Unit-2

24-08-2021
Tuesday

* Frequency analysis of point rainfall:

→ stroms of high intensity and varying durations occur from time to time. However, the probability of these heavy rainfalls varies with ~~totally~~ locality.

→ The 1st step in designing engineering projects dealing with flood control, gully control etc. is to determine the probability of occurence of particular extreme rainfall.

→ The information ~~of~~ ~~this~~ is determined by the frequency analysis of point of rainfall. data.

Relationship b/w duration & Intensity of rainfall } → duration (increase)
Intensity of rainfall (decrease).

→ Frequency analysis deals with the chance of occurence of an event over a specified period time.

→ suppose, P is probability of occurence of an event (rainfall) whose magnitude is equal to (or) in excess of specified magnitude (x).

→ The recurrence interval (return period) is to P as follows:

Ex: In an year, few events like $x_1, x_2 - - - x_m - - - x_n$ etc. are to be arranged in a decending order. (x_1 is greater than x_2)

No of sample (or) sample site = n (there are n variables their)

1, 2, 3, m, n, are ranks of precipitation.

$\therefore P(x \geq x_m) = \frac{m}{n}$ = exedence Probability $= P(x_n)$

$\therefore$ Return period $= T_n = \frac{1}{P(x_n)} = \frac{n}{m}$

The magnitude of any value which is equal to x_m or more than x_m can occured, once in a $\frac{n}{m}$ years.

→ Disadvantage:

If we want to calculate excedence probability of x_n, In that case m will become n, & n will become n then probability is equal 1, but probability never be equal to 1

→ for that we have california formula.

Methods	P (probability)
california	$\frac{m}{N}$
Hazen	$\frac{m-0.5}{N}$
weibull	$\frac{m}{N+1}$
chegudayev	$\frac{m-0.3}{N+0.4}$
Blom	$\frac{m-0.44}{N+0.12}$

$\frac{m}{N+1}$

where

m = rank assigned to data after arranging them in a descending order of magnitude.

{i.e., Maximum value assigned, m=1, the 2nd value m=2 and lowest value (m=N) }

N = Number of records.

→ weibull formula is most commonly used plotting position formula.

Example:

For a station A, the recorded annual 24h maximum rainfall is given below.

year	Rainfall (cm)	year	Rainfall (cm)	year	Rainfall (cm)
1950	13.0	1957	12.5	1964	8.5
1951	12.0	1958	11.2	1965	7.5
1952	7.6	1959	8.9	1966	6.0
1953	14.3	1960	8.9	1967	8.4
1954	16.0	1961	7.8	1968	10.8
1955	9.6	1962	9.0	1969	10.6
1956	8.0	1963	10.2	1970	8.3
				1971	9.5

(a) Estimate the 24h max. rainfall with return period of 13 and 50 years

$T = \frac{1}{P}$

(b) What would be probability of a rainfall of magnitude equal to the (or) exceeding 10cm occurring in 24h at Station A.

$P = \frac{1}{22+1}$

sol:

m	Rainfall (cm)	$P = \frac{m}{n+1}$	$T = \frac{1}{P}$
1	16	0.043	23.[illegible]
2	14.3	0.087	11.5
3	13	0.130	7.67
4	12.5	0.174	5.75
5	12	0.217	4.60
6	11.2 ~~10.8~~	0.264	3.83
7	10.8	0.304	3.29
8	10.6	0.348	2.88
9	10.2	0.391	2.56
10	9.6	0.435	2.30

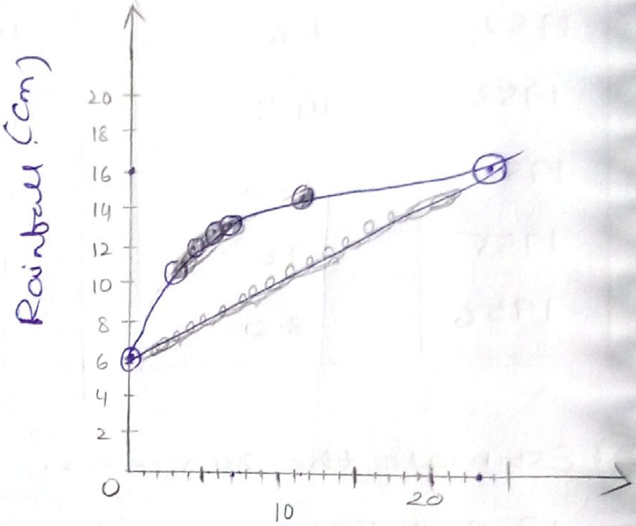
m	Rainfall (cm)	$P=\frac{m}{n+1}$	$T=\frac{1}{P}$
11	9.5	0.478	2.092
12	9	0.522	1.92
13	8.9	0.	
14	8.9	0.609	1.64
15	8.5	0.652	1.53
16	8.4	0.696	1.44
17	8.3	0.739	1.35
18	8	0.783	1.28
19	7.8	0.826	1.21
20	7.6	0.870	1.15
21	7.5	0.913	1.10
22	6.0	0.957	1.05

$$\frac{y-y_1}{y_2-y_1} = \frac{x-x_1}{x_2-x_1}$$

(or)

Take graph.

(Rainfall frequency curve)



ⓐ After interpolating & extrapolating the above graph, we can determine rainfall magnitude for 13 and 50 years return period respectively.

→ 13 years R.P. = 14.55cm (14.52 cm)

→ 50 years R.I = 18.00cm.

$\boxed{13\text{years}} \rightarrow x$, $y = ?$

$11.5 \rightarrow x_1$, $14.3 = y_1$

$23 \quad x_2$, $16 = y_2$

$$\frac{y-14.3}{16-14.3} = \frac{13-11.5}{23-11.5}$$

$y = 14.52$

50y → x y

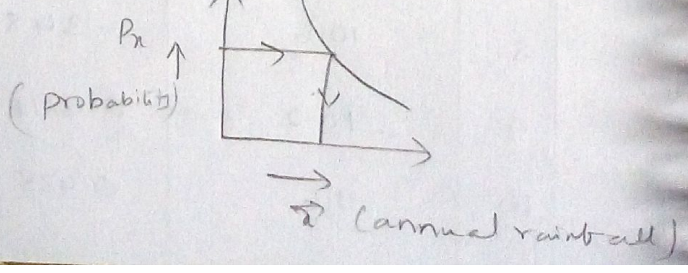
23 — 6

ⓑ For rainfall 10cm, T = 2.47 years, & P = 0.417.

R	T
10.2	2.56
9.6	2.30
10	?

$T = \frac{1}{P}$

0.4043



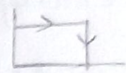
* For which flow, we can design reservoir?

different year $\rightarrow$ diff flows (either, high or low)

$\rightarrow$ Guidliness for irrigation projects 75% probability year may consider.

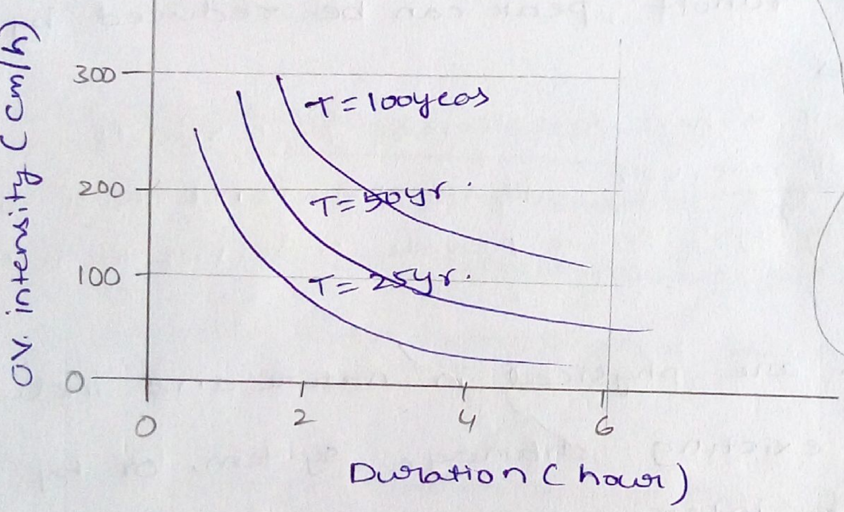
$\rightarrow$ ~~ab~~ so, for frequency analysis,

at 0.75 $\longrightarrow$ draw a horizontal line and it cuts the frequency at some point, draw a vertical ordinate

{i.e. 

* Intensity - duration - frequency curve:

For diff Intensity diff Duration.



IDF-curve
$\downarrow$
Ex: say 30 min what is intensity
$\downarrow$
$\rightarrow$ IDF curve for study area
$\downarrow$
$\rightarrow$ Identify storm (i.e. Input)
$\downarrow$
$\rightarrow$ i.e. runoff
$\rightarrow$ divide into diff sub. catchments
$\rightarrow$ cal. Runoff from each sub catchment

DO problems

$\rightarrow$ To discharge, volume & runoff, we design pipe

$\rightarrow$ above steps are for basic data

for this

	1970	1971	
15 min $\rightarrow$	x_1	x_2	$\rightarrow$ take max
30 min $\rightarrow$	x_3	x_4	$\rightarrow$ take max

} draw graph

$$i = \frac{K \cdot T_p}{T_t}$$

$$I_m = \frac{c}{(t+a)^b}$$

$$\boxed{i = \frac{K \cdot T^x}{(D+a)^n}}$$

$\rightarrow$ i - intensity max (cm/h)

$\rightarrow$ T - return period (yr)

$\rightarrow$ D - duration (h)

K, x, a, n $\rightarrow$ coefficients for area represented by station.

Aug 30 30/8/2

* Design and Management of urban Drainage system:-

Ex: Village Ex: town

→ Drainage basin can be Rural (natural) or urban (man-made)

→ when it rains on city surface three main effects are seen

* peak rate of flow increases by 8 times — Peak ↑ flow ↑

* shorter time of flow (3-45min) caused by increased velocity of runoff.

* Runoff volume increases by up to 6 times

(if Rural, more pervious infiltration ↑ but urban impervious infiltration ↓

→ The magnitude of such increases depends on many factors, such as the frequency of storms, local climate and condition of the catchment surface, etc.

→ The post development runoff peak can be reduced by structural measures

→ what is our objective is u have to decrese peak runoff.

→ purpose of flood control reservoir if reservoir is not their so peak hydrograph will be very high, so, we provide reservoir to reduce the peak.

→ structural measures are physical in nature and include

* redesigning the existing drainage system, or by providing suitable interventions in the form of storage at suitable locations in upstream catchment.
{storage reduces the peak, but not volume} Ex: boatclub

* Non-structural measures strive to keep people away from the flood waters by means of EWS and other mitigation measures.

① structural → to decrease peak flow (i.e redesigns, like pondy)

② Non-structural → early warning system, keep way from water system.

* Drainage system:

→ Drainage systems can be categorized as major and minor systems.

① * Major:

→ The major drainage systems comprises of open nallahs / and natural surface drains, etc. (which not covered fully) top open

② * Minor:

→ The minor system is the network of underground pipes and channels → from home some channel (open or closed)

→ The minor system can be categorized into 2 types
ⓐ separate
ⓑ combined

ⓐ seperate drainage system: — [drainage, strom]

→ It consists of 2 conveyance networks the ① sanitary sewers {usually underground pipes} conveying wastewater from homes and businesses to a discharge point

→ ② storm drains {underground pipes or channels} collect water from the rainfall runoff and convey it to a discharge point which is usually a natural water course or coastal waters. {discharge into river or sea}

* strom water drainage system Inventory:— (proper details about the)

→ It is observed that a proper inventory of water supply system is {maintanence, map, crosssection, slopes where pumping takes place, lifting, detention, contour maps etc.} maintained starting with details of treatment, pumping, storage and along with main feeder lines to the smallest domestic connection.

→ data ~~by~~ stored digitally {Like using GIS and etc}

→ Similarly for the sewer lines an inventory is available starting from the smallest domestic connection to the sewer/trunk mains for all areas which are serviced with a proper sewerage system. (NO need)

→ Muncipal authority generally do not keep a systematic and complete inventory, especially to the minor drainage system. As a result of this, it is difficult to plan Operation & maintainence (O & M) and upgradation of the system.

→ Even w.r. to the major drains, inventories are not maintained with clear delineation, demarcation and details of the cross-sections & slopes సరిహద్దు

If we have a drainage system, one drain is there, we have to demarcate the area of or that drain, {so that catchment collect the water & outlet with drain} if we have a contour map we can draw on edges, then catchment area we can recognize and then we demarcate the area of the outlet point}.

→ There may be natural formations & main made structures like bridge piers, transmission towers and cable laid across, service utilities like sewers, water supply and gas pipelines which reduce the cross-section available for flow.

{by constructing structures, c/s reduces, {i.e carrying capacity also reduces} in nallah then flooding takes places}

→ Besides all these, there may be existing encroachments etc

→ An inventory of existing stromwater drainage system will be prepared on GIS platform,

Geographical Information System

→ We can easily digitised drainage system of town by GIS

→ The inventory will be both watershed based to enable proper hydrologic and hydraulic analysis and ward based to enable co-ordinated adminstrative management

{ie, Boundary of inventory is not an political boundary, if drainage in ward No 1, it doesn't mean the water falling on the ward No1 will comes to this drainage, it follows only natural boundary ward-2 also come to natural boundary}

→ {Rain occured in Nashik that water reached Dowleswaram after some days & some hours}

→ Minor systems should be mapped clearly showing the interconnections with the major system besides the cross-sections with sewers lines, {everything like, dia, slope etc parameters will be captured by spacial data and Tabular data}

→ Major systems will be mapped clearly with delineation, demarcation and details of the cross-sections, slopes, drain crossings, including natural formations, and manmade structures like brige piers, ~~trans~~ transmission towers, service utilities and existing encroachments etc. This should also take into account the sewer discharges.

* Requirements for urban drainage design:

→ There is a need for the development of an adequate and functioning drainage system based on sound hydraulic & ~~dg~~ hydrologic design principles {like, runoff, intensity, time of concentration etc.

{velocity, elevation, pressure

→ The design of an urban drainage system requires knowledge of the catchment area and topography, urbanization details, rainfall intensity, hydrology, hydraulics, etc.,

Contour, elevation — vegetation, soil, etc. — 40,50, years data of rainfall.

open channel, roughness,

Catchment as basis for design:

Kakinada urban } Political
" rural } boundaries

→ states and cities have political and administrative boundaries. However, rainfall and runoff processes are independent of these, and depend on the watershed delineation.
(only follows natural boundaries)

→ Each urban area may consists of a number of watersheds
Ex: Mumbai.

definition

→ A watershed is the geographic region within which water drains into a stream, river, lake or sea.

→ The watershed may be ~~compressed~~ composed of several sub-watersheds & Catchments.

Ex: godavari
sub basin → Indravathi, (orissa & chattishgad)

***

Contour data:

→ Accurate contours are necessary for determining the boundary of a watershed/ catchment and for computing directions of flow.
(If we have a contour data simulate the drain water movement but the principle is H.E to L.E (high to low)

→ Detailed contour maps at required resolution should be prepared for proper delineation of drainage catchments.

*→ Mumbai is preparing contour maps of the city at intervals of 0.2m while chennai is preparing them for 0.3m.

* Rainfall Requirements:

→ For design of a drainage system, the conventional practice is to choose an appropriate, statistically relevant design storm to establish the stormwater flows to be conveyed, based on existing national & International process.

→ Design storms can be estimated from rainfall data records where available.

→ There is wide variation of rainfall amongst the cities and, even within the city, rainfall shows large spatial and temporal variation;

for example:

In Mumbai, on 26th july 2005, Colaba recorded only 72mm of rainfall while santa cruz, which is 22 km away, recorded 944mm in 24hours.

→ Due to high variability of rainfall in space and time rainfall measurements are required at high temporal and spatial resolution from dense rain gauge networks for the adequate design of new systems and /or ~~reno~~ Renovation of existing drainagesystem.

→ upto date IDF relationships needs to be used to maintain design standards for new systems and retrofitting/ replacement of old urban drainage systems.

→ IDF curves will be developed for each city, based on extraction of data from the raw data charts at 15-min. resolution and from AWS at 5-min. resolutions.
Automatic weather station.

→ For study each city, matrological department or concern department prepared I.DF curves. so continuously moinitor the rainfall data with ~~...~~ years

→ Runoff coefficient for long term planning.

All future ~~stf~~ storm water drainage systems will be designed taking into consideration a runoff coefficient of upto C = 0.95 for estimating peak discharge using the rational method, taking into consideration the approved landuse pattern of the city.

$Q = CIA$

↳ constant = 0.95 for peak discharge

→ operation & Maintenance:

proper operations & maintenance (O&M) are crucial for any system to be functional to designed capacity and for its durability as well, Most of stormwater drainage and sewerage system. suffer to great extent for want of proper O&M, Both the major and the minor drains are equally affected by this,

→ Govt gives O&M fund every year, operation & Maintenance is regularly cleaning and good then system is good.

→ we cannot O&M in monsoon season.

→ pre Monsoon Desilting:-

* Major drains and nallahs were originally water ways for rainwater to flow. Therefore, pre-monsoon desilting of drains had become an annual ritual. (every year before monsoon we will desilting)

* However, due to large scale urbanization and lack of required sewerage systems in place, sewage started getting discharged into these water ways, ~~with~~ all the same pre-monsoon desilting is a major O&M activity.

→ It has been generally observed all over the country that this doesnot commence and get completed on time and as such even the designed capacities are not operational.

→ As a result, of this, even lower intensity of rainfall results in flooding.

(due to silt, capacity reduced) (then chance to flooding).

* Removal of solid waste:

→ law & order should follow.
→ Need public awareness

→ solid waste disposal & its proper management have significant effects on drainage performance.

→ Most towns & cities have open surface drains besides the roads, into which there is unauthorized public disposal of waste

→ These drains need to be cleaned on a regular basis to permit free flow of water.

* premonsoon desilting of all major drains will be completed by march 31 each year (Monsoon - Rain → June 1st week start)

→ All waste removed both from the major and minor drains should not be allowed to remain outside the drain for dying, instead the wet silt should be deposited into a container and transported as soon as it is taken out from the drain. (cleaning)

→ Completion of work will be certified by representatives of local residents' welfare Associates (RWAs) / slum Dwellers Associations (SDAs) / Muncipal ward committee members besides third party certifications.

(There should be a responsible person → (i.e. govt & public responsible person) they have to certify that then bill will pay.

(it will allow liquid only)

→ Suitable interventions in drainage system like traps,
cut the solid waste to small pieces
communicators, trash racks can reduces the amount of solid waste going into the storm sewers.

→ Cleaning of minor drains will be taken up from the outlet end to upstream side. [end to upstream end side.]

→ Ageing systems will be replaced on an urgent basis,
for future plan ie 50, 60 years.

→ A masterplan will be prepared to improve the coverage of sewerage systems so that sewage will not be discharged into storm water drains, and

→ Adequate budget will be provided to take care of the men, material, equipment and machinery, special funds will be provided for safety equipment of personnel carrying out maintenance of underground man-entry sewers.
(Robo, sensor system etc are advanced system)
but in India physically by men.

* City bridges:

→ Increasing road networks for the ever increasing urban population has resulted in the construction of large number of flyovers and bridges. (due to cost of land, generally public infrastructure build on a rivers, roads, open drainage)

→ In many instances, due to the shortage of land, the piers of roads and railways bridges are located major storm water drains and/or rivers in cities. (so, because of that c/s area drain decrease and back water effect occurs)

→ These are known to cause backwater effects as much as 1m high and far away as 5km upstream thereby resulting in flooding of upstream catchments. Be causes some flooding.

→ At future road, and rail bridges in cities crossing drains should be designed such that they do not block the flows resulting in backwater effect.

{old house plinth level is much less than the road level}

* City road Levels:

→ plinth level of the houses was historically defined with reference to the ~~adequat~~ adjacent road level. However, a recent trend that has emerged in many cities is that the roads are being resurfaced without removing the older layer.

→ As a consequence, over the years, the new road levels, in many instances, are now much higher than the approved plinth level of adjacent properties.

→ so this prevents, drainage of houses and during periods of rainfall, storm water runoff causes flooding of these properties even with lower rainfall intensity.

→ All road re-leveling works or strengthening / overlay works will be carried out by milling the existing ~~level~~ layers of the road and recycling of materials obtaining as a result of miling so that road levels will be not be allowed to increase.

* Drain inlet connectivity: (on roads, we have small inlet, they collect runoff and passes through a pipe)

→ It is seen that the inlets to drain the water from the roads into the roadside drains are either not properly aligned or non-existent leading to severe water logging on the roads.

→ The provision of simple connecting element namely, the drainage inlet through which the water can flow from the roadside drain into underground drain can signifyicantly reduce the waterlogging on the roads.

* Infrastructure for strom water Management:

→ strom water structure can be divided in two groups.

* ① conventional drainage systems
* ② sustainable drainage systems (SuDS)

→ ① **Conventional drainage system:**

* These are designed to remove excess rainfall from the urban environment as rapidly as possible using drainage channels & underground pipes.

* In general, their main purpose is to avoid urban flooding

→ Different components of (C.D.S.)

ⓐ
* urban impervious surfaces:

→ conventional roofs and pavement collect water and transport it to the drainage network.

→ They are usually quite impervious.

ⓑ
* Pre-treatment devices:

→ can be used to improve stromwater quality before it is transported through the network of drainage.

ⓒ
* Pipe networks: (treated before disposing into river)

→ collect urban stromwater and convey it as rapidly as possible to outflow point or treatment plant.

→ There are two types of networks: ⓘ Combined with waste water and ⓘⓘ seperate with waste water

(d)

space

(underground storage tank)

* **structural dentention facilities:**

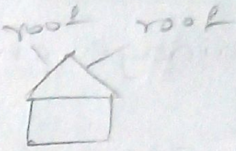
→ underground stromwater storage tanks ~~are~~ that can be used to reduce runoff peaks and floods downstream

(e)

* **Treatment plant:**

→ In Combined system, stromwater and wastewater are useually treated on a wastewater treatment plant before being released into environment.

(a)(i)



* **Conventional roof:**

→ A Roof is the covering ~~on~~ on the most upper part of a building, protecting it from rainfall,

→ Conventional roof are useually very impervious so they convey urban storm water away quickly.

→ Roof can be flat or sloping.
sloping roofs produced higher runoff Rates.

(ii)

water is collected from
* roofs
* pavements

* **standard pavement:**

→ pavements are the surface materials laid down in urban areas to sustain the traffic of vehicles and pedestrains and include roads and walkways.

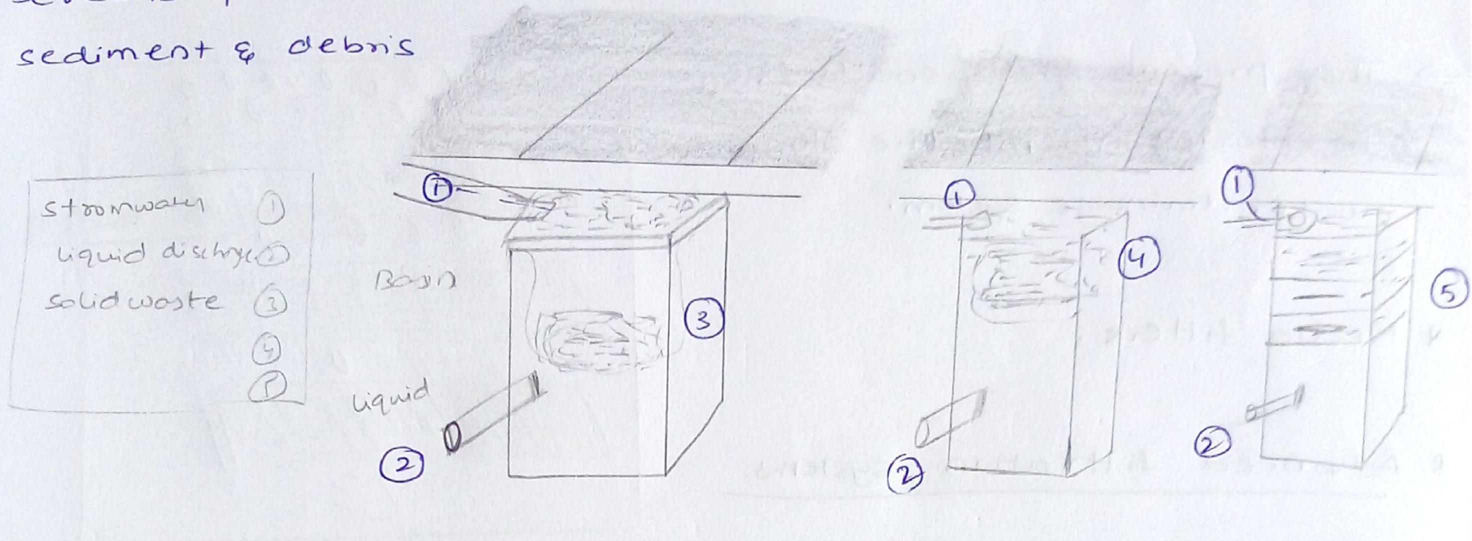
→ In general, standard pavements are completely impervious and they do not allow water to infiltrate into the subsoil.

→ water is collected and introduced into the drainage network through kerbs and gutters.

(b) → pre-treatment devices:

(i) catch basin inserts:

Catch basin inserts are manufactured filters, fabrics or screens placed in a trench drain or catch basins to remove sediment & debris

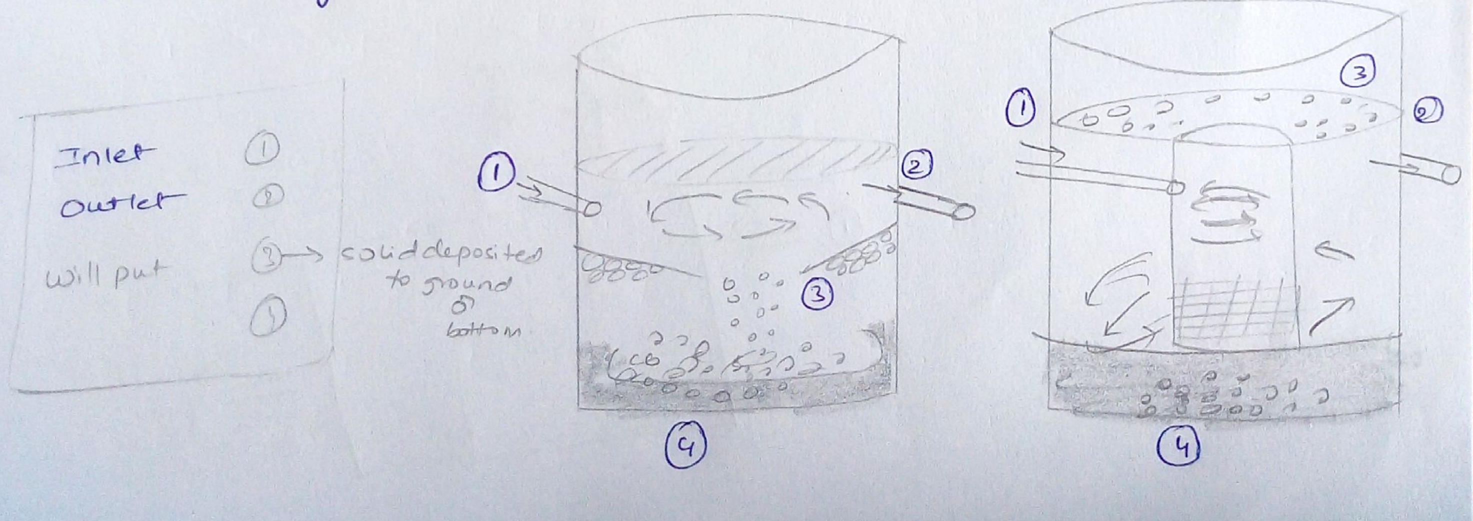


(ii) Hydrodynamic separators:

→ These are vault structures, with a gravity settling or seperation unit to remove sediments & other stormwater pollutants.

→ The water moves in circular mannar b/w inlet & outlet thus facilitating the sediment removal process within a small space

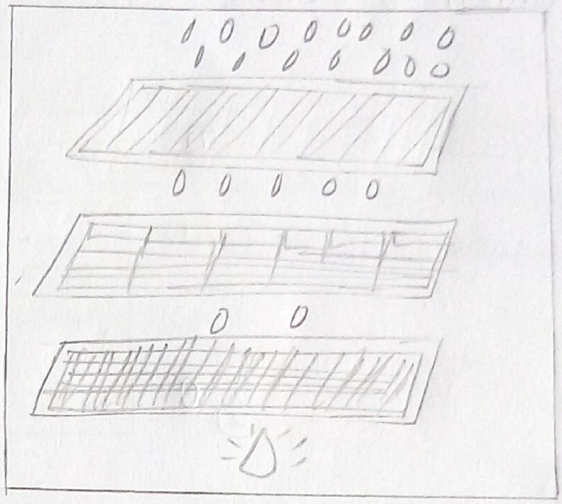
→ The forces created by circular motion causes ~~sepera~~ suspended particles to move to the center of device where they settle to bottom,



iii) Screening devices:

→ The simplest screening devices are catch basin screens, which are mesh wire or perforated plates that covers the openings of catch basins.

→ They prevent gross solids from entering into into the storm water drainage system.



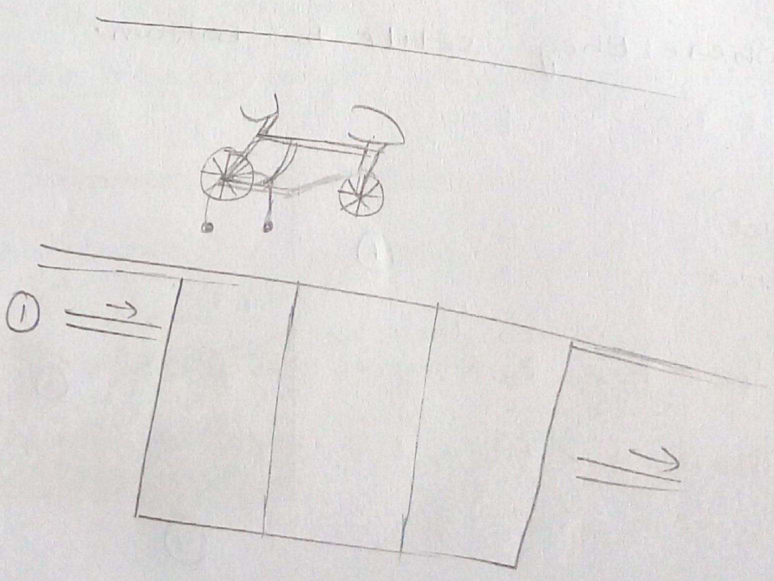
* Media filters.

* Advanced filtration systems:

→ More advanced filtration systems consists of specially designed under ground concrete or prefabricated vaults,

→ In these systems, there is an initial sedimentation process to remove large particles. After this, initial sedimentation process, stormwater, flows upwards through a filter media that removes oil and grease, metals and dissolved stormwater pollutants.

→ some devices also Include a tertiary treatment with biofilms that digest organics & nutrients.



② Sustainable Drainage systems: (SuD's)

→ These are designed both to manage the risks resulting from urban ~~and~~ runoff and to contribute to environmental environmental and landscape improvement.

→ In practice, conventional drainage systems and SuDs can be mixed in management trains to get a sound stormwater management scheme.

→ Each drainage system infrastructure can be placed in one or several parts of management trains as shown in fig. 2.14

→ The hierarchy of the infrastructures that should be considered in developing the management train is as follows.

ⓐ → Source control:

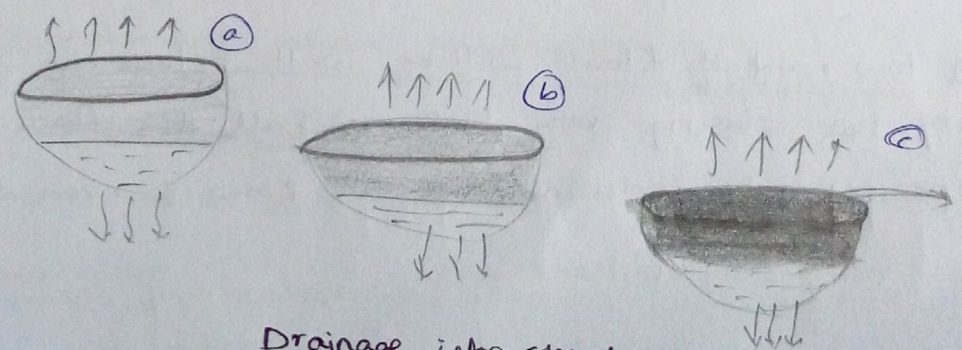
Control of runoff at or very near its source. Treating at source can result in smaller, less costly and more effective stormwater treatment facilities {SFPUC, 2009}.

ⓑ → site control:

Attenuation and treatment of runoff from a larger area. This management is made within the site boundary.

ⓒ → Regional control;

Management of runoff from a number of sites.



Drainage infrastructures.