RCC

Reinforced Concrete: When reinforcement is used in cement concrete as a integral part in order to gain extra strength of the cement concrete, it is called reinforced concrete.

Why steel is used in RC member?

Ans: i) It is cheap & economical.
ii) It develops good bond with concrete.
iii) It's thermal expansion co-efficient is near to the concrete.

Effective depth → Distance from compression face to centroid of tension steel.

Modular ratio, $n = \frac{E_s}{E_c}$; $E_c = 57000\sqrt{f'_c}$ psi

Clear Cover → Distance between outer face of the stirrup to the finished concrete surface.

Why clear cover is used?

Ans: – to prevent the steel from weathering effect.
– to prevent the steel from corrosion
– to provide thermal insulation.

Difference between WSD & USD.

WSD	USD
① Design at applied load	① Design at factored load.
② High cost design method.	② Low cost design method.
③ Strength is less than USD.	③ Strength is more than WSD.
④ Focuses on stress condition within the structural member.	④ Focuses on strength capacity of the member.

Component Name	Clear Cover
Slab	» 0.75"
Beam	» 1 1/2"
Column	» 1 1/2" (3" for saline zone)

Under reinforced beam: steel reaches its yielding before concrete
Over reinforced beam: concrete reaches its yielding before steel.
Balanced reinforced beam: steel, concrete reaches yielding at same time.

Doubly Reinforced Beam: Due to limited cross section, the concrete cannot develop the compressive force to resist the moment, in such case reinforcement is provided in compression zone. Beam contains steel in tension, compression zone is called doubly reinforced beam.

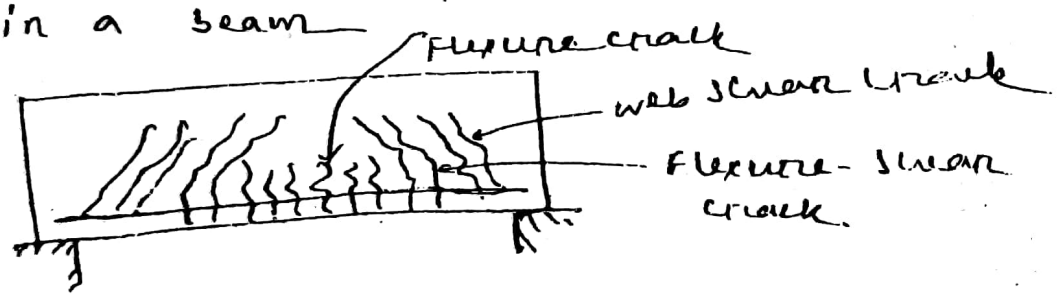
T-beam: The section of beam having greater width at the top in comparison to the width below NA is called T-beam.

Effective flange width:

① $b \leq L/4$ ② $b \leq 16t + b_w$ ③ c/c distance of beam

↳ accept the smallest one.

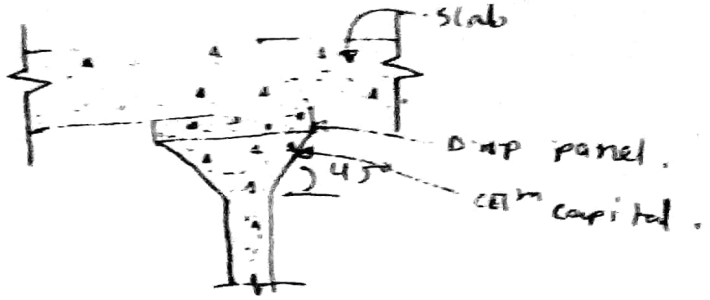
Cracks in a beam



Development length: the length of embedment necessary to develop the full tensile strength of the bar controlled by either pullout or splitting.

# one way slab	two way slab
① Beams supported two sides	① all sides supported beams
② $L/B \geq 2$	② $L/B < 2$
③ Main reinforcement is provided in only one direction.	③ both direction.

Flat slab:



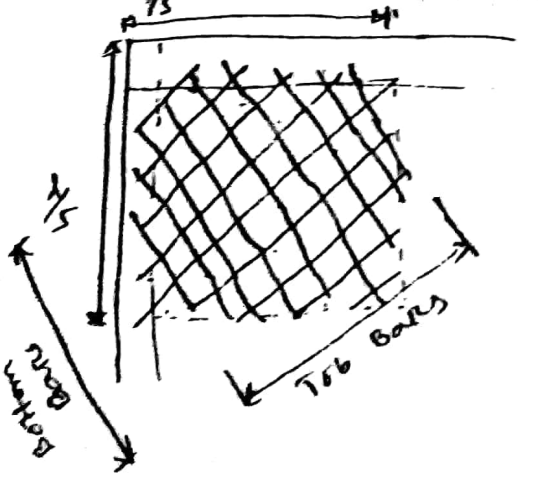
slab thickness:

Name	WSD	USD
simply supported	$L/25$	$L/20$
one end continuous	$L/30$	$L/24$
both end "	$L/35$	$L/28$
cantilever	$L/12$	$L/10$

Corner reinforcement: A special reinforcement shall be provided at exterior corners in both bottom and top of rcc slab, for a distance $L/5$ of larger span. It is provided due to -

① resist- diagonal crack

② resist- twisting moment at exterior corner of a two way slab.



column: a vertical member which carries compressive forces.

Temp. & shrinkage reinforcement:

① 40 or 50 grade → .0020 bf

② 60 " → .0018 bf

③ >60 grade → $\frac{.0018 \times 60000}{f_y}$ bf.

Min^m thickness of two way slab, $t = \frac{\text{perimeter}}{180}$

steel ratio = 1% ~ 8% (ACI)
1% ~ 6% (BNBC)

tie specification:

(a) 16 d_{main} (b) 48 d_{tie} (c) d_{min} → take smallest.

spiral specification:

$\rho_{s(min^m)} = .45 \left(\frac{A_g}{A_c} - 1\right) \frac{f'_c}{f_y}$

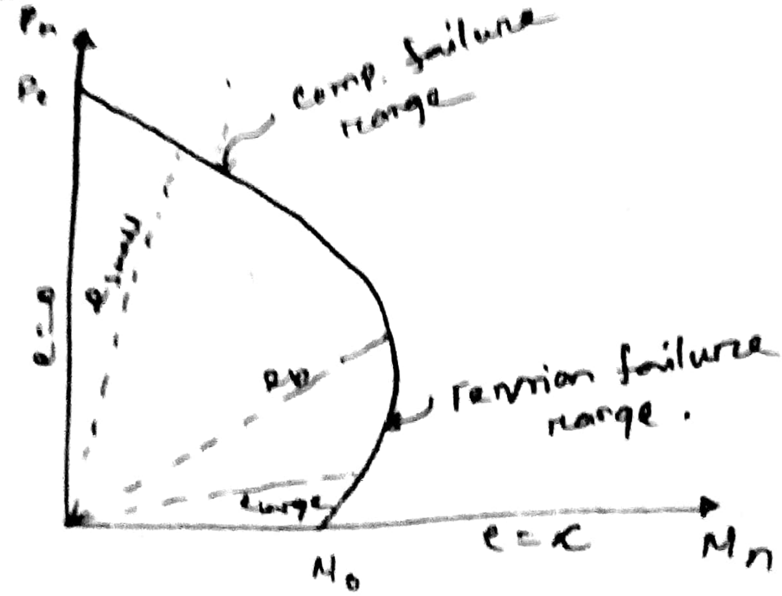
pitch, $g = \frac{1}{6} D_c$ → $1'' \le g \le 3''$

spiral ratio, $\rho_s = \frac{4 a_s}{g D_c} > \rho_{s(min^m)}$

function of tie bars:

- Hold the bars in right position
- reduce buckling effect.
- decrease development length.

Interaction diagram:



For tied colm → $\alpha = 0.80$, $\phi = 0.65$
For spiral " → $\alpha = 0.85$, $\phi = 0.65$

Punching shear, $V_c = [L^2 - (c+d)^2] \cdot w$; $v_{all} = 2\sqrt{f'_c}$

" area, $A_o = 4(c+d) \times d$

Shear force (Beam), $V_b = c\,l\,w$; $v_{all} = 1.1\sqrt{f'_c}$

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EM

* **Brick:** Artificial stone, made of clay whose chief characteristics are a plasticity when wet and stone like hardness after being heated to high temp.

* **Factors affecting quality of bricks:**
  - chemical properties of clay used
  - preparation of clay
  - process of drying - different degrees of burning.

* **Chemical composition:**

Silica	Alumina	Iron oxide	Magnesia	lime	organic matter
55%	30%	8%	5%	1%	1%

* **Brick size:**
  9.5" x 4.5" x 2.75" → without mortar
  10" x 5" x 3" → with mortar
  weight → 6 lbs.

* **Field test:**
  → Can't make mark with nail.
  → Can't brake when drops from 6ft height by forming T.
  → Gives good metalic sound.
  → Absorbs 1/5 to 1/6 th wt of brick.

* **Efflorescence:** The process of deposition of whitish powder on the surface of bricks is called efflorescence.

  causes:
  → salt presents in brick
  → Clay used for making brick contains pyrite.
  → Water used for tempering clay contains pyrites.

* **Formwork:** Formwork is a temporary construction for cast in situ concrete.

Lime: Lime is more or less impure calcium oxide (CaO) and obtained by the calcination of $CaCO_3$.

Cement: Cement is a binding material manufactured from calcareous & argillaceous substances by grinding clinker and adding gypsum.

Mineral constituents:
C_3S, C_2S, C_3A, C_4AF, $CaSO_4$.

Why gypsum is added to clinker?
Ans: to prevent flash setting.

Flash setting: the reaction of pure C_3A with water is very violent and leads to immediate stiffening of paste is called flash setting.

Clinker: when the mixer of calcareous & argillaceous materials are burnt at high temp (1500°C), the materials fuse into balls known as clinker.

Setting: → Change of cement paste from fluid to a rigid mate.

False setting: It is the name given to the abnormal premature stiffening of cement within a few minutes of mixing with water. Remixing of cement paste restores plasticity without adding more water.

Field test of cement:
① → Contains greenish grey color.
② → feel smooth when rubbed in between fingers.
③ → feel cool when hand is thrusted into bag.
④ → lump can be make powder by pressing.
⑤ → Heating when thrown in to water.

When cement is superior to lime?
Ans: → Construction of structures in wet places.
→ When more strength is required.
→ For decorative & ornamental works.

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Admixture: The materials which is used in cement paste or concrete to improve their quality is admixture

purposes: → Increase strength.
→ Retard setting action
→ Reduce shrinkage
→ Improve workability

M10 → 10 MPa → 1 : 3 : 6
M15 → 15 MPa → 1 : 2 : 4
M20 → 20 MPa → 1 : 1.5 : 3
M25 → 25 MPa → 1 : 1 : 2

Normal consistency: The water content that brings the cement paste into a standard condition of wetness.

Concrete: Artificial stone made from mixture of (inert + Binding) materials with water.

Function of water in concrete: -To develop adhesion because the cement paste adheres quickly to the wet surface of aggregates.
- To prepare a plastic mixture
- water is needed for hydration of cement paste.

Hydration: Chemical reaction of water & cement.

Function of aggregate: → gives volume to concrete.

Segregation: The separation of constituents materials of concrete is called segregation.

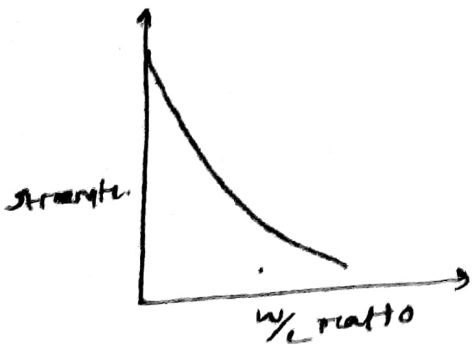
Bleeding: particular form of segregation, water comes out to the surface of concrete.

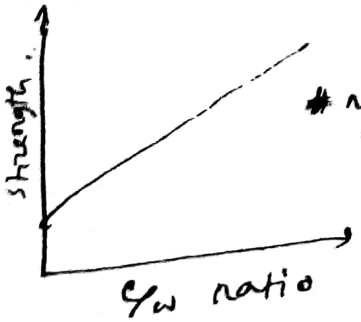
Laitance: When water comes out to the surface along with some quantity of cement and form cement paste is called laitance.

Workability: The property of concrete which determines the amount of useful internal work with minimum loss of homogeniety.

relationship betn w/c ratio and strength.

ACI → 0.4 (w/c ratio).





normally .45 ~ .6 use করা হয়।

Why cylindrical specimen is more preferable than cube

Ans: → failure is less affected by the end restraint of the specimen.

→ strength is less influenced by the properties of CA.

→ stress distribution on horizontal plane in a cylinder more uniform than square X-section.

slump: The difference between to for the mold and the top of concrete mix.

slump:

sand is cohesionless soil

clay is cohesive soil

slump value for beam & column 75mm ~ 100 mm.

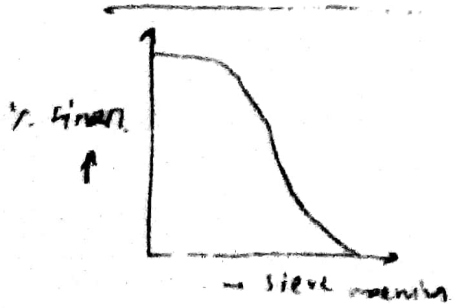
Sand: the particle passing 4.75mm and retained on 0.075mm sieve is called sand.

standard sieve:

3", 1.5", 3/4", 3/8", 3/16" (#4), #8, #16, #30, #50, #100

C.A. ← → F.A

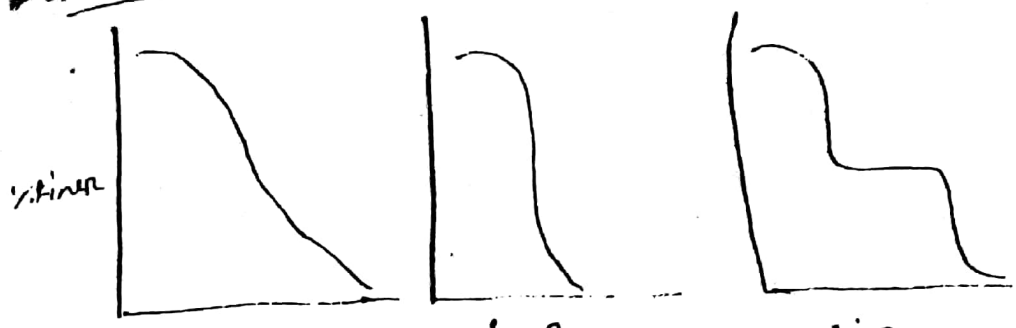
Gradation curve:



co-efficient of uniformity, $C_u = \frac{D_{60}}{D_{10}}$

" " $C_c = \frac{D_{30}}{D_{10} \times D_{60}}$

Gradation curve:



well graded | Uniformly/ poor graded | Gap Graded.

Types of Sand:

Source	Size	Bangladesh (Location)
① River Sand	① Coarse Sand	① Sylhet Sand } Source.
② Sea Sand	② Medium Sand	② Kushtia Sand. }
③ pit Sand	③ Fine Sand	

Bulking of Sand: The increase in volume of sand due to presence of moisture is called bulking of sand.

FM: $\frac{\Sigma \%\ \text{cum. retained on each std. Sieves}}{100}$

Maximum nominal size of CA (BNBC):

① $\frac{1}{5}$th of narrowest dimension between sides of forms.

② $\frac{1}{3}$rd of the depth of slab.

③ $\frac{3}{4}$th of clear spacing bet^n reinforcing bars.

Curing: The process of keeping the surface of concrete wet is called curing.

Why needed: - to complete the hydration process of cement.
- to increase the strength of concrete.
- to control of temperatures and of the moisture movement from and into the concrete

Geo-textile: Geo-textiles are permeable fabrics used in association with soil to increase soil stability, provide erosion control and aid in drainage.

Made from: - polypropylene or polyesters

Uses: used to -

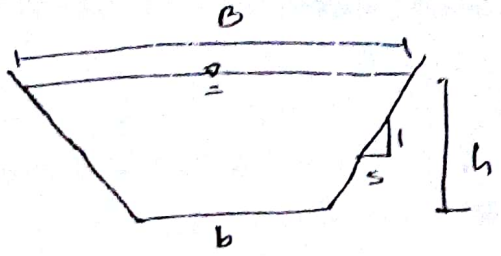
- increase soil stability
- provide soil erosion.
- aid in drainage
- reinforce fore earth structures by means of fill materials.
- to separate different sizes particle.

Hydraulics, RE, IES & PE

 # Open Channel Flow: The flow of water with a free surface is called OCF. Ex → Flow in river, lake, canal etc.

 # Pipe Flow: Flow of water without any free surface. Flow occurs due to difference in pressure.

 # Channel properties:



Top width, $B = b + 2sh$

Area, $A = bh + sh^2$

Wetted perimeter, $P = b + 2\sqrt{1+s^2}\,h$

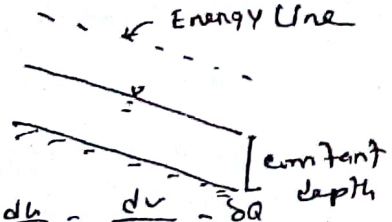
Hydraulic Radius, $R = A/P$

Hydraulic depth, $D = A/B$.

 # Steady Flow: $\left(\frac{dh}{dt} = \frac{dv}{dt} = \frac{\partial Q}{\partial t} = 0 \text{ for fixed section}\right)$

① Uniform Flow

can be steady only

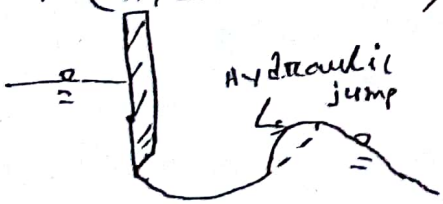


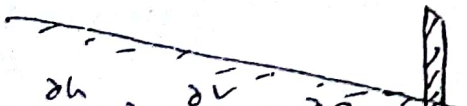
$\frac{dh}{dx} = \frac{dv}{dx} = \frac{\partial Q}{\partial x} = 0$

② GVF (Flow behind a dam)

$\frac{\partial h}{\partial x} \simeq \frac{\partial v}{\partial x} \simeq \frac{\partial a}{\partial x}$

③ RVF (Hydraulic jump)





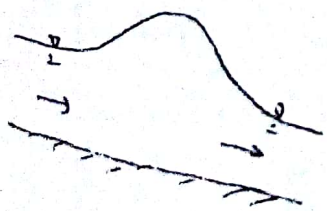
$\frac{\partial h}{\partial x} = \frac{\partial v}{\partial x} = \frac{\partial a}{\partial x} \gtrless 0$

④ SVF (Flow over a bottom rack)

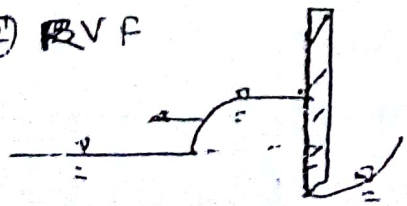
$\frac{\partial a}{\partial x} \neq 0$

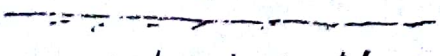
 # Unsteady Flow: $\left(\frac{\partial h}{\partial t} \neq \frac{\partial v}{\partial t} \neq \frac{\partial Q}{\partial t} \neq 0 \text{ for a fixed section}\right)$

① GVF (Flood wave)



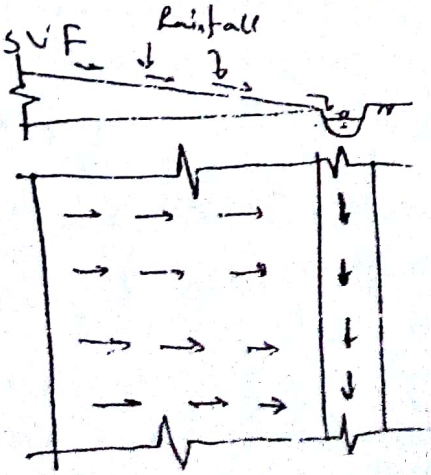
② RVF





surge due to sudden closure of gate.

③ SVF



Reynold's number, $Re = \frac{\text{Inertia force}}{\text{Viscous force}} = \frac{VR}{\nu}$ → 10^{-6} m²/s

$Re < 500$, Flow is laminar

$500 \leq Re \leq 12500$, Flow is transition

$Re > 12500$, Flow is turbulent.

Froude Number, $Fr = \sqrt{\frac{\text{Inertia Force}}{\text{Gravity Force}}} = \frac{V}{\sqrt{\frac{gD}{\alpha}}}$

$Fr < 1$ → sub-critical Flow

$Fr = 1$ → Critical Flow

$Fr > 1$ → super-critical Flow.

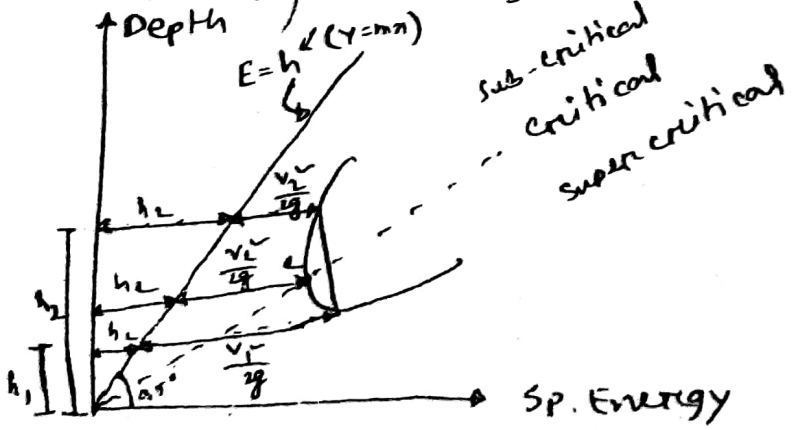
Continuity Equation: $a_1V_1 = a_2V_2 = a_3V_3 = \dots$

Energy Equation: $z_1 + h_1 + \frac{v_1^2}{2g} = z_2 + h_2 + \frac{v_2^2}{2g} + h_f$

Sp. Energy: Sp. energy at a channel section may be defined as the energy measured with respect to the channel bottom.

$$E = h + \alpha \frac{v^2}{2g}$$

Sp. Energy Curve: The variation of sp. energy with the depth of flow for a given section is sp. Energy Curve.



→ E-h curve moves right-side of 45° line always.

→ For all points except e, there are two depth for a particular depth.

→ At point e, Energy is minimum, Flow is critical.

$E_c = 1.5 h_c$

Section factor, $Z = A\sqrt{D}$

Chezy's formula: $V = C\sqrt{RS}$; $C = \sqrt{\frac{8g}{f}}$ - $30 m^{1/2}/s$

Darcy-Weisbach formula:

$$h_f = \frac{fLV^2}{2gD}$$

Manning Formula: $V = \frac{1}{n} R^{2/3} S^{1/2}$

Best hydraulic section: the section that convey's the maximum discharge for a given area is known as best hydraulic-section.

For rectangular, $b = 2h$

For triangle, $S = 1:1$

Hydraulic jump: when a supercritical flow made to change abruptly to subcritical flow, the result is also an abrupt rise of the water surface. This feature is known as hydraulic jump.

Types of jump:

$Fr = 1$ → No jump

$Fr = 1 \sim 1.7$ → undular jump

$Fr = 1.7 \sim 2.5$ → weak jump

$Fr = 2.5 \sim 4.5$ → oscillating.

$Fr = 4.5 \sim 9.0$ ~ steady

$Fr => 9$ ~ strong jump.

Hydraulic drop: the rapid change in the depth of flow from a high stage to a low stage that results in a steep depression in the water surface. It is caused by an abrupt change in the channel slope.

Aqueduct: An aqueduct is a water course constructed to convey water. It is also refers specifically to a bridge on an artificial water course.

is a structure which is used to convey water and also used in bridging purpose.

Siphon: A tube used to convey liquid upwards from a reservoir/container and then down to a lower level of its own accord.

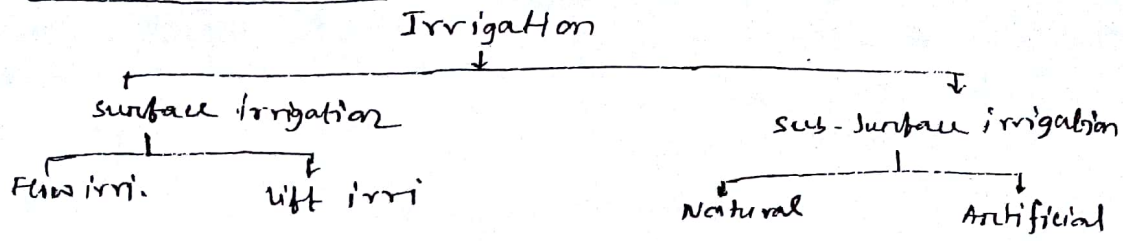
or

A bent pipe or tube through which a liquid can be drawn by air pressure up and over the edge of a container.

A canal network in which to convey water from the source of supply to the cultivation fields or farms.

Irrigation: science of artificial application of water to the land, in accordance with the crop requirements throughout the crop period for full nourishment of the crops.

Types of irrigation:



Methods of irrigation:

① Free flooding
② Border flooding
③ Check flooding
④ Basin flooding
⑤ Furrow irrigation
⑥ sprinkler irrigation
⑦ Drip irrigation

SAR: The proportion of sodium ions present in the soil is generally measured by a factor called SAR.

SAR → 0 ~ 10 → Low sodium water
SAR → 10 ~ 18 → Medium " "
SAR → 18 ~ 26 → High " "
SAR → > 26 → very high " "

EC: EC → 100 ~ 250 micromhos/cm → Low Salinity water
EC → 250 ~ 750 → Medium " "
EC → 750 ~ 2250 → High " "
EC → > 2250 → very high " "

Crop period: time (instant of sowing ~ harvesting)

Base period: time (1st watering during its sowing ~ last watering before harvesting).

Delta: total depth of water required by a crop to come to maturity is called delta (Δ).

Duty: Area of land irrigated by supplying 1 cumec of water continuously during the entire base period.

Kor watering: The 1st watering which is given to the crop when the crop is few cm high.

Paleo: The first watering before sowing the crop is called paleo.

Cash crop: → এটা বিক্রয়ের জন্য উৎপাদন করা হয়, যার নিজের ব্যবহার কম,

Crop ratio: $\frac{\text{Area irrigated in kharif season}}{\text{Area irrigated in rabi season}}$.

$\eta_c = \frac{\text{water delivered into fields}}{\text{water entering into channel}} \times 100$

Consumptive use: The total amount of water used by plant in transpiration and evaporation from adjacent soil.

Field capacity: After free drainage, the amount of water remaining in called FC.

$$FC = \frac{\text{Wt. of water retained in a certain vol}^{n} \text{ of soil}}{\text{Wt of same volume of dry soil}} \times 100$$

PWP: water content at which plant can no longer extract water content for its growth.

GCA: total area bounded by the irrigation boundary of a project.

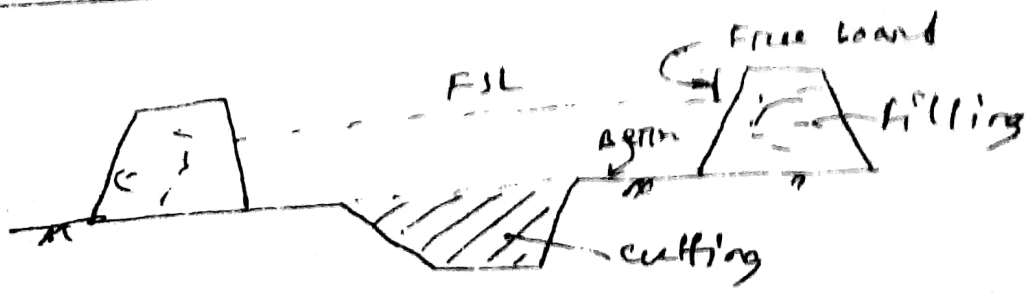
CCA: It includes all land of GCA which is cultivated.

$$C.C.A = 80\% \text{ GCA}.$$

Rigime channel: A channel is said to be in the state of rigime if the flow is such that silting & scouring need no special attention.

Canal: An artificial waterway constructed to allow the passage of boats, ships or to convey water for irrigation.

X-section of a irrigation channel:



Water logging: A land is ~~said~~ said to be water logged when its productivity gets affected and when the root zone of the plant gets flooded with water by high water table.

Causes:

1. Excessive rainfall
2. Inadequate drainage.
3. over & intensive irrigation
4. seepage of water.

Remedies:
- Reduce the intensity of irrigation
- introduce crop rotation
- improve natural drainage
- optimum use of water.

Cross-drainage work: It is a structure which is constructed at the crossing of a canal and a natural drain to dispose of drainage water without interrupting the canal supplies.

Flood: Flood is an unusual high stage of river at which the channel is filled up and above which it overflows the banks spreading water over the land and causes destruction of crops, properties and lives.

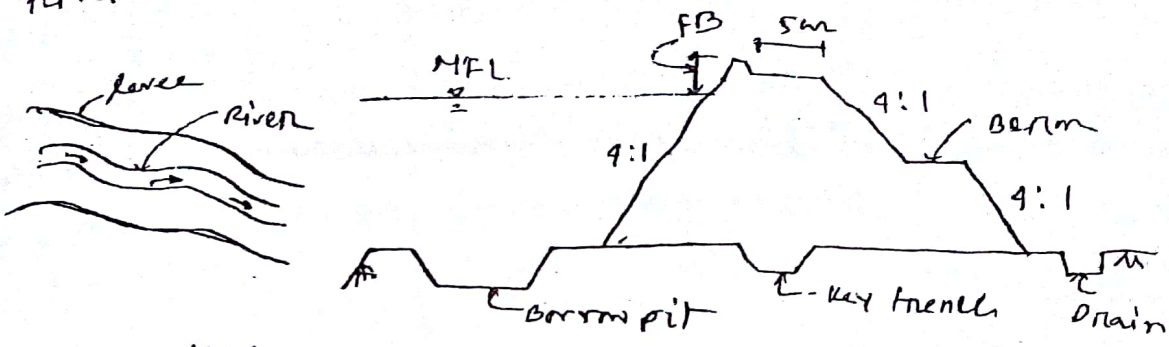
Causes of flood:

- Geographic location and climate pattern
- Excessive rainfall.
- Melting of ice.
- Reduction of river capacity.

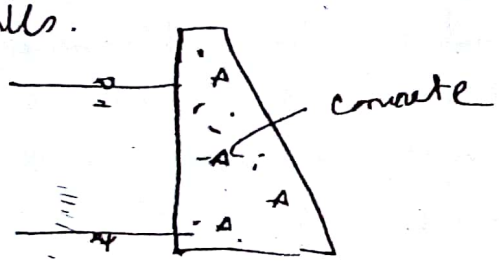
Methods of estimating flood:

a) Rational method
b) Empirical formulae
c) Unit hydrograph method.
d) Flood frequency studies.

Leveen/Dikes/Flood embankments: These are earthen banks constructed parallel to the course of the river to confine the flow of river.

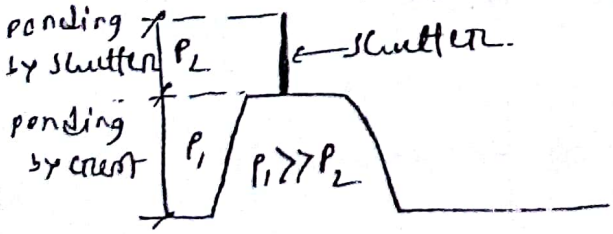


Flood walls: Masonry structures used to confine the river flow in a manner similar to levee is flood walls.

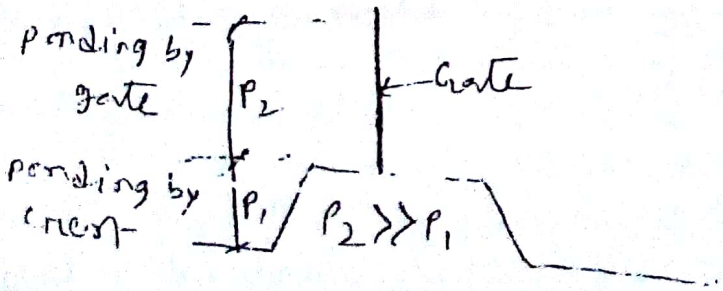


Flood plain: The total area which is affected by a flood is called flood plain.

Weir: If the major part or the entire ponding of water is achieved by a raised crest and a smaller or nil part of it is achieved by shutters, then the barrier is called weir.



Barrage: most of ponding is done by gate and smaller or nil part by raised crest is Barrage.



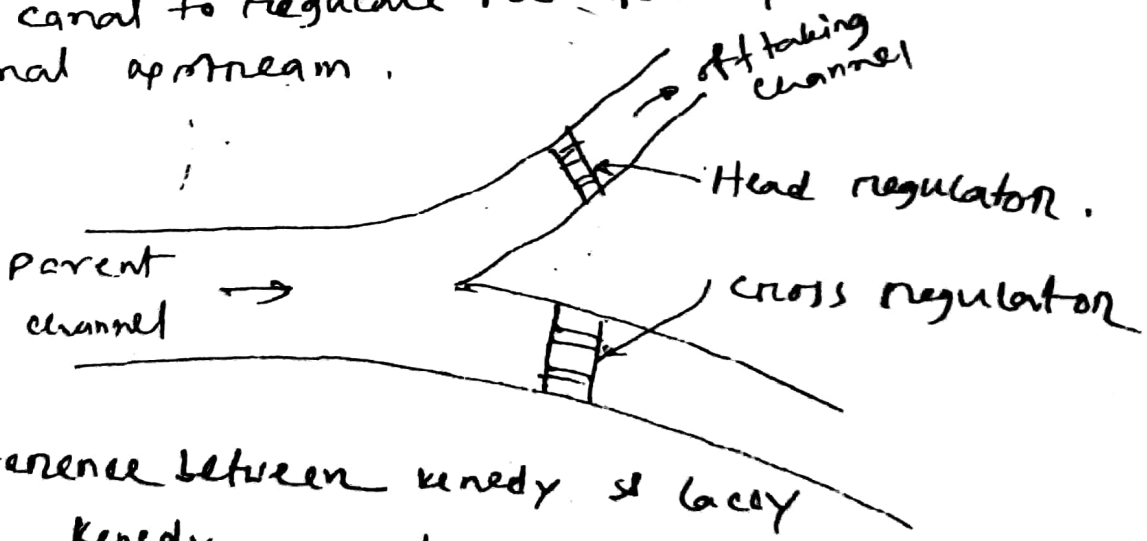
Difference between weir & barrage

Weir	Barrage
① High set crest	① Low set crest
② shutters are of smaller height	② Shutters are of greater height.
③ cheaper structure	③ costly structure.
④ ponding → mostly by crest	④ ponding → mostly by gate.

regulator: structure constructed across a canal to regulate the water level is called regulator.

i) Head regulator: A structure which is ~~constructed~~ constructed at the head of the offtaking canal to regulate the flow of water is called head regulator.

ii) Cross regulator: A structure constructed across a canal to regulate the flow of water in the canal upstream.



Difference between Kenedy & Lacey

Kenedy	Lacey
① Considers trapezoidal section.	① Scraped section.
② Channel to be in a state of true regime	② initial & final regime
③ has not given any importance on bed width & depth ratio.	③ establish a relationship between width & depth.

River: A river is a natural flow flowing water course which carries water along with sediments towards the ocean.

Classification of River:

① Based on discharge:

① Amazon river ② The Congo river
③ The Mississippi river ④ The Brahmaputra
⑤ The Ganges.

② Based on topography:

A) Hilly area →
   i) Rocky river mage
   ii) Boulder " "

B) Flood pain area →
   i) Aggrading river → rise in bed level due to silting
   ii) Degrading river → lowering of bed level due to scouring.
   iii) Stable river → x-section, alignment, slope doesn't change with time
   iv) Deltaic river → forms Δ

C) Tidal river → flow of river is influenced by the tidal variation of ocean. rise and fall of water level due to High & Low tide of ocean.

③ Based on flood hydrograph:

i) Flashy river → rise & fall of flood is sudden

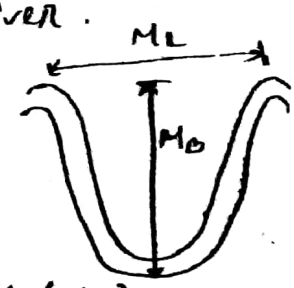
ii) virgin river → rivers can't meet with sea.

iii) Normal river → rise & fall of flood is not sudden.

④ Based on sinuosity:

① Straight river ② Meandering river
③ Braided river.

#Meandering parameters: When consecutive curve of reverse order of a river are connected, they form a meandering river.



Meander Ratio = $\frac{M_B}{M_L}$

Meander length (M_L): The tangential distance between the corresponding points of a meander.

Meander Belt (M_B): It is the distance between the outer edges of clockwise & anti-clockwise loops of the meander.

Cut off: In a excessively meandering river, a particular bend may sometimes be abandoned by the formation of a shorter channel, then the abandoned channel itself is called cut off.

Scour: It refers to the removal of materials by running water. Lowering of alluvial channel bed below an appropriate datum by the flowing water may be termed as scour.

Local Scour: It is the scour caused by the local obstruction such as bridge piers, abutments.

Scour depth, $H_s = 0.47 \left(\frac{Q}{f}\right)^{1/3}$; $f = 1.75\sqrt{d_{mm}}$

Maximum scour depth value → 4.5 m at bridge pier
↳ (confused)

River Training work: All those engineering works which are constructed on a river, so as to guide and confine the flow and to ~~control~~ regulate the river bed configuration.

Methods of river training:

① Marginal embankment / levee
② Guide banks.
③ Groynes or spurs.
④ Artificial cut-off.

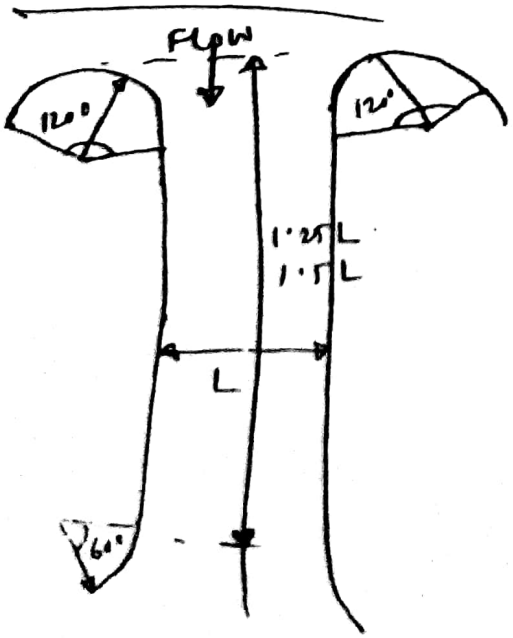
permanent river improvement works:

- Groynes
- Hard points → consists of series of short spurs constructed of stones which is extending towards river.
- vegetations
- Artificial cut-off
- Bed fixation by sills.

Temporary river improvements work:

- Bandals
- Dredging
- surface panels.

Guide banks:

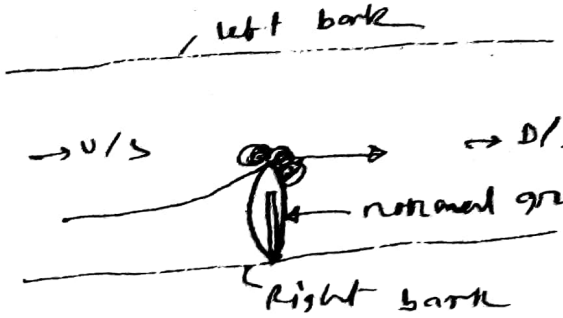


length of guide bank:

① Upstream length of guide bank = ~~0.25~~.
= 1·25 L for $Q \leq 20000\ m^3/s$
= 1·5 L for $Q > 20000\ m^3/s$

② Downstream length of guide bank = 0·25 L.

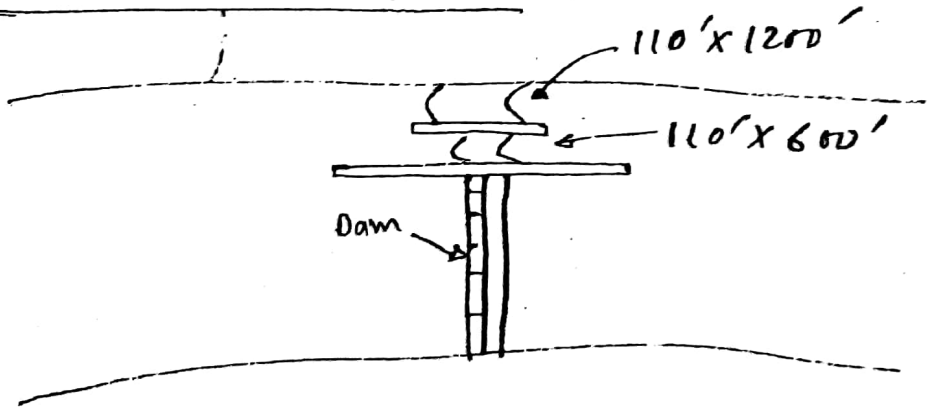
Spurs/Groynes: Groynes are the embankment constructed transverse to the river flow, extending from the bank into the river. It is also called transverse dyke.



Bank is protected by —

(i) Sheet pile
(ii) Riprap → done by rock or concrete block.
(iii) Gabions → done by locally available materials (placing one by one)
(iv) Groyne
(v) Guide bank

Lock & dam arrangement:



classification of Canal:

(1) Based on function:
   (i) Irrigation canal
   (ii) Carrier canal → carry water from one river to another
   (iii) Navigation canal
   (iv) power canal.

(2) Based on boundary surface of canal
   1. Alluvial canal
   2. Non-Alluvial canal
   3. Rigid boundary canal.

#Dewatering: The term dewatering describes the action removing groundwater or surface water from an excavated area before construction can start.

#Capillarity: The phenomenon of rise or fall of liquid in the tube of smaller diameter is called capillarity.

#Water hammer: The sudden rise of pressure has the effect of hammering action on the walls of the pipe which is known as water hammer.

$HGL = z + \frac{p}{\gamma}$ # $TEL = z + \frac{p}{\gamma} + \frac{v^2}{2g}$

#Hydrology: The science which deals with the occurrence, circulation and distribution of water of the earth and earth's atmosphere.

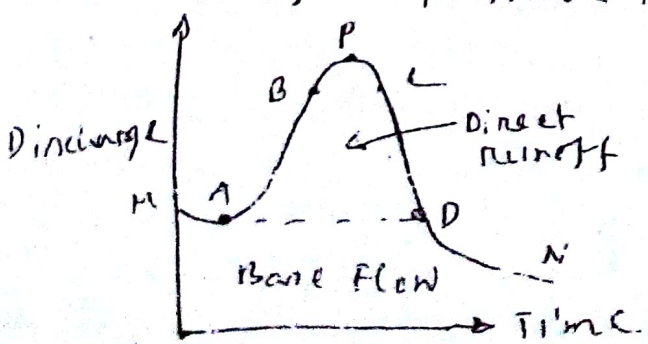
#Hydrologic cycle: The various aspects of water related to the earth can be explained in terms of a cycle known as hydrologic cycle.

#Catchment Area/watershed: The area of land draining into a stream or a water course at a given location is known as the catchment Area.

#Forms of precipitation (all forms of water that comes from atmosphere)
- Rain, Snow, Drizzle, Glaze, Sleet, Hail

#Water harvesting: It is the process of collecting runoff water from a run-off area.

#Hydrograph: It is a graphical representation of discharge plotted against time.



Effective/excess rainfall: that part of rainfall which creates direct runoff at outlet.

Point rainfall: station rainfall.

Hyétograph: ⊙ intensity of rainfall vs time plotted as a bar chart.

Unit hydrograph: Hydrograph of direct runoff resulting from one unit depth (1cm) of rainfall excess occurring uniformly over the basin.

Aquiclude: saturated ~~formation~~ and relatively impermeable formation. — clay

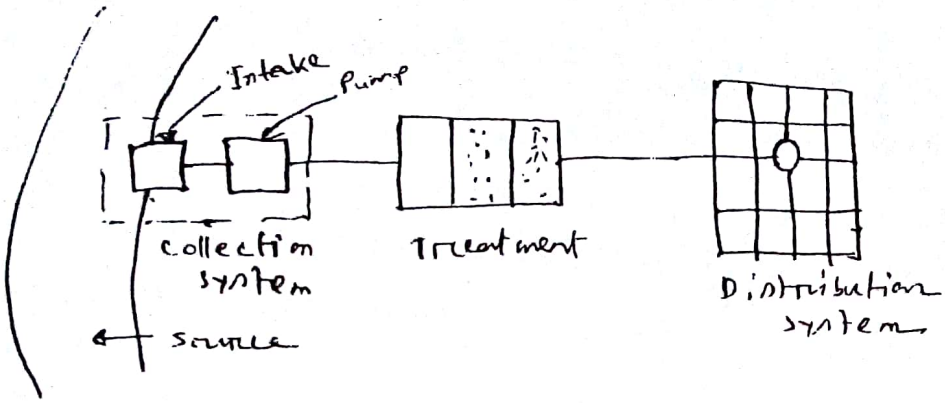
Aquitard: Formation through which only seepage is possible. — sand clay

Aquifuge: Impermeable formation — Rock

Aquifer: Formation having ability to store and transmit water.

Enviroment

* Elements of water supply:



* parameter	Bd std	WHO std
pH	6.5 ~ 8.5	6.5 ~ 8.5
Color	15 Hazen unit	15 hazen unit
Turbidity	10 NTU	5 NTU
TDS	1000 mg/L	
Hardness	200 ~ 500 mg/L	500 mg/L
Chloride	150 ~ 600* mg/L	250 mg/L
Nitrate	10 mg/L	50 mg/L
Iron	.3 ~ 1 mg/L	0.3 mg/L
As	.05 mg/L	.01 mg/L
TC	Nil/100ml	Nil/100ml
BOD	.2 mg/L	
COD	.4 mg/L	

* BOD: oxygen req by bacteria to oxidyze organic matter in aerobic condition

* COD: oxygen req by strong chemical oxydyzing agent to oxidite organic matter in acid condition.

* COD > BOD

#Coagulation: It is the process of addition of salt that produces positive ions in water and leading to destabilization of colloids.

#Flocculation: A slow mixing technique which greatly increases the probability of particle col
destabilize the particle by forming large flocs.

#Filtration: process of water purification in which water is allowed to pass through a bed of filtering media (usually sand & gravel) and purified water is collected through an underdrain system.

#SSF: In SSF, the water in allowed to pass through a bed of fine sand which retains most of the impurities present in water

- rate of filtration is Low (·1 ~ ·3 $m^3/m^2/hr$)
- no pretreat is req'd.
- Low cost of operation & maintenance
- Cleaning of filter bed by scraping.

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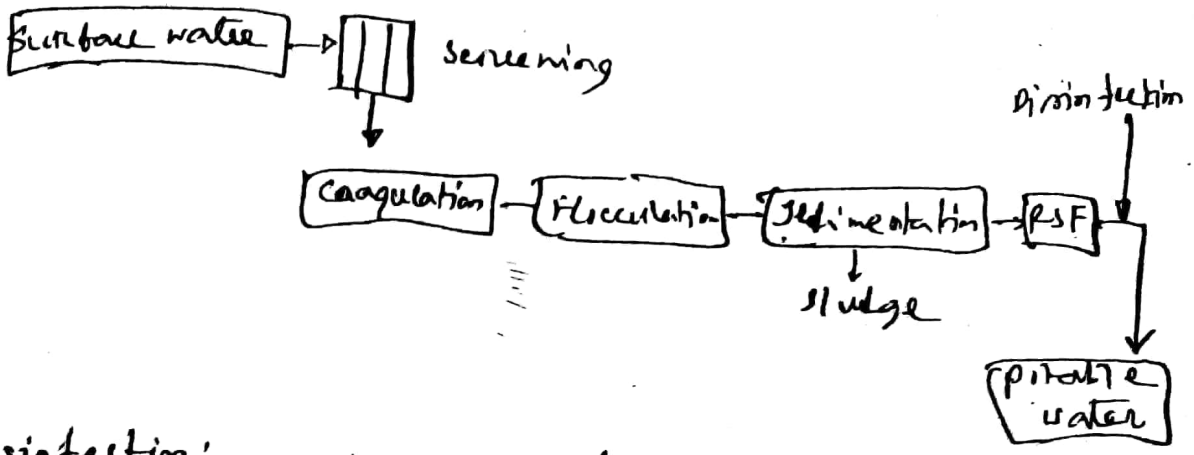
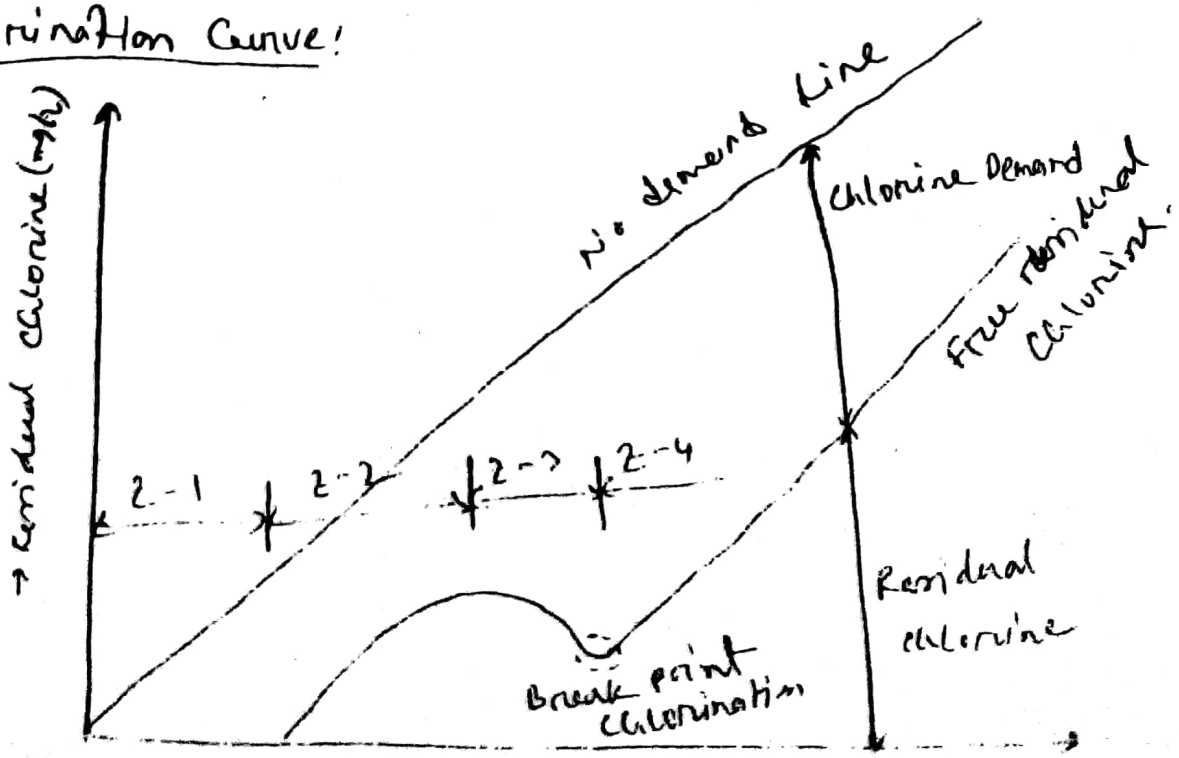
* RSF: In RSF, the water is allowed to pass through a bed of relatively larger and uniform size sand particles.
  - Rate of filtration high (5 ~ 15 $m^3/m^2/hr$)
  - pretreat is required.
  - High cost of operation & maintenance
  - cleaning of filter bed by backwashing.

Conventional water treatment system:



Disinfection: The term disinfection is used in practice to describe treatment process that have the same objectives of killing pathogenic organisms.

Chlorination Curve:



pre chlorination: application of Cl_2 before treatment process

post chlorination: . . . after

Break point Chlorination: addition of Cl_2 at break point.

Darcy's law: $V = K i$ — hydraulic gradient
↑ Co-efficient of permeability

Wastewater / sewage: It is the liquid waste conveyed by a sewer and may include domestic, industrial and storm water.

sewer: pipe / conduit → carry sewage.

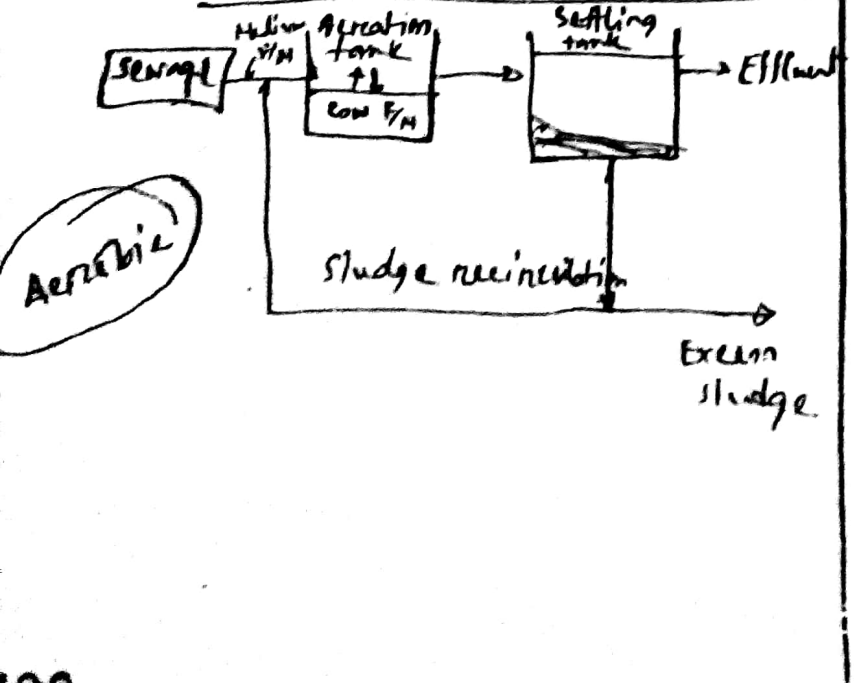
Sullage: Liquid discharge from kitchens, wash basins and excludes discharges from water closets & urinals.

Sewerage: Total system of collection, treatment & disposal.

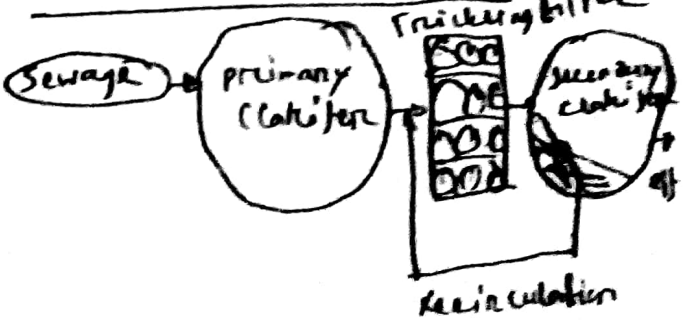
Potable water: → water safe to drink

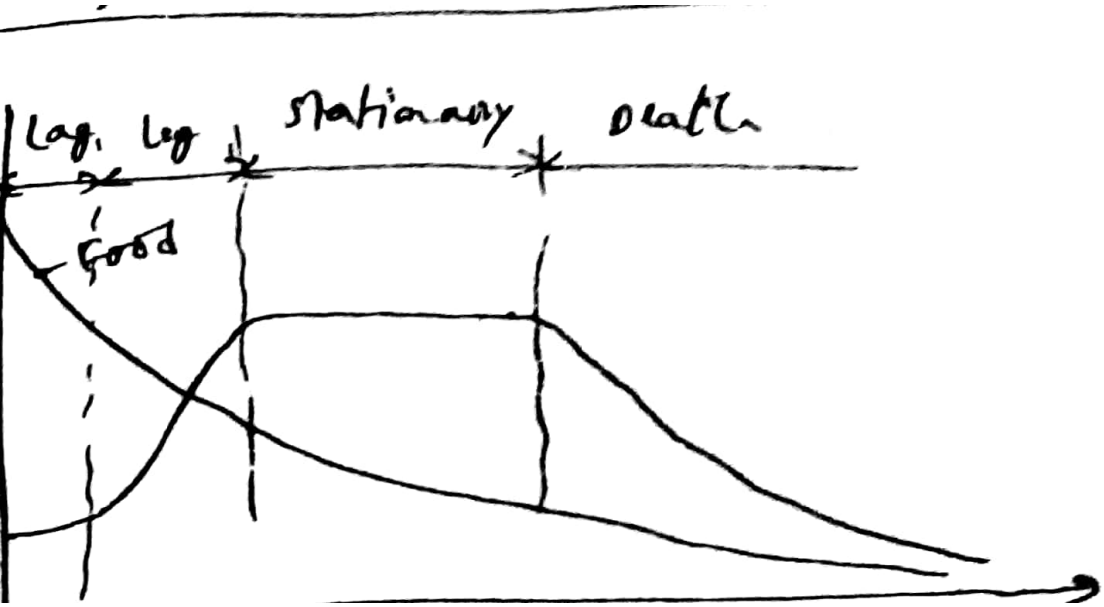
palatable water: physically acceptable, chemically not acceptable.

Activated Sludge process:



Trickling filter process:





Geotechnical Engineering

void ratio, e: $\frac{V_v}{V_s}$ # porosity, $n = \frac{V_v}{V}$ of soil.

Relative Density: The term relative density is commonly used to indicate the in situ denseness/looseness of granular soil.

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

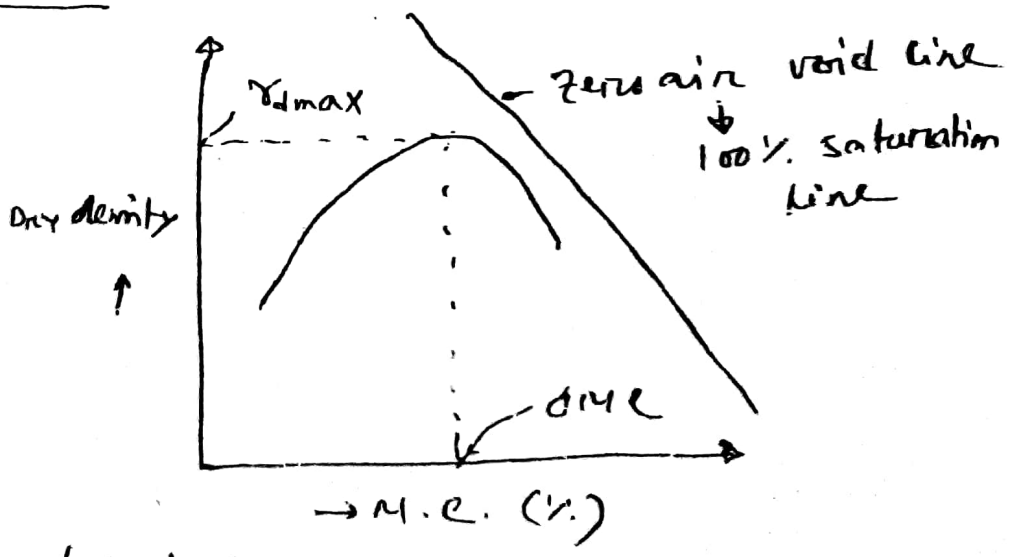
Compaction: It is a kind of densification that is realized by rearrangement of soil particle without outflow of water. It is realized by the application of mechanical energy.
- to increase the strength of soil
- to decrease the settlement.
- to increase the stability of slope.
- to decrease permeability

Difference betn Compaction & consolidation:

Compaction → Vol^m reduction due to expulsion of ~~water~~ air but no outflow of water occurs.

Consolidation → Vol^m reduction due to expulsion of both air & water (outflow of water occurs).

Compaction curve:



water acts as a lubricating agent on soil particles. The soil slip each other and moves into densily packed position so curve moves upward. Beyond a certain M.C. the curve moves downward because water takes up the spaces that would have been occupied by the soil solids

$E_M = 4.5 E_s$

Factors affecting compaction in the field:

① soil type ② Moisture content ③ compaction effort.
④ No. of roller passes.

Compaction Method:

pressure - Contact pressure betn equipment & ground
Impact - series of blows to the soil
vibration - vibrate the soil.
kneading - impact some shearing forces to the soil.

compaction equipment:

① smooth wheel roller ② sheeps foot roller.
③ vibratory roller ④ pneumatic rubber tired roller

How can we achieve 90% compaction from 80% Compaction (what factors used to)

Ans: - By increasing compaction effort.
- By ↓ moisture content (if below OMC)
- If the soil is fine grained, then use coarse grained soil.

Relative compaction: In most specification for earth-work, the contractor is instructed to achieve a compacted field dry unit wt of 90 or 95% of max^m dry unit wt determined in lab. This specification for field compaction is termed as relative compaction.

$$R = \frac{\gamma_d (FIELD)}{\gamma_d (max.lab)} * 100$$

80% Compaction means → If we get 100% compaction in laboratory, in field it is 80% of that value in the lab.

100% Compaction → Compaction value is same in field and laboratory.

USCS System:

76.2 to 4.75 — Gravel
4.75 to 0.075 — Sand
< .075 — silt & clay.

Sand → Coarse (4.75 to 2.0), Medium (2 to .425), Fine (.425 to .075)

soil Classification: (Fine)

First letter		Second letter	
M	predominantly silt	L	Low plasticity
C	" clay	H	High "
O	organic		

Coarse grained soil:

First letter		Second letter	
S	predominantly sand	P	poorly graded
G	" gravel	W	well "
		M	silty
		C	clayey

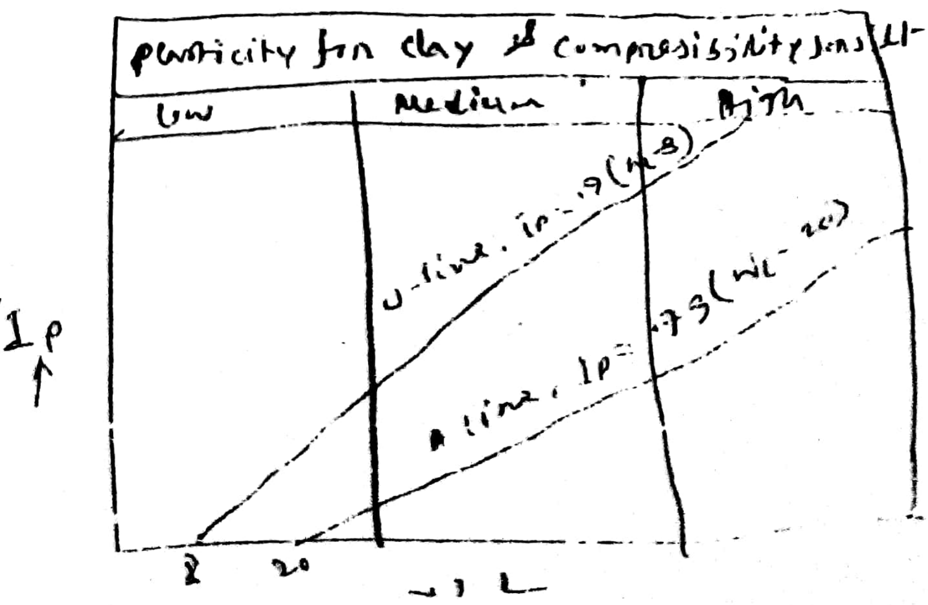
Liquid limit: water content at which soil changes from plastic to liquid state.

Plastic limit: " " " " from semisolid to plastic state.

Shrinkage limit: the maxm water content at which a reduction in water content will not cause a decrease in volume of the soil mass.

plasticity chart:

A line - उपर Inorganic clay, नीचे Inorganic silt.



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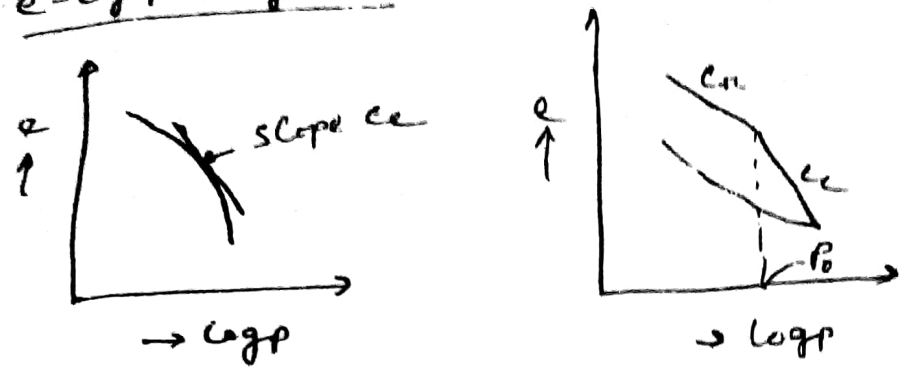
e-log p diagram:



i) NCL ii) OCL

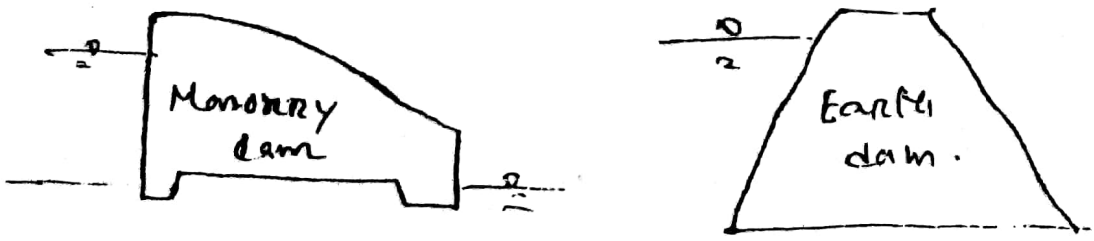
seepage: It is the slow movement of water through the continuous void space of soil.

Flownet: A series of flow lines and equipotential lines under any hydraulic structure is called flownet.

Equipotential line: The line which connects the points that show the same piezometric elevation. It is orthogonal to flow line.

Flow line: It is the line along which water particle travel from U/S to d/s.

Dam:



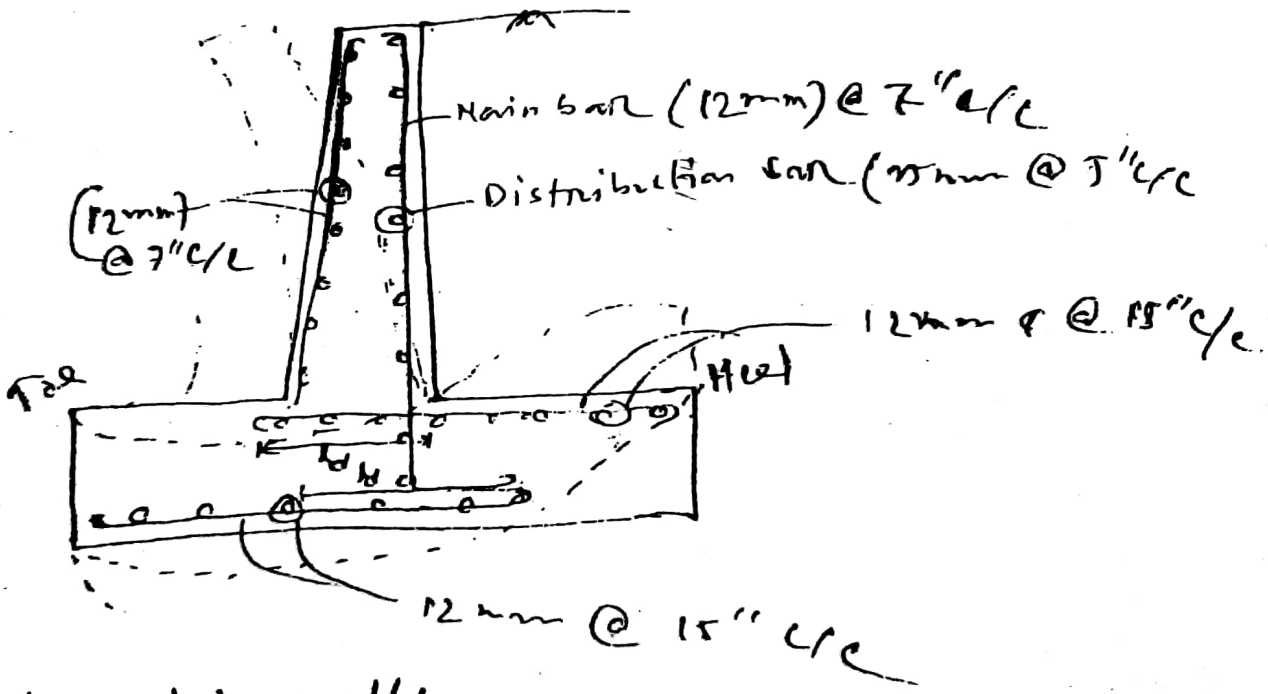
Effective stress: stress carried by soil particles.

Total stress: stress carried by soil & water.

N-value: The number of blows required to drive the SPT sampler over the depth interval of 150 mm to 450 mm. No. of blows for 1st 150 mm is neglected to avoid scaling errors.

Exit Gradient: The exit gradient is the hydraulic gradient at the downstream end of the flow line. Exit Gradient, $= \frac{\Delta h}{l}$

Detailing of retaining wall:



Types of Retaining wall:

1. Gravity retaining wall
2. Cantilever " "
3. Counterfort " "
4. Semi-gravity " "

Jamuna Bridge (Bangabandhu Bridge)

open in 1998 (June) → 4.63 Km → 6th longest in south asia.
connects Bhuapur and Sirajganj.
width → 18.5 m
long span – 100 m

padma Bridge :

→ Louhajang, Mawsliganj, Madaripur, Shariatpur
→ 6.15 Km length → 18.1 m width.
→ start construction → 7 Dec. 2014
→ ending → Dec 2020,
→ constructed by → China major Bridge Engineering Authority.

Harding Bridge

→ Paksey, Pabna, Ishwardi.
→ Named after Lord Harding
→ 1.8 Km long (truss structure)
→ 1910 সালে শুরু হয় এবং ১৯১২ সালে শেষ, train চলে 1915 সালে।

Khan Jahan Bridge

→ 1.6 Km long – 16.48 m width.
→ open 2015.

[illegible]

1. [illegible] . A bad workman quarrels with his tools.
2. [illegible] – A burnt child always fears fire.
3. [illegible] – A cat has nine lives.
4. [illegible] – A cat loves fish but is loath to wet her feet.
5. [illegible] – A little learning is a dangerous thing.
6. [illegible] – A stitch in time saves nine.
7. [illegible] – A tree is known by its fruit.
8. [illegible] – After cloud comes fair weather.
9. [illegible] – After death comes the doctor.
10. [illegible] – After meat comes mustard.
11. [illegible] – All covet, all lost.
12. [illegible] – All that glitters, is not gold.
13. [illegible] – All's well that ends well.
14. [illegible] – As you sow, so you reap.
15. [illegible] – Bachelor's wives and maid's children are always well taught

16. [illegible] – Barking dogs seldom bite.

17. [illegible] – Better an empty house than an ill tenant.

18. [illegible] – Birds of a same feather flock together.

19. [illegible] – Black will take no other hue.

20. [illegible] – Carry coal to Newcastle.

21. [illegible] – Cut your coat according to your cloth.

22. [illegible] – Diligence is the mother of good luck.

23. " " [illegible] – Industry is the mother of success.

24. [illegible] – Empty vessels sound much.

25. [illegible] – Risk all to win

26. [illegible] – Example is better than precept.

27. [illegible] – Grapes are sour.

28. [illegible] — Grasp all, lose all.

29. [illegible] – It takes two make a quarrel.

30. [illegible] – Look before you leap.

31. জোর যার, মুলুক তার - Might is right.

32. প্রয়োজনই আবিষ্কারের প্রসূতি → Necessity is the mother of invention.

33. প্রয়োজন আইন মানে না → Necessity knows no law.

34. কারো পৌষমাস কারো সর্বনাশ - Nero fiddles while Rome burns.

35. কষ্ট না করলে কেষ্ট মেলে না → No pain, no gain

36. এক মাঘে শীত যায় না - One swallow does not make a summer.

37. লোহা গরম লোহা মারো - Strike the iron while it is hot.

38. ইটটি মারলে পাটকেলটি খেতে হয় - Tit fot tat

39. অধিক সন্ন্যাসীতে গাজন নষ্ট - Too many cooks spoil the broth.

40. অপচয় করো না, অভাব হবে না - waste not, want not.

41. অতি ভক্তি চোরের লক্ষণ - Too much courtesy, too much craft.

42. ডিম না ভেঙে ওমলেট হয় না → We do not believe in omulet.

43. প্রত্যেক মানুষের জীবনে লক্ষ্য থাকা উচিত - Every person should have specific goal in life.

44. সুখ-দুঃখ মানুষের জীবনে পালাক্রমে আসে - Happiness and sadness come by rotation in human life.

45. উটকে মরুভূমির জাহাজ বলা হয় - The camel is called the ship of the desert.

46. পদ্মা বাংলাদেশের প্রধান নদীগুলোর একটি - The padma is one of the main rivers in bangladesh.

47. বাংলাদেশ একটি নিম্ন মধ্যম আয়ের দেশ - ~~[illegible]~~ Bangladesh is a middle in come country.

48. একজন মুসলমানের দিনে পাঁচ ওয়াক্ত নামাজ পড়া উচিত - A muslim should pray salat five time in a day.

49. শিশুরা ফুলের মত নিষ্পাপ - Children are like flowers.

50. পাপীরা পরিণামের ভয় পায় → sinners are afraid of results.