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ABSTRACT

The technology of pneumatics plays a major role in the field of automation and modern machine shops and space robots. The aim is to design and develop a control system controlled automotive pneumatic bumper activation with the provision for automatic braking. On sensing obstacles within close proximity say about 4m of the vehicle, actuation of the pneumatic bumper and braking is initiated. A double acting double rod pneumatic cylinder helps provide linkage between the bumper and the brake. The pneumatic bumper and braking system is used to protect the man and vehicle.

Chapter 1 : Introduction

India is considered one of fastest developing nations in the world. With large amount of investment in various sectors, there has been a rise in extensive use of vehicles. With increase in the quality and performance of the vehicles, less is considered when it comes to the safety of the vehicle. This has led to an increase in car accidents resulting in damage caused to property and life. Road accidents cater to a large percentage when compared to other causes of deaths like cancer or epidemic. An immediate solution for this alarmingly high rate is imperative.

There are various causes that result in accidents, a major cause being human error. Thus to minimize this we propose a pneumatic bumper system which acts as a damper during collision. Along with the extending bumper, there is a need of an automatic braking system, that hits the break when a collision is certain. Therefore, an economically viable and effective pre crashing system is required. It will prevent accidents in low visibility by using sensors to detect other vehicles or obstacles in the path.

Pneumatics has gained tremendous importance in the field of workplace rationalization and automation. We aim to design and manufacture a Pneumatic Bumper with automatic braking system, consisting of elements like an ultrasonic sensor, pneumatic cylinders, a microcontroller, solenoid valves. The main goal here being to improve the safety involved with automobiles.

The system is designed to detect any obstacle within a certain distance from the car bumper. In this case, the system will deploy safety measures by applying the brake and also projecting the bumper outwards to reduce impact. Thus, an improvement can be seen with the safety of a vehicle.

1.1. Aim and Objectives:

The aim of this project is to provide a safety system which would help reduce damage during accidents in four wheelers. The project involves the design, analysis and fabrication of a pneumatic bumper with automatic braking system.

Upon sensing obstacles at near proximity, two safety measures are deployed. Firstly, the bumper of the vehicle protrudes outwards with the help of a double acting double rod pneumatic cylinder. This would reduce the impact on the vehicle as well as on the passengers riding the vehicle in case of collision. The other end of the pneumatic cylinder, simultaneously initiates the brake which further reduces the chances of damage by reducing the speed of the vehicle.

The vehicle chosen for the design of the system is a **Hyundai i20**.

Following are the main objectives of Automatic Braking System with Pneumatic Bumpers:

- Design the prototype in CATIA
- Calculation and design of the various components
- Testing and analysis of the prototype
- Material procurement and costing
- Assembly of components
- Increase in passenger safety
- Increase in vehicle safety

1.2 Need:

Undeniably, accidents on highways and freeways, having fast moving traffic, are considered to be the most dangerous types of accidents. There are a lot of reasons which account for this. People traveling smoothly at high speeds and on open roads, often tend to become complacent. Before looking a solution for this, we first need to look at the reasons causing these undesirable situations.
First of all, the element of human error is always present. There are numerous cases of people falling asleep while driving, leading to disasters.

While one can never completely remove the unprecedented element of human error in any work of life, we can definitely aim to provide for a safety situation which would work in such a case. A system not dependent on human work, but automated and helped by sensors.

Another unavoidable cause for mishaps on the road is the aspect of visibility. Weather, is one of the most unpredictable and erratic factors of nature. In spite of numerous advances in meteorology, no one can predict with complete conviction the exact pattern of a day. If a particular road is inflicted with heavy fog or even during night time, visibility becomes a big issue. Even people not having any disorders with eye sight, tend to struggle at least a little bit in such adverse situations. Proving a safety measure, dependent on sensors for such situations, seems like the only reasonable and efficient answer.

Thus, the proposed Pneumatic Bumper with automatic Braking Systems, would aim to provide added safety measures for situations favorable for fatal accidents. Instead of depending of human eye sight, obstacles are detected with the help of an ultrasonic sensor.

1.3 Scope and limitations:

Our future work deals with incorporating this system with various different features to provide enhanced protection by the intelligent braking system in real time application. For that, some of the possible changes are:

- Ultrasonic sensors can be replaced by infrared sensors and can be used to sense the eye blinking and give signal to solenoid valve when driver sleeps.
- Regular bumpers can be replaced by hydraulic bumpers.
- Limit switch can be used to limit the minimum speed above which the system gets triggered.
- PIC can be implemented in system for further modifications like gradual slowdown of vehicle.
- Bumper design can further be enhanced to act as external air bags.
- With some modifications, the project can be used with timer circuits so as to apply brakes and extend the bumper after a delay of few milliseconds so that the bumper does not extend unless the vehicle just reaches the crashing distance.

Although the system have a lot scope of improvement it also has a lot of limitations which may restrict its use. Some of these are defined below:

- System has some limitations in densely traffic road, particularly danger to pedestrians.
- The pneumatic cylinders require a compressor to work, which increases the cost of the system.
- Installing this complete system, would use up a lot of space in the vehicle.
- Additional cost is required to use the system.
- System has no provision to prevent accidents from rear side of vehicle.

Chapter 2 : Literature Review

G.L. Gissinger, C. Menard, A. Constans

This paper describes a new intelligent braking system for motor vehicles. A mechatronic approach helped to avoid some of the drawbacks found in conventional systems. The brake was designed according to the so-called ‘‘full contact disc brake’’ principle, which means that the classic pads are replaced by the whole discs and that—for maximum performance brake is controlled continuously and not cyclically as with classic ABS systems.

Thus the principle of full contact disc brake is taken into consideration for the project.

Dragan Aleksendric, Zivana Jakolijevic, Velimir Cirovic

In this journal a new approach has been proposed for easy and effective monitoring modelling prediction and control of the braking process i.e. Brake performance during a cycle.

Two different dynamic neural models have been developed and integrated into the microcontroller. The neural modes based on recurrent dynamic neural networks are implemented in 8 bit CMOS microcontroller for control of the disc brake.

This gives us the idea of improving the overall performance of braking with the help of microcontroller.

Mr. Nivesh Thepade, Mr. Lakhan Thombare, Mr. Pritish Varude and

Prof. Ashish Umbarkar

The research has been carried out on an automatic braking system with pneumatic bumpers. With use of proximity sensors the distance of nearby obstacles from vehicle can be measured, and a signal can be generated to the comparator circuit which gives output to the transistor circuit. The transistor circuit output is coupled to the relay,

which controls the motor and the pneumatic circuit actuator, such as a solenoid valve. Thus reducing the speed of the vehicle with automatic braking and reducing the damage to the vehicle by using the actuating bumpers if a collision is expected by the system.

This journal helped us in the implementation of the circuit design.

Mr. Shinde Abhijeet Balasaheb, Mr. Panase Prathmesh Shantaram, Mr. Chemate Pravin Dadabhau, Mr. Pawar Sandip Raghunath and ProfDhage S.K

The system is based on intelligent electronically control system known as "Automatic pneumatic bumper braking system". This system consists of two mechanisms, Braking system and Pneumatic bumper system. Then sensor sends feedback signal to engine through the relay control to stop the working of engine. During the working of Automatic braking system simultaneously the driver also try to stop the vehicle by applying brake pedal. Limit switch is placed below the brake pedal which activates the pneumatic bumper system and brake to reduce the damage to vehicle which occurs in accidents.The journal above helps us with the circuit design and the pneumatic bumper assembly design.

Sandeep Thorat, Sanket Thorve, Jaydatta Upase and Agampal Singh Dhupar

Scope of the project is to develop an ultrasonic sensor to detect the obstacle and to process the output from the ultrasonic sensor and to drive the pneumatic cylinder as an actuator. Using ultrasonic as a ranging sensor, its function based on ultrasonic wave. The braking circuit's function is to slow down or stop the car automatically after receiving signal from the sensor. This leads us with the idea of adding sensors to pneumatic bumpers.

Chapter 3: Components

3.1 Pneumatic Cylinder:

The word ‘pneuma’ comes from Greek and means breather wind. The word pneumatics is the study of air movement and its phenomena is derived from the word pneuma. Today pneumatics is mainly understood to means the application of air as a working medium in industry especially the driving and controlling of machines and equipment.

Pneumatic systems operate on a supply of compressed air which must be made available in sufficient quantity and at a pressure to suit the capacity of the system. The key part of any facility for supply of compressed air is by means using reciprocating compressor. A compressor is a machine that takes in air, gas at a certain pressure and delivered the air at a high pressure. Compressor capacity is the actual quantity of air compressed and delivered and the volume expressed is that of the air at intake conditions namely at atmosphere pressure and normal ambient temperature.
Any gas can be used in pneumatic system but air is the mostly used system now a days. A double acting double rod cylinder makes it easier to operate the machinery as well as the movement of the system attached to it. The rod with the given specifications is used (bore diameter: 32 mm and stroke length: 100 mm)

Fig. 3.1 Pneumatic Cylinder

Bore Dia in (mm)	Rod Dia in (mm)	Working Pressure in bar		
		3	4	7
32	12	187	249	435

Table 3.1.1 Output Force

3.2 Solenoid Valve:

A solenoid is an electrical device that converts electrical energy into straight line motion and force and controls the flow of liquids and gases. These are also used to operate a mechanical operation which in turn operates the valve mechanism. Solenoids may be of two types, push type or pull type. The push type solenoid is one in which the plunger is pushed when the solenoid is energized electrically. The pull type solenoid is one is which the plunger is pulled when the solenoid is energized. The solenoid valve consists of electromagnetic coil, stem and spring.

Single 5/2 solenoid valve (1/4") was selected for speedy operation and to reduce the manual effort and also for the modification of the machine into automatic machine by means of using a solenoid valve.

Fig. 3.2 Solenoid Valve

3.3 Ultrasonic Sensor:

Ultrasonic ranging and detecting devices use high frequency sound waves called ultrasonic waves to detect presence of an object and obstacles. The transmitter and receiver circuit is used to sense the obstacle. Care should be taken in the choice of sensory devices for particular tasks. The operating characteristics of each device should be closely matched to the task for which it is being utilized. Different sensors can be used in different ways to sense same conditions and the same sensors can be used in different ways to sense different conditions. The operation of the sensor used is not affected by sunlight or black material. The sensor used is HC SR04 with ultrasonic module having 4 pins, ground, VCC, trig and echo and its range being upto 2m.

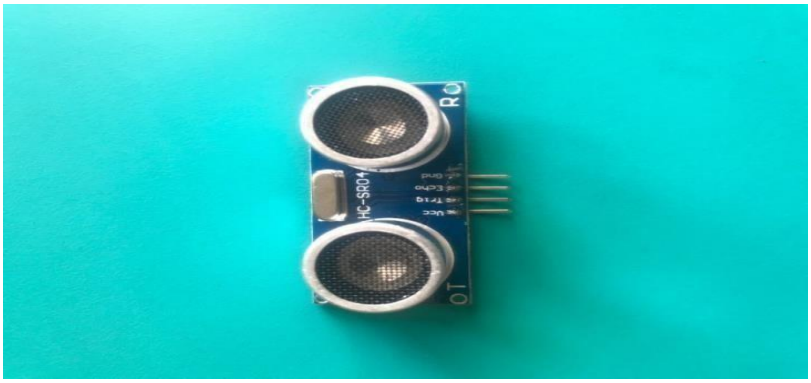

Fig. 3.3 Ultrasonic Sensor

3.4 ATmega328P

ATmega328P is a single chip microcontroller created by Atmel, which is used to program the control system.

Features-

1.7 High Performance, Low Power AVR® 8-Bit Microcontroller

- **a** 131 Powerful Instructions – Most Single Clock Cycle Execution
- **b** 32 x 8 General Purpose Working Register
- **c** Fully Static Operation

2.7 Peripheral Features

- **d** Two 8-bit Timer/Counters with Separate Prescalar and Compare Mode
- **e** One 16-bit Timer/Counter with Separate Prescalar, Compare Mode, and

1 Capture mode.

2 Real Time Counter with Separate Oscillator

3 Special Microcontroller Features

4 Power-on Reset and Programmable Brown-out Detection

5 Internal Calibrated Oscillator

6 I/O and Packages

7 23 Programmable I/O Lines

8 28-pin PDIP, 32-lead TQFP, 28-pad QFN/MLF and 32-pad QFN/MLF

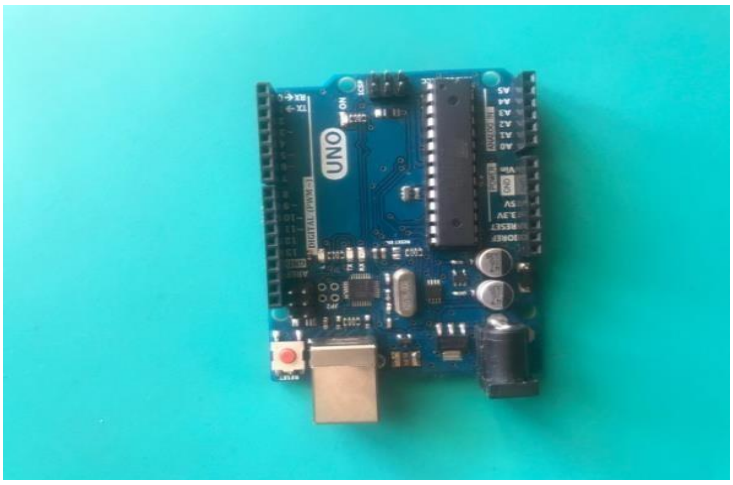

Fig. 3.4 Control Unit

3.5 Bearings:

Bearing is a device that support load and reduces the friction of motion between moving parts the materials used for bearings may be metals and alloys or non - metals. Bearings provide desired motion for the shaft. Bearing used is a deep groove ball bearing. We have used the bearing 6904 with an ID of 20mm and an OD of 37mm. Its thickness is 9mm and weight of 0.036kg. Its basic load rating are: 6.4KN and Static: 3.7KN. The limiting speeds are: Grease: 19000 rpm and oil: 23000 rpm.

Fig. 3.5 Bearings

3.6 Compressor (Air Tank):

A compressor is a device that increases the pressure of gas by reducing its volume. To actuate the double acting double rod cylinder, a source of air is required which will be provided by the compressor. The pressure required for the process is 3-4 bar which will be provided by the compressor.

3.7 Relay:

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations. This is a supporting frame and made up of mild steel. It is used to support the whole setup rigidly. The frame was made by means of welding steel rods. Mild steel has a high resistance to breakage. Mild steel, as opposed to higher carbon steels, is quite malleable, even when cold. This means it has high tensile and impact strength. Higher carbon steels usually shatter or crack under stress, while mild steel bends or deforms.

Relay used in our project is a single channel DC 5V operated relay. Maximum permissible current being 7A.

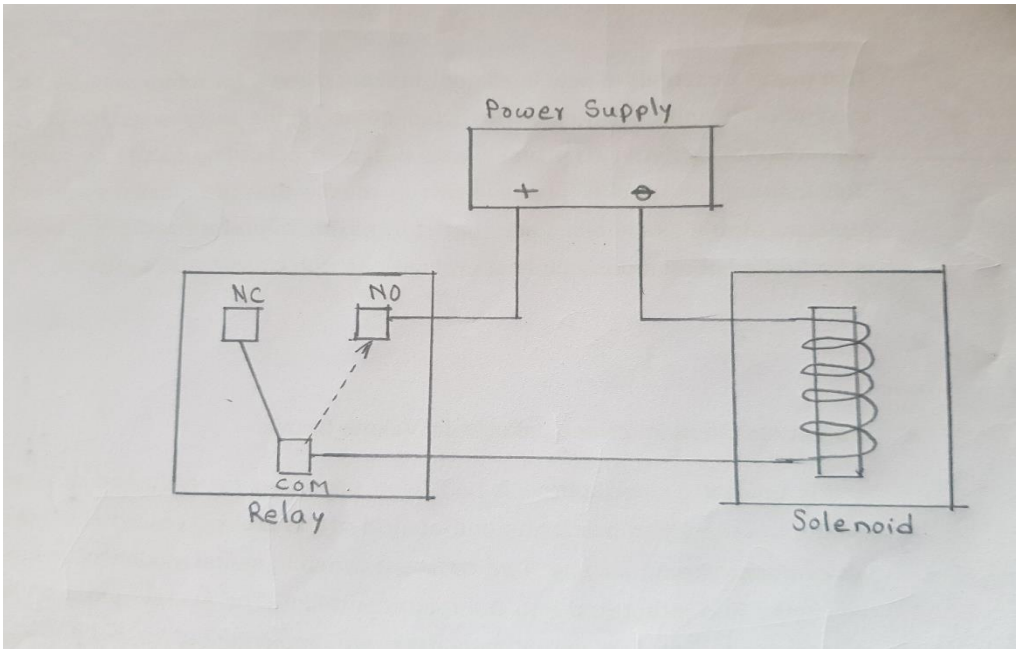

Fig 3.6 Circuit Diagram for control of relay

4. Calculations:

4.1 Shaft Calculations:

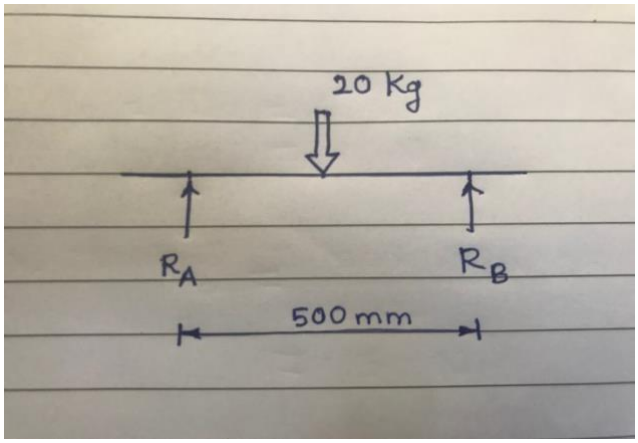

Fig. 4.1 Load Calculations for Shaft

(Assume g= 10 m/s^2)

Ra = Rb = 10*10

= **100N**

Max. Bending Moment = (20*20) * 250*10^{-3}

= 50Nm

Considering, Twisting moment "T" (Hand Rotating)

T = 1Nm

Equivalent Torque,

$\mathbf{T_{eq}} = \sqrt{(M2} + \sqrt{T2})$

$= \sqrt{(50} * 50 + \sqrt{1})$

= **50 Nm**

T_{eq} = 3.14/16 * D^3 T

Assume T = 400 MPa for mild steel

D^3 = 50 * 16/3.14 * 1/400 * 10^3

D^3 = 636.62

D = 8.6mm

D=9 mm

Assume,

FOS = 2.2

= 9 *2.2

D = 19.8 mm

D = 20 mm

Deflections:

$\theta = 32TL$ / Gπd^4

Assume G = 77GPa

G = $77*10^3$ $\theta = \frac{32\times50\times10000\times500}{77\times10000\times\pi\times16000}$

$\boldsymbol{\theta = 0.0207mm}$

4.2 Bearing Calculations:

P = XFr + YFa

Where,

P = Equivalent dynamic load (N)

X= Radial load factor

Fr = Radial load (N)

X= Axial load factor

Fa = Axial load (N)

In our case, only radial load is applies and no axial load is applied on bearing.

Fa = 0

P = XFr + 0

P = Fr since X = 1

P = 10 *9.81 since m = 10kg

P = 98.1 N

$L_{10} = 60 * N * 5000 \div 10^6$

$L_{10} = 19.5 * 10^6$ revolutions

$= 20 * 10^6$ revolutions

$C = P * (L_{10})^{1/3}$

$C = 98.1 * (20)_{1/3}$

= 266.28 N

4.3 Cylinder Calculations:

Assume minimum working pressure = 4 bar = 400 KPa

Assume,

d_1 = 32 mm, d_2 = 12 mm

$F_{min.} = 3.14 * P (d_{12} - d_{22}) / 4$

$= 3.14 * 400 *(32^2 - 12^2) / 4$

= **276.46 KN**

Assume maximum working pressure = 7 bar = 700 KPa

Assume,

d_1 = 32 mm , d_2 = 12 mm

Therefore, $F_{max} = 3.14 * P * (d_1^2 - d_2^2) / 4$

$= 3.14 * 700 * (32^2 - 12^2) / 4$

= **483.8 KN**

5. Construction

In our project, a proximity sensor (an Ultrasonic sensor) is used to monitor the distance of nearby obstacles from vehicle and it gives a signal to the control unit (Arduino UNO microcontroller). The control unit in turn gives output to a solenoid valve. The solenoid Valve is used to actuate double acting double rod cylinder. One end of cylinder is connected to the bumper, whereas the other end is connected to the sleeve of the brake drum. All components are supported on a frame. A wheel is provided through a shaft fixed on the frame. The bumper, with the provision of linear motion (inward/ outward), is mounted on the frame with the help of two shafts. Inside the bumper there is one ultrasonic sensor placed to sense obstacles and vehicle.

5.1 CAD Design of Setup

The Warning systems in any device are integrated with safety systems designed to warn the user about the potential threat. Such a system monitors the dynamic state of the possible danger in real time by processing information from various sensors. It assesses the potential threat level and decides whether a warning should be issued to the user through auditory and/or visual signals. Most of the accidents can be avoided if proper braking is applied in right time.

CATIA files of the individual parts. **All scale values are in accordance to A4 paper.**

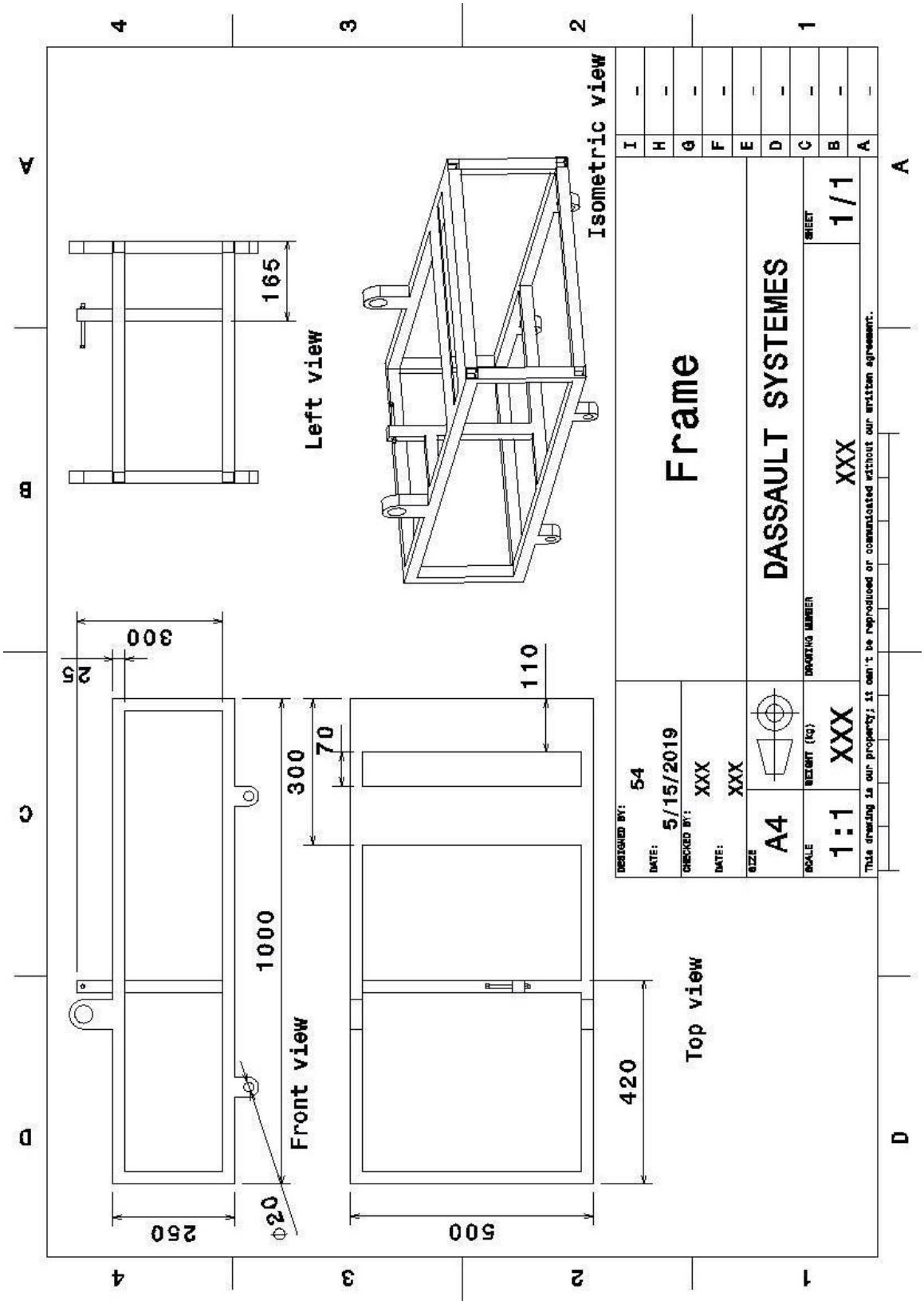

Fig. 5.1.1 Frame

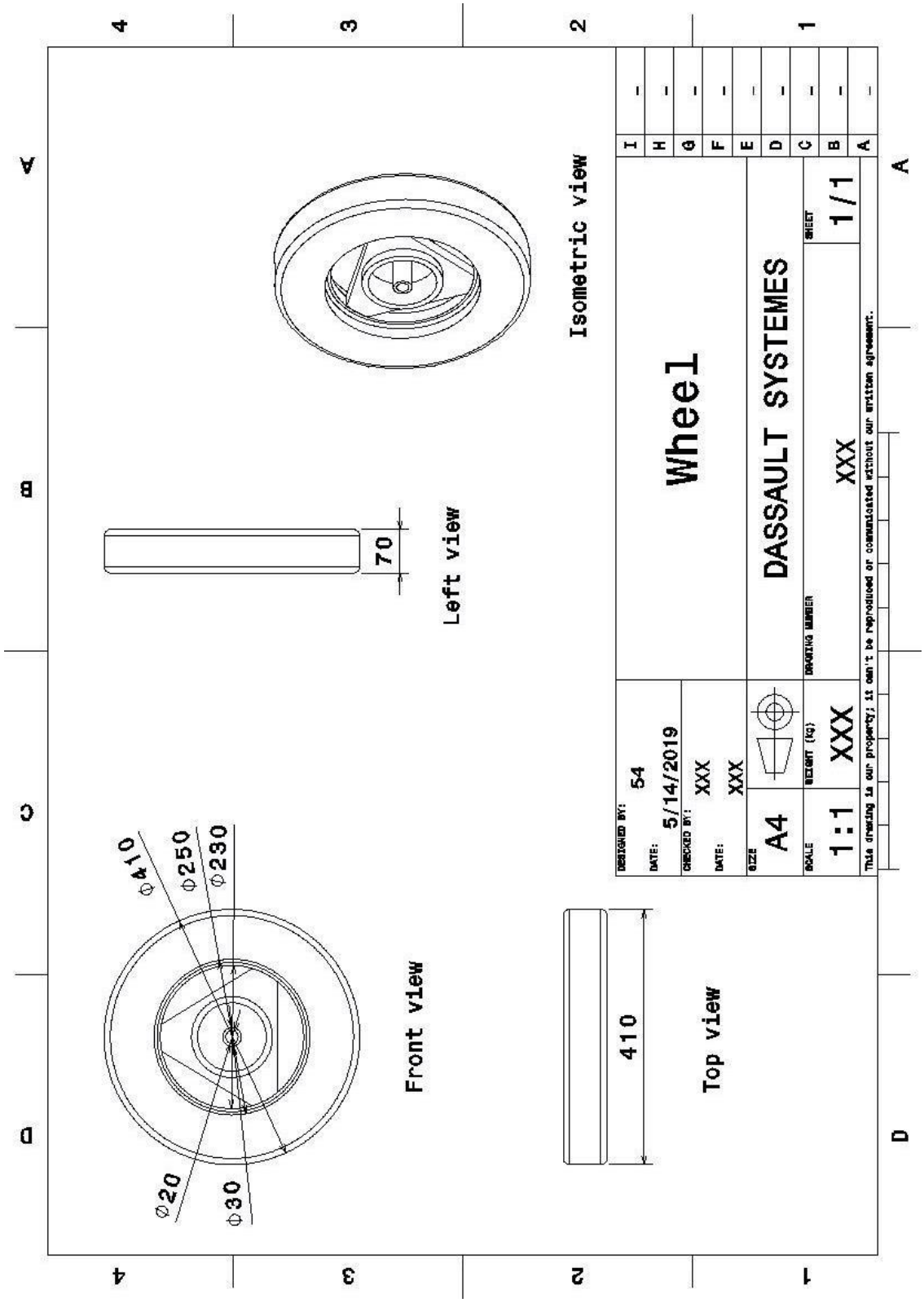

Fig. 5.1.2 Wheel

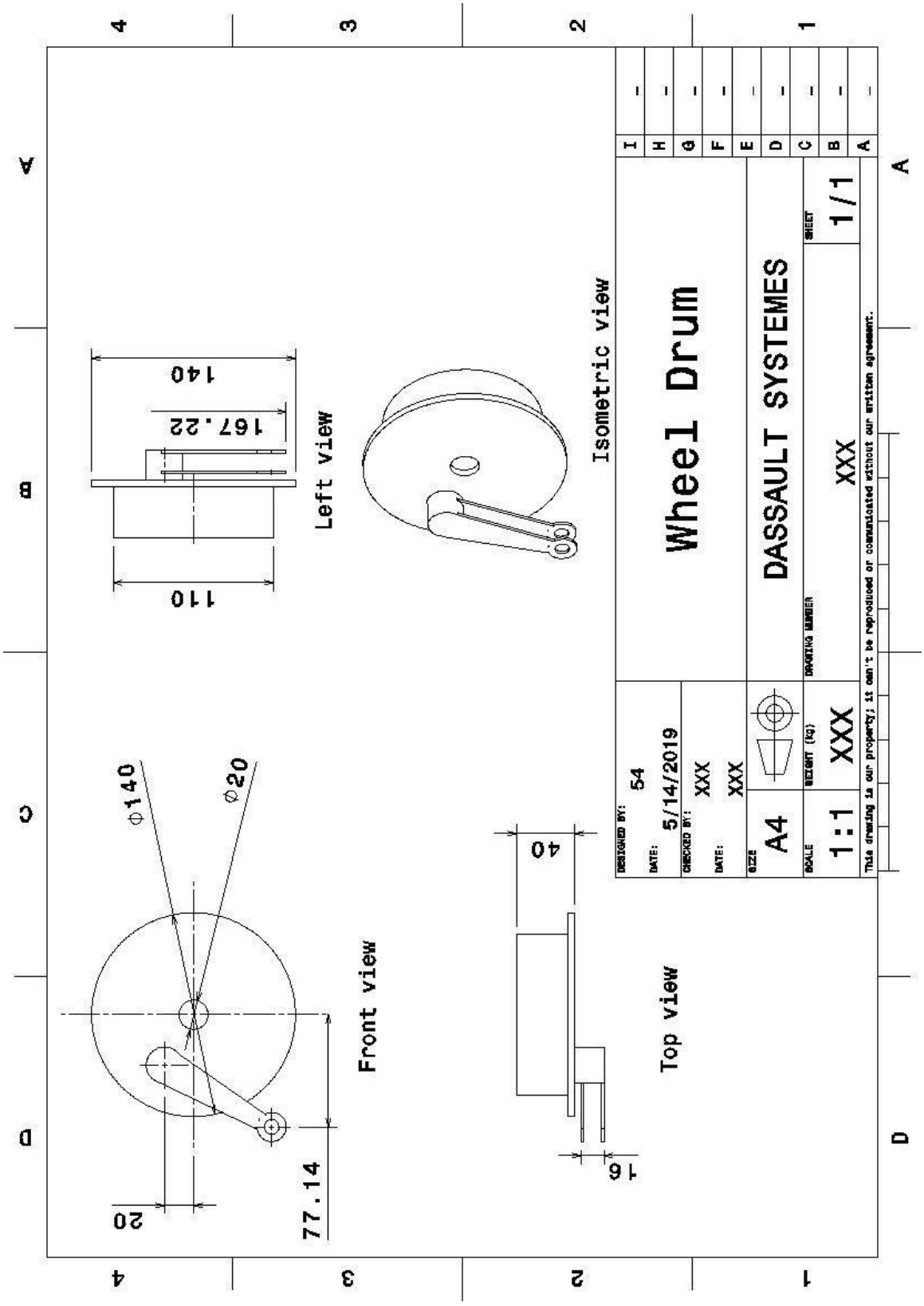

Fig.5.1.3 Wheel Drum

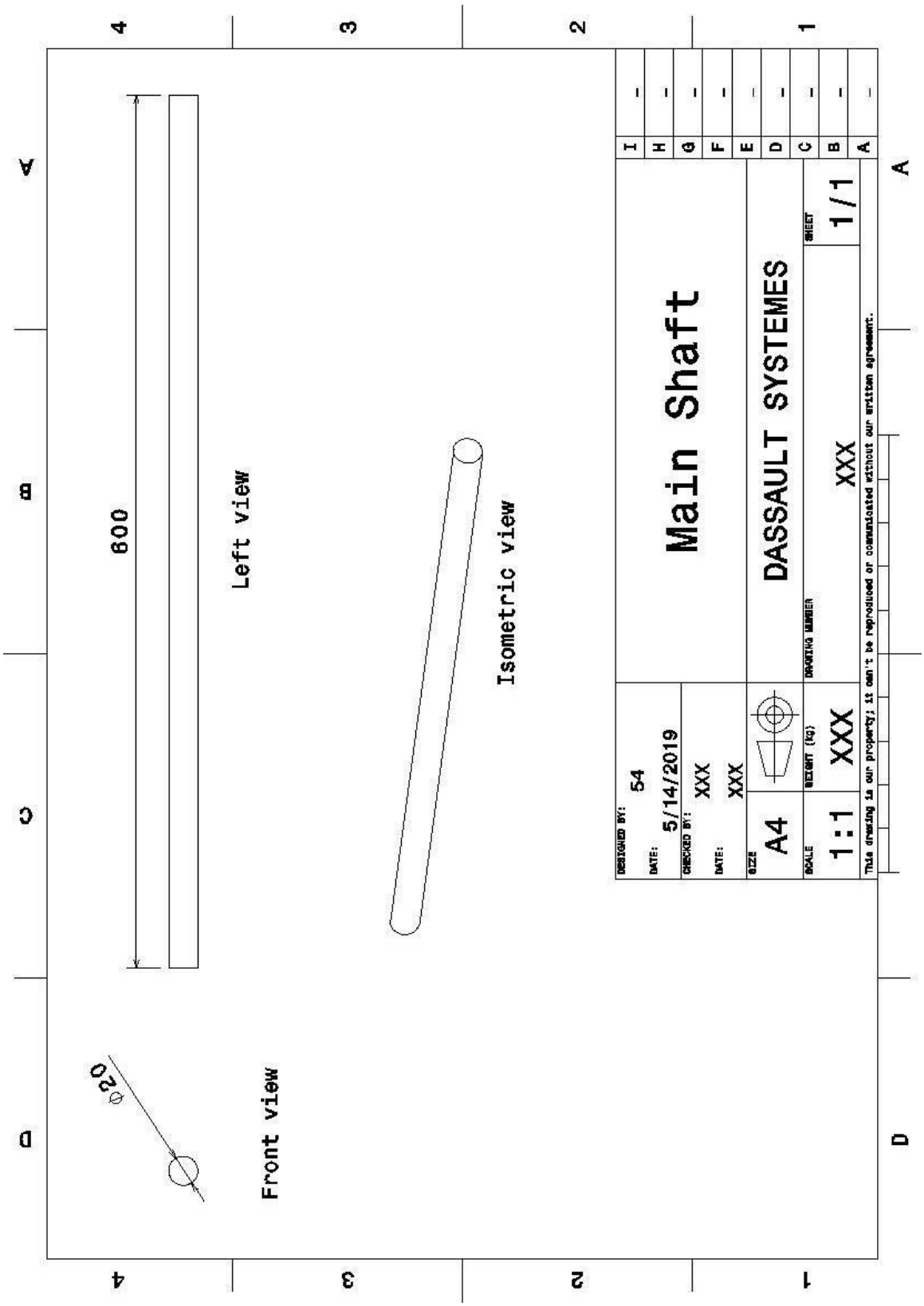

Fig. 5.1.4 Main Shaft

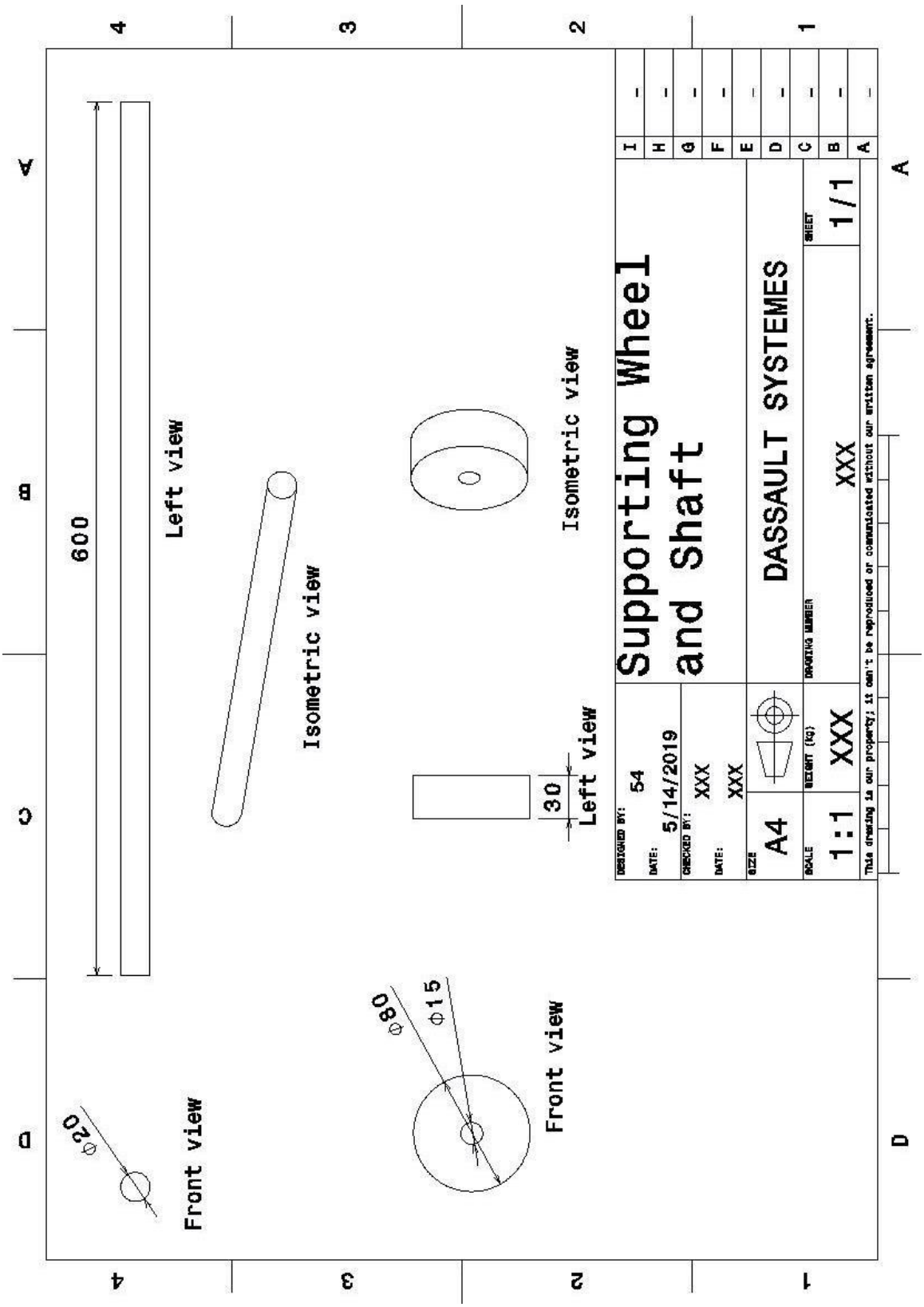

Fig. 5.1.5 Small Wheel and Shaft

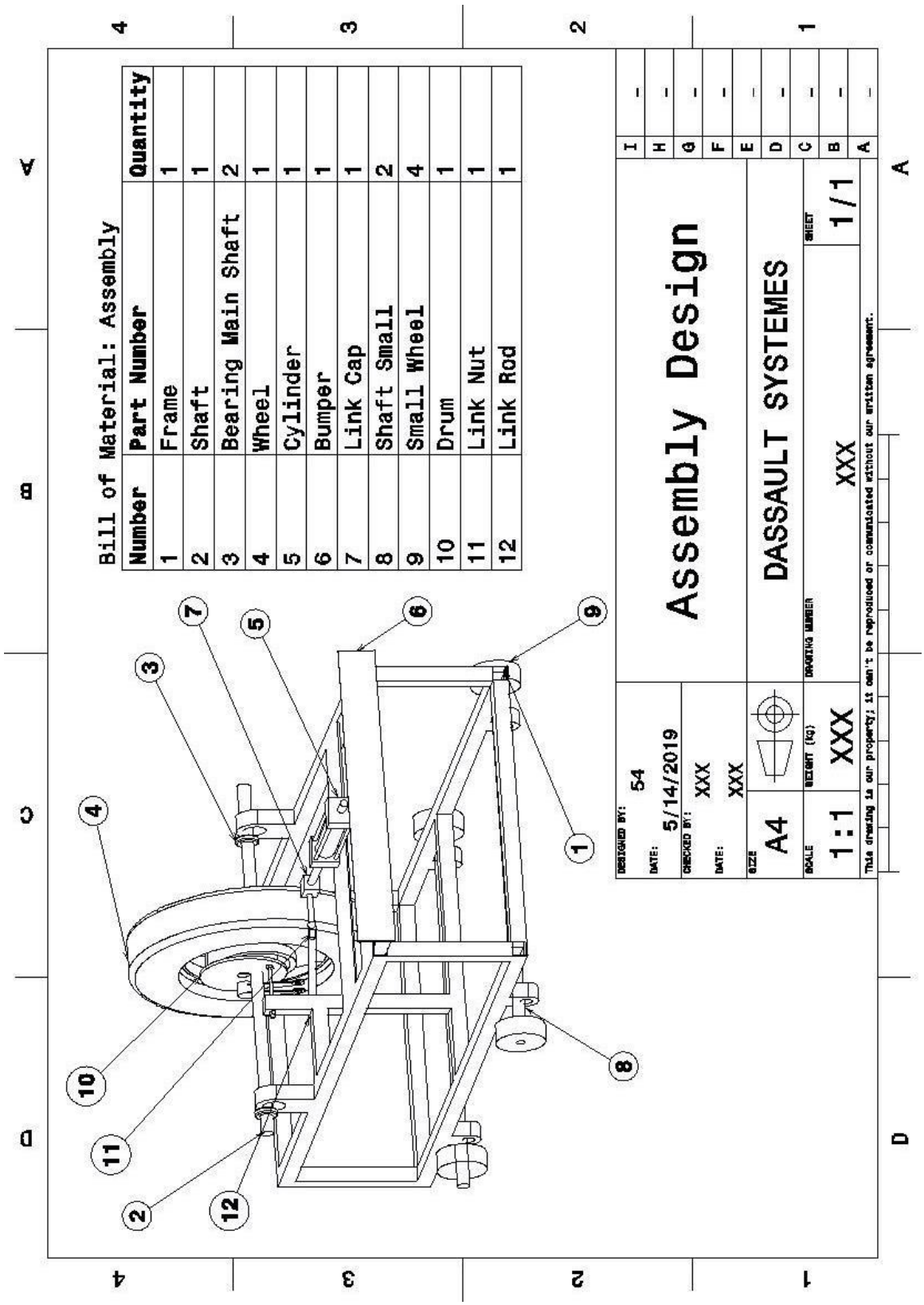

Fig. 5.1.6 Construction of Model

6 Simulation and Analysis:

The beginning of the detail design phase is when the actual parts to be manufactured are separately designed and analysed. In addition, the tooling and fabrication processes are decided. A few compromises can be made, but the design should not deviate significantly from the one with the original requirements. In addition to fabrication, the testing of the major components is also a part of detail design.

6.1 Shaft Analysis:

The analysis of Shaft is done in Catia. For the analysis of the shaft, maximum load conditions are considered. This is done to check the deflection and stresses in the shaft.

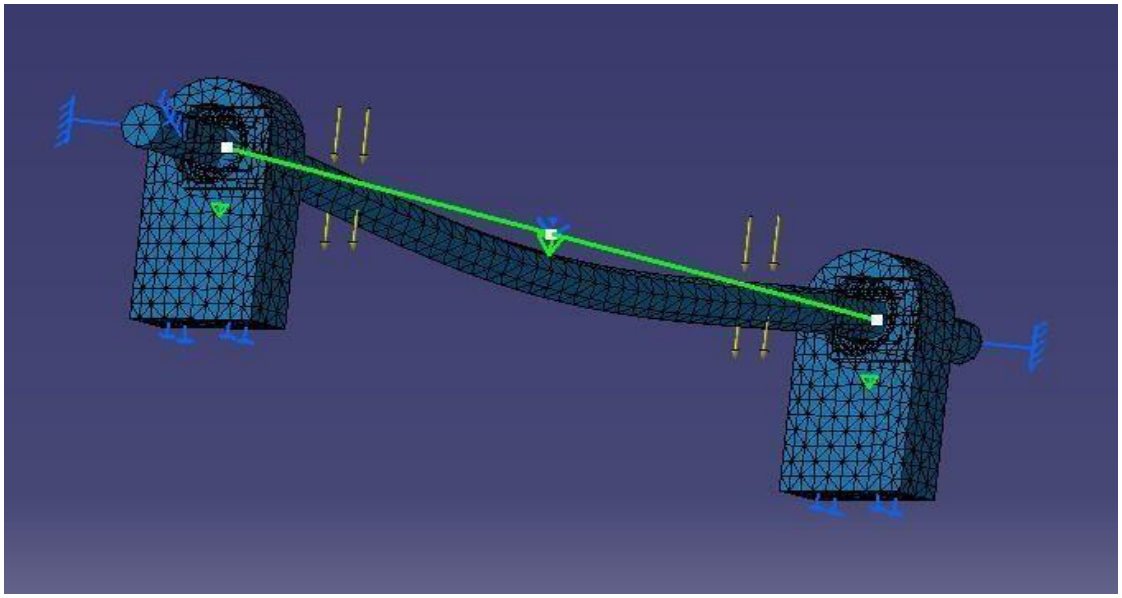

Fig. 6.1.1 Load Analysis of Shaft

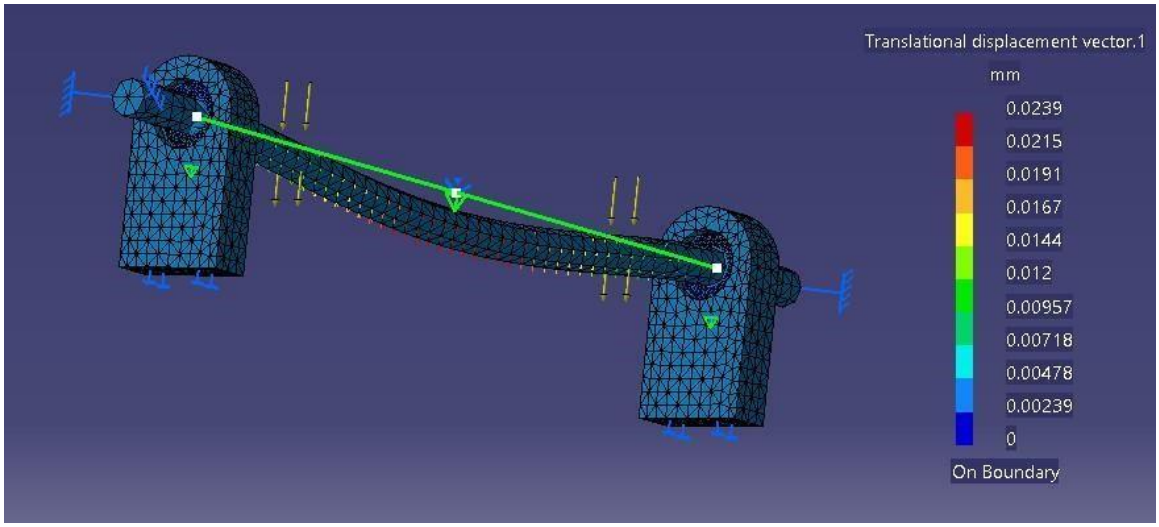

Fig. 6.1.2 Translational Displacement Vector for Shaft

6.2 Frame Analysis:

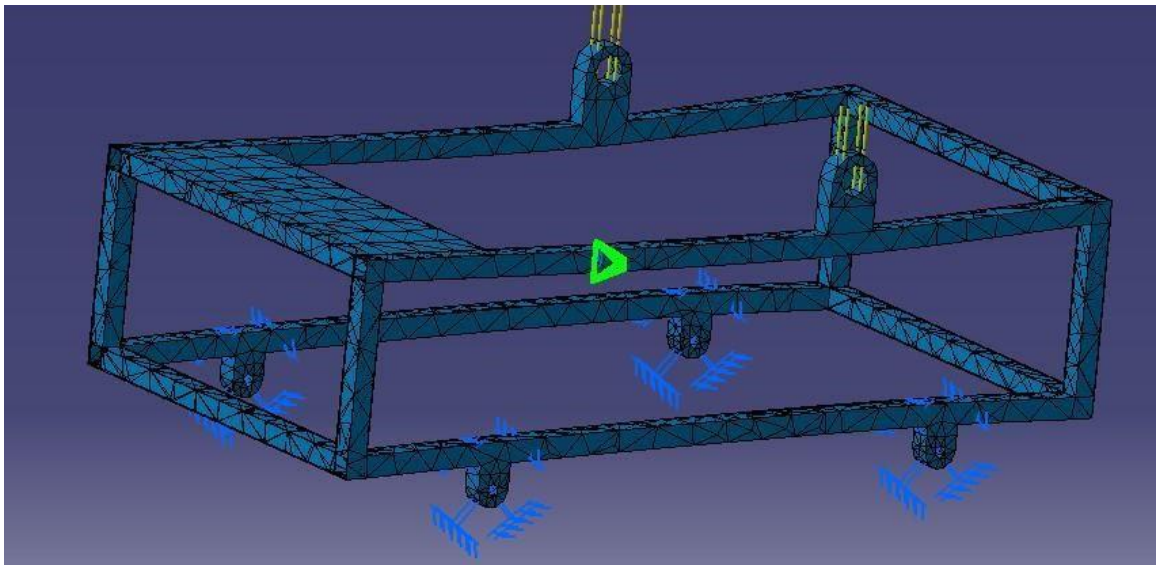

Fig. 6.2.1 Load analysis of Frame

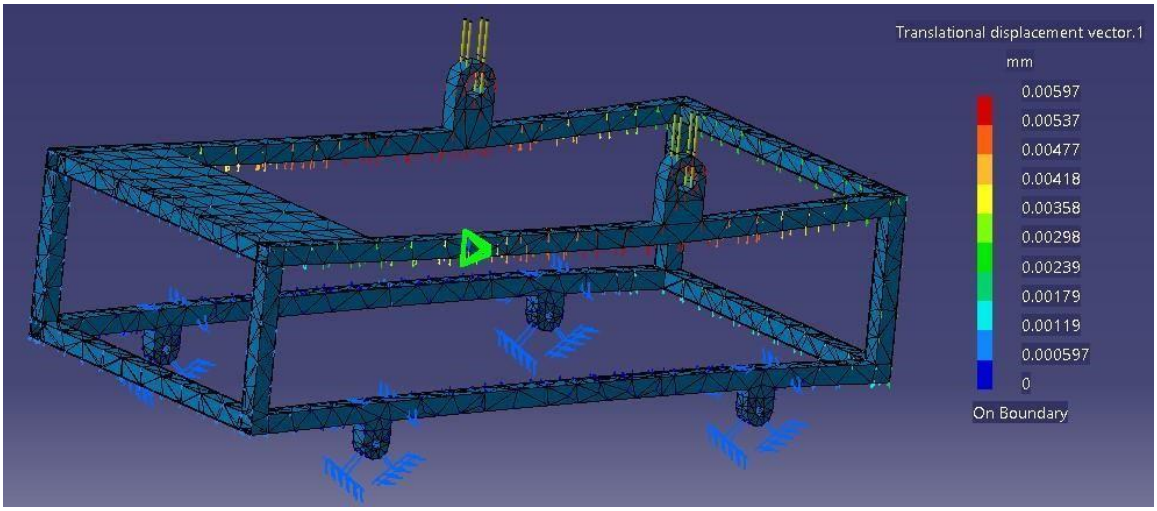

Fig. 6.2.2 Translational Displacement Vector for Frame

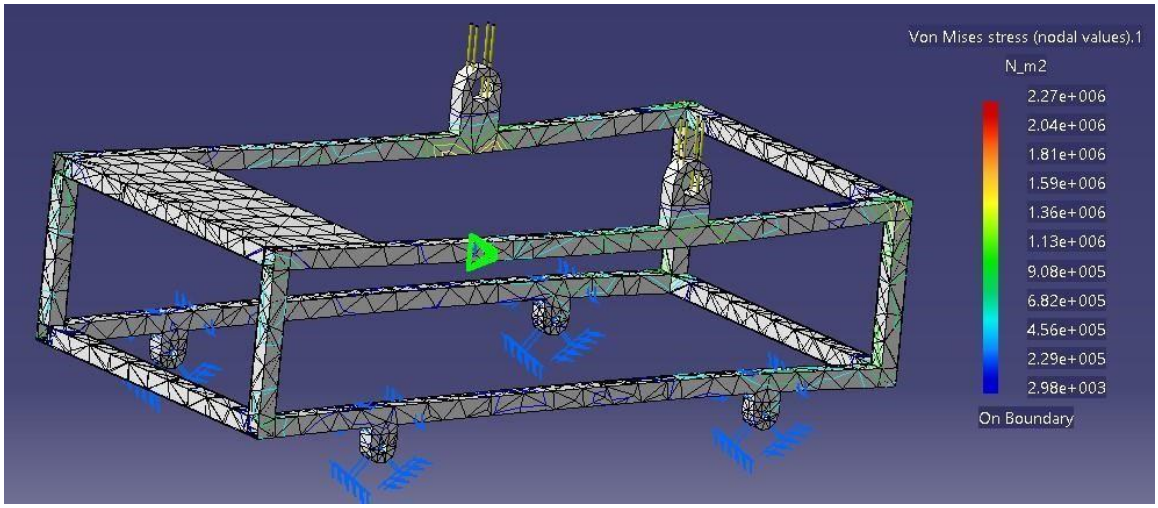

Fig. 6.2.3 Von Misses Stress (nodal values)

7 Manufacturing

M.S square pipe of diameter 25mm is used for the purpose of constructing the main frame. Mild steel being cheap and ductile in nature gives us the required properties needed for manufacturing the frame. The pipe is than cut and welded to make the desired structure.

Since wide range of electrodes can be used as well as the welded part having strength equal to parent metal, electrode welding is used

The two shafts used at the bottom of the frame are used as support and for easy movement of the structure. Four nylon wheels of dimension 80 x 30mm thick each are attached to the shaft with the help of press fitting.

Even the main shaft in the frame is made of mild steel two units of Single row ball bearing 6204ZZ are used. These bearings are fit into the bearing block which is further fit into the main shaft through gas cutting profile of 30mm thick due to low capital cost and since thick section can be cut, gas cutting is used.
For the main wheel which is mounted on the main shaft, the presence of gap between the outer diameter of the shaft and inner diameter of the wheel leads to use of sleeve. The shaft is press fit into the sleeve.

To avoid the relative rotational motion pinning process is used in sleeve and drum

8 Processes Used

8.1 Electrode Welding

It is a type of welding that uses a welding power supply to create an electric arc between a metal stick (electrode) and the base material to melt the metals at the point of contact with less requirement of equipments for the process and easy transportation of the material makes electrode welding process compatible for the project

8.2 Boring

This is a process of enlarging a hole that has already been drilled or cast by means of a single-point cutting tool

8.3 Drilling

It is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multi-point. The bit is pressed against the work-piece and rotated at rates from hundreds to thousands of revolutions per minute.

This forces the cutting edge against the work-piece, cutting off chips (swarf) from the hole as it is drilled.

In rock drilling, the hole is usually not made through a circular cutting motion, though the bit is usually rotated. Instead, the hole is usually made by hammering a drill bit into the hole with quickly repeated short movements.

The hammering action can be performed from outside the hole (top-hammer drill) or within the hole (down-the-hole drill, DTH). Drills used for horizontal drilling are called drifter drills.

In rare cases, specially-shaped bits are used to cut holes of non-circular cross-section; a square cross-section is possible.

8.4 Milling

Milling is the process of machining flat, curved, or irregular surfaces by feeding the workpiece against a rotating cutter containing a number of cutting edges. The milling machine consists basically of a motor driven spindle, which mounts and revolves the milling cutter, and a reciprocating adjustable worktable, which mounts and feeds the workpiece.

Milling machines are basically classified as vertical or horizontal. These machines are also classified as knee-type, ram-type, manufacturing or bed type, and planer-type. Most milling machines have self-contained electric drive motors, coolant systems, variable spindle speeds, and power-operated table feeds

Milling is a machining operation performed with a rotating, multi-edge cutting tool. The tool performs programmed feed movements in almost any direction for removing material from a workpiece, achieving a prismatic, polyhedral or free-form shape.

Milling is much more versatile than drilling, turning, slotting or any other material removal operation.

Each of the milling tool cutting edges removes a small amount of material, with a limited engagement into the raw piece, generally producing small chips which it is easy to remove from the cutting area.

As in all machining processes, the harder the material, the more difficult it is to remove by cutting.

8.5 Turning

Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or lathe, workpiece, fixture, and cutting tool. The workpiece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools.

The cutting tool feeds into the rotating workpiece and cuts away material in the form of small chips to create the desired shape.

Turning is used to produce rotational, typically axi-symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces.

Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners.

Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process.

Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed.

8.6 Surface Grinding

Surface Grinding is a manufacturing process which moves or grinding wheel relative to a surface in a plane while a grinding wheel contacts the surface and removes a minute amount of material, such that a flat surface is created.

The term surface grinding designates any process which accurately processes or grinds a surface.

Surface grinding method include: horizontal-spindle, vertical-spindle, vertical-spindle rotary grinding, horizontal-spindle single disk, and vertical-swivel head grinding.

The Parts require surface grinding for several reasons

- Produce a very flat surface
- Very accurate thickness, tolerance specified.
- A very smooth surface roughness Ra is specified/required.
- Cutting tool sharpening

9 Working :

In case an obstacle or vehicle enters the sensing range of the ultrasonic sensor (1.5-2 meters) a signal is sent to the microcontroller. The Microcontroller is used to control solenoid valve. Solenoid valve are used in the setup. Solenoid valve is used to actuate the double acting double rod pneumatic cylinder. On receiving a signal from the microcontroller, the solenoid valve actuates the pneumatic cylinder.

In Pneumatic cylinder one end of the rod is connected to the bumper and fixed on the frame, which can be actuated by the solenoid valve. If any obstacle enters in the range of the ultrasonic sensor, then the pneumatic cylinder is actuated and it pushes the bumper in outward direction. Thus, in the case of Collision with an obstacle, a great part of the impact is absorbed by the pneumatic cylinder.

On receiving the signal from the microcontroller the front part is actuated, the rear part gets compressed and thus pulls the brake lever making it a simultaneous process with the use of link between pneumatic cylinder rod and brake lever. We therefore get a reduction in speed with automatic braking.

Thus the system provides safety in terms of reducing impact received by the vehicle and also by automatically applying brakes and reducing the speed of the vehicle.

10 Microcontroller Programming:

```
// defining the pins
const int trigPin = 9;
const int echoPin = 10;
// defining variables
long duration;
int distance;
void setup() {
pinMode(trigPin, OUTPUT); // Sets the trigPin as an Output
pinMode(echoPin, INPUT); // Sets the echoPin as an Input
Serial.begin(9600); // Starts the serial communication
}
void loop() {
// Clears the trigPin
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
// Sets the trigPin on HIGH state for 10 micro seconds
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
```

```
// Reads the echoPin, returns the sound wave travel time in microseconds
duration = pulseIn(echoPin, HIGH);
// Calculating the distance
distance= duration*0.034/2;
// Prints the distance on the Serial Monitor
Serial.print("Distance: ");
Serial.println(distance);
//pin 8:Solenoid Valve
if(distance<=150)
{
  Serial.println("System activated");
  digitalWrite(8,HIGH);
}
else
  digitalWrite(8, LOW);
}
```

11 Bill of materials :

Sl. No.	Parts	Raw material rate / kg (Rs)	Material cost(Rs)
i	**M.S square pipe** □ 25 mm - Pipe consumption - 8mtr (Cutting and Frame welding)	60/m	560/-
ii	**M.S plate** 4mm thickness 500mm x 110mm x 4mm - 2Nos. Raw material weight - 3.40kg	50	172/-
iii	**M.S flat** 40mm x 25mm x 35mm - 4 Nos. Material weight - 1kg	65	65/-
iv	**Support Wheel Shaft** M.S. Bar Φ22 x 600 - 2 Nos. Maximum weight = 3.60kg (Machining : - T/L Φ20 step turning both end)	55	198/-
v	**Nylon wheels** Φ80 x 30mm thick x 4 Nos.	75/pc.	300/-

<table>
<tr>
<td>vi</td>
<td>Main Wheel Shaft
M.S bar Φ22 x 605mm Material weight - 1.840kg x 1Nos.

(Machining :-
- T/L. 600, blank turning through Φ20.50mm,
Circlip groove cutting)
(Shaft Grinding Φ20j5- all over)
<table><tr><td rowspan="2">Φ20j5</td><td>+0.005</td></tr><tr><td>-0.004</td></tr></table></td>
<td>55</td>
<td>101/-</td>
</tr>
<tr>
<td>vii</td>
<td>Bearing block
Raw material
-M.S gas cut profile 3omm thickness
Charged Weight :3.00kg x 2 Nos.
(125x100x30)

(Machining:

1. Thickness milling - 25mm
2. Top and bottom milling
3. Turning Φ47 M6 and circular grooving 1.85 mm
(Rs 120/pc. x 2 Nos.)
4. Pilot drilling)
<table><tr><td rowspan="2">Φ47 M6</td><td>-0.004</td></tr><tr><td>-0.020</td></tr></table></td>
<td>65/kg</td>
<td>390</td>
</tr>
</table>

viii	**Sleeve for drum** -Raw material 36 M.S. Bar x 125 x 1 No. Weight app - 1kg Complete turning	55/kg	55
ix	Drum bore (Bore 30mm) $\Phi 30^{+(0.025-0.030)}$		
x	**Linkage** 1. M6 Threaded screw x 500		100
xi	Single row ball bearing 6204ZZ Quantity - 2Nos.	150/-	300
xii	Circlip - I.D - B47 - 4Nos. Circlip - O.D - A20 - 3Nos. Cotter pin - 4 x 40 - 4Nos. Taper pin - 6 x 45 - 1No. Taper pin - 4 x 35 - 1No.	30/pc. 6/pc. 5/pc. 5/pc. 4/pc.	120/- 18/- 20/- 5/- 4/-
xiii	- Socket Head Cap Screw :-(Allen Bolt) :- SHCS:- M8 x 60 :- 4 Nos. - Socket Head Cap Screw :- SHCS :- M6 x 30 :- 4 Nos. - Hex Nut M8 :- 4 Nos.	20/pc. 6/pc.	80/- 24/-

	-Hex Nut M6 :- 4 Nos.	3/pc. 2/pc.	12/- 8/-

Table 11.1 Bill of Materials

12 Conclusion

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between institution and industries. The proposed Pneumatic bumper with automatic braking system, while being easy in operation, provides a sound alternative for safety measures in cars.

The pneumatic bumper for four wheeler is working with satisfactory conditions. We were able to understand the difficulties in maintaining the tolerances and also quality while manufacturing the system. Thus we have developed a **"*PNEUMATIC BUMPER FOR FOUR WHEELER*"** which helps us to learn how to achieve low cost automation. The application of pneumatics produces smooth operation. By using more techniques, they can be modified and developed according to the applications.

Despite its admittedly high costs, it can prove to be a good advancements in the field of automobiles. However, there still is a lot of scope for improvement in this project. The system should be programmed to operate in specific conditions as per convenience, with restrictions on triggering speed and much more. The future scope for the project is mainly making a lighter, more cost efficient system and also to make the system more dynamic when dealing with heavy traffic or extraordinary climates.

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