Aerial Delivery Research & Development Establishment Agra, (UP)

SUMMER TRAINING REPORT

TOPICS:-

1 Study of Parachutes & its application.
2 Mechanisms for disengagement of ejector ropes.
3 Airbag inflation for paratroopers.
4 Envelope developing.
5 Work order form.
6 Hydraulic press.

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It is because of the assistance and help of all these people that I completed my project successfully and on time.

ABOUT THE ESTABLISHMENT

ADRDE (Aerial Delivery Research and Development Establishment) is one of the most reputed research establishments among defence research and development organization (DRDO). ADRDE has technology and testing centre where system designed and same validated through various testing. It is premier establishment to design the various kinds of aerodynamics systems. ADRDE founded in year 1967 keeping in mind to development of parachute system but now our country has self reliance in development of parachutes for various aero dynamics and aero space applications and saved foreign exchange. During the last three decades ADRDE has successfully completed many projects on man carrying parachute, cargo and heavy equipment dropping systems, aircraft brake parachute delivery parachute system recovery parachute and related equipments.

Over a span of 30 years, many products development by ADRDE have gone into bulk production and the cost of the system produced and inducted into the services, thus saving the precious foreign exchange. It may be said that efforts at ADRDE have brought the appreciable level of self reliance in the field of parachute and allied systems with the latest state of art. Today, ADRDE has the essential infrastructure and competent manpower capable of understanding research and development programmers in parachute and allied technologies to meet operational requirements of the armed forces.

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1. Study of parachutes and its components:-

Introduction:

A parachute is an aeronautical device used to slow the motion of an object through an atmosphere by creating drag that slows the vertical descent of a body falling through the atmosphere or the velocity of a body moving horizontally. Parachutes are usually made out of light, strong cloth, originally silk, now most commonly nylon. Parachutes must slow an object's terminal vertical speed by a minimum 75% in order to be classified as such. Depending on the situation, parachutes are used with a variety of loads, including people, food, equipment and bombs.

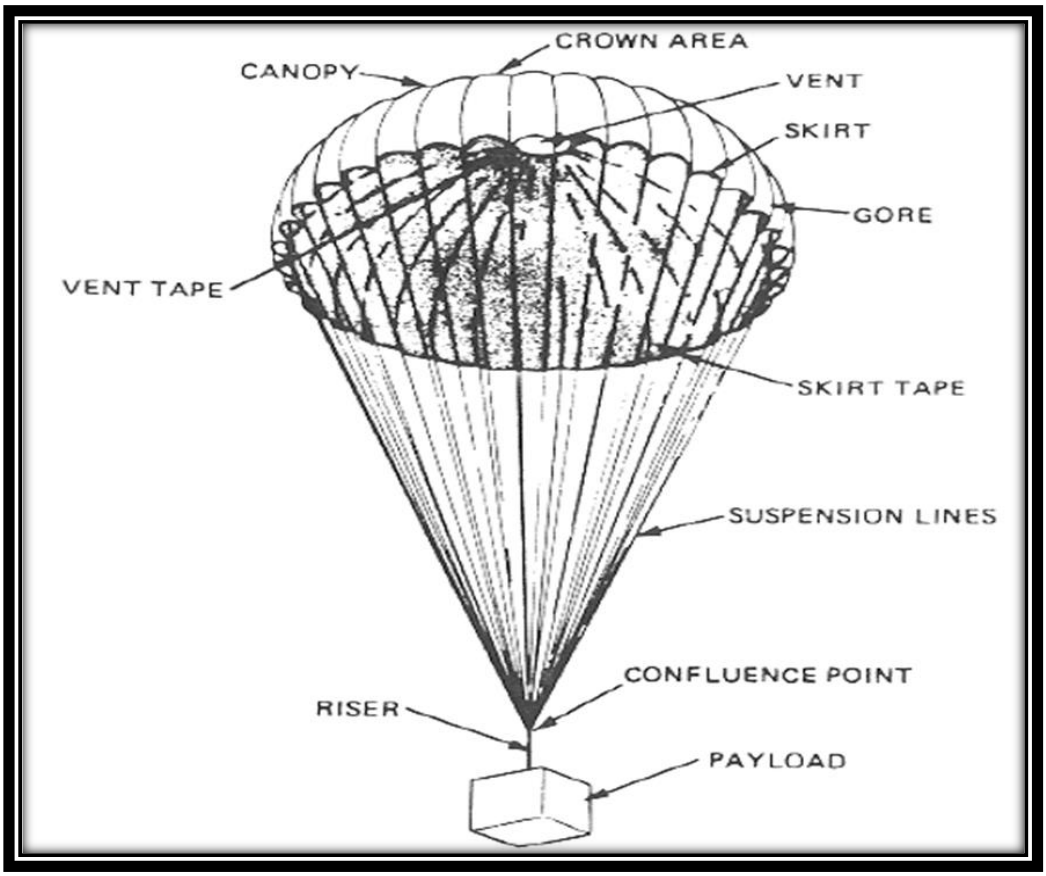
The main components of a parachute include thin fabric, suspension lines and support tapes. The suspension lines are gathered through the metal connector links located at the end of strong straps known as the 'risers'. These risers are attached to the harness, which contains the load. As the thin fabric is inflated, air gets trapped within the material and makes the parachute fabric stretch outwards and resist the fall. At the same time, the person using the chute pulls it down with his weight. Both the activities, which happen simultaneously, produce a drag, due to which the speed at which the parachute comes down decreases considerably, and instead of falling with an impact the person smoothly lands on the ground.

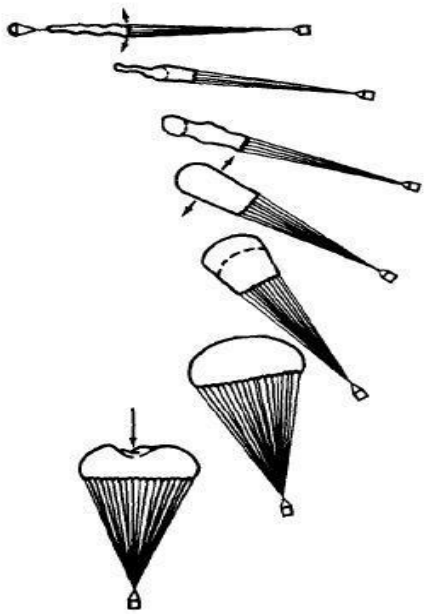
Parts of parachute:

- Canopy- The major drag producing element of the parachute. It is a device used to retard the fall of a man or package from an aircraft, consisting of a large fabric canopy connected to a harness.
- Vent- Open region at apex of canopy.
- Suspension Lines– Load bearing members extending from the canopy to the payload.
- Radials- Load bearing member running from the suspension line at the skirt to the vent lines.
- Gore- Section of a parachute canopy between two radials.
- Line Stretch- When all bridles, risers, and suspension lines are “straight” between the payload and the deployment bag and the skirt of the parachute is beginning to be accelerated to the payload velocity.
- Canopy Stretch- When the canopy is stretched straight behind.

- Snatch Force- The force required to accelerate a concentrated mass in a parachute system (e.g. the skirt mass) to payload velocity.

- Opening Force– The maximum drag force developed by the parachute.
- Over-inflation- The period in inflation where the canopy inflates to larger than its quasi-steady full open shape.
- Wake Re-contact – A phenomenon encountered when parachutes produce very rapid decelerations of payloads allowing the previously generated wake of air to overrun the inflated parachute thereby temporarily collapsing the canopy and reducing the drag to some degree.
- Fullness - The addition of material in an area to reduce the stresses in the material either by reducing the radius of curvature on a pressure loaded member or by directing load elsewhere in a tension member.
- Staging- Event where a parachute (typically a drogue parachute) is released from the payload. Most often another parachute is deployed shortly thereafter.
- Reefing- A process by which the canopy is restricted from taking its full open shape and used to tailor the drag profile and hence load history produced by the parachute. (Term derived from a similar process used on sails on boats.)
- Drogue Gun– A deployment device used to fire a projectile at high velocities from the payload .A riser connecting the projectile to a parachute forces the deployment to begin.
- Tractor Rocket – A deployment device used to drag the parachute system out of the payload and deploy it into the airstream.
- Forebody wake effect- Parachutes are always used in connection with a forebody such as parachute jumper, an aircraft, a load platform, or an Apollo type space capsule. Each forebody produces a wake that affects the parachutes.





1. Opening of canopy mouth.
2. Air mass moves along canopy.
3. Air mass reaches crown of canopy.
4. Influx of air expands crown (typical reefed inflation shape).
5. Expansion of crown resisted by structure tension and inertia.
6. Canopy reaches first fully inflated stage.
7. Skirt over-inflated, crown depressed by momentum of surrounding air mass.

Material used for fabrication of parachute:

- History of Parachute's fabrication: The canopy of the parachute was initially made of canvas, which was eventually replaced by silk. Silk, being thinner, lighter, stronger, fire resistant and easy-to-fold, proved more efficient than canvas. In late 1930s and early 1940s, World War affected silk import in the United States to a great extent. In order to counter this shortage of silk, innovators tried using different materials to make parachute canopy and finally came up with the idea of replacing silk with nylon. This proved to be beneficial, as nylon had good elasticity, was resistant to mildew and relatively less expensive.

- Properties taken into consideration while considering the fabrication of parachutes:

    1. The material has to be resistant to wind.
    2. Density of the material- Denser the material of the parachute, faster will be the speed at which the chute will come down.
    3. Rigidity- Rigidity directly affects the shape of the parachute, which in turn affects the stability.
    4. Stability- If the parachute is stable, it will descend slowly, but if it swings owing either to the shape or the movement of the parachutist, it will lose air and come down at a greater speed.

Types of parachute:

- Conical Parachutes: Possibly the earliest form of parachute is the conical shaped-parachute. As an escape device, this type of parachute was intended to allow people to get safely on the ground from burning buildings.

- Pyramid Parachute: It was a canopy that is supported by light wood held by a square bottom frame.

- Pack-style parachute: This is the predecessor of all parachutes that are stored in casings these days.

- Round parachutes: A basic drag device, round parachute is used in various settings like medical missions, cargo applications and military operations. While being described commonly as round in shape, the parachute actually resembles a dome or a jellyfish. This has been among the most popular type however; present-day parachutists don't normally use this kind of parachute

- Ram-air parachutes: For better control of speed and direction, ram-air parachutes allow the canopies to self-inflate. Like standard Para gliders, ram-air parachutes are designed to hold, spread and lessen the tension of parachute deployment on terminal.

- Ribbon/Ring Parachute: Specifically designed for supersonic speeds where ordinary parachutes would break down, this type often has a hole in the middle of the canopy to lessen the pressure as the parachute reaches the ground. On some designs, the ring of the canopy is broken into a number of ribbons that are connected by ropes so as to allow more air to pass. The leaks in between the ribbons will diminish the pressure on the parachute so that breaking or shredding of the canopy is prevented. These various types of parachutes are made according to the use they have and some are according to the technology the inventors had during their time.

- Cruciform (square) types: The unique design characteristics of cruciform parachutes decreases oscillation (its user swinging back and forth) and violent turns during descent. This technology will be used by the US Army as it replaces its current T-10 parachutes under a program called ATPS (Advanced Tactical Parachute System). The ATPS canopy is a highly modified version of a cross/ cruciform platform and is square in appearance. The decline in rate of descent will reduce the impact energy by almost 25% to lessen the potential for injury.

- Rogallo wing and other types: Sport parachuting has experimented with the Rogallo wing, among other shapes and forms. These were nearly always an attempt to increase the forward speed and reduce the landing speed offered by the other options at the time. The ram-air parachute's development and the subsequent introduction of the sail slider to slow deployment reduced the level of experimentation in the sport parachuting community.

- Annular and pull-down apex types: A variation on the round parachute is the pull down apex parachute. Invented by a Frenchman named Pierre-Marcel Lemoigne, it is referred to as a Para-Commander canopy in some circles, after the first model of the type. It is a round parachute, but with suspension lines to the canopy apex that applies load there and pulls the apex closer to the load, distorting the round shape into a somewhat flattened or lenticular shape. Some designs have the fabric removed from the apex to open a hole through which air can exit, giving the canopy an annular geometry. They also have decreased horizontal drag due to their flatter shape and, when combined with rear-facing vents, can have considerable forward speed.

Application of Parachute:-

1. Personnel

- Personnel Emergency
- Tractor Rocket Escape System
- Capsule And Ejection Seat Stabilization And Deceleration
- Rescue Missions
- Sport Para
- Smoke Jumpers

2. Airdrop

- Paratroopers
- Army Combat And Engineering Equipment's
- Aerial Resupply
- Survival Equipment

3. Aircraft Deceleration

- Approach And Landing
- Spin And Stall Recovery
- In-Flight Deceleration

4. Aircraft Vehicle Recovery

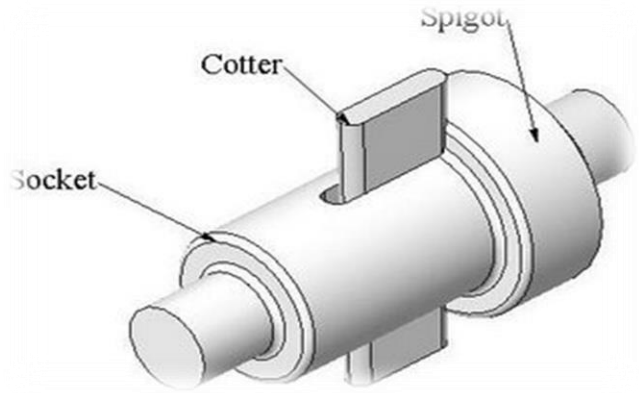
- Missile/Drone/Uvs Recovery For Reuse, Component Analysis, And Range Safety
- Sounding Rockets And Re-Entry Vehicles
- Manned/Unmanned Spacecraft
- Booster

5. Ordinance Retardation

- Bomb/Mine/Torpedo Retardation
- Flares
- Submunition
- Sonar Buoys

6. Mechanisms for disengagement of ejector ropes:-

1. Spigot and socket joint with paraffin wax disengagement mechanism:



Cotter joint is used to connect two rods subjected to axial tensile loads. It consist three components:

- Spigot
- Socket
- Cotter

The construction of cotter joint, used to connect two rods (in case we are using ropes) subjected to tensile force. When the cotter is inserted into the slot, the central portion of cotter comes in contact with spigot and the spigot gets pushed into the socket till the collar of the spigot comes in contact with the collar of socket. Finally the cotter is in contact with the spigot on one side having some clearance with the socket slot and is in contact with the socket on the other side having some clearance with the spigot slot. Clearance provided is generally 1.5 to 3 mm. Cotter gets locked because of the frictional force of the contacting surfaces.

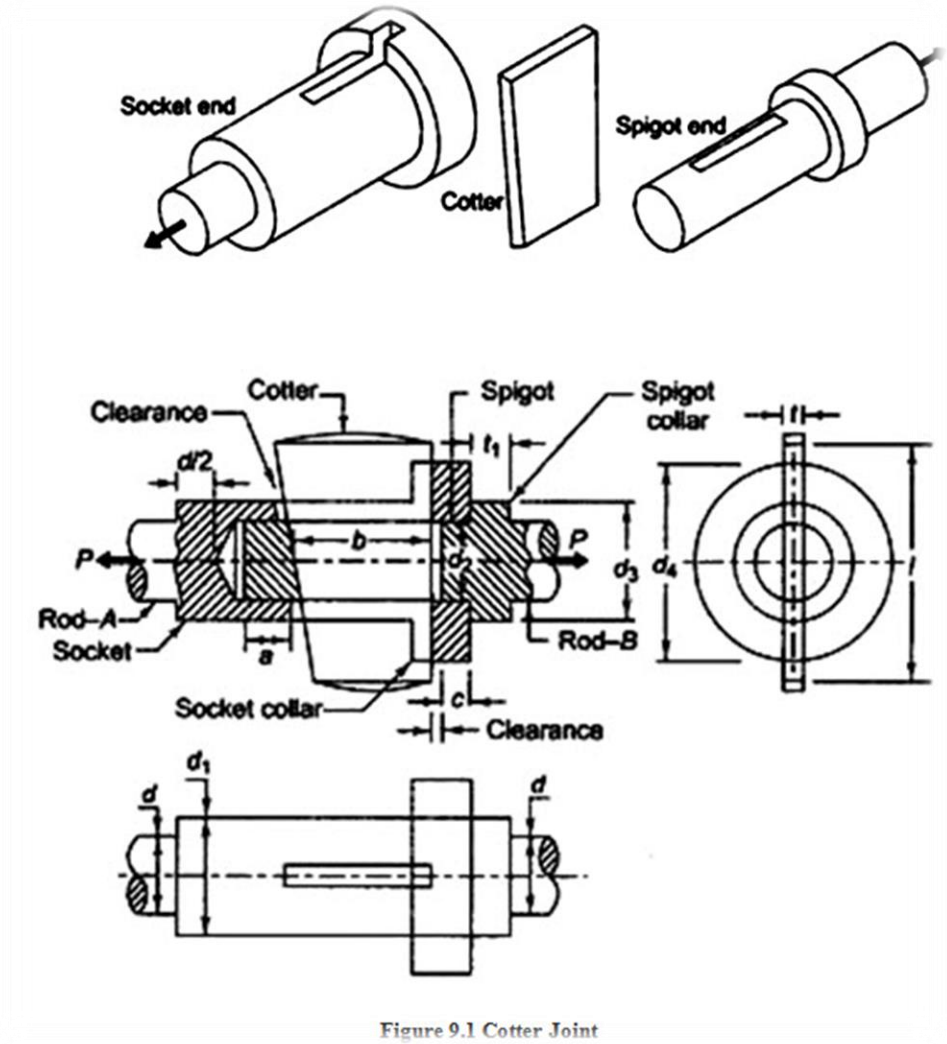


Figure 9.1 Cotter Joint

Modification:-

- We can **reduce the mean width of cotter to some extent** in order to achieve the disengagement mechanism while ejection.
- For detaching ropes, we can use paraffin wax around the cotter:

Paraffin wax:

Paraffin wax is a white, odourless solid with a typical melting point between approximately 115 and 154 °F (46 and 68 °C) having a density of approximately 0.9 g/cm3.

Now question arise: Does paraffin wax burn fast in order to get unclasp two ropes briskly?

- Paraffin candles burns quickly as compared to other even with the addition of chemicals. This wax has higher **oil content** and **lower melt temperature** therefore, it burns faster.
- **An electric sensor** can be used to send the electrical signals to the inflator in order to activate it, a thin wire provided in the initiator that will heats up for the sake of melting the wax framing the cotter.

2. **<u>Pyrotechnic cutters with explosive disengagement mechanism:-</u>**

Pyro Cutters: The design of a pyrotechnic cutter is an actuating component of a hold-down and release device, and it consists of igniters, a casing, a detonator, a shear pin, a sealing ring, a cutter, a cutting board, and an end cover.

There are basically two types of cutters: Guillotine and punch (Cartridge).

1. A guillotine cutter uses a blade knife which is propelled internally by an energetic material which hits an anvil to stop the blade and sever the material. They are used where there is a need for rapid, remote cutting of cable, wire rope, hoses or fuel lines.

2. A cartridge actuated cutter has a sealed-in cartridge. Consisting of a tubular body containing a spring-loaded firing pin and it may include a timing delayed cartridge for initiation. Once the cartridge is fired, the expanding gases produced force the cutter blade forward, severing the target material.

How a cutter works:

- A charge is detonated by an electric detonator
- A large amount of high-temperature and high-pressure gas is generated to initiate the cutter blade motion
- After moving for a certain distance, the cutter blade reaches a certain speed and gains considerable kinetic energy,
- Resulting in its collision and penetration with the target material, thereby fracturing the target material.
- Once the target material is fractured, this instantly releases the constraint of the pre-tightening force and unlocks any connecting material.

Modification:

We can use pyro cutters to detach the ropes with explosive system.

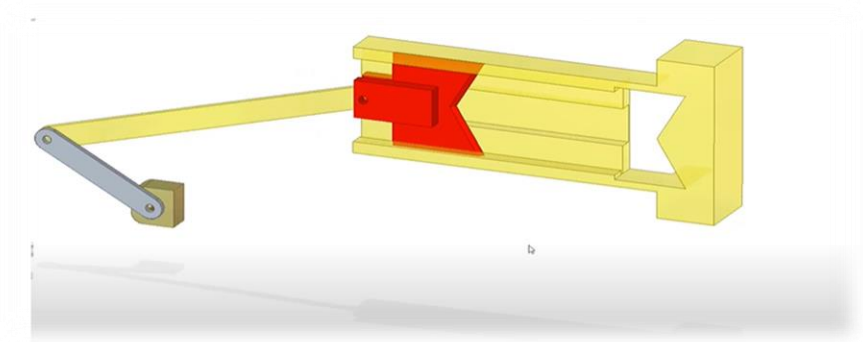
Explosive system:

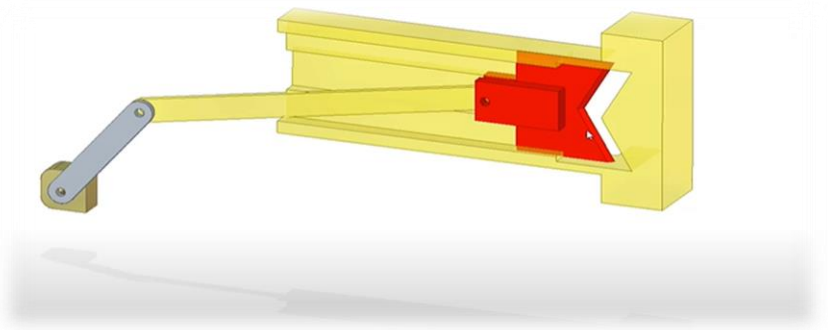
a. There is no. of different types of blades which used in pyrocutters but we can use hex blade in order to get high concentration of force to cut down the target material which is tape in our case.
b. We can use electrical sensor to activate the pyro cutter.

3. Slider- crank cutting disengagement mechanism:

Slider-crank mechanism - slider-crank mechanism, arrangement of mechanical parts designed to convert straight-line motion to rotary motion, as in a reciprocating piston engine, or to convert rotary motion to straight-line motion, as in a reciprocating piston pump.

Modification- we can use mechanical arm with cutter instead of slider in slider crank mechanism in order to cut our target material.



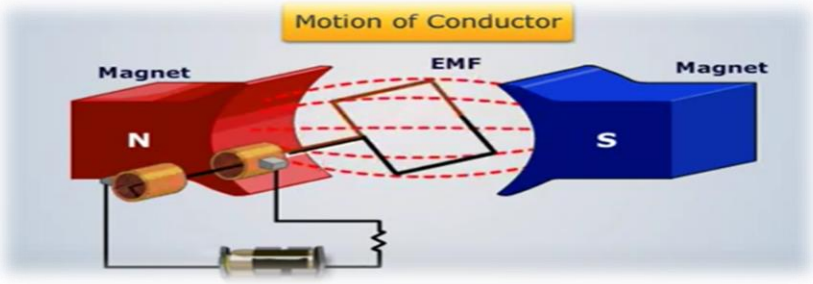


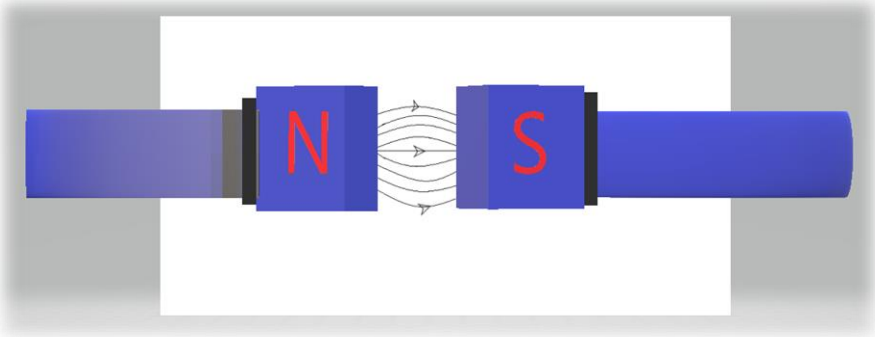
4. **Electromagnet disengagement mechanism:**

It consists of a length of conductive wire, usually copper, wrapped around a piece of metal. A current is introduced, either from a battery or another source of electricity, and flows through the wire. This creates a magnetic field around the coiled wire, magnetizing the metal as if it were a permanent magnet. Electromagnet disengagement mechanism are useful because you can turn the magnet on and off by completing or interrupting the circuit, respectively.

Modification-

We can use two electromagnets fasten with rope connected horizontally. We can apply current supply for the engagement or disengagement of these two magnets.





3. **Airbag Inflation system for paratroopers**:

- **Complication-**

When the main canopy and reserved canopy gets entangled or jumper get entangled with rope (rigging line) of parachute and parachute do not open.

- **Requirements-**

Sometime jumper gets entangled with rope (rigging line) of parachute and parachute does not open. In such case air bag inflation system could save life of jumper.

- **Applications-**

1. Air bags are supplemental protection and acts as a safety measures for paratroopers.
2. It reduces the impact force when a paratrooper hits the ground during free falling.

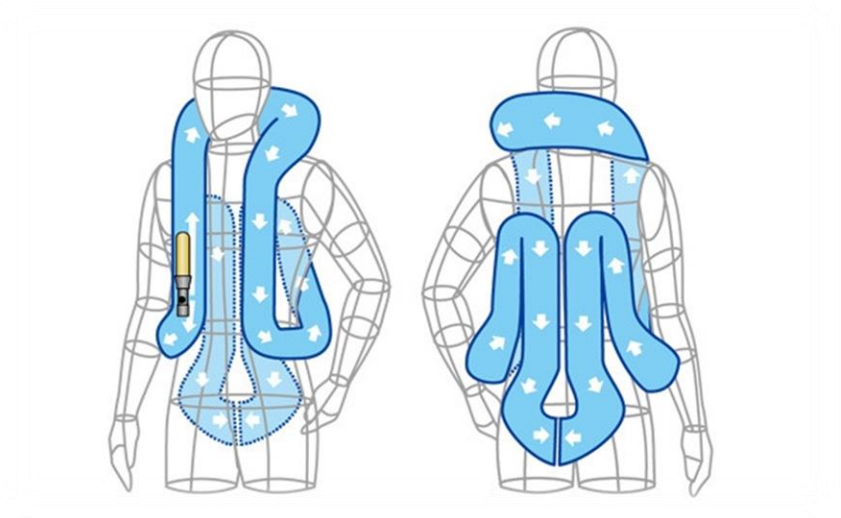
System specifications –

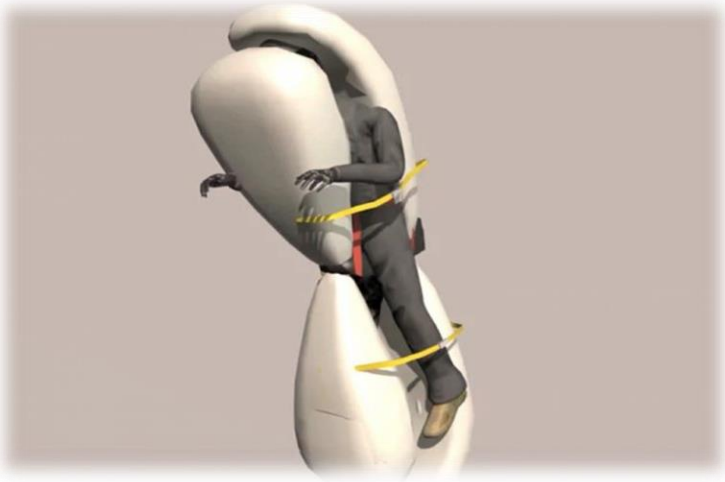
1. Velocity Sensor- A velocity or speed sensor measures consecutive position measurements at known intervals and computes the time rate of change in the position values.

   The magnet of the velocity sensor is suspended on a membrane (spring) which moves through a coil of wire. Due to the vibration, the coil of wire moves through the magnetic field of the permanent magnet and generates (induces) a voltage signal which is proportional to the vibration (velocity).

2. Height: We have taken the height of 500m from the ground into consideration for testing (free fall).

Design of inflatable system –





Impact load calculation on paratroopers-

The dynamic energy in a falling object at the impact moment when it hits the ground can be calculated as

$E = F_{weight}\ h$

$= m\ a_g\ h$ (1)

Where,

F_{weight} = force due to gravity (N)

a_g = acceleration due to gravity (9.81 m/s^2, 32.17405 ft/s^2)

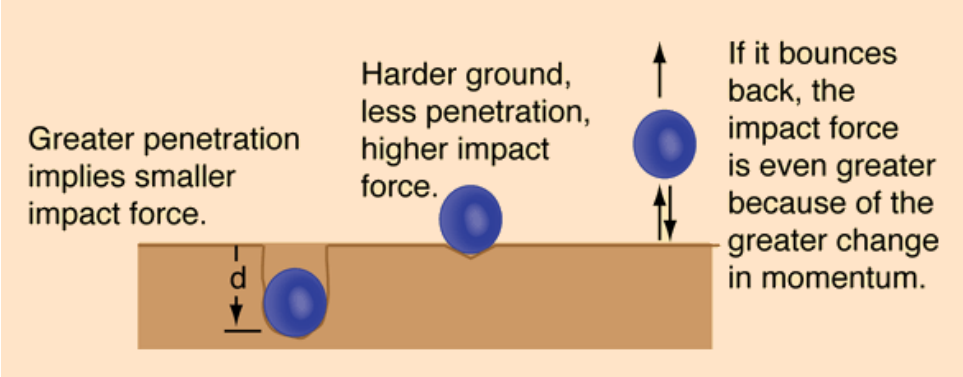
h = falling height (m)

If the dynamic energy from the fall is converted to impact work - equation 2 and 4 can be combined to

$F_{avg}\ d = m\ a_g\ h$, where d = deformation distance (m, ft)

The impact force can be expressed as

$F_{avg} = m\ a_g\ h / d$ (2)



The deformation slow-down distance can be expressed as

$d = m\, a_g\, h / F_{avg}$

ASSUMPTIONS:

A person with mass of 80kg falls from a *500 m falling height*.

Calculation-

Given- m=80kg, h= 500m

From equation (1)

$E = F_{weight}\, h$

$= m\, a_g\, h$ = 80*9.81*500 = 392400 J (3)

Dynamic energy from fall converted to impact work

From equation (2) and (3), we get

$F_{avg} = m\, a_g\, h / d$ = E/d = 392400/0.01= 3924*10^4 N (Let us assume that deformation distance = 0.1 cm

Impact force = 39240 KN

Impact load calculation on car drivers-

- Impact force eq.

F = m*v^2/2*d (1)

Where,

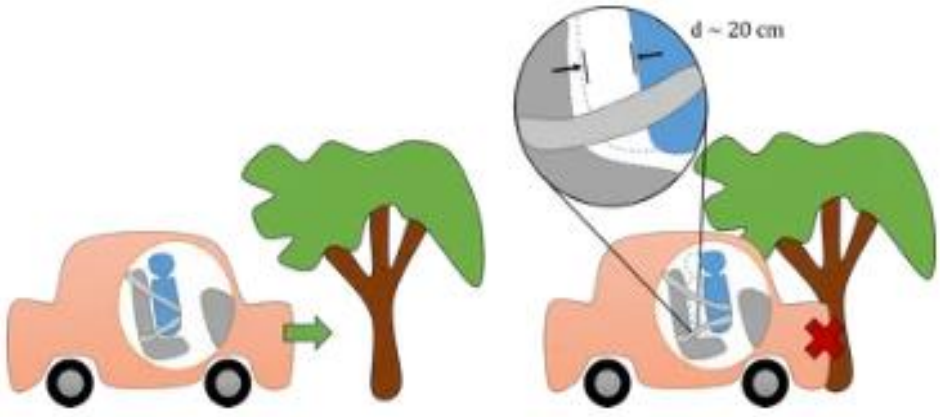
F = impact force (N

m = mass of body (kg)

v = initial velocity (m/s)

d= distance traveled during collision. (m)

Impact force exerted on the driver with seatbelt when car is travelling with an initial velocity of 100km/hr and mass of the person is 80 kg.



Given:-

Mass of person (m) =80 kg

Distance after collision (d) = 20 cm = 20/100 = 0.2m

Initial velocity (v) = 100km/hr = 100*(5/18) m/s

Putting all the values in eq. (1) then we get

F = (80*(100*(5/18)) ^2)**/** (2* 0.2) = 154320.98 N

Impact force = 154.32 KN

- Impact load :-

Impact force (F) = m*g, m = F/g, m = (154.32 *1000) / 9.81 = 15730.88 kg

Pressure during the time of inflation (P) = 200 bar

Technical requirements-

1. Height sensor.

2. 4 type of inflator to cover jumper from all sides.

3. Inflatable system.

This has been already used as air bag vest for bike safety

Idea:-

1. We can use velocity sensor.
2. We can use nylon 66 as our main fabric with neoprene coating.
3. We can use nitrogen gas to fill our inflator system.

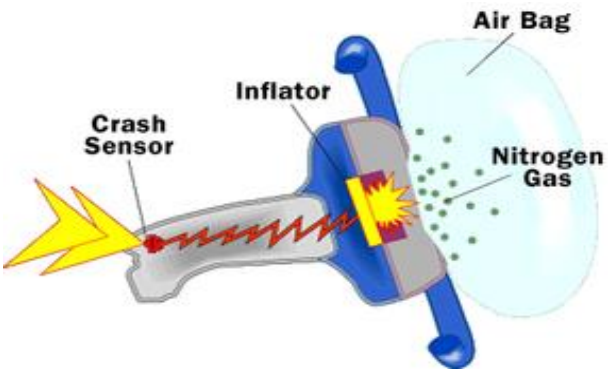
Airbag inflation system in cars –

The airbag system is perhaps the most important part of your vehicle when it comes to safety components.

How it works:

- The crash sensors present in the front of the car detects sudden decelerations and sends electrical signals to activate an initiator.
- A thin wire provided in the initiator heats up and penetrates the propellant chamber. This results in the chemical propellant inside the inflator to undergo a rapid chemical reaction. This reaction is often referred to as a pyrotechnic chain.
- This reaction produces nitrogen gas that fills the air bag. This expanding gas inflates the airbag in less than one-twentieth of a second.
- This opens up the plastic module cover and inflates it in front of the person seated in the car. The bag is inflated for just one-tenth of a second and deflated three-tenths of a second after impact.

- The inner side of the airbag is provided with a coating of cornstarch or talcum powder which is released from the bag as it is opened.



4. Laboratories Visited:-

1. Electronics & Instrumentation Lab
2. Textile Engineering
3. Technology Group
4. Textile Test Lab
5. Mechanical Test Lab
6. Chemical Test Lab
7. Prototype Fabrication Wing

5. Address storing envelope: -

The envelope in which we can store the address of ADRDE authorities and can take out the print of the same.

Technologies used:

- HTML
- CSS
- PHP

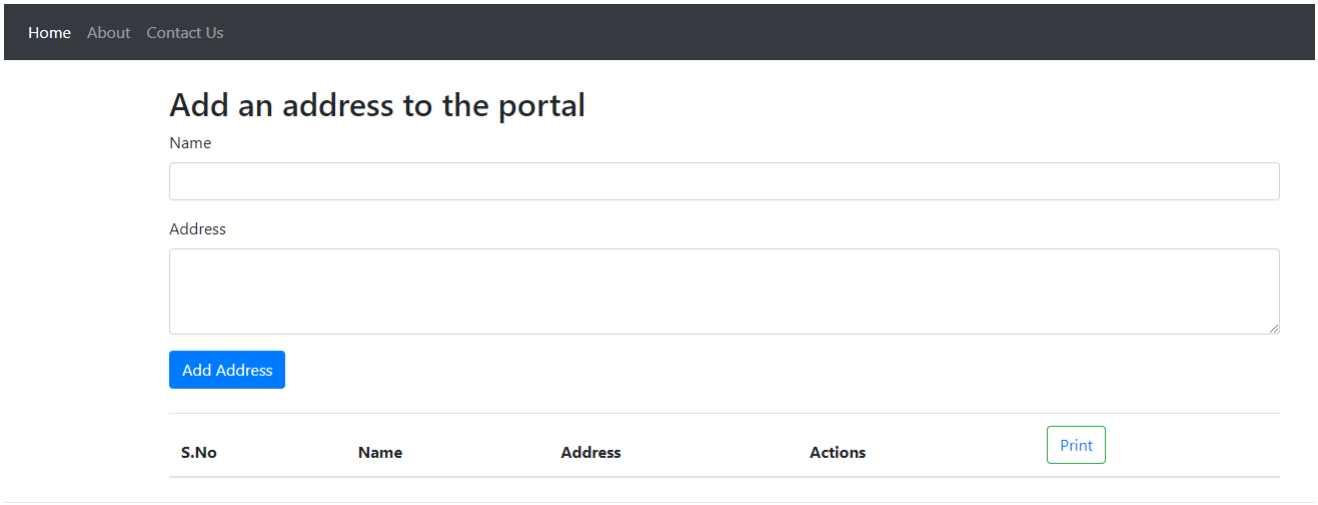
- MY SQL
- Bootstrap

Software used:

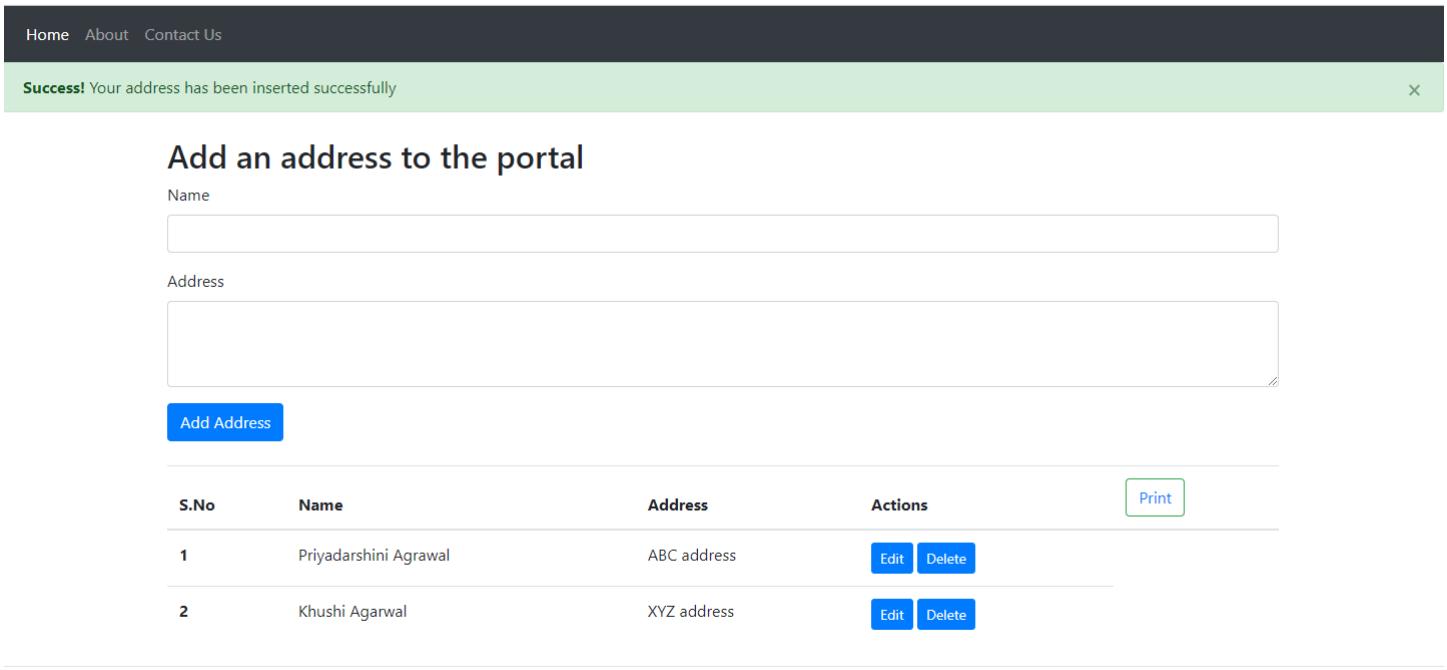
- VS Code
- Xampp server

Steps:

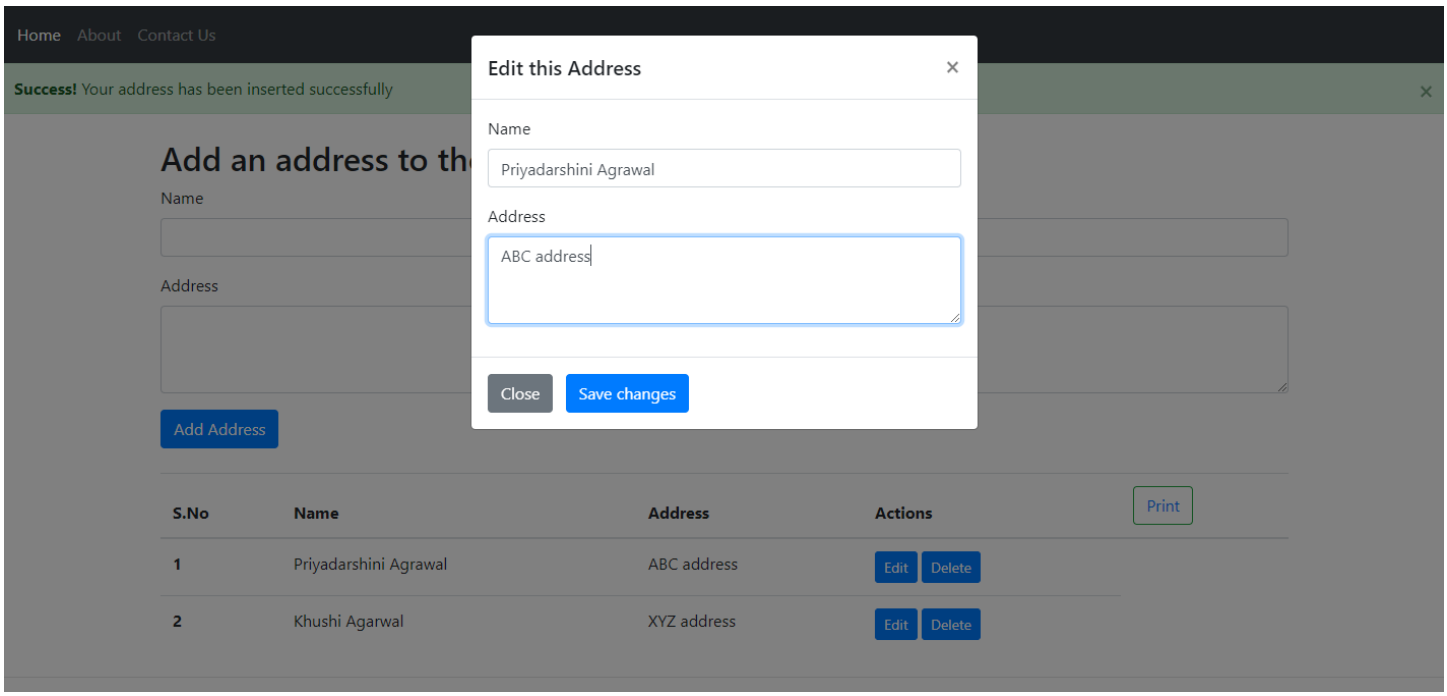
1. The address form taking two input from the user i.e., Name and address of the authorities. By clicking button it insert the information into the database.



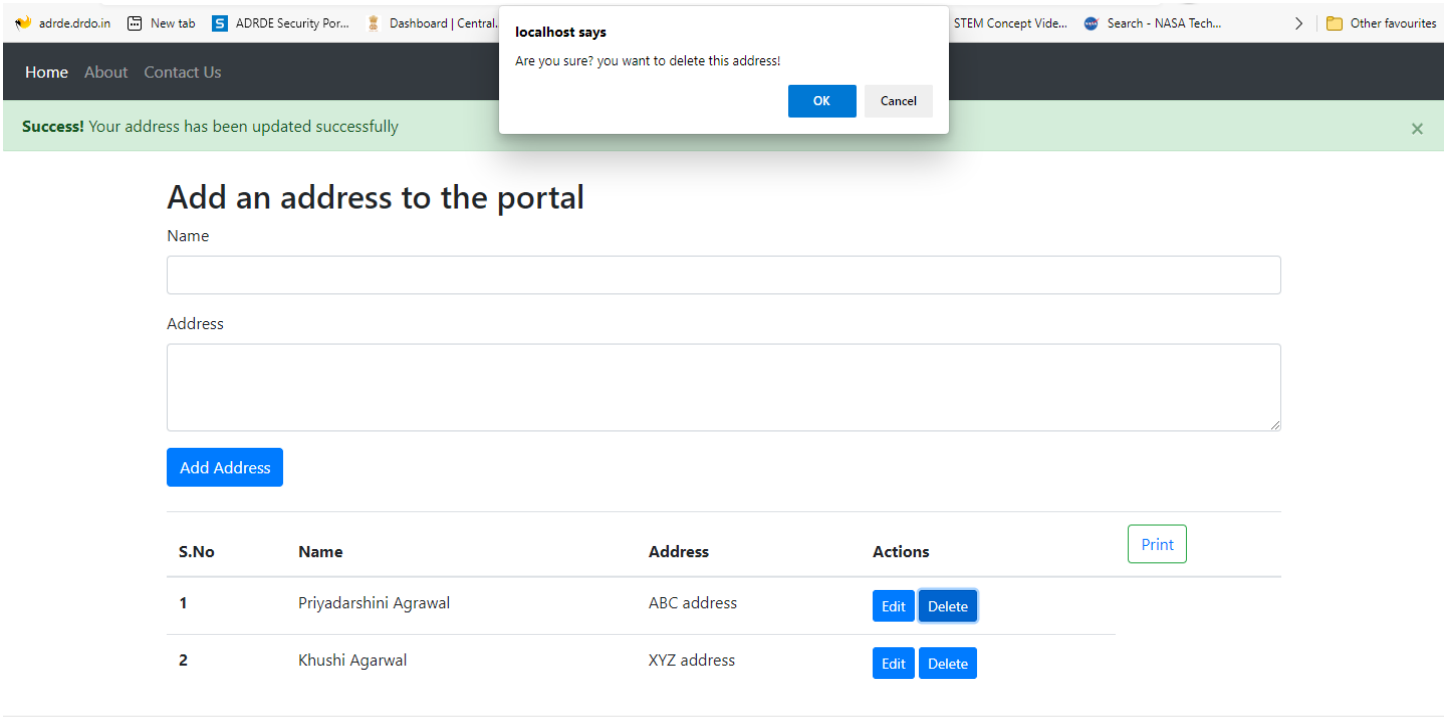
2. After inserting information, Success alert will be appeared on the screen, that indicates that the data has been stored in the database successfully.



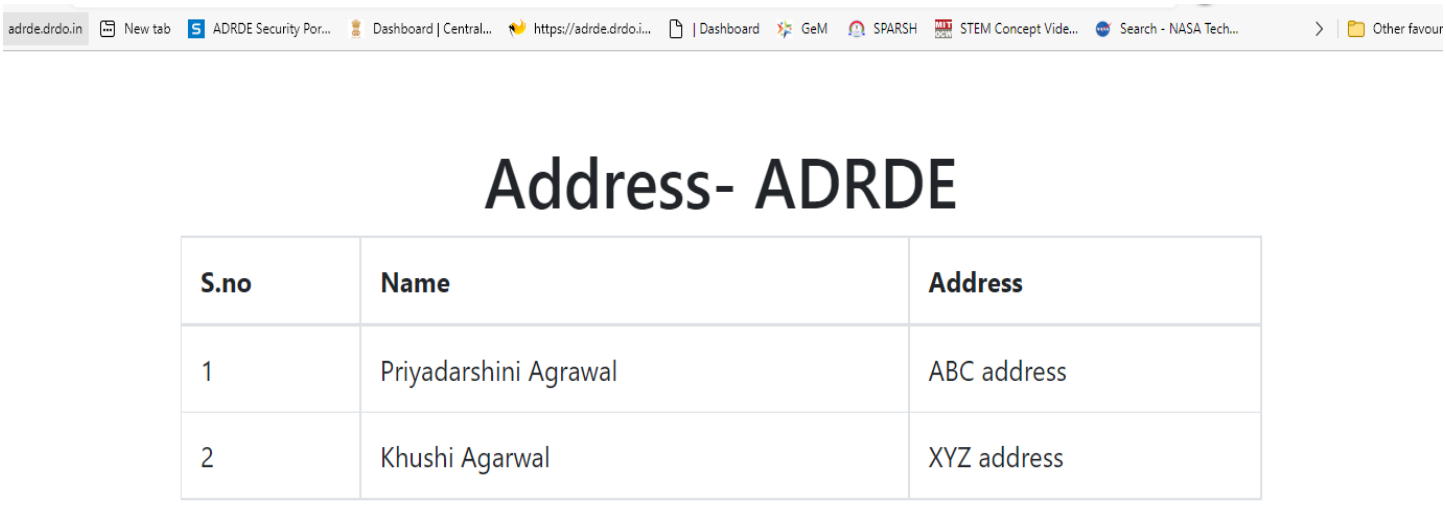
3. We can edit our data with the help of edit button given in the portal itself. The dialog box will appear as shown.



4. We can delete our data with the help of delete button given in the portal itself. The dialog box will appear as shown.



5. Now finally we can print our data with the help of print button given.



Address- ADRDE

S.no	Name	Address
1	Priyadarshini Agrawal	ABC address
2	Khushi Agarwal	XYZ address

6. Work Order form:-

A work order is a document that provides all the information about a maintenance task and outlines a process for completing that task. Work orders can include details on who authorized the job, the scope, which it's assigned to, and what is expected.

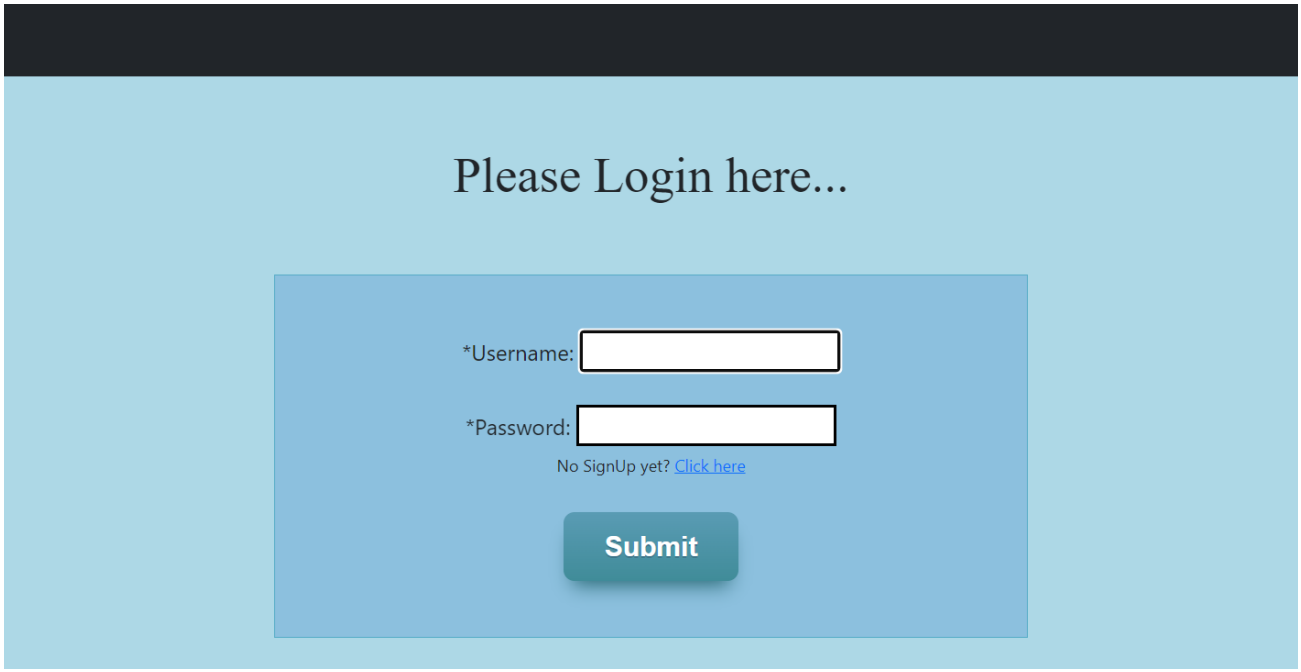
Work orders are crucial to an organization's maintenance operation. They help everyone from maintenance managers to technicians organize, assign, prioritize, track, and complete key tasks. When done well, work orders allow you to capture information, share it, and use it to get the work done as efficiently as possible.

Technologies and software used:

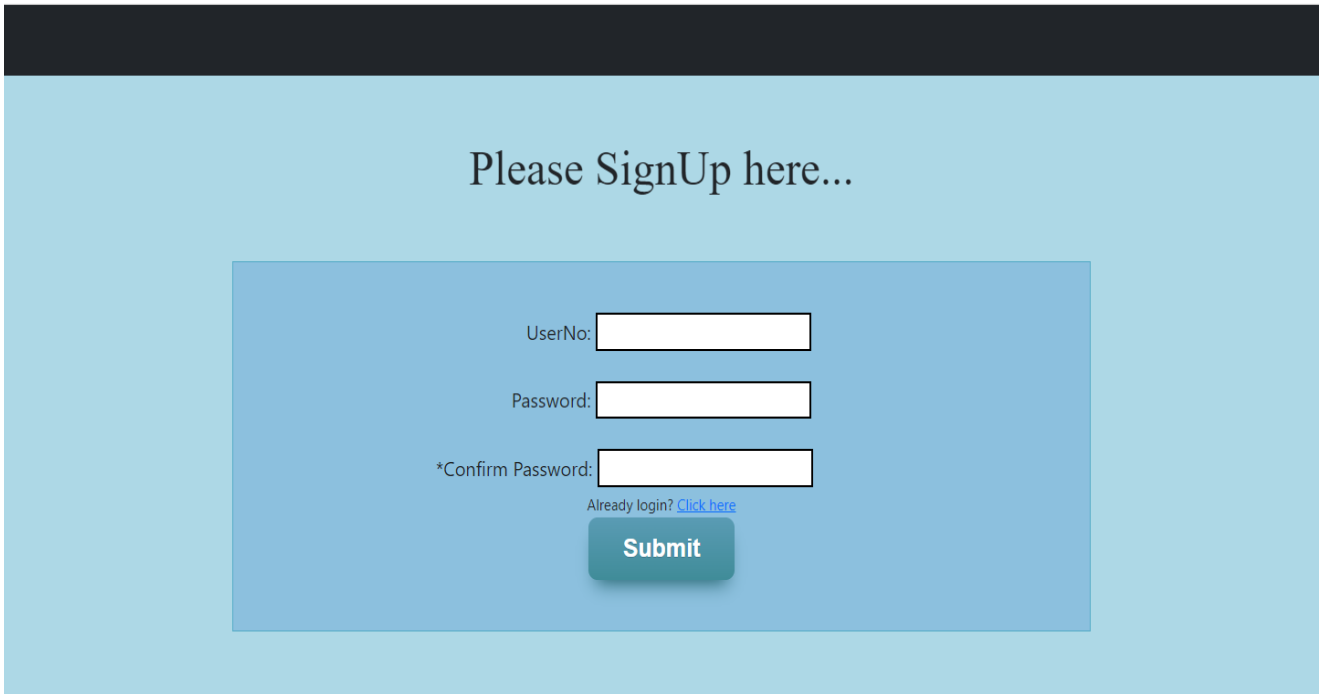
- HTML
- CSS
- Bootstrap
- VS Code

Steps involved:

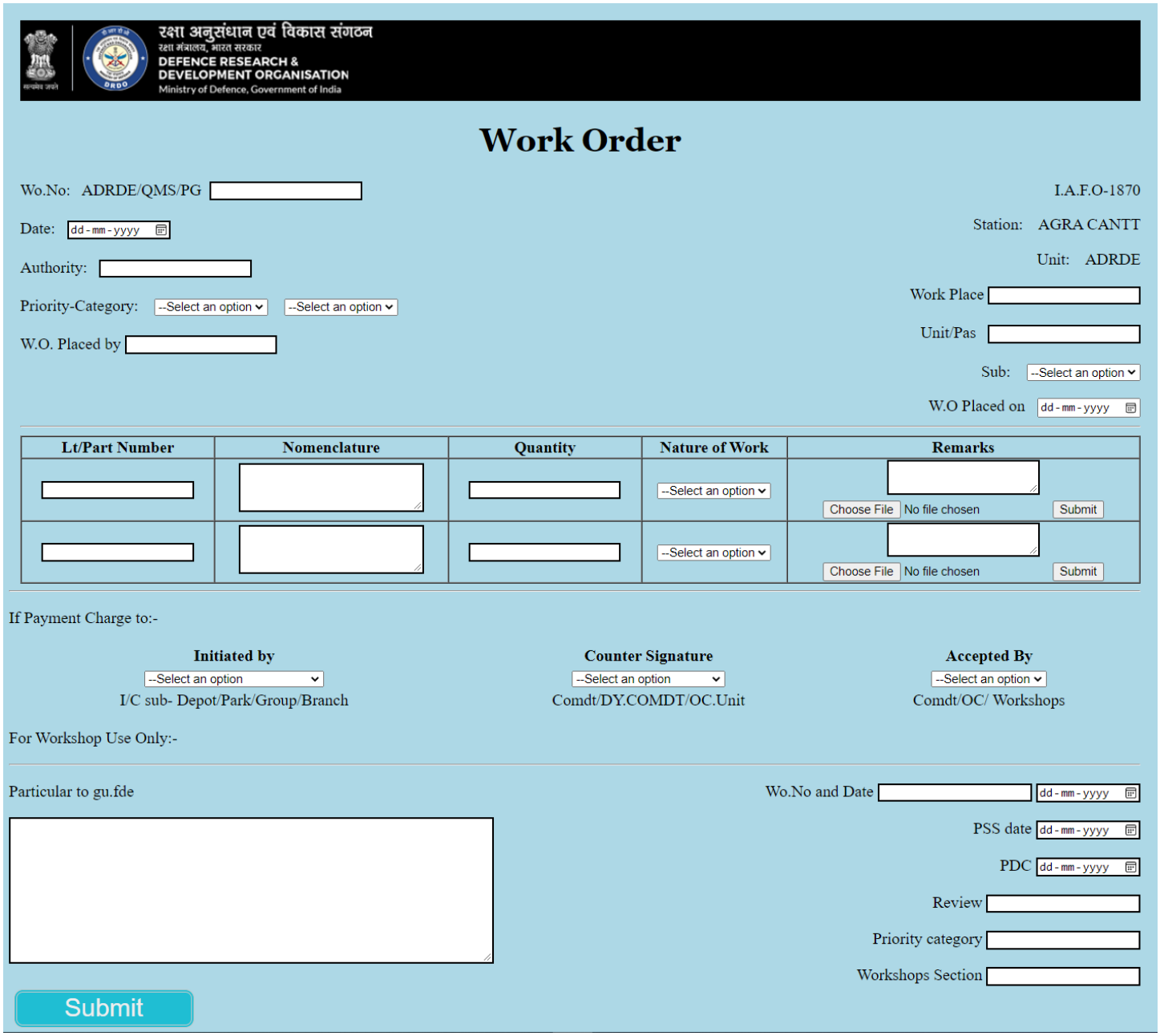
1. Login page: Users can enter their credentials to login into the address portal.



2. Sign Up page: Users can sign up for the portal and those credentials will be stored in the database for further login purpose.



3. After logging into the portal, this form will appear.



रक्षा अनुसंधान एवं विकास संगठन
रक्षा मंत्रालय, भारत सरकार
DEFENCE RESEARCH & DEVELOPMENT ORGANISATION
Ministry of Defence, Government of India

Work Order

Wo.No: ADRDE/QMS/PG

I.A.F.O-1870

Date: dd-mm-yyyy

Station: AGRA CANTT

Authority:

Unit: ADRDE

Priority-Category: --Select an option --Select an option

Work Place

W.O. Placed by

Unit/Pas

Sub: --Select an option

W.O Placed on dd-mm-yyyy

Lt/Part Number	Nomenclature	Quantity	Nature of Work	Remarks
			--Select an option	Choose File No file chosen Submit
			--Select an option	Choose File No file chosen Submit

If Payment Charge to:-

Initiated by	Counter Signature	Accepted By
--Select an option	--Select an option	--Select an option
I/C sub- Depot/Park/Group/Branch	Comdt/DY.COMDT/OC.Unit	Comdt/OC/ Workshops

For Workshop Use Only:-

Particular to gu.fde

Wo.No and Date dd-mm-yyyy

PSS date dd-mm-yyyy

PDC dd-mm-yyyy

Review

Priority category

Workshops Section

Submit

7. Hydraulic press:-

Hydraulic press is used for packing of larger size of parachute. Parachute is packed in compressed condition so that it can be accommodated in required space. Also packed parachute helps to easy opening.

- Working principle of hydraulic press-

A hydraulic press works on the ***principle of Pascal's law***, which states that when pressure is applied to a confined fluid, the pressure change occurs throughout the entire fluid. Within the hydraulic press, there is a piston that works as a pump that provides a modest mechanical force to a small area of the sample.

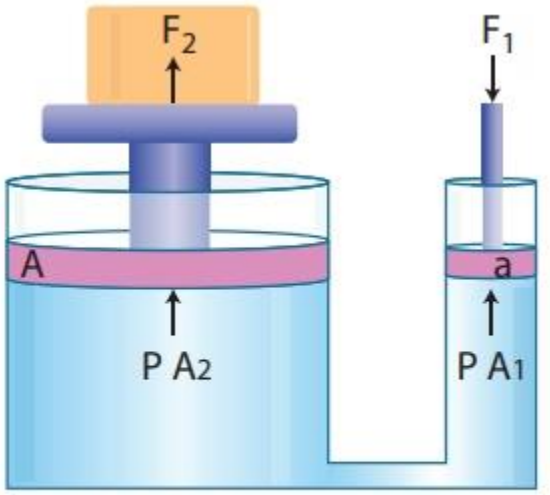


Figure 1.14 Hydraulic press

A smaller force **F_1** is required for lifting a larger weight **F_2** but still conservation of energy is still not violated because smaller force moves by a larger distance whereas larger weight is moved by a smaller distance.

Hence, work done in both the cases is same. This principle is valid because fluids act under triaxial state of strain whenever a uniaxial of biaxial stress is applied on its surface.

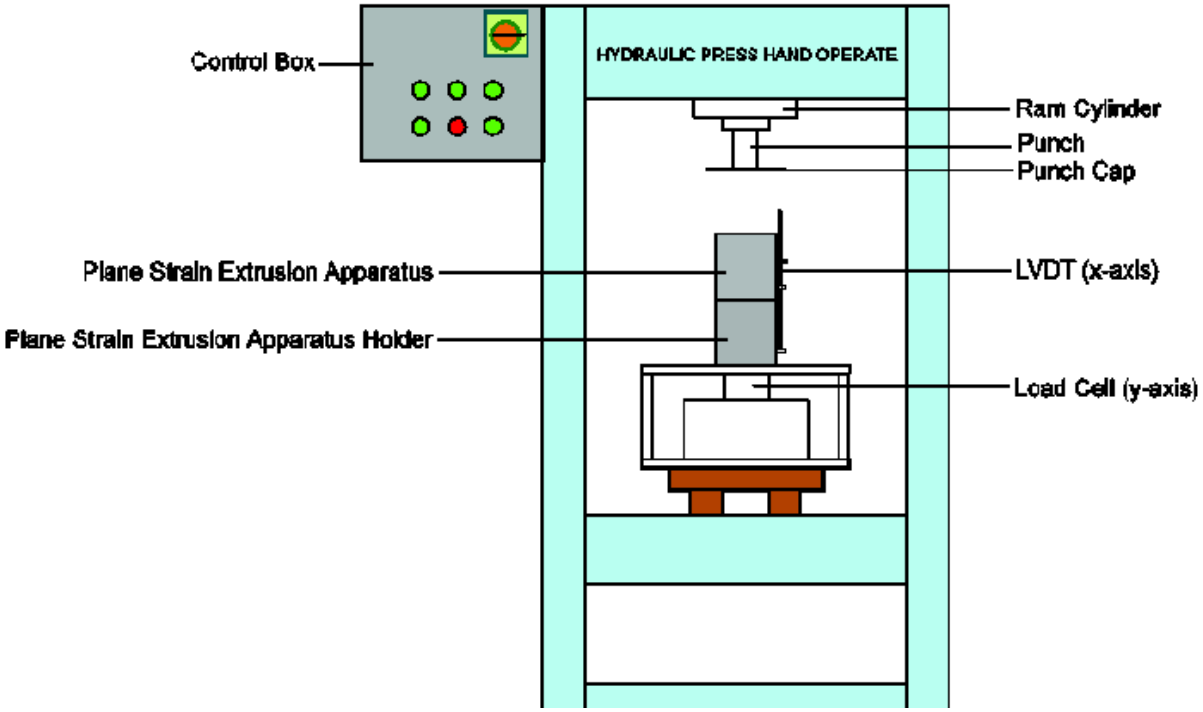
$$\boldsymbol{Force1 = Force2(\frac{Area1}{Area2})}$$

Functionality of Hydraulic press:-

A parachute is a device used to slow the motion of an object through an atmosphere by creating drag, or in the case of ram-air parachutes, aerodynamic lift. Parachutes are usually made out of light, strong cloth, originally silk, now most commonly nylon. Parachutes must slow an object's terminal vertical speed by a minimum 75% in order to be classified as

such. Depending on the situation, parachutes are used with a variety of loads, including people, food, equipment and bombs.

Components of Hydraulic Press:-



1. Frame Structure:

It consists of outer structure of Hydraulic Press where RAM, Punch Cap and Punch are installed at the top and Parachute cylinder is kept in place of Extrusion Apparatus (here, in the above diagram). The framing also consists of base plate which is movable in y-axis corresponding to the size of parachute and the respective cylinder.

2. Hydraulic hose:

It is used to convey hydraulic fluid to or between hydraulic components.

3. Hydraulic motor:

A hydraulic motor is used to pump hydraulic fluid in the system using a pump.

4. Reservoir Tank:

Hydraulic oil is stored in the reservoir tank.

5. Direction control valve:

Direction control valves (DCVs) are used to control the direction of the actuator/cylinder. Generally, a manually controlled DCV is used in the hydraulic press.

6. Pressure relief valve:

It is used to control the pressure in the system.

7. Limit Switch:

It is used to control the position of the piston of the cylinder. It prevents the cylinder to travel post a predetermined point.

8. Hydraulic Cylinder:

This is a mechanical actuator that is used to give a unidirectional force through a unidirectional stroke.