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 A slow sand fis within a filt

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)**

Lateral drains

0.6m

Main drain

(Plan view)
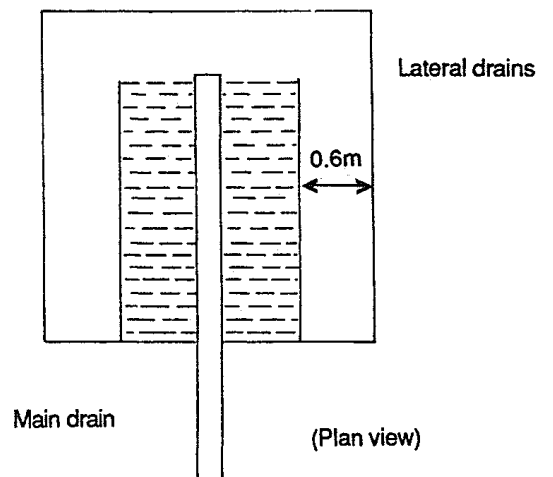
Standard bricks

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

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

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.
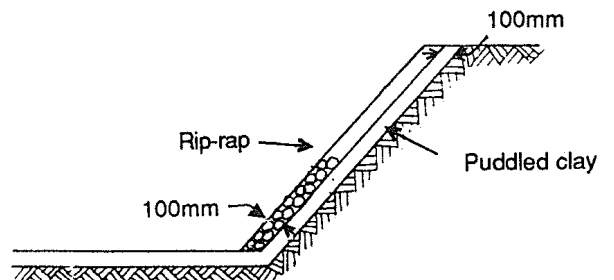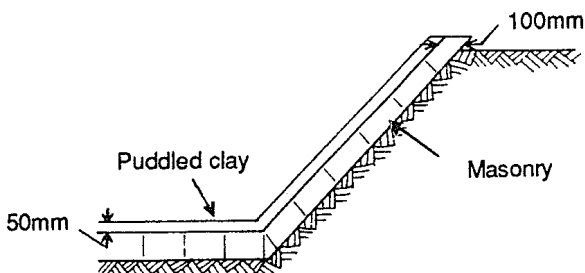
The Sand Layer

Is characterized by:

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

0.7 to 1.4mm	60mm
2 - 4mm	60mm
6 - 12mm	60mm
18 - 36mm	120mm
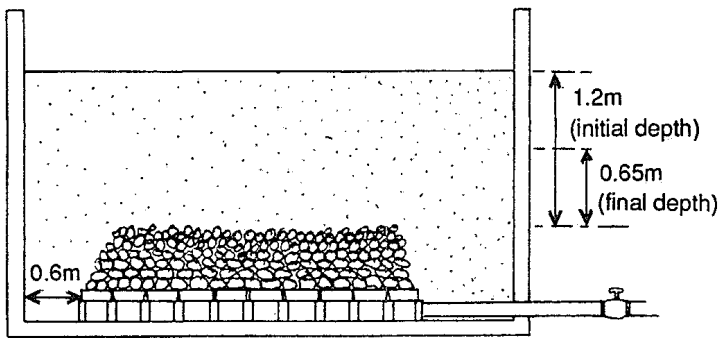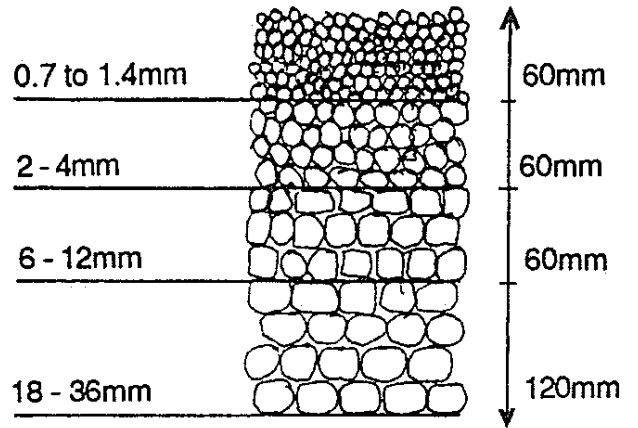
Uniformity Coefficient (U.C.) – mesh diameter (mm) of a sieve which retains 60 per cent of the sand, divided by the effective size.

E.S.

1.2m (initial depth)

0.65m (final depth)

0.6m

Sand, gravel and underdrainage

100mm

Puddled clay
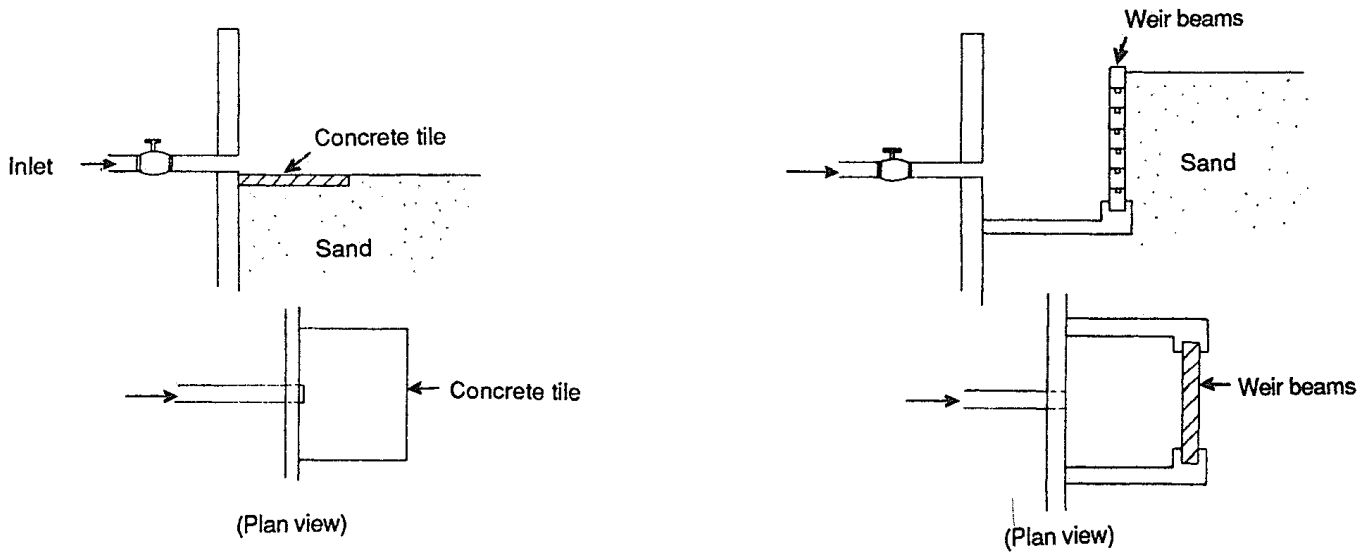
Masonry

50mm

100mm

Rip-rap

Puddled clay

100mm

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 daily production needs to be: $1000 \times 100 \times \dfrac{100}{(100 - 30)}$ = 143 000 litres/day

= 143 m³/day

The rate of filtration is 2.4m³/m²d (=0.1m/h)

Therefore – the filter tank needs to have an area of: $\dfrac{143}{2.4}$ = 56m²   (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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