure 17: Graph 3- Deformation vs. Force in Impact Condition

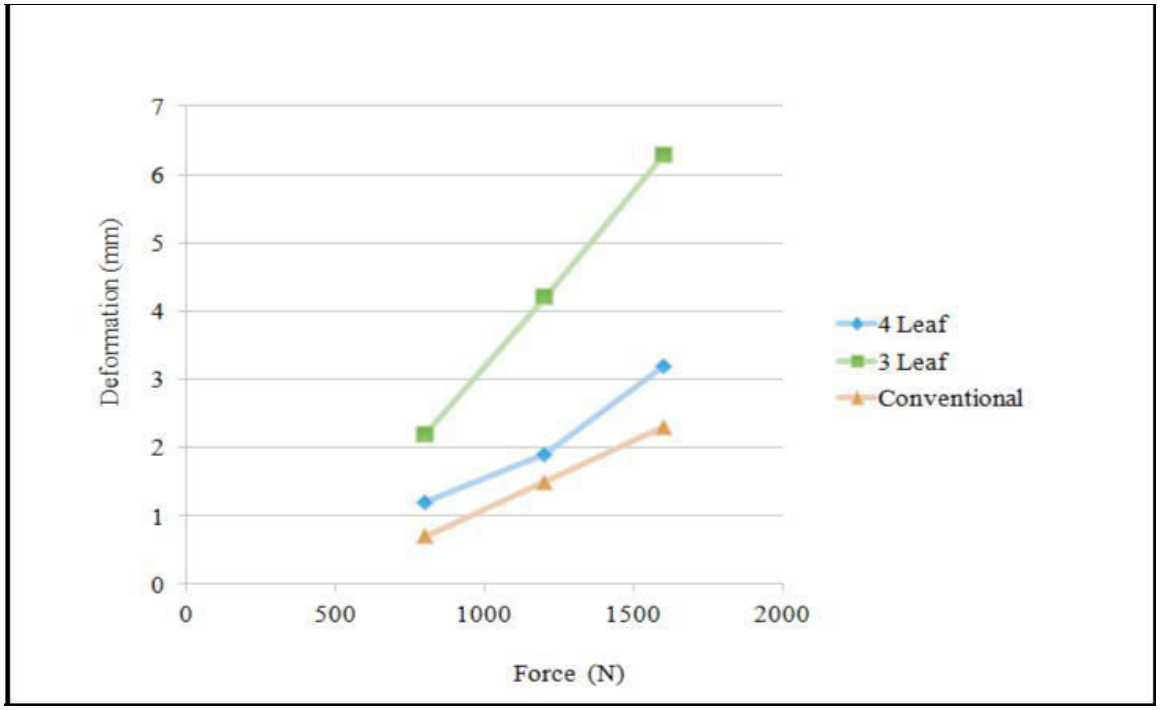


Figure 18: Graph 4- Deformation vs. Force in Lateral Conditions

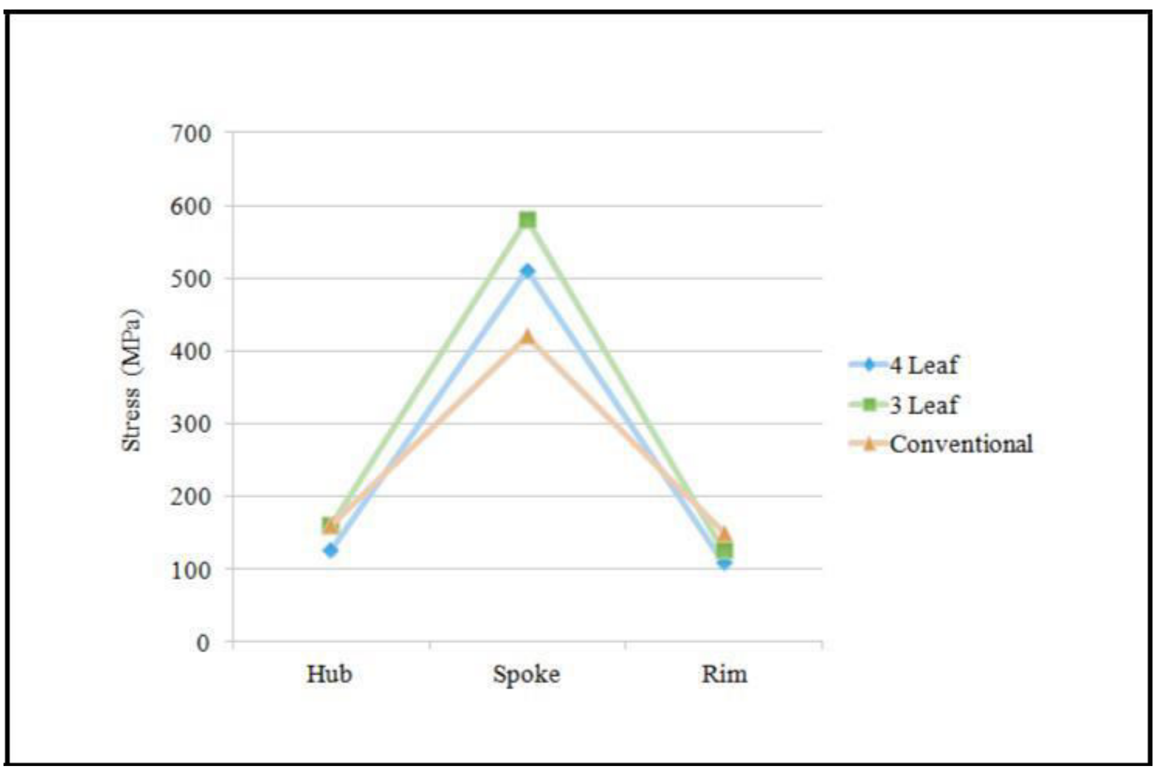


Figure 19: Graph 5- Maximum Stress at Different Components in Impact Condition.

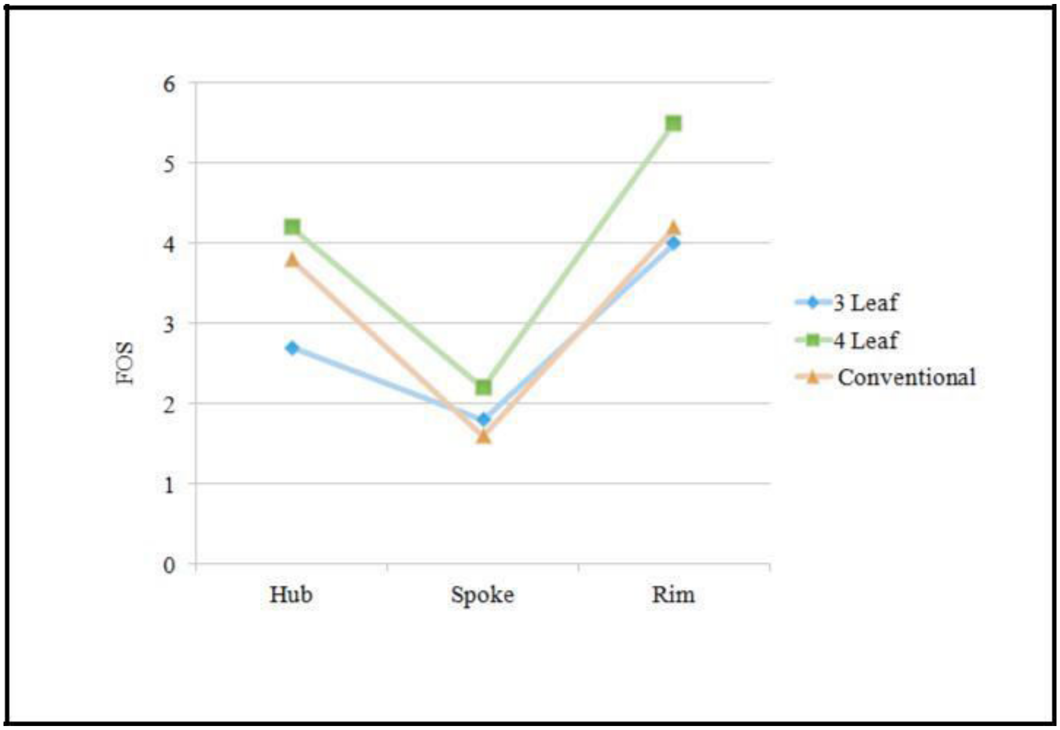


Figure 20: Graph 7- Factor of Safety at Different Components

4

FABRICATION

4.1 INTRODUCTION

Loop wheels offer you a smoother ride. Loop wheel springs are usually made up of a composite material carefully developed to offer optimum compression and lateral stability as well as strength and durability.

4.2 REINVENTION OF BICYCLE WHEEL

Shock absorbing wheel are new type of bicycle wheel that have been designed to make cycling more comfortable.

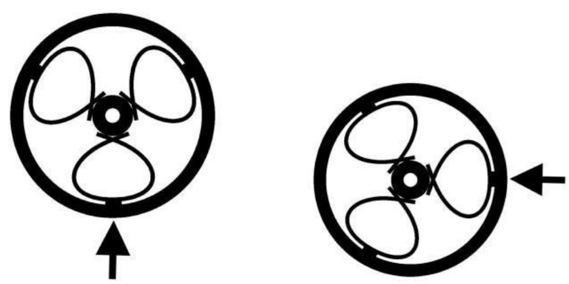
Loopwheels feature a spring system between the hub and the rim of the wheel which provides suspension – cushioning the rider from bumps and poth holes in the road. They also have a conventional hub with a hub brake and hub gears. Because of the suspension within the wheel, you can use high-pressure or puncture-resist tyres. So you don’t need to rely on fat (and sluggish) tyres to cushion your ride.

Loopwheel springs are made from a carbon composite, carefully developed and tested to give optimum compression and lateral stability as well as strength and durability. Specially-designed connectors attach the springs to the hub and rim. There are three springs in each wheel, which work together as a self-correcting system. The spring configuration allows for the torque to be transferred smoothly between the hub and the rim.

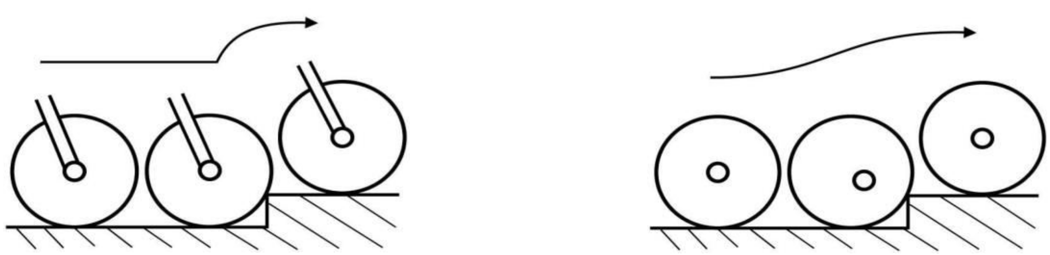
Front and rear loopwheels have different spring rates. A front and rear loopwheel can be used together as a set, or you can use a single loopwheel alongside a conventional spoked wheel. Loopwheels provide suspension on a bike which has none, or can be fitted in addition to suspension forks to give a smoother, more comfortable.

4.3 WORKING OF SHOCK ABSORBING WHEEL MECHANISM

Unlike suspension forks, loopwheels provide tangential suspension: that is, they work in every direction. So they respond to a force hit head-on in the same way as they do to a force from above or below.



The spring system between the hub and the rim of the wheel provides suspension that constantly adjusts to uneven terrain – cushioning the rider from bumps and potholes in the road. In effect, the hub floats within the rim, adjusting constantly as shocks from an uneven road hit the rim of the wheel. The spring configuration allows the torque to be transferred smoothly between the hub and the rim. We have developed loop wheels with consideration that the weight of the rider and cycle body to be equally distributed over the wheels of the bicycle. Every loop wheel is designed for same compression rate.



Conventional Shock absorbing wheel

4.4 COMPONENTS OF SHOCK ABSORBING WHEEL

4.4.1. WHEEL RIM

The rim is commonly a metal extrusion that is butted into itself to form a hoop, though may also be a structure of carbon fiber composite. Bicycle wheels are typically designed to fit into the frame and fork via dropouts, and hold bicycle tires

Metallic bicycle rims are now normally made of aluminum alloy, although until the 1980s most bicycle rims - with the exception of those used on racing bicycles - were made of steel and thermoplastic. Rims designed for use with rim brakes provide a smooth parallel braking surface

Figure 21: wheel Rim

4.4.2. LOOP SPRING

A loop spring is a simple form of spring commonly used for the suspension in wheeled vehicles. Originally called a laminated or carriage spring, and sometimes referred to as a semi-elliptical spring or cart spring, it is one of the oldest forms of springing, dating back to medieval times.

A loop spring takes the form of a slender arc-shaped length of spring steel of rectangular cross-section loops formed at either end provide for attaching to the wheel hub and rim.

The leaf spring acts as a linkage for holding the axle in position and thus separate linkages are not necessary. It makes the construction of the suspension simple and strong. Because the positioning of the axle is carried out by the leaf springs, it is disadvantageous to use soft springs i.e. springs with low spring constant. Therefore, this type of suspension does not provide good riding comfort.

Figure 22 Loop Spring

4.4.3 Hub of Wheel

A square hub is the center part of a bicycle wheel. It consists of an axle, bearings and a hub shell. The hub is the center of the wheel, and typically houses a bearing, and is where the axle is mounted inside it. The axle is hollow, following the wheel at very close tolerances. In square shape hub its faces in outer sides are provided to rest leaf springs on it.

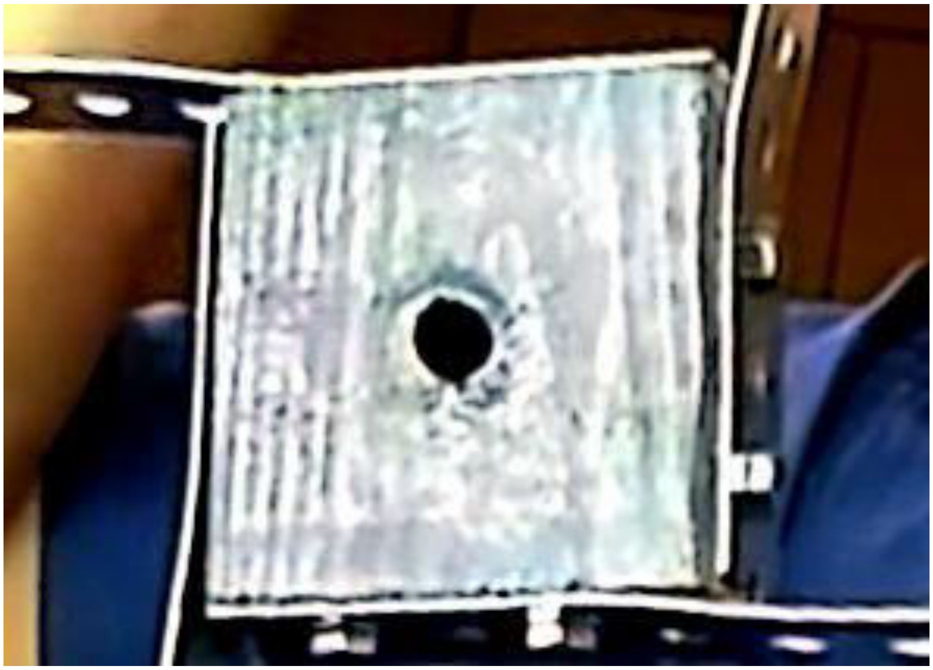


Figure 23 Square Hub

The hub sits at the centre and provides the axis of rotation. Within each hub, front and back, is the axle which attaches the wheel to the bike. On the rear wheel the hub features splines which a cassette attaches to. The bike's chain wraps around the sprockets of the cassette, and in association with the crankset and shifters, forms the bikes drivetrain which propels it forward. As well as propelling the bike forward, all road bike wheels (excluding fixed-wheel bikes) will use a rear hub with a 'freehub' mechanism which allows the bike to coast

4.4.4 AXLE OF WHEEL

The axle is attached to dropouts on the spring or the frame.

The axle can attach using a:

Quick release - a lever and skewer that pass through a hollow axle designed to allow for installation and removal of the wheel without any tools

Nut - the axle is threaded and protrudes past the sides of the fork/frame.

Bolt - the axle has a hole with threads cut into it and a bolt can be screwed into those threads.

Figure 24 Axle of wheel

4.4.5 TIRES IN BIYCLES

A **bicycle tire** is a tire that fits on the wheel of a bicycle, unicycle, tricycle, quadracycle, bicycle trailer, or trailer bike. They may also be used on wheelchairs and handcycles, especially for racing. Bicycle tires provide an important source of suspension, generate the lateral forces necessary for balancing and turning, and generate the longitudinal forces necessary for propulsion and braking. They are the second largest source, after air drag, of power consumption on a level road

Figure 25 Bicycle Tire

4.5 BENEFITS OF SHOCK ABSORBING WHEELS

- Tangential suspension

  This gives you a really smooth ride. People find they can tackle bumps, kerbs and cobbles much more easily on loopwheels than on normal, spoked wheels.

- Less vibration, increased comfort

  Less experience of the usual vibration up the arms, because loopwheels absorb and isolate us from the “noise” of the road. So we will get less wrist and shoulder ache on long rides.

- More FUN

  Last, but not least, less discomfort means more fun in long rides.

4.6 APPLICATION

- Bicycles
- Mountain Bikes
- Wheel Chairs
- Off road Bicycles

****

5

CONCLUSION

Bicycle with loop wheel suspension system provides smoother ride, high shock absorption capacity, avoids the necessity of additional suspension system. Also this loop wheels can find their applications in wheel chairs, mountain bikes because of their capacity to adjust to uneven terrain, cushioning the rider from abnormalities in the road. Analysis on deformation has been done which shows that the calculated and the values obtained using ANSYS are in accordance with each other which suggests that the design is safe. Comparing 3 leaf and 4 leaf design, the stresses developed in 3 leaf is very high and hence the design is discarded. The layout of spokes in conventional wheel enables proper stress distribution.

The main problem in the four leaf design was the high expected deflection occurring due to lateral forces. However from analysis, we can clearly see that the deformation of four leaf is more than conventional wheel. Hence the problem is satisfactorily resolved. The leaf or the spoke being the weakest component, the FOS for four leaf design is the highest. Also even after failure of leaf, the replacement of the component is simple and less expensive due to flexibility in design.

The drawback of the four leaf design in terms of stress and deformation against the conventional wheel design is balanced because of its ability to absorb shocks from any direction.

6

FUTURE EXPANSION

In the process of development of shock absorbing wheel with integrated suspension, we identified some useful features. But according to the time limitations and the human resource limitations, some feature only remain in our mind. But we would like to include them in next semester.

Remaining work to complete this model in next term is include.

- Springs can be replaced with damper.
- Provide better lateral stability.
- To reduce oscillation after absorbing shock by using more stiffer material.
- To use this system into heavy duty two wheelers by modifying this.

7

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GOVERNMENT ENGINEERING COLLEGE PALANPUR
MECHANICAL ENGINEERING DEPARTMENT
B.E. SEMESTER VIII - PROJECT-II (2181909)

INTERNAL EVALUTION (20) 2017-18

Sr. No.	Criteria Enrolment No.	Innovativeness / Creativity (4)	Review of Literature / Related Studies (4)	Selection of Proper Tools / Techniques (4)	Content and Presentation (4)	Question and Answers (4)	Total (20)
1	130610119030	3.4	3.4	3.4	3.4	3.4	17.0
2	130610119052	3.4	3.4	3.4	3.4	3.4	17.0
3	130610119059	3.8	3.8	3.8	3.8	3.8	19.0
4	140610119001	3.8	3.8	3.8	3.8	3.8	19.0
5	140610119002	3.4	3.4	3.4	3.4	3.4	17.0
6	140610119003	3.8	3.8	3.8	3.8	3.8	19.0
7	140610119004	3.8	3.8	3.8	3.8	3.8	19.0
8	140610119005	3.8	3.8	3.8	3.8	3.8	19.0
9	140610119006	3.8	3.8	3.8	3.8	3.8	19.0
10	140610119008	3.8	3.8	3.8	3.8	3.8	19.0
11	140610119009	3.4	3.4	3.4	3.4	3.4	17.0
12	140610119010	3.8	3.8	3.8	3.8	3.8	19.0
13	140610119011	3.0	3.0	3.0	3.0	3.0	15.0
14	140610119012	3.8	3.8	3.8	3.8	3.8	19.0
15	140610119013	3.8	3.8	3.8	3.8	3.8	19.0
16	140610119015	3.8	3.8	3.8	3.8	3.8	19.0
17	140610119016	3.8	3.8	3.8	3.8	3.8	19.0
18	140610119017	3.8	3.8	3.8	3.8	3.8	19.0
19	140610119018	3.4	3.4	3.4	3.4	3.4	17.0
20	140610119019	3.8	3.8	3.8	3.8	3.8	19.0
21	140610119020	3.8	3.8	3.8	3.8	3.8	19.0
22	140610119021	3.4	3.4	3.4	3.4	3.4	17.0
23	140610119022	3.8	3.8	3.8	3.8	3.8	19.0
24	140610119023	3.0	3.0	3.0	3.0	3.0	15.0
25	140610119024	3.8	3.8	3.8	3.8	3.8	19.0
26	140610119025	3.8	3.8	3.8	3.8	3.8	19.0
27	140610119026	3.8	3.8	3.8	3.8	3.8	19.0
28	140610119027	3.4	3.4	3.4	3.4	3.4	17.0
29	140610119030	3.0	3.0	3.0	3.0	3.0	15.0
30	140610119031	3.4	3.4	3.4	3.4	3.4	17.0
31	140610119032	3.4	3.4	3.4	3.4	3.4	17.0

32	140610119033	3.8	3.8	3.8	3.8	3.8	19.0
33	140610119034	3.0	3.0	3.0	3.0	3.0	15.0
34	140610119035	3.8	3.8	3.8	3.8	3.8	19.0
35	140610119036	3.8	3.8	3.8	3.8	3.8	19.0
36	140610119037	3.0	3.0	3.0	3.0	3.0	15.0
37	140610119038	3.0	3.0	3.0	3.0	3.0	15.0
38	140610119039	3.8	3.8	3.8	3.8	3.8	19.0
39	140610119040	3.4	3.4	3.4	3.4	3.4	17.0
40	140610119041	3.4	3.4	3.4	3.4	3.4	17.0
41	140610119042	3.4	3.4	3.4	3.4	3.4	17.0
42	140610119043	3.8	3.8	3.8	3.8	3.8	19.0
43	140610119044	3.4	3.4	3.4	3.4	3.4	17.0
44	140610119045	3.4	3.4	3.4	3.4	3.4	17.0
45	140610119046	3.4	3.4	3.4	3.4	3.4	17.0
46	140610119047	3.8	3.8	3.8	3.8	3.8	19.0
47	140610119048	3.4	3.4	3.4	3.4	3.4	17.0
48	140610119049	3.8	3.8	3.8	3.8	3.8	19.0
49	140610119050	3.8	3.8	3.8	3.8	3.8	19.0
50	140610119051	3.8	3.8	3.8	3.8	3.8	19.0
51	140610119052	3.0	3.0	3.0	3.0	3.0	15.0
52	140610119053	3.8	3.8	3.8	3.8	3.8	19.0
53	140610119054	3.4	3.4	3.4	3.4	3.4	17.0
54	140610119055	3.4	3.4	3.4	3.4	3.4	17.0
55	140610119056	3.4	3.4	3.4	3.4	3.4	17.0
56	140610119059	3.4	3.4	3.4	3.4	3.4	17.0
57	140610119062	3.8	3.8	3.8	3.8	3.8	19.0
58	140610119063	3.8	3.8	3.8	3.8	3.8	19.0
59	150613119001	3.8	3.8	3.8	3.8	3.8	19.0
60	150613119003	3.8	3.8	3.8	3.8	3.8	19.0
61	150613119005	3.8	3.8	3.8	3.8	3.8	19.0
62	150613119006	3.8	3.8	3.8	3.8	3.8	19.0
63	150613119007	3.8	3.8	3.8	3.8	3.8	19.0
64	150613119008	3.0	3.0	3.0	3.0	3.0	15.0
65	150613119010	3.8	3.8	3.8	3.8	3.8	19.0
66	150613119011	3.8	3.8	3.8	3.8	3.8	19.0
67	150613119012	3.8	3.8	3.8	3.8	3.8	19.0