

# **Basics of Civil Engineering**

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## **Unit III: Transportation Engineering**

**Department of Civil Engineering**

# INTRODUCTION

**Transport** : derived from Latin word

**trans**              +              **Protare**  
(across)              (to carry)

**Transportation**

Activity that facilitates physical movement of goods  
as well as individuals from one place to another

# Transportation

**Transport:** take or carry (people or goods) from one place to another by means of a vehicle, aircraft, or ship.

Source: Definition from Google

**Transportation:** the **action** of transporting someone or something or the process of being transported

Source: Definition from Google

“The **process of moving** an item from point A to point B.”

“Safe, efficient, reliable, and sustainable **movement** of persons and goods over time and space”

# Importance of Transportation

- For the rapid economic, industrial and cultural growth of any country, a good system of transportation is very essential.
- Good transport system helps in the movement of people and goods. Thus, it enables contact between different places. There by, it improves considerably the trade and industry.
- For the basic necessities of people of any region, transportation moves food, clothing, industrial products, medicines etc., both at the production and distribution stages.
- An industrialist can transport the raw materials and then market his finished products. He can do so efficiently, only through a good network system of transportation.
- A framer can market his products to the nearby market economically, only through a good system of roads.
- Export of engineering goods, etc by ships is very important for earning foreign exchanges.
- The security of a country requires a good transportation network, that is for Army, Navy and Air force.

# MODES OF TRANSPORTATION



Rail  
Transportation



Road  
Transportation



Water  
Transportation



Air  
Transportation

# MODES OF TRANSPORTATION



**Ropeway  
Transportation**



**Monorail  
Transportation**

**Metro Rail  
Transport System**



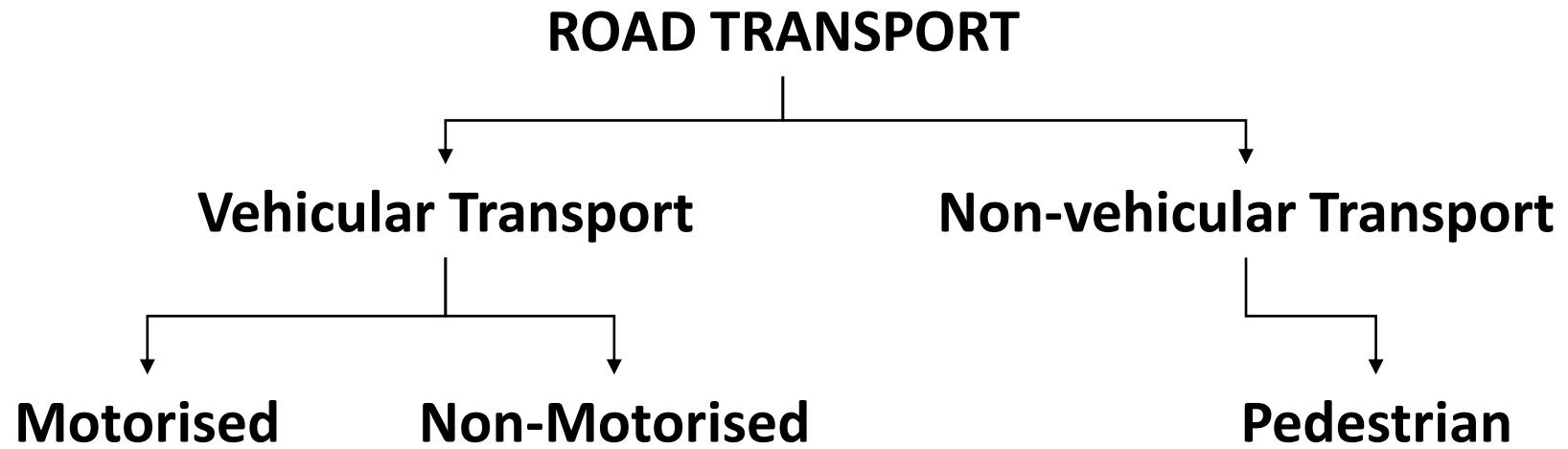
**Pipelines  
Transportation**



**Bus Rapid  
Transit System**

# **ROAD TRANSPORT**

Transport significant quantity of material, goods and passenger to short, medium and long distances



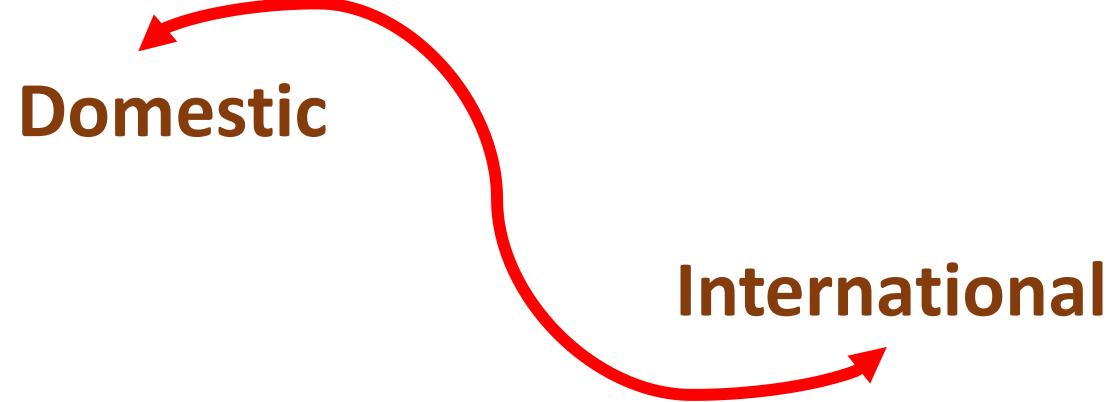
# RAIL TRANSPORT

Transport bulk quantity of material, goods and passenger to longer distances



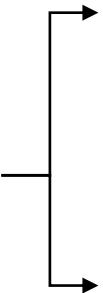
# AIR TRANSPORT

Transport bulk quantity of material, goods and passenger to longer distances



# **WATER TRANSPORT**

**WATER  
TRANSPORT**



**INLAND  
TRANSPORT**

**OCEAN  
TRANSPORT**

# ROLE OF TRANSPORTATION



**Transportation contributes to the prosperity of the nation**

## CONNECTIVITY

of/to various services and facilities

# ROLE OF TRANSPORTATION – Economic Development

Investment in transport is a key to economic growth

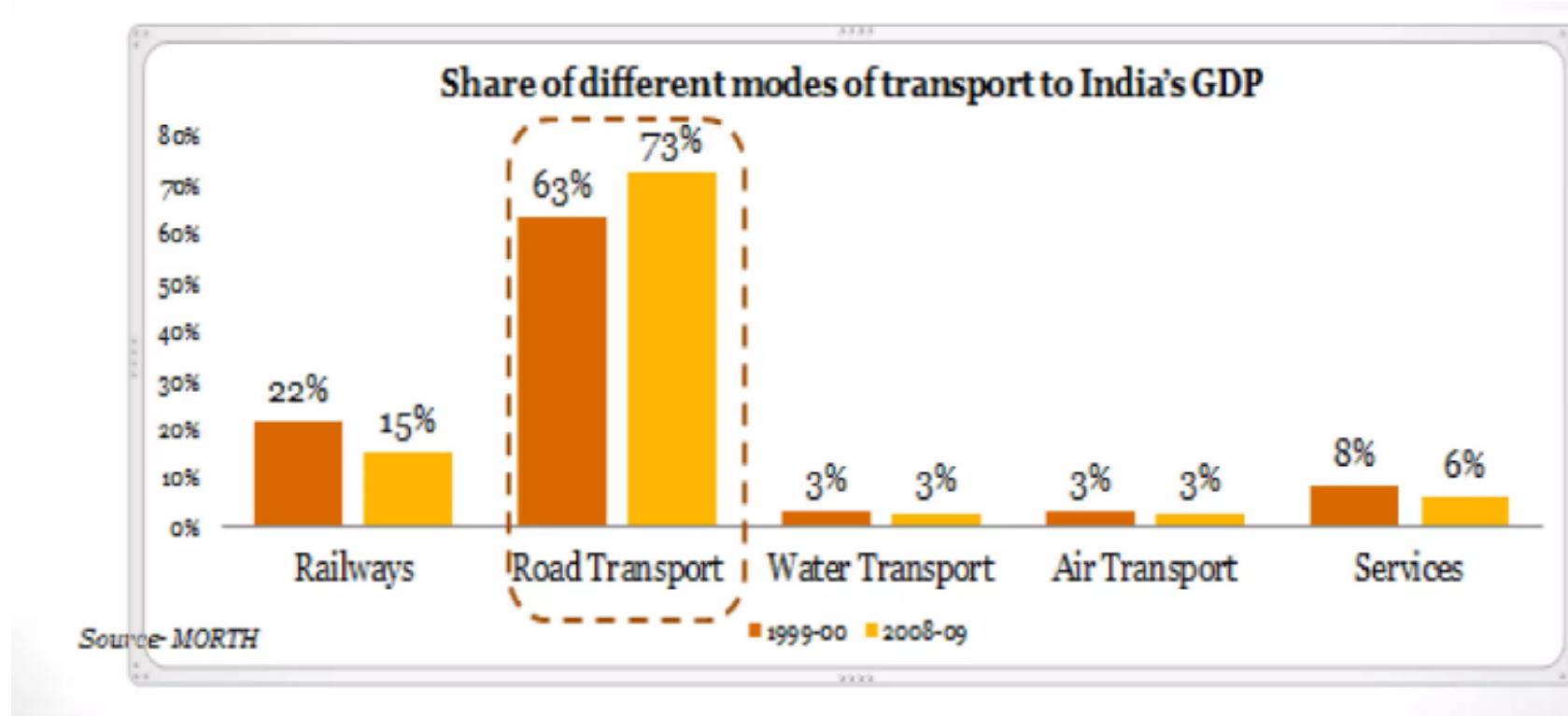
Improves communication

- ↳ Improves trades and commerce
  - ↳ Creates Opportunities
    - ↳ Generate Revenue
      - ↳ Growth in spaces



Transport sector contributes to 6% of total GDP

# Share of Different mode of transport in Indian GDP

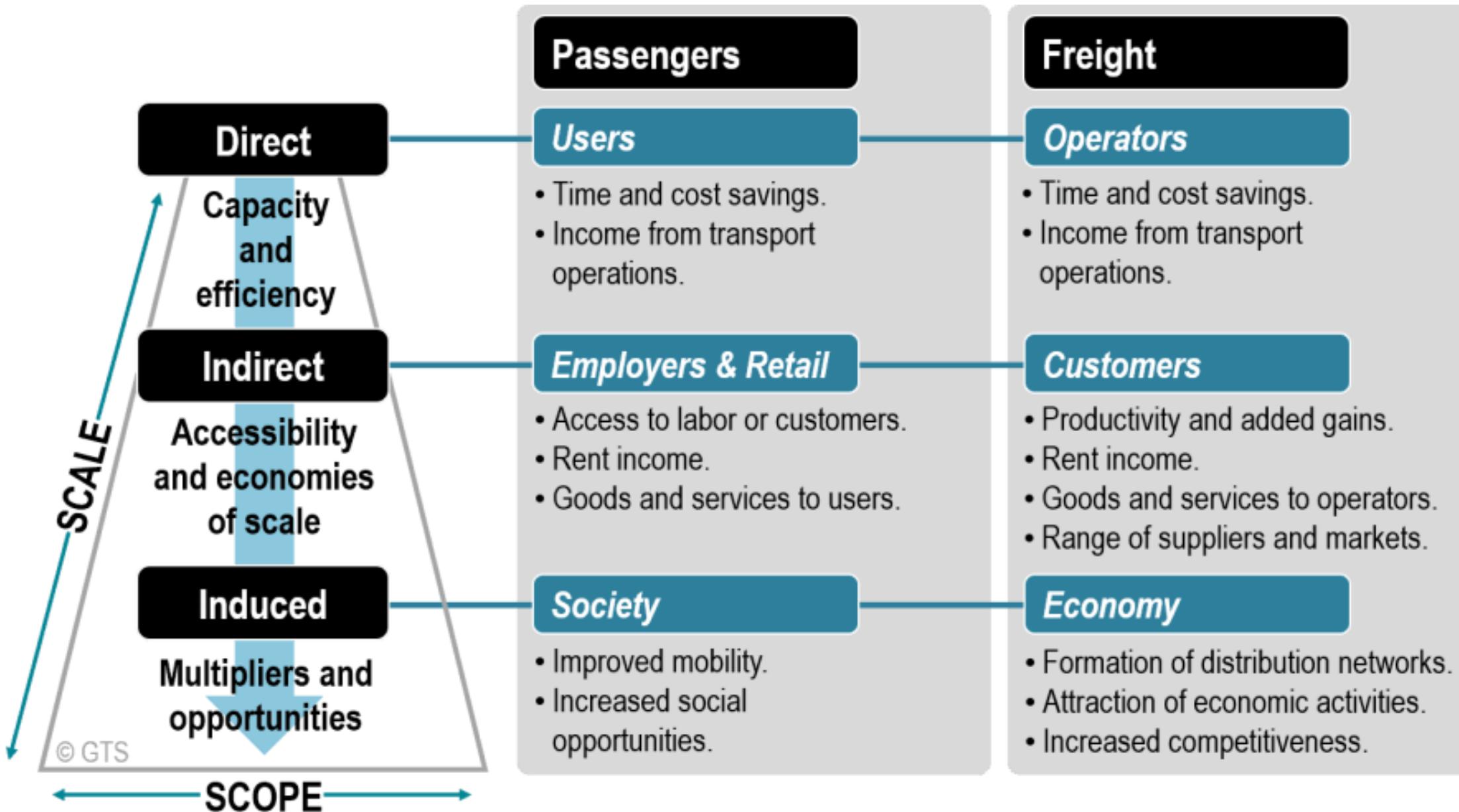


# ROLE OF TRANSPORTATION – Industrial Development

- Turning of local market into national market
- Increases the export import from the availability of raw materials
- Connecting the local market and distributor to the cities
- Increase the productivity of different industries



# ROLE OF TRANSPORTATION – Social and Cultural Development



## **ROLE OF TRANSPORTATION – Social and Cultural Development**

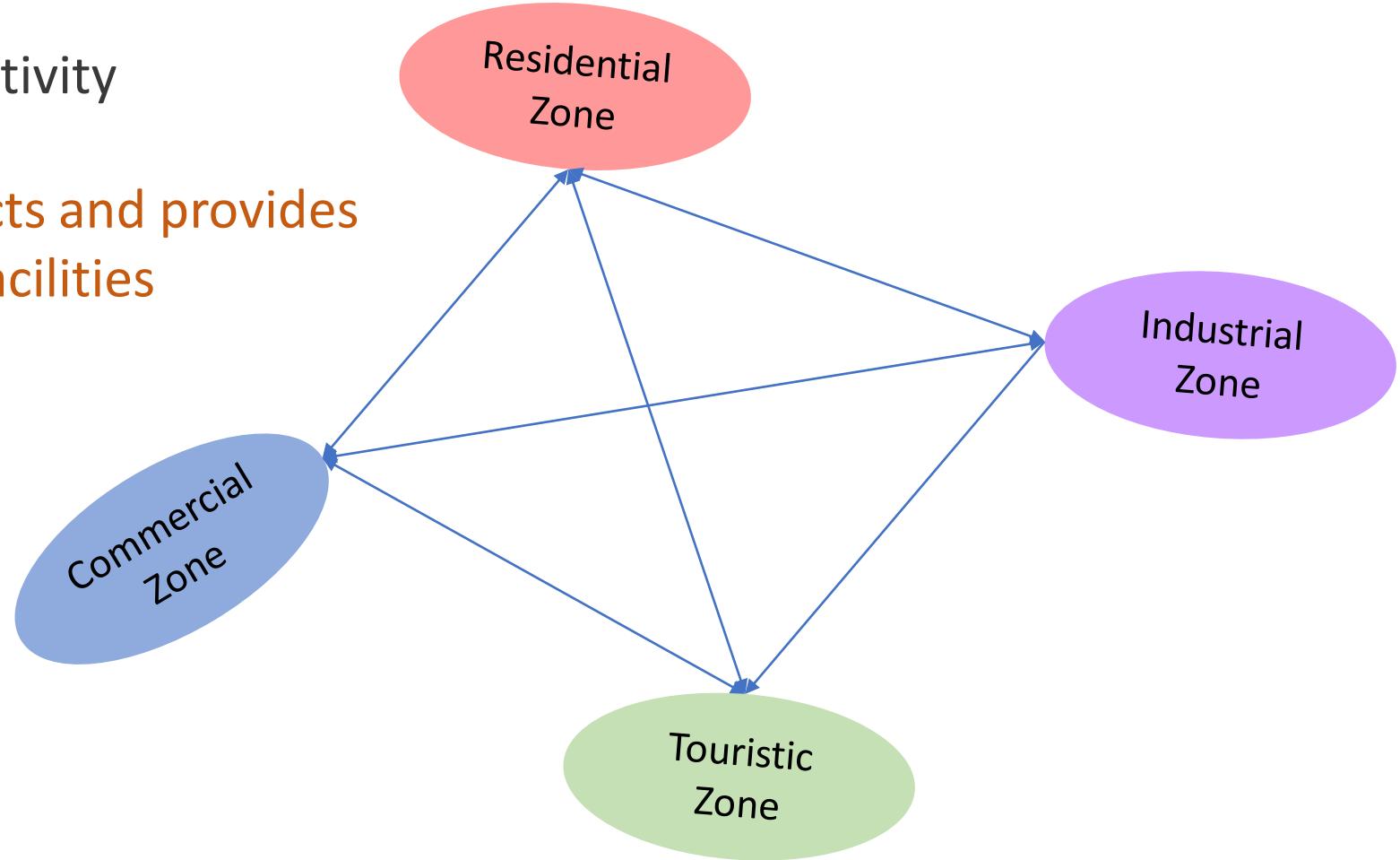
- Encourage the globalization
- Improve the living condition of people
- Influence the formation of urban societies
- Exchange and adoption of different culture

# Role of Transportation

## Economic effects of transportation

Transport — Economic activity

Transportation connects and provides various services and facilities



# Role of Transportation

## Social effects of transportation

development, settlement along the transportation routes

### 1. Sectionalism & transportation

- Reduce sectionalism within the country and outside the country
- Living conditions of colonies improves as travel distance reduced with time
- Helps in increase of knowledge between the sections of society

Community well-being

### 2. Concentration of population into urban area

- Improvement in transportation system brings prosperity in urban population
- Increase in employment opportunities and attracts population
- Important for daily internal movement of various purposes
- Encourage people to live in places away from work places thus reduction in growth of slums

### 3. Aspect of safety, law & order

- Important for rushing aids to affected areas during emergencies
- To maintain law and order
- For country's defense

# Role of Transportation

## **Social effects of transportation**

1. Community advancement
2. Economic prosperity and general development of country
3. For strategic movement in emergency for defense of the country and to maintain law and order

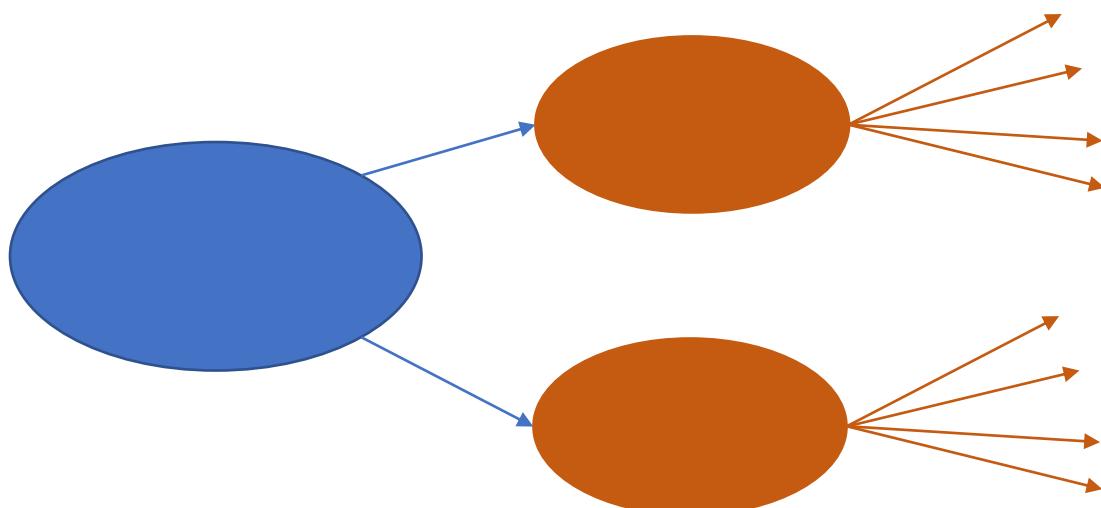
# Role of Transportation

## Role of transportation in rural development

**75% rural population** → Good transportation system leads to faster development of rural centres

# Transportation in Logistics

1. The operation of transportation determines the efficiency of moving products
2. The progress in techniques and management principles improves the moving load, delivery speed, service quality, operation costs, the usage of facilities and energy saving.
3. Transportation takes a crucial part in the Logistics Operation
4. Therefore, transportation is the base of efficiency and economy in business logistics and expands other functions of logistics system

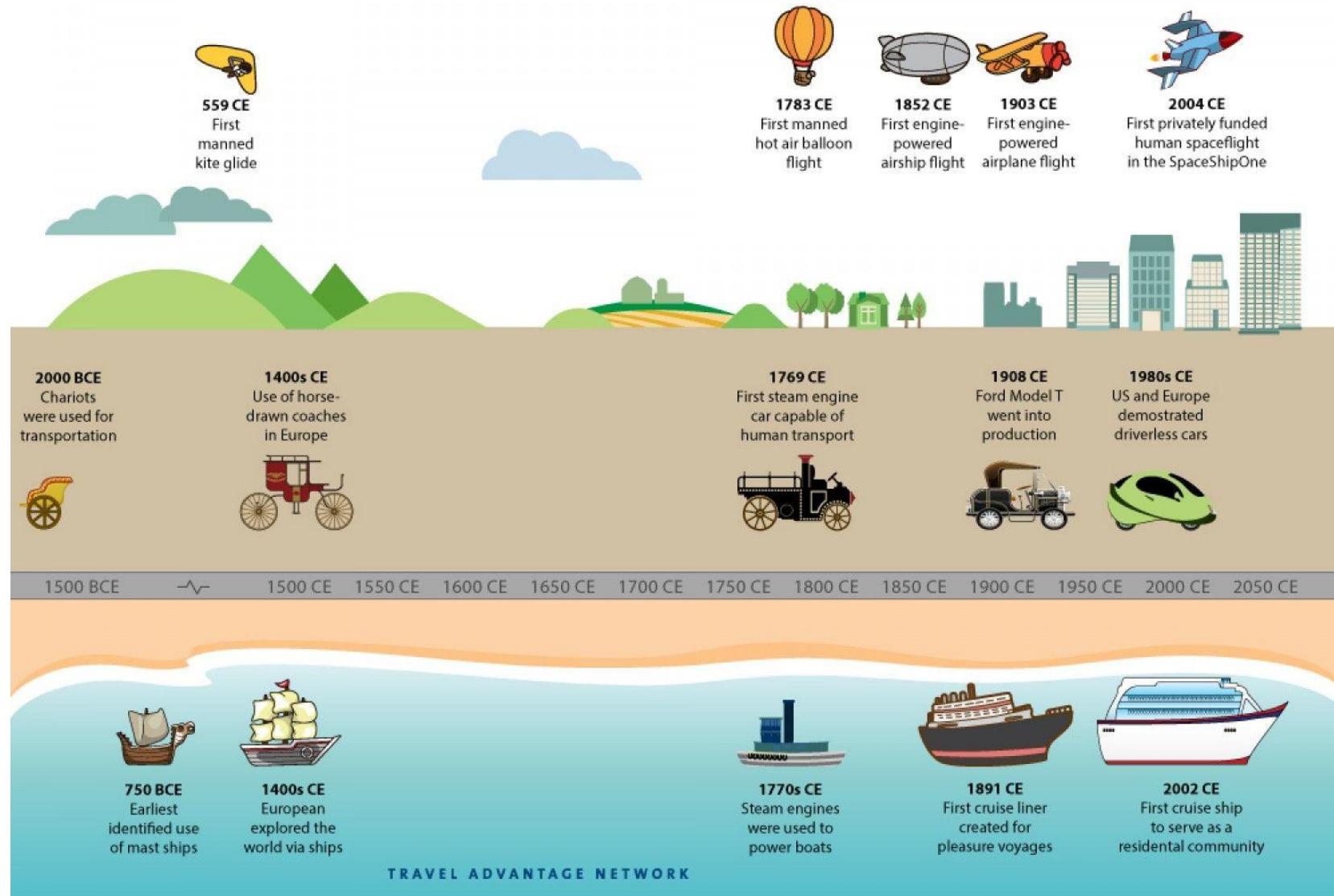


# Importance of Transportation in Logistics

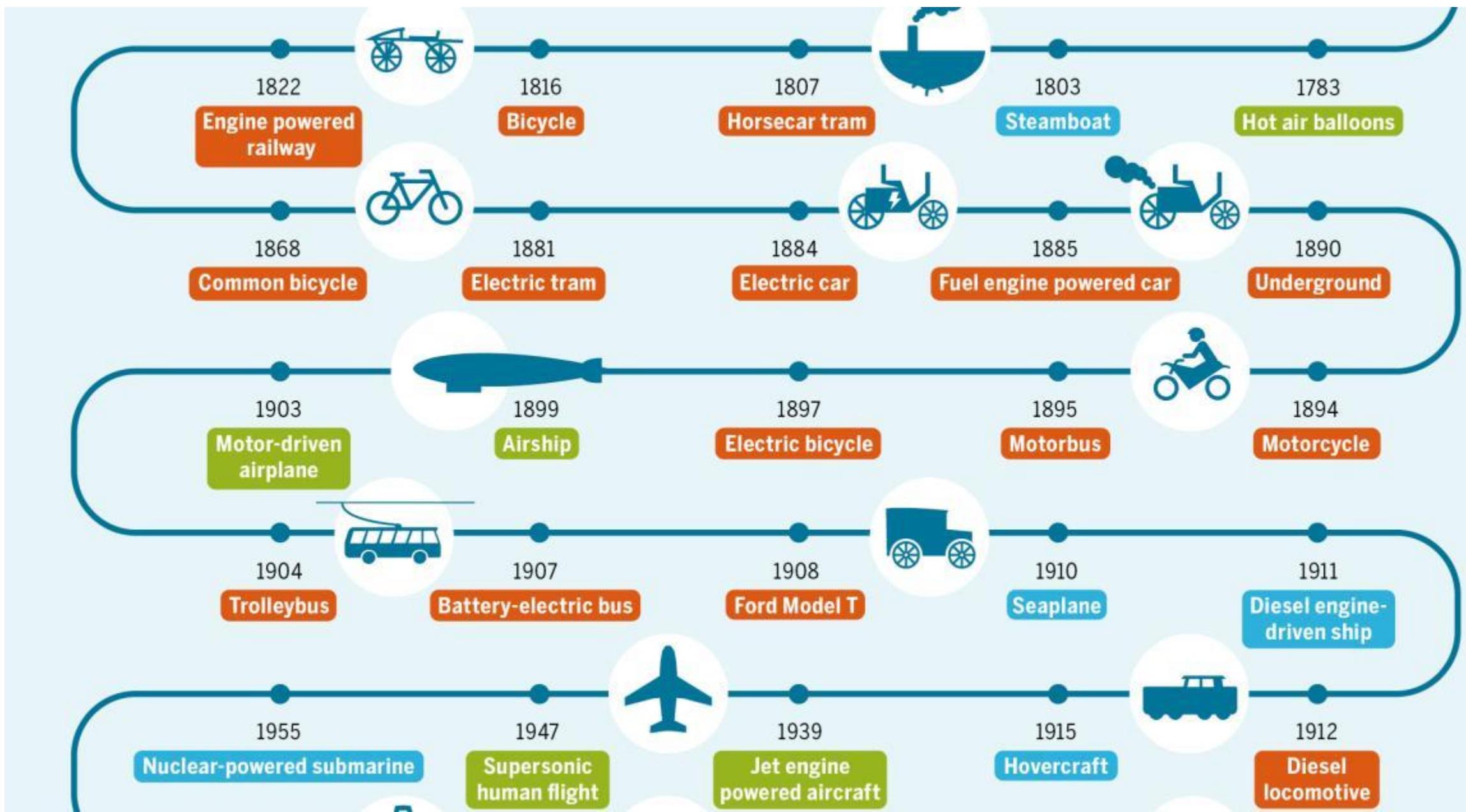
- Without well-developed transportation systems, logistics could not bring its advantages into full play.
- A good transport system in logistics activities could provide better logistics efficiency, reduce operation cost, and promote service quality.
- A well-operated logistics system could increase both the competitiveness of the government and enterprises.
- Transport system is the most important economic activity among the components of business logistics systems

# HISTORY OF TRANSPORTATION

## Transportation History - The Evolution of Travel



# HISTORY OF TRANSPORTATION



# Road Transport

## Advantages

- ✓ It is a relatively cheaper mode of transport as compared to other modes.
- ✓ Perishable goods can be transported at a faster speed by road carriers over a short distance.
- ✓ It is a flexible mode of transport as loading and unloading is possible at any destination. It provides door-to-door service.
- ✓ It helps people to travel and carry goods from one place to another, in places which are not connected by other means of transport like hilly areas.

## Limitations of Road transport

- ✓ Due to limited carrying capacity road transport is not economical for long distance transportation of goods.
- ✓ Transportation of heavy goods or goods in bulk by road involves high cost.

# Rail Transport

## Advantages of Rail transport:

- ✓ It is a convenient mode of transport for travelling long distances.
- ✓ It is relatively faster than road transport.
- ✓ It is suitable for carrying heavy goods in large quantities over long distances.
- ✓ Its operation is less affected by adverse weather conditions like rain, floods, fog, etc.

## Limitations of Railway transport:

- ✓ It is relatively expensive for carrying goods and passengers over short distances.
- ✓ It is not available in remote parts of the country.
- ✓ It provides service according to fixed time schedule and is not flexible for loading or unloading of goods at any place.
- ✓ It involves heavy losses of life as well as goods in case of accident.

# Water Transport

## Advantages:

- ✓ It is a relatively economical mode of transport for bulky and heavy goods.
- ✓ It is a safe mode of transport with respect to occurrence of accidents.
- ✓ The cost of maintaining and constructing routes is very low most of them are naturally made.
- ✓ It promotes international trade.

## Disadvantages:

- ✓ The depth and navigability of rivers and canals vary and thus, affect operations of different transport vessels.
- ✓ It is a slow moving mode of transport and therefore not suitable for transport of perishable goods.
- ✓ It is adversely affected by weather conditions.
- ✓ Sea transport requires large investment on ships and their maintenance.

# Air Transport

## Advantages:

- ✓ It is the fastest mode of transport.
- ✓ It is very useful in transporting goods and passengers to the area, which are not accessible by any other means.
- ✓ It is the most convenient mode of transport during natural calamities.
- ✓ It provides vital support to the national security and defence

## Disadvantages:

- ✓ It is relatively more expensive mode of transport.
- ✓ It is not suitable for transporting heavy and bulky goods.
- ✓ It is affected by adverse weather conditions.
- ✓ It is not suitable for short distance travel.
- ✓ In case of accidents, it results in heavy losses of goods, property and life.

# Others

Pipe lines

Elevators & Escalators

Belt conveyors

Cable cars

Aerial ropeway

Monorails

# Relative Characteristics by Transportation Modes:

Operating Characteristics	Rail	Road	Water	Pipeline	Air	Remarks
Speed	3	2	4	5	1	Air is the fastest
Availability	2	1	4	5	3	Road is the best since they can drive from origin to destination
Dependability	3	2	4	1	5	Pipeline ranks best-As the service is continuous and there is no stoppage due to traffic or congestion
Capability	2	3	1	5	4	Sea is the best-Can handle all types and size of cargo
Frequency	4	2	5	1	3	Pipeline is ranked best-As the movement is continuous
Composite Score	14	10	18	17	16	Lowest rank is the Best

# Transportation Impacts

- The speed, cost, and capabilities of available transportation have a significant economic impact on an area --- Highway, rail, freight, transit, shipping
- Countries with better/advanced transportation networks and services are leaders in industry and commerce

# What are Current Transportation Problems?

1. Financing
2. Congestion
3. Infrastructure
4. Safety
5. Population
6. Increased Truck Weights
7. Migration
8. Environmental pollution
9. Increase in crime rate
10. Hike in land cost

Road construction involves two primary types of pavement: **rigid pavement** and **flexible pavement**.

Rigid pavement is constructed with a **single layer**, while flexible pavement consists of **multiple layers**.

These methods differ in their approach to creating road surfaces, offering distinct advantages and characteristics.

Rigid pavement provides a durable and long-lasting surface, while flexible pavement offers flexibility and resistance to cracking. The choice between these two types depends on factors such as **traffic load, environmental conditions, and cost considerations**.

# **Types of Pavements**

Flexible and rigid pavements are two types of highway pavements. They differ in the way they distribute loads to the subgrade, and in their construction methods:

## **Flexible Pavements:**

Made of asphalt and aggregate materials, flexible pavements are made up of multiple layers. They bend or deflect under traffic loads, making them less likely to be damaged. They require fewer repairs over time. Flexible pavements are best suited for areas with low to moderate traffic.

## **Rigid Pavements:**

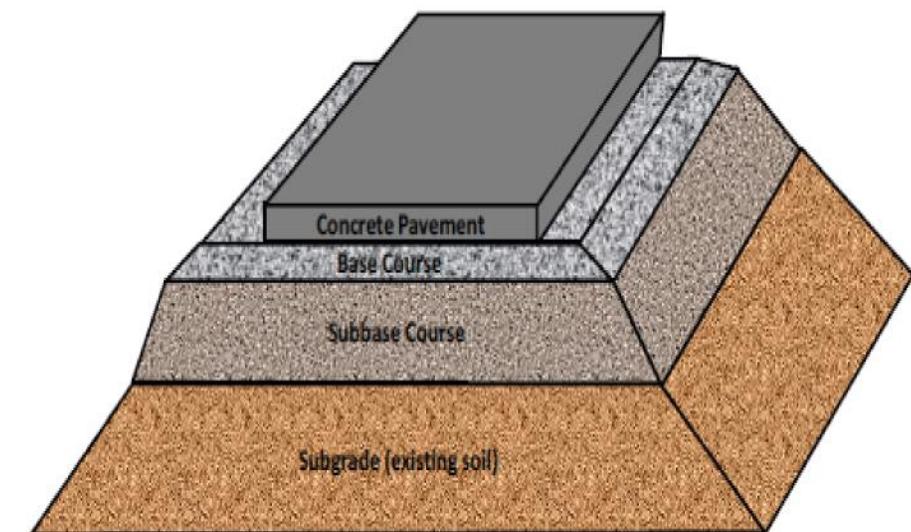
Made of concrete reinforced with steel or other hard material, rigid pavements are made up of a single layer. They are designed to be durable and withstand heavy loads and harsh weather conditions. Rigid pavements are best suited for areas with heavy traffic, such as airports, industrial areas, and high-traffic roads.

## Flexible Pavement (Bituminous Road)

- In this type of pavement, load transformation is through grain-to-grain contact.
- Flexural rigidity is very low in these types of pavement.
- In these types of pavement, if there is any failure at the bottom, then that failure also appears at the top of the pavement.
- No joints are required in these types of pavement for their construction.
- In the construction of these types of pavement, low initial cost and high maintenance cost is required.
- The vehicular load stresses decrease as the depth of the pavement increases.

**Layers-** Sub Grade, Sub-Base Course, Base Course, Prime Coat, Tack Coat, Bituminous Concrete Course, Dense Bituminous Macadam, Seal Coat.

**Layers of Flexible Pavement**



# Advantages

- The abrasion of stones is reduced due to the slurry layer being firmly bonded by bitumen.
- Bituminous road is free from cracks. Therefore, it offers a smooth riding.
- It is resistant to weathering agencies like wind, heat and rain. It resists action due to soil moisture.
- It is fairly impervious.
- There is no glare due to light reflection. Hence accidents are minimized.

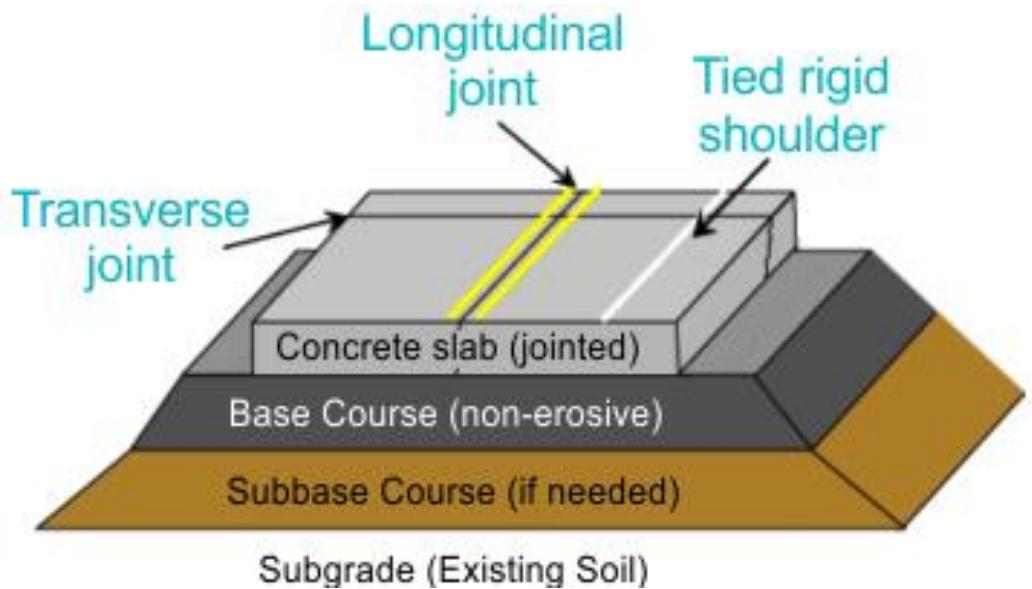
# Disadvantages

- It requires strong foundation.
- It develops corrugations or potholes.
- Under extreme heat, it is liable to become soft and will creep under traffic.
- It is not suitable for heavy iron tired traffic which cuts the surface.

## Rigid Pavements (Cement Concrete Road)-

- In this type of pavement, load transformation is through layer-to-layer action.
- Flexural rigidity is significant in these types of pavement.
- In these types of pavement, if there is any failure at the bottom then the slab will act as a bridge over the cavity.
- Expansion/Contraction joints are required in these types of pavement for their construction.
- In the construction of these types of pavements, the initial cost is high but a low maintenance cost is required.
- This type of pavement is made by using PCC or RCC.

Layers- Sub Grade, Base Course, Surface Course.



# **Advantages**

- Concrete road is smooth, rigid and dustless.
- It can withstand any volume and intensity of traffic.
- Wear and tear caused is minimum
- It can be laid on any subgrade
- It does not develop corrugations
- It can be easily reinforced when required.
- It has better weather resisting qualities.
- It has pleasing appearance with long life and less maintenance.

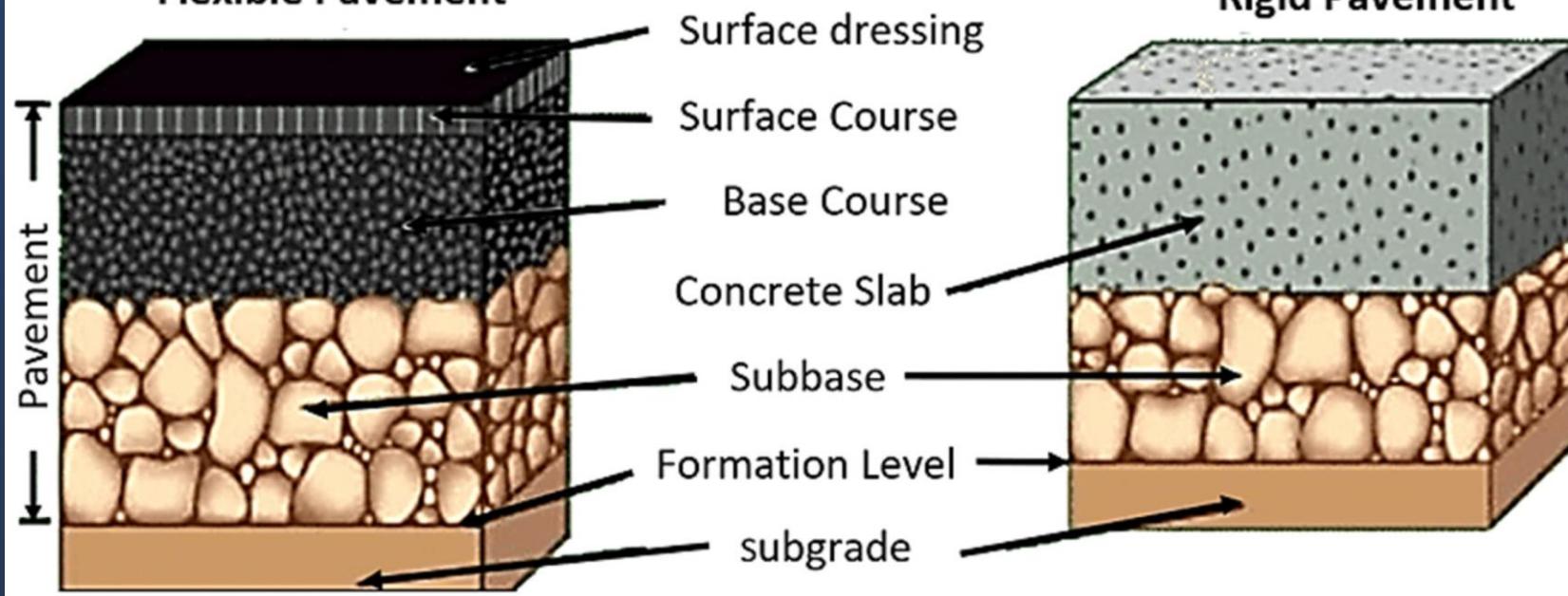
# Disadvantages

- Cost of construction is very high
- Construction of concrete road requires skilled labor and supervision
- More no of joints is to be provided, when prove to be weak spots.
- 28 days curing is required after completion, before they can be opened for traffic.
- It causes noise under iron wheeled traffic.
- It glares due to light reflection and it may lead accident.



**Flexible Pavement**

**Rigid Pavement**

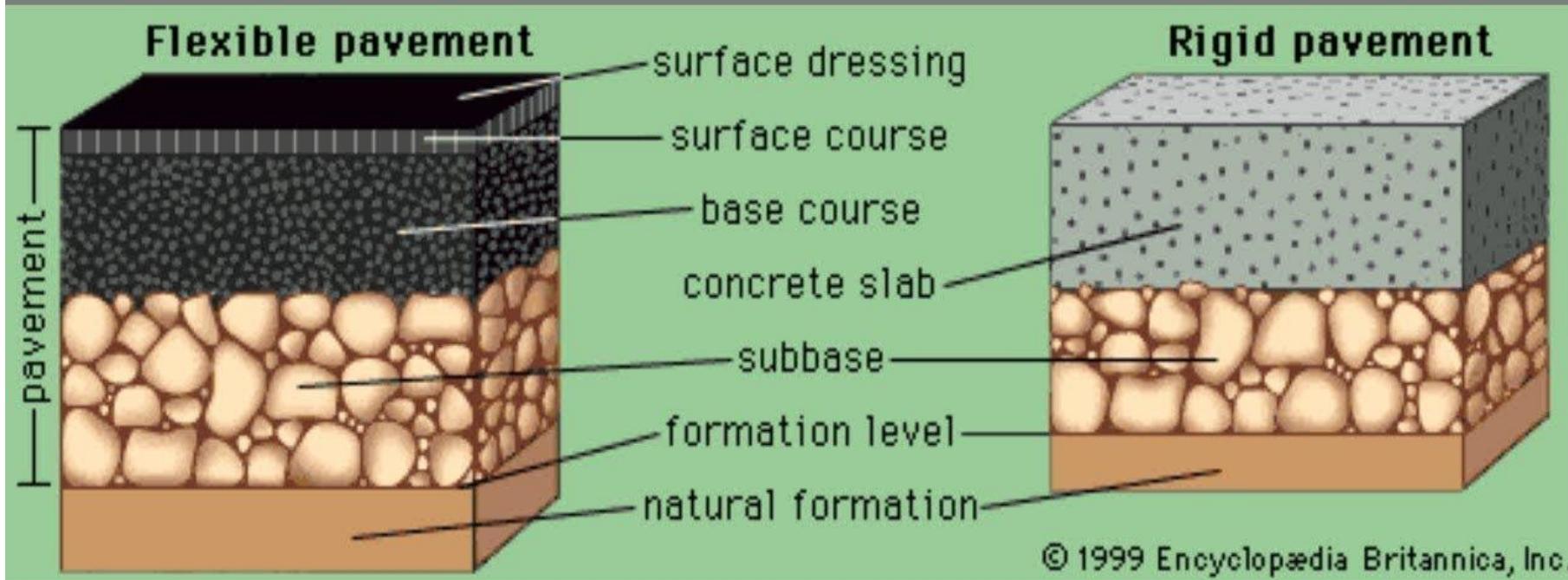


## Difference Between Flexible and Rigid Pavements

Some main differences between flexible and rigid pavements are discussed below.

<b>Flexible Pavement</b>	<b>Rigid Pavement</b>
<b>Layers-</b> Sub Grade, Sub-Base Course, Base Course, Surface Course.	<b>Layers-</b> Sub Grade, Base Course, Surface Course( Cement concrete slab).
Load transformation is through grain-to-grain contact.	Load transformation is through layer-to-layer action.
Flexural Rigidity is very low or negligible.	Flexural Rigidity is significant.
If there is any failure at the bottom then that failure appears at the top.	If there is any failure at the bottom then, the slab will act as a bridge over the cavity.
No joints are required in its construction.	Expansion/Contraction joints are required in its construction.
Low initial cost and high maintenance cost in its construction.	High initial cost but low maintenance cost in its construction.

# Difference between Flexible Pavement & Rigid Pavement



# Water transportation:

- The water transportation can further be subdivided into two categories:  
**Inland transportation and Ocean transportation.**
- 1. **Inland Water transportation:** Inland Water transportation is either in the form of river transportation or canal transportation.
- 2. **Ocean Water transportation** is adopted for trade and commerce.
- It is estimated that about **75 per cent** of international trade is carried out by shipping. The development of **navy force** is intended for national defense.
- Ocean water transportation has an limitation and it possesses high flexibility.

# Harbor Engineering

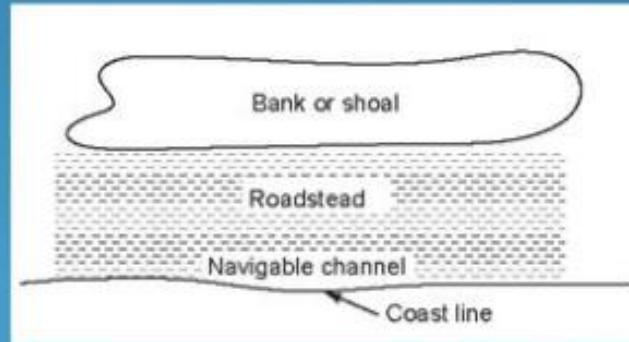
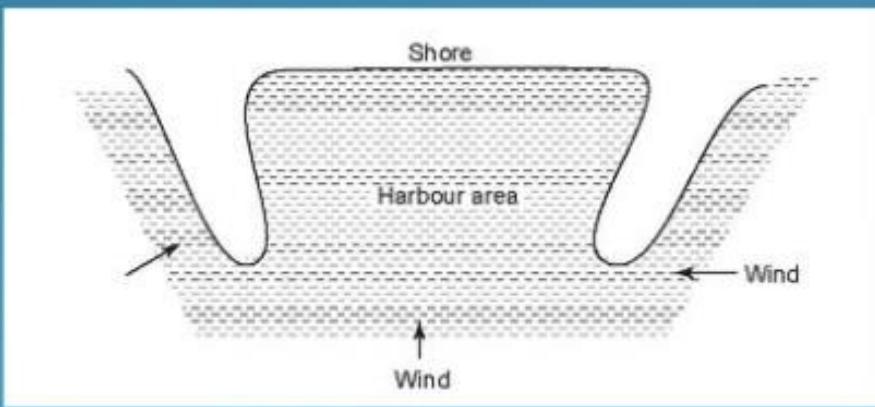
- **Harbors:** A harbor can be defined as a sheltered area of the sea in which vessels could be launched, built or taken for repair; or could seek refuge in time of storm; or provide for loading and unloading of cargo and passengers. Harbours are broadly classified as: **Natural harbors, Semi-natural harbors, Artificial harbors.**
- A harbor can be defined as a sheltered area of the sea in which vessels could be launched, built or taken for repair; or could seek refuge in time of storm; or provide for loading and unloading of cargo and passengers.
- On the other hand, harbors are water bodies where vessels, barges, and boats can be docked. The ports may be situated along the coast. Also, the harbor may be situated along inland waterways.
- Harbor Engineering deals with the construction and maintenance of fishing harbors and fish landing centers, fishery infrastructures like hatcheries, ponds, farms etc.

- **Natural harbours**

These are formed naturally by the configuration of the land, resulting in creeks or basins, usually in bays and river mouths.

Bombay (now Mumbai) and Kandla ports are examples of natural harbours in India.

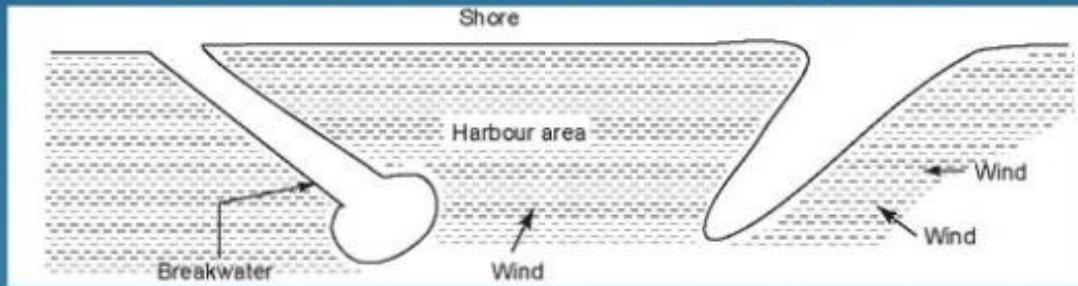
When the area within the harbour provides good anchoring and berthing conditions in the form of a deep navigable channel with a protective natural shoal, it is called a 'natural roadstead'.



- **Semi-natural harbours**

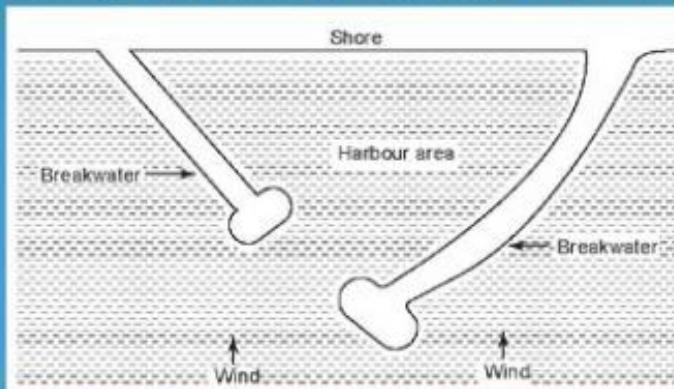
This type has protection on two sides by headlands, requiring artificial protection only at the entrance.

Visakhapatnam is an example of this type in India.



- **Artificial harbours**

These are formed by constructing what are called breakwaters to provide shelter to ships. Madras (now Chennai) harbour is a good example of an artificial harbour in India.



**Ports:** The term port is used to indicate a harbor where terminal facilities, such as stores, landing of passengers and cargo, etc. are added to it.

Thus, a harbor consists of the waterways and channels as far as the pier head lines and a port includes everything on the landward side of those lines i.e. piers, slips, wharves, sheds, tracks, handling equipment, etc.

**Classification of ports:** Depending upon the location, the ports can be classified as;

- Canal ports
- River ports
- Sea ports

## Major ports of India

Nhava Sheva- Mumbai- Kochi- Kandla- Chennai- Kolkata- Haldia- Visakhapatnam- Marmugao- Paradeep- Mangalore.

# Paradip Port

The Biggest Port of  
east coast of India



# MUMBAI PORT



# PIERS

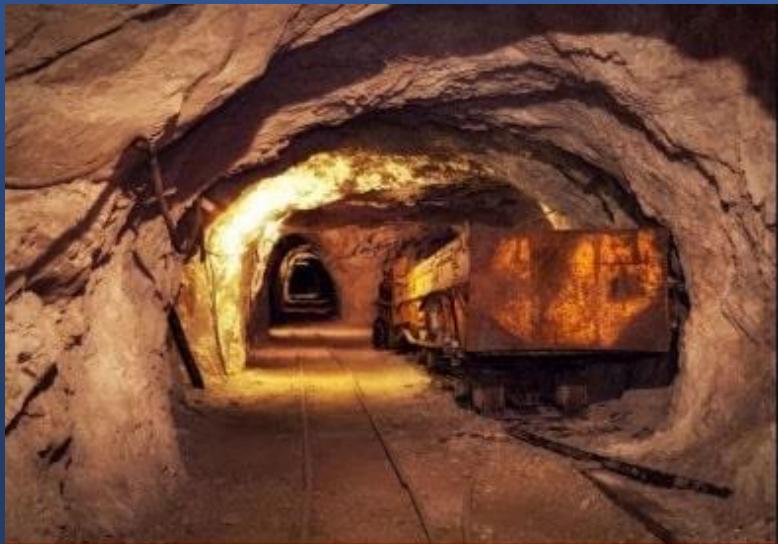
- A pier is a raised structure that rises above a body of water and usually juts out from its shore, typically supported by piles or pillars, and provides above-water access to offshore areas. Frequent pier uses include fishing, boat docking and access for both passengers and cargo, and oceanside recreation.
- **The structures which are built perpendicular or oblique to the shore of a river or sea are known as piers.**
- In the sea the piers are constructed where the sea is not deep, and the natural harbor is not convenient for allowing the ships to berth adjacent to the shore.
- In many cases, the piers are constructed with piles, columns and braces leaving good space for the ocean current to flow without causing any obstruction.
- Its width should be sufficient to satisfy its utility. It can be stated that the pier should be of sufficient width to allow easy unloading of cargo without any undue delay.

# QUAYS

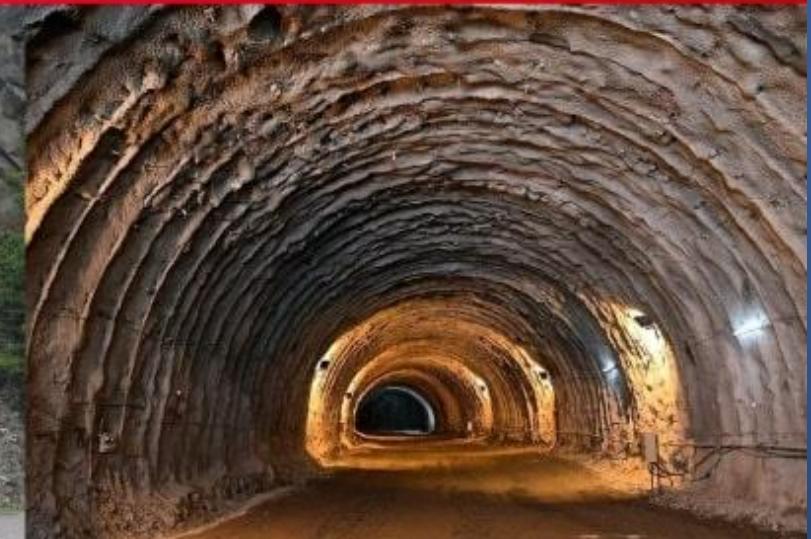
- **Stationary platforms, built along or parallel to the shore, to serve the purpose of loading and unloading of vessels brought near them.**
- **A quay basically refers to the land area surrounding a ship berth.** It is a marine structure built on the shore of a harbor or on the bank of a river or canal where ships may dock to load and unload cargo or passengers.
- It may also function as a repair place for a ship moored alongside.
- A quay is generally attached to the shore.

# Tunnel Engineering

- Tunnels are underground passages used for transportation.
- They could be used for carrying freights and passengers, water, sewage etc.
- Tunnel engineering deals with the design and construction of **underground or underwater passages** that enable transportation through obstacles such as mountains, rivers, and water bodies.
- Tunnels are essential for **road and rail networks**, as they provide efficient and often faster routes through **challenging terrains**.
- Tunnels are essential for road and rail networks, as they provide efficient and often faster routes through challenging terrains.



## TYPES OF TUNNELS



# Advantages of Tunnels

- Tunnels are more economical than open cuts beyond certain depths.
- Tunnels avoid disturbing or interfering with surface life and traffic during construction.
- Tunnels provide utility services like water, sewer, and gas.
- Tunnels prove to be cheaper than bridges or open cuts if tunnels are provided with easy gradients.
- In case of aerial warfare and bombing of cities, the tunnels would grant better protection as compared to bridges.

# Factors to be considered for Tunneling

1. Selection of location
2. Determining purpose
3. Addressing ventilation
4. Managing drainage
5. Budget consideration
6. Environmental impact assessment
7. Compliance with permit and regulations
8. Managing traffic and accessibility

# Airport Engineering

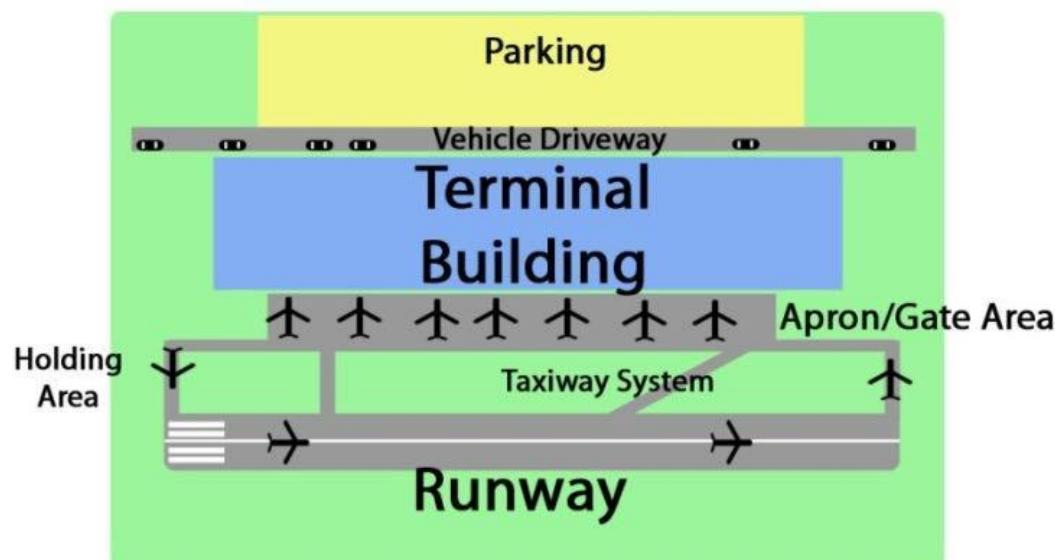
- Airport engineering is a specialized branch of civil engineering that focuses on the planning, design, construction, operation and maintenance of airports and associated facilities.
- It encompasses the development of safe, efficient and sustainable airport infrastructure to support aviation activities, including the movement of passengers, cargo, and aircraft.

# Scope of the Airport Engineering

1. **Planning:** Airport engineers are involved in the long-term planning and development of airports. This includes assessing the future needs of air transportation, forecasting passenger and cargo traffic, and strategically expanding airport facilities to meet growing demands.
2. **Design:** Airport design is a critical aspect of airport engineering. This includes runways, taxiways, aprons, terminals, air traffic control towers, lighting systems, and other infrastructures.
3. **Construction:** Airport engineers oversee the construction and expansion of airport facilities.
4. **Operation:** Airport engineers are responsible for the day-to-day operation of airport facilities. This involves managing air traffic, maintaining runways and taxiways, overseeing security measures, and ensuring the safety of passengers and aircrafts.
5. **Maintenance:** Regular maintenance is crucial to ensure the continued safe and efficient operation of an airport.
6. **Safety and security :** Engineers design and implement safety measures such as runway lighting and marking, as well as security protocols to protect passengers, aircrafts and airport facilities.
7. **Environmental considerations:** This includes addressing noise pollution, managing air quality and implementing sustainable design and operation practices to reduce the ecological foot-print of airports.
8. **Technological Advancements:** With the advancement of technology , Airport engineering is also involved in the integration of automation, data analytics and other innovative solutions to enhance airport operations, passenger experiences, and overall efficiency.

# Airport planning and Design

- **Runway design:** the runway is the primary surface on which aircraft take off and land. It must be designed to safely accommodate various aircraft types and handle different weather conditions
- **Taxiway design:** they are the paths that aircraft follow to move between runways , aprons, terminals and other areas of the airport. Taxiway design focuses on ensuring the safe and efficient movement of aircraft on the ground.
- **Apron Design:** Apron design is the strategic planning of the aircraft parking and maneuvering areas at airports. It involves layout, pavement design and safety considerations.



# Railway Engineering

- **Railway engineering** is a specialized branch of civil engineering that focuses on the **design, construction, operation, and maintenance of railway systems and infrastructure**. Railway engineers are responsible for ensuring that trains run safely and efficiently



# Importance of Railway Engineering

- Indian railways carry most of the long distances passengers' traffic & 80% of the total freight.
- Indian railways provide employment to a huge number of the people in the country .
- Provide mail services
- They carry big chunks of goods from place of production to ports.
- Iron & steel industries based upon railways as they transport raw materials & finished products from one place to another.

# **Advantages of Railways:**

## **Economical aspects:**

- Due to railways, the industrial development in far off places is possible, increasing the land values & standard of living of the people.
- Mobility of labor has contributed to industrial development.
- During famines, railways have played the vital role in transporting food & clothing to the affected areas.
- Commercial farming is very much helped by the railway network throughout the country.
- Speed movement of the commodities is possible through railways.

## **Cultural & Social aspects:**

- Railway has made it easier to reach places of religious importance.
- Railway provides a convenient & safe mode of transport throughout the country.
- During travel as people of different caste & religions sit together the interaction is developed.

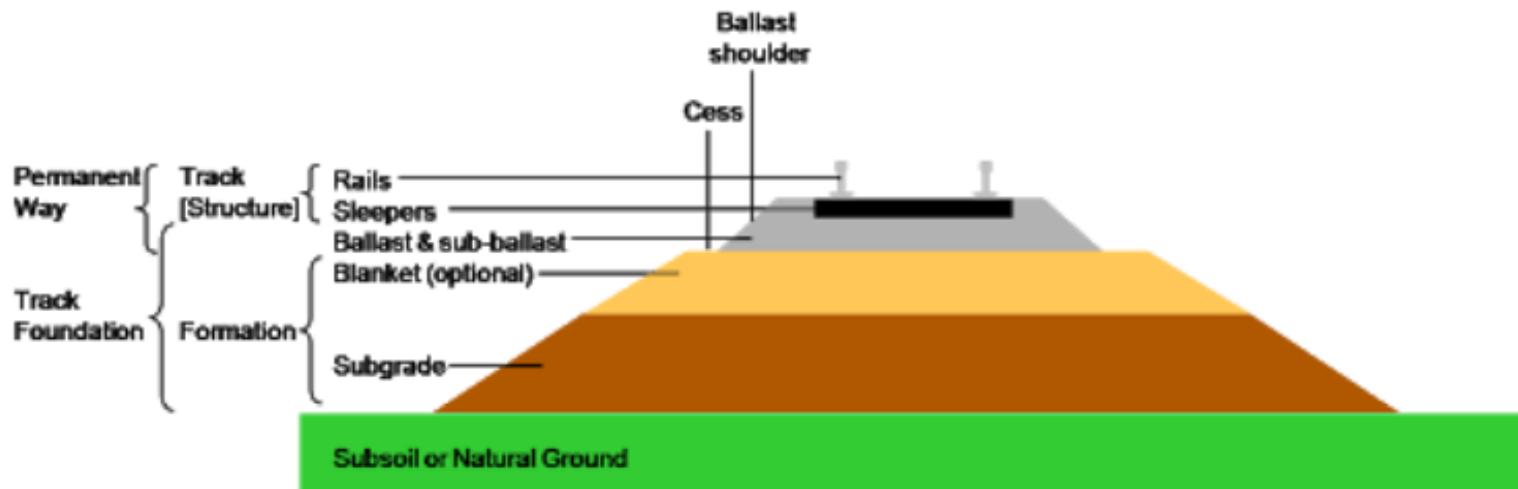
## **Political aspects:**

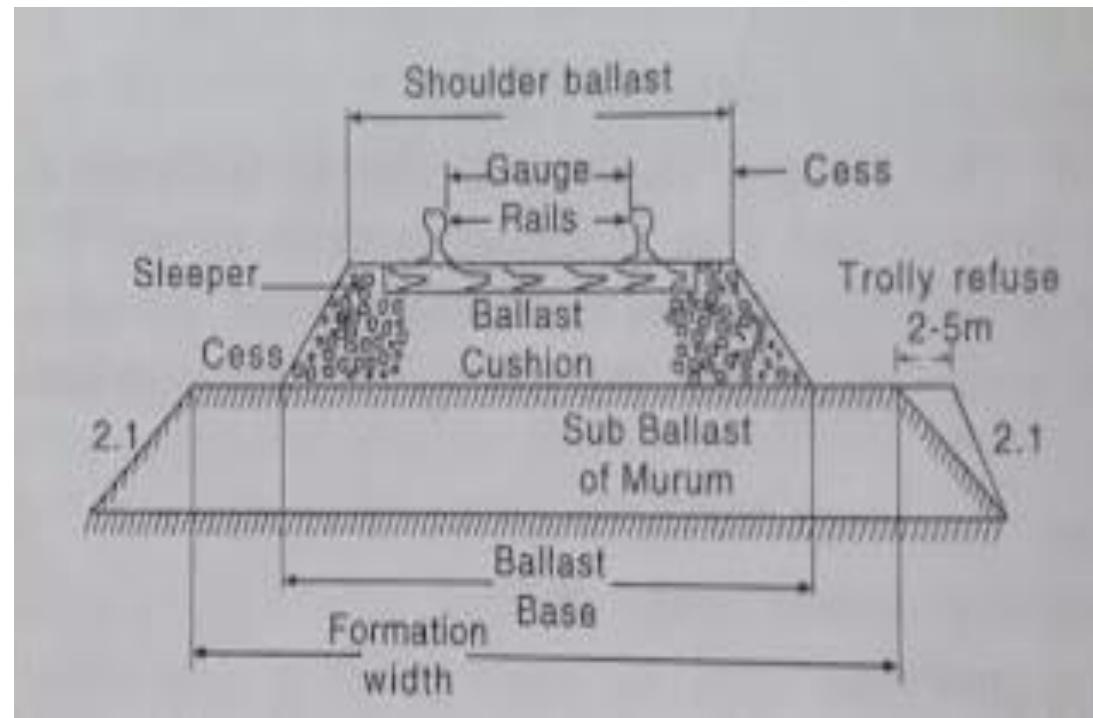
- Railways have helped in the mass migration of the population.
- Railways have created the sense of unity among the people of different religions, areas, castes & traditions.
- With adequate network of railways, the central administration has become easy & effective.

# PERMANENT WAY

**Definition:** A permanent way or a railway track can be defined as the combination of rails, fitted on sleepers and resting on ballast and sub grade.

**Components of a Railway Track:** The Typical components are: 1. Rails 2. Sleepers (or ties) 3. Fasteners 4. Ballast (or slab track) 5. Sub grade





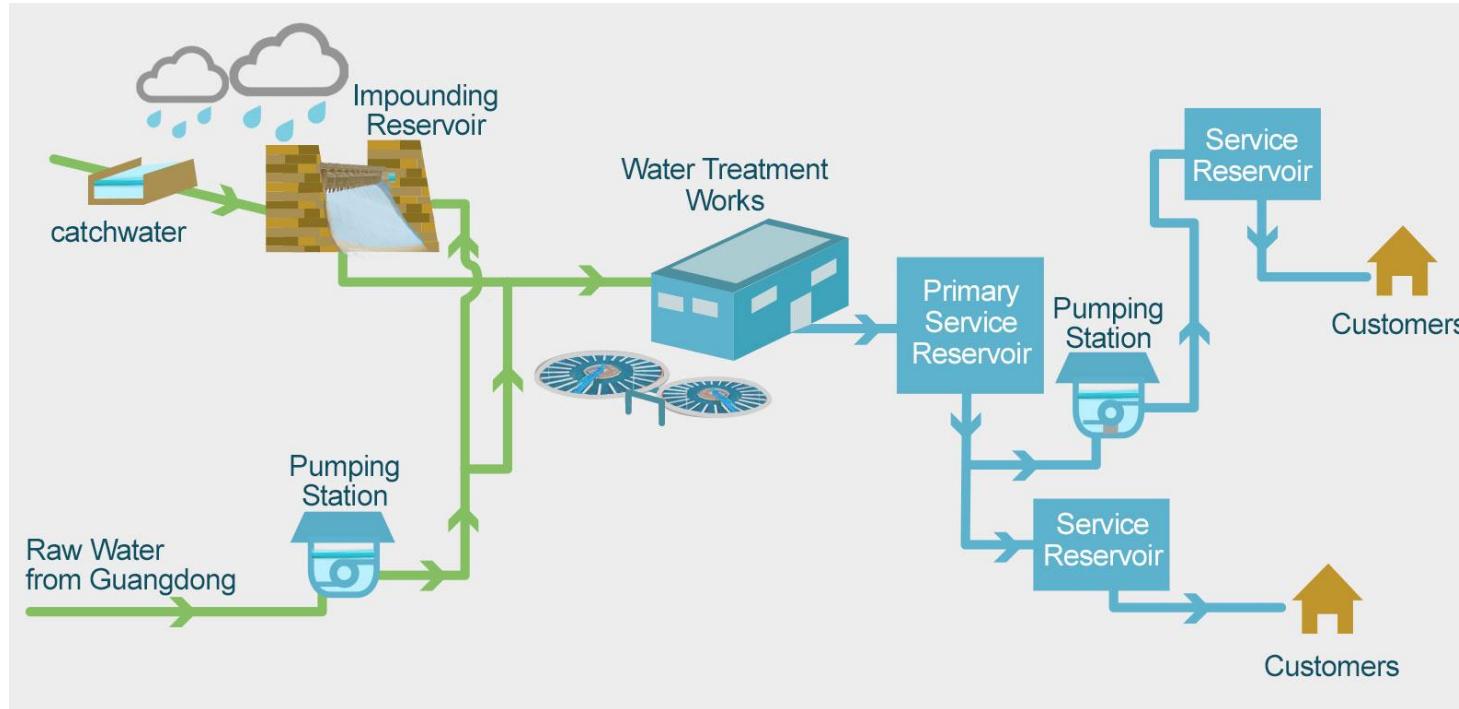
- The rails are joined in series by fish plates and bolts & they are fixed to sleepers by different types of fastenings. The sleepers properly spaced, resting on ballast are suitably packed and boxed with ballast.
- The layer of ballast rests on the prepared sub grade is called as the formation.
- The rails transmit the wheel load to the sleepers. The sleepers hold the rails in proper position and transmit the load from rails to ballast.
- The ballast distributes the load over the formation and holds the sleepers in position.
- On curved tracks, super elevation is maintained by ballast and the formation is leveled.
- Minimum ballast cushion is maintained at inner rail, while the outer rail gets kept more ballast cushion.
- Additional quantity of ballast is provided on the outer cess of each track for which the base width of the ballast is kept more than for a straight track.

An aerial photograph of a long bridge spanning across a large body of water. The bridge has multiple lanes of traffic, including cars and trucks, moving in both directions. The water below is a vibrant turquoise color with visible ripples.

# **WATER RESOURCES AND ENVIRONMENTAL ENGINEERING**

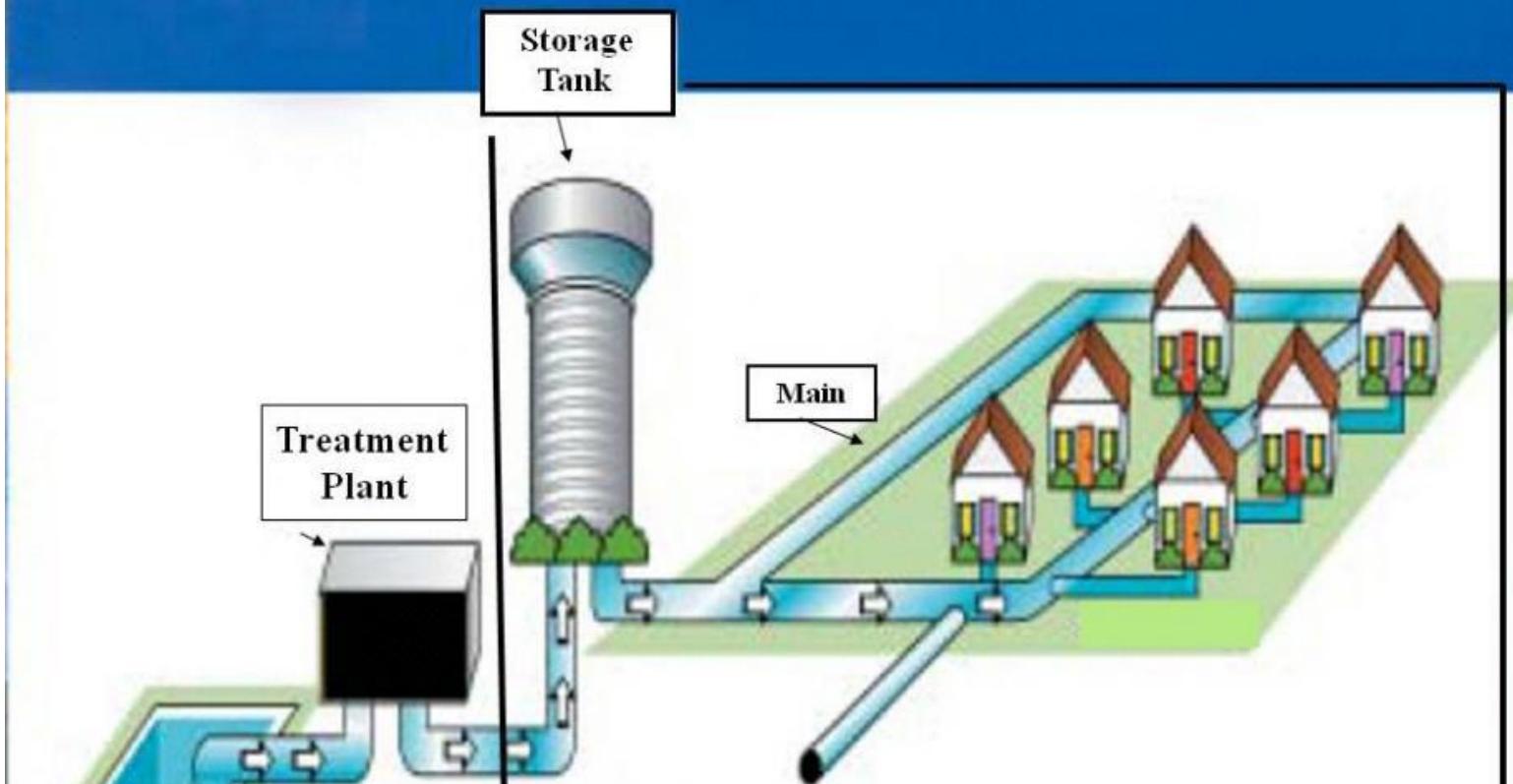
# Water Supply Network

A water supply network or water supply system of engineered hydrologic and hydraulic components that provide water supply.



schematic representation of water supply system

# Water Supply Distribution System



Note: Pumps and valves are located at a variety of locations throughout the distribution system.

## **Water Distribution :**

1. Gravity Fed Distribution
2. Pumping System
3. Dual/ Combination- Distribution lines, Rising Main

## **Types of Water supply system:**

- a. Continuous System
- b. Intermittent System

# Water Sources

The sources of water is classified into 2 types they are

**1. Surface water Sources**

- i. Ponds and Lakes
- ii. Streams and Rivers
- iii. Reservoirs

**2. Sub-surface Sources**

- i. Springs
- ii. Wells

**Ground Water:** it can be obtained using several techniques . Open well, tube well or bore well , hand pump are some of the techniques from which ground water can be extracted.

**Open Well:** in place where ground water is available at lower depth ( less than 15 m ) and water is available all year round, open well is used.

**Hand Pump:** In places where safe ground water is available up to depth of 60m , hand pump is as ideal choice for cluster habitat.

**Bore Well:** in cases where ground water is at greater depth and open wells or hand pumps are not viable, bore well or tube well is installed.

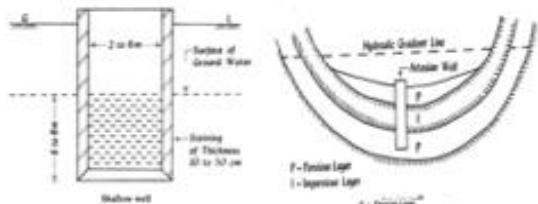
## SOURCES OF WATER

All the sources of water can be broadly divided into

1. **Surfaces sources**
2. **Sub surface sources**

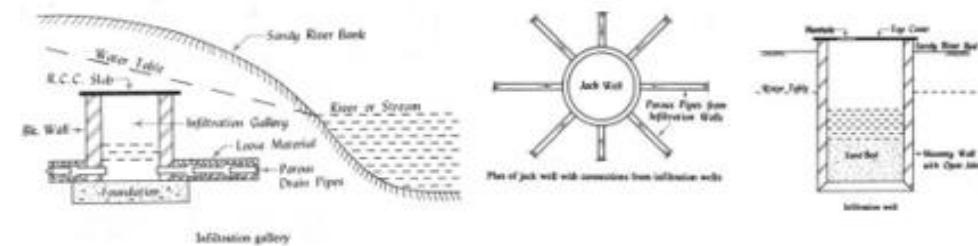
The **surface sources** further divided into

- i. **Streams**
- ii. **Rivers**
- iii. **Ponds**
- iv. **Lakes**
- v. **Impounding reservoirs etc.**



The **subsurface sources** further divided into

- (i) **Infiltration galleries**
- (ii) **Infiltration wells**
- (iii) **Springs etc**



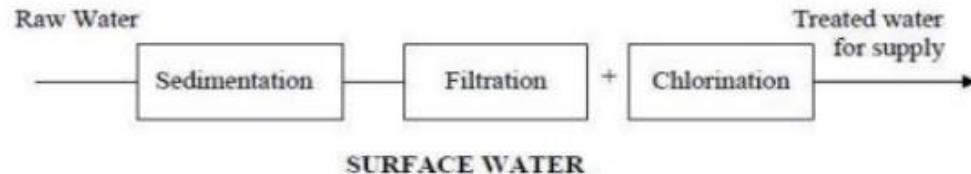
### Types of Intake structures

Depending upon the source of water the intake works are classified as following

- **Lake Intake**
- **Reservoir Intake**
- **River Intake**
- **Canal Intake**

## TREATMENT OF WATER

Raw Water



One complete water treatment plant requires the following process starting from the source of water upto the distribution zone in order of sequence.

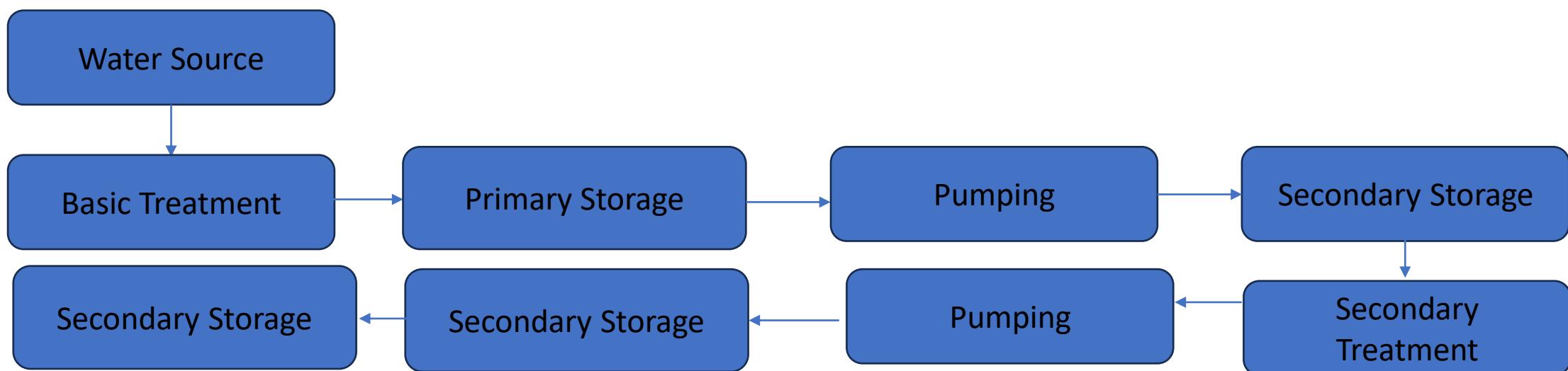
Sl.No.	Name of the unit	Purpose
1.	Intake work including pumping plant	Raw water from the source for treatment
2.	Plain sedimentation	To remove suspended impurities such as silt, clay, sand etc.
3.	Sedimentation with coagulation	To remove the suspended matter
4.	Filtration	To remove microorgans and colloidal matter
5.	Water softening plant	To remove hardness of water
6.	Miscellaneous treatment plants	To remove dissolved gases, tastes and odours.
7.	Disinfection	To remove pathogenic bacteria
8.	Clear water reservoir	To store the treated water
9.	Pumps for pumping the water in service reservoirs	If town or city is situated at higher elevation then pumping is required.
10.	Elevated or underground service reservoir	For distribution of treated water.

In treatment of water the process are

- ❖ Primary Treatment
- ❖ Secondary Treatment
- ❖ Tertiary Treatment

# Water Treatment

- Water from source is treated at village level and also at household level, if needed. If bulk water available from distant source is treated, then further treatment may not be required at village level.
- Water treatment systems are located mainly near dams.
- Basic treatment system involves removal of suspended solids through sedimentation, removal of micro-organisms and colloidal matter through sand/gravel filters, water softening through reverse osmosis (RO) system, disinfection through chlorination and any other chemical/ specialized treatment for removal of fluoride, salinity etc.



# Quality of Water and Specifications

- For drinking water, we need to maintain a good quality standards before taking it as a usage purpose.
- Water quality is tested once before treatment and offer treatment.
- Before treatment water is tested to know extent of Impurities present in water.
- After treatment, once again water is tested to ensure how far treated water meeting the standards.
- Wholesome Water- not chemically pure but does not contain anything harmful to Human body.

## **Impurities present in water:**

Impurities present in water classified based on

### **Size of Impurities**

- i. Suspended Impurities - 100 to 1  $\mu\text{m}$  (Ex- Silt, clay, algae, fungi)
- ii. Colloidal Impurities – 1 to  $10^{-3}\mu\text{m}$  ( neither in suspension nor in solution also they are electrically charged)
- iii. Dissolved Impurities –  $10^{-3}$  to  $10^{-5} \mu\text{m}$  (Salts of calcium , Magnesium & sodium)

# Specifications

- Specification for the quality of water in civil engineering are a set of defined criteria.

**The Indian Standard Specifications for Drinking Water is 10500 - 1983.**

**Some of the specifications include:**

- Colour: 5 to 20 Hazen Units
- Odor: Objectionable
- Taste: Agreeable
- Turbidity: 5-10 NTU ( Nephelometry Turbidity Unit)
- Temperature – 10 to 20°C
- pH Value: 6.5 to 8.5
- Total Hardness: Max. 300 mg/l
- Fluorides: 1 to 1.5 mg/lit
- Iron and Manganese: 0.3 mg/lit and 0.05 mg/lit

## **3. Biological water Impurities:**

- i. Biochemical Oxygen Demand – 30 mg/lit
- ii. Chemical Oxygen Demand- 250 mg/lit
- iii. Total Oxygen Demand

- 1. Purity and Impurities:** Water used in construction, especially for concrete mixing , should be free from impurities, such as excessive amount of suspended, organic matters or harmful chemicals.
- 2. pH Level:** The pH level of water should be within a specific range to avoid adverse reactions with construction materials. Water that is too acidic corrode pipes, damage concrete.
- 3. Chloride and Sulphate Content:** Elevated levels of chloride and sulfate ions in water can lead to the corrosion of reinforcement steel in concrete.
- 4. Temperature:** Water temperature can affect the setting time of concrete and other construction materials. Extreme temperatures, either too hot or too cold, can lead to problems in the curing and strength development of structure.
- 5. Microbiological Quality:** water used in construction should be free from harmful microorganisms and pathogens to ensure the safety of workers and prevent contamination of structure.
- 6. Turbidity and color:** Excessive turbidity or color in water can indicate the presence of particulate matter or dissolved substance.

# Water Storage

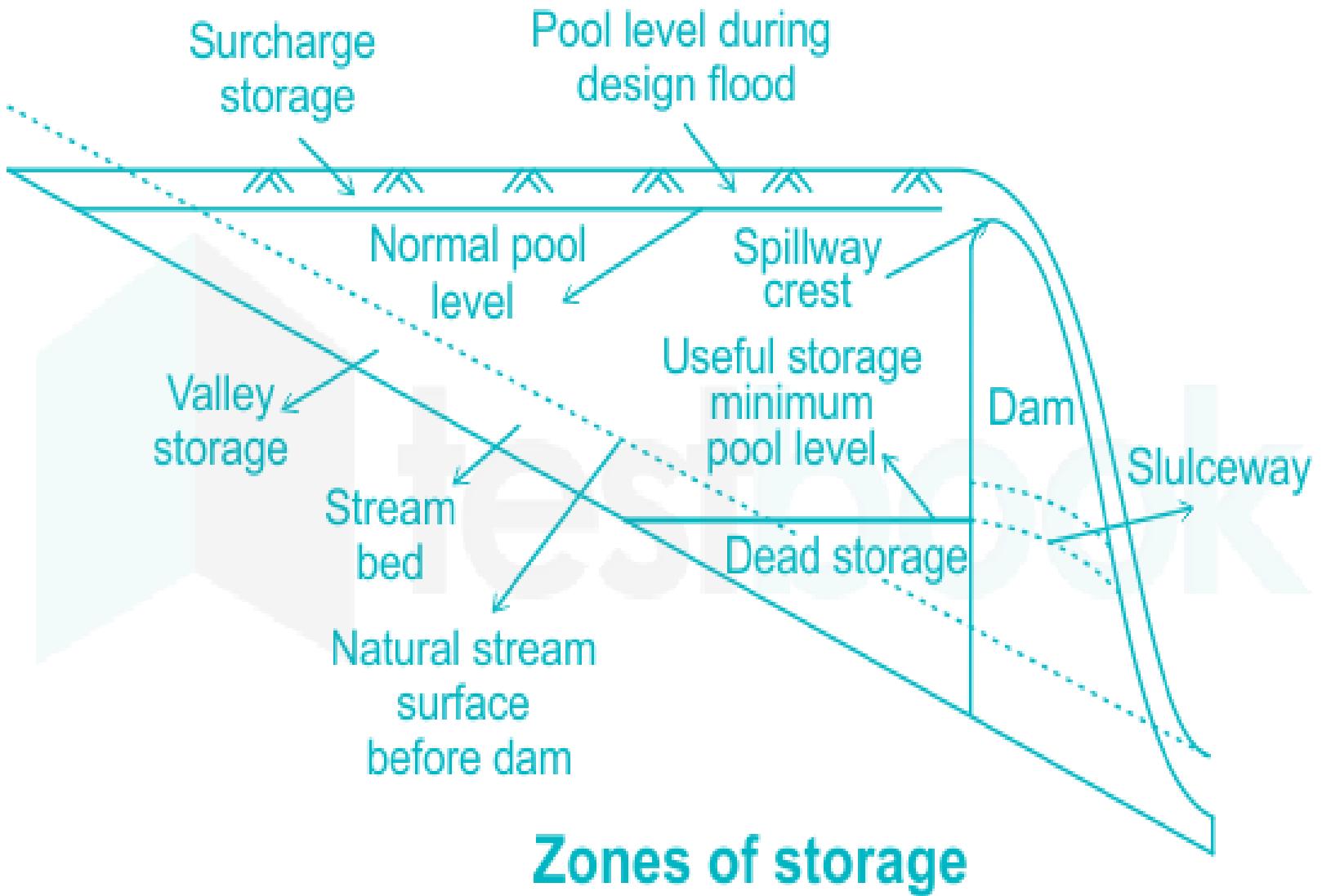
- **Elevated Surface Reservoir or Elevated storage Tank (ESR):** ESR is constructed in places, where water is to be supplied at elevated height or where the distance is large, and topography is uneven. Generally, ESR is at a height of more than 15 m. water can be distributed directly from this storage tank by gravity or pump.
- **Ground Service Reservoir (GSR):** GSR is ground level or plinth level storage tank. The plinth level is generally not more than 3 m.
- **Sump:** Sump is used as an additional storage at village/ town level. It is not used for direct distribution of water. The underground storage tank in circular shape with dome line covering is called sump.

# **Water Storage and Conveyance Structures**

- A Gravity dam is a major Hydraulic structure constructed across reservoirs to store the water for height of 100-200 meters.
- For every dam must be provided with a spillway to spill out the excess water from the reservoirs.

## **Types of Storage levels in Dam:**

- i. Surcharge Storage: Between MFL (Maximum Flood level) and NPL (Normal pool level)
- ii. Live Storage: Between NPL and MPL
- iii. Dead Storage: Between MPL and BL ( Bed Level)
- iv. Valley Storage: Below bed level of Reservoir
- v. Useful Storage: Surcharge Storage + Live Storage
- vi. Useless Storage: Dead Storage + valley Storage + Bank Storage



# Conveyance

- It is the structure at surface water bodies for the safe withdrawal of water over a predetermined pool ranges.
- For collection, storage and deliver or discharge the water is known as wet Intake.
- For collection and deliver or discharge the water is known as dry Intake.

Methods of Conveyance:

1. Gravity Conveyance: ex: Open channel flow
2. Pressure Conveyance: ex: Pipe flow

# Rainwater Harvesting

- Rainwater Harvesting (RWH) is a technique of collection and storage of rainwater into natural reservoirs or tanks or the infiltration of surface water into subsurface aquifers.
- One method of rainwater harvesting is rooftop harvesting.

**The reasons for using rainwater systems are:**

1. To improve water supply, food production, and ultimately food security.
2. To benefit water insurance households or individuals in rural areas.
3. To greatly contribute to income generation owing to food security.

# ROOFTOP RAINWATER HARVESTING

## Components

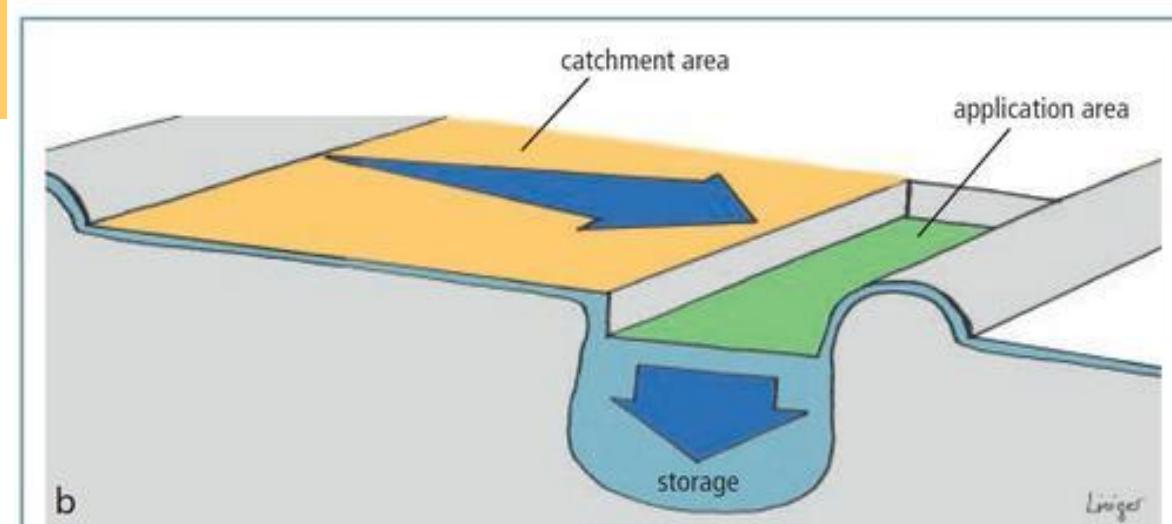
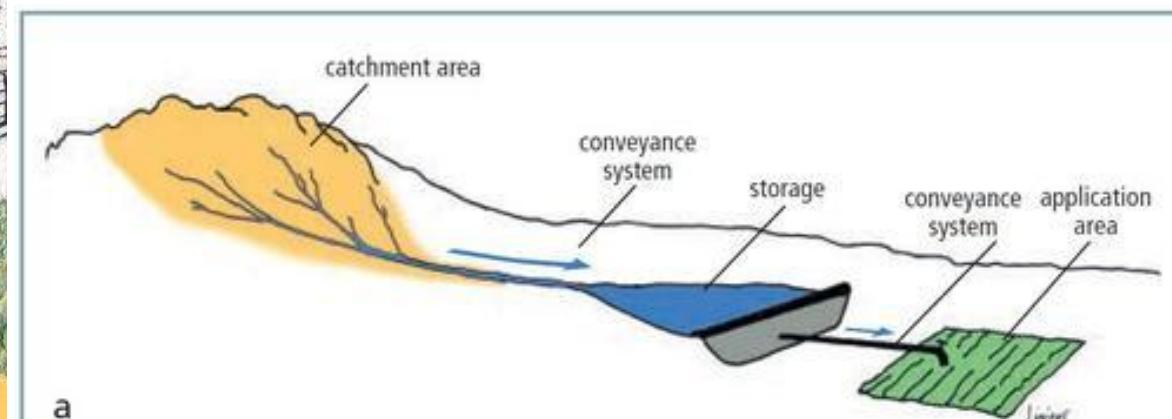
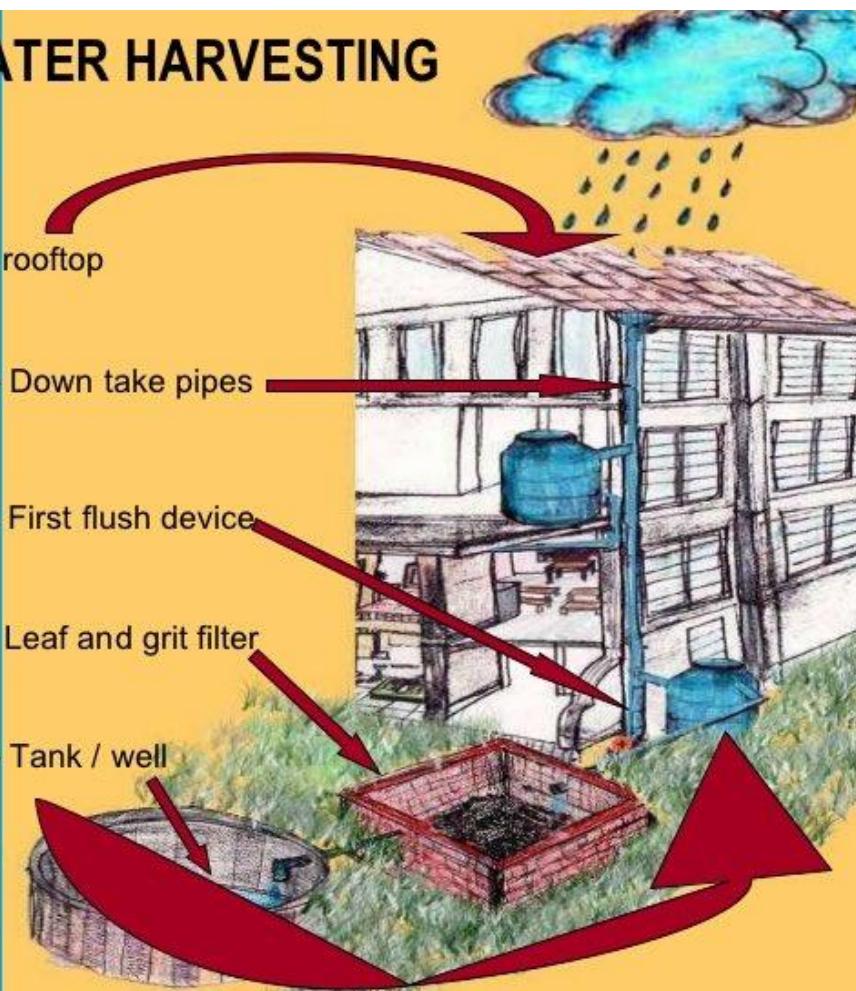
**Catchment** – rooftop

**Transportation** – Down take pipes

**Filters** – First flush device

Leaf and grit filter

**Storage** – Tank / well



# DAMS

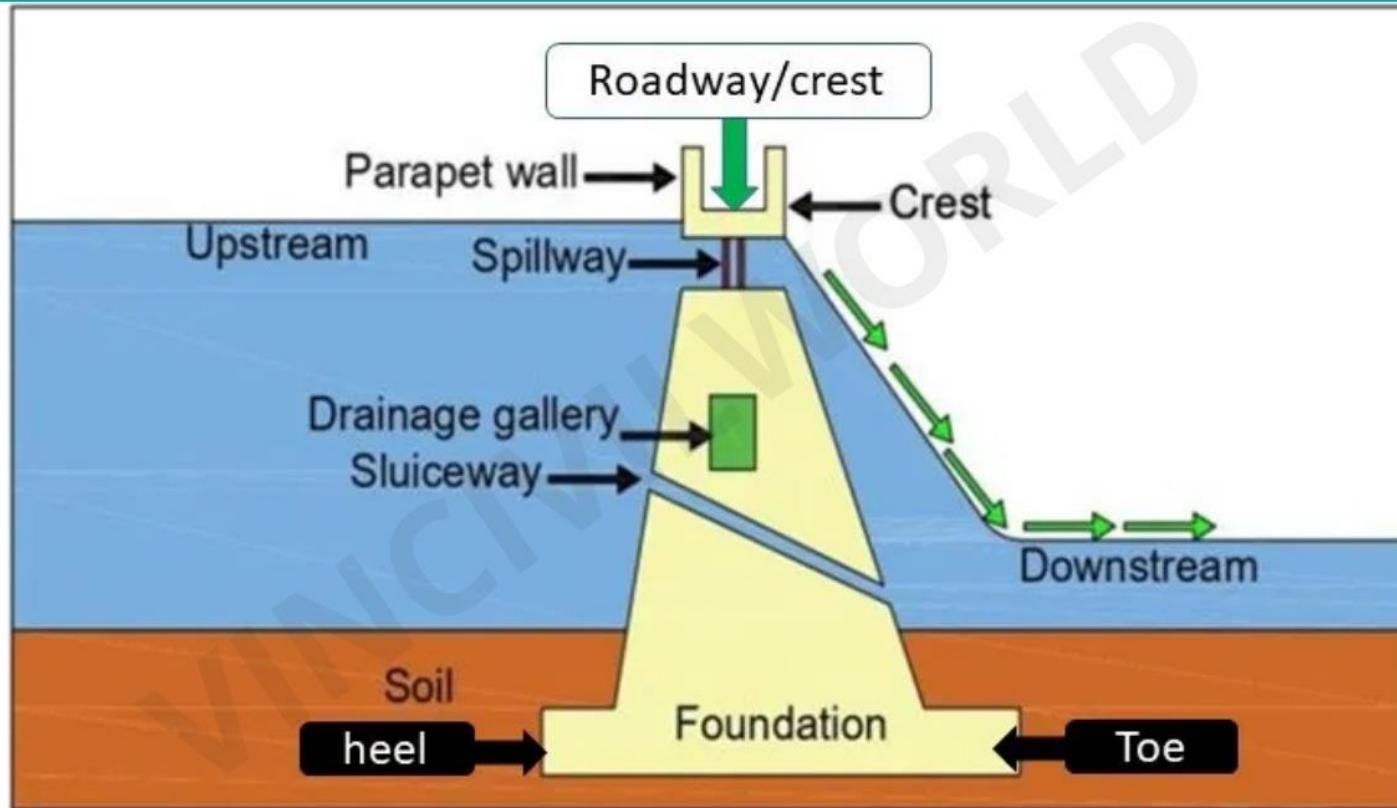
- A dam is a structure that stops the flow of water from a river or stream. A reservoir is the body of water that is created by a dam. Dams are built to store water for various purposes

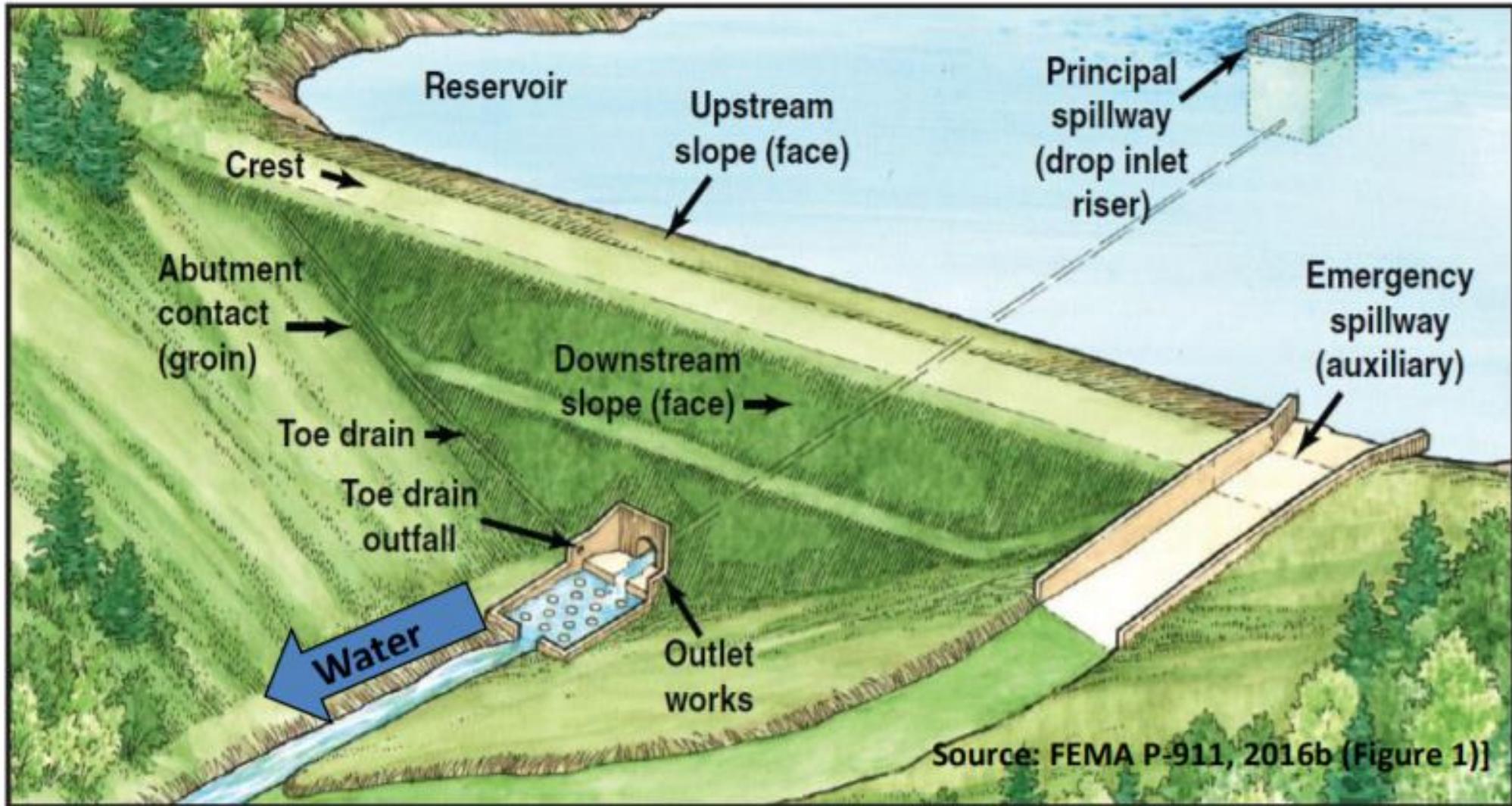
# RESERVOIRS

A reservoir is a large, man-made body of water that stores water. Reservoirs are created by building dams across rivers or lakes. The dam controls the amount of water that flows out of the reservoir.

# Components of a Dam

## COMPONENTS OF DAM





Source: FEMA P-911, 2016b (Figure 1)]

# Difference between Dams and Reservoirs

## Difference Between Dam and Reservoir



### Dam

An artificial wall or hindrance created for restraining water from flowing.

### Reservoir

A water body whose creation follows the formation of a Dam.

Dam is created as a barrier that stops or restricts the flow of water or underground streams. Whereas, Reservoir is an open-air storage area (usually formed by masonry or earthwork) where water is collected and kept in quantity so that it may be drawn off for use.

	<b>Dam</b>	<b>Reservoir</b>
Physical Appearance	Wall constructed across a river or valley	Water accumulating behind the dam
Ecological Impacts	Prevents migration of fish	Causes Displacement of people
Uses of Dams and Reservoirs	Electricity generation	Supply of water for consumption and agriculture
Tourist attraction and transport	It is a tourist attraction site	Facilitates Water Transportation

**THANK  
YOU**

