

CE2354 ENVIRONMENTAL ENGINEERING II

(FOR VI – SEMESTER)

UNIT – II

SEWER DESIGN



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UNIT II

SEWER DESIGN

TYPES OF SEWER

Following materials are generally used in the construction of sewer.

- Bricks
- Stoneware
- Cement concrete
- Cast iron
- Asbestos cement

BRICK SEWERS

- Bricks are used for large size sewers because they are cheap
- These sewers are plastered outside to prevent the entry of tree roots
- These sewers are constructed carefully because they will deform, and leakage problem occurs

VITRIFIED CLAYS OR STONWARE PIPES

- ∅ These pipes are manufactured from vitrified clay or stoneware.
- ∅ These pipes are manufactured in sizes upto 600mm in dia and 60cm to 90cm
- ∅ These pipes should be capable to withstand hydraulic pressure upto 1.5 kg/square cm
- ∅ care should be taken during manufacture that they may be free from any fire and air crack and must be capable to bear the load of soil if buried under the ground upto 4.5 depth.

CEMENT CONCRETE PIPES

- ∅ These pipes are smooth and light in weight. These are generally jointed by collar joints
- ∅ Cement concrete pipes are manufactured in factories and they are transported to site
- ∅ Cement concrete pipes are not durable and have short life.
- ∅ These pipes are corroded by sanitary sewage gases.
- ∅ Protective coating should be used inside and outside where excessive corrosion takes place.

ASBESTOS CEMENT PIPES

- ∅ These are manufactured from a mixture of cement and asbestos fiber.
- ∅ The mixture cement and asbestos is first placed over rotating steel.
- ∅ Mandrel in uniform thickness and then it is passed by means of steel pressure balls.
- ∅ The steel roll compacts the mixture into dense and homogeneous mass.
- ∅ These pipes subjected to corrosion by acids, highly septic sewage and by high Sulphur content soil

CEMENT IRON PIPES

- ∅ These sewers are most suitable under the following conditions.
- ∅ When the sewer line is to be carried in exposed position.
- ∅ When the sewer is to be laid below or under the buildings
- ∅ When the sewage is to be pumped or conveyed under pressure.
- ∅ When the ground is build up type or unstable and there are chances of sinking

JOINTS

Circular sewer pipes which are manufactured by the industries are joined after placing in position. These pipes of joints depend upon the internal pressure, load and material of the pipe.

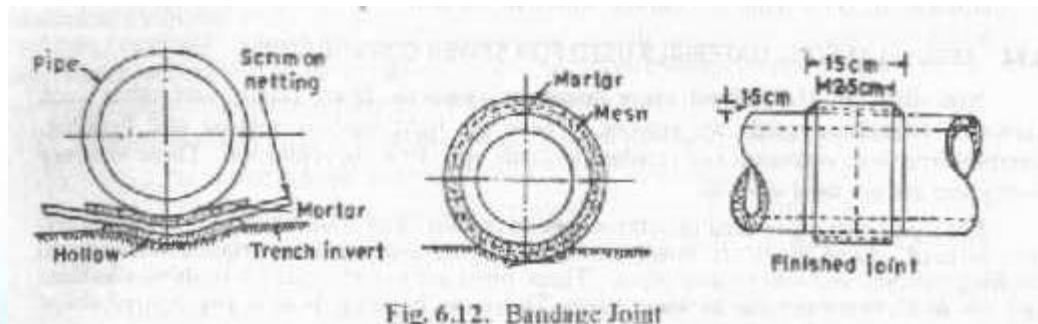
The following are the requirements of joints

- ∅ It should be economical and easy in construction
- ∅ Offer resistant to penetration and should be durable, should not absorb anything.
- ∅ Should be easily available in required quantity.
- ∅ It should be non absorbent.

BANDAGE JOINT

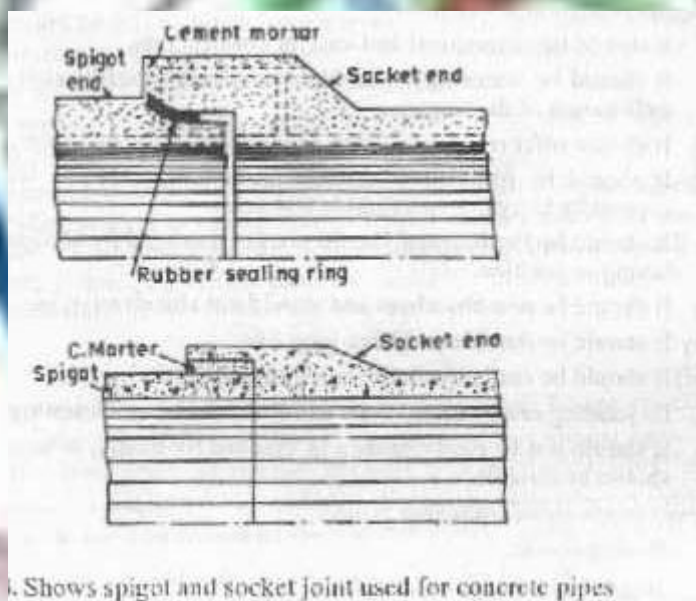
- ∅ This joint is mostly used for concrete pipes.

- Ø At the end of the pipe a hollow is scooped out 25mm deep, 75mm ahead.
- Ø This hollow is filled with a mortar to the invert of the trench
- Ø Now netting is placed on the mortar and scrim is placed on the netting
- Ø On the screen 6.5mm thick cement mortar is layed.
- Ø The faces of the pipes at the ends are coated with mortar.
- Ø Finally neting is tightly wrapped around the pipes.
- Ø Finally netting is covered with mortar.



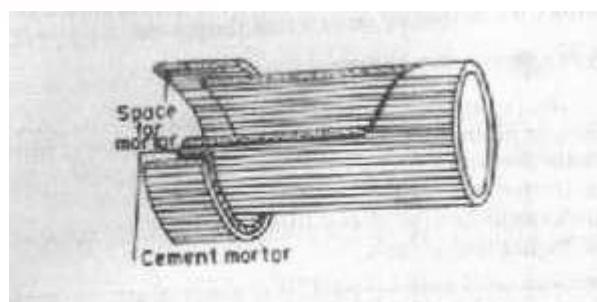
SPICOT AND SOCKET JOINT

This joint is used mainly for cast iron pipes of all sizes.
Method of jointing is as that of joints in water supply.



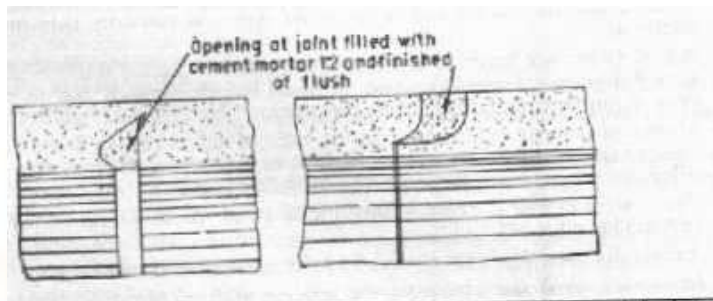
COLLAR JOINT

- § This is generally used for large diameter pipes.
- § The loose collar covers two specially shaped pipe ends as shown in the figure.



FLUSH JOINT

- Ø This is generally used for sewers passing below culverts.
- Ø The pipes are specially shaped as shown in the figure to form a self centering joint with an internal jointing space of 1.3cm wide.
- Ø Cement mortar is used for filling the joint space.



Water Supply Plumbing Systems in Buildings and Houses

Plumbing System in Water Supplies and Associated Terms

Plumbing is a general term which indicates the practice, materials and fixtures used in the installation or maintenance of all pipings, fixtures, appliances, and other appurtenances used in connection with both public or private water supply systems as well as sanitary or drainage systems, within or adjacent to any building or its connection with any point of public disposal.

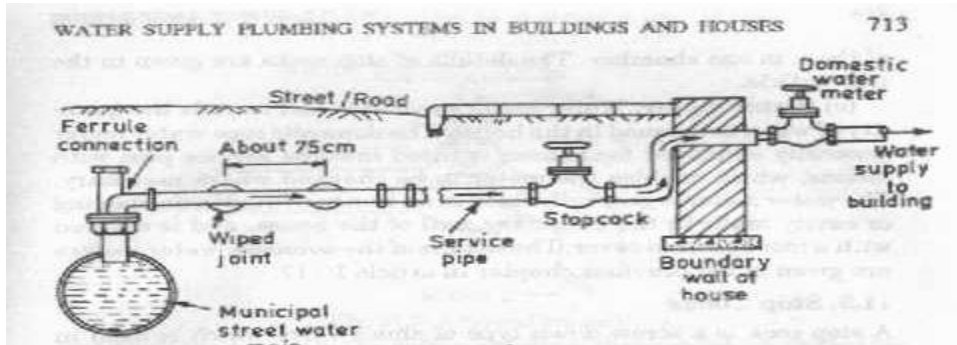
The House Water Connection

Fig. 11.1. The Water Connection.

(i) **Ferrule.** A ferrule is a right angled sleeve made of brass or gun metal, and is joined to a hole drilled in the water main, to which it is screwed down with a plug. Its size usually varies between 10 to 50 mm dia. For all other connections of more than 50 mm dia, a tee branch connection, off the water main, is used.

(ii) **Goose neck.** Goose neck is a small sized curved pipe made of a flexible material (usually lead) and is about 75 cm in length forming a flexible connection between the water main and the service pipe.

(iii) **Service pipe.** Service pipe is a galvanised iron pipe of size less than 50 mm dia. It should be laid underground in a trench in which no sewer or drainage pipe is laid. The service pipe which supplies water to the building through the municipal main is thus connected to the main through the goose neck and ferrule.



PIPE AND PIPE FITTINGS

- Various type of material used in the construction of sewer pipes have been discussed.
- All those materials are also used in the construction of pipes required in drainage.
- In drainage works stoneware, asbestos cement, lead and iron pipes are used.
- For jointing, laying and fixing of soil waste, rain water and vent pipes of various types of fittings are used.

Soil and rain water fittings

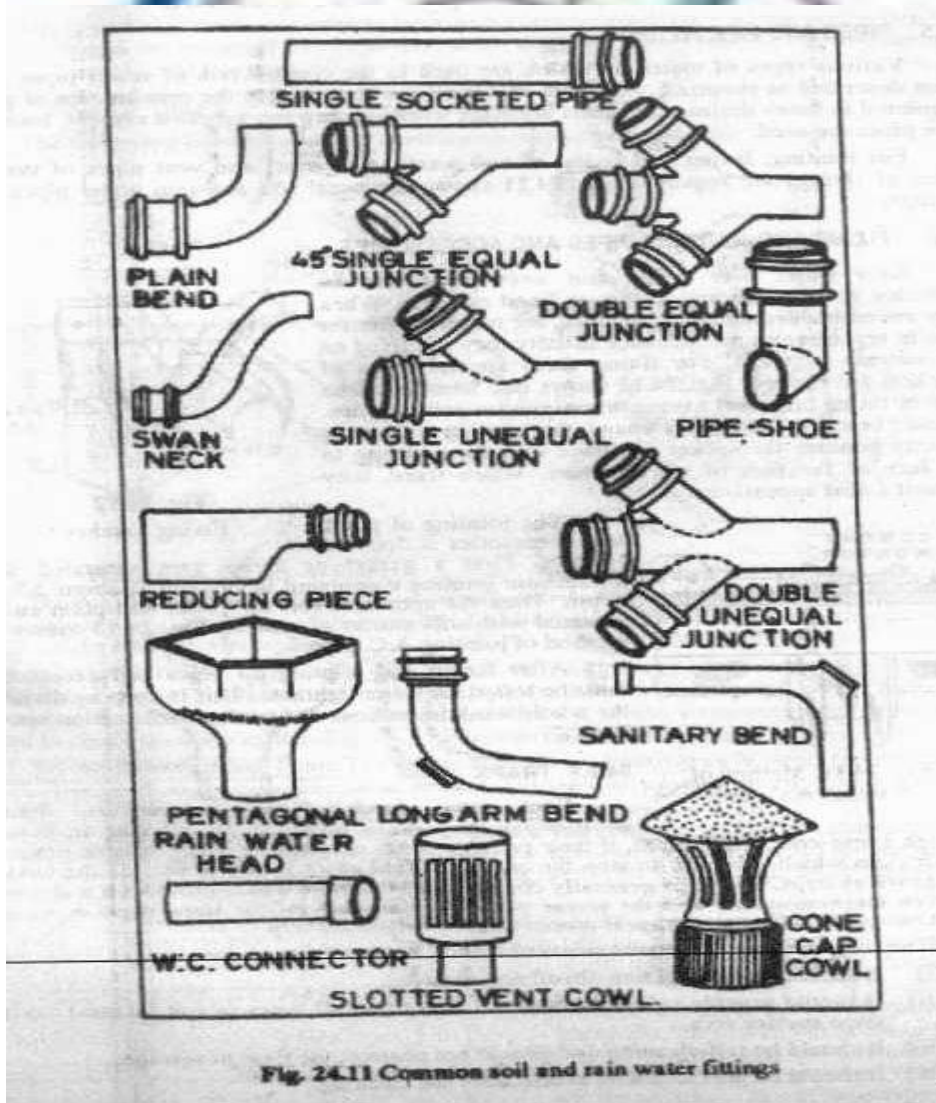


Fig. 24.11 Common soil and rain water fittings

24.7. TRAPS.

Foul gases produced in the sewers, drains, waste-pipes may cause nuisance by entering in houses

The water seal of the trap can break under the following conditions :

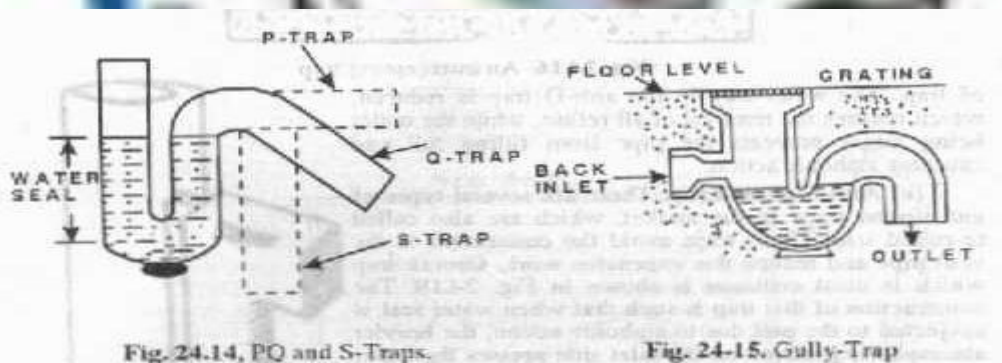
- (i) If there is any crack in the bottom of seal or the joint is faulty.
- (ii) If for a long time the seal is not in use, its water will evaporate into the atmosphere.
- (iii) If due to blockage or any other reason there is increase in the pressure of the sewer gases, it will pass through the water of seal.
- (iv) If partial vacuum is created in the sewer fittings, it will suck up the seal water. To avoid the breakage due to this reason, the portion between the trap and the soil pipe should be connected to the vent pipe.

TYPES OF TRAPS

The following types of traps are most commonly used in practice:

(a) **P, Q and S-Traps.** These traps are classified according to their shape. Fig. 24.14 shows these traps. They essentially consist of a U-tube which retains water acting as a seal between the foul gas atmosphere.

(b) **Gully-Traps.** This trap is provided at different places in the drain pipes. Waste water from sinks, bath etc. enters in through back inlet and unfoul water from the sweeping of rooms, courtyards etc. enters from the top, where a coarser screen grating is fitted to check the solid matter. Fig. 24.15 illustrates a gullytrap.



(c) **Anti-Siphon Trap.** There are several types of anti-siphon traps in the market, which are also called re-called trap. These traps avoid the connection to the vent pipe and reduce this expensive work. Greval trap which is most common is shown in Fig. 24.18. The construction of this trap is such that when water seal is subjected to the pull due to siphonic action, the heavier atmospheric pressure on the inlet side presses the water down and the air can pass from by-pass tube B as shown in Fig. 24.18 (a) and the water is stored in through C, when the pressure on both sides becomes equal, the water stored in trough C, falls back in the tube and seals it as shown in Fig. 24.18 (b)



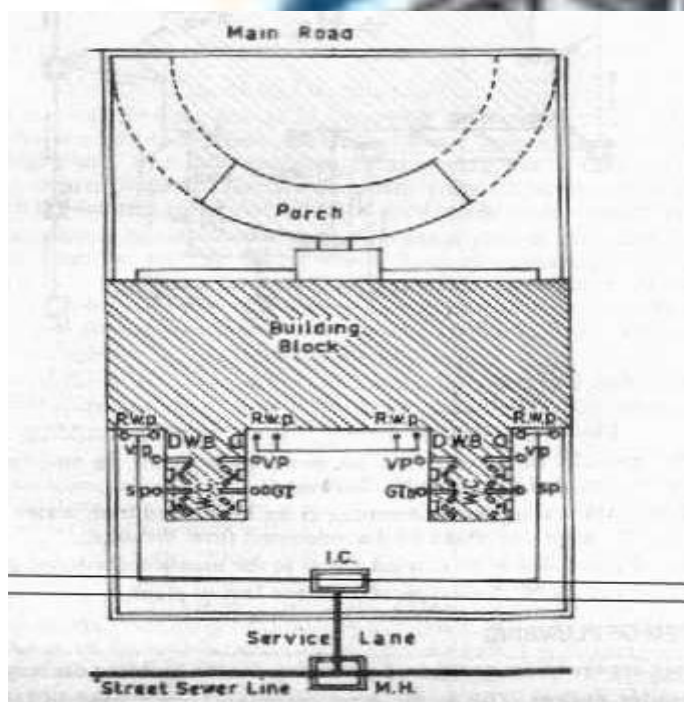
24.9. HOUSE DRAINAGE PLANS

Before starting the plumbing work, it is most essential first to prepare the drainage plans. In the same way as detailed drawings are prepared before the starting of the construction of buildings, the detailed drainage plans should also be prepared.

The following points should be kept in mind while preparing the drainage plans :

- (i) The drains should be laid in such a way so as to remove the sewage quickly from the building. The quick removal is governed by the fall of the pipes. the drains should be laid at such a slope that self-cleaning velocity is developed in them. The following slopes are usually sufficient :

1	in	40	for	10 cm	pipe
1	in	60	for	15 cm	pipe
1	in	90	for	23 cm	pipe.



Drains and Sewers

OPEN DRAINS.

These are used for conveying less foul water from kitchens, bathrooms, washing-places and rain water from courtyards, roads, roofs, open grounds etc. except foul discharges from water closets. The open drains carry away sullage and rainwater upto natural water courses or discharge it in public sewer.

DRAIN SECTIONS

- (i) An ideal drain section should fulfil the following conditions:
- (ii) It should develop self-cleaning velocity with minimum dry weather flow.
- (iii) It should have sufficient free board at its top, even during maximum discharge.
- (iv) It should be clean in construction and maintenance.
- (v) It should be such that it can be easily cleaned.
- (vi) It should be structurally safe and stable.

It should be constructed with non-corrosive materials and should have sufficient resistance to the erosion.

In practice only four common sections of sewers are used, which have been successfully tested by experience. They are :

- (a) Semi-circular section, (b) U-section,
- (c) V-section, and (d) Rectangular section.

Semi-circular Section.

SEMI CIRCULAR SECTIONS

This type of drain is mostly used for small drains due to its easiness in laying, stability and cheapness. Half round glazed stone-ware pipe is used for its construction. If the discharge in this section decreases, the self-cleaning velocity will not develop and deposits will settle down in the bottom and will cause obstruction to the flow of sewage.

U-section. In semicircular section if the sides are raised, it becomes U-section. It is used at such places where discharge is more and cannot be taken by a semicircular drain. Half stoneware pipe is laid in the bottom and over it masonry work is done as shown in Fig. 6.2.

V-section. This section gives self-cleaning velocity even for very small discharges because greater depth is available in each case. In the invert one-third to one-fourth stone-ware pipe or concrete block is laid and the sides are constructed with brick or flag stones and are plastered. It is easy to clean this type of section. These sections may subtend 120° , 100° or 60° at the centre of stoneware pipe.

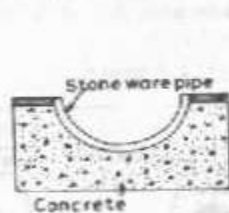


Fig. 6.1 Semi-circular Section

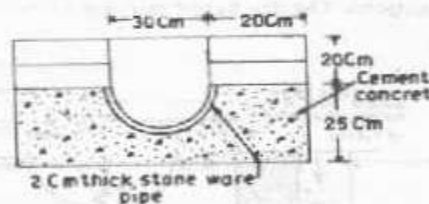


Fig. 6.2. U-Section

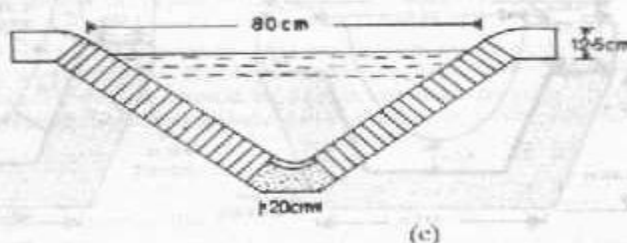
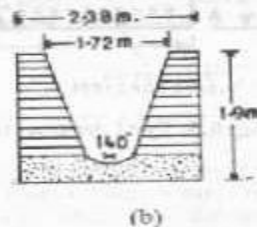
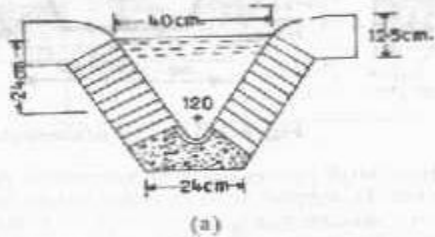


Fig. 6.3. V-Section

SEWER SECTIONS

6.4 SEWER

For conveying foul discharges from water-closets of public and domestic buildings, chemical mixed water from industries, closed conduits are required which can carry these foul matters without creating any nuisance outside the town. These closed conduits are called sewers and are laid under ground. Connections from public, domestic and industrial buildings are made to these sewers which carry foul matter. As the sewage contains acidic discharges also, the sewers should be constructed with such materials which can resist corrosion and abrasion against it also.

Sewers should have such cross-section that self-cleaning velocity should be developed even during dry weather flow. No deposits should settle down in the bed of sewers under any circumstances. These should be laid in the town at such a slope that water in case of flood in river at the outlet should not come out from the manholes and cause insanitary conditions.

Following are the common sewer sections

Following are the common sewer-sections:

1. **Old Rectangular.** These were used in ancient times and are not used nowadays. It was constructed by laying concrete in the bottom and constructing sides with stone or brick masonry and then plastering.

2. **New Rectangular.** This is constructed with R.C.C. which may be precast or cast-in-situ.

3. **Circular brick-sewer.** This type of section is used under culverts and at such places where big diameter is required for short lengths. These sections are plastered from inside. In olden days these were common, but now-a-days these are not used due to their much wear and difficult centering.

4. **Circular pipes.** Precast asbestos cement concrete pipes reinforced with steel are mostly used now-a-days. Sometimes steel pipes with lining of cement concrete on inside and outside are used. Cast iron pipes are also used on large scale for branch sewers. Laying of these pipes is very simple.

5. **Semi-elliptical.** This section is suitable for sewers carrying large discharge throughout the year. These are usually constructed with R.C.C.

6. **Horse-shoe type.** This is constructed with R.C.C. and is used in case of heavy discharges. Usually it has semi-circular shape on the top with sides inclined or vertical. The invert may be flat, circular or paraboloid in section. Its height is less than the width.

7. **Basket handle type.** The shape of this section is similar to that of basket-handle, therefore it is called as Basket-handle type. R.C.C. is used for the construction of this section.

This section is designed in such a way that self-cleaning velocity is developed even in D.W.F. This section is not commonly used.

8. **Egg-shaped sewers.** The depth of these sewers is one and half times of their width. In olden form it was used with greater radius at bottom, but in new shape smaller radius is used at the bottom. These types of sewer sections are mostly used because in dry weather, self-cleaning velocity is available due to greater depth of water as compared with other sections. These are mostly constructed with concrete and brick arch with special invert at bottom or of R.C.C. These sections are always constructed at the site.

This section is most suitable for combined system, because it gives self-cleaning velocity even in D.W.F. This section can be equally suitable for separate system, because it will easily accommodate the flow of sewage with the development of the town. It has good hydraulic properties, even better than circular section with low discharge. The only disadvantage is that its construction is difficult and it is less stable than circular section, hence it requires good masonry backing.

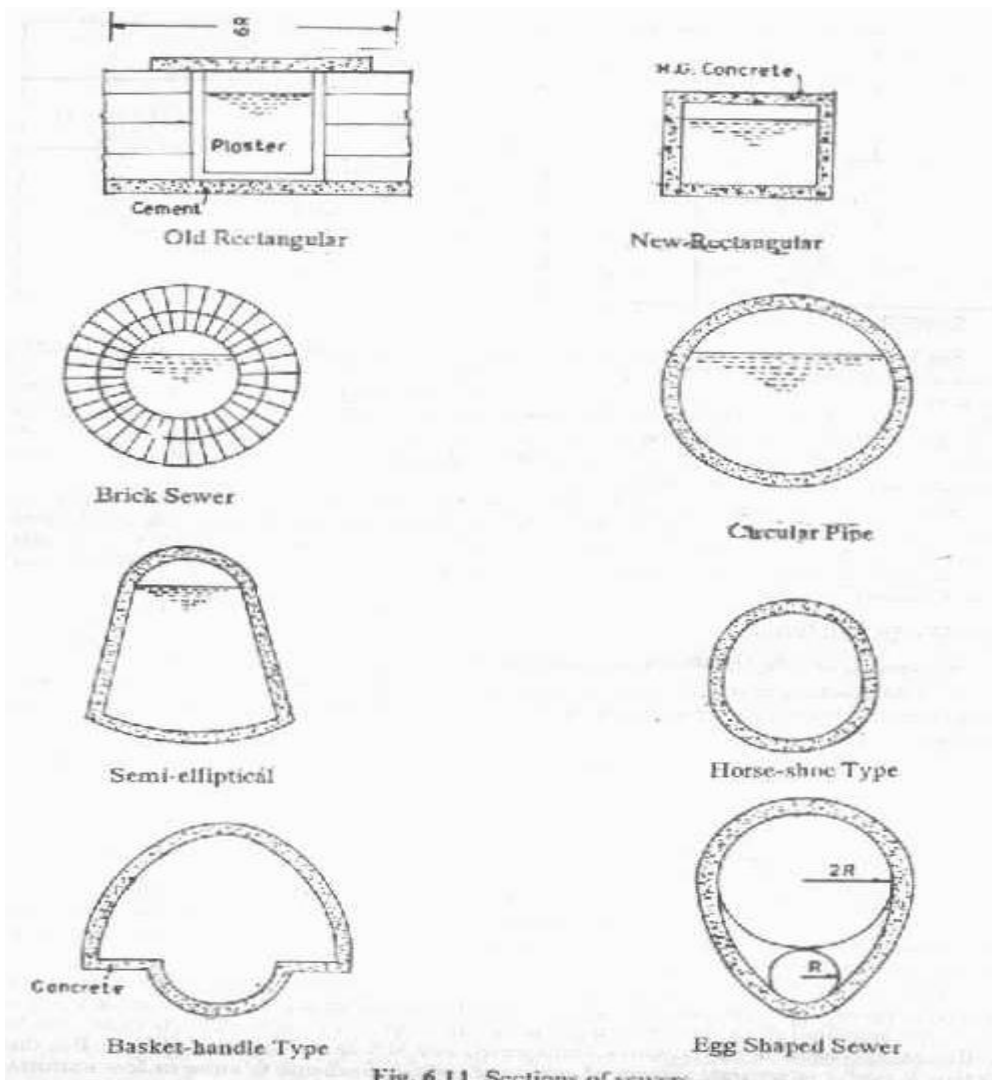


Fig. 6.11. Sections of sewers.