Urban flood control and rain water harvesting

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ABSTRACT: *Haryana & Punjab experience 70-80 cm of rainfall annually. These states have witnessed large population growth, huge construction & unplanned urbanisation in the last two decades. Due to the rapid unplanned urbanisation, streets are inundated with the water & water table is getting lowered.. People have started experiencing the water woes. Unplanned rapid urbanisation causes soil erosion & sedimentation in the rain There is rapid & huge with drawl of ground water leading to depleting water table. Rain water harvesting is the panacea for depleting water table, soil erosion & flooding of streets during storms. Whereas rooftop harvesting is asimpler task, ssurface run off harvesting a daunting and challenging task.*

Key Words: :

1 .INTRODUCTION

-longevity of any pavement depends on the drainage. Various distresses in pavement are due to structure failure or dissolving of bitumen. Rainwater is dissipated in three ways. Evaporation, runoff & infiltration. Whenever the intensity of rainfall is more than infiltration , surface run off takes place. This problem in further compounded in cities due to paving of roads & roof top surfaces where no infiltration takes place. Urban water sheds is different. There is lot of area which is impermeable where no infiltration takes place .This run off combined by pumping out of water year after year has severely depleted the water table. Whereas water could be pumped out with hand pumps two decades back, it is no longer possible these days. Sowing of paddy which is not the natural crop of this area has made the matter worse. Paddy is a natural crop of coastal areas. Paddy requires 150 cm of water during the sowing season. Another 5 cm is required for taking the seed to sapling stage. Two third of this requirement is met by pumping out of water. Last two decades saw water table going down at the rate of .5m per year. Whereas water table was 70-80 feet below ground level two decades back, it has gone down to 150to 200 feet & up to 300 feet below ground level in some areas. Flood water harvesting and use of interlocking tiles can help solve the problems of flooding as well as depleting water table. In this paper ,I have tried to explain why harvesting is inevitable, different methods of harvesting and how do geotextiles behave behind a filter material.

2. OBJECTIVES OF HARVESTING

- To reduce run off loss and soil erosion.
- To avoid flooding of roads.
- To meet the growing demands of water.
- To improve the depleting water table..
- To reduce ground water contamination.
- To supplement ground water supplies during lean seasons like summers and drought etc.
- To increase infiltration and reduce runoff which chokes runoff drains..
- To check erosion of fertile top soil to increase productivity.
- To check the contamination of ground water.

3 HISTORY OF RAIN WATER HARVESTING

Detailed history of rain water harvesting has been given by Gould &Nissen-Peterson (1999). Exact date of harvesting cannot be stated but it certainly has its origin from early civilizations. There has been evidence of storing rain water in rubble masonry dating back to 3000 BC in India .(Agarwal&Narain, 1997). In israel also surface run off from hillside used to be stored in cisterns to be later used for domestic and agricultural purposes. Probably they started harvesting water in 2000 B.C.Dug wells and ponds were in every village to store water. The storage system at the palace of Knossos in the Mediterranean region is a sophisticated rainwater collection and impounding system is believed to be from 1700 B.C.Use of roof top rain water had also been in use to meet domestic needs of water in Sardinia since 6th century BC(Crastatal , 1982).. Roof top rain water had been used by many roman civilizations to meet their domestic needs of water (Kovacs, 1979).

4. HYDROLOGICAL ANALYSIS ON DRAINS

Urban watersheds are different from usual watersheds. Lot of area is paved or rooftops where no infiltration takes place. C value for urban watershed is different and slandered value. From the hydrological analysis it has been concluded that the peak discharge from watershed cannot be carried by the drains even when there is no sedimentation . Thus the solution of flood problem calls for the reduction of peak discharge by some means. RWH scheme can provide a solution to flood & also check water scarcity & also save energy in pumping out water from deeper depths

- Peak discharge from any water shed is given by

Q = CIA/3600000

Q = Peak discharge or runoff (comic)

C = Runoff coefficient

I = Max intensity of runoff for the time of concentration of the selected discharge storm in (mm/hr)

A = area of water shed in m sq.

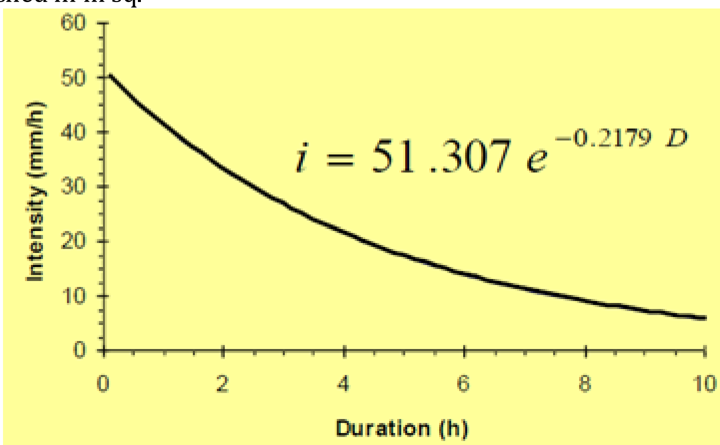

Fig4.1. Rainfall Intensity curve (Ref. Sarma&Goswami, 2004)

TABEL 4.1 Standard values of C for Urban watershed(Ref Sarma..et.al2005)

S.No.	Land Use type	C- Values
1	High Residential	0.21
2	Medium Residential	0.22
3	Low Residential	0.22
4	Open Mix Forest(slope>30%)	0.25
5	Open Mix Forest(slope<30%)	0.20
.6	Dense Mix Forest(slope>30%)	0.20
7	Dense Mix Forest(slope<30%)	0.15
8	Agricultural land(Scrubland)	0.40
9	Beel (swampy)	0.36
10	Light Industrial	0..20
11	Heavy Industrial	0.25
12	Mixed built up	0.30
14	Public, Semi public and Educational institute	0.30

5. FUNCTIONING OF PVC SCREENS OR GEOTEXTILES

It is very interesting to observe and understand the interaction between geotextile and soil. As the water flows through geotextiles. initially there may be migration of soil particles which are finer than pores of the geotextile. But as this progresses, a filter media automatically develops behind the geotextile. This filter media satisfy two criterion. First is that any particle size in the media is larger than the pore space ahead of it in the direction of flow. So there is no immigration of soil particles. Second criterion ensures that permeability of filter media is maintained and flow is not affected. Bridging network develops behind the PVC screens and very fine particles are trapped immediately as they enter the filter media. Water free of sediments is obtained as it passes the geotextile. This water can be used to recharge the aquifers as it does not contaminate or degrade the quality of ground water. A minute examination of the structure of the soil filter media shows it to consist of bigger soil particles at the extremity nearest the geotextile progressing through to the original soil at the extremity farthest away from the geotextile. This soil filter zone is, in effect, a reverse granular filter constructed only from the in situ soil particles, and thus will always remain compatible with the undisturbed in situ soil (whereas with conventional granular filters, this is not always the case).

As soil water keeps on flowing through the completed soil filter- geotextile system, the soil filter material actively filters out the soil water from the undisturbed soil mass while the geotextile retains the soil filter zone in place, preventing collapse into the drainage layer. Thus the function of the geotextile in one directional filter is not to filter actively the soil water but to act as a catalyst in the formation a stable soil filter from the insitu soil and retain it in that position. However, the choice of the correct geotextile is critical to the formation of a stable effective soil filter. For the ideal filter performance, the permeability of the soil filter and the geotextile should always be equal to or greater than the permeability of the in situ soil. If the permeability of any of these falls substantially below that of the in situ soil, the performance of the filter system will be less than the optimum.

6 .DIFFERENT TYPES OF WAYS OF HARVESTING

6.1 RECHARGE PITS

Recharge pits are used for houses having a covered area of less than 1500sq feet. A pit is made which is 1-2m wide and 2-3 m deep. This pit is backfilled with pebbles(10-20mm),gravel(5-10mm) and sand(1-2mm).The sand is at the top and pebbles at the bottom. PVC screens may be used to prevent the aggregates from getting mixed up. Water is brought to these pits with 10 cm diameter PVC pipe. An arrangement is made to reject the first showers as it may contain leaves and dust. Mesh is provided at roof top at the inlet. Sand layer at the top is cleaned annually or as per requirements. These pits are suitable where there are shallow aquifers. Pits can store 3000-4000litres of water which subsequently infiltrates.. Cost of recharge pit is around two thousand rupees.

6.2 RECHARGE TRENCHES

- Recharge trenches are provided for buildings having roof area of 250-500 sq. m. and where permeable soil strata is available at shallow depth. The dimension of the trench can be 0.5 to 1 m wide, 1 to 1.5m. deep and 10 to 20 m. long. These t`renches can also be made along the whole boundary wall of the house ..The amount of water to be harvested determines the size of trench. The trench is filled with pebbles(10-20mm),gravel(5-10mm)and sand(1-2mm).Finer varieties of aggregates are at top. Sand at the top is cleaned whenever it gets clogged due to finer particles. Water from roof top is made to flow through 10cm diameter PVC pipe to trench. A mesh is provided at the roof top to prevent the debris and leaves from entering the trench. A bye pass arrangement is made to prevent the first shower from entering the trench. De silt chamber may be provided to facilitate sedimentation of clayey soil or fine particles. Cost of providing recharge trenches is 4-5 thousand rupees.

6.3 TUBE WELL

It is suitable for areas where water table has gone down considerably and aquifers are recharged through existing tubewells.PVC pipes 10cm in diameter are used to collect rooftop rainwater. Water from first rain is let off and subsequently it is brought to on line filter. Online filter is PVC pipe 1-1.2 m long and 15-20cm in diameter. It is divided into three zones. First zone has gravel(6=10mm)followed by pebbles(10-20mm) and lastly cobbles(20=40mm).These filters have reducer of 6.25cm diameter pipe at both the ends. Filtered water is released into existing wells. Incase the water to be harvested is high in volume , pits may be used in place of online filter. Pits are connected to de silt chamber and to wells through 10cm diameter PVC pipe. They are backfilled with pebbles(10-20mm) at the bottom and gravel(5-10mm) above it. Finally there is a sand layer at the top.PVC screens may be used so that the materials do not get mixed up. Sand layer is cleaned annually or as per requirement. Filtered water from the pit is used to recharge aquifers. Water is released into tubewells to recharge aquifers.

6.4 TRENCH WITH RECHARGE WELL.

Trenches with recharge wells are used in areas where large quantity of water has to be harvested in short period of time. Trench can be 1-2 m wide and 1-2m deep. .length of the trench can be along the periphery of boundary wall or lesser if there are constraints due to availability of space. The trench is backfilled with pebbles(10-20mm), gravel(5-10mm) and sand(1-2mm).The sand is at the top and pebbles at the bottom.

PVC screens may be used to prevent the aggregates from getting mixed up. Water is brought to these pits with 10 cm diameter PVC pipe. An arrangement is made to reject the first showers as it may contain leaves and dust. Mesh is provided at roof top at the inlet. Sand layer at the top is cleaned annually or as per requirements. Reverse well points are provided in these trenches. Reverse well point is a slotted pipe wrapped with pvc screens. .Filtered water enter the well point connected with 10cm diameter pipe which again has a well point where it reaches aquifer.water can also be discharged in any sand layer above the aquifers.

6.5 DAMS

Water in hilly areas can be harvested by constructing dams across the valley. They harvest rainwater during monsoon and the water is used for irrigation purposes throughout the season. Dams can be made of concrete or earthen dams are also made. For low capacity reservoirs, they can be made with bamboo also, These dams are multi purpose projects. Beside generating hydroelectric power, they also prevent erosion. Water is stored in the reservoir behind the dam. Geological studies are done before finalizing the site for the exact location of dam and that of reservoir. Study of folds and faults in the rock strata is done before finalizing the location of dam and the reservoir. The filling season of a reservoir is in monsoon and starts from mid june and extends upto mid September.

6.6 STORAGE TANKS

Water can also be stored in a tank. These tanks can be made of concrete or steel. In case they are made of mild steel, 6mm thick sheet with 6mm weld on edges can be used. In case of corrosion resistant varieties of steel,3mm thick sheet can be used. in case of concrete, M20 concrete is used with reinforcement. Thickness of the slabs or walls is governed by depth of the tank.10 cm thickness is sufficient for depth up to ten feet's. Ideal location of the tank should be four to five feet above the DPC level. At such location no energy will be required in filling as well as withdrawal of water from the tank. Size of the tank is governed by area of the roof and amount of rainfall. They are designed to store one month run off from roof surface. For a plot size of 100 square m.

Expected rainfall in a month during monsoon=20 cm

Volume of water to be harvested=.2mx100sqm=20cum

The ideal shape of the tank is cylindrical. Tanks in the shape of a cuboids are subject to structural failure. Fluids exert equal pressure on all sides. Walls of a cuboids tank are subjected to undue pressures and may fall apart at edges and corner. If viewed from the purpose of economy, cylindrical shapes have less surface area for a given volume...Water can be brought to these tanks with the help of 10 cm diameter pipe..The first shower is rejected as it may contain lots of fine grain soil particles ,leaves and dust etc. Mesh is provided on the roof top before collecting this water. Minimum slope of 1:16 is provided anywhere in the system for drainage purpose.

6.7 INTERLOCKING TILES

Interlocking tiles offer variety of advantages vis-à-vis concrete and bitumen roads. They can carry much larger loads compared to concrete slabs of same thickness. Advantages they offer offset the extra cost incurred in making roads from conventional methods. If they are laid on half cm sand bed, interlocking tiles allow infiltration of water through them. It not only prevents the run off, but also helps in recharge of ground water. The joints in the locking tiles offer variety of advantages. Water percolates through them and ultimately reaches the ground water. These roads behave like permeable bed. They can carry heavy loads as compared to porous asphalt pavements. Individual tiles contract and expand and there are no tension cracks due to stresses arising out of temperature .Further if any single tile is damaged, it can be replaced and there is no need to replace the whole block.

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