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## Water Supply Engineering

1. Water Demand
2. Quality Parameters of Water
3. Treatment of Water
4. Distribution, source and Conveyance of Water



**Que. 1**

**Which is the latest Indian standard drinking water specification that is followed?**

(a) IS 10500 : 2012
(b) IS 10500: 2014
(c) IS 10500: 2015
(d) IS 10500: 2016

Que. 1

**Which is the latest Indian standard drinking water specification that is followed?**

**(a) IS 10500 : 2012**

**(b) IS 10500: 2014**

**(c) IS 10500: 2015**

**(d) IS 10500: 2016**



# GOV OF INDIA MANUAL

**MANUAL ON WATER SUPPLY AND TREATMENT**



# GOV OF INDIA MANUAL

TABLE 2.1

RECOMMENDED PER CAPITA WATER SUPPLY LEVELS FOR DESIGNING SCHEMES

| Sl. No. | Classification of towns/cities | Recommended Maximum Water Supply Levels (lpcd) |
|---|---|---|
| 1. | Towns provided with piped water supply but without sewerage system | 70 |
| 2. | Cities provided with piped water supply where sewerage system is existing/contemplated | 135 |
| 3. | Metropolitan and Mega cities provided with piped water supply where sewerage system is existing/ contemplated | 150 |



# GOV OF INDIA MANUAL

*b) Institutional Needs*

The water requirements for institutions should be provided in addition to the provisions indicated in (a) above, where required, if they are of considerable magnitude and not covered in the provisions already made. The individual requirements would be as follows:

| Sl.No. | Institutions | Litres per head per day |
|---|---|---|
| 1. | Hospital (including laundry) | |
| | (a) No. of beds exceeding 100 | 450 (per bed) |
| | (b) No. of beds not exceeding 100 | 340 (per bed) |
| 2. | Hotels | 180(per bed) |
| 3. | Hostels | 135 |
| 4. | Nurses' homes and medical quarters | 135 |
| 5. | Boarding schools / colleges | 135 |
| 6. | Restaurants | 70(per seat) |
| 7. | Air ports and sea ports | 70 |

| Sl.No. | Institutions | Litres per head per day |
|---|---|---|
| 8. | Junction Stations and intermediate stations where mail or express stoppage (both railways and bus stations) is provided | 70 |
| 9. | Terminal stations | 45 |
| 10. | Intermediate stations (excluding mail and express stops) | 45 (could be reduced to 25 where bathing facilities are not provided) |
| 11. | Day schools / colleges | 45 |
| 12. | Offices | 45 |
| 13. | Factories | 45 (could be reduced to 30 where no bathrooms are provided) |
| 14. | Cinema, concert halls and theatre | 15 |



| Industry | Unit of production | Water requirement in Kilolitres per unit |
|---|---|---|
| Automobile | Vehicle | 40 |
| Distillery | (Kilolitre Alcohol) | 122-170 |
| Fertilizer | Tonne | 80-200 |
| Leather | 100 Kg (tanned) | 4 |
| Paper | Tonne | 200-400 |
| Special quality paper | Tonne | 400-1000 |
| Straw board | Tonne | 75-100 |
| Petroleum Refinery | Tonne(crude) | 1-2 |
| Steel | Tonne | 200-250 |
| Sugar | Tonne (Cane crushed) | 1-2 |
| Textile | 100 Kg (goods) | 8-14 |



*a) Physical And Chemical Quality Of Drinking Water*

The physical and chemical quality of drinking water should be in accordance with the recommended guidelines presented in Table 2.2.

TABLE 2.2

RECOMMENDED GUIDELINES FOR PHYSICAL AND CHEMICAL PARAMETERS

| Sl. No. | Characteristics | *Acceptable | **Cause for Rejection |
|---|---|---|---|
| 1. | Turbidity (NTU) | 1 | 10 |
| 2. | Colour (Units on Platinum Cobalt scale) | 5 | 25 |
| 3. | Taste and Odour | Unobjectionable | Objectionable |
| 4. | pH | 7. 0 to 8.5 | <6.5 or > 9.2 |
| 5. | Total dissolved solids (mg/l) | 500 | 2000 |
| 6. | Total hardness (as $CaCO_3$) (mg/l) | 200 | 600 |
| 7. | Chlorides (as Cl ) (mg/l) | 200 | 1000 |
| 8. | Sulphates (as $SO_4$) (mg/l) | 200 | 400 |
| 9. | Fluorides (as F) (mg/l) | 1.0 | 1.5 |
| 10. | Nitrates (as $NO_3$) (mg/l) | 45 | 45 |
| 11. | Calcium (as Ca) (mg/l) | 75 | 200 |
| 12. | Magnesium (as Mg) (mg/l) | ≤ 30 | 150 |



| Sl. No. | Characteristics | *Acceptable | **Cause for Rejection |
|---|---|---|---|
| | If there are 250 mg/l of sulphates, Mg content can be increased to a maximum of 125 mg/l with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates | | |
| 13. | Iron (as Fe) (mg/l) | 0.1 | 1.0 |
| 14. | Manganese (as Mn) (mg/l) | 0.05 | 0.5 |
| 15. | Copper (as Cu) (mg/l) | 0.05 | 1.5 |
| 16. | Aluminium (as Al) (mg/l) | 0.03 | 0.2 |
| 17. | Alkalinity (mg/l) | 200 | 600 |
| 18. | Residual Chlorine (mg/l) | 0.2 | >1.0 |
| 19. | Zinc (as Zn) (mg/l) | 5.0 | 15.0 |
| 20. | Phenolic compounds (as Phenol) (mg/l) | 0.001 | 0.002 |
| 21. | Anionic detergents (mg/l) (as MBAS) | 0.2 | 1.0 |
| 22. | Mineral Oil (mg/l) | 0.01 | 0.03 |

| | | | |
|---|---|---|---|
| | **TOXIC MATERIALS** | | |
| 23. | Arsenic (as As) (mg/l) | 0.01 | 0.05 |
| 24. | Cadmium (as Cd) (mg/l) | 0.01 | 0.01 |
| 25. | Chromium (as hexavalent Cr) (mg/l) | 0.05 | 0.05 |
| 26. | Cyanides (as CN) (mg/l) | 0.05 | 0.05 |
| 27. | Lead (as Pb) (mg/l) | 0.05 | 0.05 |
| 28. | Selenium (as Se) (mg/l) | 0.01 | 0.01 |
| 29. | Mercury (total as Hg) (mg/l) | 0.001 | 0.001 |
| 30. | Polynuclear aromatic hydrocarbons (PAH) (µg/l) | 0. 2 | 0. 2 |
| 31. | Pesticides (total, mg/l) | Absent | Refer to WHO guidelines for drinking water quality Vol 1. – 1993 |
| | **RADIO ACTIVITY+** | | |
| 32. | Gross Alpha activity (Bq/l) | 0.1 | 0.1 |
| 33. | Gross Beta activity (Bq/l) | 1.0 | 1.0 |

NOTES

* The figures indicated under the column 'Acceptable' are the limits upto which water is generally acceptable to the consumers.

acceptable, but still may be tolerated in the absence of an alternative and better source but upto the limits indicated under column "Cause for Rejection" above which the sources will have to be rejected.

\+ It is possible that some mine and spring waters may exceed these radio activity limits and in such cases it is necessary to analyze the individual radio-nuclides in order to assess the acceptability or otherwise for public consumption.





*c) Fire Fighting Demand*

It is usual to provide for fire fighting demand as a coincident draft on the distribution system along with the normal supply to the consumers as assumed. A provision in kilolitres per day based on the formula of $100\sqrt{p}$ where, p = population in thousands may be adopted for communities larger than 50,000. It is desirable that one third of the fire-fighting requirements form part of the service storage. The balance requirement may be distributed in several static tanks at strategic points. These static tanks may be filled from the nearby ponds, streams or canals by water tankers wherever feasible. The high rise buildings should be provided with adequate fire storage from the protected water supply distribution as indicated in 10.3.2.



*b) Bacteriological Guidelines*

The recommended guidelines for bacteriological quality are given in Table 2.3.

TABLE 2.3
BACTERIOLOGICAL QUALITY OF DRINKING WATER[a]

| Organisms | Guideline value |
|---|---|
| **All water intended for drinking** | |
| E.coli or thermotolerant coliform bacteria[b,c] | Must not be detectable in any 100-ml sample |
| **Treated water entering the distribution system** | |
| E.coli or thermotolerant coliform bacteria[b] | Must not be detectable in any 100-ml sample |
| Total coliform bacteria | Must not be detectable in any 100-ml sample |
| **Treated water in the distribution system** | |
| E.coli or thermotolerant coliform bacteria[b] | Must not be detectable in any 100-ml sample |
| Total coliform bacteria | Must not be detectable in any 100-ml sample. In case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12 month period. |

**Source** : WHO guidelines for Drinking Water Quality Vol.1 – 1993.



# Water Supply Engineering

## Chapter 1: Water Demand

- **To design a water supply scheme, we must first estimate the population for which the scheme should be designed.**
- **The scheme once installed must cater for the demand of projected population up to some pre determined future date.**

# Water Supply Engineering

## Design Period:

- A water supply scheme includes huge and costly structures such as reservoirs, dams, pumping units, distribution system, etc. which can not be replaced or increased in their capacities easily.
- Various components are designed such that future needs of the community gets satisfied. This future need is called Design Period.
- The design period should be neither too short nor too long

*As per Government of India Manual (GOI)*

| Sr No | Item | Design period in years |
|---|---|---|
| 1 | Storage by Dam | 50 |
| 2 | Intake works | 30 |
| 3 | Pumping<br>i) Pump house<br>ii) Electric motors and pumps | <br>30<br>15 |
| 4 | Water treatment Units | 15 |
| 5 | Pipe connections to several treatment units and other small appurtenances | 30 |
| 6 | Raw water and clear conveying units | 30 |
| 7 | Clear water reservoirs at the head works, balancing tanks, serive reservoir | 15 |
| 8 | Distribution system | 30 |





**Que. 2**

A town water supply scheme is commonly designed for a population

a) at present year

b) after one decade

c) after two decades

d) after three decades





**Que. 2**

A town water supply scheme is commonly designed for a population

a) at present year

b) after one decade

c) after two decades

**d) after three decades**

| Sr No | Item | Design period in years |
|---|---|---|
| 1 | Storage by Dam | 50 |
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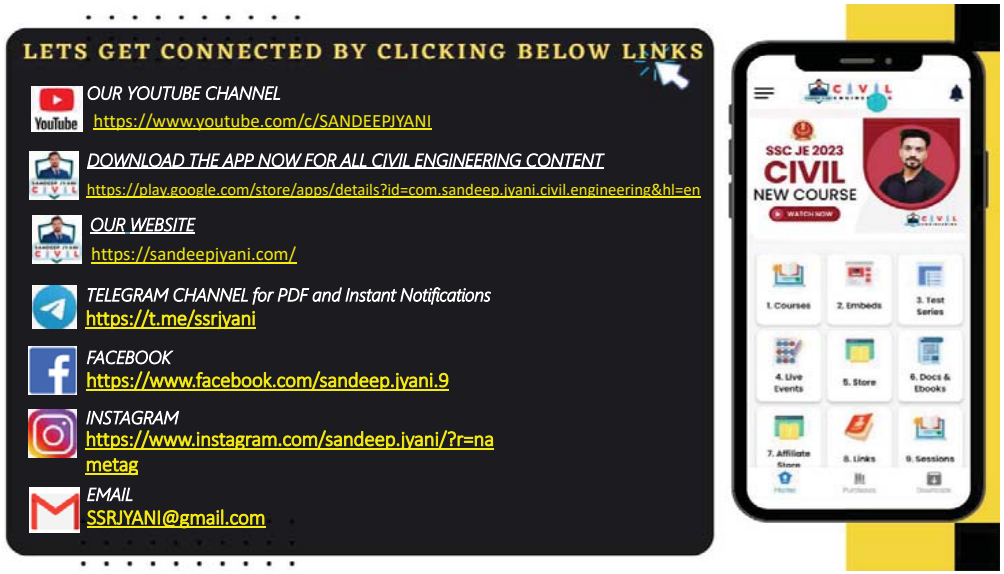
| 6 | Raw water and clear conveying units | 30 |
| 7 | Clear water reservoirs at the head works, balancing tanks, serive reservoir | 15 |
| 8 | Distribution system | 30 |



# Water Demand

## 1. Domestic Water Demand

- Water required in private buildings for drinking, cooking, gardening, etc.
- GOI manual lays down a limit on water consumption between 135 LPCD to 225 (Litre Per Capita per Day)
- Under ordinary conditions, Minimum domestic water requirement for a town with full flushing system should be taken as 200 LPCD
- For low income groups (LIG), demand can be reduced to 135 litres per capita per day



## Environment Engineering II

1. Waste Water Characteristics
2. Biochemical Reactions in waste water
3. Disposal of Sewage Effluents
4. Design of Sewerage system
5. Treatment of Waste water
6. Solid waste management
7. Air and noise pollution

## Some Important Terms

✓ ***DOMESTIC SEWAGE:***

- It is the sewage obtained from the lavatory basins, urinals & water closets of houses, offices & institutions. It is highly foul on account of night soil and urine contained in it. Night soil starts putrefying & gives offensive smell. It may contain large amount of bacteria due to the excremental wastes of patients. This sewage requires great handling &disposal.

✓ ***INDUSTRIAL SEWAGE:***

- It consists of spent water from industries and commercial areas. The degree of foulness depends on the nature of the industry concerned and processes involved.

## Some Important Terms

✓ ***RUBBISH:*** It consists of sundry solid wastes from the residencies, offices and other buildings. Broken furniture, paper, rags etc are included in this term. It is generally dry and combustible.

✓ ***SEWAGE:*** It is a dilute mixture of the wastes of various types from the residential, public and industrial places. It includes waste water and foul discharge from the water closets, urinals, hospitals, stables, etc.

✓ ***SANITARY SEWAGE*** : It is the sewage obtained from the residential buildings & industrial effluents establishments.

## Some Important Terms

- ***REFUSE:*** This is the most general term to indicate the wastes which include all the rejects left as worthless, sewage, sullage etc
- ***GARBAGE:*** It is a dry refuse which includes, waste papers, sweepings from streets and markets, vegetable peelings etc. The quantity of garbage per head per day amounts to be about 0.14 to 0.24 kg for Indian conditions. Garbage contains large amount of organic and putrefying matter and therefore should be removed as quickly as possible.

## ENVIRONMENTAL ENGG-2

PRACTICE QUESTIONS

**Que.**

The term 'Refuse' generally does not include

a) Putrescible solid waste

b) Excreta

c) Non-putrescible solid waste ashes

d) Ashes

**Que.**

The term 'Refuse' generally does not include

a) Putrescible solid waste
b) Excreta
c) Non-putrescible solid waste ashes
d) Ashes



## Some Important Terms

✓ ***STORM WATER***: It is the surface runoff obtained during and after the rainfall which enters sewers through inlet. Storm water is not foul as sewage and hence it can be carried in the open drains and can be disposed off in the natural rivers without any difficulty.

## Some Important Terms

✓ ***SULLAGE***: It is the discharge from the bath rooms, kitchens, wash basins etc., it does not include discharge from the lavatories , hospitals , operation theaters , slaughter houses which has a high organic matter .

## Some Important Terms

✓ ***SEWERS:***

- Sewers are underground pipes which carry the sewage to a point of disposal.

✓ ***SEWERAGE:***

- The entire system of collecting, carrying &disposal of sewage through sewers is known as sewerage.

✓ ***DRY WEATHER FLOW (DWF):***

- Domestic sewage and industrial sewage collectively, is called as DWF. It does not contain storm water. It indicates the normal flow during dry season

## Waste Water Characteristics

- Waste water is usually classified as
  - → Industrial waste water and
  - → Municipal waste water
- Industrial waste water with characteristics compatible with municipal water is often discharged into municipal sewer.
- Many Industrial waste waters require pretreatment to remove non compatible substances prior to discharge into the municipal sewers



Que.

The pH value of fresh sewage usually:

a) less than 7

b) More than 7

c) Equal to 7

d) Zero





Que.

The pH value of fresh sewage usually:

a) less than 7

b) More than 7

c) Equal to 7

d) Zero





Que.

The characteristics of fresh and septic sewage respectively are

a)Acidic and alkaline

b)Alkaline and acidic

c)Both acidic

d)Both alkaline

Que.

The characteristics of fresh and septic sewage respectively are

a)Acidic and alkaline

b)Alkaline and acidic

c)Both acidic

d)Both alkaline

2. pH Value
   - The alkalinity of fresh waste water is alkaline but as time passes it becomes acidic because of the bacterial action in anaerobic processes





Que.

The minimum dissolved oxygen which should always be present in water in order to save the aquatic life is:

a) 1 ppm

b) 4 ppm

c) 10 ppm

d) 40 ppm





Que.

The minimum dissolved oxygen which should always be present in water in order to save the aquatic life is:

a) 1 ppm

b) 4 ppm

c) 10 ppm

d) 40 ppm





Que.

Dissolved oxygen in streams is

a) maximum at noon

b) Minimum at noon

c) Maximum at midnight

d) Same throughout the day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## "OUR SESSIONS"


## SCHEDULE FOR NEW BATCH ON APP

**Important Notice: Schedule of Examinations**

The Commission has decided to conduct the following examinations in the month of October, 2023 as per the schedule given below:

| Sl. No. | Name of Examination | Schedule of Examination |
|---|---|---|
| 1 | Junior Engineer (Civil, Mechanical, Electrical and Quantity Surveying & Contracts) Examination(Paper-I), 2023 | 9th, 10th &11th October, 2023 |
| 2 | Stenographer Grade `C' & `D' Exam, 2023 | 12th & 13th October, 2023 |
| 3 | Junior Hindi Translator, Junior Translator and Senior Hindi Translator Exam, 2023 | 16th October, 2023 |

2. The candidates are advised to visit the website of the Commission at regular intervals for further updates.

Under Secretary (C-II)
17.05.2023

# IRRIGATION

Irrigation is defined as the process of artificial supply of water to soil for raising crops.

It is a science of planning and designing an efficient, low-cost, economic irrigation system tailored to fit natural conditions.

It is the engineering of controlling and harnessing the various natural sources of water, by constructing dams and reservoirs, canals and headworks, and finally distributing the water to the agricultural fields.

Irrigation engineering includes the study and design of works in connection with river control, drainage of waterlogged areas and generation of hydroelectric power.



**Que. 1**

**Irrigation canals are generally aligned along**

**a)Ridge line**

**b)Contour line**

**c)Valley line**

**d)Straight line**

IRRIGATION ENGINEERING

INSTANT PRACTICE QUESTIONS

Que. 1

Irrigation canals are generally aligned along

a) Ridge line

b) Contour line

c) Valley line

d) Straight line



IRRIGATION ENGINEERING

INSTANT PRACTICE QUESTIONS

Que. 2

Which of the following is not a cash crop?

a) Jute

b) Tea

c) Rice

d) Sugarcane

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IRRIGATION ENGINEERING

INSTANT PRACTICE QUESTIONS

Que. 2

Which of the following is not a cash crop?

a) Jute

b) Tea

c) Rice

d) Sugarcane

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IRRIGATION ENGINEERING

INSTANT PRACTICE QUESTIONS

Que. 3

The interval of supply of irrigation water depends on

a) Crop only

b) Soil and crop

c) Crop and climate

d) Soil, crop and climate

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Que. 3

The interval of supply of irrigation water depends on

a) Crop only

b) Soil and crop

c) Crop and climate

d) Soil, crop and climate





Que. 4

A canal, designed to irrigate throughout the year is

a) Permanent canal

b) Perennial Canal

c) Continuous Canal

d) Green Canal





Que. 4

A canal, designed to irrigate throughout the year is

a) Permanent canal

b) Perennial Canal

c) Continuous Canal

d) Green Canal





Que. 5

On rolling land, the method of applying water is

a) Check Flooding

b) Free Flooding

c) Border Flooding

d) Furrow Flooding

Que. 6

On rolling land, the method of applying water is

a) Check Flooding

b) Free Flooding

c) Border Flooding

d) Furrow Flooding





Que. 7

The state of soil when plants fail to extract sufficient water for their requirement

a) Maximum saturated point

b) Permanent wilting point

c) Ultimate Utilization point

d) None of these





Que. 8

The state of soil when plants fail to extract sufficient water for their requirement

a) Maximum saturated point

b) Permanent wilting point

c) Ultimate Utilization point

d) None of these





Que. 9

A sprinkler irrigation system is suitable when

a) Land gradient is steep

b) The soil is having Low permeability

c) Water table is low

d) The crops to be grown have deep roots

# FLUID MECHANICS

CIVIL ENGINEERING BY SANDEEP JYANI

## FLUID MECHANICS

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## Fluid Mechanics

- Fluid Properties
- Manometry
- Hydrostatic Forces
- Buoyancy and Floatation
- Fluid Kinematics
- Fluid Dynamics and Fluid Measurements



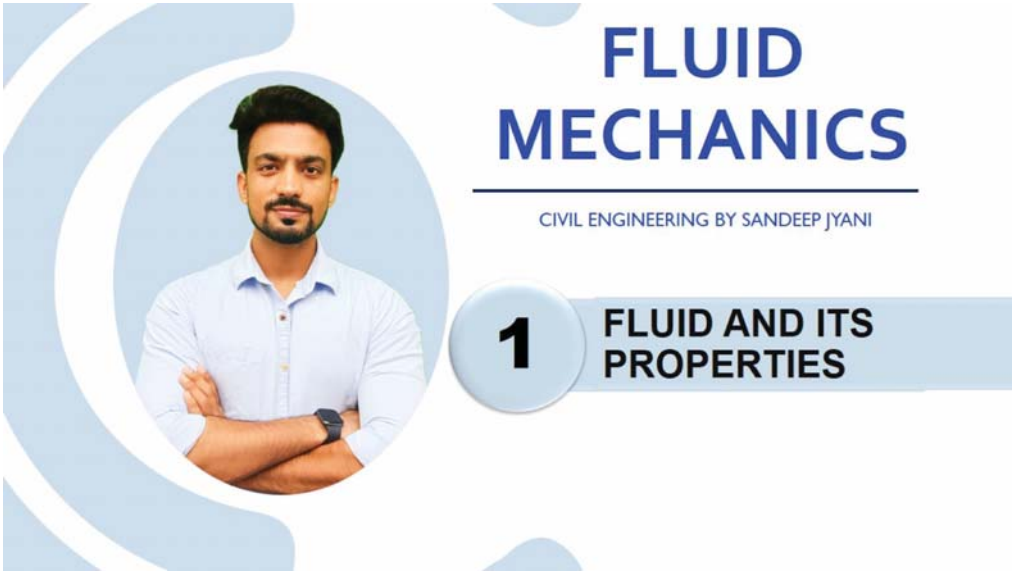
## Fluid Mechanics

- Viscous flow of Incompressible fluid
- Flow through pipes
- Drag and Lift force
- Boundary layer theory
- Turbulent Flow
- Dimensional Analysis and model analysis

## Fluid Mechanics and HM

- Notches and Weirs
- Impact of Jet and Turbines
- Pumps
- Open Channel Flow






## Mechanics

1. Engineering Mechanics
2. Strength of Materials
3. Fluid Mechanics

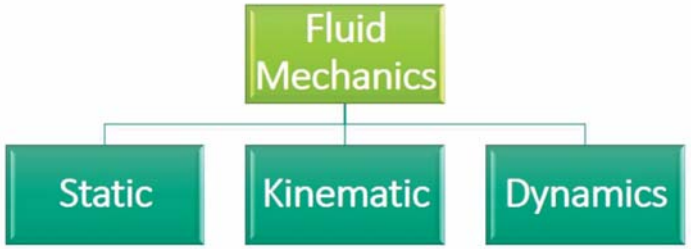
## Mechanics

(Branch of Science which deals with study of Forces and their Effects on bodies)

**1. Engineering Mechanics**
- Branch of Science that deals with study of forces and their effects on **RIGID BODIES**
- Displacement, Velocity, Acceleration, etc

**2. Strength of Materials**
- Branch of Science that deals with study of forces and their effects on **DEFORMABLE BODIES**
- Stress, Strain, etc

**3. Fluid Mechanics**
- Branch of science that deals with study of forces and their effects on **Fluids**
- Flow, continuous deformation, viscosity, etc




# Fluid Mechanics

Branch of science that deals with behavior of fluid(liquid or gases) at rest as well as in motion

**1. Static**

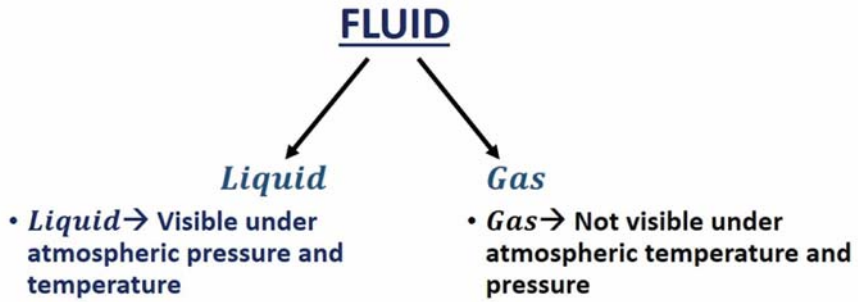
- Study of fluids at rest is called as Fluid Statics

**2. Kinematics**

- Study of Fluids in motion where ***pressure forces are not considered*** is called Fluid Kinematics

**3. Dynamic**

- **Study** of Fluids in motion, where ***pressure forces are also considered*** for the fluids in motion




- ***Liquid*** → **Visible under atmospheric pressure and temperature**
- ***Gas*** → **Not visible under atmospheric temperature and pressure**





**Que. 1**

Fluid is a substance that offers no resistance to change of

a) Pressure

b) Volume

c) Shape

d) Density

**Que. 1**

Fluid is a substance that offers no resistance to change of

a) Pressure

b) Volume

c) Shape

d) Density

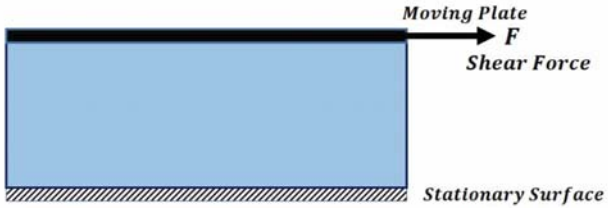


## Some Basic Terms

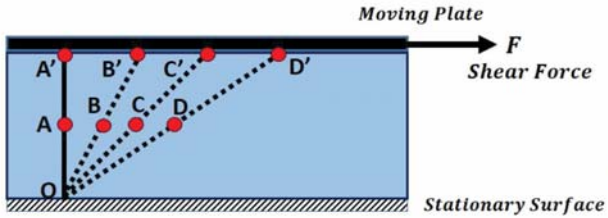
- **FLUID: A fluid is a substance which is capable of flowing under the action of Shear Force**
- **In this connection fluid can also be defined as the state of matter that cannot sustain any shear stress.**
- **However smaller the force may be, i.e. under the action of even small shear force also, the fluid is capable to flow**

## Some Basic Terms

- **FLUID: A fluid is a substance which is capable of flowing under the action of Shear Force**

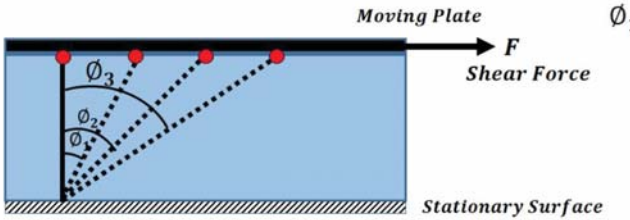



**FLUID: A fluid is a substance which is capable of flowing under the action of Shear Force**




If a shear stress τ is applied at any location in a fluid, the element OAA' which is initially at rest, will move to OBB', then to OCC'. Further, it moves to ODD' and continues to move in a similar fashion.

**FLUID: A fluid is a substance which is capable of flowing under the action of Shear Force**




$\emptyset_1 < \emptyset_2 < \emptyset_3$

$$\tau \propto \frac{d\emptyset}{dt}$$

$\frac{d\emptyset}{dt}$ = continuous deformation is called as Flow.

# UNITS and DIMENSIONS

- All physical quantities are given by a few fundamental quantities or their combinations. The units of such fundamental quantities are called Base Units.
- Combinations of them being called Derived units
- The system in which length, mass and time are adopted as the basic quantities, and from which the units of other quantities are derived, is called the Absolute System of Units

# Absolute System of Units

1. MKS system of units
   - This is the system of units where
     - metre (m) is used for the unit of length,
     - kilogram (kg) for the unit of mass, and
     - second (s) for the unit of time as the base units
2. CGS system of units
   - This is the system of units where
     - Centimetre (cm) is used for length,
     - Gram (g) for mass, and
     - second (s) for time as the base units.
3. International system of units (SI)

# Absolute System of Units

3. International system of units (SI)
   - Important fundamental SI units:
     - metre (m) for length,
     - kilogram (kg) for mass,
     - second (s) for time,
     - ampere (A) for electric current,
     - kelvin (K) for thermodynamic temperature,
     - mole (mol) for mass quantity and
     - candela (cd) for intensity of light.
   - Derived units consist of these units.


## PRINCIPAL PROPERTIES OF BUILDING MATERIALS

### 1. Density

- It is mass of unit volume of homogenous material

$$\rho = \frac{m}{V}\ (\frac{kg}{m^3})$$

| Material | Density (g/cm³) |
|---|---|
| Brick | 2.5-2.8 |
| Granite | 2.6-2.9 |
| Wood | 1.5-1.6 |
| Steel | 7.8-7.9 |

## PRINCIPAL PROPERTIES OF BUILDING MATERIALS

### 2. Bulk Density

- It is the mass of a unit volume of material in its natural state (with pores and voids) calculated as

$$\rho_b = \frac{M}{V}\ (\frac{kg}{m^3})$$

| Material | Density (kg/m³) |
|---|---|
| Brick | 1600-1800 |
| Granite | 2500-2700 |
| Sand | 1450-1650 |
| Pine Wood | 500-600 |
| Steel | 7850 |

## PRINCIPAL PROPERTIES OF BUILDING MATERIALS

### 3. TRUE/ABSOLUTE SPECIFIC GRAVITY

- Specific Gravity of solid particles of a material is the ratio of weight/mass of a given volume of solids to the weight/mass of an equal volume of water at 4° C.

$$G_S = \frac{\gamma_s}{\gamma_w}$$

- At 4° C , $\gamma_w$ = 1 g/cc or 9.8 kN/m3
- The absolute specific gravity is not much of practical use.

### 4. APPARENT/MASS SPECIFIC GRAVITY

- If both the permeable and impermeable voids are included to determine the true volume of solids, the specific gravity is called apparent specific gravity.

$$G_M = \frac{\gamma_{bulk}}{\gamma_w}$$

# PRINCIPAL PROPERTIES OF BUILDING MATERIALS

## 5. POROSITY

- Porosity is the degree to which volume of the material of the material is interspersed with pores. It is expressed as a ratio of the volume of pores to that of the specimen.
- Porosity is indicative of other major properties of material, such as bulk density, heat conductivity, durability, etc

$$\eta = \frac{V_V}{V}$$

## 6. VOID RATIO

- It is the ratio of volume of voids to volume of solids

$$\eta = \frac{V_V}{V_s}$$

# PRINCIPAL PROPERTIES OF BUILDING MATERIALS

## 5. HYGROSCOPICITY

- It is the property of a material to absorb water vapour from air. It is influenced by air-temperature and relative humidity; pores—their types, number and size, and by the nature of substance involved.

## 6. Water Absorption

- The ratio of the mass of water present to the mass of solid particles is called the water content ($w$), or sometimes the moisture content.

## 7. Weathering Resistance

- It is the ability of a material to endure alternate wet and dry conditions for a long period without considerable deformation and loss of mechanical strength.

# PRINCIPAL PROPERTIES OF BUILDING MATERIALS

## 10.FROST RESISTANCE

- It denotes the ability of a water-saturated material to endure repeated freezing and thawing with considerable decrease of mechanical strength. Under such conditions the water contained by the pores increases in volume even up to 9 per cent on freezing. Thus the walls of the pores experience considerable stresses and may even fail.

## 11.HEAT CONDUCTANCE

- It is the ability of a material to conduct heat. It is influenced by nature of material, its structure, porosity, character of pores and mean temperature at which heat exchange takes place. Materials with large size pores have high heat conductivity because the air inside the pores enhances heat transfer. Moist materials have a higher heat conductivity than drier ones.

# PRINCIPAL PROPERTIES OF BUILDING MATERIALS

## 12.REFRACTORINESS

- It is the ability of a material to withstand prolonged action of high temperature without melting or losing shape. Materials resisting prolonged temperatures of 1580° C or more are known as refractory.
- High-melting materials can withstand temperature from 1350–1580° C, whereas low-melting materials withstand temperature below 1350° C.

## 13. DURABILITY

- It is the ability of a material to resist the combined effects of atmospheric and other factors

# CEMENT

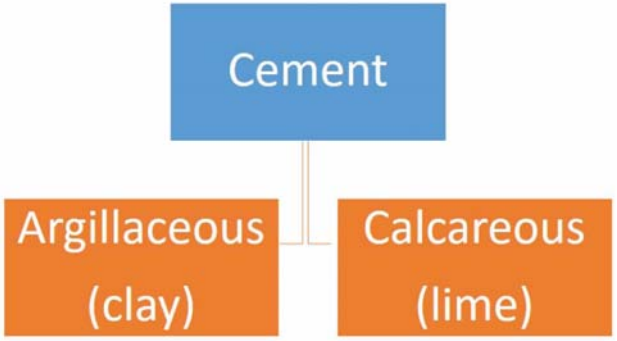




# CEMENT

- Cements in a general sense are adhesive and cohesive materials which are capable of bonding together particles of solid matter into a compact durable mass
- Its primary function being to bind the fine (sand) and coarse (grits) aggregate particles together.
- Joseph Aspedin of was the first to introduce Portland cement in 1824 formed by heating a mixture of limestone and finely divided clay in a furnace to a temperature

# Cement




# Constituents of Cement

| | |
|---|---|
| Lime (CaO) | • 62-65% |
| Silica ($SiO_2$) | • 17-25% |
| Alumina ($Al_2O_3$) | • 3-8% |
| Gypsum ($CaSO_4$) | • 3-4 % |
| Iron Oxide ($Fe_2O_3$) | • 3-4% |
| Magnesia (MgO) | • 1-3% |
| Sulphur (S) | • 1-3% |
| Alkalies ($K_2O$, $N_2O$) | • 0.2-1 |

*MAJOR*

## Functions of Different Constituents of Cement

1. **Lime (62-65%)**
   - **Imparts strength and Soundness (volume)**
   - **Excess- it becomes difficult to combine with other compounds, free lime will be present in clinkers which makes cement unsound, causes it to expand & disintegrate**
   - **Deficiency- reduces strength of cement, causes it to set quickly**
2. Silica(17-25%)
   - Imparts Strength to Cement
   - Excess- increases strength of cement BUT increases setting time of cement

## Functions of Different Constituents of Cement

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2. **Silica(17-25%)**
   - **Imparts Strength to Cement**
   - **Excess- increases strength of cement BUT increases setting time of cement**
3. **Alumina (3-8%)**
   - **Imparts quick setting property**
   - **Reduces clinkering temperature, if it is in excess weakens the cement**

## Functions of Different Constituents of Cement

4. **Gypsum (3-4%)**
   - **Present in form of calcium sulphate**
   - **Used to increase initial setting time of cement**
5. Iron Oxide (3-4%)
   - Imparts Colour, Strength and hardness to cement
   - It induces reddish brown tint to the cement
6. Magnesia (1-3%)
   - Imparts Strength and colour to cement (yellowish tint)
   - Excess- makes cement unsound

## Functions of Different Constituents of Cement

4. **Gypsum (3-4%)**
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5. Iron Oxide (3-4%)
   - Imparts Colour, Strength and hardness to cement
   - It induces reddish brown tint to the cement
   - *It helps highly silicious raw materials to burn*
6. Magnesia (1-3%)
   - Imparts Strength and colour to cement (yellowish tint)
   - Excess- makes cement unsound

## Functions of Different Constituents of Cement

7. **Sulphur (1-3%)**
   - **It is also responsible for imparting soundness**

   **Note: Soundness due to lime and Magnesia can be measured directly but *no test is available to measure soundness due to sulphur***
8. Alkalies (0.2-1%)
   - Presence of alkalies causes **efflorescence** and staining of structure
   - Alkalies react with water and white grey spots are formed
   - *Alkalies **accelerate setting** of cement paste*

## Bougues Compounds/Composition of Cement Clinker

- **Various constituents combine in burning and form cement clinker. The compounds formed in the burning process have properties of setting and hardening in presence of water**

1. TriCalcium Aluminate (Celite)
2. TetraCalcium Alumino Ferrite (Felite)
3. TriCalcium Silicate (Alite)
4. DiCalcium Silicate (Belite)

They are known as Bogue compounds after the name of Bogue who identified them. Le-Chatelier and Tornebohm have referred these compounds as Alite (C3S), Belite (C2S), Celite (C3A) and Felite (C4AF).

## Bougues Compounds

1. **TriCalcium Aluminate ($C_3A$ or $3CaO.Al_2O_3$)**
   - **4-14% by weight**
   - **Formed within 24 hours of addition of water in cement**
   - **Responsible for maximum amount of heat of hydration**
   - **It is responsible for initial set, higher heat of hydration and greater tendency to volume changes**



## Bougues Compounds

2. **TetraCalcium Alumino Ferrate ($C_4AF$ or $4CaO.Al_2O_3.Fe_2O_3$)**
   - **10-18% by weight**
   - **It is also formed within 24 hours of addition of water to cement**
   - **Amount of heat of hydration evolved during formation of this compound initially is comparatively more which goes on decreasing with time**
   - **It is also responsible for flash set but generates less heat**


## WHAT IS SOIL ?

- For a Civil Engineer, soil means all natural occurring, relatively unconsolidated earth material- organic or inorganic in character that lies above the bed rock

## SOIL MECHANICS

- Soil Mechanics is the branch of science that deals with the application of principles of mechanics, hydraulics and some chemistry to engineering problems related to soils

## Soil Engineering/ Geotechnical Engineering

- Soil Engineering includes soil mechanics, geology, structural engineering, soil dynamics and disciplines related to obtain solutions of practical soil problems.
- Geotechnical Engineering includes Soil Mechanics, Rock mechanics, soil engineering, rock engineering

## Role of Soil Mechanics in Civil Engineering

- It is ultimate foundation material that supports the structure
- It is the most abundant building material
- Soil structure interaction needs to be studied for excavation, Earth retaining structures, etc
- Soil behaviour with respect to vibrations

## Is it simple to study SOIL?

## History of Soil Mechanics

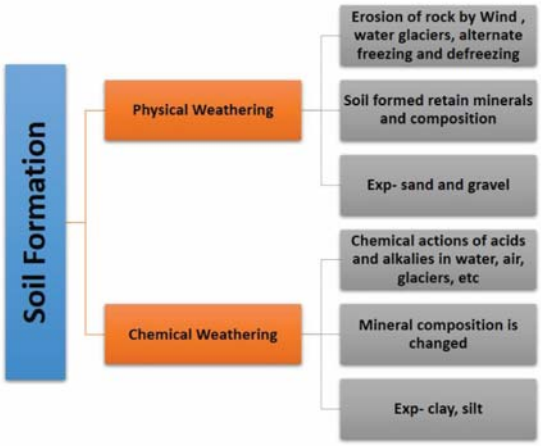
- Modern discipline of soil mechanics began in 1925 by Karl Terzaghi
- Karl Terzaghi is known as FATHER OF SOIL MECHANICS
- He wrote a book Erdbaumechanik

## Origin of Soil and soil water relationships

- Soil is composed of particles found from the disintegration of rocks.

Soil = Rock + Organic Matter

- Formation of Soil takes place by two methods:
  1. Physical Weathering
     - The agencies responsible for physical weathering are the impact and grinding action of flowing water, ice, wind and splitting actions of ice, plants and animals
  2. Chemical Weathering
     - Chemical weathering or decomposition of rocks is caused mainly by oxidation, hydration, carbonation and leaching by organic_ acids and water






# Soil Deposits

- ***Residual Soils*:** Located at location of formation
- ***Transported Soil:*** Transported from parent location to a new location
  - **Alluvial deposits:** deposited by river
  - **Lacustrine deposit:** deposited by still water of lakes
  - **Marine deposit:** deposited by sea Water, exp Marl Clay
  - **Aeolian deposit:** deposited by wind , example: Loess
  - **Glacial deposit:** deposited by glaciers , example: drift, till
  - **Colluvial deposit:** transported by Gravity exp: Talus

# Some important Soils

- **Bentonite clay:**
  - Has high percentage of montmorillonite
  - Highly plastic, high swelling and shrinkage
  - Formed due to volcanic ash, used as drilling mud
- **Black cotton soil:**
  - Contains high percentage of montmorillonite
  - Has high swelling and shrinkage potential
  - Has very low bearing capacity
  - Formed from chemical weathering of basalt

# Some important Soils

- **Loam:** mixture of sand silt and clay, known as Garden soil
- **Indurated clay:** hardening of clay due to heat and pressure
- **Organic clays:** soil gets mixed with decomposed vegetation and dead and decayed matter
  - **Muck:** inorganic + organic matter
  - **Peat:** fully decomposed organic matter, highly compressible
  - **Humus:** Top soil, it contains partly decomposed organic material

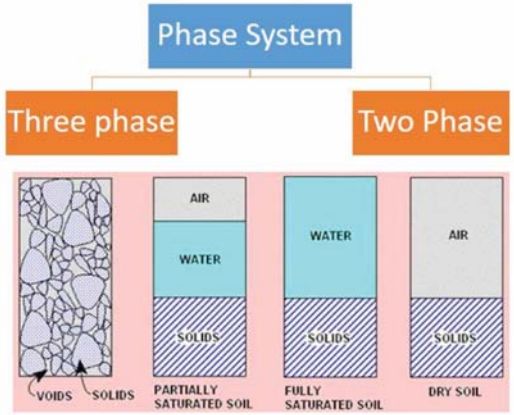
# Some important Soils

- **Loess:** A loose deposit of wind-blown silt that has been weakly cemented with calcium carbonate and montmorillonite. Loess is formed in arid and semi-arid regions and stands in nearly vertical banks.
- **Tuff:** A small-grained, slightly cemented volcanic ash that has been transported by wind ,or water
- **Glacial till (boulder clay):** a mixture of boulders, gravel, sand, silt and clay, deposited by glaciers and not transported or segregated by water.
- **Varved clay:** Alternate thin layers of silt and clay deposited in fresh water glacial lakes by outwash from glaciers. The silt is· deposited in warm weather during heavy run off and clay is deposited in cold weather during small run off. Generally, one band of silt and clay is deposited each year.

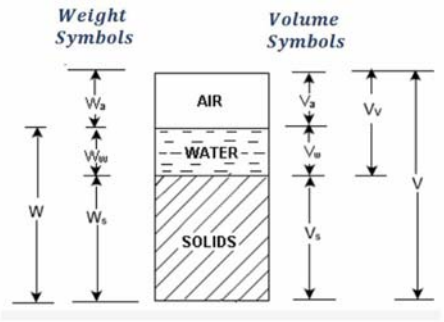
# Some important Soils

- **Gumbo:** A sticky, plastic, dark coloured clay
- **Hard Pan:** A layer of extremely hard, cohesive soil that can hardly be drilled with ordinary, earth boring tools.
- **Colluvial Soil:** The accumulation of rock debris or talus at the base of a steep cliff or a rock escarpment. Its position results mainly from the effect of the force of gravity acting on the rock fragments broken from the rocks above.
- **Mine Tailings:** These are silt-sized materials resulting as waste after extraction of minerals from natural rock.

# Soil Water Relationships




# Soil Water Relationships



# Soil Water Relationships

1. *Void ratio (e)* is the ratio of the volume of voids ($V_v$) to the volume of soil solids ($V_s$)

$$e = \frac{V_V}{V_S} \qquad e = \frac{n}{1-n}$$

2. *Porosity (n)* is the ratio of the volume of voids to the total volume of soil (V )

$$n = \frac{V_V}{V} \qquad n = \frac{e}{1+e}$$

3. *Degree of saturation (S)* The volume of water (Vw) in a soil can vary between zero (i.e. a dry soil) and the volume of voids. This can be expressed as the degree of saturation (S) in percentage.

$$s = \frac{V_w}{V_V}$$

# Soil Water Relationships

4. *Air content ($a_c$)* is the ratio of the volume of air ($V_a$) to the volume of voids.

$$a_c = \frac{V_a}{V_V}$$

5. *Percentage air voids ($n_a$)* is the ratio of the volume of air to the total volume.

$$n_a = \frac{V_a}{V} \qquad n_a = n \times a_c$$

6. *Water content (w):* The ratio of the mass of water present to the mass of solid particles is called the water content ($w$), or sometimes the moisture content. Its value is 0% for dry soil and its magnitude can exceed 100%

$$w = \frac{W_w}{W_s}$$

# Soil Water Relationships

7. *True Specific Gravity (Gs)*:

$$G_s = \frac{\gamma_s}{\gamma_w}$$

8. *Mass Specific Gravity (Gm)*:

$$G_m = \frac{\gamma_t}{\gamma_w}$$

- $G_s = \begin{cases} 2.6 - 2.7 \; for \; Inorganic \; soils \\ 1.2 - 1.4 \; for \; Organic \; Soil \end{cases}$

# Soil Water Relationships

10. *Relative Density:*

$$I_D = \frac{e_{max} - e}{e_{max} - e_{min}}$$

10. *Relative Compaction*

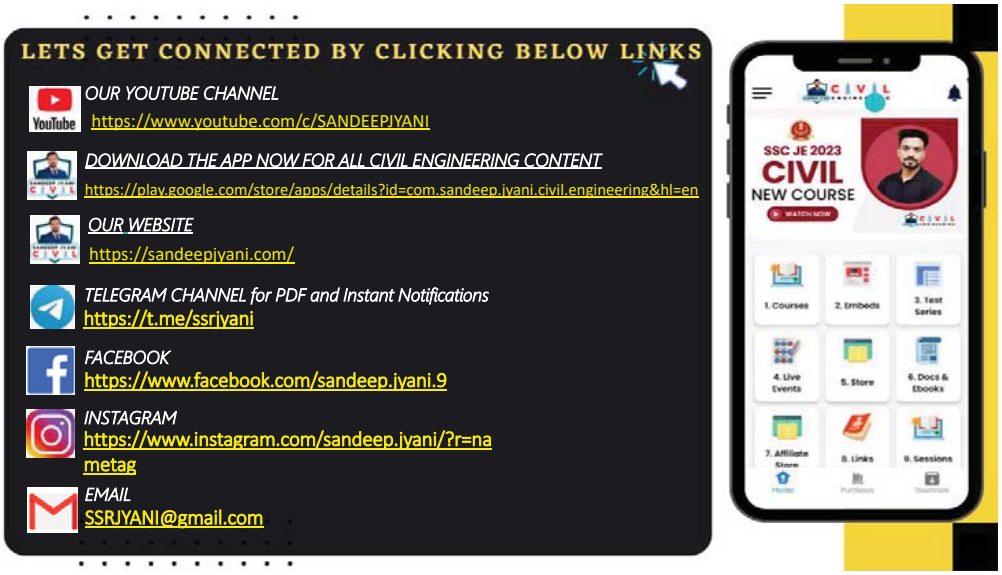
$$R_c = \frac{\gamma_d}{\gamma_{d\,max}}$$

$$= \frac{\frac{G\gamma_w}{1+e}}{\frac{G\gamma_w}{1+e_{min}}}$$

$$\Rightarrow R_c = \frac{1+e_{min}}{1+e}$$

And $R_c = 80 + 0.2\,RD$

| Relative Density | Classification |
|---|---|
| <15 | Very loose |
| 15-35 | Loose |
| 35-65 | Medium |
| 65-85 | Dense |
| >85 | Very Dense |



## Concrete Technology Syllabus

- Properties, Advantages and uses of concrete
- Cement aggregates
- Importance of water quality, water cement ratio, workability
- Mix design, storage, batching, mixing, placement, compaction, finishing and curing of concrete
- Quality control of concrete
- Hot weather and cold weather concreting
- Repair and maintenance of concrete structures

## What is Concrete ?

- Concrete is a manmade building material that looks like stone.
- The word "concrete" is derived from the Latin concretus, meaning "to grow together."
- CONCRETE = FILLER + BINDER



## Depending on what kind of binder is used

- Hydraulic cement concrete
- Non-hydraulic cement concrete
- Asphalt concrete
- Polymer concrete



## CHARACTERISTICS OF CONCRETE

- Economical
- Ambient temperature hardened material
- Ability to be cast
- Excellent resistance to water
- High-temperature resistance
  - calcium silicate hydrate (C–S–H), will not be completely dehydrated until 910°C
- Ability to consume waste
  - GGBFS = ground granulated blast-furnaces slag), waste glass, and ground vehicle tires in concrete

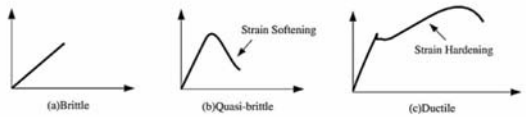


## CHARACTERISTICS OF CONCRETE

- Ability to work with reinforcing steel
- Less maintenance required

## Limitations

- Quasi-brittle failure mode




- Low tensile strength
- Low toughness (1/50 to 1/100 of that of steel)
- Low specific strength (strength/density ratio):



## Limitations

- Formwork is needed
- Long curing time
- Cracks



## Classification of concrete in accordance with unit weight

| Classification | Unit Weight (Kg/m3) |
|---|---|
| Ultra-lightweight concrete | <1200 |
| Lightweight concrete | 1200 - 1800 |
| Normal-weight concrete | 2400 |
| Heavyweight concrete | >3200 |



## Classification in accordance with compressive strength

## Grades of Concrete

*IS 456: 2000 is REFERRED ONLY UPTO M60 grade of concrete*

| Group | Designation | Characteristic Compressive Strength OF 150mm cube at 28 days ($N/mm^2$) |
|---|---|---|
| Ordinary Concrete | M10 | 10 |
| | M15 | 15 |
| | M20 | 20 |
| Standard Concrete | M25 | 25 |
| | M30 | 30 |
| | M35 | 35 |
| | M40 | 40 |
| | M45 | 45 |
| | M50 | 50 |
| | M55 | 55 |
| | M60 | 60 |
| High Strength Concrete | M65 | 65 |
| | M70 | 70 |
| | M75 | 75 |
| | M80 | 80 |
| | M85 | 85 |
| | M90 | 90 |
| | M95 | 95 |
| | M100 | 100 |



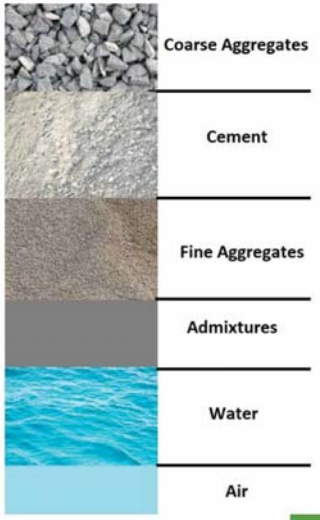
## Concrete classifications in accordance with additives

| Classification | Additives |
|---|---|
| MDF | Polymers |
| Fiber-reinforced concrete | Different fibers |
| DSP concrete | Large amount silica fume |
| Polymer concrete | Polymers |



## MATERIALS FOR MAKING CONCRETE

**CONCRETE a mixture of Cement, sand aggregate and water in a limited proportion**






## Materials for Concrete: *CEMENT*

**5.1 Cement**

The cement used shall be any of the following and the type selected should be appropriate for the intended use:

a) 33 Grade ordinary Portland cement conforming to IS 269
b) 43 Grade ordinary Portland cement conforming to IS 8112
c) 53 Grade ordinary Portland cement conforming to IS 12269
d) Rapid hardening Portland cement conforming to IS 8041
e) Portland slag cement conforming to IS 455
f) Portland pozzolana cement (fly ash based) conforming to IS 1489 (Part 1)
g) Portland pozzolana cement (calcined clay based) conforming to IS 1489 (Part 2)
h) Hydrophobic cement conforming to IS 8043
j) Low heat Portland cement conforming to IS 12600
k) Sulphate resisting Portland cement conforming to IS 12330

*Pozzolans* are silicate-based materials which while **in itself has little or no cementious property** but they react with (consume) the calcium hydroxide generated by hydrating cement to form additional cementitious materials.

**5.2.1.4** ***Metakaoline***

**Metakaoline having fineness between 700 to 900 $m^2/kg$ may be used as pozzolanic material in concrete.**

**NOTE—Metakaoline is obtained by calcination of pure or refined kaolintic clay at a temperature between 650°C and 850°C, followed by grinding to achieve a fineness of 700 to 900 $m^2/kg$. The resulting material has high pozzolanicity.**

**Amendment No. 5 to IS 456 : 2000**

'5.2.1.4 *Metakaolin*

Metakaolin conforming to IS 16354 may be used as part replacement of ordinary Portland cement.'

## MATERIALS FOR MAKING CONCRETE : WATER

- Water with pH 6 to 8 should be used
- It should be free from impurities
- Excessive impurities may affect setting time, strength, durability and may cause efflorescence, surface discoloration, and corrosion of stee



## Materials for Concrete: Water



**Table 1 Permissible Limit for Solids**
*(Clause 5.4)*

| Sl No. | | Tested as per | Permissible Limit, Max |
|---|---|---|---|
| i) | Organic | IS 3025 (Part 18) | 200 mg/l |
| ii) | Inorganic | IS 3025 (Part 18) | 3 000 mg/l |
| iii) | Sulphates (as $SO_4$) | IS 3025 (Part 24) | 400 mg/l |
| iv) | Chlorides (as Cl) | IS 3025 (Part 32) | 2 000 mg/l for concrete not containing embedded steel and 500 mg/l for reinforced concrete work |
| v) | Suspended matter | IS 3025 (Part 17) | 2 000 mg/l |

**5.4.2 The *p*H value of water shall be not less than 6.**



## Impurities in Water

- Suspended Particles
  - Water containing more than 2000 ppm (parts per million) of dissolved solids affects certain cements adversely.
- Inorganic Salts:
  - The presence of salts of zinc, manganese, tin, copper and lead considerably reduce the concrete strength.
  - Sodium phosphate, sodium borate and sodium iodate act as retarders and cause a marked reduction in the strength of concrete.
  - Zinc chloride retards the set of concrete and the 3-day strength test cannot be performed.
  - The presence of *calcium chloride accelerates setting* and hardening of cement. *Carbonates of sodium and potassium cause a rapid setting* and may reduce the concrete strength.



## Impurities in Water

- Sugar
  - Sugar up to *0.05* per cent by weight of water is *harmless*.
  - Sugar up to *0.15* per cent by weight of cement *retard the setting time*, reduce the early strength and increase the 28 day strength
- Oils
  - Mineral oil (petroleum has less effect on development of strength than other oils.
  - Vegetable oils have detrimental effect on concrete strength particularly at later ages
- Algae
  - Algae, present in mixing water or on the surface of aggregate either reduces bond by combining with the cement or reduces strength by entraining a large amount of air in the concrete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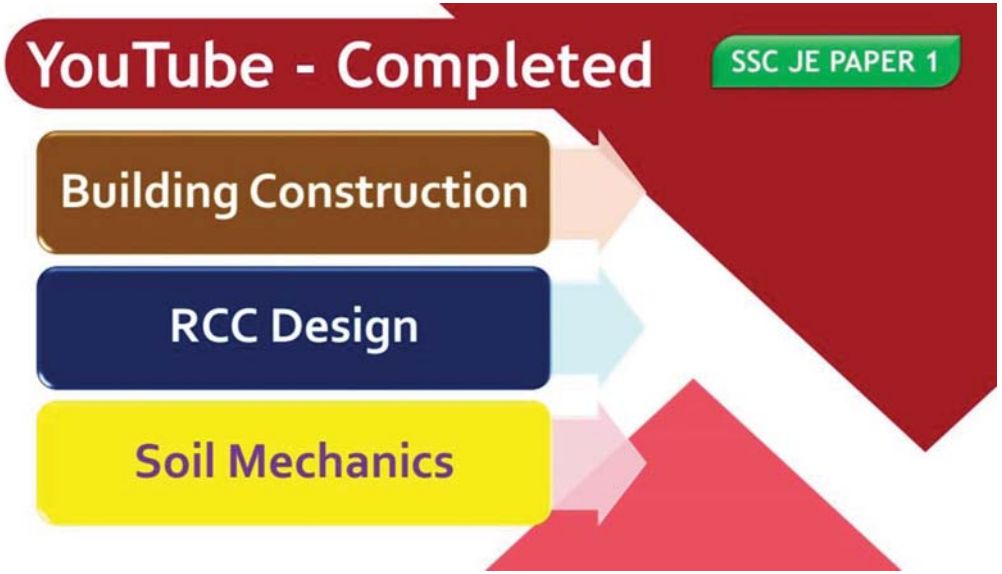


# Week 2 : YouTube

SSC JE PAPER 1

| | |
|---|---|
| Live Test 3 | Monday, 4 September, 2023 |
| Strength of Materials | Tuesday, 5 September, 2023 |
| Live Test 4 | Wednesday, 6 September, 2023 |
| Concrete Technology | Thursday, 7 September, 2023 |
| Steel Design | Friday, 8 September, 2023 |
| Live Test 5 | Saturday, 9 September, 2023 |

# Week 3 : YouTube

SSC JE PAPER 1

| | |
|---|---|
| Environmental Engineering 1 | Tuesday, 12 September, 2023 |
| Environmental Engineering 2 | Wednesday, 13 September, 2023 |
| Live Test 6 | Thursday, 14 September, 2023 |
| Hydraulics | Friday, 15 September, 2023 |

# Week 4 : YouTube

SSC JE PAPER 1

| | |
|---|---|
| Live Test 7 | Monday, 18 September, 2023 |
| Traffic Engineering | Tuesday, 19 September, 2023 |
| Railway Engineering | Wednesday, 20 September, 2023 |
| Live Test 8 | Thursday, 21 September, 2023 |
| Highway Engineering | Friday, 22 September, 2023 |
| Live Test 9 | Saturday, 23 September, 2023 |

# Week 5 : YouTube

SSC JE PAPER 1

| | |
|---|---|
| Building Materials | Monday, 25 September, 2023 |
| Live Test 10 | Tuesday, 26 September, 2023 |



## Introduction

- Estimate is the probable cost of any task

Or

- It is process of calculation of quantities and cost of various items of a work

MONEY TIME
and
RESOURCES ?

## Weightage of the Subject (Last 4 exams)

- 2018: 10 marks
- 2019: 11 marks
- 2020: 7.3 marks
- 2022: 10 marks



Que. 1

Which should give a clear picture or idea of the whole project or work ?

(a) Estimate

(b) Specification

(c) Report

(d) Plan



Basics of ESTIMATE AND COSTING
UPRISE CIVIL ENGINEERING CRASH COURSE

Que. 1

Which should give a clear picture or idea of the whole project or work ?

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(b) Specification

(c) Report

(d) Plan

CIVIL ENGINEERING BY SANDEEP JYANI

Basics of ESTIMATE AND COSTING
UPRISE CIVIL ENGINEERING CRASH COURSE

Que. 2

Working out exact quantities of various items of work is known as

(a) Quantity

(b) Estimating

(c) Valuation

(d) rate analysis surveying

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Que. 2

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Que. 3

Valuation of anything is an estimation of its value in terms of

(a) Quantity

(b) Money

(c) equipment

(d) materials





Que. 3

Valuation of anything is an estimation of its value in terms of

(a) Quantity

(b) Money

(c) equipment

(d) materials

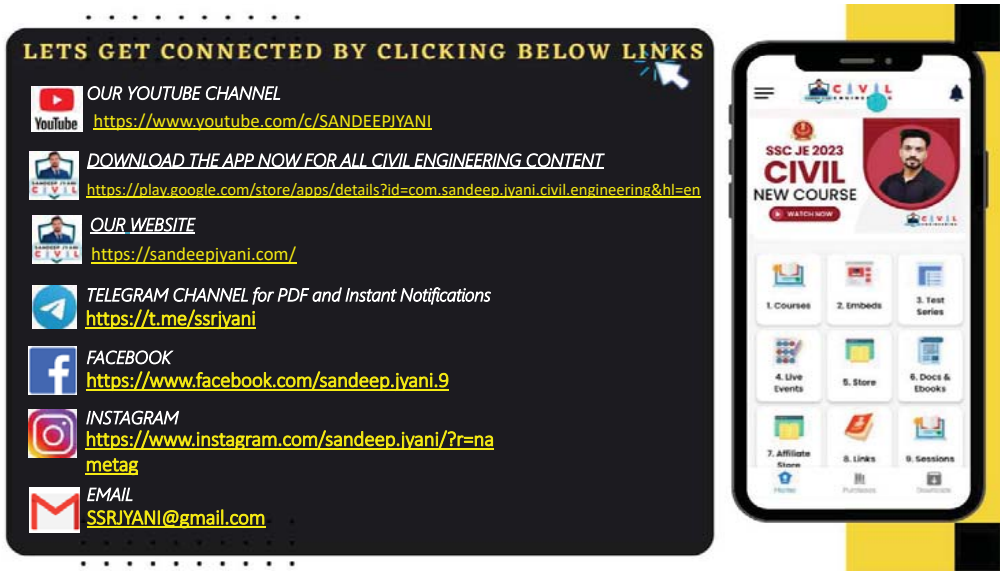


## QUANTITY SURVEY

- Quantity survey means calculations of quantities of materials required to complete the work concerned

## QUANTITY SURVEY

- Detailed specifications gives the nature, quality and class of work, materials to be used in the various parts of work , quality of the material, their proportions, method of preparation, workmanship and description of execution of work are required.


# HYDROLOGY

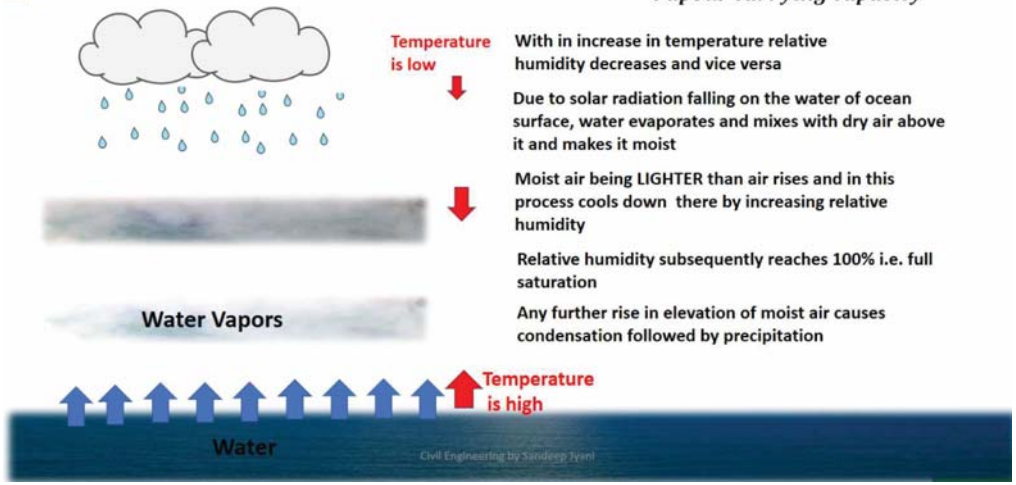
**Hydrology** is a science which deals with the occurrence, circulation and distribution of water of the earth and earth's atmosphere.

**Hydrological Cycle:** It is also known as water cycle. The hydrologic cycle is a continuous process in which water is evaporated from water surfaces and the oceans, moves inland as moist air masses, and produces precipitation, if the correct vertical lifting conditions exist.

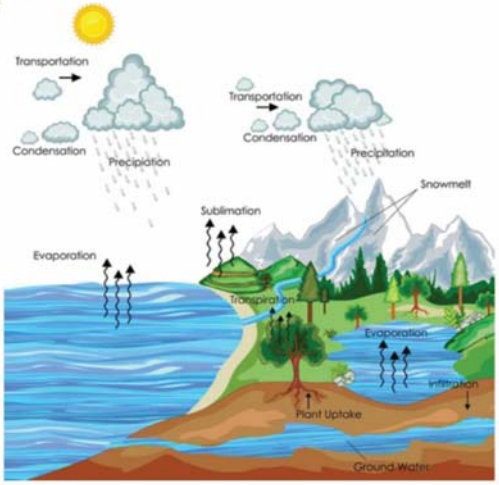
**Extent of Hydrological Cycle:** 1 km below earth surface to 15km above earth surface

# Relative Humidity

$$R.H = \frac{Actual\ vapour\ carried}{Vapour\ carrying\ capacity}$$



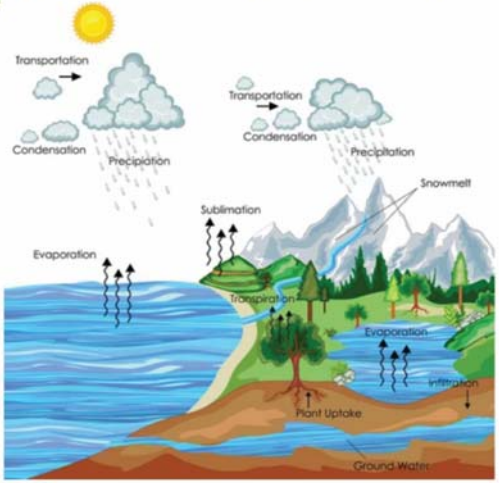
## HYDROLOGICAL CYCLE




## STAGES OF HYDROLOGICAL CYCLE

1. Precipitation
2. Infiltration
3. Interception
4. Depression storage
5. Run-off
6. Evaporation
7. Transpiration
8. Groundwater

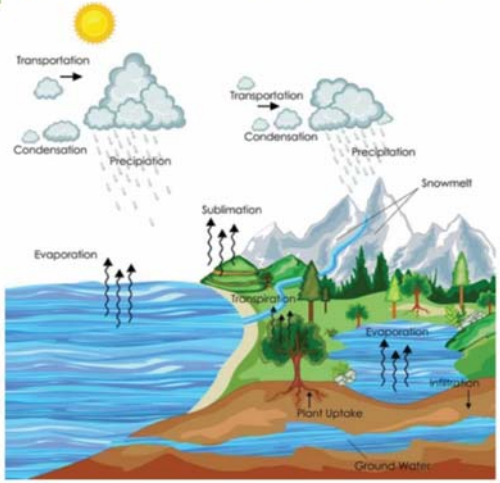
## HYDROLOGICAL CYCLE




**Evaporation:**

Change of water from liquid to gaseous state

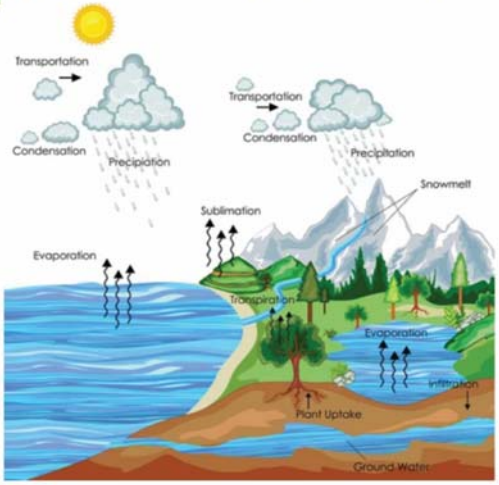
## HYDROLOGICAL CYCLE




**Precipitation:**

The deposition of water on Earth surface as, snow, rain, hailstone, etc

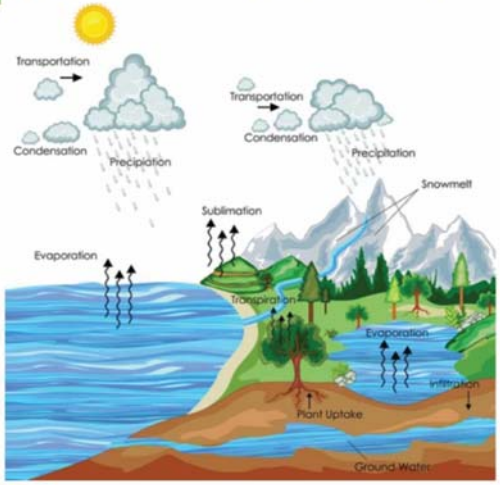
# HYDROLOGICAL CYCLE




**Interception:**

**Short term retention of rain water on vegetation, rooftops, etc**

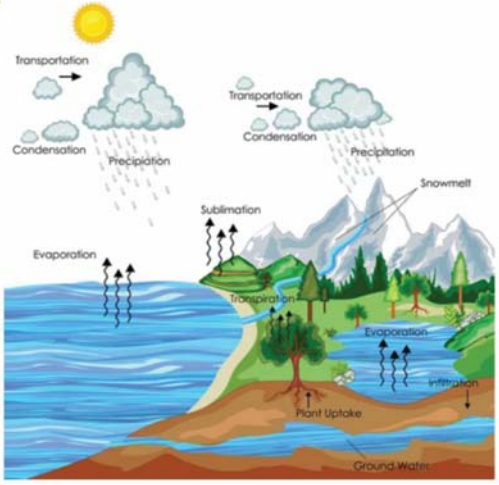
# HYDROLOGICAL CYCLE




**Infiltration:**

**Movement of water into the soil from surface**

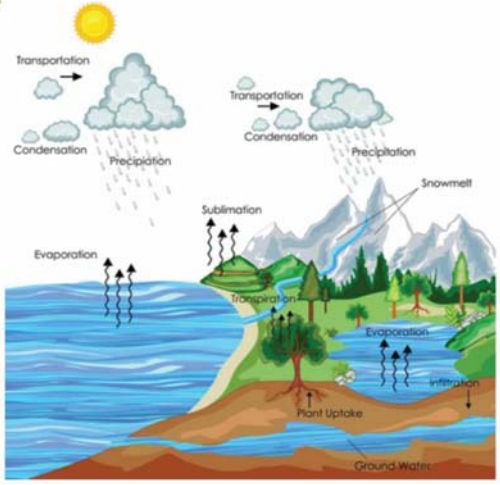
# HYDROLOGICAL CYCLE




**Percolation:**

**Movement of water from one soil layer to another**

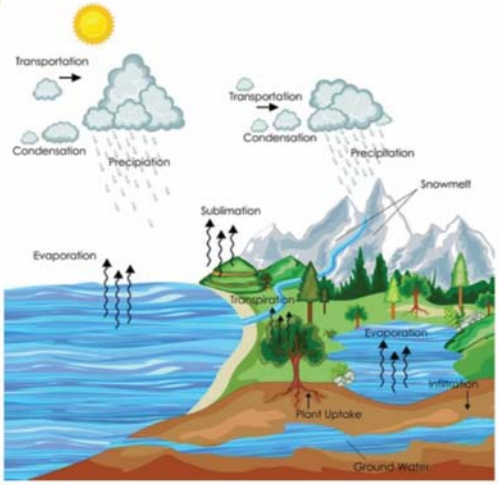
# HYDROLOGICAL CYCLE




**Transpiration:**

**It is water absorbed from the ground and evaporated into atmosphere through leaves**

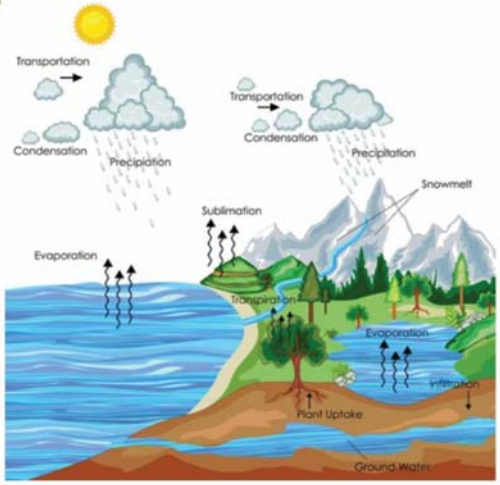
# HYDROLOGICAL CYCLE




**Interflow:**

**Ground water flowing horizontally above the ground water table and below the surface (Sub surface flow)**

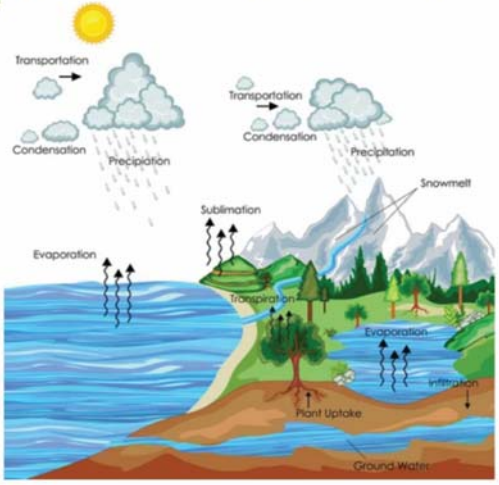
# HYDROLOGICAL CYCLE




**Depression storage:**

**Rain water accumulated in small depressions and ditches above the surface**

# HYDROLOGICAL CYCLE

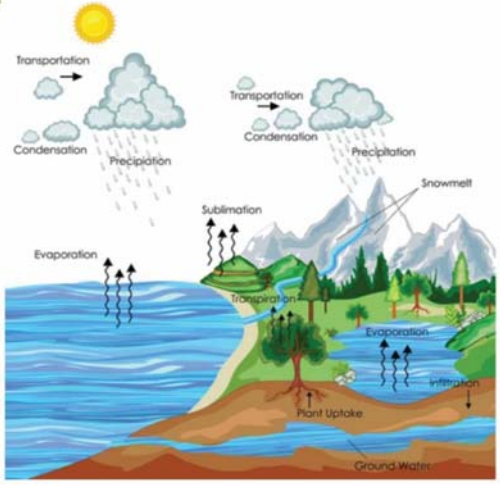



**Surface run off:**

**It is part of rain that reaches the stream immediately after rainfall, flowing over the surface**

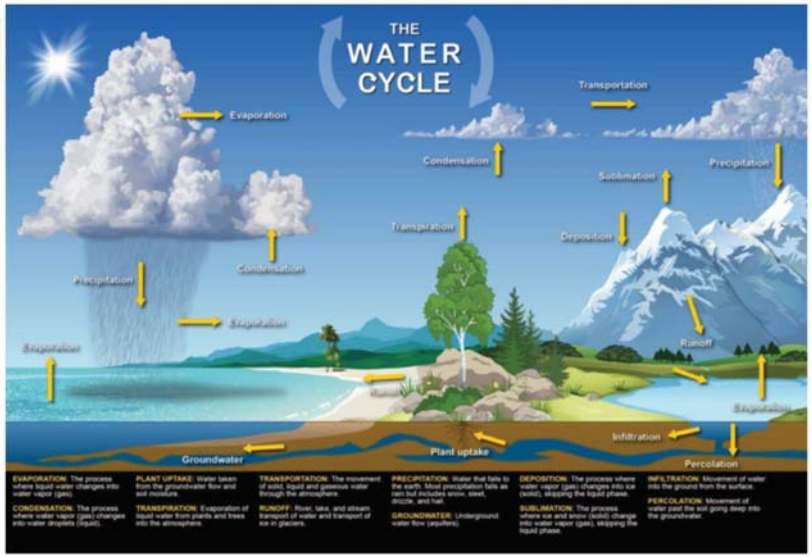
**Also known as DIRECT RUN OFF or RAINFALL EXCESS**

# HYDROLOGICAL CYCLE

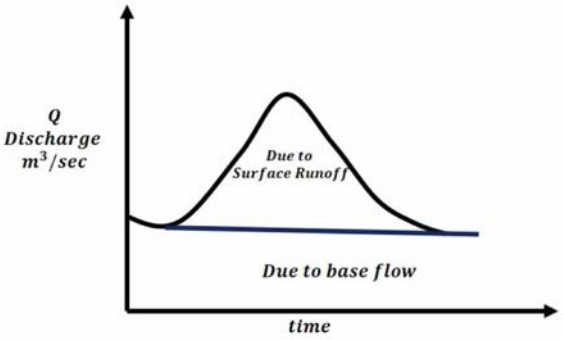



**Base flow/Dry weather flow/Effluent seepage:**

**It is discharge obtained in any stream due to ground water table seepage.**




# Hydrograph / Flood Hydrograph




# Catchment Area

- It is the area of land where surface water from rain and melting snow converges to a single point known as Catchment Outlet where water joins other water bodies such as River or oceans
- Catchment area is also called as "River Basin" or "Basin"
- Each catchment is separate topographically from adjacent catchments by Geographical barriers called Ridges (elevated land), hills or mountain



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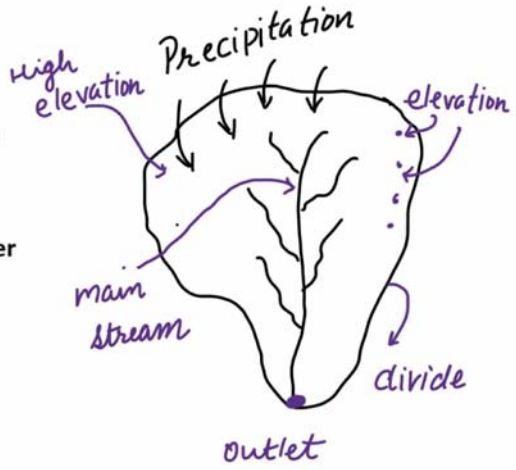

# SURVEYING

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## Chapter 1: Fundamentals of Surveying

Surveying is an art of determining relative position of points on, below and above the earth surface, entering it graphically and numerically.



## Objectives of Surveying

1. To determine relative position of points
2. To Layout or mark out proposed structure on the ground
3. To measure relative quantities like area & volume

# Methods of Presenting measurements:-

- **Numerically : AB = 260 km (examples)**
- **Graphically :**


- **Generally Graphical representation is done in the from of**
- **Plan $\xrightarrow{on}$ Large scale**
- **Map $\xrightarrow{on}$ Small scale**



# Methods of Presenting measurements:-

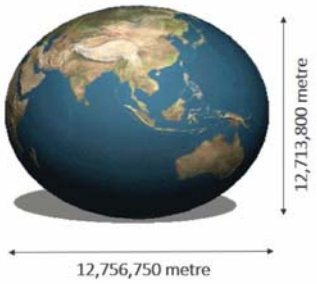
- ***Vertical*** distances on the plan (on) map can be shown with the help of ***contours and spot levels***.
- ***Contours*** are imaginary line joining points of equal elevation on the earth surface.
- Spot levels are reduced level or height of individual points
- Contour gives better visualization of the area.



# Basic Definitions

1. **Shape of Earth**
   a) **Oblate spheroid → slightly flattened at poles, polar axis is 43.5 km smaller than Equatorial axis**
   b) **Ellipsoid → Equatorial section is slightly elliptical in nature**
   c) **Ovalloid → Southern Hemisphere is slightly larger than Northern hemisphere**

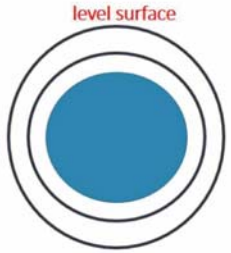
- We can observe that no geometrical shape perfectly defines shape of earth.
- Therefore a new name has been given, i.e, "***GEOID***":-
- Or the ease in calculation the shape of earth is assumed to be "Spherical"

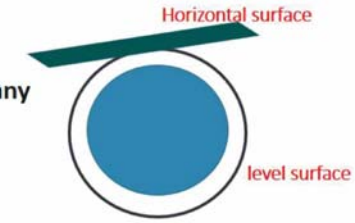





# Basic Definitions

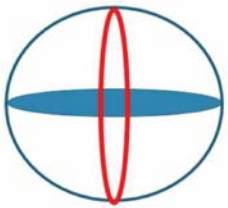
2. **Level Surface**
   - **Level surface is a curved surface parallel to earth surface and every point, it is equidistant from the centre of the Earth, every element on the level surface is perpendicular to plumb line**
3. **Level line**
   - **It is a line in the level surface**
4. **Horizontal plane:**
   - **It is a plane tangential to Earth surface at any point.**
   - **It is also normal to plumb line**



# Basic Definitions

5. **Great Circle:**
   - It is an imaginary circle passing through centre of the Earth
   - A great circle divides earth into two equal parts
   - Example : Equator and longitude
6. **Spherical triangle:**
   - A spherical triangle is that triangle which is formed on the surface of a sphere by intersection of three arcs of great circle
   - The Arcs enclosing the spherical triangle are called as its sides, and the angles in which these Arcs intersect are called as "Spherical Angle".







# Basic Definitions

6. **Spherical triangle:**
   - A spherical triangle is that triangle which is formed on the surface of a sphere by intersection of three arcs of great circle
   - The Arcs enclosing the spherical triangle are called as its sides, and the angles in which these Arcs intersect are called as "Spherical Angle".
   - Spherical Angle is defined as the angle between tangents to the great circle drawn at the point of intersection.
   - Length of a side of a spherical triangle is defined as angle subtended by that side at the centre of the earth



# Basic Definitions

6. **Properties of Spherical triangle:**
   - Length of a side of a spherical triangle should be less than equal to 180°
   - Each angle of a spherical triangle should be less than 180°
   - Sum of three spherical sides should be in between 0° to 360°
   - Sum of spherical angles should be in the range of 180° to 540°

Note:-

- Amount by which sum of the angles of a spherical triangle exceed by 180° is called as "spherical excess"
- Surface Area of a spherical triangle should be less than $2\pi r^2$ where r → radius of the Earth

# Note

- Length of an arc of 12 kilometres long lying on Earths surface is only 1 cm greater than the subtended chord
- Difference between sum of angles in a plain triangle and a those in a spherical triangle is ONE SECOND for a triangle at Earth's surface having area of 195 $km^2$.

**BC PUNMIA**

*Plane surveying* is that type of surveying in which the mean surface of the earth is considered as a plane and the spheroidal shape is neglected. All triangles formed by survey lines are considered as plane triangles. The level line is considered as straight and all plumb lines are considered parallel. In everyday life we are concerned with small portions of earth's surface and the above assumptions seem to be reasonable in light of the fact that the length of an arc 12 kilometres long lying in the earth's surface is only 1 cm greater than the subtended chord and further that the difference between the sum of the angles in a plane triangle and the sum of those in a spherical triangle is only one second for a triangle at the earth's surface having an area of 195 sq. km.

**SK DUGGAL**

When we deal with only a small portion of earth's surface, the above assumptions can be justified. The error introduced for a length of an arc of 18.5 km is only 0.0152 m greater than the subtended chord and the difference between the sum of the angles of spherical triangle and that of plane triangle is only one second at the earth's mean surface for an area of 195.5 $km^2$. Therefore, for the limits of the provisions stated above, the survey may be regarded as a plane survey.



# Classification of Surveying

**Surveying can be classified into many types on the basis of instrument used, place of survey, purpose of survey etc.**

**But mainly surveying is classified as, Plane Surveying, Geodetic Surveying.**

| Plane Surveying | Geodetic Surveying |
|---|---|
| In the Plane Surveying we neglect the effect of Curvature and plotted Measurements are projected on Horizontal plane | Geodetic survey is done for large Area in which effect of Curvature of the Earth surface is considered |
| Area < 195.5 $km^2$ | Area ≥ 195.5 $km^2$ |
| It is done for local surveys | It is done by Survey of India to establish control points which serves the purpose of reference point for local surveys |
| Plane trigonometry | Spherical Trigonometry |



# NOTE

- Length of an arc of 12 kilometres long lying on Earths surface is only 1 cm greater than the subtended chord
- Difference between sum of angles in a plain triangle and a those in a spherical triangle is ONE SECOND for a triangle at Earth's surface having area of 195 $km^2$.



# Classification based on Purpose

1. Topographical survey:
   - **These surveys are used to obtain Maps which show details of maps and man made features on the Earth surface including elevation**
   - **Ex: Mountains – water bodies woods valley, rivers etc.**
2. Engineering Survey:
   - **These are surveys used for Engineering works like Railway, Highway, Bridge etc.**
   - **Building:- 1:50 to 1:200**
   - **Bridge & other civil engineering works :- 1:500 to 1:2500**

## Classification based on Purpose

3. Cadastral Survey:-
   - It is done to establish property boundaries
4. Hydrographic Survey:
   - These are the surveys done on (or) near the water body
   - Ex:- River, lake etc.
5. Astronomical Survey
   - With the help of this survey we can determine Latitude, longitude. Local mean time at any place on the Earth surface



## Classification based on Purpose

6. Geological Survey
   - It is done to determine information about various strata of earth surface



## Classification based on Instrument

1. Chain Surveying:-
   - It is simplest type of surveying in which only linear measurements are done with the help of chain and tape and no angular measurements are done
2. Compass Surveying:-
   - It is the branch of Surveying in which horizontal angles and directions of lines are measured with compass and length of line are measured with chain and tape.
3. Theodolite Survey
   - In this Surveying Horizontal and vertical angles are measured with theodolite and distances are measured with chain on tape



## Classification based on Instrument

4. Levelling
   - In this type of Survey, elevations of various points are measured with the leveling instrument and a vertical staff
5. Plane table Surveying
   - In plane table Surveying, plan or Map is produced by determining directions of various points and taking linear measurements with chain on Tape.
6. Tachometric Surveying
   - In this Surveying horizontal & Vertical distances are measured with an instrument called "Tachometer".

# RAILWAY ENGINEERING

## SANDEEP JYANI

## CIVIL ENGINEERING

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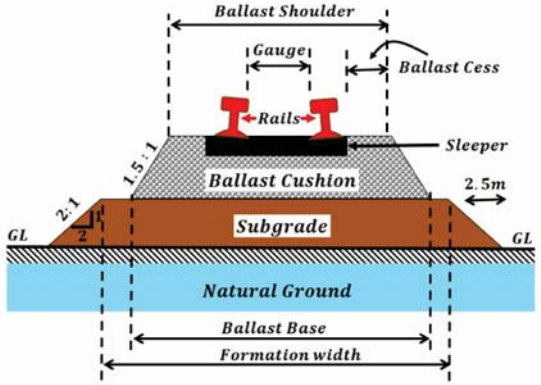
## Railway Engineering

- Modern steam Engine was invented by George Stephenson of England in 1814
- First train of the world was successfully run on 27th September 1825 between Stockton and Darlington
- First train in India was run on 16th April 1853 between Mumbai and Thane with four coaches and one steam locomotive for a distance of 34km.
- THE RAILWAY SYSTEM IN INDIA IS BIGGEST IN ASIA AND THE SECOND LARGEST IN THE WORLD UNDER SINGLE MANAGEMENT

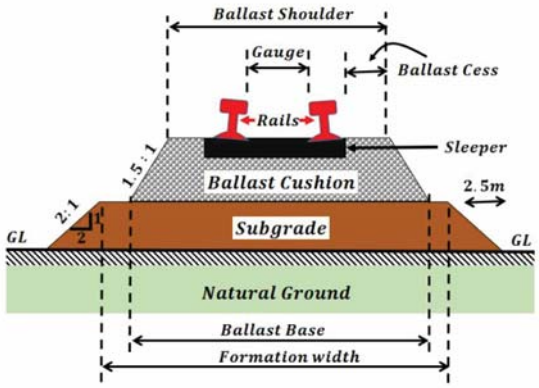


## The Permanent Way



# The Permanent Way

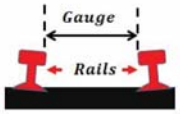
- The combination of rails fitted on sleepers and resting on ballast and subgrade is called Railway Track or Permanent Way.






# Railway Gauge

- Clear distance between inner faces of two rails near their tops is called a gauge




1. **Broad Gauge (BG):**
   - 1.676 m wide
   - Adopted for main cities and routes of maximum intensity
   - Speed of locomotive is restricted to 96 kmph to 120kmph
2. **Metre Gauge**
   - 1m wide
   - Adopted for undeveloped areas
   - Speed of locomotive restricted to 80kmph
3. **Narrow Gauge**
   - 0.762m wide
   - Gauge is adopted for hilly areas and thinly populated areas
5. **Feeder Track Gauge**
   - 0.61m
6. **Standard Gauge**
   - 1.435m
7. **Light Gauge**
   - 0.610m



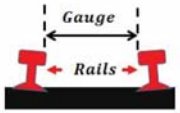
# Uni-gauge Policy of Indian Railways

- The multi-gauge system is not only costly and cumbersome but also causes serious bottlenecks in the operation of the Railways and hinders the balanced development of the country.
- Indian Railways therefore took the bold decision in 1992 of getting rid of the multi-gauge system and following the unigauge policy of adopting the broad gauge (1676 mm) uniformly.



# Railway Gauge

## Loading Gauge

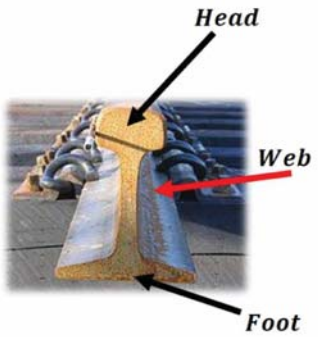



- The gauge representing maximum width and height upto which a railway vehicle may be built
- The loading gauge represents the maximum width and height to which a rolling stock, namely, a locomotive, coach, or wagon, can be built or loaded.

| *Gauge* | *Maximum height of rolling stock* | *Maximum width of rolling stock* |
|---|---|---|
| BG | 4140 mm (13′7″) | 3250 mm (10′8″) |
| MG | 3455 mm (11′4″) | 2745 mm (9′0″) |

# Rail Section

- Rails are continuous steel sections laid along two parallel lines over sleepers.
- They form a suitable track for train and should be strong enough to bear the stresses developed in the track due to wheel loads, lateral and other forces as well as variation due to temperature changes
- The rail section is designated by ***mass per metre length***






# Rail Section

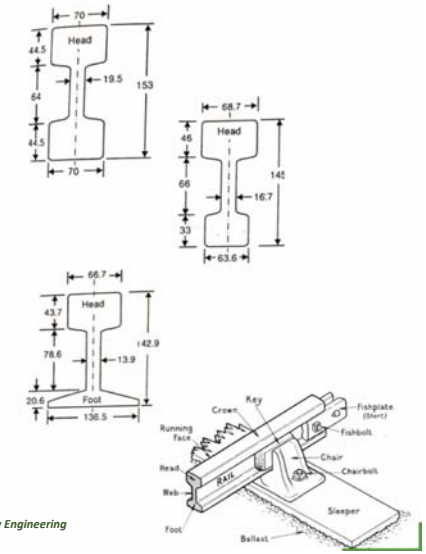
| Sr no | Type of Gauge | Type of Rail Section | Mass (kg/m) |
|---|---|---|---|
| 1 | Broad Gauge | 55 R | 55 |
| 2 | Metre Gauge | 45 R<br>35 R<br>30 R | 45<br>35<br>30 |
| 3 | Narrow Gauge | 25 R | 25 |

R stands for revised British specifications



# Rail Section

1. ***Double Headed Rail***
   - Both heads of rail section are kept equal
2. ***Bull Headed***
   - In this rail, top head is made heavier and lower head is provided with only required quantity of steel
3. ***Flat Footed***
   - Top head is made slightly less than that of bull headed rail and bottom is made flat footed
   - *Mostly used in Indian Railways because of better rigidity and stiffness to resist lateral and vertical forces*
   - It is simple to fix them with sleepers as neither chair nor key is required



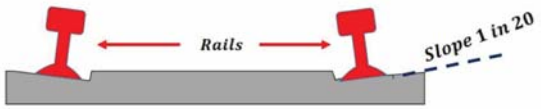



# Length of Rail

- For **Broad gauge**, standard length of Rail is $12.8\ m$, and
- For **metre gauge**, standard length is $11.89\ m$

# Tilting of Rails

- Placing of rail of the track at an inward slope of 1 in 20 is known as *Tilting of rails.*
- *Main purpose of it is to reduce wear on inside edges of the rail in a track*






# Selection of Rail

- A rail is designated by *weight per unit length*
- Factors to be considered in deciding the weight of rail are
  1. Speed of train
  2. Gauge of the track
  3. Axle load and nature of traffic
  4. Type of Rails (DH/BH/FF)
  5. Spacing of sleepers (Sleeper density)
  6. Maximum permissible wear on top of rails (5% of wt of rail)



# Selection of Rail

- A General rule adopted is to specify a certain constant value of the ratio between the weight of the rail and the locomotive axle load.
- In India the ratio is **1/510**.

$$\frac{Weight\ of\ the\ rail\ in\ tonnes}{Locomotive\ axle\ load\ in\ tonnes} = \frac{1}{510}$$



Que . For a locomotive axle load of 22.86 tonnes, the weight of rail required will be…?

a) 44.8 kg
b) 48.4 kg
c) 50 kg
d) 22.86 kg

$$\frac{Weight\ of\ the\ rail\ in\ tonnes}{Locomotive\ axle\ load\ in\ tonnes} = \frac{1}{510}$$

$$\Rightarrow \frac{Weight\ of\ the\ rail\ in\ tonnes}{22.86} = \frac{1}{510}$$

$$\Rightarrow Weight\ of\ the\ rail\ in\ tonnes = 44.8\ kg$$

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b) 48.4 kg
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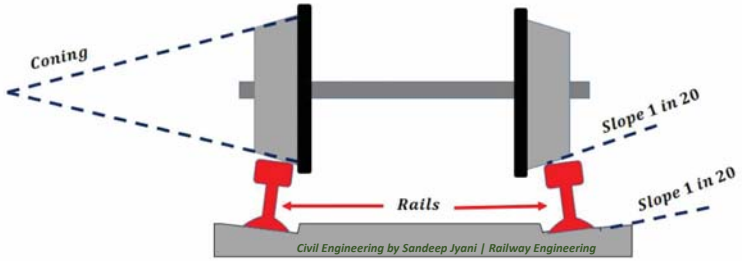
$$\frac{Weight\ of\ the\ rail\ in\ tonnes}{Locomotive\ axle\ load\ in\ tonnes} = \frac{1}{510}$$



# Coning of Wheels

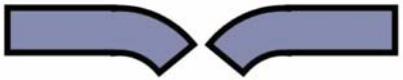
- Wheels of train are coned at an angle of $1\ in\ 20$ as well as the rails are also laid at angle of $1\ in\ 20$
- Its purpose is that the train wheel can move at the centre of rail.
- If due to any sideway effect, the wheels of the train will move sideway, then the diameter of sideway wheel will increase and other wheel will decrease
- Hence length travelled by both wheels will be unequal which results in diverting back the wheel to its centre
- It also helps similarly when the train moves on any curve






# Hogging and Buckling of Rails

- The loose packing under the rails and loose fish plates cause the rail ends to bent down and deflect. This is known as ***Hogging of rails***
- When the rails get out of their original position due to insufficient expansion joint gap, the phenomenon is known as ***Buckling of Rails***





# Creep of Rail

- Longitudinal Movement of Rail in a permanent track due to speedy rolling stock is known as Creep of Rail

***Drag Theory:***
***When the train starts, it pushes the rail backwards***
***When the train stops, it pushes the rail forwards***

**Percussion Theory**– Creep is developed due to the impact of wheels at the rail end head of joints. When wheels leave the trailing rail and strike the facing rail end at each joint, it pushes the rail forward resulting in creep.

Development of wave motion in the rails by a moving train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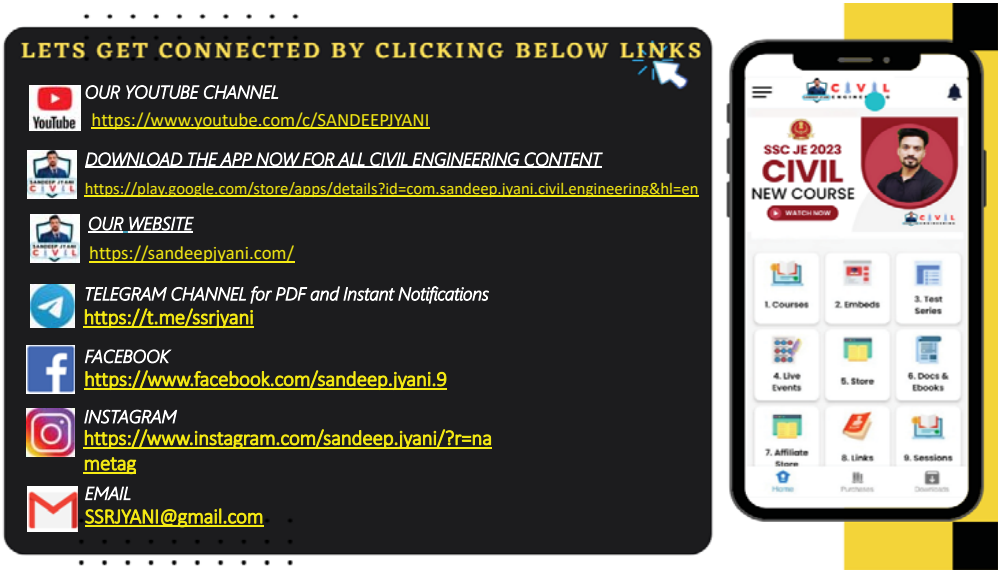
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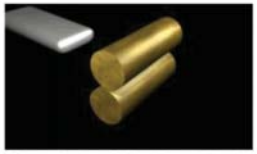
## STEEL VS CONCRETE

- A significant difference between steel and concrete constructions is that the designer has more control over the shape of reinforced cement concrete elements
- For Building Steel Structure, designer is compelled to use standard rolled sections



## Advantages and Disadvantages of Steel

- The main advantages of steel structures are their smaller weight-to-strength ratio, speed of erection and dismantling, and its scrap value.
- Faster degradation of their strength in the events of fire, requirement of skilled, personnel and the accuracy desired in fabrication are the major drawbacks

## Steel Structures are divided into two principal groups:

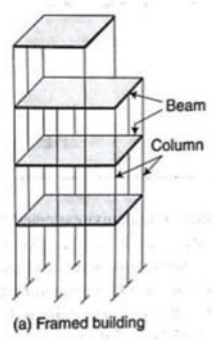
**STEEL STRUCTURES**

- Made mainly of plates, sheets
- Exp: tanks, bins, chimneys, roof covering

**FRAMED STRUCTURES**

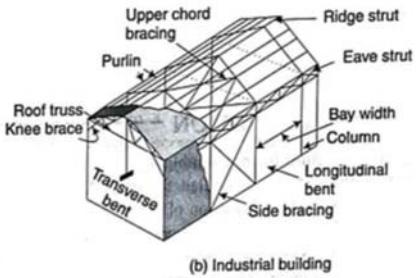
- These are assembly of tension, compression and flexural members
- Exp: truss frame, rigid frames, girders and columns, etc

## Some Examples of Steel Structures



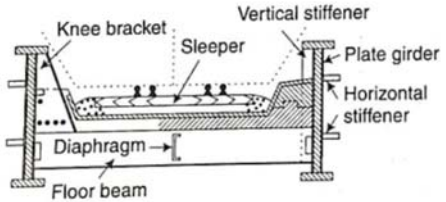

(a) Framed building

## Some Examples of Steel Structures

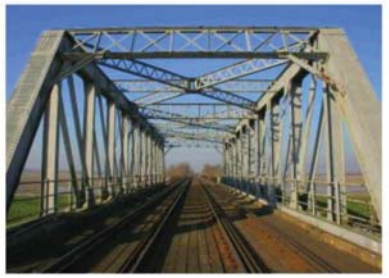


(b) Industrial building

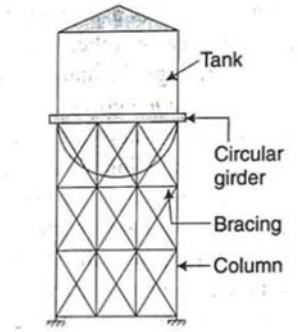
## Some Examples of Steel Structures



(c) Rail-road bridge

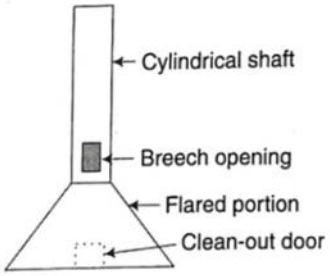


## Some Examples of Steel Structures



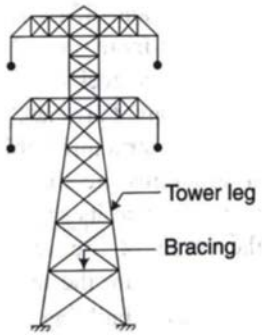
(d) Overhead water tank

## Some Examples of Steel Structures



(e) Self-supporting steel stack

# Some Examples of Steel Structures




(f) Transmission line tower

# Standards, Specifications and Codes

**A standard contains a set of technical definitions, specifications and guidelines for performance and safety. It becomes code when adopted by Governmental bodies.**

1. **IS Handbook No. l ·Properties of Structural Steel Rolled Sections**
2. **IS: 875-1987 Code of Practice for Design' Loads for Building and Structures**
3. **IS: 800-2007 Code of Practice for use of Structural Steel in General Building Construction**



IS 800 : 2007
(Reaffirmed 2012)
(Reaffirmed 2017)

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*( तीसरा पुनरीक्षण )*

*Indian Standard*

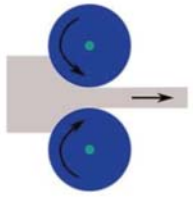
GENERAL CONSTRUCTION IN STEEL — CODE OF PRACTICE

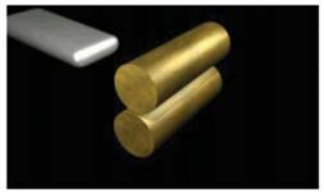
*( Third Revision )*

ICS 77.140.01

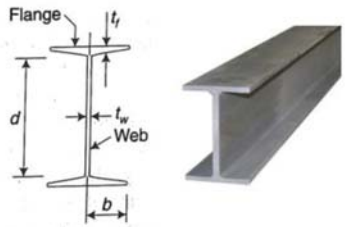
# ROLLED STEEL SECTIONS

- **Rolling is a metal forming process in which metal is passed through one or more pairs of rolls to squeeze and reduce the thickness, to make the thickness uniform, and/or to impart a desired mechanical property. The concept is similar to the rolling of dough.**
- **Rolling is classified according to the temperature of the metal rolled. If the temperature of the metal is above its recrystallization temperature, then the process is known as hot rolling. If the temperature of the metal is below its recrystallization temperature, the process is known as cold rolling.**





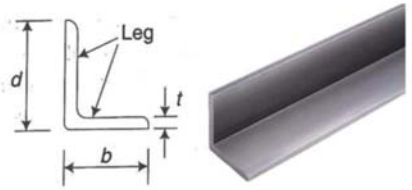
## Rolled Structural Shapes and Dimensions



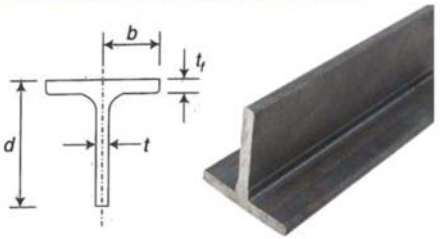

(a) Rolled beams and columns


(b) Rolled channels

## Rolled Structural Shapes and Dimensions

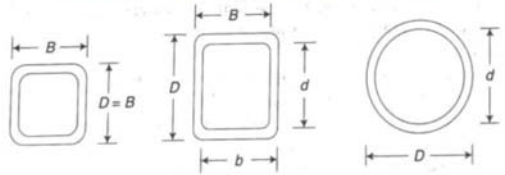



(c) Angles (unequal)




(d) Tees

## Rolled Structural Shapes and Dimensions




Square hollow sections (SHS)

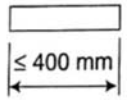
Rectangular hollow sections (RHS)

Circular hollow sections (CHS)

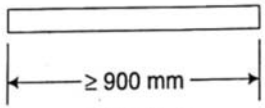
(e) Hollow sections (tubes)

## Rolled Structural Shapes and Dimensions

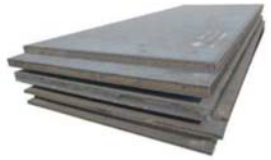

(f) Bars




(g) Flats




(h) Plates



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## Mechanics

STRENGTH OF MATERIALS

(Branch of Science which deals with study of Forces and their Effects on bodies)

### 1. Engineering Mechanics

- Branch of Science that deals with study of forces and their effects on RIGID BODIES
- Displacement, Velocity, Acceleration, etc

### 2. Strength of Materials

- Branch of Science that deals with study of forces and their effects on DEFORMABLE BODIES
- Stress, Strain, etc

### 3. Fluid Mechanics

- Branch of science that deals with study of forces and their effects on **Fluids**
- Flow, continuous deformation, viscosity, etc

## WHAT ARE WE GOING TO STUDY?

STRENGTH OF MATERIALS

- STRENGTH OF MATERIALS
- MECHANICS OF MATERIALS
- MECHANICS OF SOLIDS
- MECHANICS OF STRUCTURES
- MECHANICS OF DEFORMABLE BODIES



## STRENGTH OF MATERIALS

STRENGTH OF MATERIALS

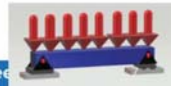
Simple Stresses and Strains | Principal Stress and Strain | Shear Force and Bending Moment | Simple Bending Theory | Shear Stresses in Beams | Deflection in Beams | Torsion | Columns and Struts | Thin Cylinders | Miscellaneous Topics



## STRENGTH OF MATERIALS

STRENGTH OF MATERIALS

Simple Stresses and Strains → Principal Stress and Strain → Shear Force and Bending Moment → Simple Bending Theory → Shear Stresses in Beams → Deflection in Beams → Torsion → Columns and Struts → Thin Cylinders → Miscellaneous Topics





## WHAT IS STRENGTH?

STRENGTH OF MATERIALS

The ability of a material to resist external load against failure.

Primary objective of any PROJECT designing is *STRENGTH.*

## WHY DO WE STUDY STRENGTH OF MATERIALS?

STRENGTH OF MATERIALS



## WHY DO WE STUDY STRENGTH OF MATERIALS?

STRENGTH OF MATERIALS

- The main objective of *Strength of Materials* is to study various properties of materials and derive the expressions of DEFORMATIONS, STRESS, STRAIN which develop under different loading conditions by suing experimentally obtained elastic properties like YOUNG'S MODULUS, POISSON'S RATIO



## The ultimate AIM is to make a plan...

STRENGTH OF MATERIALS

- Selection of appropriate materials
- Calculation of appropriate Dimensions
- Selection of Manufacturing process
- Checking the safety of the Structures against various limits



## ASSUMPTIONS WHILE STUDYING SOM

STRENGTH OF MATERIALS

1. Material is assumed to be Homogenous and Isotropic
2. Material obeys Hooke's law
3. Member is assumed to be prismatic
4. Load is assumed to be as static load (direction and magnitude of load remains constant with respect to time)
5. Self weight of components is neglected
6. Member is assumed to be under static equilibrium

## ASSUMPTIONS WHILE STUDYING SOM

STRENGTH OF MATERIALS

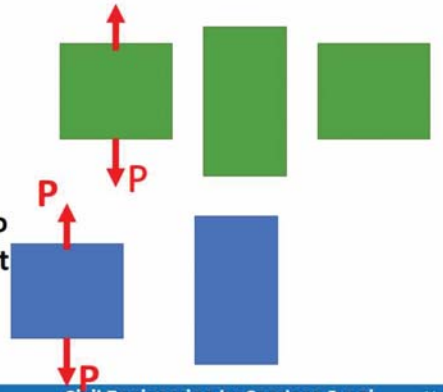
6. Material is solid and continuous and no cracks, no voids are there in the material



## Properties of Materials

STRENGTH OF MATERIALS

- ***Stiffness:*** Resistance against deformation is stiffness
  - $K \uparrow \Rightarrow \delta \downarrow$
- ***Elasticity:*** A material is said to be Elastic when it regains its original shape and size on removal of load
- ***Plasticity:*** Property of material due to which material undergoes permanent deformation

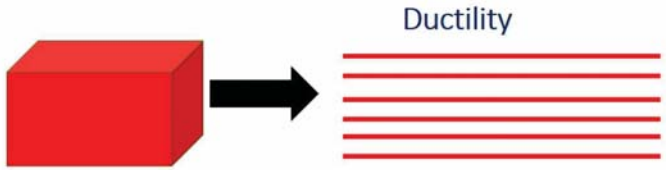





## Properties of Materials

STRENGTH OF MATERIALS

- ***Ductility:*** The Capacity of materials to allow these large deformations or large extensions without failure is termed as ductility. The materials with high ductility are termed as ductile materials






## Properties of Materials

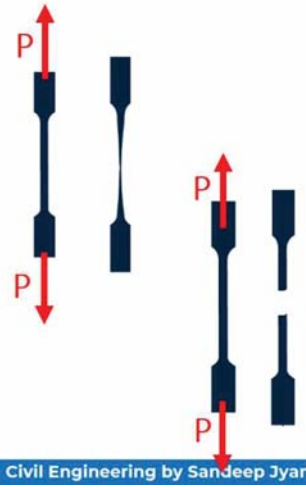
STRENGTH OF MATERIALS

- ***Brittle:***
  - A material that is weak in tension , strong in compression and fails suddenly are called as Brittle
  - Exp: Glass, wood, cast iron, etc

# Ductile and Brittle Materials

STRENGTH OF MATERIALS

1. **Ductile Materials:**
   - The Capacity of materials to allow these large deformations or large extensions without failure is termed as ductility. The materials with high ductility are termed as ductile materials.
2. **Brittle Materials:**
   - A brittle material is one which exhibits a relatively small extensions or deformations to fracture, so that the partially plastic region of the tensile test graph is much reduced.






# NOTE

STRENGTH OF MATERIALS

- **For Ductile materials**
  - $FOS = \frac{yield\ stress}{working\ stress}$
- **For Brittle Materials**
  - $FOS = \frac{ultimate\ stress}{working\ stress}$

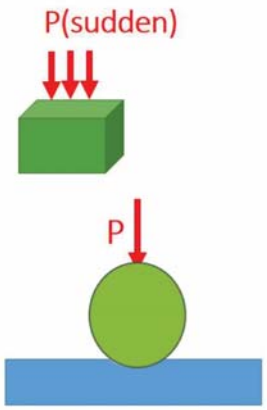


# Properties of Materials

STRENGTH OF MATERIALS

- ***Toughness:***
  - Toughness is resistance to sudden loading or to absorb mechanical energy upto fracture
- ***Hardness:***
  - Hardness is the resistance of a metal to the penetration of another harder body which does not receive a permanent set.
  - A material's ability to withstand friction, essentially abrasion resistance, is known as hardness

Brunel Hardness test
**indentation remains on the surface of the test specimen**
Hard steel ball is used






# Properties of Materials

STRENGTH OF MATERIALS

- ***Malleability:***
  - Property of Material due to which it can be Spread or sheets can be formed
  - A material can be malleable but not ductile (exp. lead)