Environmental Engineering - I

What is Environmental Engineering :-

Environmental Engineering is the branch of Engineering.

To protect the Environment by using of some Engineering Principles

It is also applied science and Technology to protection of assets and Control the waste (రక్షణ) From human and animal activities

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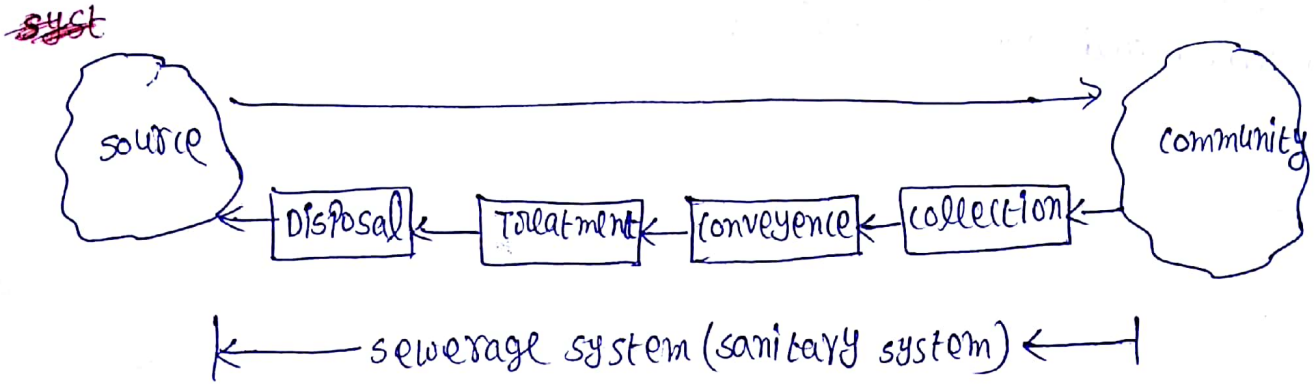
UNIT-I

Introduction to sanitation:-

(పారిశుధ్యం)
(పరిసరాల పరిశుభ్రత)

sanitation means safe disposal of hazardus waste after the treatment and protecting the human health

sanitation system promotes proper disposal of human and animal wastes



objective (లక్ష్యం):-

To quickly drain out waste wates from the community to make it safe prior to disposal

(ప్రజారోగ్యం)

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sewage:-

All kinds of liquid waste produced by the community. This includes Domestic waste water, Industrial waste water and storm water

sullage:-

Less offensive liquid waste produced by the community (లేత్ర వ్యర్థం) is known as sullage

Ex:- waste water from bathrooms, wash basins, kitchen sink and storm water.

sewer:-

A conduit carrying sewage is known as sewer

(మురుగు తీసుకెళ్లే గొట్టం)

sewerage:-

Network of sewers employed in collection and carrying of sewage by water carriage system through sewers, is known as "sewerage"

Dry weather Flow (DWF):-

Domestic and Industrial waste water together known as DWF

wet weather Flow (WWF):-

storm water resulting from the community is known as WWF

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Night soil (or) Human Excreta (or) Fecal matter:-

Human waste (or) Toilet waste.

Garbage:-

Decayed fruits, grass, leaves, paper pieces, vegetables etc

Rubbish:-

All sundry solid waste of paper, broken furniture waste building materials etc are known as rubbish.

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System of sanitation:-

The system of sanitation can be devided into 4 sections

(i) Back ground
(ii) Types of sewerage system.
(iii) Considerations for types of systems
(iv) Patterns of collection systems.

(i) Back ground:-

You have to take some area in that area, sewage should be generated. for the safe disposal of this sewage. first to collect the sewage. in particular location after collection of sewage treat ment should be necessary before disposal ~~To achieve this sew~~

when the sewage should be treated the following conditions should be satisfied.

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* sewage should not pollute the drinking water source either surface (or) ground water (or) water bodies

* The untreated sewage during conveyance should not be exposed into atmosphere. and should not be present in animals in sewage.

* The sewage should not unsightly appearance (or) odour nuisances and should not become a place for breeding of flies.

* It should not cause harm to public

Methods of sewage collection and disposal:-

There are two methods are having for methods of sewage collection and disposal

1) Dry and conservancy system (or) method
2) water carriage system.

Dry and conservancy method:-

The collection system means collection of sewage generated from the individual house and transporting it to a common point where it can be treated. before the disposal.

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There are two methods are having in sewage collection and disposal (4)

1) Dry and conservancy system (or) method.
(పొడి పద్ధతి)

2) water carriage system.

1) conservancy method. 2) water carriage system.

In olden days waste is generated from ~~water closets~~ water closets (నీరు ఉపయోగించని మరుగుదొడ్లు) was collected by conservancy methods and often, liquid waste was transported through open drain to finally join natural drains. since the excreta. was carried. (మల మూత్రాలు)

through carts (బండ్లు), It was not hygienic method for transportation to the disposal point. Now, collection and conveyance of sewage is done in watter carriage system. where it is transported (నీటి రవాణా)

in closed conduit using water as a medium.

~~closed~~ (మూసివేసిన)

(sewage ని closed places లో మూసివేసిన water ని medium గా ఉపయోగిస్తారు)

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(ii) Types of ~~sewage~~ sewerage system:-

The sewerage system can be divided into three types

They are 1) combined system
2) seperated system and
3) Partially combined and partially seperated system.

1) combined system:-

→ In combined system the domestic sewage and run off water from the resulting of storm both are passing in same conduit (same pipe) of sewerage system.

→ In countries like India where rainy days are very few, so this system will be face the many problems for maintaining and self cleaning in sewers during dry season.

→ The sewage discharge is lower than the design discharge in conduit (pipe) ~~after that~~ in this sewage will be added the storm water for discharging

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(2) Seperated system:-

In seperated system, seperate conduits are used; one carrying sewage and other carrying storm water runoff.

→ The storm water is collected can be directly discharged into the water body. In that runoff water there is no any foul gases and sewage so no treatment ~~is~~ generally no treatment is provided. But treatment is required before disposal of sewage

→ The sewage is collected from the city this sewage ~~is treated~~. treatment should be done before it is discharged into the water body (or) used for irrigation

→ seperate system is advantageous and economical for big towns

(3) Partially combined and partially seperated system:-

In this system part of the storm water especially collected from roofs and paved courtyards of the buildings (ఇండ్లు) (ప్రాంగణాలు)

These storm water will be combined with sewage is coming from houses and institutions etc.

→ The storm water from the other places is collected seperately using seperate storm water conduits

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1.2 Relative merits and demerits:-

For combined system:-

Advantages:-

-> where the rainfall is falling throughout of a year in that areas no need of flushing of sewers why because the rain water combined with sewage so the velocity will be developed due to more quantity

-> only one set of pipe is required for transporting of sewage

-> In congested areas it is easy to place one pipe. in that areas will be construct in 2 pipes it is difficult why because area is not available.

Disadvantages:-

-> In that area small period of rainfall occurs in a year. in that areas it is not suitable for combined system why because self cleaning velocity may not develop in sewers, resulting in silting.

-> Large flow is required to be treated at sewage treatment plant before disposal hence resulting in higher operating cost of the treatment plant

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For seperated system:-

Advantages:-

→ sewage will be flows in seperated pipe so in treatment plant treatment should be done only on sewage so resulting in economy of treatment

→ this system may be less costly

→ this system is economical due to less flow.

Disadvantages

→ self cleaning velocity may not developed at certain locations in sewers and hence flushing of sewers may be required

→ this system requires two set of pipes, which may be difficult in congested area.

→ this system will required maintenance of two set of pipe lines and hence maintenance cost is more.

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For Partially Combined and Partially seperated systems:-

Advantages:-

→ Economical and reasonable size sewers are required.

→ work of house plumbing is reduced. why because rain water from roofs, sullage from bath rooms and kitchen etc are combined with (excess rainwater is now) discharge from single outlets

→ Flushing of sewers may not be required because why because small portion of storm water is allowed to enter in sanitary sewage.

Disadvantages:-

→ Increased cost of pumping as compared to seperate systems at treatment plants

→ self cleaning velocity may not develop in the sewers

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(iii) Consideration for types of system :-

Following points are considered before finalizing the type of collection system

→ The seperate system requires laying of two sets of conduits where as in combined system only one bigger size conduit is required.

→ Laying of two seperate conduits may be difficult in the congested streets

→ In combined system of sewers are facing a problem for silting (పూడిక) during non-monsoon season (వర్షాకాలం), hence they are required to be laid at steeper gradients. ~~so steeper grad~~

So steeper gradients for the sewers may required more number of pumping stations, particularly for flat terrain, which make the system costly.

→ Large quantity of waste water is required to be treated before discharge in case of combined system, Hence ~~large~~ result large capacity treatment plant is required

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→ In separate system, only sewage is treated before it is discharged into natural water body

Generally no treatment is required for collecting rainwater before it is discharged into natural water body

→ In separate system pumping is required only for sewage

pumping can be avoided for storm water

→ In combined system large capacity pumping station is required to safely handle the flow

(iv) Patterns of collection system-

The pattern of collection system depend upon.

* The topographical and hydrological features of the area.
*
* The location and methods of treatment and disposal works
* The type of sewage system employed and
* extent of area to be served.

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Following Patterns can be adopted for collection systems as per the suitability (8)

(a) perpendicular pattern
(b) Interceptor Pattern
(c) Radial Pattern
(d) Fan Pattern and.
(f) zone Pattern.

(a) perpendicular Pattern:-

→This

→It is suitable for seperate system and partially seperate system for storm water drains

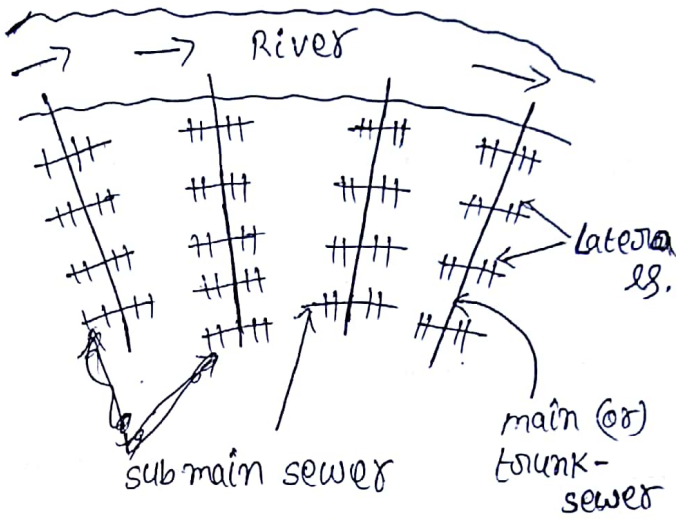


Fig: Perpendicular Pattern of collection system

→This pattern is not suitable for combined system why because treatment plant is required to be installed at many places; other wise it will pollute the water body where the sewage is discharged.

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(b) Interceptor Pattern:-

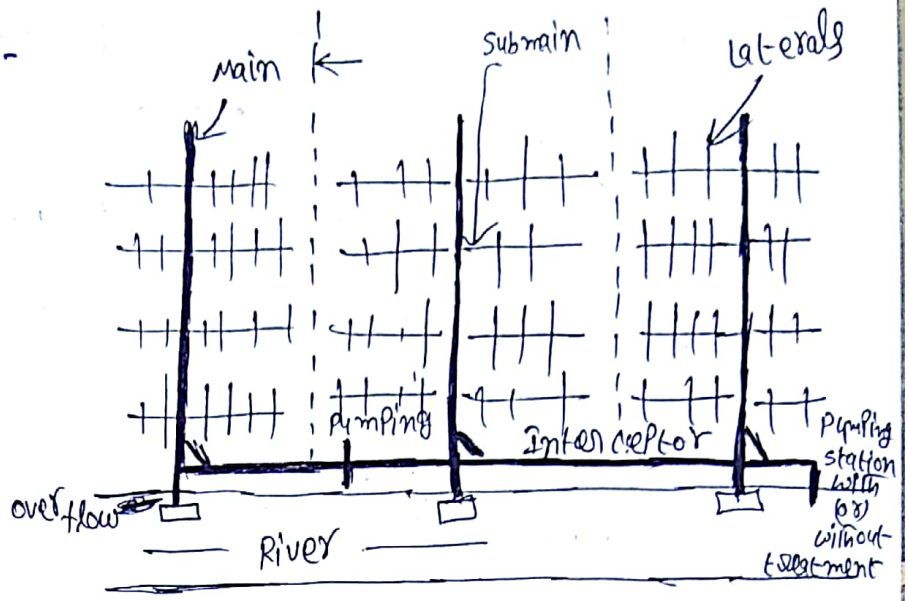


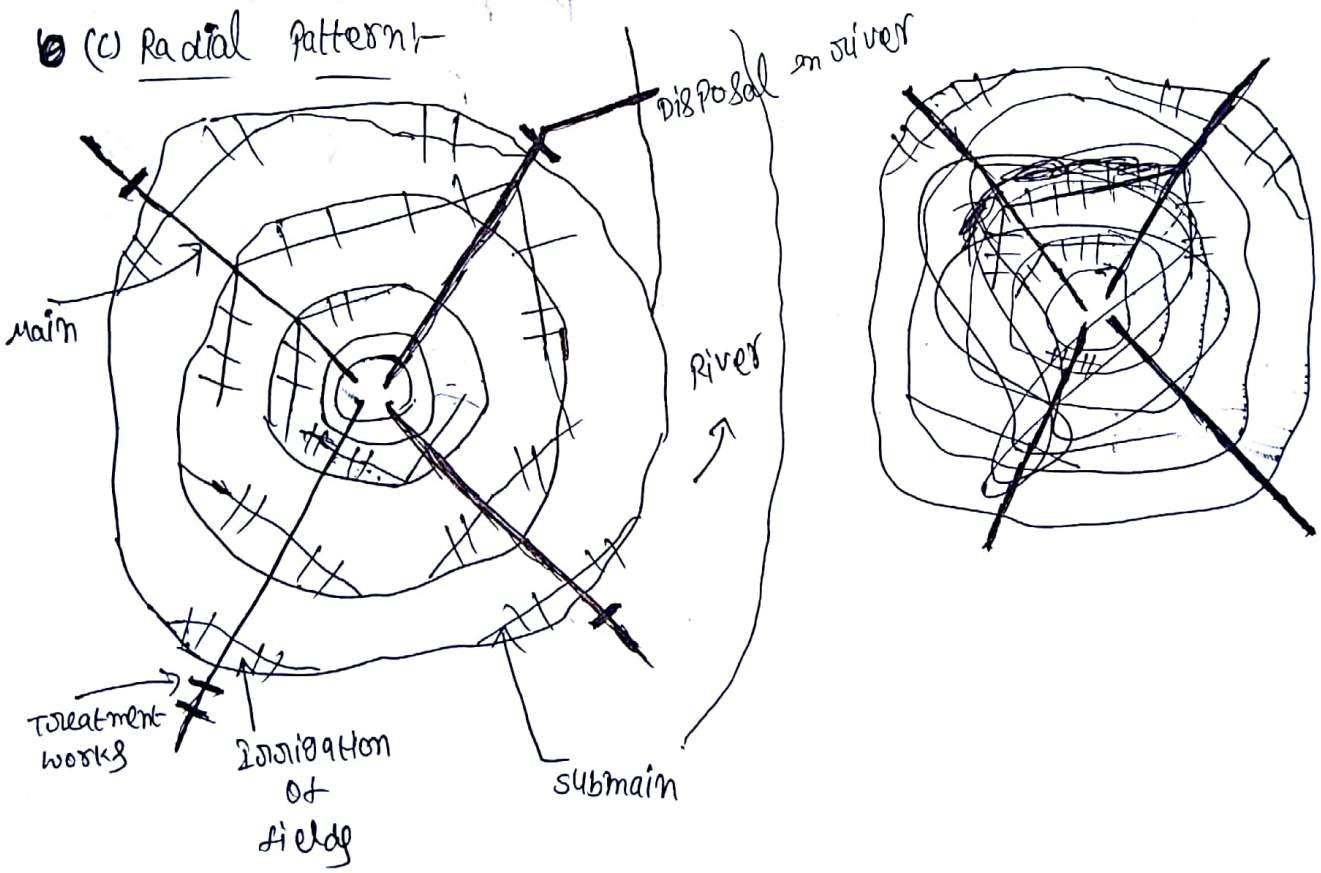
Fig: Interceptor pattern of collection system

→ sewers are intercepted with large size sewers as shown in figure

→ Interceptor carries sewage to a common point, where it can be disposed off with (or) without treatment

→ over flows should be provided to handle very large flow.

(c) Radial Pattern:-



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→ It is suitabul for land disposal

→ In this pattern sewers are laid radially outwards from the centre, hence this pattern is called as Radial pattern. as shown in fig

→ The draw back in this pattern is more number of disposal works are required.

(d) Fan pattern:-

→ This pattern is suitable for a city situated at one side of the natural water body such as river

→ The entire sewage flows to a common point where one treatment plant is located as shown in fig.

→ In this number of converging main sewers and submains are used forming a fan shape

→ single treatment plant is required in this pattern,

→ The draw back in this pattern is that large dia sewer is required, near to the treatment plant as entire sewage is collected at a common point

→ The city will be extent (or) developing the city we required. treatment plant should be Increased

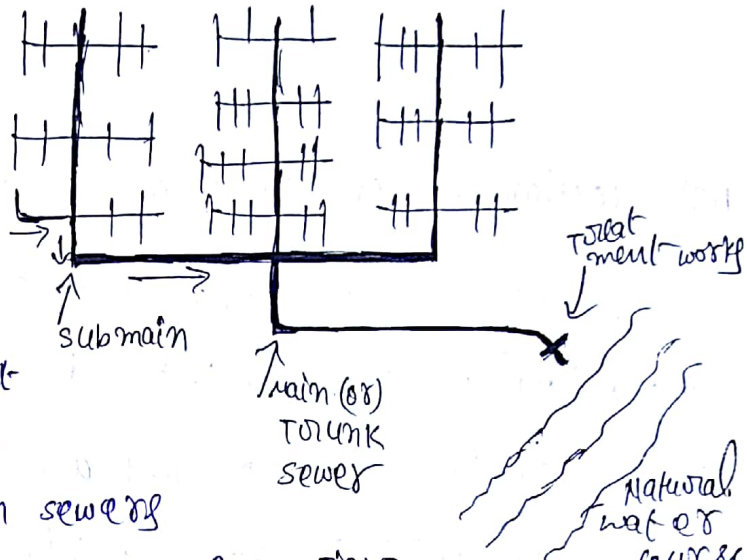


Fig: Fan pattern of collection system

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(c) Zone Pattern

→ More number of interceptors are provided in this Pattern

→ This Pattern is suitable for sloping area than flat areas

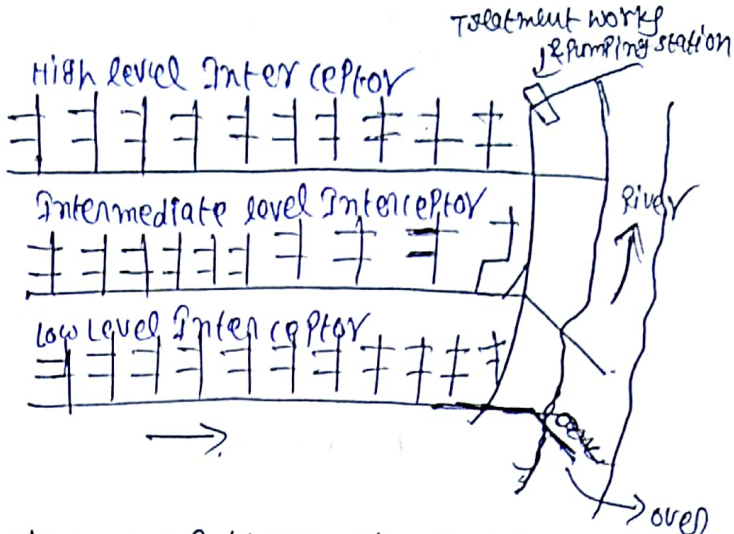


Fig : Zone Pattern of collection system

1.3) Collection and Conveyance of waste waters:-

As discussed earlier, we have two methods of sewage collection and disposal. They are, Dry and conservancy system and water carriage system. Dry and conservancy system is used in olden days which is not hygienic, hence neglected whereas water carriage system is currently using in now a days where it need a well designed sewerage system.

1.4) Sewerage :-

All kinds of liquid waste produced by the community is known as sewerage. which includes Domestic waste water, Industrial waste water and storm water.

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1.5 Classification of sewerage system:-

→ The Net work of sewers employed in collection (or) All kinds of liquid waste produced by the community is known as sewerage (10)

The classification of sewerage system can be classified into 3 types

1) Combined system
2) Seperated system.
3) Partially Combined & Partially seperated system

1) Combined system:-

→ only one sewer which drain Dry weather flow (DWF) & wet weather flow (WWF)

Dry weather Flow (DWF) :- Domestic and Industorial waste water to gether is known as DWF

Wet weather Flow (WWF) :- storm water resulting from the community is known as WWF

→ ~~It is suitable for~~ only one set of sewer It carrying both sanitary sewage & storm water. It is called.

→ It is suitable for where the area will have average rating and rainfall seasons spread for short period.

Ex: Chennai

(2) seperated system:-

→ It having two sets of sewers one for DWF and another for WWF

→ suitable for where the area will recieves heavy non-uniform rains and rainfall spread for lang period

Ex: mumbai

(3) Partially Combined & Partially seperated system:-

→ It employs two sewers, one for WWF alone and other one use for DWF during normal rainfall period

→ It is suitable for which recieve moderate rating (or) occasional heavy rating

Ex: A.P

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1.6 Estimation of Sewage Flow (DWF) and storm water Drainage (WWF)

Before designing the sewers it is necessary to estimate DWF & WWF

* combined sewer is designed for combined discharge.

$$Q_{combined} = Q_{DWF} + Q_{WWF}$$

* In seperate system one sewer is designed for Q_{DWF} and storm water sewer is designed for Q_{WWF}

Estimation of DWF: $[Q_{DWF}]$

Q_{DWF} = Population * Per Capita sewage Flow

Per Capita sewage Flow = per Capita water supply * Factors.

where

Factors = The amount % of water supply convert into sewage 70 to 80 % of water supply converts into sewage & reach sewer.

Hence

Q_{DWF} = Population * Per Capita water supply * factors.

* on calculating the product of "population", "per capita water supply" and "factor" to gether. we can find estimate of DWF.

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Estimation of WWF : [Q_{WWF}]

Wet weather flow (i.e) runoff from urban catchments resulting from community is estimated by "Rational formula"

This formula is applied for catchments whose area is < 5000 ha

(Empirical formula but universal)

$1 Km^2 = 100 ha$

$$Q_{WWF} = \frac{AIR}{360}$$

where

A → Area of catchment in ha.

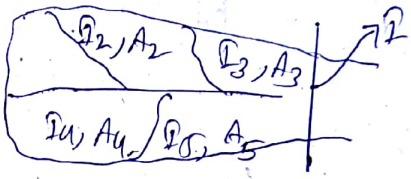
I → Impermeability factor (or) Runoff factor = $\frac{\text{Runoff}}{\text{Rainfall}}$

R → Rainfall intensity in "mm/hr"

$$R = \frac{\text{Depth of rainfall}}{\text{Duration of rainfall}}$$

Calculating I :

$$I = \frac{\Sigma A_i * I_i}{\Sigma A_i}$$



Rainfall Intensity, R

$$R = \frac{25.4 * a}{t_c + b}$$

where t_c = time of concentration in "min"

a, b = constants

R → mm/hr

"a" and "b" values depends on duration of storm "t"

- If t = 5 min to 20 min, then a = 5 b = 10
- If t > 20 min, then a = 10 b = 20

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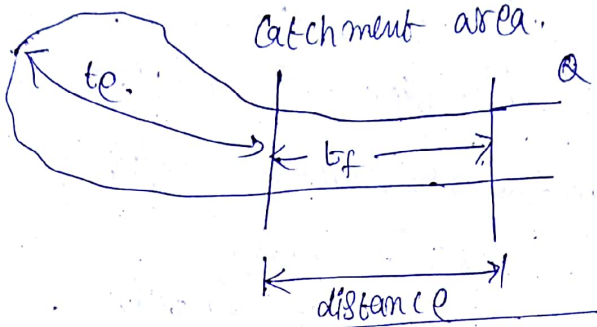
If duration of storm "t" is not given Then

duration of storm "t" = time of concentration "t_c"

$$t \simeq t_c$$

Time of concentration, t_c = time of entry (t_e) + time of flow (t_f)

$$t_c = t_e + t_f$$



$$t_f = \frac{\text{distance travel in the drain}}{\text{velocity of flow in the drain}}$$

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1.7 Fluctuations:- (only DWF)

Since dry weather flow depends on the quantity of water used, and as there are fluctuations in rate of water consumption. There will be fluctuations in DWF also

DWF లో water quantity అనేది depend అవుతుంది. అలాగే water consumption లో fluctuations వల్ల DWF లో కూడా fluctuations వస్తాయి.

It can be assumed that

maximum daily flow = 2 * average daily flow

minimum daily flow = 2/3 * average daily flow

(1.8) Types of sewers:-

(a) sanitary sewer :- It carries sanitary sewage (i.e) waste water from municipality including domestic and industrial waste water

(b) storm sewer :- It carries storm sewage including surface runoff & street wash.

(c) Combined sewer:- It carries domestic, industrial and storm sewage

(d) House sewer :- It is the sewer conveying sewage from plumbing system of a building to common/municipal sewer

The pipe fitting for the water supply & sanitation

i.e house sewer అనేది ఇంటిలో sewage ని బయట municipal sewer or common sewer లో కలిపేది

(e) lateral sewer (street sewer) :- This sewer carries discharge from house sewers

(f) sub main sewers:- This sewer receives discharge from two (or) more sewers

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(g) Main / trunk sewer :-

It receives discharge from two or more submains

(h) out fall sewer It receives discharge from all collecting system and conveys into point of final disposal.

(1.9) Hydraulics of sewers and storm drains:-

A conduit carrying sewage is known as sewer

→ The sewers and storm drains are generally designed as open channels except flow will be flowing on under pressure

→ The flow will be flowing in sewer under pressure these sewers are designed them as in the case of inverted syphons

[- portion of sewer laying below HGL (Hydraulic Gradient line) where sewer flows under pressure is known as Inverted syphon]

HGL (Hydraulic Gradient line) :-

A line joining the points of highest elevation of water in a series of vertical open pipes rising from a pipeline in which water flows under pressure.

→ In the case of inverted syphons the discharge lines from the sewage pumping stations, which always flow under pressure

→ various empirical formulae, which have been used for determining the design velocities of flow in sewers and drains are given below

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(a) Chezy's formula.

It states that, $\boxed{V = C\sqrt{rs}}$

where V → velocity of flow in the channel in "m/sec"

r = hydraulic mean radius of channel (i.e) hydraulic mean depth

$= \frac{a}{P}$ where a = area of channel

P = wetted perimeter of channel.

for a circular sewer running full, 'r' is given by

$$r = \frac{\pi D^2/4}{\pi D}$$

$$= \frac{D}{4}$$

D → Diameter of the sewer

s → hydraulic gradient, equal to ground slope for uniform flows

(i.e) the head drop between the two points divided by length

c → chezy's constant; depends on size & shape of the channel, roughness of the channel surface, the hydraulic characteristics of the channel, etc.

"c" value can be obtained by kutter's (or) Bazing formula

* the channel station may be designed by using $\boxed{Q = AV}$

where A → flow area of the cross section of the channel

V → flow velocity in the channel

Kutter's formula:-

The value of "c" is given by.

$$\boxed{C = \frac{\left[23 + \frac{0.00155}{s}\right] + \frac{1}{n}}{1 + \left[23 + \frac{0.00155}{s}\right]\frac{n}{\sqrt{r}}}}$$

where s = Bed slope of the sewer (for uniform flows)

r = Hydraulic mean depth $= \frac{a}{P}$

n = Rugosity coefficient depends on type of channel surface which are given for different surfaces in the following table,

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→ Bazin's formula:-

The value of "C" to be used in Chezy's formula is

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

where $r \rightarrow$ Hydraulic mean depth of channel $= \frac{a}{P}$

$K \rightarrow$ Bazin's constant as given by following table.

(b) manning's formula:-

most popular formula used for designing sewers & drains in USA as well as India. It is

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

where

$r \rightarrow$ hydraulic mean depth $= \frac{a}{P}$

$s \rightarrow$ Bed slopes of the sewer (for uniform flows)

$n \rightarrow$ Rugosity coefficient (n) are the same as were given by Kutter represented the table given there

(c) Crimp and Burges formula:-

It is commonly used in England. It is

$$V = 8.35 * r^{2/3} * s^{1/2}$$

where

~~v, m and i have the same meaning as 5/1~~

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This formula is comparable to mannings formula, having

$\frac{1}{n} = 83.5$ (or) $n = 0.012$

Hence, this formula is identical to mannings formula for all those sewer materials for which 'n' is taken as 0.012

(d) William-Hazens formula:-

This formula is generally used for flows under pressure for designing water supply pipes and is seldom used for designing sewers. It is

$$V = 0.85 * C_H * r^{0.63} * s^{0.54}$$

The value of coefficient C_H may be taken as shown in table.

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1.10 Design of sewers

Sewer design involves 1) fixing cross section of the sewer
2) fixing the gradient (or) slope

→ sewers are designed as "open channels" through open conduits are used.

→ sewage flow by gravity in the sewer

→ In gravity conduit- the sewage will be flows some velocities so you must be provided at proper slopes
no pumping is suggested in the sewage

→ To fix the gradient and section the following formulae are used

$$Q = AV$$

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

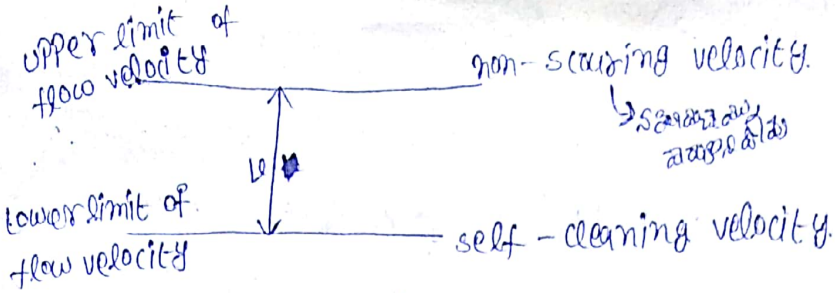
→ Basically in sewers circular geometric cross section is preferred, why because circular sections are hydraulically more efficient and helps in generating the more flow velocities comparing to other geometric sections.

→ In sewers sewage always partially flows (i.e) there is some empty space is kept in the sewer to accomodate incidental (ప్రమాదవశాత్తు) unexpected & unforcing sewage flow reasons.

→ The flow velocity in the sewer should not to be too high. and should not be too low.

→ velocity of flow in sewer should be any where b/w. self cleaning velocity to non scouring velocity

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self cleaning velocity $< V <$ non-scouring velocity

self cleaning velocity:-

It is the main flow velocity at which no silting (అవక్షేపం) and setting of particles occur inside the sewer

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

V_{self} = 0.6 to 0.9 m/sec (Range)

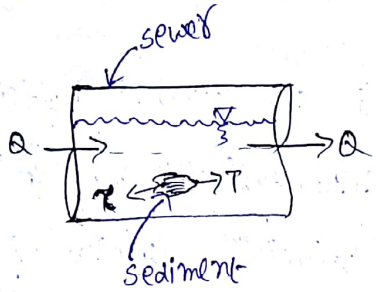
K → character of sediment (sediment constant)

f → Friction Factor

s → specific gravity of particle

d → size of sediment (or) particle.

g → gravitational acceleration constant



- $T \geq \tau$ → no silting (or) no ~~setting~~ settling
- $T < \tau$ → silting & ~~setting~~ settling

; T - Tractive flow, τ - Shear resistance

NON-scouring velocity:

It is the max flow velocity allowed in the sewer at which no scouring of sewer interiors occur

Types of sewers	NON-scouring velocity (m/sec)
Concrete (or) RC sewers	2.5 to 3
Cast Iron sewer	3.5 to 4.5

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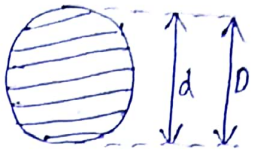
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For the designing of sewers, the following flow conditions are assumed.

Case 1:- when sewer running full then $\boxed{d = D}$

where d = depth of sewage flow in sewer

D = Diameter of sewer



we know $Q = AV$

we have, $A = \frac{\pi}{4} D^2$; $P = \pi D$ → perimeter

$R = A/P = D/4$

we know, $V = 1/n * R^{2/3} * S^{1/2}$

$\Rightarrow V = \frac{1}{n} * (D/4)^{2/3} * (S)^{1/2}$ → (I)

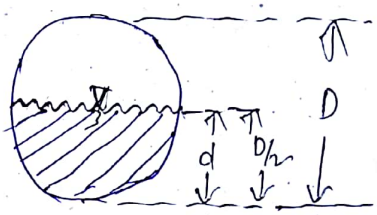
$\Rightarrow Q = AV = \left[\frac{\pi}{4} D^2\right] * \left[\frac{1}{n} * (D/4)^{2/3} * (S)^{1/2}\right]$ → (II)

From equations (I) and (II), we can calculate "D" and "S"

Case 2:- when sewer running half full then $\boxed{d = D/2}$

we have, $A = \frac{\pi}{8} D^2$; $P = \frac{\pi D}{2}$

$R = \frac{A}{P} = \frac{D}{4}$



we know, $V = \frac{1}{n} * R^{2/3} * S^{1/2}$

$\Rightarrow V = 1/n * (\frac{D}{4})^{2/3} * (S)^{1/2}$ → (I)

$\Rightarrow Q = AV = \left[\frac{\pi}{8} D^2\right] * \left[\frac{1}{n} * (\frac{D}{4})^{2/3} * (S)^{1/2}\right]$ → (II)

From equations (I) and (II), we can calculate "D" and "S"

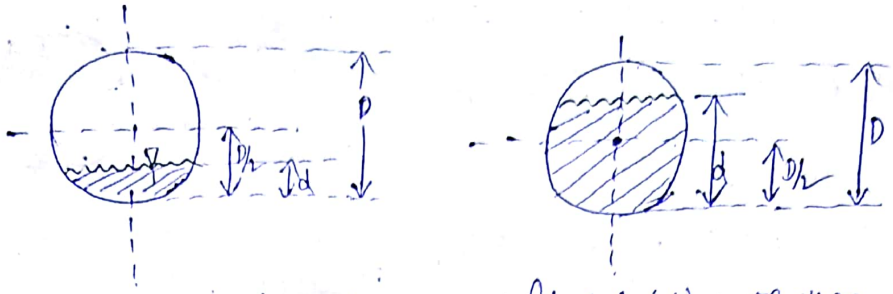
Note:- For a given diameter & for a given slope the velocity of flow is same, for sewers running full & half full but discharges are different

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Case (3): when sewer running less than half full $\boxed{d < \frac{D}{2}}$:

Case (4): when sewer running more than half full $\boxed{d > \frac{D}{2}}$:



When sewers running less than half full (or) more than half full Partial flow diagrams (or) Partial flow tables are used to pick up the hydraulic parameters.

Table: Partial flow table

* In the above table; q, v, a, r represents Partial flow hydraulic parameters.

Q, V, A, R represents Full flow hydraulic parameters.

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1.11 Appurtenances in sewerage :- (sewerage లలో ఉండే అనుబంధ భాగాలు)

(అనుబంధాలు / ఉపయోగాలు)

(a) **Inlet :-** Collect water from road surface and admit same into storm water sewer

(b) **Catch basin :-** It is a special inlet
It admits only storm water into sewer
It retain sand and the other particles inside the inlet.

(c) **Clean out :-** It is used for cleaning (or) removing of obstructions to the sewage flow

(d) **Man holes :-** Inspection, Repair, maintanance and cleaning of sewers carried out by using man holes

* special conditions for using man holes are
  - ↳ To connect sewers
  - ↳ To change the direction of sewage flow
  - ↳ To transfer sewage from high level sewer to low level sewer

(e) **Lamp holes :-**
These are used to inspect the holes with lamp (లాంప్) for inspection purpose. (తనిఖీ చేయడం)

(f) **Flushing Tank :-**
These are used to flush water at periodic intervals into a sewer

→ It is a pneumatic system (గాలి ఒత్తిడి ఉపయోగించే system లేదా)

(g) **Ejectors :-** It is a low lift demanding pump

→ To deliver sewage from low level house sewer to high level street sewer

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h) Inverted syphon:-

Portion of a sewer lying below Hydraulic gradient line (H.G.L) where sewage flows under pressure known as Inverted syphon.

→ Now we will briefly discuss about some of the main appurtenances

* street inlet:-

~~A street inlet is an opening~~

street inlets (or) gullies are the openings in the gutter (or) street-kerb to collect the storm water. (రోడ్ వాటర్ పట్టే రంధ్రం) (సైడ్ వాక్) (రోడ్)

and surface wash flowing along the street

→ these inlets are placed at the road gutters generally at street junctions.

→ If the streets are very long, more than 200m, inlets are also provided at the intermediate points at 100, 130m spacing.

~~→ Inlets are not necessary in the case~~

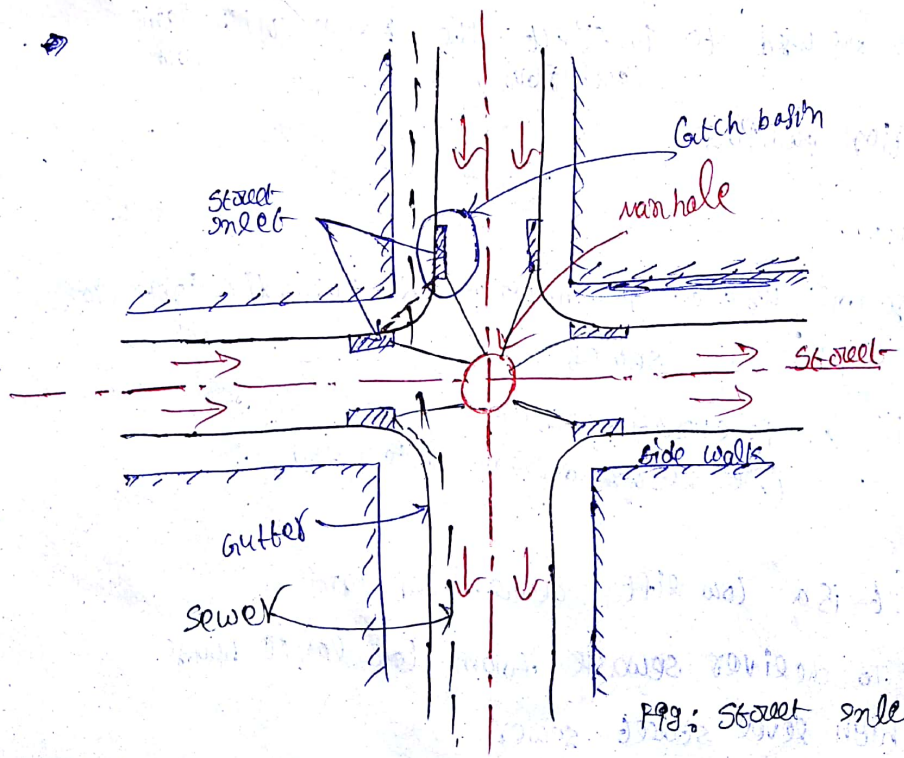


Fig: Street inlet

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→ Inlets are located usually at street intersections near kerb places

→ Inlets are of two types (i) curb inlets, when fixed vertically in the kerb and (ii) Gutter inlet, when fixed horizontally in the gutter

→ The Inlets are of three types (i) curb inlet (ii) Gutter inlet (iii) Combined gutter and curb inlet

(i) curb inlet

→ which an opening is provided in the road curb for entrance of storm water

→ These curb inlets are fixed vertically in the curb

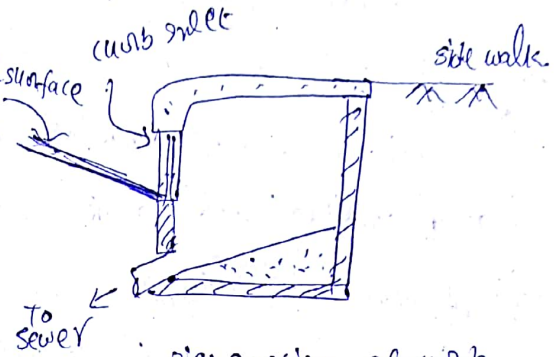


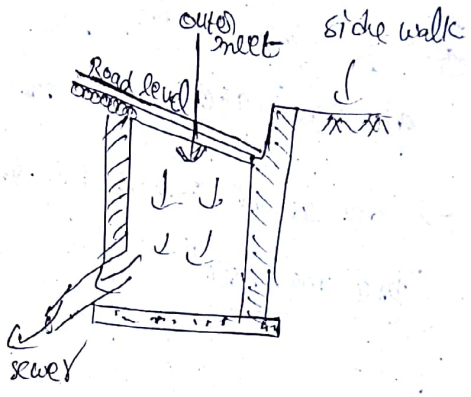
Fig: Section of curb Inlet with Catch Pit

(ii) Gutter Inlets

→ These are placed directly below the road gutter. and storm water directly enters them from the top

→ such inlets catch very large volume of water and are most suitable in roads having steep slopes, because such curb inlets may fail to catch all the storm water

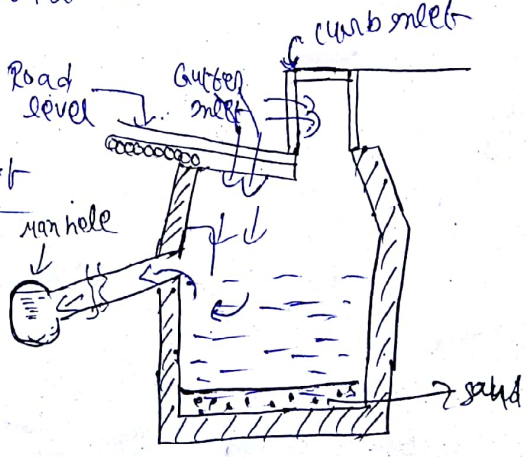
→ Gutter inlets are fixed horizontally in the gutter



(iii) Combined gutter and curb inlets

→ storm water entering from both the gutter and curb.

→ curb inlets are mostly preferred in practice



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Man hole:-

→ The man hole covers and frames are made of cast-iron. These are classified as light, medium and heavy types weighing about 51, 153 & 255 kg respectively. and are used depending on the type of traffic

→ The size of the opening should be provided 50cm - 55cm dia. A man should be go inside & come out side with this size satisfactory

→ The working chamber provides a working space for a man to stand inside and carry out requisite work of cleaning (or) inspection (అవసరమైన)

→ It is constructed in brick masonry and is either rectangular (or) circular in plan

→ In man holes, where two (or) more sewers joint at approximately the same level

→ one of the masonry using man holes in now-a-days is "Drop man hole"



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Lamp Holes:-

A lamp hole is constructed of stone ware (or) cut iron pipe 225–300 mm dia baked in concrete and build of a T-Junction on the sewer

→ Lamp holes are found suitable for use under the following situations

→ where it becomes necessary to inspect bends in the sewer

→ where manholes can be constructed with difficulty

→ ~~Where the~~

→ In certain circumstances with no other flushing devices available, the sewer is to be got flushed.

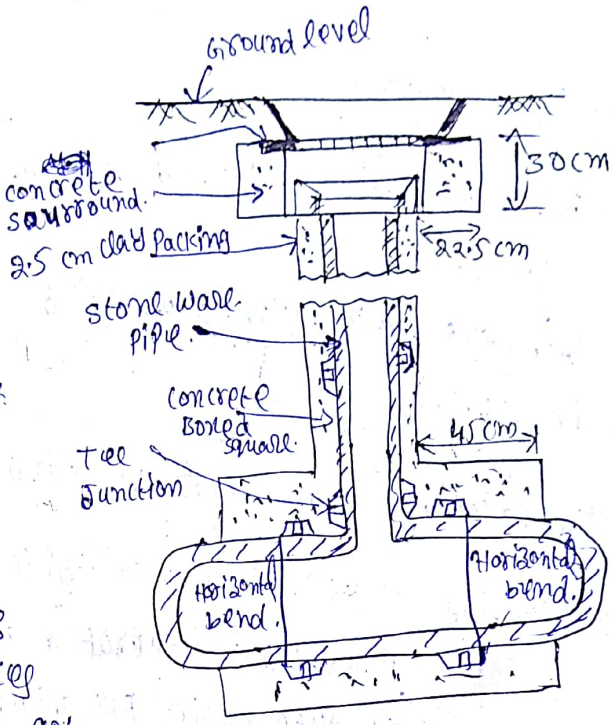


Fig:- Lamp hole

Catch Basin:-

→ A Catch basin is an inlet

→ which allows grit, sand (or) debris to settle out and are thus prevented from entering into the sewer

→ The outlet usually trapped to prevent escape of odours from the sewers and to retain floating matter

→ In present days Catch basins are not provided, It is essential. ~~The sewer pipe lines~~ The efficient sewers to be provided this sewers to carry the little bit of grit (or) debris permitting and also self-cleaning velocity having

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→ Catch basins requires to be periodically cleaned up, why because this will cause breeding of mosquitoes.

Flushing tanks:-

→ These are devices to hold water. used in flushing sewers.

→ this action is useful to prevent the clogging in sewers

→ the location should at the dead end (or) at head of the sewers

→ flushing tanks are of two types

1) manually operated flushing tank &
2) Automatic flushing Tank

→ The manually operated tanks have a simple arrangement of leading up water (or) sewage in the sewer.

plugging the inlet and outlet ends of the sewer.

→ the manhole (or) tank is filled with water from a house, the outlet end is then opened and the water (or) sewerage rushes out, thus flushing the sewer.

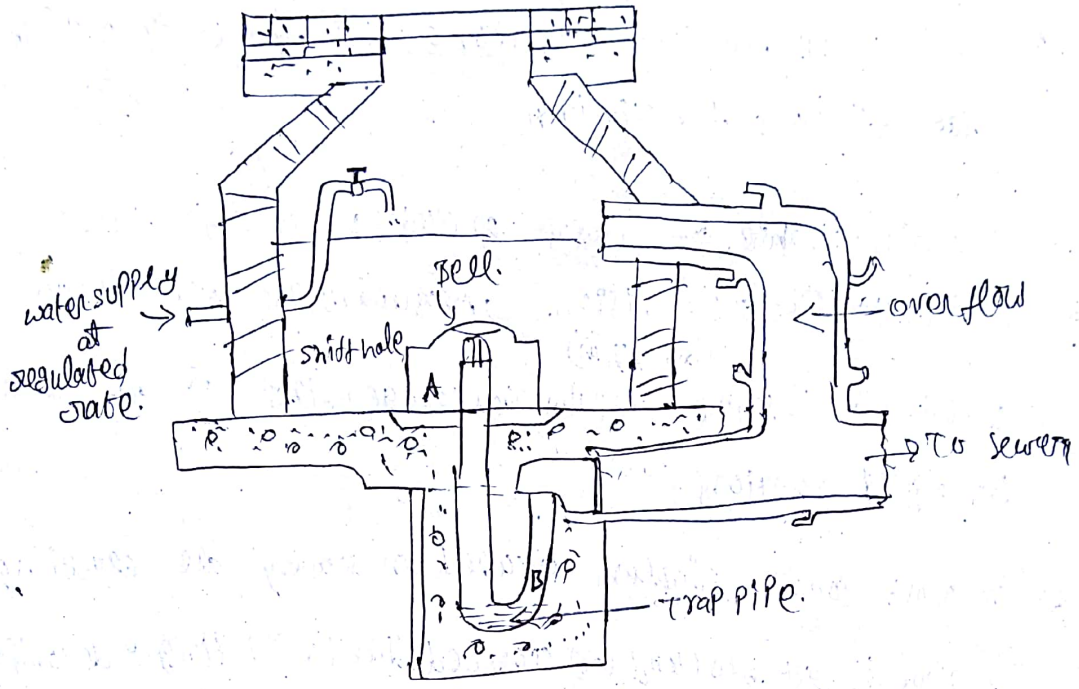
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→ The automatic flushing tank should have such characteristics as

* minimum number of moving parts to be used for flushing action
→ The initial cost & maintanance is high.

~~Action of flushing tank:~~



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Cleaning & ventilation of sewers:-

→ The cleaning & ventilation of sewers is very mandatory in now a days

Maintenance of sewers:-

→ cleaning to keep them free from any clogging and to carry out the repairs to the damaged portions if any this will cause prolong their life of sewer, & sufficient functioning

→ The maintenance of sewers includes: Their frequent Inspection & supervision, measuring the rate of flow, cleaning & flushing, repair the leakage joints (or) any other damaged portions

→ The most common problem occured in sewers are clogging The sewers get blocked (or) clogged due to silting & decomposition of debris, grit and other floating matters present in the sewage

→ The sewers are generally designed to flow with a self-cleaning velocity, The silting get removed in sewers The sewers are laid on flatter gradients

→ The main cause of clogging was Greasy and oily matters coming from kitchens, hotels & restaurents (or) Industries

→ So while reducing this clogging the municipal sewers are regularly cleaned.

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Cleaning of sewers:-

→ The sewers are periodically cleaned to avoid the clogging

→ for cleaning small sewers a man who can not enter into the sewer - flushing operations should be enough the flushing we required large volume of water to be used for flushing

→ The medium sized sewers are generally cleaned by using scrapping instruments, which are dragged through the sewer (or pipe)

~~→ A sewer cleaning rod called "Crane Rodding~~

→ The large size of sewers which can be entered into the men are generally cleaned by manual labour.

→ A man enter into the sewer pipe and remove the deposited materials by hand shovels etc. and collect it up in buckets and remove it outside the manhole.

→ "Pills" have been successfully used in USA for cleaning badly clogged sewers.
"Pills" are nothing but a series of light floating wooden (or) rubber hollow balls. when such a ball is rolled into the sewer, it gets struck up at the place where heavy deposition takes place.

→ These pill restrict the flow in that place rising the velocity of flow in neighbouring and as result the scouring will get moved

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→ After that the balls picked in a net at the next down stream manhole.

→ The larger size of balls are used and unless in one manhole and pick up other manhole.

→ The process is repeated.

→ A string is generally tied to the ball by which it can be pulled out, if it gets stuck up in the blockage

→ Sufficient precautions and care must be taken while entering the sewers. otherwise some time foul poisonous and explosive gases may released. in sewer pipes

Precautions to be taken while entering in to the sewer :-

→ Various poisonous explosive gases which are generally found present in sewers are Hydrogen sulphide (H_2S), Carbon dioxide (CO_2) & methane (CH_4)

→ The all hazardous gases are present so a man while entering into pipe it is difficult to breathing.

The following precautions should be taken while allowing the workers to enter the sewer.

(1) Firstly, we want to clean the sewer at man hole, so the man hole should be open half an hour before its cleaning. It will use the atmospheric oxigen should enter into the sewer

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(iii) The tests should be carried out any hazardous gases are present inside the sewer (or) not.

(a) H_2S gas may be detected by exposing a sheet of paper. should placed entry of sewer the paper turns black

If the paper turns black H_2S gas is present inside the sewer.

(b) CO_2 gas may be detected by lowering, a miners safety lamp near the level of man hole. If the flame are coming with in 5 minutes, the CO_2 is present inside of sewer.

when any gases are present in the sewer we have to be used nose masks before enter into the sewer pipe, only permissible safety lamps, rubber boots & non-sparking tools should be used.

→ If any case, the workers going down for inspection. must be tied with ropes to their waists (waisted) to pick up top very fastly.

→ The responsible officer should preferably be present to direct the opesations

→ Any smoking (or) carrying lights inside the sewer are strictly prohibited.

→ Necessary warning signals should be erected.

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ventilation of sewers:-

Sewers must be properly ventilated for the following reasons:

(i) The decomposition of sewage inside the sewers may result in the production of various sewer gases such as CO_2, CO, CH_4, H_2S, NH_3, N_2, etc which should disposed into atmosphere while providing the ventilation.

→ If these gases are not removed it may cause serious problems occurs while entering the workers into the sewer

(ii) Another reason for ventilating sewers is to provide. To achieved a continuous flow of sewage inside the sewer. Thus preventing the formation of air-locks in the sewage.

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Methods of ventilation:-

1) use of ventilating column:-

the ventilating columns are generally designed to serve two purposes

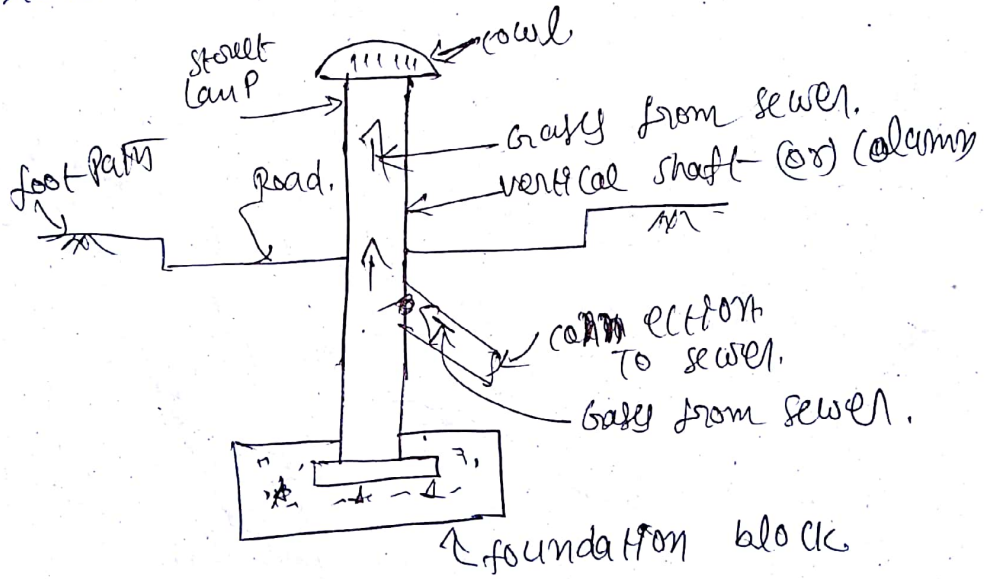
→ one for ventilating the sewer and the other for working as a support street lamps, sign boards etc.

⇒ the diameter of the ventilating column is preferably kept equal to one third of the dia. of the sewer

→ the ventilating columns should be kept large height of the near by structure.

→ the ventilation pipe should joint the large column of the building.

→ these pipes should be provide out side of building.



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→ The top of ventilating column should be covered with wire mesh so as to prevent the birds from build. their nest at the top and to prevent any thing (dirt) directly falling into the pipe

→ The ventilation pipe should be kept in open place should be kept the sunlight fall on to the pipe. They help for causing proper circulation of air

2) use of ventilating man hole covers
3) Proper Design of sewers
4) use of mechanical Devices
5) un obstructed outlets
6) House vent & soil pipes
7) Artificial ventilation

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Problems

(1)

1) A 300mm dia sewer is to flow at 0.3 depth on a grade ensuring a degree of self-cleaning equivalent to that obtain at full depth at a velocity of 0.90 m/sec. Find the required grade and associated velocity and rate of discharge at this depth. Assume mannings surgosity coefficient n of 0.013 the variations of n with depth may be neglected.

Sol) From mannings formula, we have

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

At full depth, using capital letters, we have.

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

using $V = 0.9$ m/sec

$N = 0.013$

$R = D/4$

$= \frac{300}{4}$ $= 75$ mm.

$= 0.075$ m.

we have $V = \frac{1}{N} R^{2/3} \sqrt{S}$

$0.9 = \frac{1}{0.013} (0.075)^{2/3} \sqrt{S}$

$\sqrt{S} = \frac{0.9 \times 0.013}{0.178}$

$\sqrt{S} = 0.0657$

$S = 0.0043$ (i.e 4.3 %)

$Q = AV$

$= \frac{\pi}{4} (0.3)^2 * 0.9$ cumecs

$= 0.064$ cumecs

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Now, at a depth (d) equal to 0.3 times the full depth (D), we have

$$\frac{d}{D} = 0.3$$

Using table 4.8 we have for

$$\frac{a}{A} = 0.252$$

$$\frac{r}{R} = 0.684$$

Now for the sewer to be the same self-cleansing at 0.3 depth (d) as it will be at full depth. we have the gradient (S_s) required from equation

$$S_s = \left(\frac{R}{r}\right) S$$

$$S_s = \frac{1}{0.684} S$$

$$= \frac{1}{0.684} \times 0.0043$$

$$= 0.0063 \quad (\text{i.e } 6.3\ \%)$$

Now, the velocity V_s generated at this gradient is given by Eqn 4.25 as

$$V_s = \frac{N}{n} \left(\frac{r}{R}\right)^{1/6} \times V$$

$$= 1 \times (0.684)^{1/6} \times 0.9\ m/sec$$

$$= 0.939 \times 0.9$$

$$= 0.846\ m/sec \quad \text{Ans}$$

The discharge q_s is given by Eqn (4.26) as

$$q_s = \frac{N}{n} \left(\frac{a}{A}\right) \left(\frac{r}{R}\right)^{1/6}$$

$$q_s = (1)\ (0.252)\ (0.939)\ (0.684)\ \text{cumecs}$$

$$= 0.017\ \text{cumecs}$$

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(Q) Determine the size of a circular sewer for a discharge of 600 lps running half-full Assume $i = 0.0001$ and $n = 0.015$

Sol

$d = 0.5D$ $[\because d = D/2]$

$\frac{d}{D} = 0.5$

$q = 600$ liters/sec

$= 0.6$ cumecs

$S = i = 0.0001$

$n = 0.015$

From table 4.8 at $\frac{d}{D} = 0.5$

we have $q/Q = 0.5$

$Q = q/0.5$

$= \frac{0.6}{0.5} = 1.2$ cumecs

Assuming 'n' not to vary with depth, we have by using mannings formula

$Q = A.V$

$Q = A * 1/n * R^{2/3} * \sqrt{S}$ $[\because V = 1/n * R^{2/3} * S^{1/2}]$

$1.2 = \left[\left(\frac{\pi}{4} D^2\right)\right] * \left[\frac{1}{0.015} * (D/4)^{2/3} \sqrt{0.0001}\right]$ $[\because R = A/P = D/4]$

$(4)^{2/3} = 2.52$

$\left(\frac{1}{0.0001}\right)^{1/2} = 100$

$\frac{1.2 \times 0.015 * 4 * 2.52 * 100}{\pi} = D^{8/3}$ $[\because D^n D^{2/3} = D^{2+2/3} = D^{8/3}]$

$D^{8/3} = 5.78$

$D = (5.78)^{3/8}$

$= (5.78)^{0.375}$

$= 1.93$ m.

Hence, the diameter of the sewer required

$= 1.93$ m

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* Alternatively when table 4.8 is not available, we may solve the problem as follows

we know that $\frac{d}{D} = 0.5$

=

when the sewer runs partially full, at a depth "d"

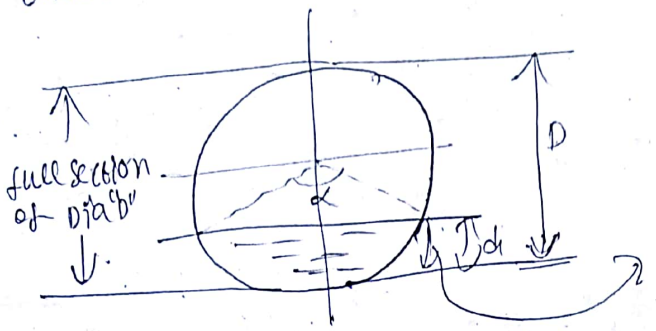


Fig: Partially filled circular sewer section.

The depth at partial flow

$= d = \left[\frac{D}{2} - \frac{D}{2}\cos\frac{\alpha}{2}\right]$

when 'α' = central angle in degrees

$\therefore$ Proportionate depth $= \frac{d}{D}$

$= \frac{1}{2}\left[1 - \cos\frac{\alpha}{2}\right]$

we know that $\frac{d}{D} = 0.5$

$= \frac{1}{2}\left[1 - \cos\frac{\alpha}{2}\right]$

$\cos\frac{\alpha}{2} = 0$

$\frac{\alpha}{2} = 90^0$

$\alpha = 180^0$

Now using eqn 4.13 we have

$$a = \frac{D^2}{4}\left[\frac{\pi\alpha}{360^0} - \frac{\sin\alpha}{2}\right]$$

$$= \frac{D^2}{4}\left[\frac{\pi\cdot(180)}{360^0} - \frac{\sin 180^0}{2}\right]$$

$$= \frac{D^2}{4}\left[\frac{\pi}{2} - 0\right]$$

$$= \frac{\pi D^2}{8}$$

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(8)

Now we using eq (4.15), we have.

$$P = \pi D \frac{\alpha}{360^0}$$

$$= \pi D \frac{180^0}{360^0}$$

$$= \frac{\pi D}{2}$$

$$r = \frac{a}{P}$$

$$= \frac{\frac{\pi D^2}{8 \cdot 4}}{\frac{\pi D}{4}} = D/4.$$

using mannings formula we have.

$$Q = AV$$

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

$$0.6 = \frac{\pi D^2}{8} \times \frac{1}{0.015} \times (D/4)^{2/3} (0.0001)^{1/2}$$

$$\therefore D^{8/3} = \frac{0.6 \times 0.015 \times 8 \times 2.52 \times 100}{\pi}$$

$$D = 1.93 \text{ m}$$

$\left[\because \left(\frac{D}{4}\right)^{2/3} = 2.52\right.$

$\left.\left(\frac{1}{0.0001}\right)^{1/2} = 100\right.$

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(6) Calculate the velocity and discharge through a well rounded concrete lined ~~stone~~ smooth lined channel 2.4m wide and 1.2m deep built to a slope of 1 in 200, when running completely full use Bazin's coefficient in Chezy's formula

$$C = \frac{157.6}{1.81 * \frac{K}{\sqrt{R}}}$$

where $K = 0.3$ for smooth concrete lined surface

Sol: Area of channel $(A) = 2.4\,m * 1.2\,m$

$= 2.88$ sqm

wetted perimeter $(P) = 2.4 + 1.2 + 1.2 + 2.4$

$= 7.2\,m$

$R = A/P$

$= 2.88/7.2 = 0.40\,m$

Now, $C = \frac{157.6}{1.81 + \frac{K}{\sqrt{R}}}$

$= \frac{157.6}{1.81 + \frac{0.3}{\sqrt{0.40}}} \Rightarrow \frac{157.6}{1.81 + 0.474}$

$\Rightarrow \frac{157.6}{2.284} \Rightarrow 68.99$

Using, Chezy's formula, we have

$V = C \cdot \sqrt{RS}$

$= 68.99 \sqrt{0.40 * \frac{1}{200}}$

$= 68.99 \times 0.0447$

$= 3.08$ m/sec

Discharge $Q = AV$

$= 3.08 * 2.88$

$= 8.88$ cumecs

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(W)

(8) Calculate the diameter and discharge of a circular sewer laid at a slope of 1 in 400 when it is running half full, and with a velocity of 1.9 m/sec (n in manning's formula = 0.012)

Soln:- when pipe is running half full,

The area of section

$$a = \frac{\pi D^2}{8}$$

The wetted perimeter $P = \frac{\pi D}{2}$

$$m = A/P$$

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

Using mannings formula, we have

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

$$1.9 = \frac{1}{0.012} \left[\frac{D}{4}\right]^{2/3} (1/400)^{1/2}$$

$$D^{2/3} = 1.9 * 0.012 * 2.52 * 20$$

$$= 1.15$$

$$D = (1.15)^{3/2}$$

$$= 1.23 \text{ m}$$

[$\because (4)^{2/3} = 2.52$

$(400)^{1/2} = 20$]

Hence, use 1.23 m dia sewer

Discharge $Q = aV$

$$= \frac{\pi D^2}{8} * 1.9$$

$$= \frac{\pi (1.23)^2}{8} * 1.9 \text{ m}^3/\text{sec}$$

$$= 1.13 \text{ cumecs}$$

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(5) Design a section of a combined circular sewer from the data given below:

Area to be sewed 150 hectares

Population = 50,000

max Permissible velocity = 3.2 m/sec

Time of entry = 5 min

time of flow = 20 min

Rate of water supply = 270 lit/sec/day/capita

Impermissibility factor = 0.45

Assume 75% of water supplied converts into sewage?

WWF = wet weather flow

DWF = Dry weather flow

Sol:-

To find d = ?

$Q_{combined} = Q_{WWF} + Q_{DWF}$

Area = 150 hectares

Population = 50,000

velocity V = 3.2 m/sec.

t_e = 5 min.

t_f = 20 min

Water supply = 270 lpcd (litres per capita per day)

I = 0.45

factor = 75% $= \frac{75}{100} = 0.75$

Q_{DWF} = Population * Per capita water supply * factor.

= 50,000 * 270 * 0.75

= 10125000 lit/sec/day

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$1\,m^3 = 1000$ litres

$1\,lit = \frac{1}{1000}\,m^3$

$= \frac{5900 * 270 * 0.75}{10^3 \times 24 * 60 * 60}$

$Q_{DWF} = 0.117\ m^3/sec$ ✓

$Q_{WWF} = \frac{AIR}{360}$

$R = \frac{25.4 * a}{t_c + b}$ (formula)

$t_c = t_e + t_f$

$= 5 + 20 \Rightarrow 25\,min. > 20\,min$

5 – 20 min.
$a = 30, b = 10$ ✓

So $a = 40$, $b = 20$ (∵ see the table)

$R = \frac{25.4 * 40}{25 + 20} = 22.57$

$Q_{WWF} = \frac{150 * 0.45 * 22.57}{360}$

$Q_{WWF} = 4.23\ m^3/sec$ ✓ ($t_f > 500$ metres only, this formula is not valuable)

total discharge $= Q_{DWF} + Q_{WWF}$

$= 0.117 + 4.23$

$= 4.347\ m^3/sec$

Discharge $= A * V$ [∵ $Q = AV$]

$4.347 = \pi/4\, d^2 * 3.2$

$\pi/4\, d^2 = \frac{4.347}{3.2}$

$d = 1.315$ metres

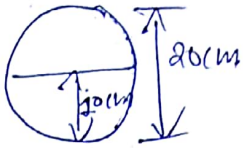
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(Q) A 20cm dia sewer is laid @ a slope of 0.004 and is designed to carry a discharge at a depth of 10cm with mannings n = 0.014, then Calculate the design discharge in litres/sec = ? (6)

Sol:

dia = 20cm = $\frac{20}{100}$ = 0.2m



S = i = 0.004

discharge depth d = 10cm = $\frac{10}{100}$ = 0.1m

n = 0.014

$Q = A * V$

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

$r = A/P$

$r = \frac{\text{Area}}{\text{wetted Perimeter}}$

$= \frac{\pi/4 \, D^2}{\pi D/2} = D/4$

$V = \frac{1}{0.014} * \left(\frac{0.2}{4}\right)^{2/3} * (0.004)^{1/2}$

$= 0.613$

$Q = \frac{\pi/4 \, D^2}{2} * V \quad [\because Q = AV]$

$= \frac{\pi}{8} * (0.2)^2 * 0.613$

$Q = 9.63 * 10^{-3} \, m^3/sec$

$Q = 9.63$ litres/sec

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(3) ~~A rectangular~~ A residential area has an area of 50 hectares and its length is 2400 m. A circular storm sewer is to be laid for that area. A velocity of 1 m/sec may be allowed when discharging at maximum rate time of entry from the farthest area is 10 min Calculate the storm discharge by assuming the Impervious factor as 0.8 ?

Sol :-

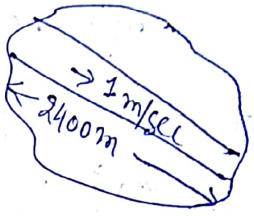
Area = 50 hectares

length = 2400 m

velocity = 1 m/sec

I = 0.8

Te = 10 min



Time of concentration = Te + Tf

Time of flow (Tf) = $\frac{\text{Distance travelled}}{\text{velocity}}$

$= \frac{2400\ m}{1\ m/sec}$

$= 2400$ sec

$T_f = \frac{2400}{60} = 40$ min

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[∵ If t = 5 min to 20 min. then a=30, b=10
If t 20 min to 100 min a=40 b=20]

Time of concentration (T_c) = Te + Tf

= 10 + 40

= 50 min > 20 min. [∵ t > 20 min a=40, b=20]

a = 40 , b = 20 ~~from the table~~.

$Q_{DWF} = \frac{AIR}{360}$

$R = \frac{25.4 * a}{t+b}$

$R = \frac{25.4 * 40}{50+20} = 14.5$

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10, 18, 22, 25, 26, 36, 45, 46, 47, 49, 52, 56, 58, 60 (7)

$$Q_{WWF} = \frac{A \Omega R}{\cdot 360}$$

$$= \frac{50 * 0.8 * 14.5}{360} \ m^3/sec$$

4) A circular sewer of 45cm dia was designed for a town population of 30,000 the sewer was designed to carry 3.5 times of DWF what slope should be provided to the sewer when Running full? Take $n = 0.012$ in manning's equation Assume 80% of factor for water supply 150 lpcd?

Sol

Population = 30,000

Dia (D) = 45cm

= 0.45m

~~$Q_{combined} = D_{DWF}$~~

$Q = 3.5 * D.W.F$

$n = 0.012$

factor = 0.8 = 80%

water supply = 150 lpcd

Q_{DWF} = ~~30000~~ Population * Per Capita water supply * factor

$$= \frac{30,000 * 150 * 0.8}{1000 * 24 * 60 * 60}$$ ($\because$ litre/day $\cong m^3/sec$)

$Q_{DWF} = 0.042 \ m^3/sec$

$Q = 3.5 * 0.042 = 0.147 \ m^3/sec.$

sewer is running full.

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

$$0.147 = \left[\pi/4 (0.45)^2\right] * \left[\frac{1}{0.012} * \left(\frac{0.45}{4}\right)^{2/3} S^{1/2}\right]$$

~~$S = 0.0022$~~

$S = 2.209 \times 10^{-3}$

$S = \frac{1}{453}$

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