CE-441-ENVIRONMENTAL ENGINEERING II

LECTURE 6-LAYING & CONSTRUCTION OF SEWERS

Engr. Abdul Mannan Zafar

Lecturer,
Institute of Environmental Engineering & Research (IEER)
University of Engineering and Technology, Lahore

amzafar@uet.edu.pk

1- Excavation of Trenches

Excavation is done according to the size of trench and required gradient

Minimum width of trench (mm) = 1.5D + 300

Where D is internal dia of sewer pipe

2- Sheeting and Bracing

Trenches in unstable materials requires sheeting and bracing to prevent cave in or collapse of side walls

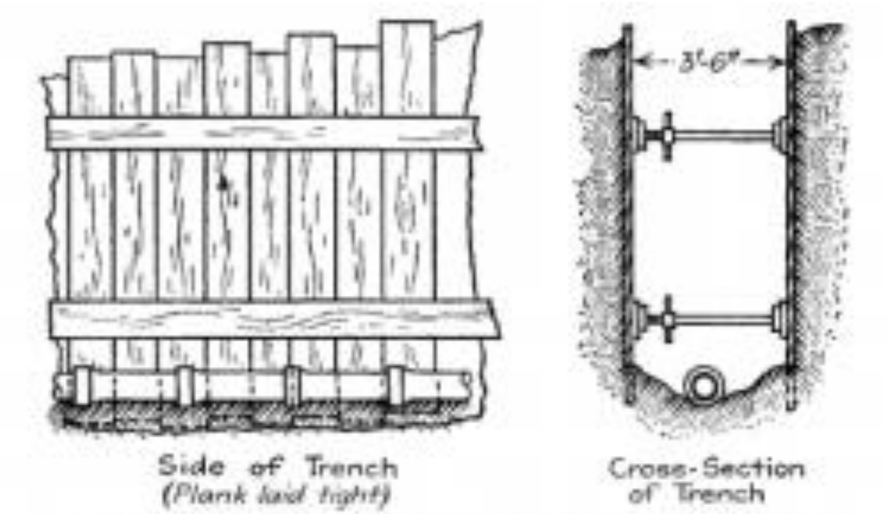


Fig. 36.—Laying of plank for trench dug in sandy ground.

3- Dewatering

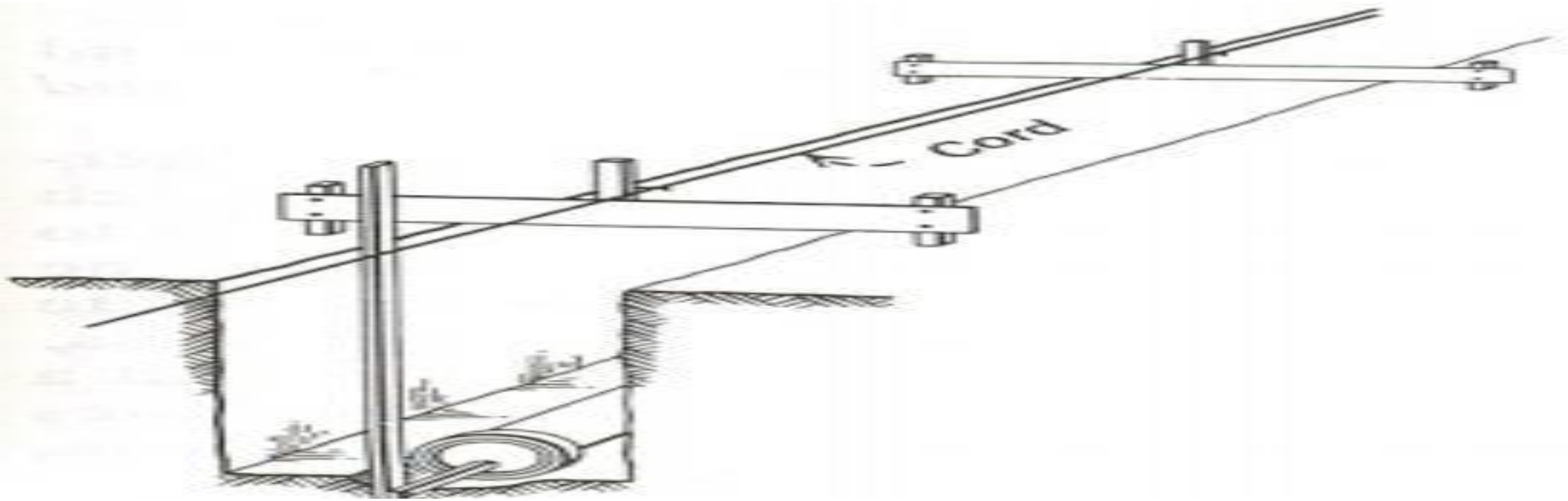
It is done when sewer is laid under water table

4- Pipe Laying

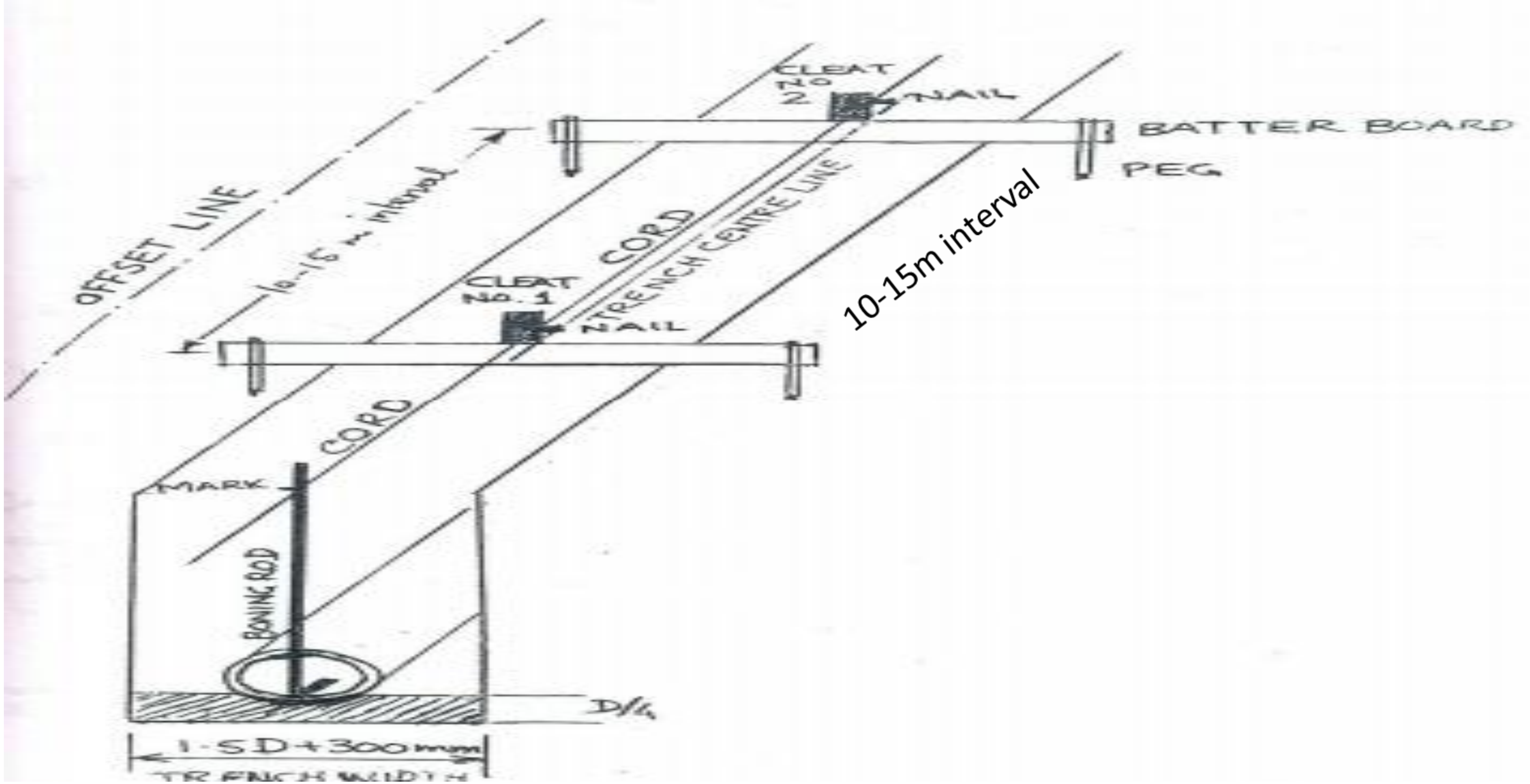
- Inspection of pipes for cracks or defects
- Use of chains to lower down pipes
- Joining of pipes by pressing them with a lever or winch

5-Lines and Grades

- An offset line is located where it will not be disturbed or covered. The contractor, then, measures from the offset line and lays out the trench on the ground
- Place the batter boards(wooden pieces) across the trench at 10-15 m intervals with the help of pegs,



STEPS FOR THE CONSTRUCTION OF SEWER-Lines & Grades



STEPS FOR THE CONSTRUCTION OF SEWER-Lines & Grades

- The centerline of the sewer is marked on the batter boards by nailing an upright cleat on it to indicate sewer alignment by measuring from the offset line

- Place nail on each cleat at some even distance above the sewer grade or invert level of sewer

- Stretch a string over the nails ,from cleat to cleat to indicate the slope of the sewer.

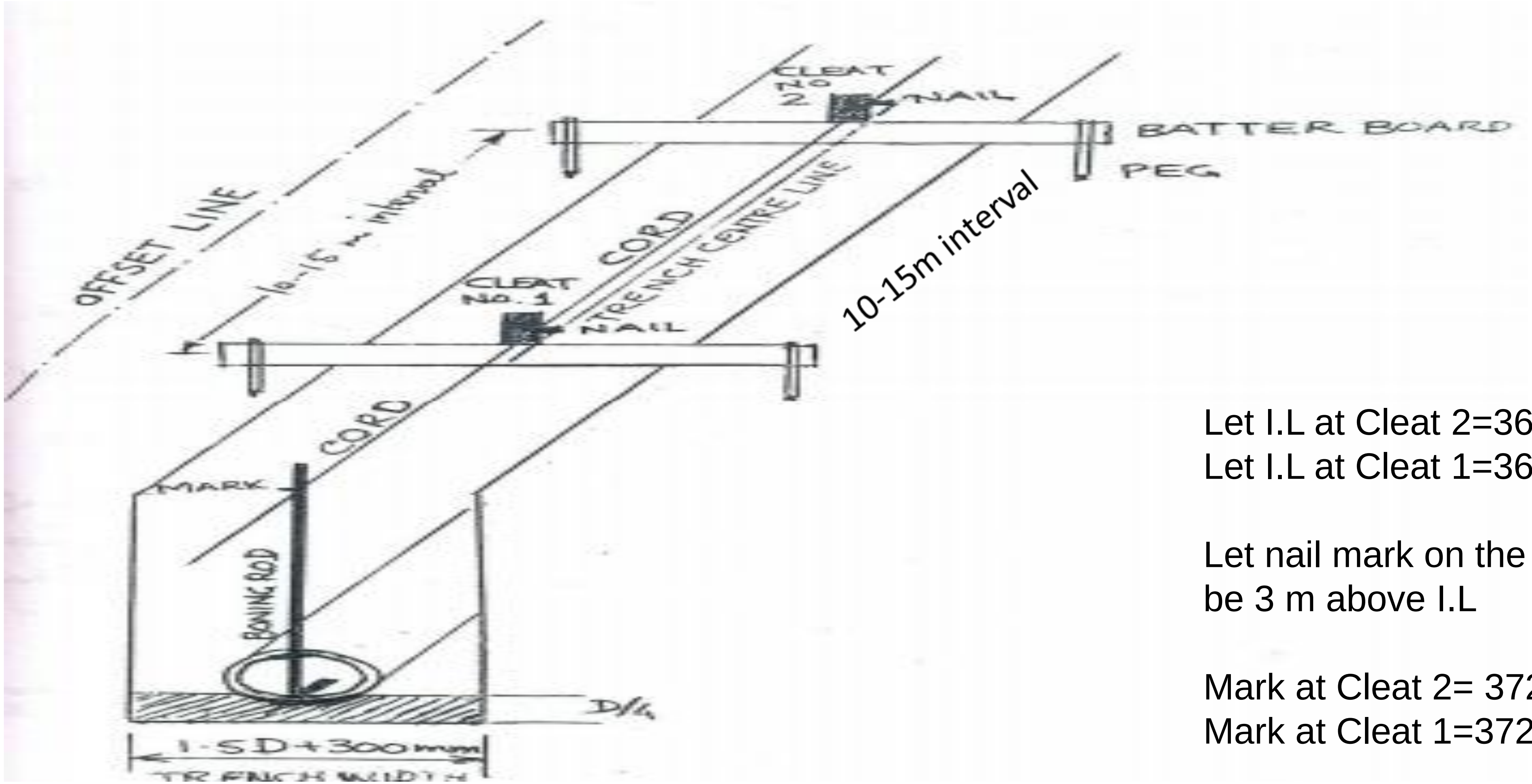
STEPS FOR THE CONSTRUCTION OF SEWER-Lines & Grades

- Transfer the sewer alignment from the cord to the bedding surface or sewer bottom using plumb bob

- Transfer sewer slope or grade by means of boning rod marked with even increments.(Boning rod is a stick in even foot marks and having a short piece fastened at right angle to its lower end)

- Check the grade by placing short piece of boning rod on the invert level of each length of sewer and noting the proper mark(e.g 3m) touches the cord.

STEPS FOR THE CONSTRUCTION OF SEWER-Marking at Cleat



Let I.L at Cleat 2=369.50
Let I.L at Cleat 1=369.30

Let nail mark on the cleat be 3 m above I.L

Mark at Cleat 2= 372.50
Mark at Cleat 1=372.30

Mark on the boning rod=3m from the bottom end

6- Backfilling

- Trenches should be backfilled immediately after the pipe is laid and jointing is done except in case of concrete beddings
- Earth should be dropped into the trench carefully until 2’ of cover in place. Thereafter backfill may proceed more rapidly.

Sewer pipes

- **Qualities to look for:**

1. Cheap
2. Durability for long life
3. Abrasion Resistant Interior to withstand Scouring
4. Impervious walls to prevent leakage
5. Adequate strength to resist failure under backfilling or traffic load

- **Types of pipes**

- PVC,PCC, RCC, Cast Iron, Steel,

Cement Concrete Pipes

PCC Pipes:

- Normally used for small storm drains and sanitary sewers
- They are manufactured with dimensions and strengths specified by ASTM
- Size : 100-600mm diameter
- 3 Classes depending upon strengths and thickness of wall

According to strength

- **Class1,Class 2,Class 3**

According to wall thickness

- **Class A, Class B, Class C**

RCC Pipes:

- Normally used for sanitary and combined sewers
- They are manufactured with dimensions and strengths specified by ASTM
- Size : 225-1000+mm diameter
- Classes depending upon strengths and thickness of wall

According to strength

- **Class 1,2,3,4,5**

According to wall thickness

- **Class A, Class B, Class C**

Back fill load on sewer

- Sewer design requires prior knowledge of soil and site conditions in order to determine over burden loads that will placed on pipes because are not ordinarily pressurized, are often more deeply buried than water mains
- They are normally made of brittle ,rather weak materials, the effect of soil and other external loads are quite important.

- **Total load = Back fill load + live load**

- Back fill load-depends upon
- ❑ Trench width
- ❑ Depth of fill above
- ❑ Unit weight of fill Material
- ❑ Frictional characteristics of backfill

- Live loads- on the surface rarely influence design of sanitary sewer because of their great depth

Backfill Load on Sewer

- Back fill load on buried pipes can be calculated by using **"Marston's equation**

$$W=C\mathit{w}B^2$$

Where,

- W=load on the pipe per unit length, Kg/m
- *w(density)*=weight of the backfill material per unit volume, Kg/m^3
- B= width of the trench →1.5D+300mm (as minimum)
- C=coefficient

Backfill Load on Sewer

- A coefficient “C” depending upon :
- ❖ Depth of fill on top of the pipe
- ❖ Fill material, character of construction

- For ordinary trench construction C is calculated as

$$C = \frac{1 - e^{\frac{-2K\mu H}{B}}}{2K\mu}$$

Source: E.W. Steel)

-
- Where,
- μ’=coefficient of sliding friction
- K=ratio of active lateral pressure to vertical pressure
- For most soils Kμ used between 0.1-0.16(0.11 for saturated clay)
- H=depth of fill above the top of the pipe
- B=width of trench

- For structurally stability, **strength of sewer(determine by 3 edge bearing test)** > **back fill load**

Value of Kμ' & Unit weight of Material

Soil type	Maximum value of $K\mu'$
Cohesionless granular material	0.192
Sand and gravel	0.165
Saturated top soil	0.150
Clay	0.130
Saturated clay	0.110

	Unit weight	
Material	kg/m^3	lb/ft^3
Dry sand	1600	100
Ordinary sand	1840	115
Wet sand	1920	120
Damp clay	1920	120
Saturated clay	2080	130
Saturated topsoil	1840	115
Sand and damp topsoil	1600	100

Source: (E.W. Steel)

Numerical(Load bearing)

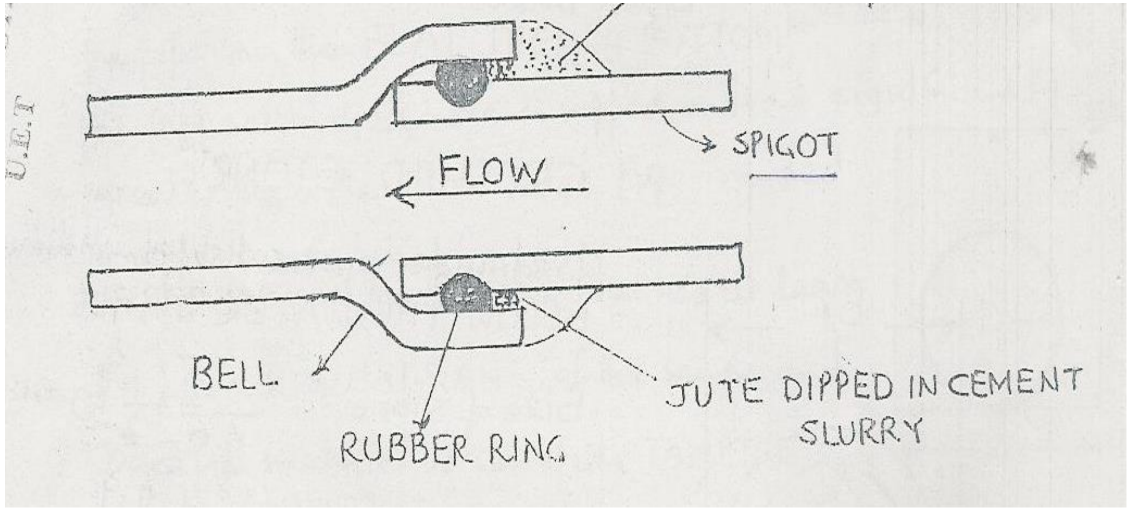
- A 600 mm concrete sewer is to be placed in a 1.5m wide trench. The cover of the back fill on the sewer is 4 m and composed of saturated clay weighing 2080 kg/m^3. Determine the load on the pipe.

Sewer joints

- **Bell-spigot joint**

Employed for sewers

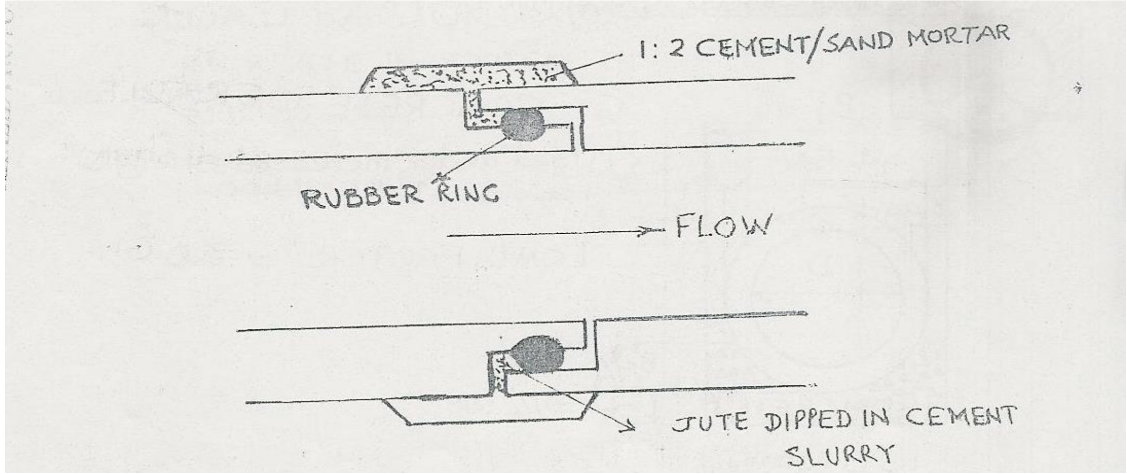
from 225 mm to 600mm



- **Tongue and groove joint**

Employed for sewers

from > 600mm diameter



SEWER BEDDING

- **Provision of proper bedding is very important**

1. In developing the strength of the pipe
2. Assuring that it is laid under proper grade
3. Preventing subsequent settlement
4. In unfavorable conditions bedding is particularly important

Load Factor

It is the increase in sewer strength by provision of proper bedding

Strength of RCC pipe

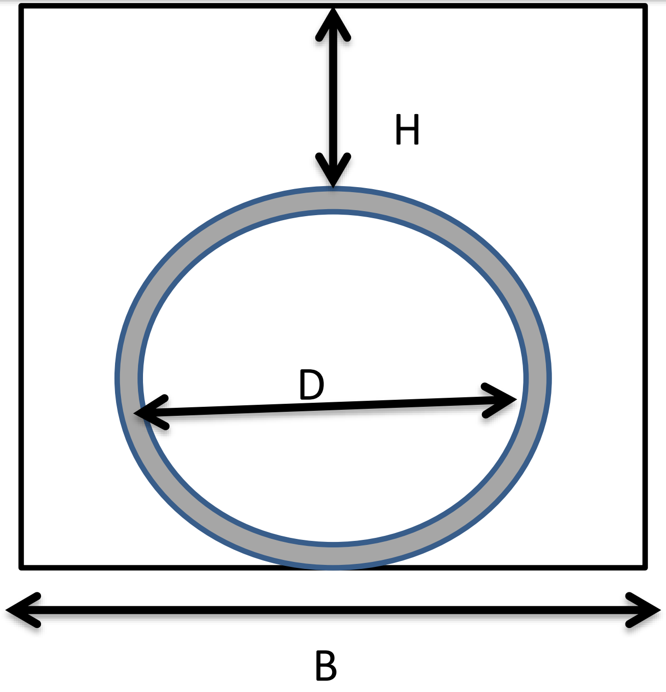
- Three edge bearing test is used to measure strength of RCC pipes. Load is applied on a pipe to produce 0.25mm crack.
- The test defines the load that can be safely supported by the sewer.
- Load Factor- express the increase in strength

Numerically ,

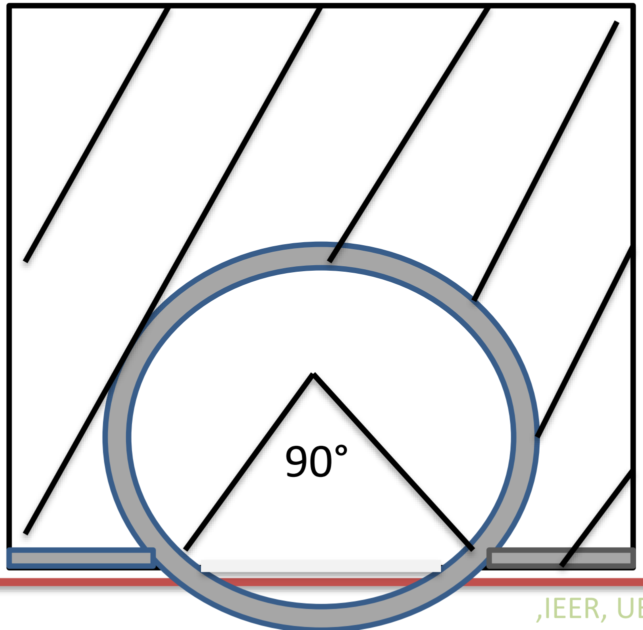
$$Load\ factor = \frac{laod\ carrying\ capacity}{3 - edge\ bearing\ strength}$$

Sewer bedding & strength of pipe

The pipe will not be able to support a load significantly greater than the three edge bearing test if the pipe is laid on flat bottom trench.

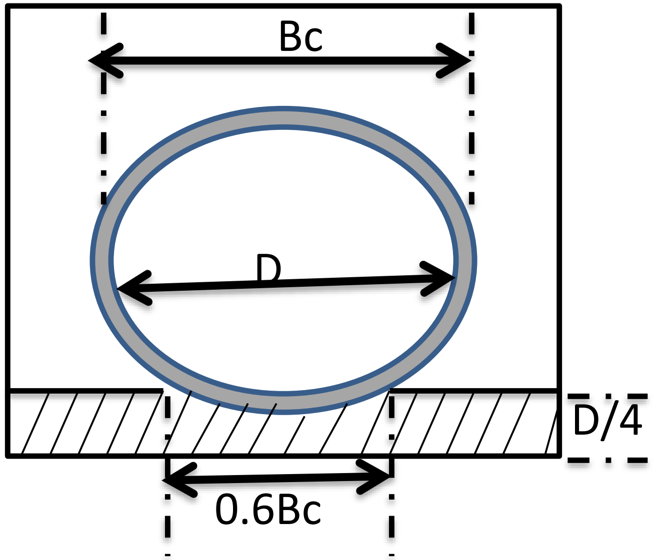


Back fill material is carefully tempted around the sides of the sewer, the supporting strength of the pipe significantly increases



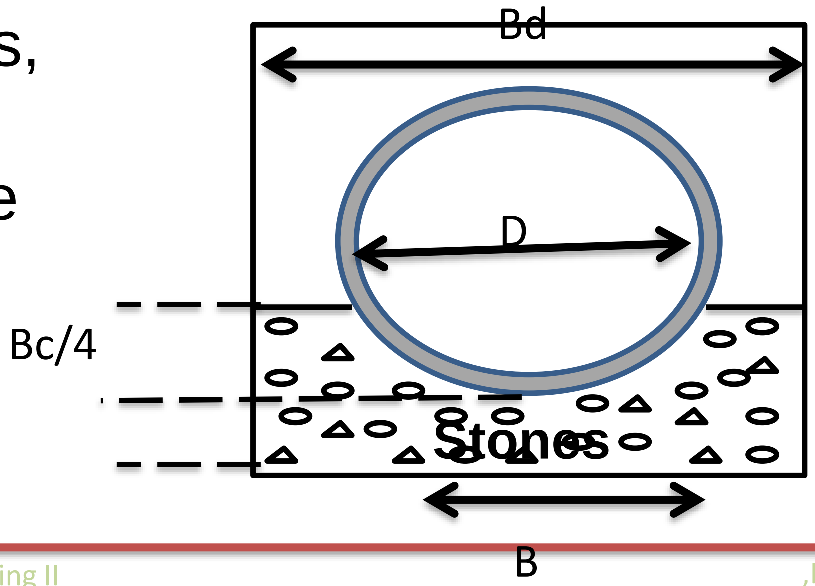
Brick Ballast

Used under poor subsoil conditions, Above the water table
Size of the ballast 1″-1.5″ gauge
Load factor = 1.7



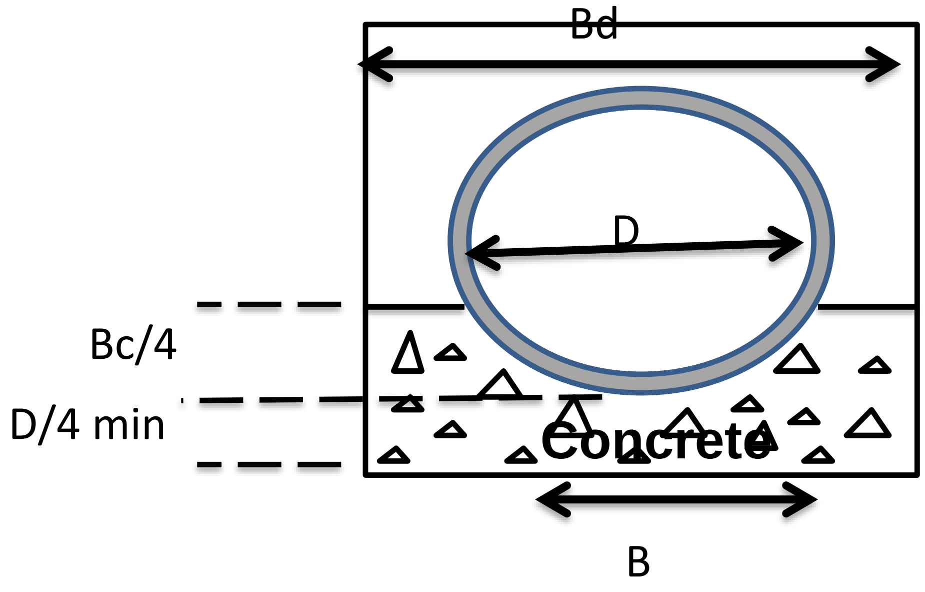
Crushed Stone

Used under poor subsoil conditions, Below the water table
Size of the stone 3/4″-1.5″ gauge
Load factor = 1.9

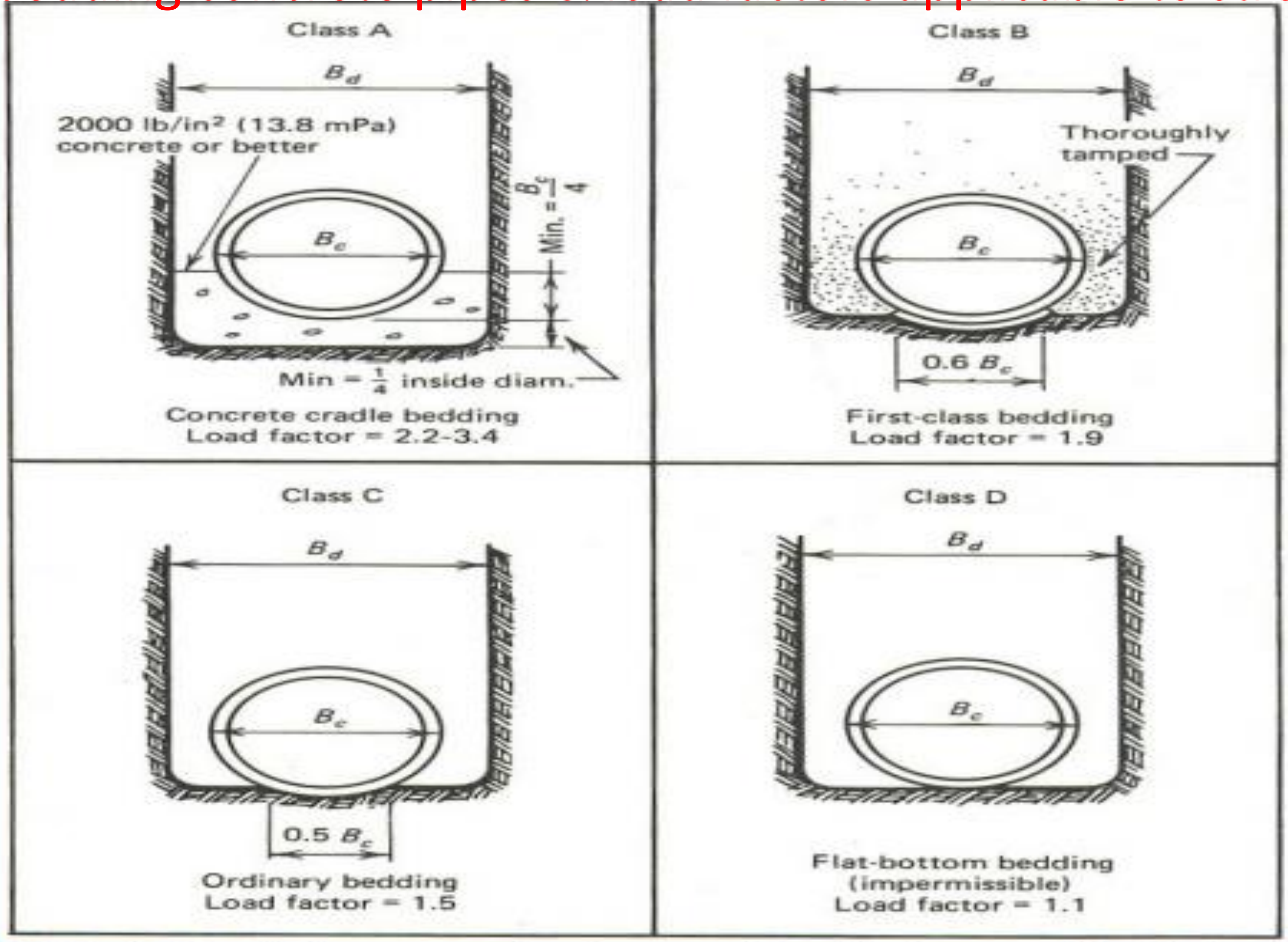


Concrete Cradle

Used under increased strength requirements
Load factor = 3



Method of bedding concrete pipes & load factors applicable to strength



Method of bedding concrete pipes and load factors applicable to strength

Sewer Appurtenances

- Devices which is used in addition to the pipes and conduits,that all essential for the operation of the sewer system.
- Manholes, Drop manholes
- Inlets, Catch basins
- Oil and grease traps
- Pumping stations

Manholes

- **Purpose**

❑Cleaning

❑Inspection

❑House connection

- **Provision at**

❑Junctions

❑Change in direction or alignment

❑Change in gradient and size of sewer

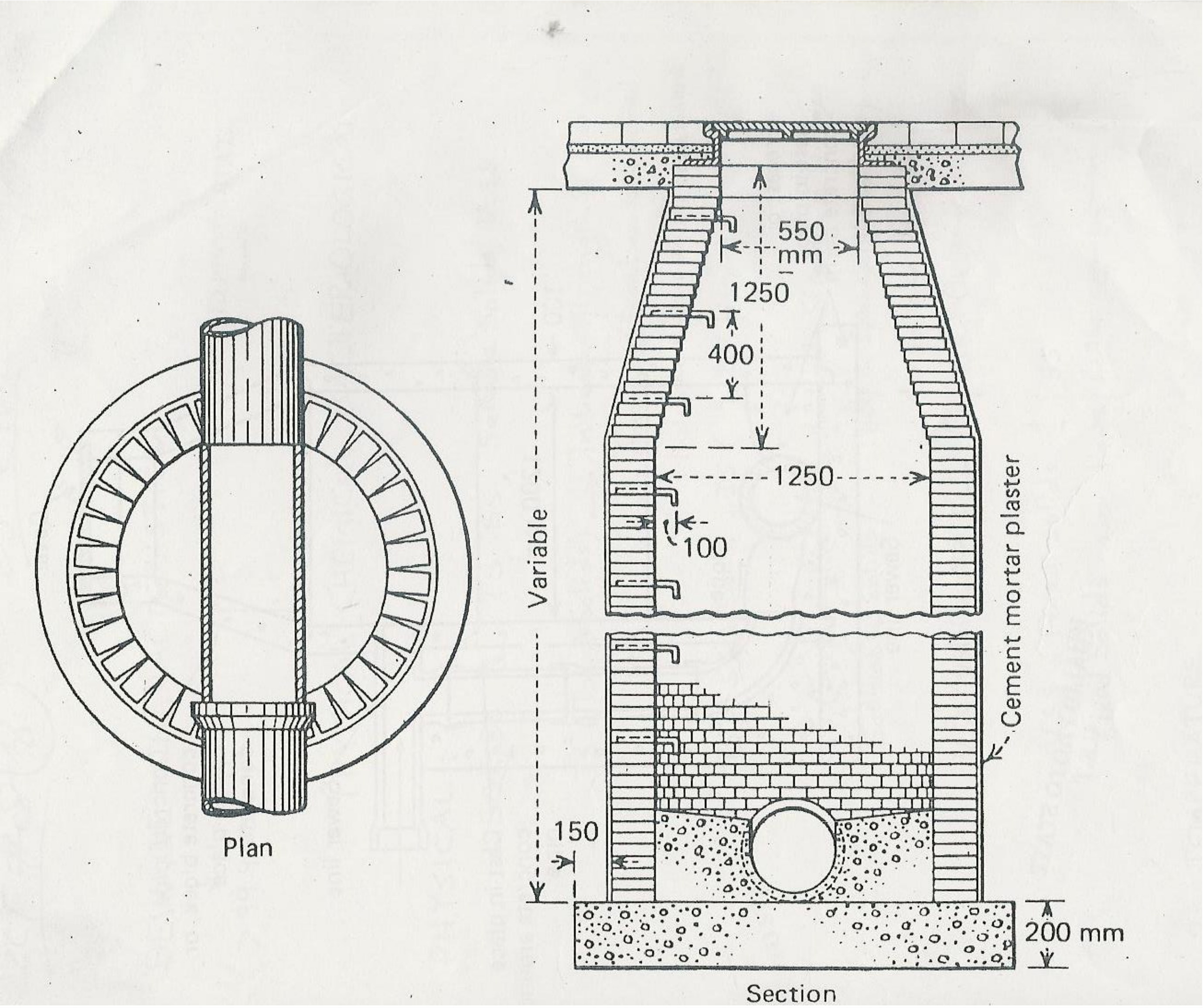
- **Spacing**

❑Not > 100 m (sewer size 225-375mm)

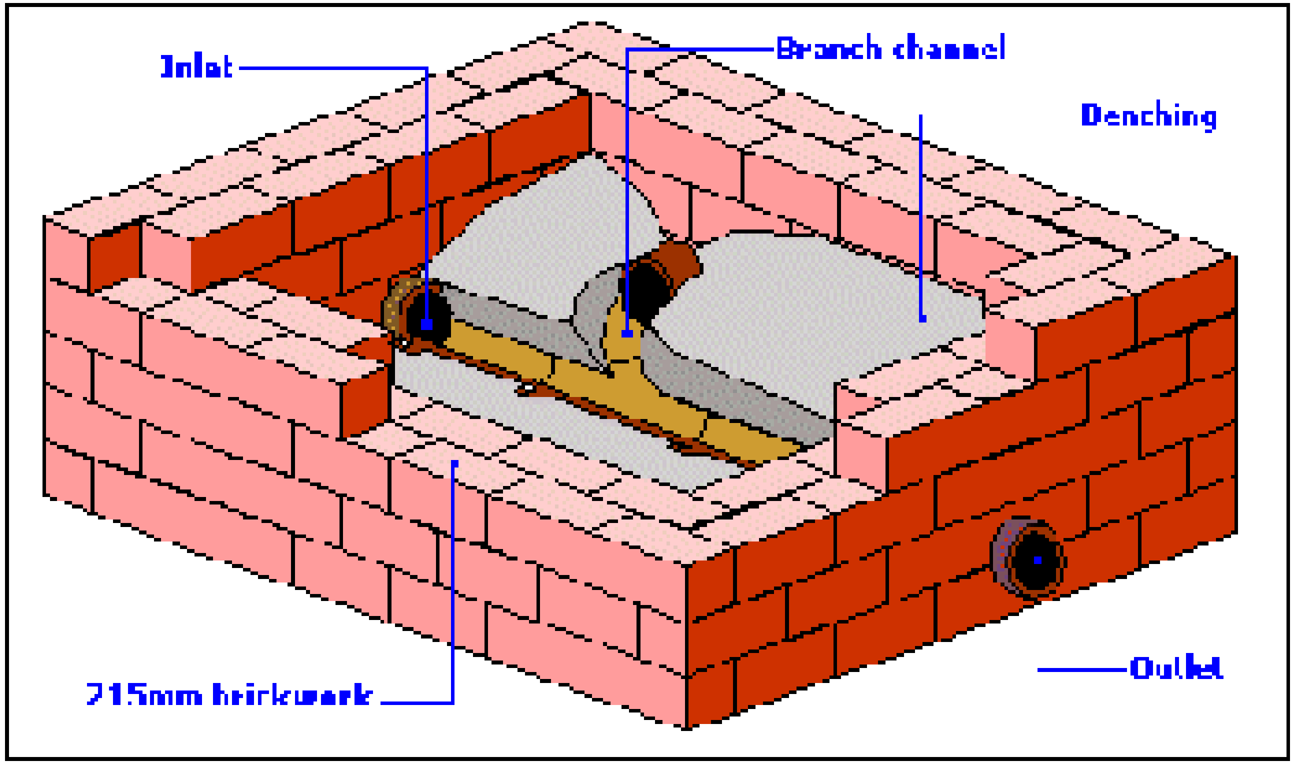
❑Not >120 m(sewer size 450-750mm)

❑Not >150m(sewer size >750mm)

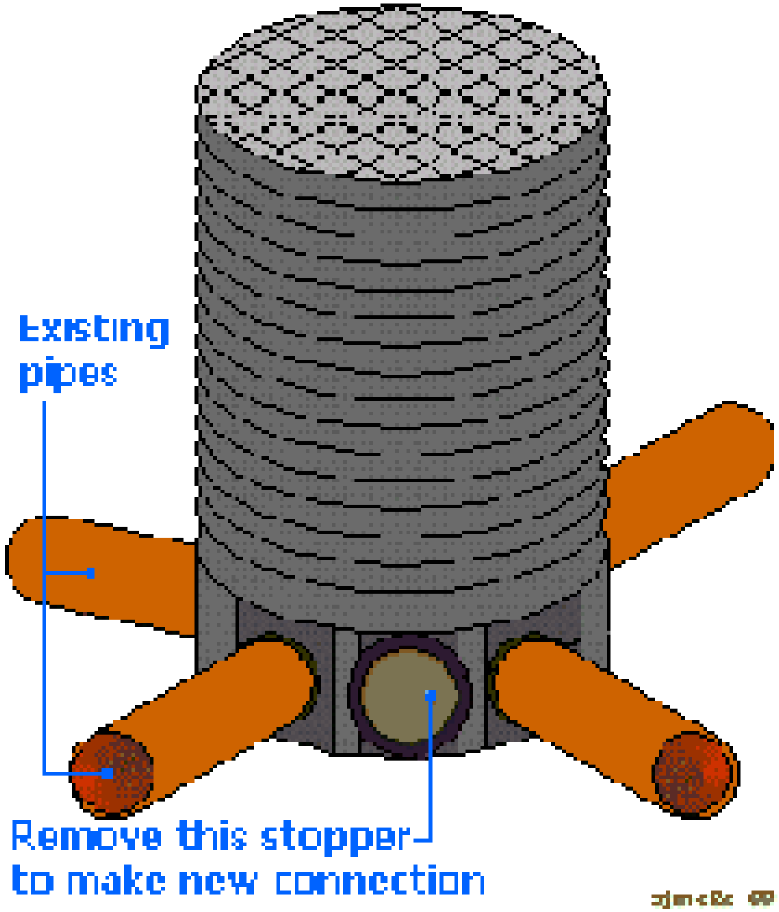
Manhole


550
mm
1250
400
1250
100
Variable
Cement mortar plaster
150
200 mm
Plan
Section

Manhole



BRICK BUILT MANHOLE



PLASTIC MANHOLE WITH EXTENSION RINGS ON TOP

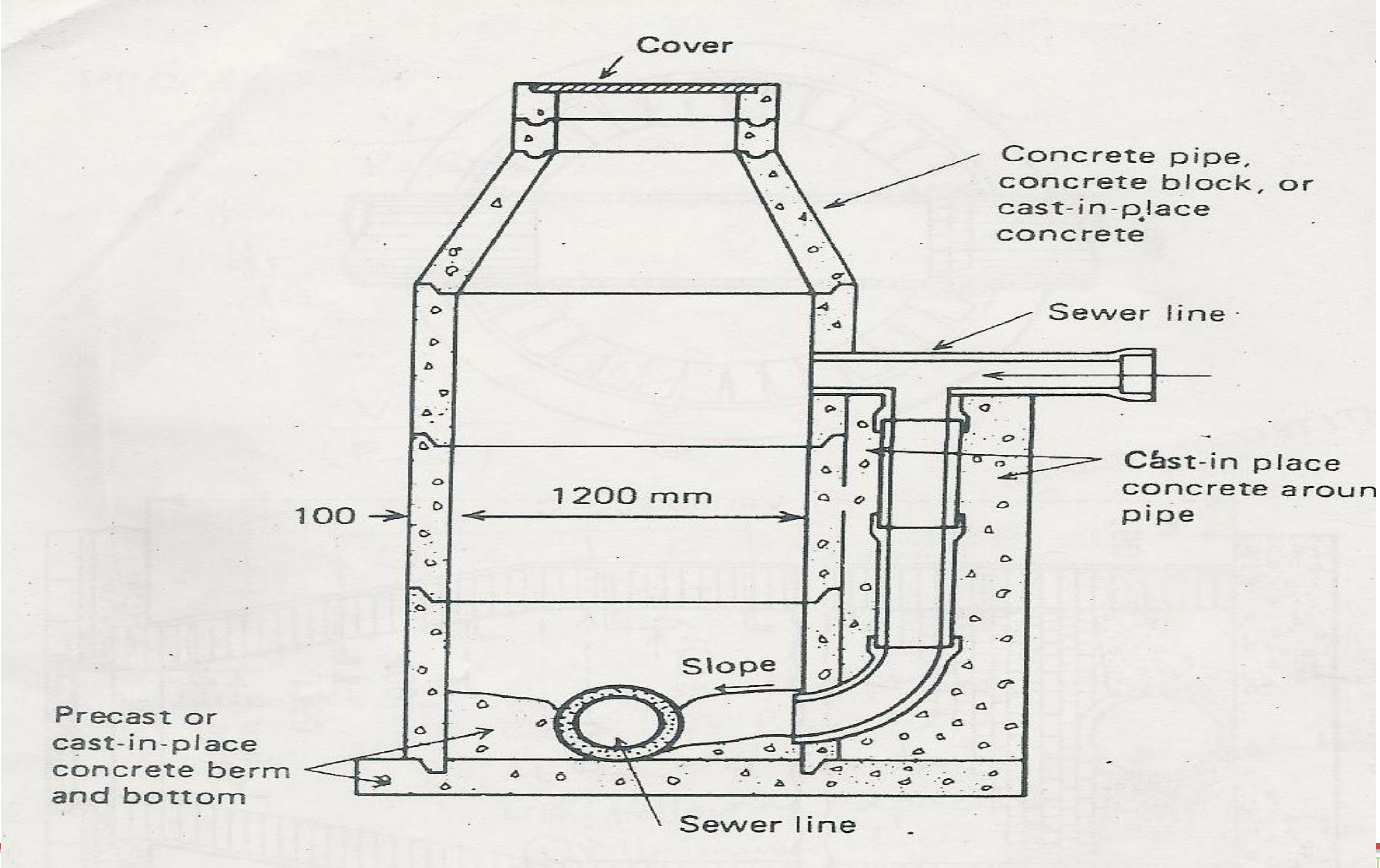
Drop Manhole

-If the underground sewer pipe is to stay below ground it must follow the average gradient of the slope.

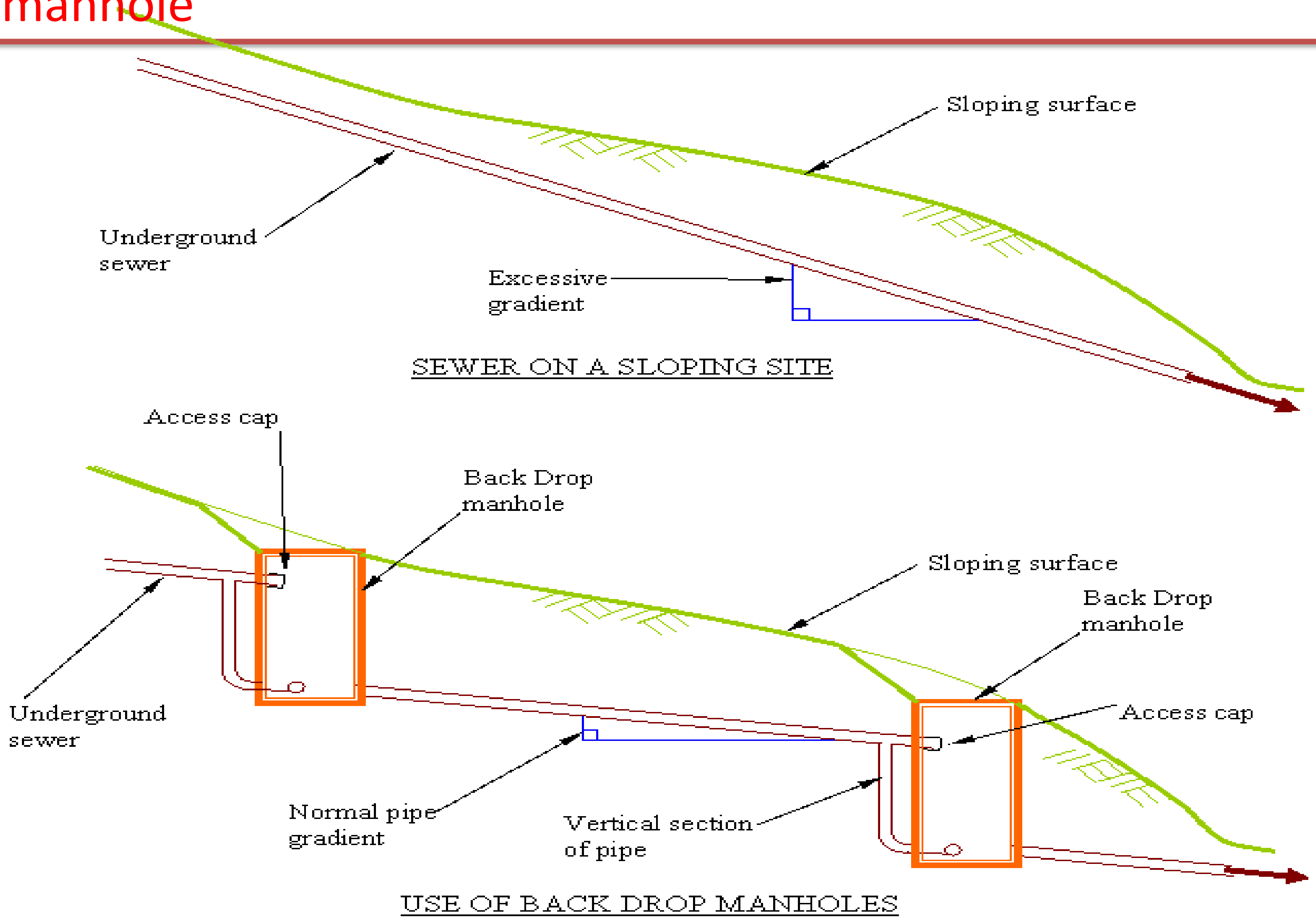
-Sometimes **pipe gradient becomes too steep**, resulting in the solids being left stranded in the pipe therefore causing a blockage.

-To overcome this problem the drop manhole was developed, as shown

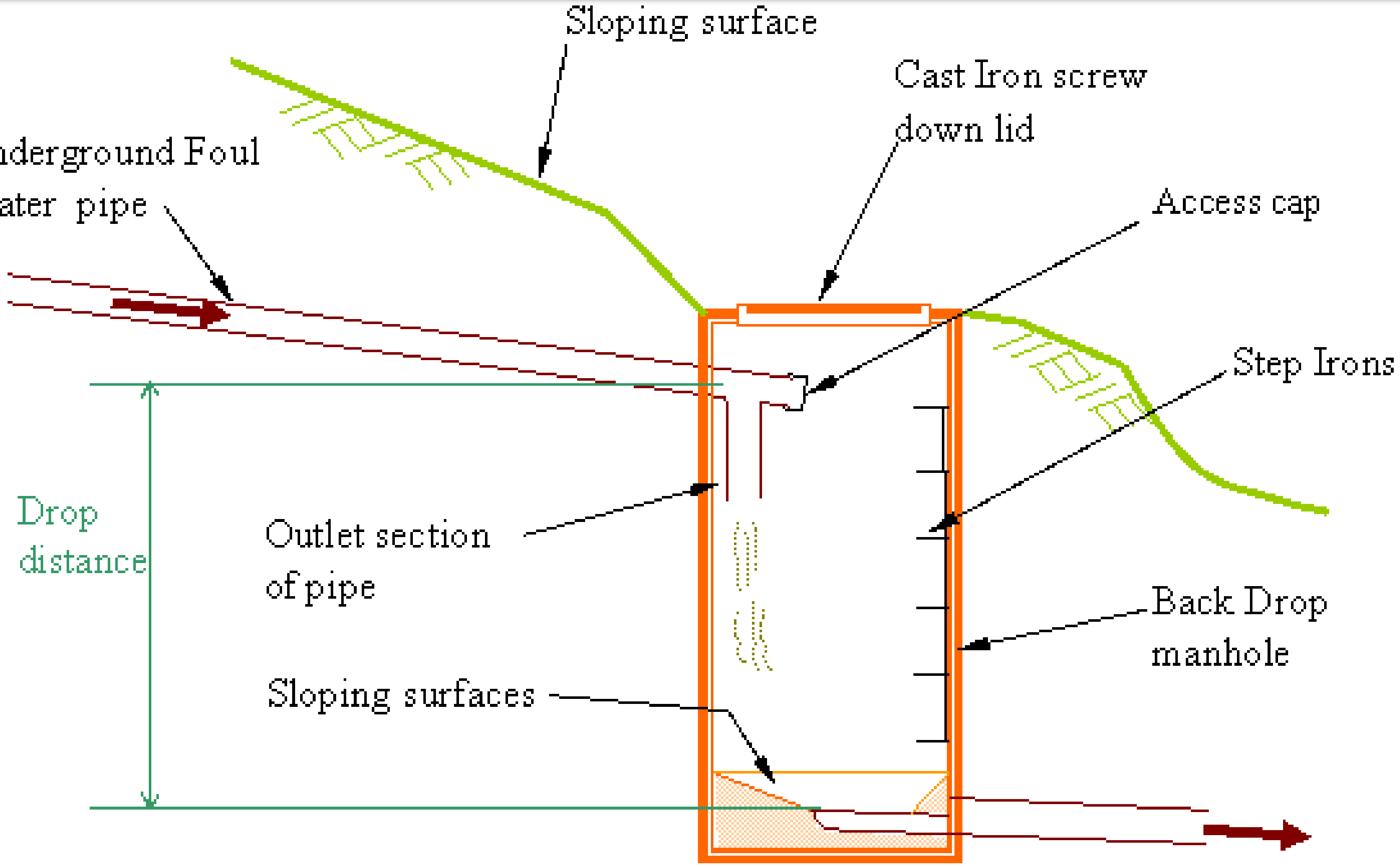
Drop Manhole



Back drop manhole



Back drop manhole with internal outlet pipe



BACK DROP MANHOLE WITH INTERNAL OUTLET PIPE

Inlets

- Opening into a storm or combined sewer for entrance of storm runoff

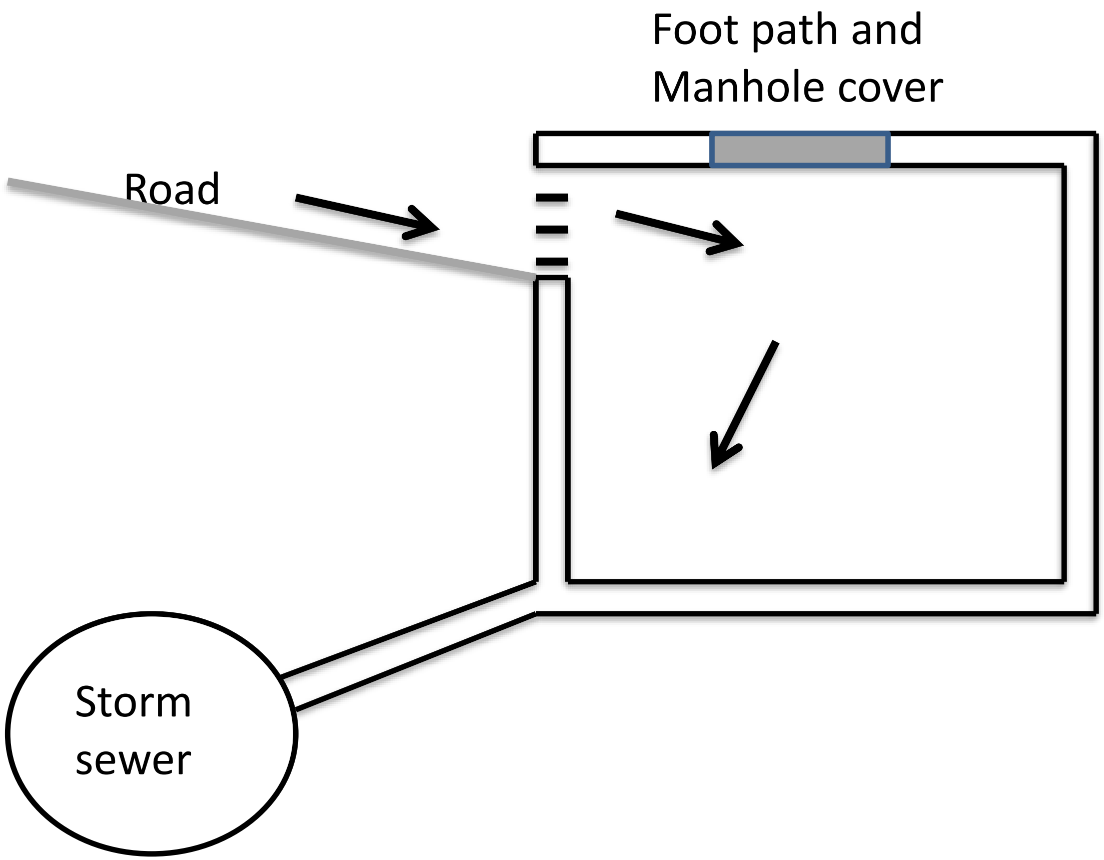
- It is designed to permit the passage of water from the street surface into sewer

- Two types if inlets are usually used

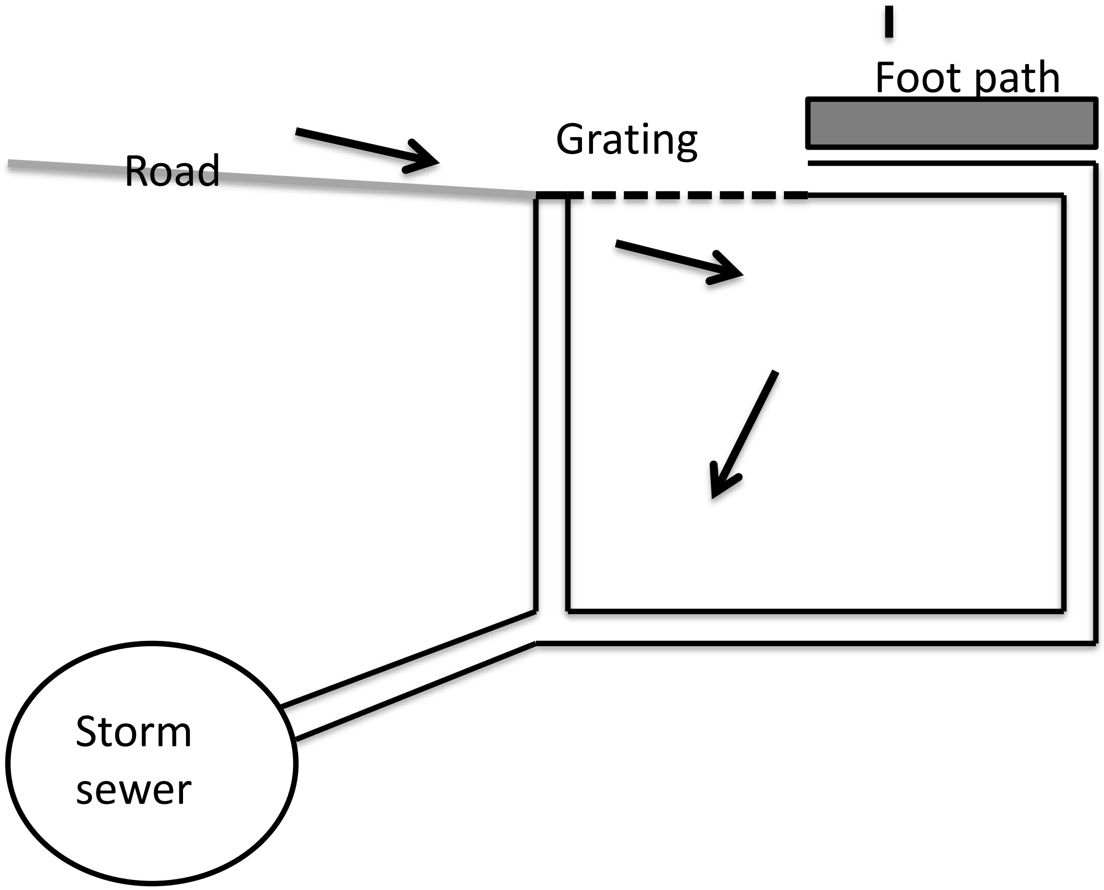
❖ Curb Inlet

❖ Gutter Inlet

Curb Inlet



Grating Inlet



Catch Basins

- These are like inlets but deeper enough to store the settle grit which is then removed periodically.