VISVESVARAYA TECHNOLOGICAL UNIVERSITY

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A Project Report
On

" ULTRASONIC DISTANCE MEASUREMENT WITH INTELLIGENT BRAKING SYSTEM "

Submitted in partial fulfillment of the requirements as a part of the curriculum,

Bachelors of Engineering in Mechanical Engineering

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CERTIFICATE

Certified that the project work entitled "ULTRASONIC DISTANCE MEASUREMENT WITH INTELLIGENT BRAKING SYSTEM**"** is a bonafide work carried out by **Mr. Sagar N, Mr. Shatish Shukla, Mr. Sheethal Kumar BM , Mr. Siddhinath Chatterjee,** bonafide students of **CMR Institute of Technology** in partial fulfillment for of the requirements as a part of the curriculum, **Bachelors of Engineering in Mechanical Engineering,** of **Visvesvaraya Technological University, Belagavi** during the year **2019-20**. It is certified that all correction/suggestion indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of the project work prescribed for the bachelor of engineering degree.

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2.	

DECLARATION

We, students of Eighth Semester, B.E, Mechanical Engineering, CMR Institute of Technology, declare that the project work titled **" ULTRASONIC DISTANCE MEASUREMENT WITH INTELLIGENT BRAKING SYSTEM "** has been carried out by us and submitted in partial fulfillment of the course requirements for the award of degree in **Bachelor of Engineering in Mechanical Engineering** of **Visvesvaraya Technological University, Belagavi,** during the academic year 2019-2020.

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ULTRASONIC DISTANCE MEASUREMENT WITH INTELLIGENT BRAKING SYSTEM

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PARTICULAR

CHAPTER-1

SYNOPSIS

Until well into the twentieth century, most devices developed for measuring distance worked on the same principle. The measured distance is compared with a standard unit of length. Other means are available. One of these is the measurement of time taken by the sound wave to cover a certain distance. This sound normally lies beyond human hearing. The ultrasonic sensor is used to measure the distance in digital form and also automatically braking the vehicle when the obstacle closer to the vehicle.

The aim is to design and develop a control system based an intelligent electronically controlled automotive braking system is called "AUTOMATIC BRAKING SYSTEM". This Braking system is consists of ultrasonic sensor, Control Unit, Pneumatic breaking system. The Ultrasonic sensor is used to detect the obstacle. There is any obstacle in the path, the ultrasonic sensor senses the obstacle and controller activates the relay switch of the solenoid coil to apply brake

In our project of **'ULTRASONIC DISTANCE METER"** is suitable for measuring distances between 25 cm and about 6 m. The measured distance is shown on a 3-digit liquid crystal display (LCD). The low current drawn by the unit makes battery operation possible: 'LO BAT' reading on the LCD indicates when the battery needs to be replaced. The block diagram of this meter is shown in figurer. This is having the four major parts of the meter

- A sender and A Receiver
- Timing and time reference section
- A counter with display

CHAPTER-2

INTRODUCTION

A car has three braking system – the accelerator, the gears and the brakes themselves. A controlled, well anticipated and unhurried act of slowing down or stopping will involve the use of all the three.

With proper observation of the road and traffic ahead, a driver can see the need for a reduction in speed long before he has to apply the brakes. The accelerator becomes a brake as soon as the foot is lifted from it. A period of deceleration should ideally, always precede the use of the foot brake.

Gear becomes a braking system when the vehicle is shifted to a lower gear. When approaching a hazard the procedure to be followed is first to decelerate and then application of foot brakes and finally changing to a lower gear. The third part of the braking system consisting of the brakes themselves are the most important part and it is only with this part the vehicle can be brought to rest abruptly if needed. With the other two the accelerator and the gear the vehicle loses its momentum very slowly.

Electric brakes a type of the braking system not very popular can be used commercially in passenger cars as they have several advantages. Electromagnetic brakes are used in other fields such as bottling plants. They are used for bringing the assembly to a quick stop each time for filling up the bottles. In this project we propose to deal with a new type of electromagnetic brake using a solenoid switch.

Most magnetic breaking relay on the attractive force generated with in a gap magnetic circuit which generate forces on the supported shaft because this force is quadratic I magnetic flux intensity in the circuit; it is only possible to pull the shaft. To accomplish bi or multidirectional control of the shaft. Several electromagnets are arranged around the shaft and are operated differentially to improve the linearity and dynamic performance of these differentially arranged magnets. It is commons to free bias the air gaps with constant flex density. This biasing can be accomplished in a number of ways but usually it is done by applying a biasing current to the oils, which energize the magnetic circuits. The primary advantages of this scheme a reduction in electrical power consumption. Magnetic bearings employ the repulsive forces of opposed magnetic fields generated by electromagnets in this slider and the base. They achieve straight line accuracy to 0.00004-inches / foot through a control loop that employs capacity, proximately sensors in position freed back for controlling the amplifiers that generate the magnetic fields.

Magnetic Breaking can support loads in excess of 1000 pounds, magnetic Breaking have no moving parts to wear and can be used in vacuum condition so there is no friction in contact places.

NEED FOR AUTOMATION:

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation. The main advantages of all pneumatic systems are economy and simplicity. Automation plays an important role in mass production.

For mass production of the product, the machining operations decide the sequence of machining. The machines designed for producing a particular product are called transfer machines. The components must be moved automatically from the bins to various machines sequentially and the final component can be placed separately for packaging. Materials can also be repeatedly transferred from the moving conveyors to the work place and vice versa.

Nowadays almost all the manufacturing process is being atomized in order to deliver the products at a faster rate. The manufacturing operation is being atomized for the following reasons.

- ※ To achieve mass production
- ※ To reduce man power
- ※ To increase the efficiency of the plant
- ※ To reduce the work load
- ※ To reduce the production cost
- ※ To reduce the production time
- ※ To reduce the material handling
- ※ To reduce the fatigue of workers
- ※ To achieve good product quality
- ※ Less Maintenance

CHAPTER-3

CLASSIFICATIONS OF BRAKES

The brakes for automotive use may be classified according the following considerations.

1. PURPOSE
2. LOCATION
3. CONSTRUCTION
4. METHOD OF ACTUATION
5. EXTRA BRAKING EFFORT

Based on the above considerations, brakes are classified with respect to following factors.

1. With respect to application,
    a. Foot brake
    b. Hand brake

2. With respect to the number of wheels,
    a. Two wheel brakes
    b. Four wheel brakes

3. With respect to the method of braking contact
    a. Internal expanding brakes
    b. External contracting brakes

4. With respect to the method of applying the braking force.
    a. Single acting brake
    b. Double acting brakes.

5. With respect to the brake gear,
    a. Mechanical brake
    b. Power brakes

6. With respect to the nature of power employed
    a. Vacuum brake
    b. Air brake
    c. Hydraulic brake
    d. Hydrostatic brake
    e. Electric brake

7. With respect to power transmission,
    a. Direct acting brakes
    b. Geared brakes

8. With respect to power unit,
    a. Cylinder brakes
    b. Diaphragm brake

The foot brake or service brake is always applied by a pedal, while the parking brake is applied by a hand lever. The parking brake is intended chiefly to hold the car in position. The parking brake can be set in the "ON" position by means of a latch while the service brake remains on only as long as the driver presses down on the pedal.

The hand brake is normally used only after the driver has stopped the car by using the foot brake. Its other use is as an emergency brake to stop the car if the foot braked system should fail. The hand or parking brakes operates on a pair of wheels, frequently the rear wheels. When drum type rear brakes are used, the same shoes can be used for both hand and foot control.

The drum type of brake may either be a band brake or a shoe brake. Both band brakes and shoe brakes may be either external or internal. The band brakes generally are external and shoe brakes internal. In drum brakes the drum is attached to the wheel and revolves with it. Friction to slow the drum is applied from inside by the shoes which do not rotate but are mounted on a stationary metal back plate. There are different types of drum brakes such as a two leading shoe arrangement – which gives an augmented response to pedal effort because of its self applying arrangement. A leading-trailing shoe is a cheaper and better alternative as it is equally effective whether the car is going forward or backwards.

Manufacturers design drum brakes so that rain, show or ice or grit cannot get inside and decrease braking efficiency for moisture greatly reduces the friction between the linings and the drum.

The dissipate quickly the considerable amount of heat generated when braking a fast moving heavy car large brake drums would be required. Disc brakes do the job more efficiently, for the cooling air can get to the rubbing between each piston and the disc, there is a friction pad held in position by retaining pins, spring plates etc. Passages are drilled in the caliper for the fluid to enter or leave each housing. These passages are also connected to another one for bleeding. Each cylinder contains a rubber selling ring between the cylinder and the piston.

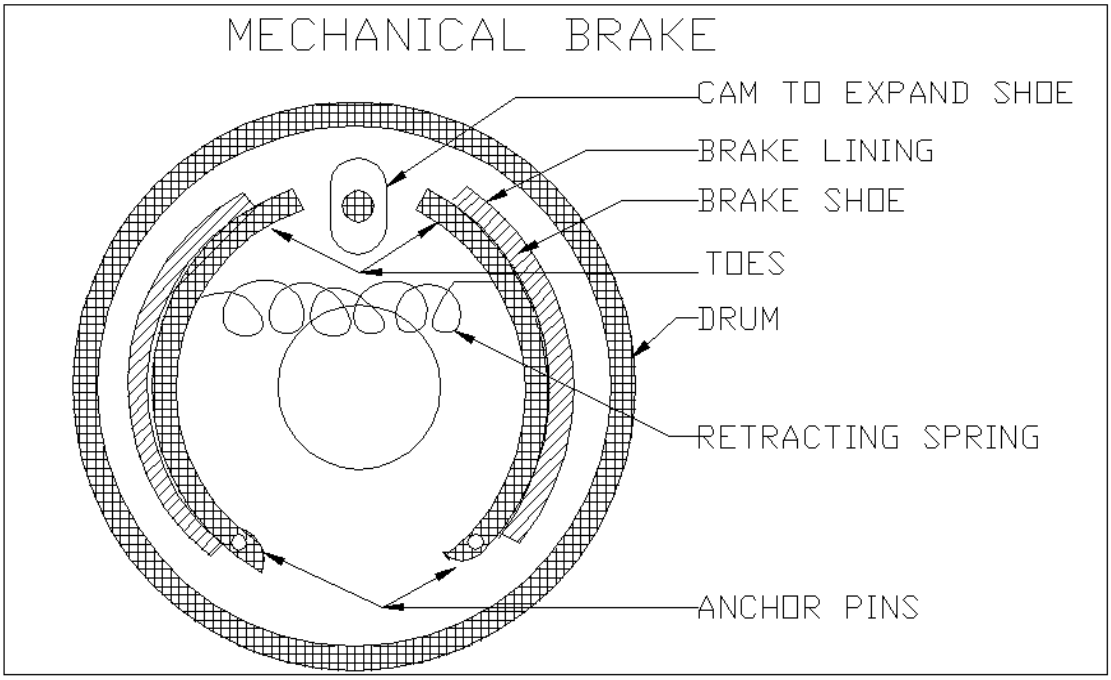
When the brakes are applied, hydraulically actuated piston move the friction pads into contact with the disc, applying equal and opposite forces on the later. On releasing the brakes, the rubber sealing rings act as return springs and retract the pistons and the friction pads away from the disc.

Now let us see in detail about different braking systems in automobiles.

MECHANICAL BRAKE:

In a motor vehicle, the wheel is attached to an auxiliary wheel called drum. The brake shoes are made to contact this drum. In most designs, two shoes are used with each drum to form a complete brake mechanism at each wheel. The brake shoes have brake linings on their outer surfaces. Each brake shoe is hinged at one end by on anchor pin, the

other end is operated by some means so that the brake shoe expands outwards. The brake linings come into contact with the drum. Retracting spring keeps the brake shoe into position when the brakes are not applied. The drum encloses the entire mechanism to keep out dust and moisture. The wheel attaching bolts on the drum are used to contact wheel and drum. The braking plate completes the brake enclosure, holds the assembly to car axie, and acts the base for fastening the brake shoes and operating mechanism. The shoes are generally mounted to rub against the inside surface of the drum to form as internal expanding brake as shown in the figure.



HYDRAULIC BRAKES:

The hydraulic brakes are applied by the liquid pressure. The pedal force is transmitted to the brake shoe by means of a confined liquid through a system of force transmission.

The force applied to the pedal is multiplied and transmitted to brake shoes by a force transmission system. This system is based upon Pascal's principle, which states that "The confined liquids transmit pressure without loss equally in all directions".

It essentially consists of two main components – master cylinder and wheel cylinder the master cylinder is connected by the wheel cylinders at each of the four wheels. The system is filled with the liquid under light pressure when the brakes are not in operation. The liquid is known as brake fluid, and is usually a mixture of glycerin and alcohol or caster-oil, denatured alcohol and some additives. Spring pressure, and thus the fluid pressure in the entire system drops to its original low valve, which allows retracting spring on wheel brakes to pull the brake shoes out of contact with the brake drums into their original positions. This causes the wheel cylinder piston also to come back to its original inward position. Thus, the brakes are released.

AIR BRAKE:

Air brakes are widely used in heavy vehicle like buses and trucks which require a heavier braking effort that can be applied by the driver's foot. Air brakes are applied by the pressure of compressed air, instead of foot pressure, acting against flexible diaphragms in brake chamber. The diaphragms are connected to the wheel brakes. These diaphragms are controlled through a hand or foot operated valve. The brake valve controls brake operation by directing the flow of air from a reservoir against diaphragms in the brake chamber when the brakes are applied and from brake chambers to tube atmosphere when the brakes are released. The air compressor, driven by the engine furnishes compressed air to the reservoir fall below a set valve.

ELECTRIC BRAKE:

Electric Brakes are also used in some motor vehicles, although these are not very popular. Warner electric brake is one of the examples of such brakes. An electric brake essentially consists of a electromagnet within the brake drum. When the current from the battery is utilized to energize the electromagnet, which actuates the mechanism to expand the brake shoe against the brake drum, thus applying the brakes. The severity of braking is controlled by means of a rheostat, which is operated by the driver through the foot pedal.

Electric brakes are more simple. These brakes do not require complicated operating linkage. Only cable is required to take current from the battery to the electromagnet. Also, these are very quick in action as compared to other types of brakes.

VACUUM BRAKES / SERVO BRAKES:

A serve mechanism fitted to the braking system reduces the physical effort the driver has to use on the brake pedal most servo mechanisms are of the vacuum assistance type. A pressure differential can be established by subjecting one side of the piston to atmospheric pressure and the other side to a pressure below atmospheric pressure by exhausting air from the corresponding end of the servo cylinder.

REGENERATIVE BRAKING:

Electricity powered vehicles use regenerative braking for stopping the vehicle. With regenerative braking pressing the brake pedal does not necessarily activate a conventional friction brake. The motor controller controlling the vehicle is treated as a generator which slows the vehicle and simultaneously provides an output for charging the battery. Since the effectiveness of regenerative braking falls of with vehicle speed. Electric vehicles will have to be fitted with conventional hydraulic friction brakes as well as with regenerative systems.

CHAPTER-4

TYPES OF MAGNETIC BRAKING:

- Radial Magnetic Breaking
- Thruster Magnetic Breaking

Concept of electronics feed system:

The feed back circuit for the electromagnetic Breaking involves,

1. Power amplifier.
2. Positional transducers.

Electromagnetic breaking use powerful electromagnets to control the position of a steel shaft. Sensors are used to detect the shaft position. Steady and variable loads can be supported and since no liquid lubricants is involved, new machine designs arrangements become possible.

1. Radial Breaking:

A diagram of the radial breaking is figure. This breaking is designed to operate at one end of the rotor and central radial forces only. Four radially magnetized are segment magnets form a cylindrical magnet sandwiched between a four leg through the working air gap, radially along the shaft, and returns to the permanent magnet via the radial bias pole leg and through the working air gap. The return path for the active flux is then circumferentially around the stator in the figure. This design only four poles and four coils, unlike actively biased designed, which generally requires eight or more.

In addition, since the coils for an each bearing axis are wired in series, the bearing control system requires only current amplifier channel per axis, which is half as many as are required by the actively biased bearing. This design was selected because in this application it was more radially compact than a design with active control of all of the air gaps and has been however the operating character is essentially the same. Sizing of the permanent

magnets was accomplished by matching the manufacture B_H curve to the magnetic impedance of the circuit and then over sizing the actual magnets. The bias flux was then adjusted in the final design by adjusting the effective length of the oscillator air gap immediately adjacent to the permanent magnet this gap was filled with shims composed either of aluminum or silicon steel. By manipulating the relative members of the shims, the reluctance of the bias flux return path was varied thereby permitting adjustment of the bias flux density. The actual density was measured with the shaft centered using a hall effective flux probe. In the final construction the bias flux density was expected to be adjusted to about 0.51 tesla in the radial breaking and about 0.6 tesla in the thrust breaking, or about half of the 1.2 tesla saturation density of the silicon iron.

2. Combination of Radial / Thrust Magnetic Breaking:

This type of breaking holes both the radial and thrust breaking construction. This type of breaking is used to accommodate both the radials and thrust forces incoming the bearing at the end of the rotor, a combination breaking provides both radial and thrust support. A scheme of this breaking design, revealing the various magnet paths, is shown in figure.

The radial portion of the breaking is identical to that which was described in previous section. In this type of breaking the thrust control however, is implemented by a unique magnetic flux configuration. The permanent magnet bias flux passing along the shaft splits equally between the two thrust poles before returning to the permanent magnet. A simple active coil produces a perturbation flux, in the shape of the toriod, which symmetrically adds or subtracts to the bias flux in the working air gaps between the thrust disk and the thrust poles.

CHAPTER-5

LITERATURE

The Reverse Alert System is first developed by Surveillance Guard Corporation (SVG). It was the world first aftermarket automatic braking system that can be fitted to any vehicle. This system firstly fitted in Australian vehicles and has been taken extensively trialed across the passenger vehicle market, road transportation and taxi industries. This system begins with ultrasonic sensors that were fitted at rear of the vehicle. These sensors detect an object at 1.6m a signal is sent to a solenoid located at the front of the vehicle. The solenoid is attached to a flexible cable that runs through the firewall and is attached to a universal brake pedal clamp that is fitted on the brake pedal. Subsequently, when the solenoid is activated this pulls the brake pedal -stopping the vehicle automatically.

The Reverse Alert Technology was installed on following vehicles:

- Two Ford Ranger Light Commercial Vehicles (1 x 1.6m and 1 x 2.5m systems) and
- Two Hino Trucks (both equipped with the 1.6m system) – EWP and Line Truck.

ABS (Anti-lock Braking System) which helps the rider gets a hassle free braking experience in muddy and watery surfaces. [4] It applies a distributed braking and prevents skidding and wheel locking. In 1988 BMW sold for the first time electronic-hydraulic motorcycles. The first Japanese maker selling motorcycles with ABS was Honda ST1100 equipped optionally with electro-hydraulic ABS module in 1992.

With the ABS, if the rider only brakes with the front or rear wheel, the braked wheels tends to lock up faster as if both brakes would have been applied. A Combined Braking System (CBS) distributes the brake force also to the non-braked wheel to lower the possibility of a lock up, increase deceleration and reduce suspension pitch. [10] Volvo is all set to launch its new XC60 SUV which will sport laser assisted braking which will be capable to sense a collision up to 50 mph and apply brakes automatically.

CHAPTER-6

WORKING PRINCIPLE

The function of a vehicle brake is to stop slowly it down when moving or to prevent it from moving when it is stationary.

A brake works by causing friction between a non rotating part of the car and a disk or drum which turns with a road wheel. Friction produces the force needed to slow the car and convert the energy of the moving vehicle into heat which disperses into the air around the brakes.

The force of friction depends on the nature of the surfaces in contact, on the force pressing them together and on their relative motion. Within certain limits the retarding force due to brakes application is proportional to the pressure with which the bands or shoes are applies to the drums and to the coefficient of friction between lining and drum. However when the force of application reaches a certain value. The brakes lock and the road wheels slide over the pavement, hence any further increase in the force of application has no effect. Thus the maximum braking effect which can be produced depends on the adhesion between tyre and road, which intern depends on the load carried by the wheels on which the brakes act and on the coefficient of friction between tyre and road. The speed of conversion of the kinetic energy into heat energy governs the rate at which the vehicle slows down.

CONDITION FOR MAXIMUM BRAKING:

1. All wheels are held on the verge of skidding
2. Adhesion between the tyre and road is excellent.

CONDITION FOR TYRE ADHESION:

1. Type of road surface.
2. Condition of surface wet, dry greasy, state and design of tyre tread.

BIASING OF MAGNETIC BREAKING

The key to understanding the role of permanent magnet's magnetic breaking lies in the general issue of biasing. Consider the simplest magnetic as shown in the figure, but omit the lower electromagnet. By omitting the finite permeability of the iron, the current in the coil controls the flux density.

B (μo N1 I1) / 2 g 1 through

Where μo is permeability of free space

= (4 X 3.144) X 10^{-}7 H/m.

N1 is no. of turns

g1 is air gap length (0.5mm).

the force, which was generated by this breaking on the shaft, is related to the square of the magnetic flux density in the gaps between the pole faces and the shaft

F = B2 A g1 / μo N1 2 I1 2 A g1 2

Where,

Ag1--- it is the area of each of the upper air gaps, assuming that they are equal. (Therefore, the total volume of each air gaps is g1 X Ag1)

The only parameter in this equation that can be controlled directly is the current It, which is squared. Consequently, it is only possible to pull the shaft toward the magnet; it is not possible to push the shaft. In some applications where there is a very large static force whose orientation is consistent and the dynamic loads are always less than the static level, it is sufficient to have a breaking which can only pull. However most applications require that the breaking able to exert a force in either direction. To accomplish this bi-directional capacity, another electromagnet is added to the bearing on the opposite side of the shaft, as shown in figure 1. In this scheme, the net force generated by the two magnets is given by

F = μo N1 2 I1 2 A g1/4 g1 2 - μo N2 2 I2 2 A g2 2 ----------3

Generally, the two magnets are designed to have the same pole faces area (Ag1 = Ag2 = Ag) and the same number of coil turns (N1 = N2 = N) the opposed geometry dicates that the gaps once related to a nominal gap, ga, and the shaft displacement, x, by gt = go – x and g2 = go + x. This reduces (3) to

F = μo N 2 Ag / 4 { I1 2 / (g0 – x) 2 – I2 2 / (g0 + x) 2} ----------4

The two currents, I1 and I2 predominantly control the breaking force clearly, the problem of selecting these currents is under determined in that there once two variable to choose in generating a single result F. If the two currents are set equal to each other there, for the nominal centered case where x = 0, no free will be produced. the same condition holds if 1 1 = -1 2 because the two currents are squared by the force law.

One approach, which has been promoted for use on spacecraft where energy is at a premium, to further restrict the currents to be positive.

I1 = { I : I > 0; 0 : I < 0 I2 = { 0: I>0 : -I : I < 0 ----------5

Under this restriction, the force is property controlled by the single variable I:

F = { μo N 2 I 2 Ag / 4 (g0 – x) 2 : I>0
{ -μo N 2 I 2 Ag / 4 (g0 + x) 2 : I < 0 ----------6

This scheme is readily demonstrated to make the most efficient use of the current.

The drawback to energizing only one coil at a time lies in the achievable dynamic performance. Because the coils of the magnetic breaking are inductive, the rate at which the current can be varied depends directly upon the available power supply voltage. If the power supply voltage is V sup and the coil inductance is less than the fastest that the coil current can be varied is

DI / dt max = = or – Vsup / L ----------7

When the temporal of the shaft position ‘x’ and the resistive loss in the coil have been neglected. For the control scheme of (6), the force slew rate or force time rate of change is

Df / dt = I μo N 2 Ag / 2 (g0 + or – x) 2 dI / dt ----------8

Where again, the time variation of the shaft position x has been neglected. Since the current slew is limited by (7), the force slew rate is similarly limited:

$$\left| DF / dt \right| <= \left| I \right| \mu o\, N2\, Ag / 2\, (go + or - x)2\, Vsup / L$$

Note that the inductance L, is given by

$$L = N d\Phi / dI = N\, Ag\, dB / Di = \mu o\, N2\, Ag / 2\, (go + or - x)$$ ----------10

Permitting reduction of (9) to

$$\left| Df / dt \right| <= \left| I \right| Vsup / go + or - x$$ ----------11

If the force F is to be sinusoidal, then its peak slew occurs at the point where f = 0 which corresponds to the point where [I] = 0. Unfortunately, this is precisely the point where, by I1 the available force slew rate is zero due to the finite power supply voltage. Thus, control schemes, which only energize a simple coil at a time, will inherently distort the force in the neighborhood of F = 0. Using nonlinear control techniques for I cannot alleviate this problem: it is fundamental to the physical device.

The most common remedy to this problem is to use both coils simultaneously. Here, a fixed bias current Ib and a variable perturbation current ip are introduced such that

I1 = { Ib + ip ; Ib + ip > 0
{ 0; Ib + ip < 0
I2 = { Ib – ip; Ib –ip > 0

{ 0; Ib – ip < 0 ----------12

With this arrangement, the force produced by the bearing is

F = μo N2 Ag / 4 {(Ib + ip)2 / (go – x) 2 – (Ib – ip) 2 / (go + x)2)}: | ip | < = | Ib | -----13

When the shaft is centered (x=0) this reduces to

F = μo N2 Ag Ib / go 2 | ip | < = | Ib |, x = 0 ----------14

This relationship has the practical advantage that it is linear in the control variable ip, but it has the rather more substantial dynamic advantage in that the achievable force slew rate is never zero unless Ib is zero:

| Df/dt | max = | dip/dt | max μo N2 Ag/2 | Ib + ip/ (go – x) 2 + Ib –ip/ (go + x)2 |
= Vsup/L μoN2 Ag / 2 | Ib + ip / (go – x) 2 + Ib – ip / (go + x) 2 |

For the nominally centered case (x = 0), this can be simplified as

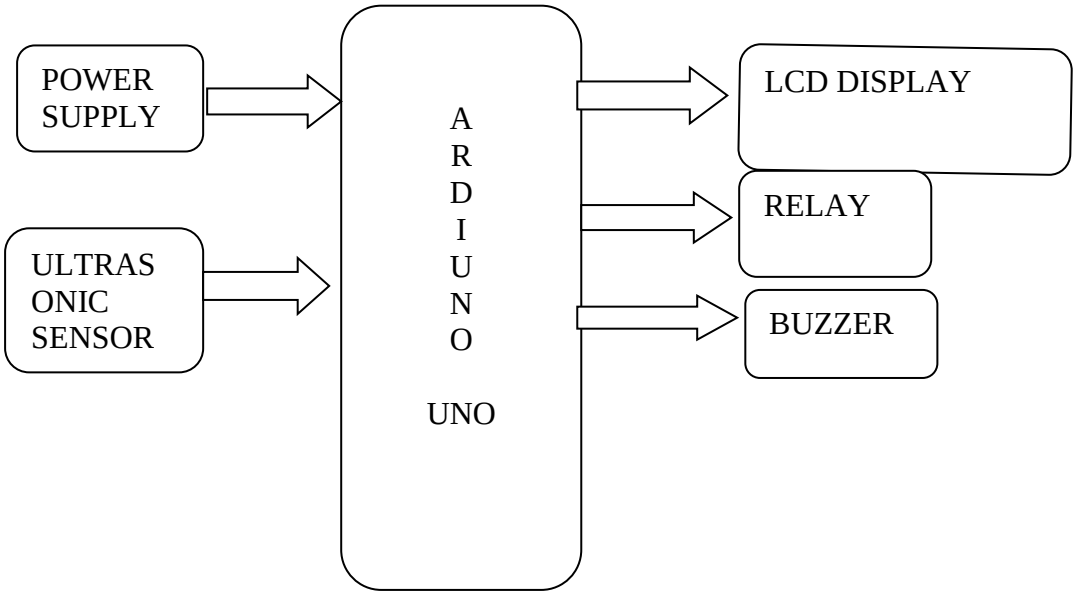
| Df/dt | max = 2 Vsup Ib / go ----------15

This limit is quite independent of ip indicating that the achievable force slew rate is invariant as long as | ip | < = | Ib |.

CHAPTER-7

ELECTRICAL ENGINEERING MATERILAS

BLOCK DIAGRAM



WORKING:

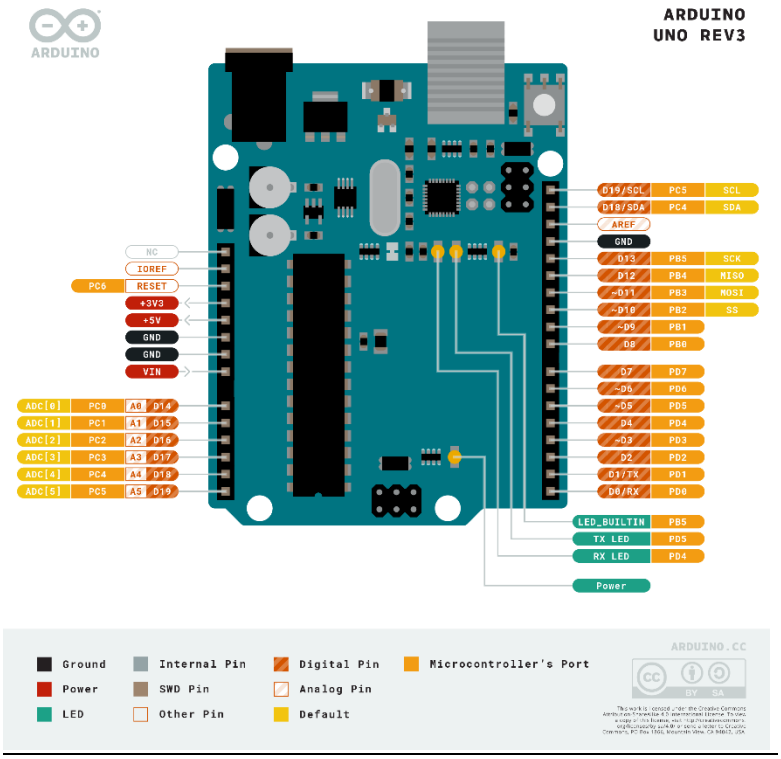
Power Supply

Here arduino board, GSM modem operates with 12V DC, LCD display, sensor circuit operates with DC 5V supply and this supply is provided by regulator of LM7805. 12V step down transformer with rectifier and filter is used to give power supply (or adapter can be use depends upon our requirement).

Arduino Uno

Arduino Uno is a microcontroller board based on 8-bit ATmega328P microcontroller. Along with ATmega328P, it consists other components such as crystal

oscillator, serial communication, voltage regulator, etc. to support the microcontroller. Arduino Uno has 14 digital input/output pins (out of which 6 can be used as PWM outputs), 6 analog input pins, a USB connection, A Power barrel jack, an ICSP header and a reset button.



How to use Arduino Board

The 14 digital input/output pins can be used as input or output pins by using pinMode(), digitalRead() and digitalWrite() functions in arduino programming. Each pin operate at 5V and can provide or receive a maximum of 40mA current, and has an internal pull-up resistor of 20-50 KOhms which are disconnected by default. Out of these 14 pins, some pins have specific functions as listed below:

- **Serial Pins 0 (Rx) and 1 (Tx):** Rx and Tx pins are used to receive and transmit TTL serial data. They are connected with the corresponding ATmega328P USB to TTL serial chip.
- **External Interrupt Pins 2 and 3:** These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.
- **PWM Pins 3, 5, 6, 9 and 11:** These pins provide an 8-bit PWM output by using analogWrite() function.
- **SPI Pins 10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK):** These pins are used for SPI communication.

- **In-built LED Pin 13:** This pin is connected with an built-in LED, when pin 13 is HIGH – LED is on and when pin 13 is LOW, its off.

Along with 14 Digital pins, there are 6 analog input pins, each of which provide 10 bits of resolution, i.e. 1024 different values. They measure from 0 to 5 volts but this limit can be increased by using AREF pin with analog Reference() function.

- Analog pin 4 (SDA) and pin 5 (SCA) also used for TWI communication using Wire library.

Arduino Uno has a couple of other pins as explained below:

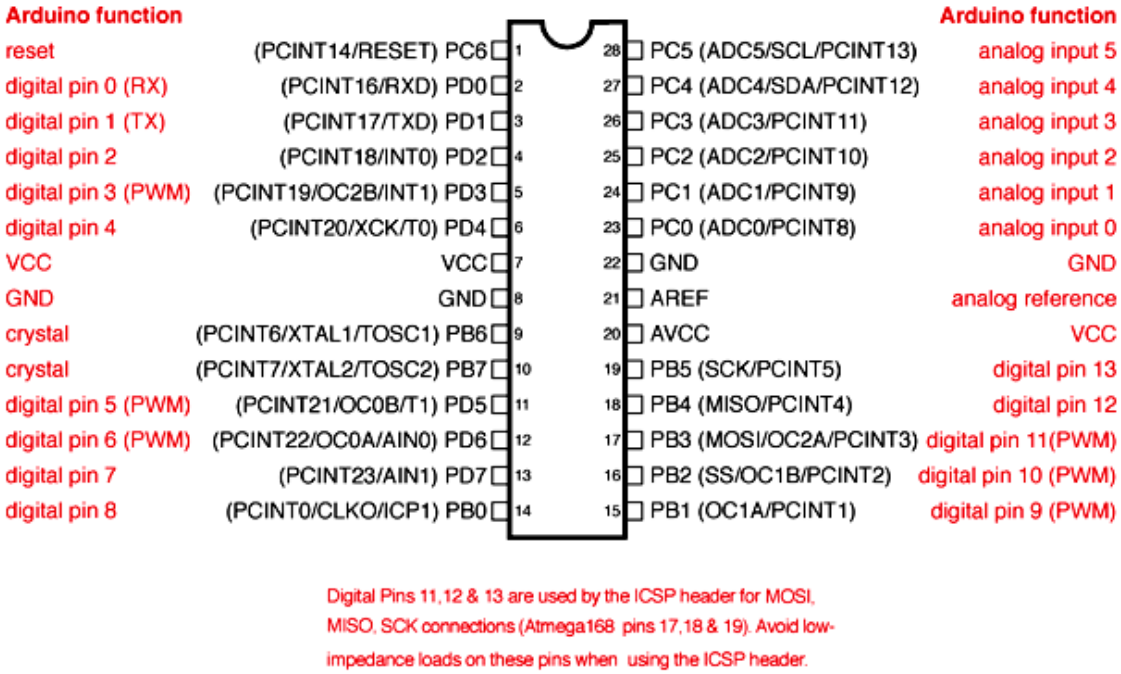
- **AREF:** Used to provide reference voltage for analog inputs with analogReference() function.
- **Reset Pin:** Making this pin LOW, resets the microcontroller.

Communication

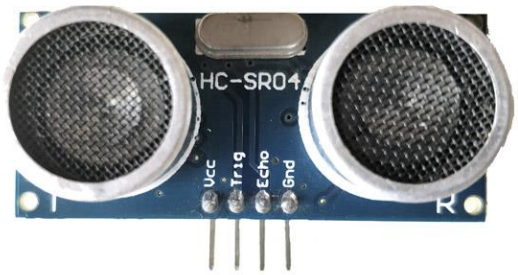
Arduino can be used to communicate with a computer, another Arduino board or other microcontrollers. The ATmega328P microcontroller provides UART TTL (5V) serial communication which can be done using digital pin 0 (Rx) and digital pin 1 (Tx). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The ATmega16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, a .inf file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. There are two RX and TX LEDs on the arduino board which will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (not for serial communication on pins 0 and 1). A SoftwareSerial library allows for serial communication on any of the Uno's digital pins. The ATmega328P also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus.

Arduino Uno to ATmega328 Pin Mapping

When ATmega328 chip is used in place of Arduino Uno, or vice versa, the image below shows the pin mapping between the two.



Arduino IDE (Integrated Development Environment) is required to program the Arduino Uno board



HC-SR04 Ultrasonic Sensor

HC-SR04 Sensor Features

- Operating voltage: +5V
- Theoretical Measuring Distance: 2cm to 450cm
- Practical Measuring Distance: 2cm to 80cm
- Accuracy: 3mm
- Measuring angle covered: <15°
- Operating Current: <15mA
- Operating Frequency: 40Hz

Equivalent distance measuring Sensors

US transmitter Receiver pair, IR sensor module, IR sensor pair, IR Analog distance sensor,

HC-SR04 Ultrasonic Sensor - Working

As shown above the **HC-SR04 Ultrasonic (US) sensor** is a 4 pin module, whose pin names are Vcc, Trigger, Echo and Ground respectively. This sensor is a very popular sensor used in many applications where measuring distance or sensing objects are required. The module has two eyes like projects in the front which forms the Ultrasonic transmitter and Receiver. The sensor works with the simple high school formula that

Distance = Speed × Time

The Ultrasonic transmitter transmits an ultrasonic wave, this wave travels in air and when it gets objected by any material it gets reflected back toward the sensor this reflected wave is observed by the Ultrasonic receiver module as shown in the picture below

Now, to calculate the distance using the above formulae, we should know the Speed and time. Since we are using the Ultrasonic wave we know the universal speed of US wave at room conditions which is 330m/s. The circuitry inbuilt on the module will calculate the time taken for the US wave to come back and turns on the echo pin high for that same particular amount of time, this way we can also know the time taken. Now simply calculate the distance using a microcontroller or microprocessor.

How to use the HC-SR04 Ultrasonic Sensor

HC-SR04 distance sensor is commonly used with both microcontroller and microprocessor platforms like Arduino, ARM, PIC, Raspberry Pie etc. The following guide is universally since it has to be followed irrespective of the type of computational device used.

Power the Sensor using a regulated +5V through the Vcc ad Ground pins of the sensor. The current consumed by the sensor is less than 15mA and hence can be directly powered by the on board 5V pins (If available). The Trigger and the Echo pins are both I/O pins and hence they can be connected to I/O pins of the microcontroller. To start the measurement, the trigger pin has to be made high for 10uS and then turned off. This action will trigger an

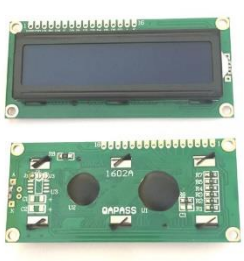
ultrasonic wave at frequency of 40Hz from the transmitter and the receiver will wait for the wave to return. Once the wave is returned after it getting reflected by any object the Echo pin goes high for a particular amount of time which will be equal to the time taken for the wave to return back to the sensor.

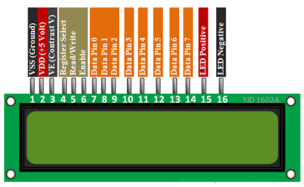
The amount of time during which the Echo pin stays high is measured by the MCU/MPU as it gives the information about the time taken for the wave to return back to the Sensor. Using this information the distance is measured as explained in the above heading.

Applications

- Used to avoid and detect obstacles with robots like biped robot, obstacle avoider robot, path finding robot etc.
- Used to measure the distance within a wide range of 2cm to 400cm
- Can be used to map the objects surrounding the sensor by rotating it
- Depth of certain places like wells, pits etc can be measured since the waves can penetrate through water

16x2 LCD Module





16x2 LCD Module
16x2 LCD Module Pinout

Pin Configuration

Pin No:	Pin Name:	Description
1	Vss (Ground)	Ground pin connected to system ground
2	Vdd (+5 Volt)	Powers the LCD with +5V (4.7V – 5.3V)
3	VE (Contrast V)	Decides the contrast level of display. Grounded to get maximum contrast.
4	Register Select	Connected to Microcontroller to shift between command/data register
5	Read/Write	Used to read or write data. Normally grounded to write data to LCD
6	Enable	Connected to Microcontroller Pin and toggled between 1 and 0 for data acknowledgement
7	Data Pin 0	Data pins 0 to 7 forms a 8-bit data line. They can be connected to Microcontroller to send 8-bit data. These LCD's can also operate on 4-bit mode in such case Data pin 4,5,6 and 7 will be left free.
8	Data Pin 1	
9	Data Pin 2	
10	Data Pin 3	
11	Data Pin 4	

12	Data Pin 5	
13	Data Pin 6	
14	Data Pin 7	
15	LED Positive	Backlight LED pin positive terminal
16	LED Negative	Backlight LED pin negative terminal

Features of 16×2 LCD module

- Operating Voltage is 4.7V to 5.3V
- Current consumption is 1mA without backlight
- Alphanumeric LCD display module, meaning can display alphabets and numbers
- Consists of two rows and each row can print 16 characters.
- Each character is build by a 5×8 pixel box
- Can work on both 8-bit and 4-bit mode
- It can also display any custom generated characters
- Available in Green and Blue Backlight

16x2 Display Equivalents

Dot Matrix LED Display, 7-Segment LED Display, OLED Display, TFT LCD Screen Display

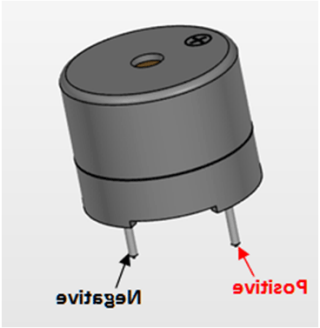
Brief Description on LCD modules

LCD modules are very commonly used in most embedded projects, the reason being its cheap price, availability and programmer friendly. Most of us would have come across these displays in our day to day life, either at PCO's or calculators. The appearance and the pinouts have already been visualized above now let us get a bit technical.

16×2 LCD is named so because; it has 16 Columns and 2 Rows. There are a lot of combinations available like, 8×1, 8×2, 10×2, 16×1, etc. but the most used one is the 16×2 LCD. So, it will have (16×2=32) 32 characters in total and each character will be made of 5×8 Pixel Dots. A Single character with all its Pixels is shown in the below picture.

Now, we know that each character has (5×8=40) 40 Pixels and for 32 Characters we will have (32×40) 1280 Pixels. Further, the LCD should also be instructed about the Position of the Pixels. Hence it will be a hectic task to handle everything with the help of MCU, hence an **Interface IC like HD44780**is used, which is mounted on the backside of the LCD Module itself. The function of this IC is to get the **Commands and Data** from the MCU and process them to display meaningful information onto our LCD Screen. You can learn how to interface an LCD using the above mentioned links. If you are an advanced programmer and would like to create your own library for interfacing your Microcontroller with this LCD module then you have to understand the HD44780 IC is working and commands which can be found its datasheet.

Buzzer



Buzzer Pin Configuration

Pin Number	Pin Name	Description
1	Positive	Identified by (+) symbol or longer terminal lead. Can be powered by 6V DC
2	Negative	Identified by short terminal lead. Typically connected to the ground of the circuit

Buzzer Features and Specifications

- Rated Voltage: 6V DC
- Operating Voltage: 4-8V DC
- Rated current: <30mA
- Sound Type: Continuous Beep
- Resonant Frequency: ~2300 Hz
- Small and neat sealed package
- Breadboard and Perf board friendly

Equivalents for Passive Buzzer

Piezo Electric buzzer, Speaker, Active Passive Buzzer with Module

How to use a Buzzer

A **buzzer** is a small yet efficient component to add sound features to our project/system. It is very small and compact 2-pin structure hence can be easily used on breadboard, Perf Board and even on PCBs which makes this a widely used component in most electronic applications.

There are two types are buzzers that are commonly available. The one shown here is a simple buzzer which when powered will make a Continuous Beeeeeeppp.... sound, the other type is called a readymade buzzer which will look bulkier than this and will produce a Beep. Beep. Beep. Sound due to the internal oscillating circuit present inside it. But, the one shown here is most widely used because it can be customised with help of other circuits to fit easily in our application.

This buzzer can be used by simply powering it using a DC power supply ranging from 4V to 9V. A simple 9V battery can also be used, but it is recommended to use a regulated +5V or +6V DC supply. The buzzer is normally associated with a switching circuit to turn ON or turn OFF the buzzer at required time and require interval.

Applications of Buzzer

- Alarming Circuits, where the user has to be alarmed about something
- Communication equipments
- Automobile electronics
- Portable equipments, due to its compact size

Relay Module

A relay is basically a switch which is operated by an electromagnet. The electromagnet requires a small voltage to get activated which we will give from the Arduino and once it is activated, it will pull the contact to make the high voltage circuit.

It runs on 12V and we can control it with any micro-controller but we are going to use Arduino.

Pin out of 12V relay module

The Arduino relay module has total of six pins: three on one side and three on other side.On the bottom side, there are three pins which are signal, 5V and ground. We will connect these pins with the Arduino. While on the other side, there are NC (Normally close), C (Common) and the NO (normally open) which are the output pins of the 12V relay. There, we will connect the output device.

Normally open state (NO) VS Normally closed state (NC)

The Arduino relay module can be used in two states which are

- Normally open state (NO)
- Normally closed state (NC)

Normally open (NO)

In the normally open state, the initial output of the relay will be low when it will be powered. In this state, the common and the normally open pins are used.

Normally closed state (NC)

In the normally closed state, the initial output of the relay will be high when it will be powered. In this state, the common and the normally close pins are used.

PROGRAM

```
#include <LiquidCrystal.h>
// initialize the library by associating any needed LCD interface pin
// with the arduino pin number it is connected to
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);
#define ECHOPIN 13        // Pin to receive echo pulse
#define TRIGPIN 10        // Pin to send trigger pulse
#define buzzer  7
#define relay   9
void setup()
{
  lcd.begin(16,2);
  Serial.begin(9600);
  pinMode(ECHOPIN, INPUT);
  pinMode(TRIGPIN, OUTPUT);
  pinMode(7, OUTPUT);
  //pinMode(8, OUTPUT);
  pinMode(9,OUTPUT);
}
```

```
void loop()
{
    lcd.setCursor(0,1);
  // Start Ranging -Generating a trigger of 10us burst
  digitalWrite(TRIGPIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIGPIN, HIGH);
  delayMicroseconds(10);
  digitalWrite(TRIGPIN, LOW);
  // Distance Calculation

  float distance = pulseIn(ECHOPIN, HIGH);
  distance= distance/58;

 {
    lcd.setCursor(0,1);
  lcd.print("distval=");
  Serial.print("distval=  ");
  lcd.print(distance);
  Serial.println(distance);
```

```
 lcd.print("cm");
 Serial.println("cm");


 delay(1000);



  if((distance>=15)&&(distance<=25))
 {
 digitalWrite(7,LOW);
 digitalWrite(9,HIGH);//breaking
 }
  else if((distance>=50)&&(distance<=55))
 {

digitalWrite(7,HIGH);
 digitalWrite(9,LOW);//indication
 }
 else if((distance>=70)&&(distance<=75))
 {

digitalWrite(7,HIGH);
 digitalWrite(9,LOW);

 }
  else if((distance>=100)&&(distance<=105))
  {
  digitalWrite(7,HIGH);
 digitalWrite(9,LOW);//indiacation
  }
  else
  {
  digitalWrite(7,LOW);
 digitalWrite(9,LOW);
  }
 }
}
```

CHAPTER-8

FACTORS INVOLVED IN BRAKING OF A VEHICLE

STOPPING TIME AND DISTANCE

If the coefficient of friction between the ground and the tyre is unity then the total retarding force produced at the wheel will be equal to the retarding force assumed by a freely falling body. Under this condition the deceleration due to gravity. At this stage the brakes are said to be cent percent efficient.

Stopping distances vary with brake conditions (perfect fair or bad and the speed of the vehicle when brakes are applied). The distances vary with the type of road surface and condition of tyre treads. Stopping distance is reaction (or thinking) distance plus braking distance (while is dependent on speed). The reaction distance is the minimum safe distance at which you should follow another car. The time a driver takes to stop depends on the time it takes for him to react – 0.4 to 0.7 sec. – as well as the time it takes the brake to half the car. During this time the car travels for what is called the thinking distance. Locking the sheets extends the braking distance and can lead to loss of directional control. To give best braking results without loss of directional control and regardless of road-surface grip condition. Antilock braking systems are being developed.

The chart shows the average thinking and braking distances for medium sized cars with 60% efficient brakes and 80% efficient brakes travelling at speeds of 48,80 and 112 km/hr. On a dry road when the coefficient of friction varies between 0.65 and 0.85 (usually 0.6).

Thinking distance	Braking distance	Efficiency
48 kmph.		
9.14 m	15.84 m	60%
9.14 m	11.58 m	80%
80 kmph.		
15.24 m	42.67 m	60%
15.24 m	32.00 m	80%
112 kmph.		
21.34 m	83.82 m	60%
21.34 m	62.48 m	80%

Efficiency of the brakes of a vehicle should vary from 50-80% to stop the vehicle within reasonable distance.

The efficiency of properly adjusted brakes should be at least 80 percent. Severe braking at high speeds involves serious hazards because the driver is likely to lock the wheels. Thereby throwing the car into a skid and the passengers are likely to be thrown off their seats. A fast stop is not only uncomfortable but may result in personal injury. The time required to bring the vehicle load stop by means of brakes varies directly with the initial speed. But the stopping distance varies as the square of the speed.

RELATION OF STOPPING DISANCE

When the vehicle is braked from a steady speed of V(km/h). When a freely falling body of mass 1 kg is acted upon by a force of 1 kg. The mass is accelerated at the rate of 9.81 (m/s^2). The acceleration is directly proportional to thee force acting on the body and it is inversely proportional to the mass accelerated. It can be represented by the equation,

f = F g/w

Where,

f = acceleration (m/s^2)

F = force acting on the body

W = weight of the body

g = acceleration due to gravity m/s^2).

The deceleration of a moving mass may be considered as negative acceleration. When the vehicle is brought to rest by the application of its brakes, the maximum value at decelerating force can be represented by

F = μ w

Where,

W = weight of the vehicle

u = coefficient of friction

The max. braking force is available only if the brakes are applied on all the four wheels. The value of the coefficient of friction between the tread of a rubber tyre and a clean dry concrete road lies between 0.6 x 0.85 under ideal conditions. It is reasonable to assume value of as 0.6.

The rate of deceleration can be represented as,

f = μ wg/w.

= μg.

If the speed of the vehicles is v km/hr. its velocity is,

$$V = \frac{1000}{3600} \times V = \frac{5}{18} \times v \text{ (m/s).}$$

To bring the vehicle to stop from an initial velocity of V = (5/18) x v (m/s). When the rate of deceleration is ug (m/s^2), the time

$$t = \frac{(5/18) \times v}{ug}$$

When the deceleration is constant the mean velocity is half of initial velocity

i.e., (5/36) x v (m/s)

stopping distance = mean velocity x time

= (5/36) x v x (5/18) x v/ug

Stopping distance = $25/648 \times v^2/(0.6 \times 9.81)$

= $0.00656\ v^2$

Table gives the minimum stopping distances at different speeds of the vehicle based on the above equation.

Speed (km/hr)	10	20	30	40	50	60
Distance (m)	0.656	2.624	5.9	10.5	16.4	23.62
Speed (km/hr)	70	80	90	100		
Distance (m)	32.2	42.1	53.2	65.6		

The above distances are for emergency braking in order to avoid accidents. However this high rate of deceleration causes discomfort to the passengers. The maximum rate of deceleration which is not likely to interfere with the passenger comfort is about 2 (m/s^2).

BRAKE OPERATING EFFICIENCY

Brakes operate most efficiently when they are applied so that the Wheels do not quite lock. But continue to turn without slipping on the road. This is because more energy can be absorbed when the wheels are turning than when the brakes lock the wheels, so that the tyres slide on the road. The power absorbed by the friction of the brake drums and lining the

frictional losses of the power transmission system and the rolling friction of the tyres is greater than the sliding friction of the tyres on the road. For this reason it is usually safer, especially when travelling on slippery highways to use the deceleration of the engine, with or without brakes, rather than brakes alone for slowing down a car. In addition locked brakes cause excessive tyre wear.

WHEEL LOCKING

Wheel locking occurs the friction between the shoes and brake drum exceeds the friction between the tyre and road surface. Frictional force is essential for gripping the tyres on the road surface. The brakes will stop the car more quickly when they are not locked and also the wear and Lear on the tyres are greatly reduced. Maximum braking effort obtainable is greater with low pressure than with high pressure tyres as the former hold the road better. The chief objection to locking of the rear wheels is that it is almost certain to throw the car into a skid.

The advantages of four wheel over two wheel brakes are that the former materially reduces the skidding tendency of a car. When there are brakes on two wheels only it takes only about one half of the pedal pressure to lock them. On greasy roads even a slight applications is likely to lock a pair of rear wheel brakes unless the engine is in gear and once the wheels are locked they will slide easily sideways as forward. All that is necessary to start a skid is that the centre line of resistances encountered by the front wheels does not pass through the centre of gravity of a car or of a car or if one front wheel encounters greater resistance than the other locking the front wheels will not produce a rear wheel skid.

WEIGHT TRANSFERENCE

Ideally the braking effort should be distributed between the front and rear wheel in proportion to the weight that they carry. This will vary according to the design of the car (whether it is front engine or rear engine) the number of passengers and the amount of luggage but the effect of applying the brakes is to throw some of the weight forward. This ‘transfer’ adds to the load on the front wheel and similarly, reduces the load on the rear wheel. Most of the braking is done by the front brakes.

When the brakes are applied hard there is a greater transfer of weight and the rear wheel tend to lock, which often causes the tail of the car to slide sideways. If the front wheels become locked first the car will usually slide in a straight line, but steering control will be lost. Locking the wheels by heavy braking is much more likely on slippery roads so caution is needed on a treacherous surface. Overturning of the vehicle occurs due to the inertia force acting at the centre of gravity of the vehicle and the retarding force acting on the road surface.

The application of the brakes to the car causes a couple to act which tends to rotate the car as a whole in a vertical plane about its centre of gravity. This couple increases the pressure between the front wheels and the road and decreases that between the rear wheels and the road. Wheel locking would occur on the rear wheel earlier than front wheel if there were no transference of load from the rear to the front axle during braking.

Weight transfer

Let f = the retarding force

W = the wt. Of the vehicle

μ = the coefficient of friction

h = the height of the centre of vehicle from the ground.

Therefore

$F = \mu w$ = inertia force

Couple produced = $\mu w \times h$

Let w be the weight transferred from the rear to the front of the vehicle and l be the wheel base. The balancing couple will be w x l.

Therefore $w \times l = \mu wh$

$W = \mu wh/l$

In case of motor cars the average value of h/l is of the order of 1/5. taking the value of μ = 0.6

W = 0.12m

i.e., 12% of the car weight is transferred to the front during braking.

BRAKING EFFICIENCY

The application of retarding force on a vehicle gives rise to deceleration. The braking deceleration like the acceleration due to gravity is expressed in m/s. The braking system efficiency is measured in terms of the rate at which it will bring the vehicle to a stationary position from a given speed. The braking efficiency is expressed as ratio of its deceleration rate to the due to gravity.

Let f = the deceleration

g = the acceleration due to gravity

Braking efficiency = f/g x 100%

The braking efficiency is maximum when f = g.

HEAT GENERATION AND OPERATION TEMPERATURES:

The chief problem in connection with vehicle brakes is to key them from attaining excessive temperatures in service, as such temperatures accelerate the wear of the friction linings and may have injurious effects on the brake drums or discs. The maximum rate of heat generation by the brakes, varies with the maximum temperature, reached by the brakes and with the average speed of travel. Both of these factors have increased continuously with increase in proportion of engine power to vehicle weight, with improvement in roads and with streamlining of vehicles. On the other hand, the ability of brakes to get rid of the they generate has decreased as the reduction in wheel diameters has made it necessary to use small brake drums, and ventilation of brakes has been impaired by modern styling, which encloses both further reduces air circulation over the brakes by the provision of deep bumpers.

In the brake the heat generated at the interface between the drum or the disc and the lining, and most of it must flow off through the drum or disc as the lining is a very poor heat conductor.

Under severe braking conditions heat is generated at a very rapid rate, and the time available is too short to allow much of it to be dispersed to the atmosphere during a single stop. Therefore, in an emergency stop from a high speed most of the heat generated must be absorbed by the drum or disk. The material close to the friction surface reaches a high temperature and there is a steep temperature gradient along the path of heat flow.

Excessive heating of the brakes can result in fade. Heat causes temporary changes in the friction properties of the material used for brake pads and linings, and the brakes become less efficient as they get hotter. Normal efficiency generally returns when they cool again. Brake pads and linings also wear away faster at higher temperatures. In a good friction material the change in their property is gradual at high temperatures. A poor material suffers sudden friction loss and the brakes fail. Graph illustrates the variation of friction with increase in temperature.

DIVISION OF BRAKING EFFORT BETWEEN FRONT AND REAR

During braking there is considerably more weight on the front than on the rear wheels. It has also been established that under most driving conditions that locking of the front wheels is less hazardous than lock of the rear wheels. It has therefore become the practice in passenger cars in the proportion of 60 rear. This unequal division of the braking effort can be brought about by applying the front brakes with great force (using wheel cylinders of larger bore), by using linings or by providing for a higher degree of self energisation for the front brakes. If both sets of brakes are of the same size and the front brakes do a greater share of the work, they will reach a higher temperature and wear faster. The most rational division of the braking effort between the wheels, would seem to be in proportion to the loads on the different wheels under full load conditions and with the brakes fully applies.

TIME LAG:

In air brake systems there is necessarily a slight lag between motion of the brake pedal and full application of the brakes, as it takes time for the air to pass from the brake valve to the brake chambers. Only very little time is required for the air pressure to make itself in the brake chambers, but in an emergency application fractions of a second counts. Brake action begins as soon as the clearance between brake shoes and drum is taken up. But

additional time elapses before the pressure in the brake drum reaches the full valve for which the brake pedal is set. Larger tubing and such units as brake values and relay values have been redesigned to afford greater air flow capacity and thus reduce the lag.

BRAKE TESTS:

When the vehicle is moving, it can stopped by applying the bakes. It is obvious that break pedals cannot be pressed instantaneously and the vehicle cannot be stopped instantaneously. First the driver thinks, then lifts the leg, presses the brake pedal and then the vehicle stops after moving some distance. So it is necessary to note how much time is required to stop the vehicle and how long it will travel after applying the brake. These two factors are directly dependent on the speed of the vehicle. 1. Stop test. For testing brakes, this test is usually adopted after overhauling the brakes. The vehicle is moved at a speed and the brakes are suddenly applied. Then the time taken to stop and the distance moves after the application of the brakes is checked.

2.Stop watch test: To perform this test, the vehicle is moved at some 70 km/hr. then the brakes are applied. The time and distance are noted.

Let T = Time taken to stop the vehicle after applying the brakes.

D = Distance moved by the vehicle after applying the brakes.

Then brake efficiency is given by

$= (D-T^2) \times 6 \times \frac{1}{4}$

3. Brake testers are also used for testing the brakes. They work on the principle of declinometer. Taply brake meter is a type of brake tester. This brake meter is placed on the vehicle floor for testing the brakes.

CHAPTER-9

COMPONENTS OF A BRAKING SYSTEM

BRAKE DRUMS:

Brake drums are thin cylindrical members whose outside ends are closed and the inside open to admit the brake shoes. Previously brake drums were made in the form of steel pressings. The product had some defects – the cooling of the drum not effective since of friction materials on the inside of the brake drum. An improved design of brake drum use a nickel-iron casting with suitable ribs for cooling purposes.

The brake drums of these days are invariably manufactured out of cast iron, cast iron and steel, chrome nickel iron, aluminium alloy and magnesium alloy cast ribbed with cast iron liners. The drums of composite and centrifuge construction have also bend used. Aluminimum and magnesium alloy drums run much cooler than cast iron drums but they are not much reliable as the latter.

The size of the brake drums is of 203 to 294 mm (in our case 207 mm). They generally have ribs or fins on the outside of the braking surface to help in the dissipation of heat generated.

BRAKE LINING MATERIALS:

Earlier wood, leather, fabric and even steel blocks were used as materials to work against the drum. Steel, rim or rubber tyre of the wheel. These materials were not found suitable later on because they used to get charred due to high speeds of the vehicles as well as increase in weight. These days all brake linings are manufactured out of asbestos-based materials. The material has sufficient coefficient of friction as well as it can withstand high temperatures of the order of 340^{o}c without getting affected. Following are the four different types of asbestos based materials used for brake linings.

1. Moulded pulp.
2. The impregnated asbestos sheet.
3. The folded and compressed fabric.

4. The woven strip.

Fillers such as asphalt, natural gums and oils, rubber and synthetic resins are added to improve the frictional characteristics of lining and also to counteract the effect of oil, grease and water. The linings are manufactured by hot pressing hydraulically.

The fluid used in the braking system is a special kind of fluid which has to be satisfactory under all conditions. It must meet certain requirements as mentioned below.

1. It must have a high boiling point.
2. It must remain fluid at the lowest temperature at which the vehicle is likely to operate.
3. It must be chemically stable.
4. It must have lubricating properties.
5. It must not attack the rubber and metallic parts.

Most fluids are based on polyglycois additiven are added to achieve the required properties. A 50% solution of castor oil in alcohol to which a neutralizer is added, meets the above mentioned requirements satisfactorily. The neutralizer is added to counteract the effect of any free acids which may be present in castor oil or alcohol. The brake fluid in service is subject to gradual deterioration because the moisture content of air finds its way slowly into the brake fluid.

BRAKE SHOES:

The shoes of the brake are generally of T section. They are either cast or fabricated from sheet metal. Even cast aluminium alloy shoes are used. The have the advantages of low weight and high heat conductivity. Aluminium alloy shoes are not suitable where a hardened surface is required for a cam or other actuating member of work against. The shoes are stiffened with the help of ribs, if they are quite wide when compared to the diameter of the brake. Even channel section is used instead of 1 section.

The heel of the shoe is rounded to slide into a groove on an abutment which is fixed e backing plate.

LINING THICKNESS

The lining thickness of car barker range between 3.97 and 6.25mm. generally motor cars have 4.75 mm thick linings. In case of commercial vehicles the thickness of the lining is of the order of 12.7 to 19.05 mm. Generally the linings are secured to the shoes with the help of rivets. Presently the linings are being commented to the shoes. In this practice the lining can be used until it is practically worn away. In case of riveted lining one half of the total lining must be discarded. In case of heavier vehicles the linings are secured to the shoes with the help of flat-headed bolts, nuts and lock washers. This method makes there lining job quite easy.

LINING AREA:

When the vehicle is being stopped, the kinetic energy gets dissipated. This energy is directly proportional to the weight of the vehicle. The energy dissipating capacity of a brake, depends upon the area of frictional contact, is proportional to the gross vehicle weight. Since the kinetic energy of the vehicle varies as the square of the speed, more braking area is required, for high speed victuals. The vehicles operating with frequent stops also need brakes of extra size.

In case of cars the brakes are provided with one square centimeter of lining area for every 2 kg. Of gross vehicle weight. In case of commercial vehicle the lining area of one square centimeter for every 4 kg of gross vehicle weight. The diameter of the drum can be calculated by the relationship 0.60 (w) where w, is the gross weight of the vehicle in kg.

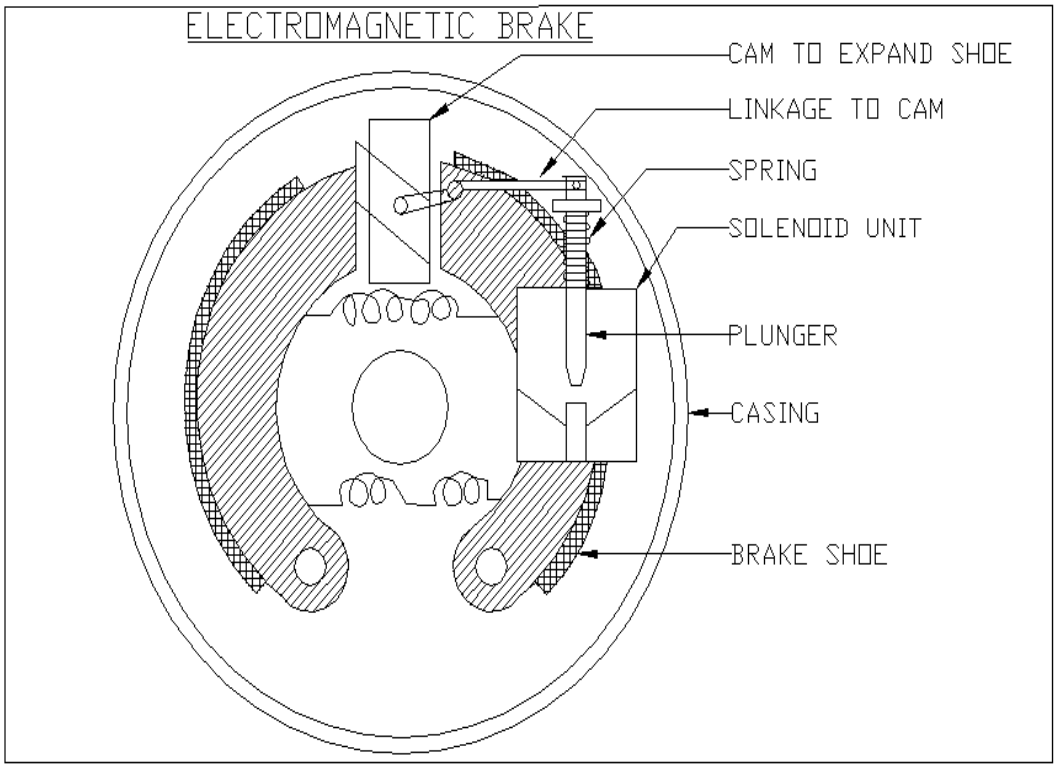
BRAKE BACKING PLATE:

The brake backing plate is the base which carries the actuating mechanism and the abutments. It also acts as the reaction member for the braking torque. It must be sufficiently stiff it is likely to deflect unduly thus affecting the braking torque adversely and uneven lining wear is also likely. The stiffness of the plate is further increased by providing pressed in corrugations.

The steady pins are mounted on the plate for the purpose of keeping the shoes at a constant distant from the plate and also to prevent them from tilting. Manual adjusters for the purpose of adjusting brakes are attached to the plate. The outer edges of the drum thereby keeping dirt and water away from the braking system..

LINING WEAR:

Lining wear is practically proportional to the work done by the shoes. It is seen that the self energizing shoe wears more rapidly than the other when the are of the lining, the material and the pressure applied to the shoes at their free end by the wheel cylinder of cam are the same. The rate of wear of the lining is maximum at the middle and it decreases towards the ends. In view of this, even some brake shoes are designed in such a fashion that the thickness of lining is not uniform through its length. They are thick at the middle and the thickness decreases towards the ends. In this case the material is used in the most economical manner.



BRAKE CLEARANCE:

During the course of operation of brakes, wear and tear of the linings takes place. Hence, the clearance provided between the lining and the drum in the initial stage increases thus necessitating adjustment. Generally the adjustment is made at the toe and heel of the shoe. When there is enough clearance at the toe and heel it will be sufficient at the other points. In the case of two shoe brakes the clearance provided between the lining and the drum varies between 0.250 mm to 0.375mm. even some manufacturers specify as low a clearance as 0.150mm. the small clearance has the advantage of giving larger ratio of pedal movement to brake-shoe radial movement although it does increase the chance of making the brakes self-locking.

CHAPTER-10

FABRICATION

Electromagnetic brake works in the principle that the attractive force of the opposite pole was to be used for performing the braking system. when an electric current is passed through solenoid switch where electric field is converted into magnetic filed, plunger Reciprocates, this Reciprocating motion is connected Rotary motion through mechanical linkage and can operates the shoe.

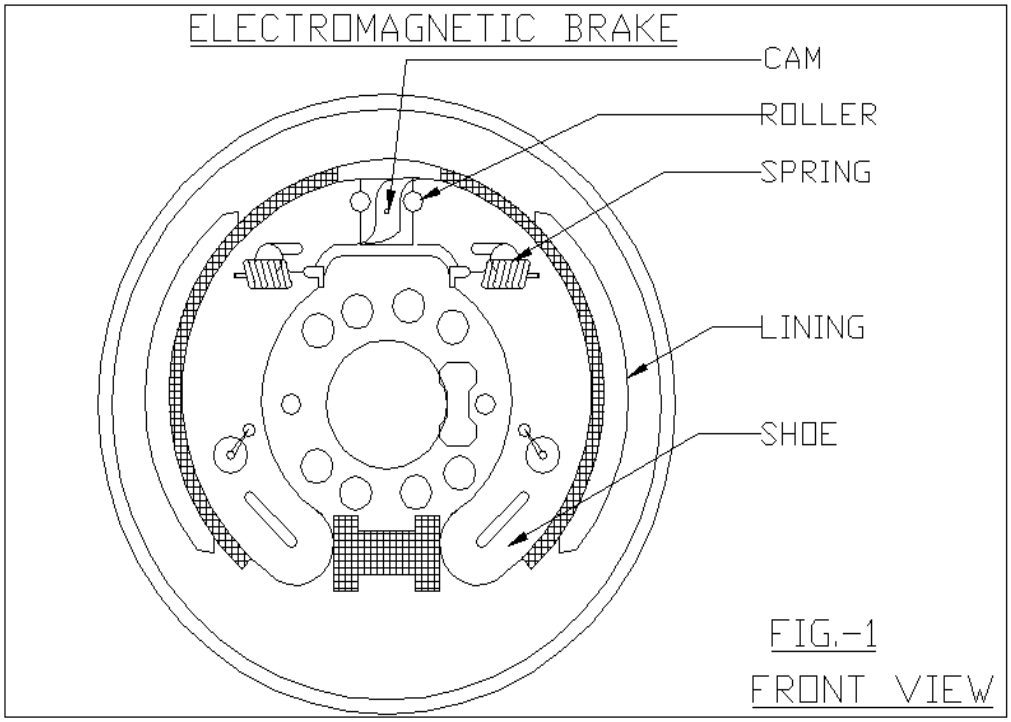
We are taking Hydraulic Brake into modification the existing Hydraulic Brake comes under 3 categories. They are,

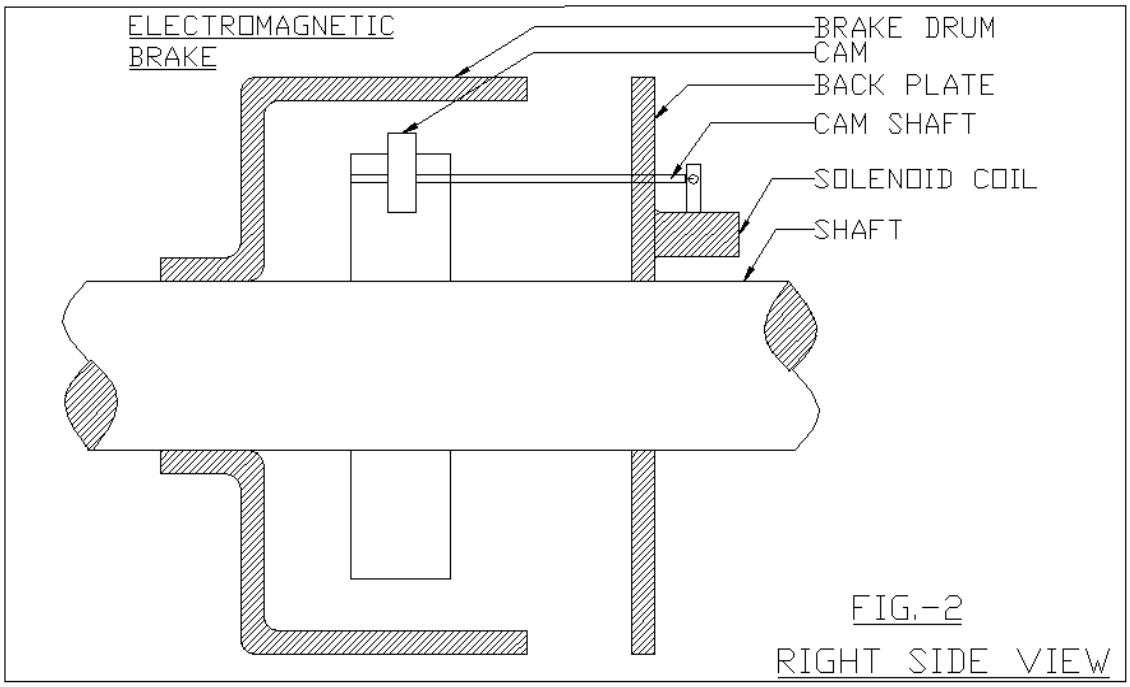
i. Both ends of shoe connected by wheel cylinder.
ii. One side wheel cylinder and other end pivoted.
iii. One side wheel cylinder and other side by Hand Brake.

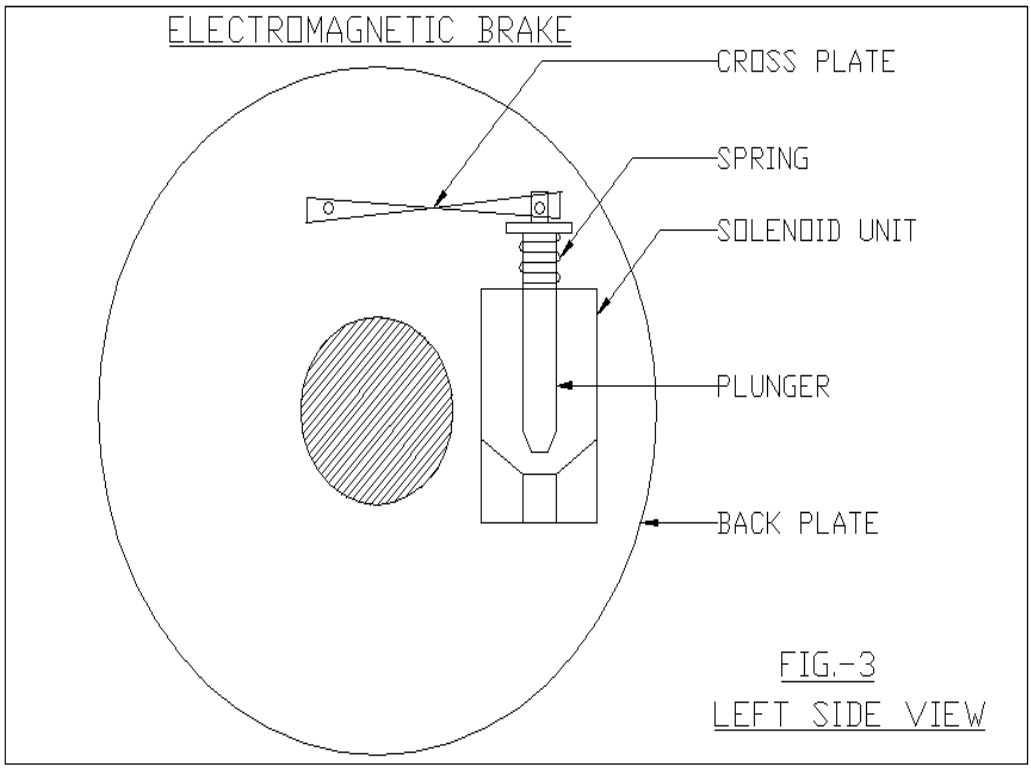
This project is designed in such a manner that one side by electromagnetic Brake and other by Hydraulic Braking system shown in fig. (1).

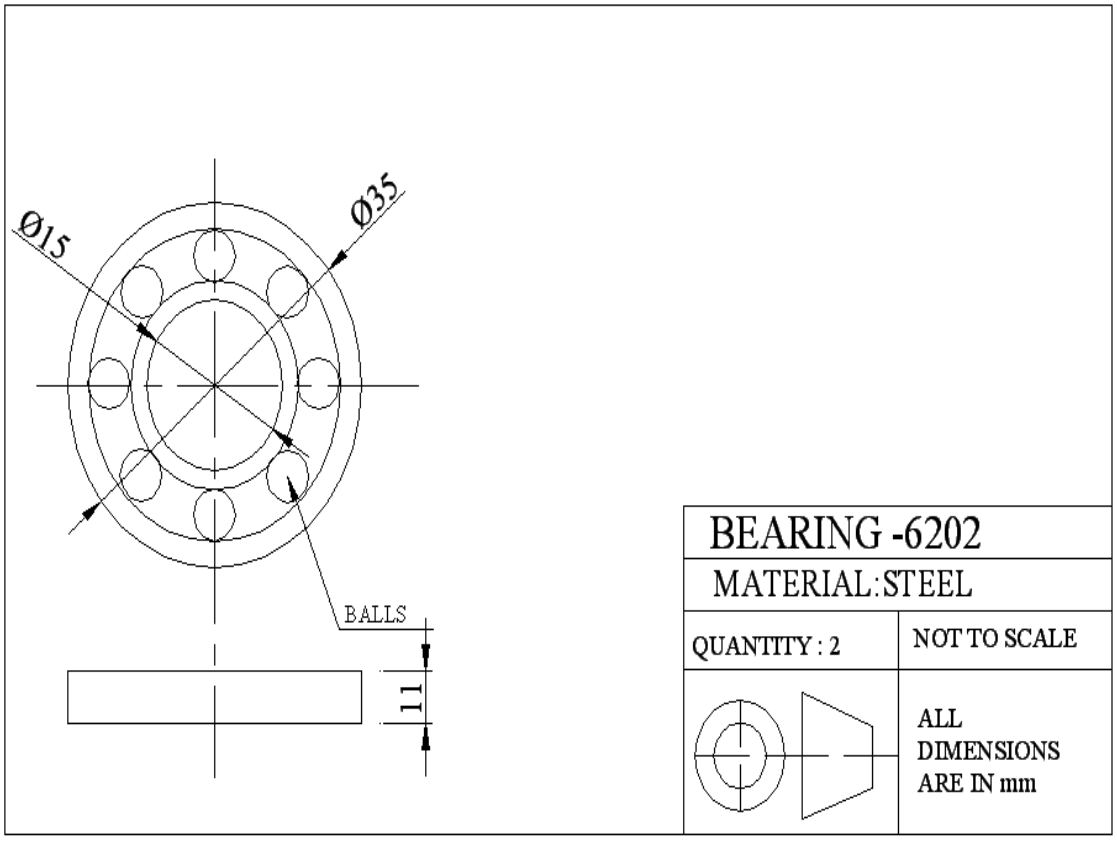
Constructionally, cam is connected to solenoid switch which is fixed on Back-plate through mechanical linkage shown in fig (2). This mechanical Linkage had a shaft and a cross-plate. Cross-plate converts Reciprocating motion into Rotary motion. This Rotary motion is given to shaft from, solenoid switch (Reciprocating motion) through cross plate shown in fig. (3). Solenoid switch is supplied with a 12V battery through key type switch.

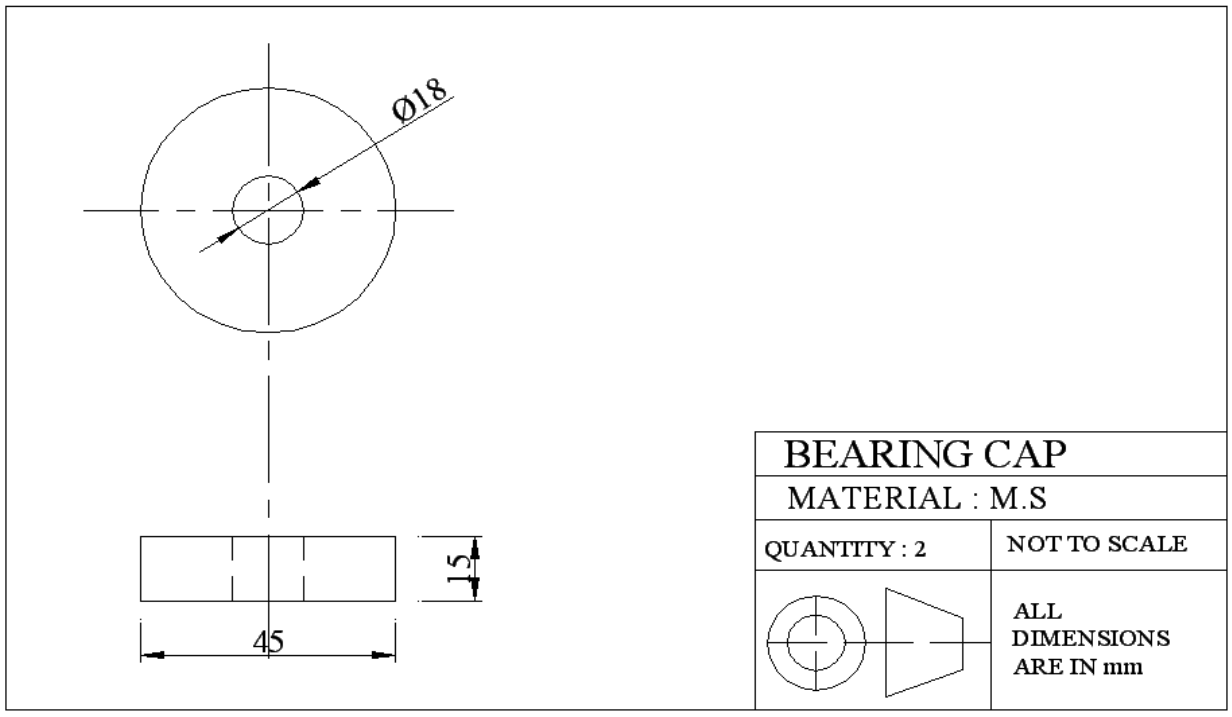
When solenoid switch receives power, electromagnet is magnetized, which attracts plunger. This attractive force causes the plunger to reciprocate. This reciprocating motion is converted to Rotary-motion and is used to perform braking action by cam.

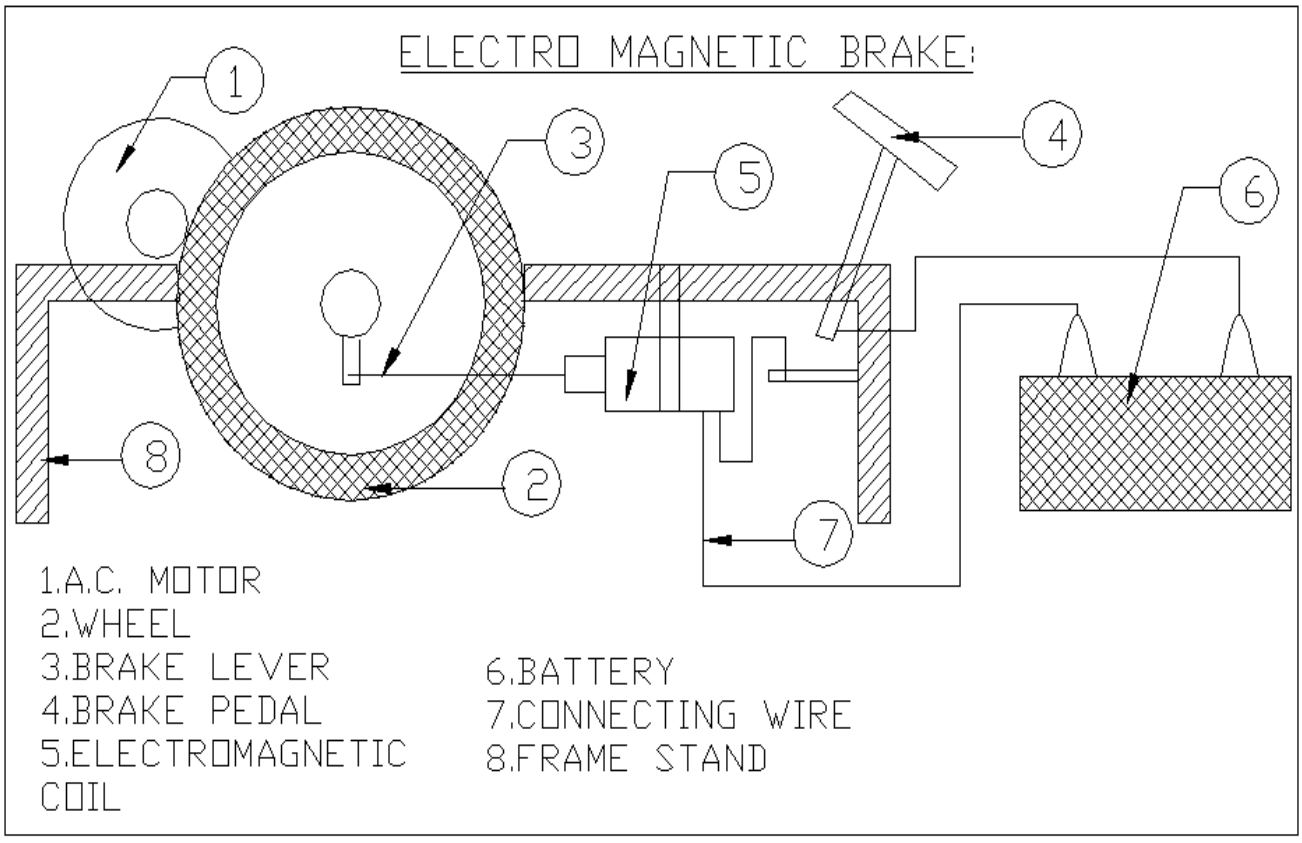

ELECTROMAGNETIC BRAKE
CAM
ROLLER
SPRING
LINING
SHOE
FIG.-1
FRONT VIEW


ELECTROMAGNETIC
BRAKE
BRAKE DRUM
CAM
BACK PLATE
CAM SHAFT
SOLENOID COIL
SHAFT
FIG.-2
RIGHT SIDE VIEW


ELECTROMAGNETIC BRAKE
CROSS PLATE
SPRING
SOLENOID UNIT
PLUNGER
BACK PLATE
FIG.-3
LEFT SIDE VIEW


Ø15
Ø35
BALLS
11
BEARING -6202
MATERIAL:STEEL
QUANTITY : 2
NOT TO SCALE
ALL
DIMENSIONS
ARE IN mm


Ø18
15
45
BEARING CAP
MATERIAL : M.S
QUANTITY : 2
NOT TO SCALE
ALL DIMENSIONS ARE IN mm


ELECTRO MAGNETIC BRAKE
1
2
3
4
5
6
7
8
1.A.C. MOTOR
2.WHEEL
3.BRAKE LEVER
4.BRAKE PEDAL
5.ELECTROMAGNETIC COIL
6.BATTERY
7.CONNECTING WIRE
8.FRAME STAND

SOLENOID SHIFT:

A description of the starting system of a self motor is given so that an idea of working of the solenoid shift can be obtained.

A strong electromagnet is used to operate the shifting mechanism of an overrunning clutch drive, when current is sent through the solenoid coil (electromagnet windings) it attracts a soft iron core called a plunger which operates the shift lever. The solenoid unit is mounted solidly on the frame of the starting motor. The movement of the shift plunger also operates the contact disc which completes the circuit between the starting motor and the battery. The solenoid assembly contains two windings a shunt winding (hold in coil) and a series winding (pull in coil). When the starter switch is closed the current flowing through the coils energizes them sufficiently to attract the plunger to shift the pinion gear. When the plunger is completely drawn in it pushes a contact disc which completes the circuit between the battery and the starting motor. The action also "shorts out" the series (pull-in) coil, which is in parallel with the solenoid terminals, leaving the shunt (hold-in) coil to hold the plunger. The shunt coil is grounded to the frame. In this way the large current needed for the pull in coil are reduced to zero while the engine is being cranked. A return spring disengages the pinion when the circuit is broken by releasing the starter switch. This action also forces the plunger out and breaks the circuit to the starting motor.

The shift lever arrangement in the above set up is used for operating the cam. Fig(4) illustrates the working of the solenoid cam arrangement.

SETUP FOR TESING THE ARRANGEMENT:

The setup for testing the arrangement can be made more practical by coupling the brake drum to an I.C. engine through a pulley belt drive. Before the brake is applied the connection can be removed through a dog-clutch arrangement. The amount of power consumed from the battery must be calculated. Also the brake drum way be made to rotate at different rotations per minute and the brakes may be applied and the time required for stopping may be note

CHAPTER-11

DESIGN AND CALCULATIONS:

CALCULATION FOR Force to operate Brake shoe (F)

F = (m + M/C)

Allowable pressure for Asbestos = 0.7b N/mm²

Total moment of Normal force (M)

M = ½ p br OA [(Ø₂-¬ı) + ½ (sin2Ø₁-sin2Ø₂)]

= ½ x 0.75 x 5 x 97 x 85 [(1.83 – 0.175) + ½ (sin20-sin216]

= 39959.47 N-mm.

Total momentum of the friction force (M)

M = μ pbr [r (cosØ₁-cosθ₂) + OA/4 (cos2θ₂-cos 2θ₁)

= 31947.52 N mm.

Therefore Force (F) = (M + M)/C

= (39959.47-31947.52)/155

= 51.69 N.

Force to operate brake shoe = 51.69N.

Calculation for Diameter of shaft

Subjected to torque

Material = Carbon steel (C14)

Force = 51.69 N = 5.269 kgf.

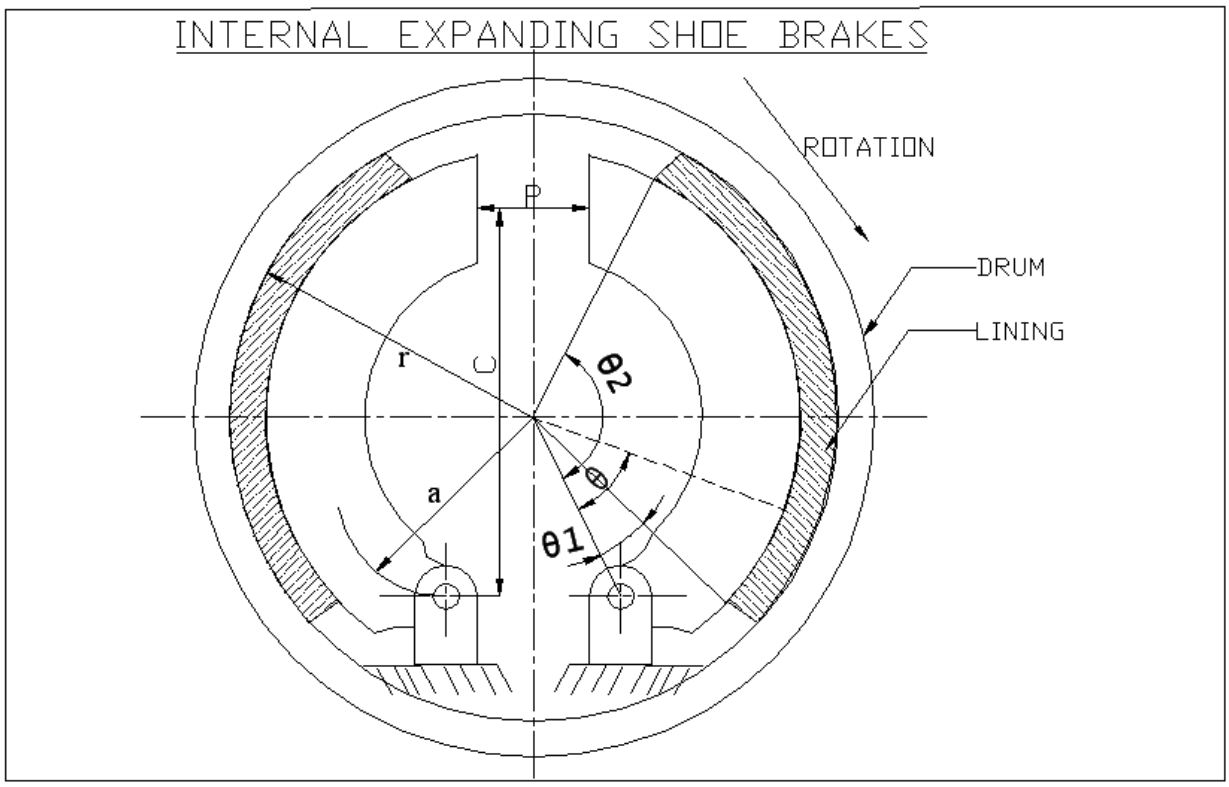
Radius = 0.097 m.

Torque = Force x Radius (kgfm)

= 5.269 x 0.097

= 0.511 kgfm

(d) dia of the shaft = 20.5 mm (From PSG-Design Data book)



CHAPTER-12

APPLICATIONS, ADVANTAGES AND DISADVANTAGES

- Used in Crane Control System
- Used in Winch Controlling
- Used in Lift Controlling
- Used in Automobile purpose

FEATURES OF THE BRAKE

Hydraulic Brake operates on liquid pressure. In case there is a leakage in brake lines, the brake fails. The brake shoe also tends to get ruined due to this. So automobile engineering prefer to use more reliable brake like air brake which are costlier.

Electromagnetic Brake which is very sensitive (concentrate only on mechanical linkage) can be used as an emergency brake. Simultaneous application of both Hydraulic and electromagnetic Brake provide more contact surface between brake shoe and drum, there by very effectively slowing the vehicle.

Another useful function of electromagnetic brake is that it can be used as an effective parking brake in slope. Here we engaged the brake shoe with stationary drum by cam. Hence locking the wheel from rotation.

Cost-wise Electromagnetic Brake are very cheap as the number of element are less and construction also very simple. Running cost also reduced since maintenance of the brake is not required.

This can also be used in bottling industry where conveyers are used. These conveyers are generally stopped at pre determined interval. This can be done quite simple by using Electromagnetic Bra

APPLICATIONS

1. Used in Crane Control System
2. Used in Winch Controlling
3. Used in Lift Controlling
4. Used in Automobile purpose
5. Used in high speed trains.
6. Used in military application such as spy robot.
7. Used in heavy trucks.
8. Used in heavy vehicles as well as light vehicles.

ADVANTAGES

1) Problems of drum distortion at widely varying temperatures. Which is common for friction-brake drums to exceed 500 °C surface temperatures when subject to heavy braking demands, and at temperatures of this order, a reduction in the coefficient of friction („brake fade“) suddenly occurs.
2) This is reduced significantly in electromagnetic disk brake systems.
3) Potential hazard of tire deterioration and bursts due to friction is eliminated.
4) There is no need to change brake oils regularly.
5) There is no oil leakage.
6) The practical location of the retarder within the vehicle prevents the direct impingement of air on the retarder caused by the motion of the vehicle.

DISADVANTAGES

1. Braking speed is constant.
2. This braking is not a smooth one.
3. High Battery power is required.
4. May be chance of electro-magnetic coil failure.

CHAPTER-13

COST ESTIMATION

SL.NO.	NAME OF PARTS	MATERIAL	QUANTITY	AMOUNT (RS)
1	Electromagnetic Coil	Aluminium	1	1800/-
2	Wheel	Rubber	1	2200/-
3	Breaking Liver	M.S	1.5 meter	80/-
4	Brake Arrangement	Aluminium Disc	1	800/-
5	D.C. Motor	CI	1	850/-
6	Frame Stand	M.S	1	1800/-
7	Battery (12V)	Lead-acid	1	900/-
8	Connecting wire	Cu	1 meter	200/-
9	CONTROLLER UNIT		1	2500/-

LABOUR COST

LATHE, DRILLING, WELDING, GRINDING, POWER HACKSAW, GAS CUTTING:

Cost = 2000/-

OVERHEAD CHARGES

The overhead charges are arrived by “Manufacturing cost”

Manufacturing Cost = Material Cost + Labour cost

= 14000+2000

= 16000

Overhead Charges = 10% of the manufacturing cost

= 1600

TOTAL COST

Total cost = Material Cost + Labour cost + Overhead Charges

= 14000+2000+1600

= 17600

Total cost for this project = 17600

CHAPTER-14

FUTURE SCOPE

The future scope is to design and develop a control system based on an automotive braking system is called ----**Automatic Braking System.** The Automatic Braking System with ultrasonic sensor would alter the driver when the distance between vehicle and obstacle is in within the sensing range zone the brakes are applied. This is the new function in this prototype design that could be possibly used for all the vehicles. By making it safer this system will provide better guarantee for vehicles safety and avoid losses. Therefore, the safety system of vehicles will be developed and may have more market demands.

It is can be further used for large type of heavy vehicles like buses, trucks, cranes, tractor, etc. We can surely get the information about the obstacle detection sense zone according to vehicle condition. It is verily useful to public sector and users. It is also **avoids the accidents in large or metropolitan cities**. So we feel it is a better idea for automatically braking of vehicle with moderate cost.

CHAPTER-15

CONCLUSION

Hydraulic Brake operates on liquid pressure. In case there is a leakage in brake lines, the brake fails. The brake shoe also tends to get ruined due to this. So automobile engineering prefer to use more reliable brake like air brake which are costlier. Electromagnetic Brake which is very sensitive (concentrate only on mechanical linkage) can be used as an emergency brake. Simultaneous application of both Hydraulic and electromagnetic Brake provide more contact surface between brake shoe and drum, there by very effectively slowing the vehicle.

- The accidents caused by automobiles are injuring lakhs of people every year.
- The safety measures starting from air bags and seat bealts have now reached to Smart vehicles with automatic braking functionality.
- The researches of Intelligent Vehicles Initiative in USA and the Ertico program of Europe are working on technologies that may ultimately lead to **vehicles that are wrapped in a cocoon of sensors with a 360 –degree view of their surroundings.**

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