15. Slow sand filter design

Sand Filter Design

Slow sand filtration is a simple and effective technique for purifying surface water. It will remove practically all the turbidity from water, together with virtually all harmful eggs, protozoa, bacteria and viruses without the addition of chemicals and may frequently be constructed largely with local materials.

A slow sand filter consists basically of three different layers within a filter box. These layers are from bottom to top: the underdrainage system, the gravel layer and the sand. It is only the sand which plays any part in the treatment process.

The underdrainage may consist of:

* perforated pipes of asbestos cement
* porous or perforated unglazed pipes
* perforated pipes of PVC

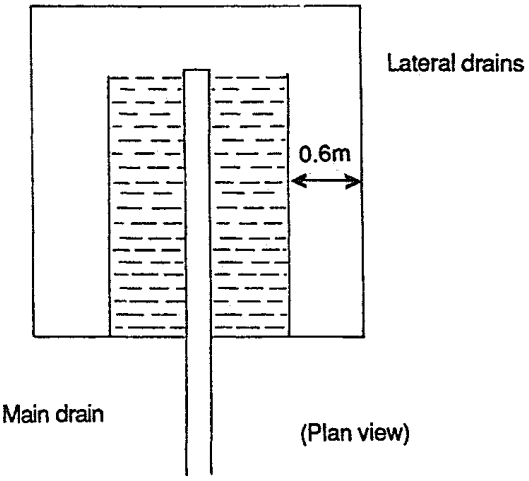
If pipes are employed, a series of lateral drains (80mm diameter) are connected to a main drain.

Perforations of 2 to 4mm diameter are made on the underside of the lateral drains at intervals of 150mm.

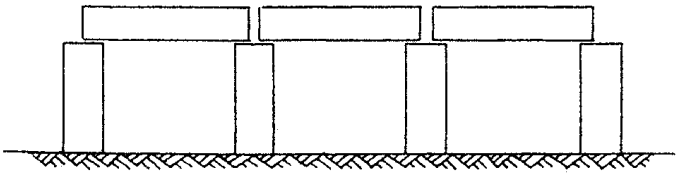
Cross-sectional area of main drain = sum of cross-sectional areas of all lateral drains.

or of

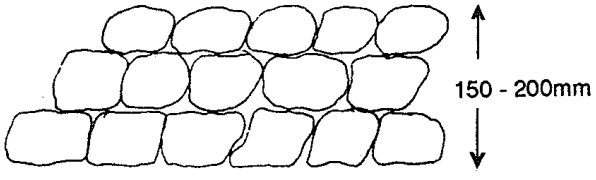
* **concrete tiles**
* **household bricks**
* **large gravel (40 - 100mm)**



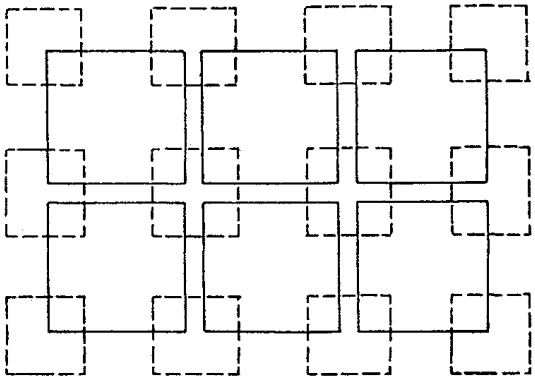
Standard bricks



Large gravel (40 - 100mm)



Concrete tiles – whole tiles are set on quarter-tiles as illustrated



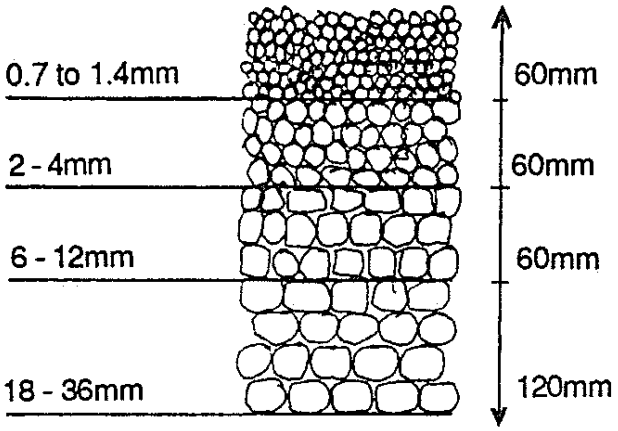
The underdralnage should not be closer to the wall than 0.6m.

Slow sand filter design

The Gravel Layer

The gravel layer Is arranged in four graded levels. All gravel must be clean.

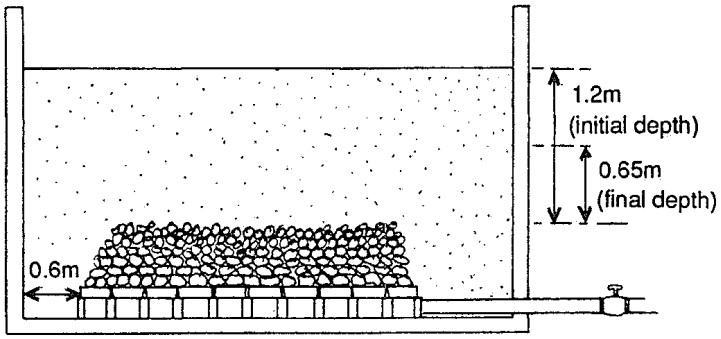
The gravel layer should not be closer than 0.6m to the walls. This means that any water which runs quickly down the walls and does not filter through the sand layers (ie, it 'short-circuits' the system) must pass through some depth of sand before entering the gravel and underdrainage.



The Sand Layer

Is characterized by:

Effective Size (E.S.) – mesh diameter (mm) of a sieve which retains 90 per cent of the sand.



Sand, gravel and underdrainage

Uniformity Coefficient (U.C.) – mesh diameter (mm) of a sieve which retains 60 per cent of the sand, divided by the effective size.

E.S. – between 0.2mm and 0.4mm

U.C. – less than 3.0, preferably less than 2.0

Suitable sand is usually easy to find locally. If any grading is necessary, it is normally sufficient to remove only the coarsest grains and the very finest grains.

Filter Box

The filter box may be constructed either with vertlcal sides or with sloping sides.

If designed to have vertical sides it may be constructed of either:

- mass-concrete
- ferrocement
- masonry
- reinforced concrete

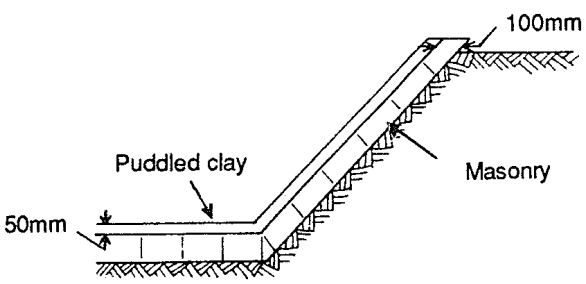
During construction the wall must be roughened where it will be in contact with the sand in order to prevent short curcultlng (see section on the gravel layer).

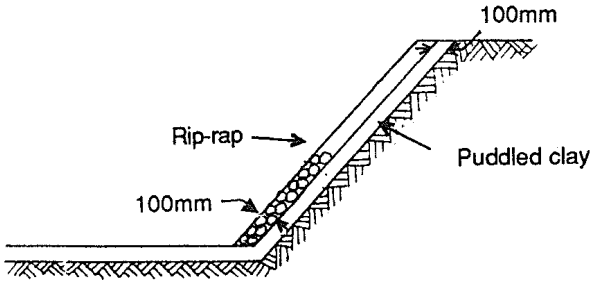
If the filter box is designed to have sloping sides it may be constructed either of:

- mass-concrete
- masonry
- puddled clay
- rip-rap

Commonly, masonry will be employed and the system made watertight by adding a layer of puddled clay

Sloping walls are simpler to construct and can usually be made with locally available material but cannot be guaranteed to be always watertight.

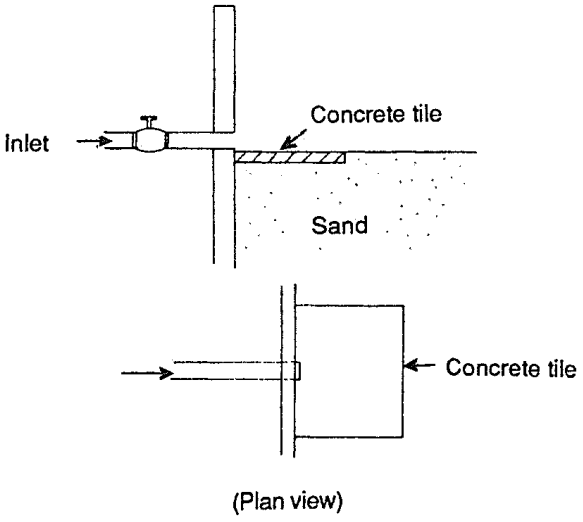


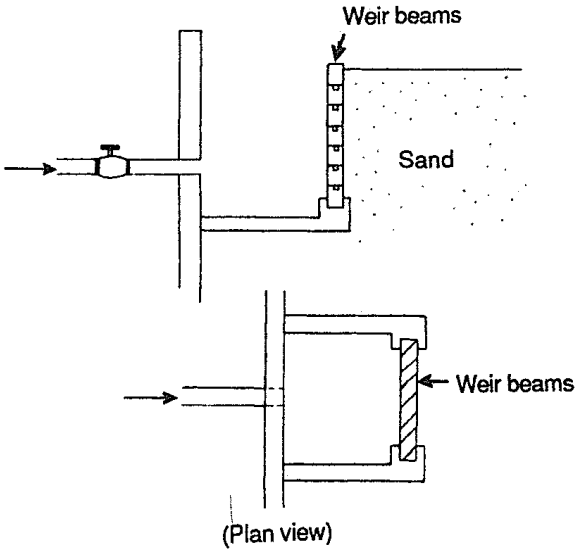


Inlet Arrangements

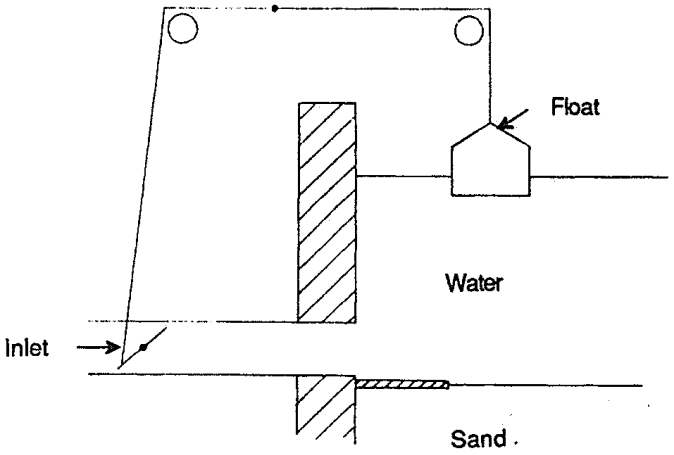
There are two main types of inlet arrangement.

The concrete tile is a splash tile to prevent water falling directly onto the sand-bed and eroding It.





The inlet is controlled either by a hand operated gate valve or by a float controlled butterfly valve.

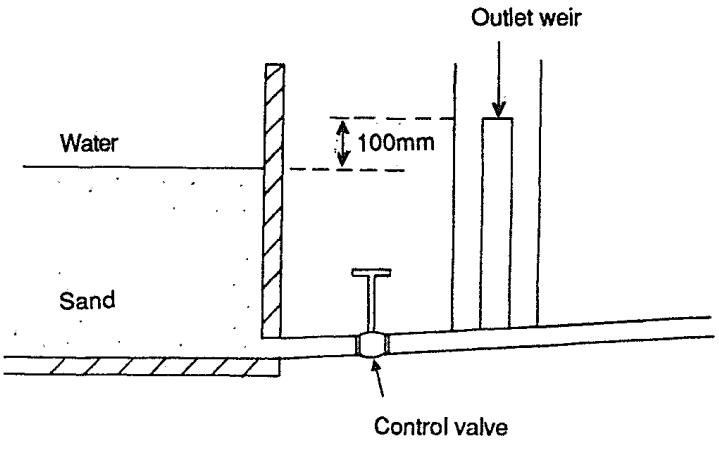


Water Reservoir

This is normally maintained at a constant depth of between 1.0m and 1.5m.

Outlet Arrangement

The outlet flow is maintained at the design flow rate by a hand-operated gate valve which is adjusted every day. It is essential to provide an outlet weir which is above the height of the sand bed.



Slow sand filter design

The size of the filter

The size of a slow sand filter is determined by several factors. For example:

Population of 1000 with water consumption of 100 litres/capita day.

Wastage can be assumed to be 30 per cent of production.

Therefore – total dally production needs to be: $1000 \times 100 \times \frac{100}{(100 - 30)}$ = 143 000 litres/day = 143 m^3/day

The rate of filtration is 2.4m^3/m^2d (=0.1m/h)

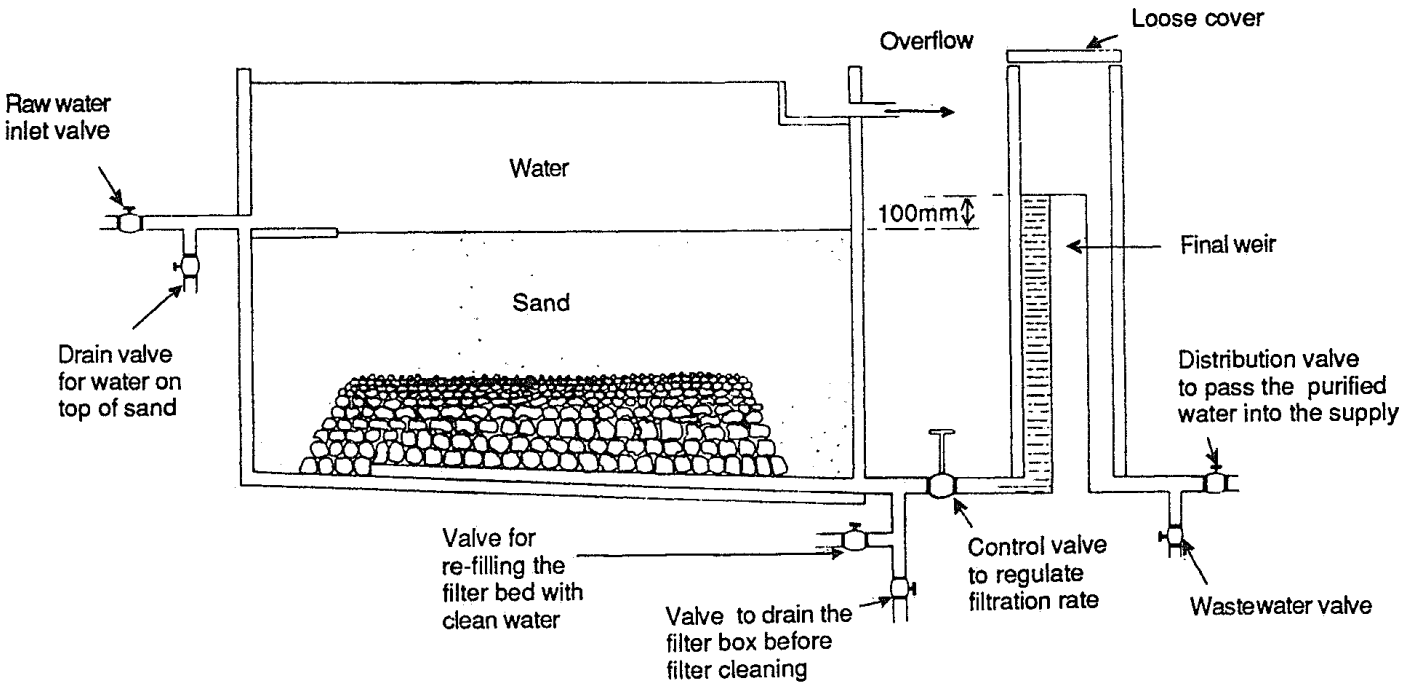
Therefore – the filter tank needs to have an area of: $\frac{143}{2.4}$ = 56m^2 (7m x 8m)

Two parallel filters are required, each 7m x 4m, with a common divide wall.

Overall filter tank height is made up of:

above level of water	–	0.3
water	–	1.0
sand	–	1.2
gravel	–	0.3
underdrainage	–	0.15
foundations	–	0.15
		3.10 metres

The Final Design



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