Unit - II Sewer Design

Sewerage :-

. (2m) The complete system of collection of sewage & conveyance of sewage to treatment units by using sewers is called as sewerage system. This system network consists of house sewer, lateral sewer, branch sewer, main sewer, etc...,

Hydraulic flow in sewers :-

The water supply pipes does not carry out any wastes, but sewer pipes contain heavier particles which leads to clogging (blockage) in order to avoid it is necessary that pipes must be of such size at such gradient to generate self *.* cleaning velocities.

→ The sewers are design large enough to carry the max. sewage discharge while flowing (1/2 (or) 3/4 (or) 2/3 full)

. → Generally, the sewer pipe size less than 0.4 m φ are designed as running half full at maximum discharge

. → half full

. → 3/4 (or) 2/3

→ The sewer pipe is greater than 0.4 m 2/3 (or) 3/4 full.

Hydraulic formulas for determining flow velocities in sewers.

* Flow velocity ⟶ Design of sewers.

$$Q = AV$$

Chezy's formula:-

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

Circular channels: $R = D/4$ $(P = \pi D)$

V = Velocity of flow in channel

r = hydraulic mean depth / radius. $R = \frac{A}{P}$

S = hydraulic gradient.

C = Chezy's constant

Kutter's formula:-

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

$$C = \frac{\left(23 + \frac{0.00155}{S}\right) + 1/n}{1 + \left(23 + \frac{0.00155}{S}\right) \times \frac{n}{\sqrt{r}}}$$

n = rugosity co-efficient.

r = hydraulic mean depth

**

'n' for stone pipes = 0.012

'n' for Cement pipes (RCC) = 0.013

'n' for Caste iron = 0.012

Manning's formula:-

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

n = rugosity co-efficient

r = hydraulic mean depth

S = hydraulic gradient

Bazin's formula:-

$$C = \frac{157.6}{1.81 + K/\sqrt{r}}$$

K = Bazin's Constant (K = 0.11) **

William's Hazen's formula:-

** (13m)

$$V = 0.85\, C_H\, r^{0.63} S^{0.54}$$

CH = William's Hazen's constant
(CH values for pipes)

** RCC = 110

Caste Iron = 100

Gravaline = 100

Steel = 100

Plastic = 120

Crimp & Burgel's :-

$$V = 83.5\ r^{2/3}\ s^{1/2}$$

r = hydraulic mean depth

s = hydraulic gradient.

Self-Cleansing Velocity :-

The velocity with which the deposite particles of a given size must be washed off at a particular velocity is called Self Cleaning velocity.

[At some point velocity of water ↑ to remove the impurities settled at the bottom].

Note :-

For removing the impurities mostly present in Sewage it is necessary that min. velocity of about 0.4 m/s is needed & avg. of 0.9 m/s is developed.

Non-Scouring Velocities :-

The max. velocity at which the scouring action of sewer surface is absent at a particular velocity that velocity is known as non-scouring velocity.

Self cleaning Velocity

- ✓ It is the main velocity of Sewage flow
- ✓ It is designed for to avoid the Setting of particles.

Non - Scouring Velocity

- ✓ It is the max Vel. of Sewage flow
- ✓ It is designed for to avoid the Scouring action of particle in the Sewer.

Design of Sewer:-

- ✓ The Size of the Sewer Varies from 100 mm ϕ, length assigned to 6 m.
- ✓ It is exceeds 6m, the ϕ is increased to 150 mm.

Factors Considered for the design of Sewer:-

- ✓ Rate of Sewage water Supply.
- ✓ Type of sewer material
- ✓ Velocity of flow.
- ✓ Slope of ground
- ✓ Shape of Sewer

Design procedure:-

→ Formation of Zones:-

✓ Alignment of Sewer is along with the alignment of road

✓ Area is divided into different Zones.

→ Arrangement of Sewer:-

✓ Split the area into gravity / slope

✓ It is based on low lying area & high lying area. The flow of Sewer line is from high to low.

→ Quantity of Sewage:-

✓ It is based on the Sewage System types such as Seperate & combine System.

→ Velocity of flow:-

For avoiding the Silting / Setting & Scouring of Sewer.

→ Cross-Section of Sewer:-

$$Q = AV \Rightarrow \boxed{A = \frac{Q}{V}}$$

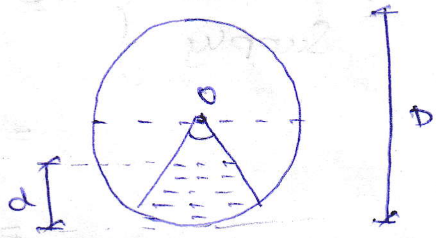
→ Gradiant:-

Section of a circular sewer:-

Two Condition:-

✓ Water fully flowing

✓ partially flow
(half flow)



d = Sectional flow when the pipe is partially flow.

D = Depth of water when flowing full

Condition: 01

When water is running full:-

$$A_f = \frac{\pi}{4} D^2 \quad (m^2)$$

$$P_f = \pi (D) \quad (m)$$

$$V_f = \frac{Q_f}{A} \quad (m/s)$$

01. Design a Sanitary Sewage to serve population of 50,000 with 110 lit pcd. Assume the necessary conditions. (water is running full)

Given:-

P = 50,000

water demand } = 110 lpcd.

Solution:-

$$\left.\begin{array}{l}\text{Avg. water} \\ \text{Supply}\end{array}\right\} = \text{population} \times \text{water demand}$$

$$= 50{,}000 \times 110$$

$$= 5.5 \times 10^6 \text{ lpcd}$$

$$= \frac{5.5 \times 10^6}{24 \times 60 \times 60 \times 1000}$$

Avg. water supply $= 0.063 \ m^3/s$

Assume 80% of water supply is considered as sewage

Avg sewage $= 0.8 \times 0.063$

$= 0.05 \ m^3/s$

Max. Sewage flow $= 3 \times$ avg. flow of sewage

$= 3 \times 0.05$

$$\therefore Q = 0.153 \ m^3/s$$

From manning's formula,

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

apply,

$n = 0.012$

$S = 1$ in 500 (assume)

$$\boxed{V = \frac{Q}{A}} \quad \text{and} \quad \boxed{r = \frac{D}{4}}$$

$$\Rightarrow \frac{Q}{A} = \frac{1}{n}\left(\frac{D}{4}\right)^{2/3}(s)^{1/2}$$

$$Q = A \cdot \frac{1}{n}\left(\frac{D}{4}\right)^{2/3} s^{1/2}$$

$$Q = \left(\frac{\pi D^2}{4}\right)\left(\frac{1}{n}\right)\left(\frac{D}{4}\right)^{2/3}\left(\frac{1}{500}\right)^{1/2}$$

$$0.153 = \left(0.785\ D^2\right) \times 83.33 \times \left(\frac{D^{2/3}}{2.519}\right) \times 0.0447$$

$$0.153 \times 2.519 = 3.120\ D^{8/3}$$

$$2 \times \frac{2}{3} + \frac{2}{3} = \frac{8}{3}$$

$$D^{8/3} = \frac{0.385}{3.120} = 0.123$$

$$D = (0.123)^{3/8}$$

$$\Rightarrow D = 0.455\ m$$

$$\therefore \boxed{D \simeq 0.4\ m}$$

Velocity,

$$V = \frac{Q}{A} = \frac{0.153}{\frac{\pi}{4}(0.4)^2} = 0.962\ m/s$$

$$\therefore \boxed{V = 0.962\ m/s}$$

Result :-

The velocity should be within self cleaning velocity.

The avg. self cleaning velocity is 0.4 - 0.9 m/s.

Sewer materials :-

- ✓ Cast iron pipes
- ✓ stone ware pipe
- ✓ GI pipes.
- ✓ AC pipe (~~abs~~ asbestos cement)
- ✓ Steel pipes
- ✓ RCC pipe.
- ✓ plastic pipes

Condition : 02

(13m) When the section is flowing partially full :-

~~Dept~~ Depth of flow (d) $= \frac{D}{2}\left(1 - \frac{\cos\theta}{2}\right)$

Area of flow (Ap) $= \frac{\pi D^2}{4}\left[\frac{\theta}{360} - \sin\theta/2\right]$ $\quad \frac{\pi}{4}D^2\left(\frac{\theta}{360} - \frac{\sin\theta}{2\pi}\right)$

Perimeter (P) $= \frac{\pi D \theta}{360}$

hydraulic depth (r) $= \frac{\text{Area}}{\text{Perimeter}}$

$$\boxed{r = 1 - \frac{360 \times \sin\theta}{2\pi\theta}}$$

Condition : 03 (half full).

***

Q2. A town has a population of one lakhs persons with per capita water supply of 200 lit/day design a sewer running 0.7 times full at max. flow condition. Take $n = 0.013$, slope 1 in 500, peak factor = 3.

Given:

$P = 1,00,000$

Rate of water supply = 200 lit/day

Peak factor = 3

$n = 0.013$

Slope = 1 in 500

Solution:

Avg. water supply (Discharge) $= 200 \times 1,00,000$

$= 20 \times 10^6$

$= \frac{20 \times 10^6}{24 \times 60 \times 60 \times 1000}$

$= 0.2315 \ m^3/s$

Assume 80% of water supply is considered as sewage

Avg. sewage $= 0.1852 \ m^3/s$

Max. sewage flow $= 3 \times 0.1852$ (3 → peak factor)

$Q = 0.5556 \ m^3/s$

From manning's formula,

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

Sewer running is 0.7 times,

Thus, $\boxed{\frac{d}{D} = 0.7}$

Area of flow $(A_p) = \frac{\pi}{4} D^2 \left[\frac{\pi\theta}{360} - \sin\theta/2\right]$

$$\therefore A_p = \frac{\pi D^2}{4}\left[\frac{\theta}{360} - \frac{\sin\theta}{2\pi}\right] \quad \text{—— (1)}$$

Since,

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

$$\Rightarrow \cos\theta/2 = \left(1 - 2\left(d/D\right)\right)$$

$$= \left(1 - 2(0.7)\right)$$

$$\frac{\theta}{2} = \cos^{-1}(-0.4)$$

$$\therefore \boxed{\theta = 227°9'}$$

From (1)

$$A_p = \frac{\pi}{4} D^2 \left[\frac{227.15}{360} - \frac{\sin(227.15)}{2 \times 3.14}\right]$$

$$= 0.785 D^2 \left[0.6309 + 0.1167\right]$$

$$\boxed{A_p = 0.5868 D^2}$$

perimeter (P) $= \frac{\pi D \theta}{360}$

$= \frac{3.14 \times D \times 227.95}{360}$

$\therefore \boxed{P = 1.9812 D}$

Hydraulic depth (R) $= \frac{r}{2} - \frac{360 \times \sin\theta}{2\pi\theta}$

$= \frac{r}{2} - \frac{360 \times \sin(227.95°)}{2 \times 3.14 \times 227.95}$

$\boxed{R = \frac{A}{P} = 0.295 D}$

Velocity (V) $= \frac{Q}{A}$

$\boxed{Q = \frac{1}{n} R^{2/3} \times A \times S^{1/2}}$

$0.5556 = \frac{1}{0.013} (0.295 D)^{2/3} \times (0.586 D^2) \times (1/500)^{1/2}$

$42.738 = 0.0116 D^{8/3}$

$3684.3 = D^{8/3}$

$\therefore D = 0.835 \text{ m} \simeq 1 \text{ m}$

$\boxed{V = \frac{Q}{A}}$

$\therefore \boxed{D = 1 \text{m}}$

Hence, design the sewer of circular of size 1 m ϕ, velocity of 0.947 m/s running partially full.

H.W.

03. Design the circular sewer for the discharge of 600 lit/sec running half full assume

*$I = 0.0001$ & $n = 0.015$
(slope)
(hydraulic gradient)

Solution:

$$\text{Rate of flow} = \frac{600}{1000} = 0.6\ m^3/s$$

Assume 80% of water supply considered sewage

$$\text{Avg sewage Quantity} = 0.6 \times 0.8$$

$$= 0.48\ m^3/s$$

$$\text{Max. Quantity} = 3 \times \text{Avg. flow}$$

$$= 3 \times 0.48$$

$$= 1.44\ m^3/s$$

$$d = D/2\ (1 - \cos\theta/2)$$

$$\cos\theta/2 = (1 - 2(d/D)) = (1 - 2 \times 1/2)$$

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

$$\theta/2 = \cos^{-1}(0) = 90$$

$$2(0.5) = 1 - \cos\theta/2$$

$$\theta = 180°$$

$$A = \frac{\pi}{4} d^2 \left[\frac{180'}{360'} - \sin 180/2\pi\right]$$

$$A = 0.392 \times D^2$$

$$P = \frac{\pi D \theta}{360°} = 1.57 \times D$$

**$$r = \frac{A}{P} = \frac{0.392}{1.57}\left(\frac{D^2}{D}\right) = 0.249$$

$$D = 1.3$$

From Manning's formula.

$$\frac{Q}{A} = \frac{1}{n} R^{2/3} S^{1/2}$$

$$1.2 = 0.3925 \times D^2 \left(\frac{1}{0.015}\right) (0.25D)^{2/3} (0.0001)^{1/2}$$

$$1.2 = 0.3925 \times D^2 \times 66.66 \times 0.396\ D^{2/3} \times 0.01$$

$$1.2 = 0.1036\ D^{8/3}$$

$$\therefore D = 2.50\ m$$

$$V = \frac{Q}{A} = \frac{1.2}{0.3925 \times D^2}$$

$$= \frac{1.2}{0.3925 (2.5)^2} = 0.489\ m/s$$

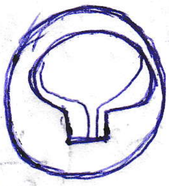
$$\therefore V = 0.489\ m/s.$$

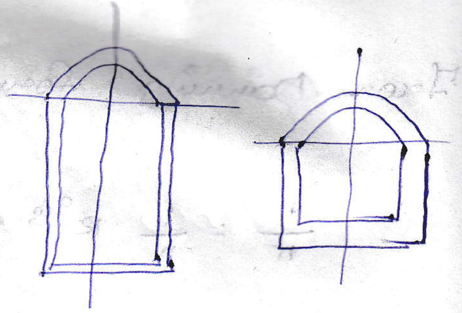
Hence, design the circular sewer of size 2.5 m ф at a velocity 0.489 m/s running of half full.

Small bore System :-

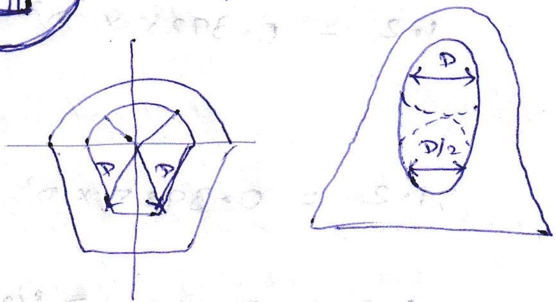
. (2m) The small bore sewage system collects all household water including black water & grey water in small diameter pipes & laid at fairly flat gradients.

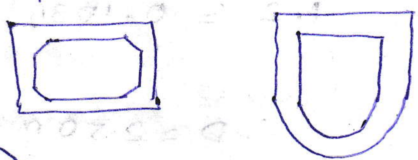
Shape of Sewer Sections:-

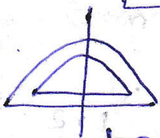




- ✓ Basket handle.
- ✓ Horse shoe.
- ✓ Rectangular
- ✓ Semi - Elliptical
- ✓ Egg shaped
- ✓ parabolic Section.
- ✓ Semi - circular Section
- ✓ U - Shaped Section.







→ Upper portion shape of the basket handle is broader & bottom is narrower. During rainy season it is used as combined sewer.

→ Large sewer with high discharge

→ More stable than circular sewer. Easy for construction. It can store sewage as tank.

→ More stable on soft soil. It is not suitable for carrying small quantity of waste water at high depth it posses better ~~high~~ hydraulic properties.

→ It is used for combined flow, Non - uniform discharge it gives high velocity @ low flow.

→ Upper arch takes the shape of parabola, it carries small quantities of discharge.

→ Wider base @ bottom & it is suitable for constructing larger sewers. It posses better hydraulic properties.

→ The sewer is in the shape of U. It is used as combined sewer & has predominent flow.

Qu. A combined sewer of a circular section is to be laid to serve a population of 1 lakh, max permissible flow velocity of 3 m/s time of entry is 10 min & time of flow 20 min per capita water supply 200 lit/day co-eff of runoff (K) is 0.45 max rain fall is 5 cm. Calc. the size of sewer (d)
(Po)

(continue)

Trapezoidal

$y = 0.5\sqrt{B}$

$\therefore (y = 1.5)$

$A = (B + y)\,y$

$P = B + 2\sqrt{2}\,y$

$Q = \frac{1}{36} K \cdot P_c \cdot A$

$P_c = P_0 \left[\frac{2}{1 + T_c} \right]$

$T_c = T_i + T_f$

Design of Storm water drain :-

For designing the storm water discharge first of all contour maps are collected & position of various link drains & sources of disposal are properly planned.

The depth of drain is considered by the following relation,

$$y = 0.5 \times \sqrt{\text{width}} = 0.5 \times \sqrt{B}$$

-

when, discharge < 15 cumes.

Q5 Design an unlined trapezoidal section for the out fall reach of an open urban storm water drain. Draining a catchment area of 120 hectors.

Given :

Inlet time = 18 min.

Flow time = 30 mins.

$T_c = T_i + T_f$
$= 48$ min

Co.eff of runoff = 0.6

Design water surface slope 1 in 3,000

Max. permissible flow velocity 0.9 m/s

The drain has to be designed for 5 yrs with rain frequency 48 min duration 52 mm for 5 years.

Pc *-*

Solution:-

$T_c = T_i + T_f = 18 + 30 = 48$ min.

(T_c – Time of Concentration)

Critical rainfall:-

$$Q_p = \frac{1}{36} \times K \times A \times P_c$$

52 mm → Depth

$$P_c = \frac{52\,(mm)}{48/60} \quad 5.2\,cm$$

$$P_c = P_o \left[\frac{2}{1+T_c}\right]$$

$$P_c = 6.5 \text{ cm/hr}$$

$$\Rightarrow Q_p = \frac{1}{36} \times 0.6 \times 120 \times 6.5$$

$$Q_p = 13 \text{ cumecs}$$ < 15 cumecs

$\because (Q_p < 15)$

$\Rightarrow$ Depth of drain, $y = 0.5 \times \sqrt{B}$

$1.5 = 0.5\sqrt{B}$

$\therefore B = 9\,m$

From Manning's formula,

$$\Rightarrow Q = \frac{1}{n} A R^{2/3} S^{1/2}$$

$A = 15.75\,m^2$

$P = 13.24$

$$R = \frac{A}{P} = \frac{(B+y)\,y}{(B+2\sqrt{2}(y))}$$

$$R = 1.189\,m$$

Smooth Surface $\Rightarrow$ $Q = \frac{1}{0.013} \times (15.75)(1.189)^{2/3}(1/3000)^{1/2}$

$$Q = 24.83\ m^3/sec \text{ (or) cumecs.}$$

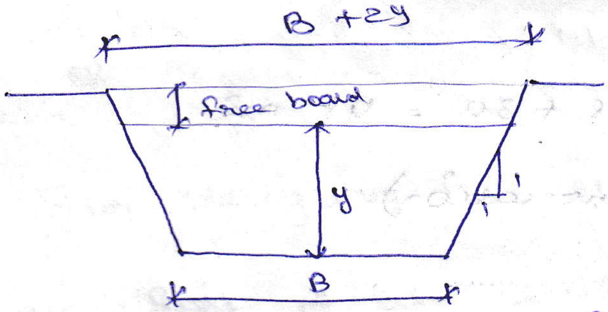
$n = 0.025$

Hard surface

$$Q = \frac{1}{0.025} \times (15.75)(1.189)^{2/3}(1/3000)^{1/2}$$

$$Q = 12.9 \text{ cumecs}$$

$\because (y = 0.5\sqrt{B})$



** Hence, we trapezoidal drain with bed width of 9.5 m & water depth 1.5 m with 1:1 side slope laid @ longitudinal slope of 1 in 3000

$$V = \frac{Q}{A} = \frac{12.9}{15.75} = 0.819 \text{ m/s}$$

Hence Satisfy.

Sewer appurtenances :- (cleaning purpose)

→ Man hole
→ Drop man-hole
→ Lamp hole
→ Catch basins
→ Street - inlets
→ Grease
→ Inverted siphons
→ Clean Outs.
→ Flushing tank.
→ Storm regulators.
→ Junction Chamber

(2m) It is a add. Structure which are constructed at suitable intervals along the sewage. It is used for operation & maintanance

Man-hole :-
✓ Cleaning, inspection, ventilation
(bend, junction, change of gradient, dia change)

(i) Shallow (ii) Normal (iii) Deep (> 1.5 m)
→ cover heavy
→ top size low

↓ 1.5 depth
Square (1×1 m)
Rectangle (0.8 - 1.2 m) c/s

(2m) (inspection chamber)
D = 0.7 to 0.9 m
lighter cover @ top.

Components :-
✓ Access shaft (upper portion of deep man hole)

Rectangular - 0.75 to 0.6 m.
Circular min ϕ - 0.6 to 0.7 m

Depth - Depends upon breadth.

✓ Working chamber (lower portion of man hole)
(Cleaning operation).

Rectangular - 1.2 to 0.9 m
Circular min ϕ = 1.2 m

*. Ht not less than 1.8 m [Ht ≮ 1.8 m]

✓ Benching (bottom portion of man hole)

→ Cement Concrete Structure.

→ U-Shape.

✓ Side walls:

→ Brick / Stone masonry. & RCC

→ Brick wall – 9" (or) 22.5 cm

$t = 10 + 4D$ D = Depth of excavation (m)

→ RCC – cost ↑, Skill person needed.

✓ Steps & Ladder:

→ Steps are providing designing in the man hole.

→ Cast - Iron.

→ 40 cm below the G.L (starts from)

✓ Cover & frame:

→ Cover – Caste Iron. (wt – 90 to 270 kg)

→ Frame – cast Iron (20 to 25 cm) → thickness
(10 cm) → wide

{ Rectangular – 0.6 to 0.45 m
circular (ϕ) – 0.5 to 0.6 m }

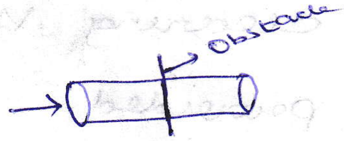
[Arrows → Direction of flow of Sewage]

[Flesh → Normal drain]

(P.NO: 110) SK garge

Lamp holes :-

It is the small opening on sewer to permit the insertion of man holes into the sewer.

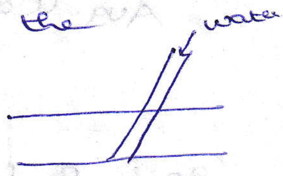


→ Cast Iron

→ ϕ = 20 to 30 cm

Clean Outs :-

It is an ~~bend~~ inclined pipe extending from the ground & connected to the underground sewer.



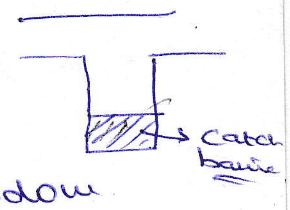
→ water clearing

→ Flexible rod

Street inlets (gullies)

During rainy season the water is in drainage is high when the inlets are provided & connected into the man hole, the water will drain.

Catch basins :-



→ Operation & maintance

↔ Organic → Decompose → odour

→ It can be deposited under into the catch basin. It can be cleaned periodically, the organic matters are decomposed & producing foul odours.

→ It is breeding places for mosquitoes.

→ In case the sewer laid on flat gradient & not producing self clearing velocity. flushing tank is provided.

——— x ——— x ——— x ———

Q4 H.W

Solution:-

Avg. water supply = 200 x 10,000 lit/day

= 0.231 cumes (m^3/s)

80% of water supply,

Avg. sewage discharge (Q) = 0.8 x 0.231

= 0.185 cumes

Max. Sewage discharge = 3 x 0.185

$Q = 0.556$ cumes

Time of concentration

$T_c = T_i + T_f$

= 10 + 20 = 30 min

$T_c = 30/60 = 0.5$ hrs

Max. rainfall (P_0) = 5 cm/hr

$P_c = P_0 \left(2/_{1 + T_c} \right)$ *

$= 5 \left(2/_{1+0.5} \right)$

$= 10/1.5$

$P_c = 6.67$ cm/hr

Max. Storm run off $(Q_p) = 1/36 \times K \times P_c \times A$

$= 1/36 \times 0.45 \times 6.67 \times 12$

$Q_p = 10$ cumes

The combined max. discharge

$= 10 + 0.556$

$Q = 10.556$ cumes

$A = \frac{Q}{V} = \frac{10.556}{3}$

$= 3.51\ m^2$

$A = \frac{\pi}{4} d^2$

$d^2 = \frac{4A}{\pi}$

$d = \sqrt{\frac{4A}{\pi}}$

Dia of Sewer pipe $\left(\frac{\pi}{4} \times d^2\right)$ $= \sqrt{4/\pi \times 3.51}$

$= 2.11\ m$

Sewer pipe of 2 m dia is used.

———— × ———— × ————

Software used in Sewer design :-

(2m)

- ✓ Sewer CAD V8 i
- ✓ Sewer GEMS
- ✓ Storm CAD.
- ✓ Capterra
- ✓ CARM

$P_c = P_0 \left[\frac{2}{1 + T_c}\right]$

$Q = \frac{1}{36} K . P_c . A$

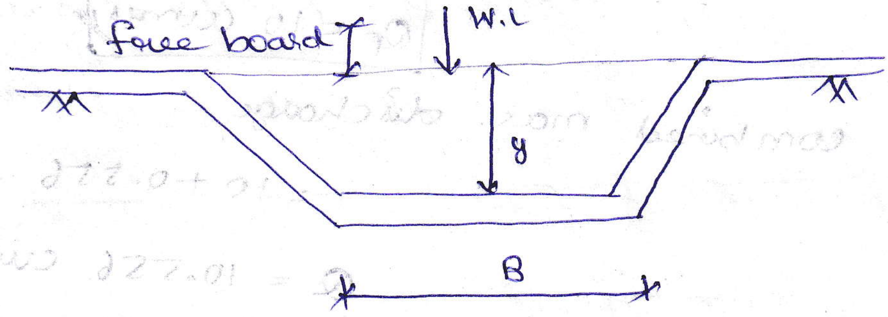


fig.05

06. Design a suitable stone pitched section for a drain required to pass the excepected urban drainage from the catchment area of 300 hectares. The max. hourly (P_o) is 4 cm/hr & the time of concentration (T_c) is 1 hour. The longitudinal slope 1 in 2300

Given:

Area = 300 hectares

Rainfall intensity = 4 cm/hr

T_c = 1 hours.

$$P_c = P_o\left(\frac{2}{1+T_c}\right)$$

$$= 4\left(\frac{2}{1+1}\right) = 4.$$

$\therefore$ $\boxed{P_c = 4}$

$$Q_p = \frac{1}{36} K P_c A$$

$$= 1/36 \times 0.45 \times 4 \times 300$$

$$\boxed{Q_p = 15 \text{ cumecs}}$$

$A = (B+y)y$

$P = (B+2\sqrt{2})y$

$$y = 0.5 \times \sqrt{B}$$

assume depth, $\boxed{y = 1.5 \text{ m}}$

$$1.5 = 0.5 \times \sqrt{B}$$

$$\therefore \boxed{B = 9\text{m}}$$

$$A = (B+y)\,y$$

$$= (9 + 1.5)\,1.5$$

$$\boxed{A = 15.75 \text{ m}^2}$$

$$P = B + 2\sqrt{2}\,y$$

$$= 9 + 2\sqrt{2} \times 1.5$$

$$\boxed{P = 13.24}$$

$$R = \frac{A}{P} = 1.18 \text{ m}$$

$$Q = \frac{1}{n} R^{2/3} S^{1/2} \cdot A.$$

$$= \frac{1}{0.025} \times (1.18)^{2/3} (1/2300)^{1/2} (15.75)$$

$$\boxed{Q = 14.6 \text{ m}^3/\text{s}} \quad < 15 \text{ cumecs}$$

$A = (B+y)y$

$P = (B+2\sqrt{2})y$

Unit -2 Important Question

01. Design of Sanitary sewer (problem)

02. Design of Storm sewers (problem)

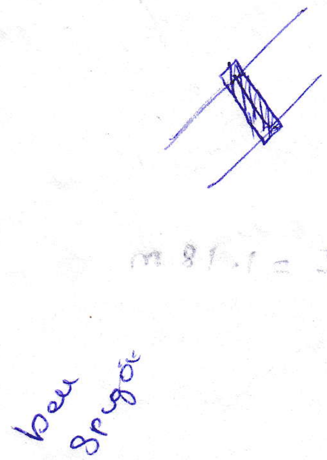
03. One pipe & two pipe system

04. Laying, joining & testing of sewer.

05. pumps & classification of pumps.

06. Hydraulics of flow in sewers (Derivation)

07. Sewer appurtenance (manhole, deep manhole, catch basins, gullie's, oil & grease tracks)



Laying, Joining & testing of pipes :-

Joint :-

A joint may be defined as assambleage used for connecting two pipes without any leackage / losses.

Types :- (Depends on the types of sewer pipes, type sewerage system, strength & flexibility of joint, internal pressure of pipe, external loads).

- ✓ Cement mortar joint (1:1.5)
- ✓ Collar joint.
- ✓ Flexible / bitumenous joint.
- ✓ Mechanical joint.
- ✓ Open joint.

→ Rich cement mortar of 1:1.5 (or) 1:2 is apply b/w space of bell and spigot end, the mortar is placed b/w bell & spigot ends, & joints is finished by applying cement mortar @ an angle of 45° on the outer face.

→ The collar joints are used for larger ϕ sewers, the ends of the sewer are plain in this joints, the ends of the sewer are placed near each other & collar of slightly big dia are placed over ends of sewer.

~~→~~ The annular Space b/w the collar & ends of Seewer is filled with cement mortar of 1:1.5

→ Bitumen is used for jointing two pipes the joint is flexible, the alignment of pipe is tedious. & there is possibility of sewage settlement

→ The ends of the sewer are placed together (or) because of pipes width bell & spigot end no filling of material is placed, in the annular space b/w pipes

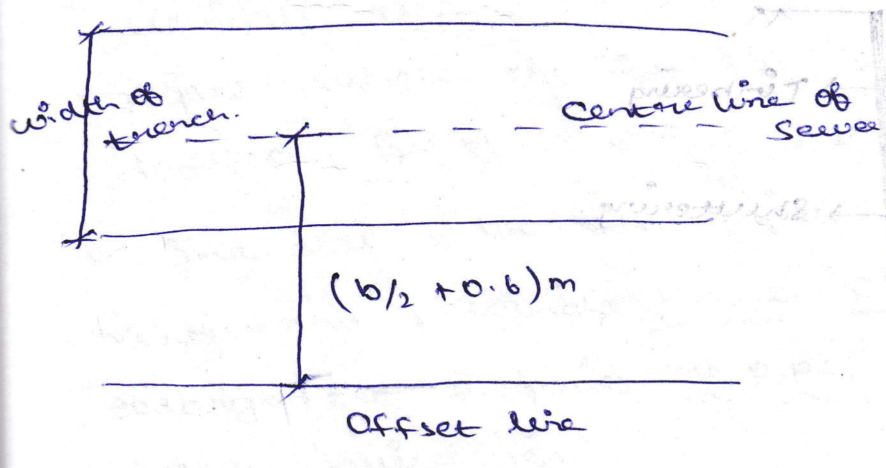
→ This joint have a ring when pressed against rubber gaskets it makes the joint water tight. The mechanical devices such as flanged rings, bolts are used to keep two ends of sewer water tight, mainly these joints are provided for metallic pipes.

Laying of Sewers:-

Step involved in laying of sewer:-

- ✓ Setting out
- ✓ Alignment & formation of gradient.
- ✓ Excavation of trench.
- ✓ Laying & jointing.
- ✓ Testing
- ✓ Backfilling.

→ From the longitudinal section of the ~~posted~~ sewer line, the position of manholes are located on the ground, is general practice to lay sewer line b/w two manholes at a time, the setting out is carried out starting from tail end (or) outfall end. The centre line of sewer is properly maintained by



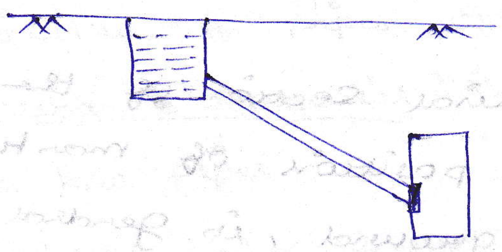
Excavating trenches:

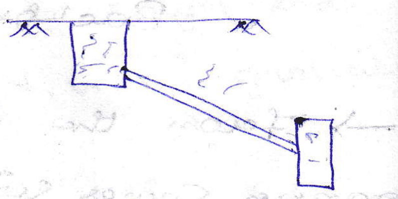
width = 1.5 m (ie) > dia of sewer

Small dia pipes width 60 to 75 cm.

Ordinary (or) soft soil grounds are embedded in concrete.

Water testing: **Smoke test**



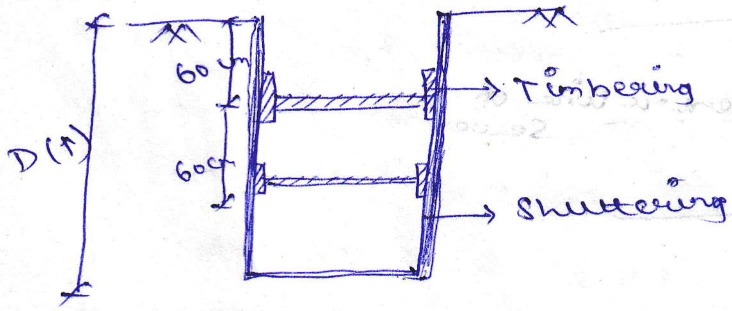


Ball test → check obstacle.

Air test → large ϕ pipes ly, alternate for water source.

pressure (100 mm of water)
↳ 75 mm – good
(< 70 mm) – leackage problem

✓ soap water is used to determine the leackage.



Pump :-

It is the mechanical device, lift the water from lower ~~see~~ stream to upper stream.

Types :- (13m)

Centrifugal pump ← Radial / Mixed / Axial

Reciprocating pump

Air pressure pump.

principle { → cavity, → Impeller

Easy installation, pit / sump, No clogging, breaker up (1500mm)

Systems of plumbing :- (P.No: 471)

**.

→ Two pipe system (Night soil, Sullage)

→ Single pipe stem.

Two pipe System :-

✓ The best & most improved type of system of plumbing. In this system two sets of vertical pipes are laying one for draining night soil & another is sullage.

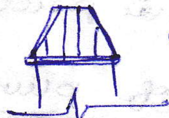
✓ The pipes carrying night soil is called soil pipes & sullage carrying pipes is called sullage pipes.

✓ The soil fixtures such as latrine & urinals are connected through branch pipes where as the sullage fixture, sullage fixtures, etc..,

✓ The soil & waste pipes are seperately ventilating provide vent pipes. ** This arrangement requires 4 pipes. Suitable for large buildings.

One pipe System:

In this System instead of using two Seperate System, only one main vertical pipe is provided which collects night soil as well as sulage water.

The main pipe is ventilated itself by providing cowl pipe  and is add. Seperate vent pipe is provided

~~One~~ Two pipe System
→ 4 pipes. (Two set)
↗ Night soil (soil pipe) & Sewage (sewage pipe)
↗ Seperate ventilation (4)
↗ Costlier
↗ Difficult

~~Two~~ One pipe System
→ 2 pipes.
↗ Suitable for Small frame only.
ventilation through cowl
↗ cheaper
↗ Easy.