

INTRODUCTION TO SANITATION

* **Garbage:-**

This term is used to indicate dry refuse and it includes decay fruits, grass, leaves, sweepings and vegetables etc.

* **Sewage:-**

The term is used to indicate the liquid waste from the community and it includes sewage, effluvia from animals, etc., vegetables etc., industrial waste and storm water (rain).

* **Combined sewage:-**

It indicates the combination of sanitary sewage and the storm water with or without industrial waste.

* **Sullage:-**

Waste water from bathrooms, kitchen etc.

* **Sewer:-**

The underground conduit or drain through which sewage is conveyed.

* **Sewerage:-**

The entire science of collecting and carrying sewage and treatment through sewer.

* **Rubbish:-**

All sundried solid waste are papers, broken-furnitures, waste, waste building materials, pottery etc.

* Methods of collection:-

Two types

- ① conservancy system
- ② water carrying system

* Sewerage system

Three types

- ① combined → Storm water + Domestic waste → single pipe
- ② separate → 2 pipes ← storm
Domestic
- ③ ..

Heavy rains during small period

- ④ Partially separate

① Combined system:-

When only one set of sewer is laid carrying both the sanitary sewerage and storm water

combined system is mostly used in the areas having small rainfall which is evenly distributed throughout the area

In crowded areas also this system is used

② Separate system:-

When the domestic and industrial sewage are taken in one set of sewers whereas storm and surface water are taken in another set of sewers

Rainfall is heavy when it is short period, it is better to provide separate system

③ partially separate system:-

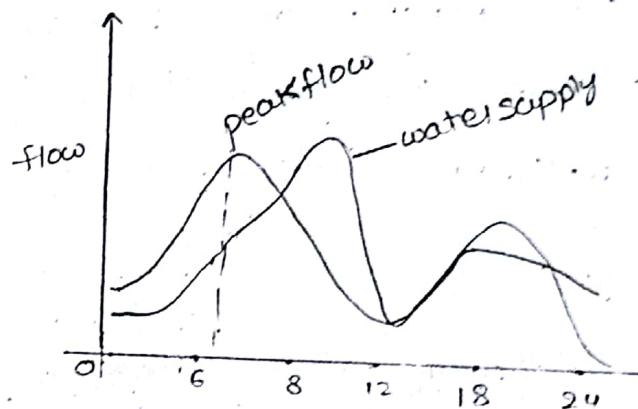
If a portion of storm water is allowed to enter in the sewers to carrying sewage and the remaining storm water flows in separate set of sewers

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* Factors affecting sanitary sewage:-

- population
- Rate of water supply — lit/capital/day
- Type of area served as residential, Industrial
- Ground water infiltration

* Variation of sewage:-



- Dry weather flow → sanitary sewage.
- Wet weather flow → storm water,
- Net quantity of sewage → water supplied + additional private water + infiltration - subtraction due to water losses
 - not entering the sewerage system
- Maximum daily flow → 2 × annual average daily flow
- Maximum hourly flow → 1.5 × maximum daily flow
 - 3 times

Minimum daily flow = $\frac{2}{3}$ (annual average daily flow)

Minimum hourly flow = $\frac{1}{3}$ (minimum daily flow)

= $\frac{1}{3}$ (annual average daily flow)

Note:-

Generally 70 to 80% of accepted water supply is considered as quantity of sewage produced

- * A city has a projected population of 60,000 spread over an area of 50 hectares. Find the design discharge for the separate sewer line by assuming rate of water supply of 250 Lpcd (lit/capital demand) and out of this total supply only 75% reaches in sewer as waste water.
- Mention necessary assumptions.

Sol

Given data : Population = 60,000

$$\text{Rate of supply} = 250 \text{ litre/capital demand day}$$

↓
75%

$$\text{Sewage} = 60,000 \times 250 \times 0.75$$

$$= 1125 \times 10^4 \text{ litre/day}$$

$$= \frac{1125 \times 10^4 \times 10^{-3}}{24 \times 60 \times 60}$$

$$\left[10^4 = 10^{-3} m^3 \right]$$

$$\text{Discharge} = 0.13 m^3/\text{sec}$$

Assuming peak factor is in b/w 1 to 2.5

$$\text{Total design discharge} = 2 \times 0.13$$

$$= 0.26 m^3/\text{sec}$$

- * Factors affecting storm water:-
- Area of catchment
- shape & size of catchment
- nature of soil
- Obstructions (trees, fields, garden)
- Intensity & duration of rainfall

* Estimation of rainfall

2 methods

$$\textcircled{1} \quad \textcircled{2} \quad \text{Rational } Q = \frac{CIA}{360} \text{ (m}^3\text{/sec)}$$

A = Area (hectares)

I = Intensity (mm/hr) of rainfall

C = coefficient of runoff

$$= \frac{C_1 A_1 + C_2 A_2 + \dots + C_n A_n}{A_1 + A_2 + \dots + A_n}$$

$$Q = \frac{25.40}{t+b}$$

$a = 30, b = 10$ when $t = 540$ min

$a = 40, b = 20$ when $t = 20$ min

$t = \text{time of entry} + \text{time of flow}$

~~17/17~~ Time of concentration :-

The period after which the entire catchment area will start contributing completely to the runoff

* Time of entry :-

Time taken by the rainfall to run from the most distant point of the watershed to the inlet of the sewer

* Time of flow :-

It is the time required for the flow of water in the sewer to the point under consideration

time of concentration = time of entry + time of flow

- * The catchment area of a city is 200 hectares. Assuming that the surface on which the rainfall is distributed as follows

Type of surface	% of area	Runoff coefficient
Roof	20	0.9
Pavement & yards	15	0.8
Towns gardens	30	0.15
Macadamised roads	20	0.40
Vacant plots	15	0.10

- a) calculate the impervious factor if maximum intensity of rainfall is 40mm/hr. calculate the quantity of storm water which will reach sewer lines

(a)

$$\text{Given data } A = 200 \text{ hectares}$$

$$I = 40 \text{ mm/hr}$$

$$A_1 = \frac{20 \times 200}{100} = 40 \text{ hectares}$$

$$A_2 = \frac{15 \times 200}{100} = 30 \text{ hectares}$$

$$A_3 = \frac{30 \times 200}{100} = 60 \text{ hectares}$$

$$A_4 = \frac{20 \times 200}{100} = 40 \text{ hectares}$$

$$A_5 = \frac{15 \times 200}{100} = 30 \text{ hectares}$$

$$C = \frac{C_1 A_1 + C_2 A_2 + \dots + C_5 A_5}{A_1 + A_2 + \dots + A_5}$$

arperian
factor C

$$C = \frac{0.9 \times 40 + 0.8 \times 30 + 0.15(60) + 0.4(40) + 0.1(30)}{40 + 30 + 60 + 40 + 30}$$
$$= 0.44$$

Rational method $A = \frac{CIA}{360}$

$$= \frac{0.44 \times 40 \times 200}{360}$$

$$Q = 9.77 \text{ m}^3/\text{sec}$$

- b) If the density of population is 300 persons per hectare and the rate of water supply is 250 lit/capita/day calculate the quantity of sanitary sewage for separate system and partially separate system.

$$1 \rightarrow 300 \text{ p/ha}$$

$$300 \rightarrow$$

$$200 \times 300 = 60,000$$

$$Q = \frac{60,000 \times 250}{24 \times 3600} \quad : P \times A \times 250$$

$$= 173.61 \text{ lit/sec}$$

$$\text{Design discharge} = 2 \times 173.61$$

$$= 347.22 \text{ lit/sec}$$

$$= 0.347 \text{ m}^3/\text{sec}$$

partially separate system:

$$Q = \frac{CIA}{360}$$

C \rightarrow roofs, pavement & yards

$$C = \frac{40 \times 0.9 + 0.8 \times 30}{40 + 30} = 0.857$$

$$Q = \frac{0.857 \times 40 \times 900}{360}$$

$$= 19 \text{ m}^3/\text{sec}$$

$S = \text{Stormwater} + \text{Surf}$

$$= 19 + 0.173$$

$$= 19.173 \text{ m}^3/\text{sec}$$

- * A certain district of a city has a projected population of 50,000 residing over a area of 40 hectares find the design discharge for the following sewer line for the following data

Rate of water supply = 200 lit/capita/day

Average impermeability coefficient for the entire area = 0.3

Time of concentration = 50 min

The sewer line is to be designed for the flow equivalent to the wet weather flow + twice the dry weather flow

Use Rational method. Assume that 75% of water supply reaches in sewer as waste water

$$\mathcal{I} = 0.3$$

$$A = 40 \text{ hectares}$$

$$T = 50 \text{ min}$$

$$\text{Population} = 50,000$$

$$\text{water supply} = 200 \text{ lit/capita/day}$$

$$\text{For } t = 50 \text{ min}, \quad a = 40; \quad b = 20$$

Quantity
dry

$$\text{sewage} = 50,000 \times 200 \times 0.75$$

$$= 7500000 \text{ lit/day}$$

$$= \frac{7500000}{24 \times 60 \times 60}$$

$$= 86.80 \text{ lit/sec} \Rightarrow 86.80 \times 10^3$$

$$0.0868 \text{ m}^3/\text{sec}$$

$$Q = \frac{25.4 Q}{t+b}$$

$$= \frac{25.4(40)}{50+20}$$

$$= 14.51 \text{ mm/hr.}$$

Closed

wet weather flow $Q = \frac{CIA}{360}$

$$0.3 \times 14.51 \times 40$$

$$360$$

$$= 0.483 \text{ m}^3/\text{sec}$$

area

$$Q = \text{wet weather flow} + 2 \text{ (dry weather flow)}$$

expected

flow equivalent

$$= 0.483 + 2(0.0868)$$

an

$$= 0.6566 \text{ m}^3/\text{sec}$$

porously

led to

strategic

1
A
Estimate the peak flow in m^3/sec for the design of sewers
for a population of 240 per hectare spread over an area
12 km^2 . Assume water supply of 135 lit/capital/day, with a
sewage generation of 75% of the water supply.

peak factor 2.25

Given data population = 240 / hectare

$$1 \text{ sq km} \\ = 100 \text{ hect}$$

$$A = 12 \text{ km}^2 \rightarrow 12 \times 100 = 1200 \text{ hectares}$$

$$\text{water supply} = 135 \text{ lit/capital/day}$$

sewage enters in a sewer by water supply 75%.

peak-factor = 2.25

Quantity of sewage emitted into sewer by water supply

$$\text{dry weather flow} = \frac{135 \times 240 \times 1200 \times 0.45}{24 \times 60 \times 60}$$

$$Q_1 = 337.5 \text{ litres/sec}$$

$$= 337.5 \times 10^3 \text{ m}^3/\text{sec}$$

$$= 0.3375 \text{ m}^3/\text{sec}$$

Quantity of sewage entering due to storm (wet weather flow)

$$Q_2 = \frac{CIA}{360}$$

$$\text{Design discharge} = \text{peak-factor} \times Q_1$$

$$Q_L = 2.25 \times 0.3375$$

$$= 0.759 \text{ m}^3/\text{sec}$$

* Discuss the various methods for estimating sewage flow and storm water flow

so

Estimating Storm water flow:

2 methods

① Rational method:

$$Q = \frac{CIA}{360}$$

② Empirical formula methods.

(i) BUIKLI - Zeigler formula

$$Q = 296 CR_i A (SLA)^{1/4}$$

2. Scouring velocity :-

It is the maximum flow velocity at which there is no scouring of sewer interior material.

* Types of sewers :- Classification based on material

① Asbestos cement (AC) pipes sewers

No effect to acids & salts

Cannot carry heavy loads

They are laid vertically

② Light-weight pipes sewers

③ Steel - sewer

④ Brick - sewer

⑤ plastic - sewer

⑥ CI sewer (cast Iron)

⑦ cement sewer

Classification based on layout (collection)

Lateral sewer

sub main sewer

main / trunk sewer

outfall sewer (treatment plant)

* Sewer appurtenances :-

→ Man hole

deep

medium

shallow

M.

* Drop man hole

* Lamp holes

→ Street Poles

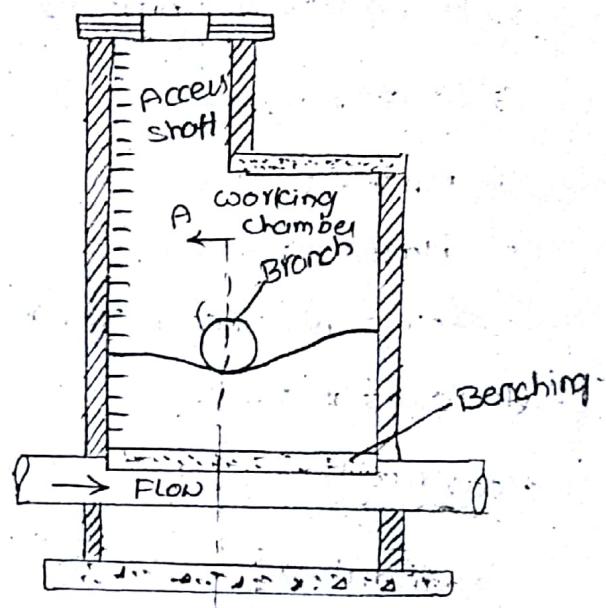
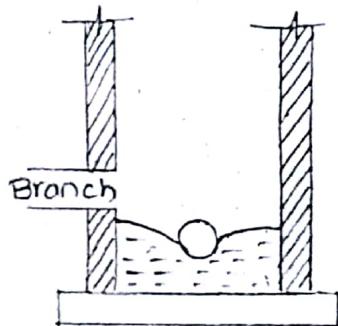
- catch basin
- flushing tank
- grease and oil traps
- inverted siphon

Sewer appurtenances :-

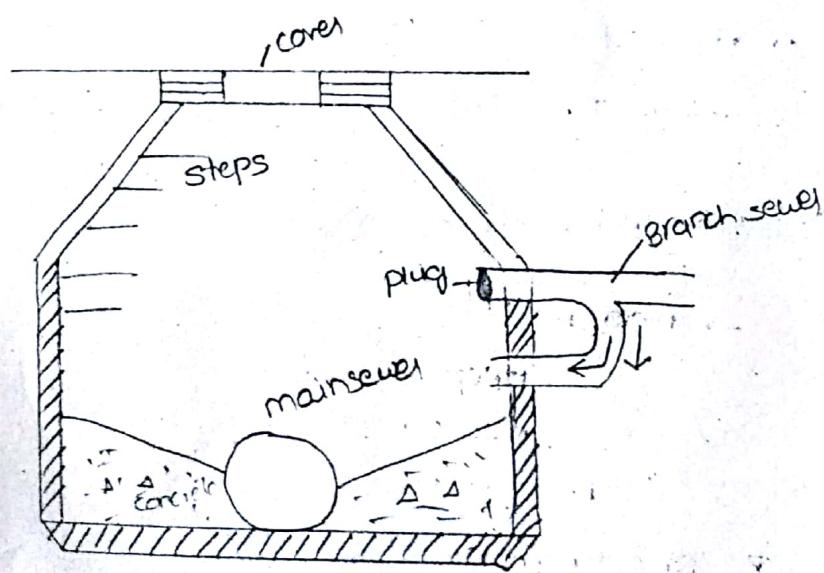
Those structures which are constructed at suitable intervals along a sewerage system and help in its efficient operation and maintenance.

12/11/17

Manholes :-

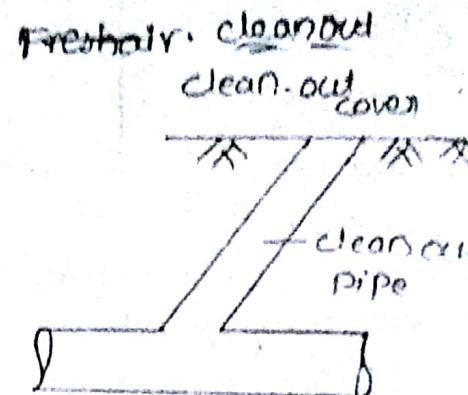
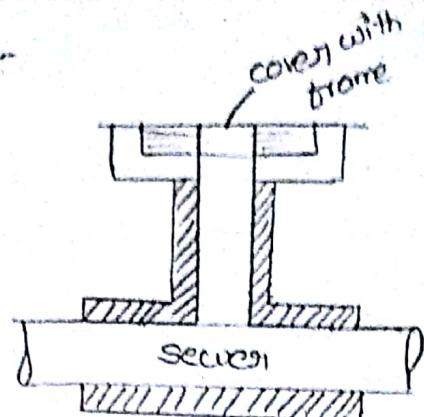


Drop manhole :-

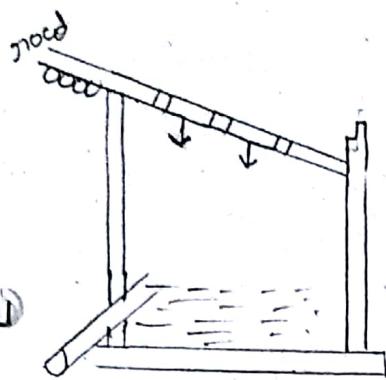


Lamp hole:
(on)

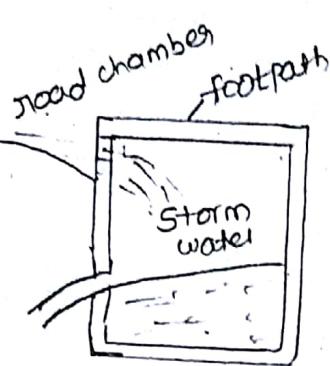
Fresh air inlet



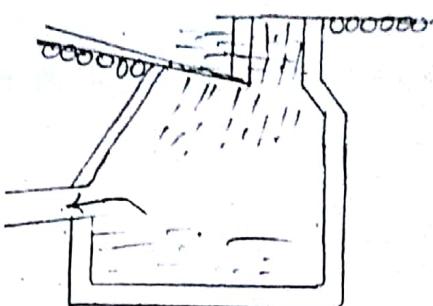
Street inlets: 3 types



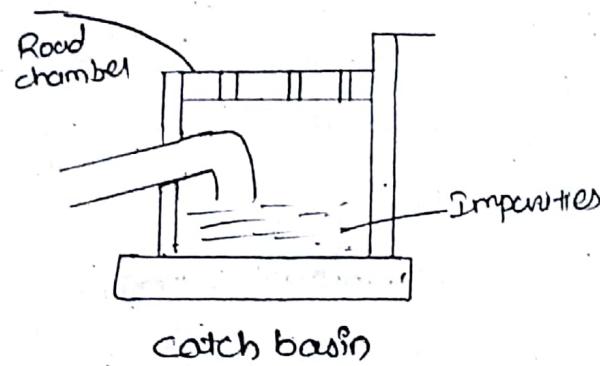
Gutter inlet



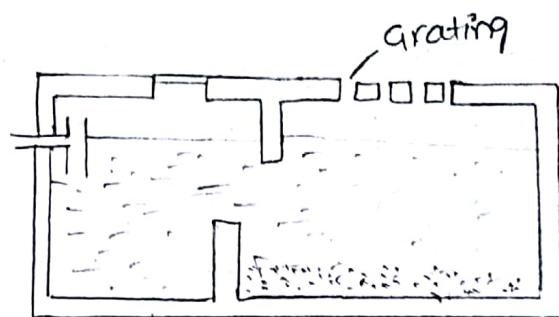
Curb inlet



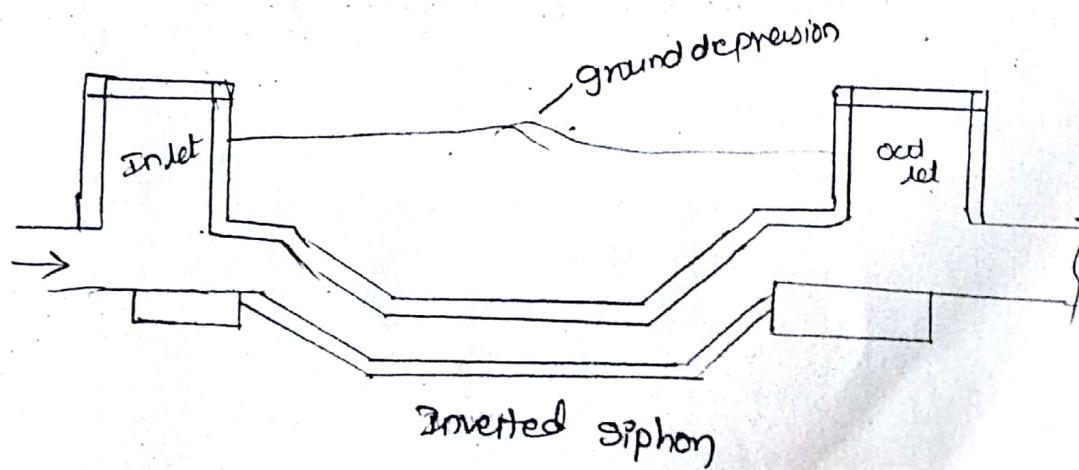
Combined gutter and
Curb inlet



Catch basin

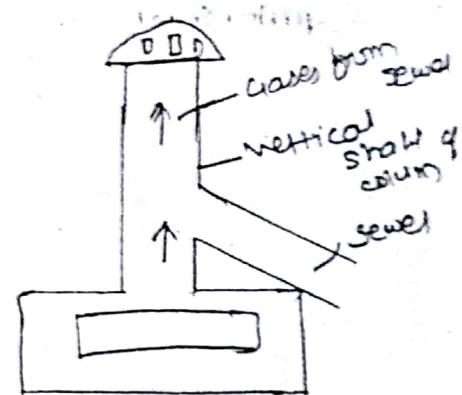
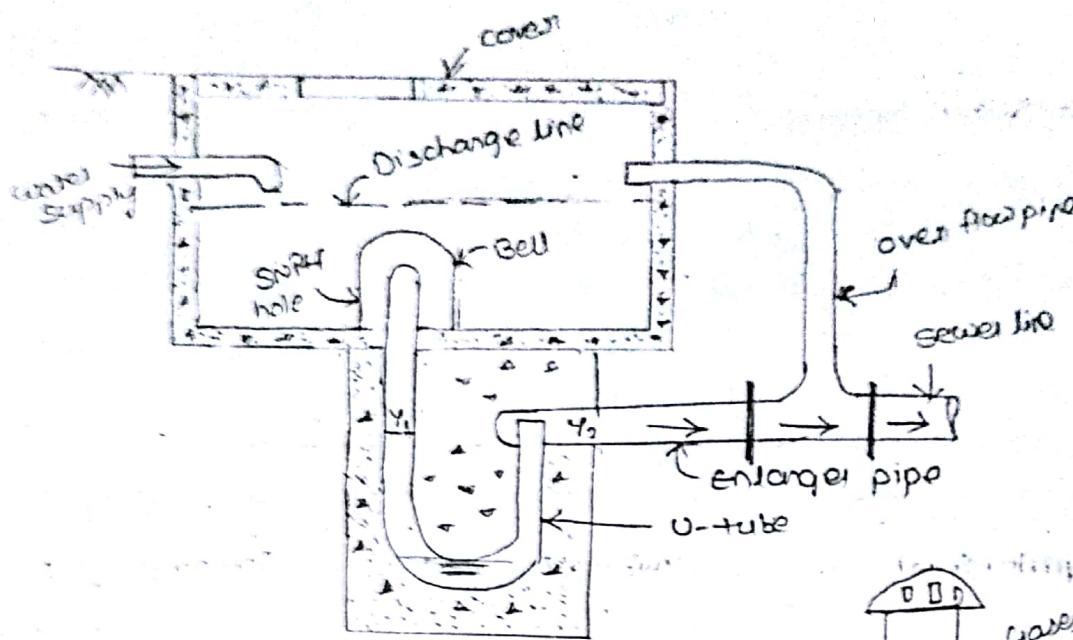


sand, grease and oil traps



* Flushing toilet
pg. 153

Automatic
Hand operated



Ventilating column

pg. 156

- * Cleaning and maintenance of sewer

Pumping of waste water

necessity of pump:-

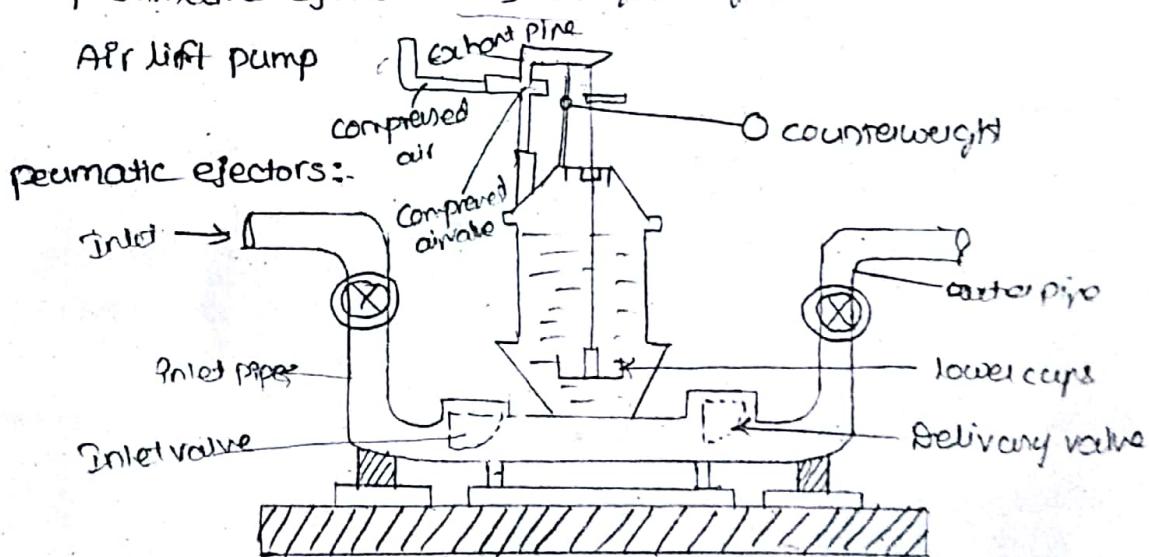
- Low lying areas
- Basement
- Ridges
- out fall lift

Location of pumping station:-

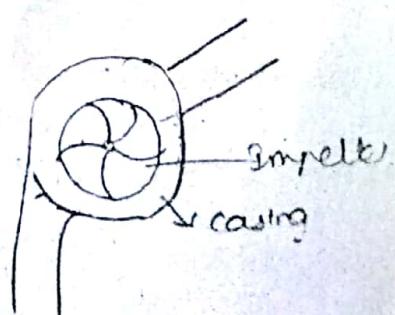
- Topography
- Elevation
- Bedrock

(i) Types of pumps:-

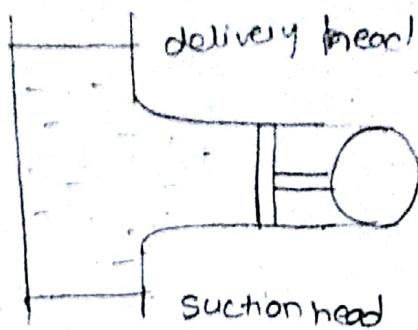
- Centrifugal pumps ^{It contains impeller} → more efficiency, discharge
- Reciprocating → dust particles is present then it knots, clogging
- Pneumatic ejectors ^{Fo} → small quantity delivers
- Air lift pump



centrifugal pump



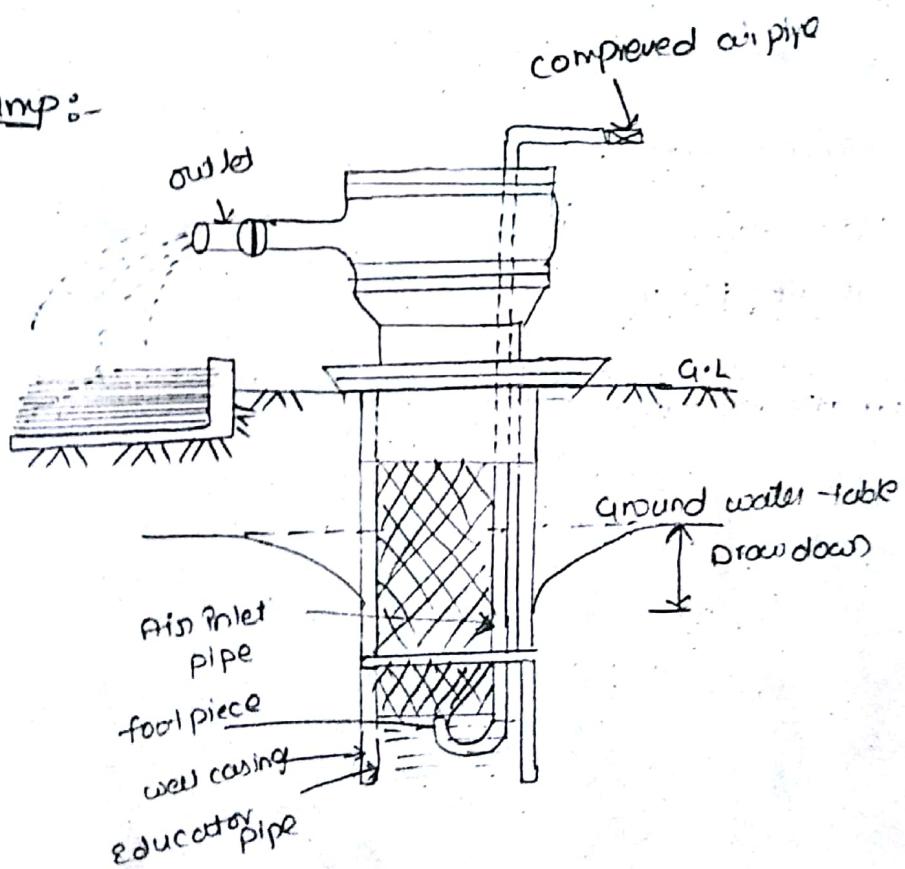
Reciprocating pump:-



* Advantages of pneumatic ejectors :-

- Automatic, no escape of sewer gases
- Less chance of clogging

Air lift pump:-



- Works on compressed air
- No moving parts, Hence ^{more} suitable for sewage pumping
- It consists of vertical pipe called educator pipe

b) Hatt's formula

$$Q = 292 C R^2 A (SIA)^{1/5}$$

c) Metcalf and Eddy's formula

$$Q = 28.32 \left[\frac{25000}{2.47 A + 125} + 15 \right]$$

d) Faller's formula

$$Q = \frac{CM^{0.8}}{13.23}$$

e) Fanning's formula

$$Q = 12.8 M^{5/8}$$

f) Talbot's formula

$$Q = 22.4 M^{1/4}$$

Q = runoff in m^3/sec

C = runoff coefficient

I = intensity of rainfall in cm/hr

S = slope of the area in metre/ thousand meters

A = drainage area in hectares

M = drainage area sq cm

(H1W)

* Determine the design peak flow in m^3/sec for an area of 6.25 sq km with a density of population of 330 person/hectare. Assume per capita water supply 150 Lpcd and sewage contribution of 70% of water supply. Given data

$$A = 6.25 \text{ km}^2 = 6.25 \times 1000000 = 625 \text{ m}^2$$

$p = 330 \text{ person/hectare}$

water supply = 150 Lpcd

sewage contribution = 70%

peak-factor (1.5 to 3) = 2.5

Quantity of actual sewage entered into sewer by water flow supply

$$\text{dry weather flow} = \frac{150 \times 330 \times 625 \times 0.7}{24 \times 60 \times 60}$$

$$Q_1 = 250.65 \text{ litres/sec}$$

$$= 0.25 \text{ m}^3/\text{sec}$$

$$1 \text{ litre} = 10^{-3} \text{ m}^3$$

$$\text{Design discharge} = \text{peak-factor} \times Q_1$$

$$= 2.5 \times 0.25$$

$$= 0.625 \text{ m}^3/\text{sec}$$

* Design of sewers :-

circular section

Sewers are designed to

① Fix the cross-section of sewer

② Slope of sewer

Sewer are designed as open channels through closed conduits are used

For design purpose, formulas used are

a) continuity equation

$$Q = AV$$

b) Manning's formula

$$V = \frac{1}{n} r^{2/3} s^{1/2}$$

Sewer always carry partial flow i.e., empty space is provided inside the sewer to accomodate unexpected unforeseen, incidental sewage flow. That space can also be used to accomodate gases evolved temporarily

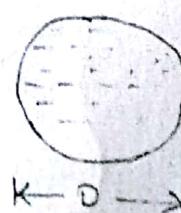
Circular geometric cross sections are preferred to

Other geometric cross-sections because they are hydrologically more efficient

→ Sewer are running full.

$$V = C \sqrt{m i}$$

$$V = \frac{1}{n} m^{2/3} s^{1/2}$$



m = hydraulic mean depth

$$\text{wetted area } A = \frac{\pi D^2}{4}$$

$$\text{wetted perimeter } P = \pi D$$

$$m = \frac{A}{P} = \frac{\frac{\pi D^2}{4}}{\pi D} = D/4$$

iii) sewer one running half full.

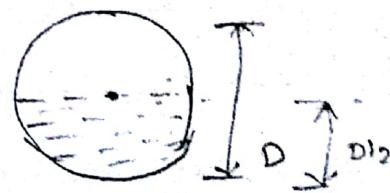
m = hydraulic mean depth

$$A = \frac{\pi D^2}{4} \times \frac{1}{2} = \frac{\pi D^2}{8}$$

$$P = \pi D \times \frac{1}{2}$$

$$m = \frac{A}{P} = \frac{\frac{\pi D^2}{8}}{\pi D/2} = \frac{D}{4}$$

$$m = D/4$$

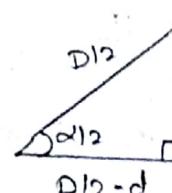
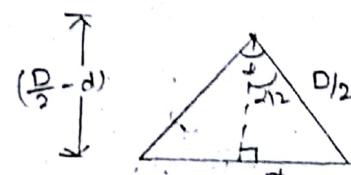
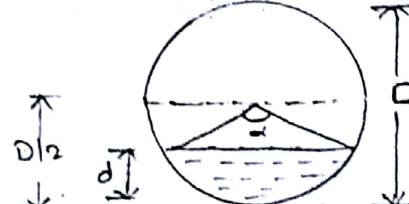


iii) Partially filled sewer

Depth of partial flow

$$d = \left(\frac{D}{2} - \frac{D}{2} \cos \alpha_{1/2} \right)$$

$$\text{Proportionate Depth} = \frac{d}{D}$$



$$\sin \alpha_{1/2} = \frac{d}{D}$$

$$d = \frac{D}{2} \sin^2 \frac{\alpha_{1/2}}{2}$$

$$\cos \alpha_{1/2} = \frac{(D/2 - d)}{D/2}$$

$$d = \frac{D}{2} - \frac{D}{2} \cos \alpha_{1/2}$$

a = area of flow

- area of sector - area of triangle

$$\frac{\pi D^2}{4} \cdot \frac{d}{360} = \frac{1}{4} [\pi (\frac{D}{2} + d) (\frac{D}{2} - \sin \frac{d}{2})]$$

in min. o

equivalent

by g

$$\frac{\pi D^2}{4} \cdot \frac{d}{360} = \left[\frac{D}{2} \cos \frac{d}{2} + \frac{D}{2} \sin \frac{d}{2} \right]$$

sin & cos law

$$\frac{\pi D^2}{4} \cdot \frac{d}{360} = \left[\frac{D^2}{4} \cdot \sin \frac{d}{2} \right] \quad \frac{\sin \frac{d}{2}}{\frac{D}{2}} = \sin \frac{d}{2} \cdot \cos \frac{d}{2}$$

$$\frac{\pi D^2}{4} \left(\frac{d}{360} - \frac{\sin \frac{d}{2}}{2\pi} \right)$$

$$\text{circ. area} = \frac{a}{A}$$

$$= \frac{\pi D^2}{4} \left(\frac{d}{360} - \frac{\sin \frac{d}{2}}{2\pi} \right)$$

$$\frac{\pi D^2}{4}$$

$$\frac{a}{A} = \frac{d}{360} - \frac{\sin \frac{d}{2}}{2\pi}$$

0.014

$$\text{perimeter } \phi = \pi D \cdot \frac{d}{360}$$

or 44.2

pe of

0.4405

c

$$P = \pi D$$

12

$$\text{circular perimeter} = \frac{p}{P} = \frac{\pi D \frac{d}{360}}{\pi D} = \frac{d}{360}$$

$$\Rightarrow \frac{d}{360}$$

in depth

$$= \frac{a}{P} = \frac{\left(\frac{d}{360} - \frac{\sin \frac{d}{2}}{2\pi} \right) \frac{\pi D^2}{4}}{\left(\frac{d}{360} \right) \pi D}$$

ring at

$$= \frac{D}{H} \left[1 - \frac{\sin \frac{d}{2}}{2\pi} \times \frac{360}{2} \right]$$

the

$$\frac{a}{P} = \frac{\pi D^2}{4} / \pi D \Rightarrow \frac{D}{4}$$

Proportionate hydraulic mean depth

$$\frac{m}{M} = \frac{D\bar{h} \left[1 - \frac{360^\circ \sin \alpha}{2\pi d} \right]}{D\bar{h}}$$

$$= \left[1 - \frac{360^\circ \sin \alpha}{2\pi d} \right]$$

5.1.1.1

Proportionate velocity

λ = velocity

v = velocity of partial flow, $v = \frac{1}{n} r^{2/3} \sqrt{S_0}$ or

$$\frac{1}{n} m^{2/3} \rho^{1/2}$$

$$\frac{v}{v} = \left[1 - \frac{360^\circ \sin \alpha}{2\pi d} \right]^{2/3}$$

$$v = \frac{1}{n} m^{2/3} \rho^{1/2}$$

$$v = \frac{1}{n} M^{2/3} \rho^{1/2}$$

$n \rightarrow$ constant; manning's coefficient of roughness

$$\frac{v}{v} = \left(\frac{m}{M} \right)^{2/3}$$

$\rho \rightarrow$ constant

$$Q = AV$$

$$\frac{Q}{A} = \frac{\pi D^2}{4} \left[1 - \frac{360^\circ \sin \alpha}{2\pi d} \right]^{2/3} \\ \left[\frac{\pi D^2}{4} \left(\frac{\alpha}{360} - \frac{\sin \alpha}{2} \right) \right]$$

Proportionate discharge

$$\frac{q}{a} = \frac{av}{Av} = \left(\frac{a}{A} \right) \left(\frac{v}{v} \right)$$

$$= \left(\frac{\alpha}{360} - \frac{\sin \alpha}{2\pi} \right) \left[1 - \frac{360^\circ \sin \alpha}{2\pi d} \right]^{2/3}$$

* A 350mm dia sewer is to flow at 0.35 depth on a grade ensuring a degree of self cleaning equivalent to that obtained at full depth at a velocity of 0.8 m/sec. find the required grade

i) Associated velocity

ii) Rate of discharge at this depth

Hannings roughness coefficient - 0.014

proportionate area - 0.315

proportionate wetted perimeter - 0.472

proportionate hydraulic mean depth - 0.7705

Self-cleansing velocity :- minimum velocity

At full depth, $V = 0.8 \text{ m/sec}$, $D = 0.35 \text{ m}$, $n = 0.014$

At 0.35 depth; $\frac{d}{D} = 0.35$, $\frac{A}{n} = 0.315$, $\frac{P}{P} = 0.472$

At full depth

$$\frac{m}{M} = 0.7705$$

$$V = \frac{1}{n} m^{2/3} g^{1/2}$$

$$0.8 = \frac{1}{0.014} (D/4)^{2/3} P^{1/2}$$

$$0.8 = \frac{1}{0.014} \left(\frac{0.35}{4}\right)^{2/3} g^{1/2}$$

$$g = 3.239 \times 10^{-3}$$

now for a sewer to be the same self cleansing at 0.35 depth as it will be at full depth, we have the gradient required from the equation

$$\frac{S_s}{S} = \frac{M}{m}$$

$$S_0 = \frac{H}{m} \times s$$

$$\left(\frac{m}{H} = 0.4705 \right)$$

$$S_0 = \frac{1}{0.4705} \times 3.209 \times 10^{-3}$$

$$S_0 = 4.2 \times 10^{-3}$$

velocity generated at this grade at 0.35 depth is given by equation

$$V_0 = \frac{N}{n} \left(\frac{m}{H} \right)^{1/6} V$$

$$= 1 \times (0.4705)^{1/6} \times 0.8$$

$$= 0.465 \text{ m/sec}$$

Now discharge

$$q_0 = a V_0$$

$$= \frac{\pi}{4} (0.35)^2 \times 0.315 \times 0.465$$

$$= 0.023 \text{ cumec}$$

$$\frac{a}{A} = 0.315$$

$$a = 0.315 \times A$$

* * P

Determine the size of circular sewer for a discharge of 800 lit/sec running half-full. Assume hydraulic gradient of 1 in 1250 and Manning's coefficient $n = 0.012$. ~~Q = 800 lit/sec~~

$$n = 0.012$$

$$Q = 800 \text{ lit/sec}$$

$$= 0.8 \text{ m}^3/\text{sec}$$

$$Q = AV$$

$$V = \sqrt{m^2 B g^{1/2}}$$

$$= \sqrt{(D/t)^{2/3} g^{1/2}}$$

$$= \frac{1}{0.012} \left(\frac{D}{t}\right)^{2/3} g^{1/2}$$

$$\Rightarrow Q = AV$$

$$\Rightarrow 0.8 = \int \frac{\pi}{4} (D)^2 \left[\frac{1}{0.012} \left(\frac{D}{t}\right)^{2/3} g^{1/2} (0.02828) t \right]$$

$$\Rightarrow 0.4321 = D^2 \left(\frac{D}{t}\right)^{2/3}$$

$$\Rightarrow 0.4321 = D^2 D^{2/3} (0.3968)$$

$$\Rightarrow 1.0887 = D^{8/3}$$

$$\Rightarrow [D = 1.03m]$$

- * A RCC sewer of 500mm diameter is laid at a slope of $1\text{ in }750$ using Ritter's equation for calculating C Chezy's equation. find the velocity and discharge

$$f = 0.012$$

Ritter's equation

$$C = \left(\frac{23 + \frac{155 \times 10^{-5}}{f} + \frac{1}{D}}{1 + \left(23 + \frac{155 \times 10^{-5}}{f} \right) \frac{D}{750}} \right)^{1/4}$$

$$n = 0.012$$

$$D = 500\text{mm} = 0.5\text{m}$$

$$f = \frac{1}{750}$$

$$m = \frac{D}{t} = \frac{0.5}{4} = 0.125\text{m}$$

$$C = \frac{23 + \frac{155 \times 10^{-5}}{(11.50)} + \frac{1}{0.012}}{1 + \left(23 + \left(\frac{155 \times 10^{-5}}{11.50} \right) \right) \frac{0.012}{10.125}}$$

$$C = \frac{107.4958}{1.82010}$$

$$C = 59.06$$

$$V = C \sqrt{mf}$$

$$= 59.06 \sqrt{0.125 \times 11.50}$$

$$= 0.762 \text{ msec}$$

$$Q = AV$$

$$= \frac{\pi}{4} (0.5)^2 (0.762)$$

$$= 0.149 \text{ m}^3/\text{sec}$$

* Self cleansing velocity:-

The minimum velocity at which no solids get deposited at the bottom of sewer convert of sewer

$$V_s = \sqrt{\frac{8K}{f} (s-1) gd}$$

$d \rightarrow$ diameter of particles

$K \rightarrow$ character of sediment

$f \rightarrow$ frictional factors

$s \rightarrow$ specific gravity of particles

$g \rightarrow$ acceleration due to gravity

- Air inlet pipe is located in the in the educator pipe
- top end of air inlet pipe is connected to air compressor
- compressed air is released throughout the air diffuser which is at bottom of inlet pipe
- Air is mixed with sewage and forms bubbles and forms having low specific gravity than sewage, hence the sewage inside the educator pipe gets lifted up as the density is low
- low efficiency
- can lift upto small heights only

* Types of pumping stations:-

pumping stations are provided with two separate wells

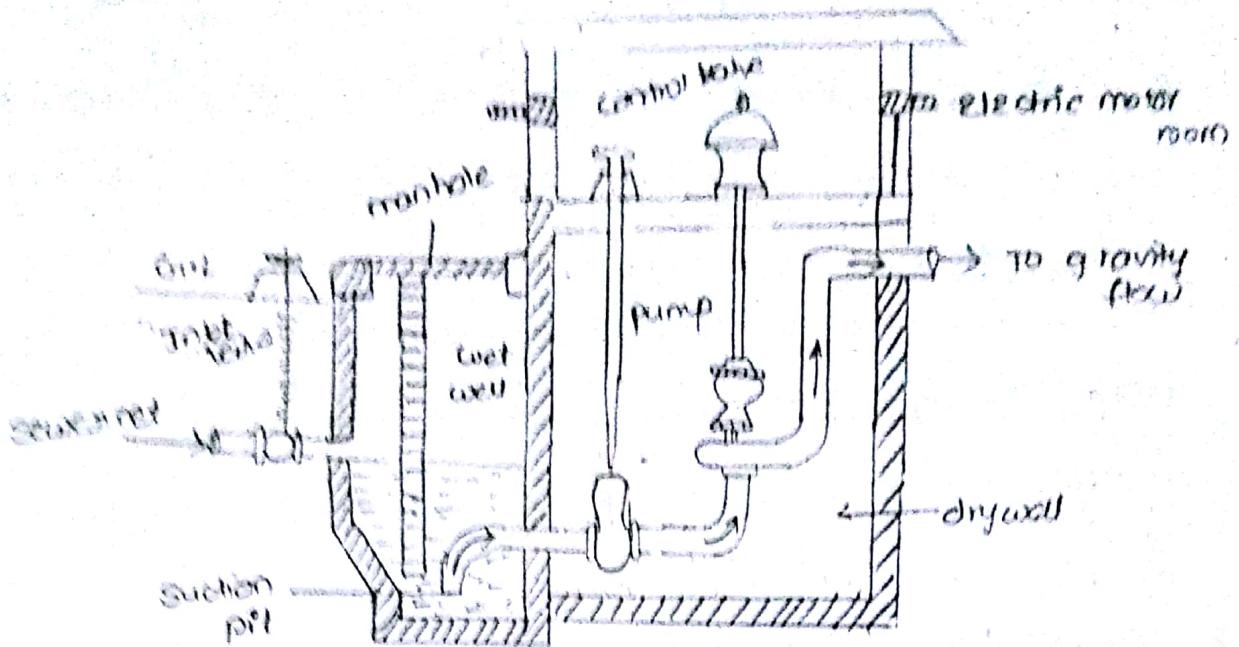
- ① wetwell for receiving the incoming sewage
- ② dry well for installing the pumps

These are 3 types for providing well

- circular with central dry well and peripheral wetwell
- rectangular with dry and wet wells adjacent to each other
- circular with dividing wall to separate the dry and wet well

* Components of pumping system:-

- ① structure of pump house
- ② screening & grit chamber
- ③ wetwell / sump well
- ④ drywell / pump room
- ⑤ pumping with driving engine
- ⑥ pipes, valves & fitting



Design period \rightarrow 30 years

① Structure of Pump house :-

- \rightarrow It should withstand the forces of floatation,
- \rightarrow Site should not be flooded
- \rightarrow Dry and wet wells should be of R.C.C structure
- \rightarrow Design for 30 years
- \rightarrow While designing 'pumphouse' provisions should be made for easy removal and installation of pumps and motor

② Screening and grit chamber :-

- \rightarrow Removal of sand, gravel, wood etc., from sewage before letting it to pumping station, or else there would be waste and tear of machinery
- \rightarrow Through screens floating matter is removed and in grit chambers heavier inorganic solids get settled down

③ Wetwell / Sumpwell :-

- Sewage from city is received from all pumping stations in a tank called Sump or wetwell
- capacity :- It can store for atleast 2 hours ~~day~~ ^{feed}
- prevent ~~days~~ ^{- tank} having capacity of 20 to 30 min is sufficient
- It is placed at the level than sewage from trunk sewers flows into it by gravity
- Gate walls to stop sewage flow during inspection

④ Pump room / Dry well :-

- place where pumps are installed
- size of dry well should be sufficient more numbers of pumps in the feature
- under ground masonry or RCC having circular or Rectangular shape in plan
- provide independent cells so that priming doesn't takes place
- usually pumps are not located in wet wells

⑤ Pumping with driving engine or motor :-

- In the dry well above the sewage level in the wetwell
- pumps can be directly coupled to driving units

⑥ Pipe, valves & fittings:-

- CI pipes are to be provided
- size of pipes to maintain flow velocity of 0.6 to 0.9 m/sec
- no of valves bends should be less to prevent losing head
- check valves to be provided in the sewer line to prevent the back flow of sewage during floods

19/7/14

* House drainage

- Arrangements provided in a house or building for collecting and conveying waste water flow to drain pipe by gravity to join either a public sewer or domestic septic tank is called house drainage
- Aim is to maintain health conditions to dispose the waste as early as possible

Principles of house drainage:-

- Minimum length of pipes are used
- The drainage pipe of multi storied building is provided at a single pipe out of the building
- self cleansing velocity must be followed
- traps are used in sanitary pipes
- minimum types of traps must be provided

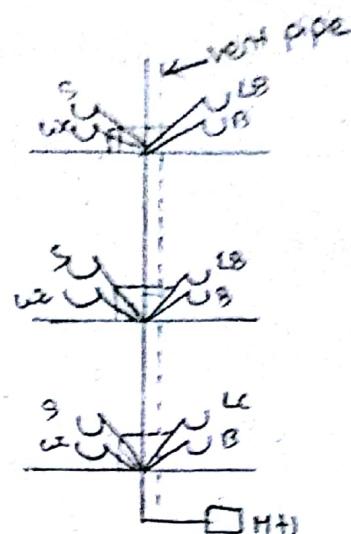
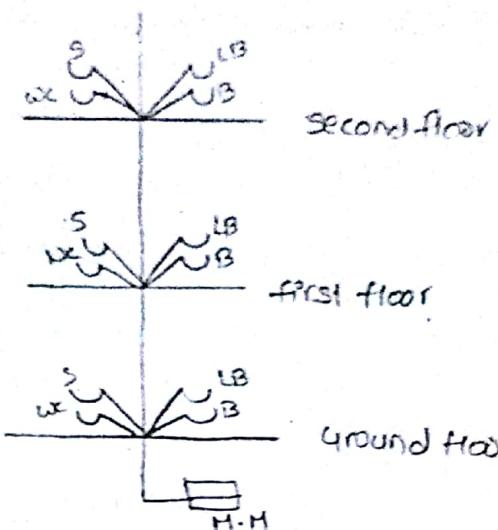
* sanitary fittings:

- Wash basin → Angle back for fixing at junction of 2 walls
- flat back for mounting on wall

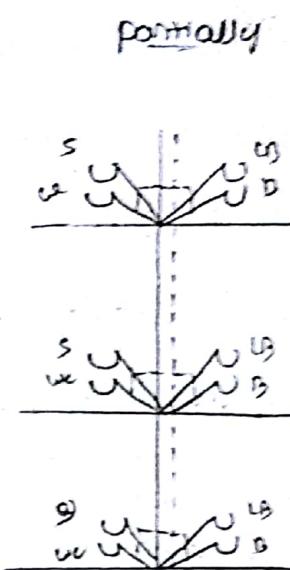
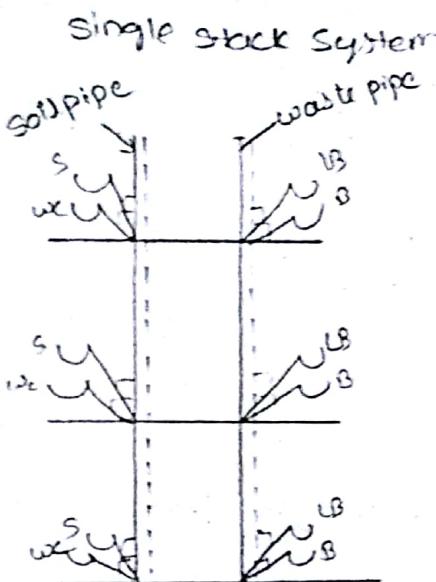
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21/11/17

* Systems of plumbing :-



S → sink
SC → water closet
LC → lavatory basin
B → Basin
HH → front hole



Two pipe system

single pipe system