CE-441- ENVIRONMENTAL ENGINEERING II

Lecture 2 – steps for design of sewer system

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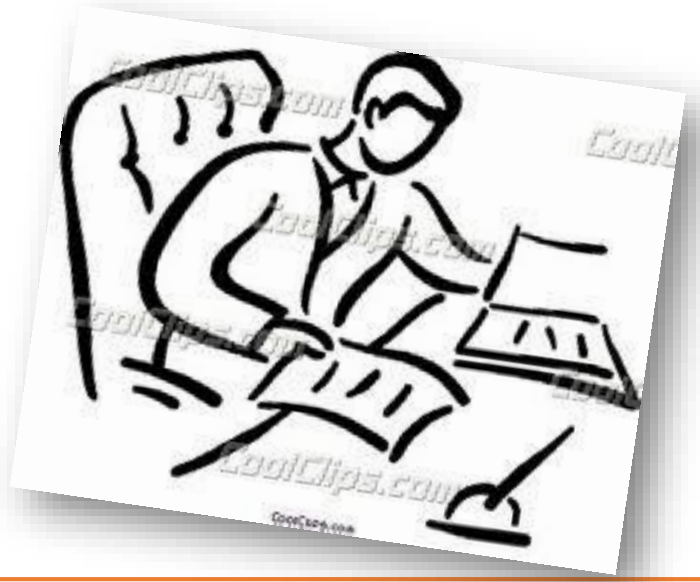
Steps

1. Preliminary Investigations
2. Design Criteria Considerations
3. Actual Design
4. Preparation of Drawing and BOQ
5. Subsequent Modification



1.Preliminary Investigation

- Obtain maps and drawings that furnish following information about the area

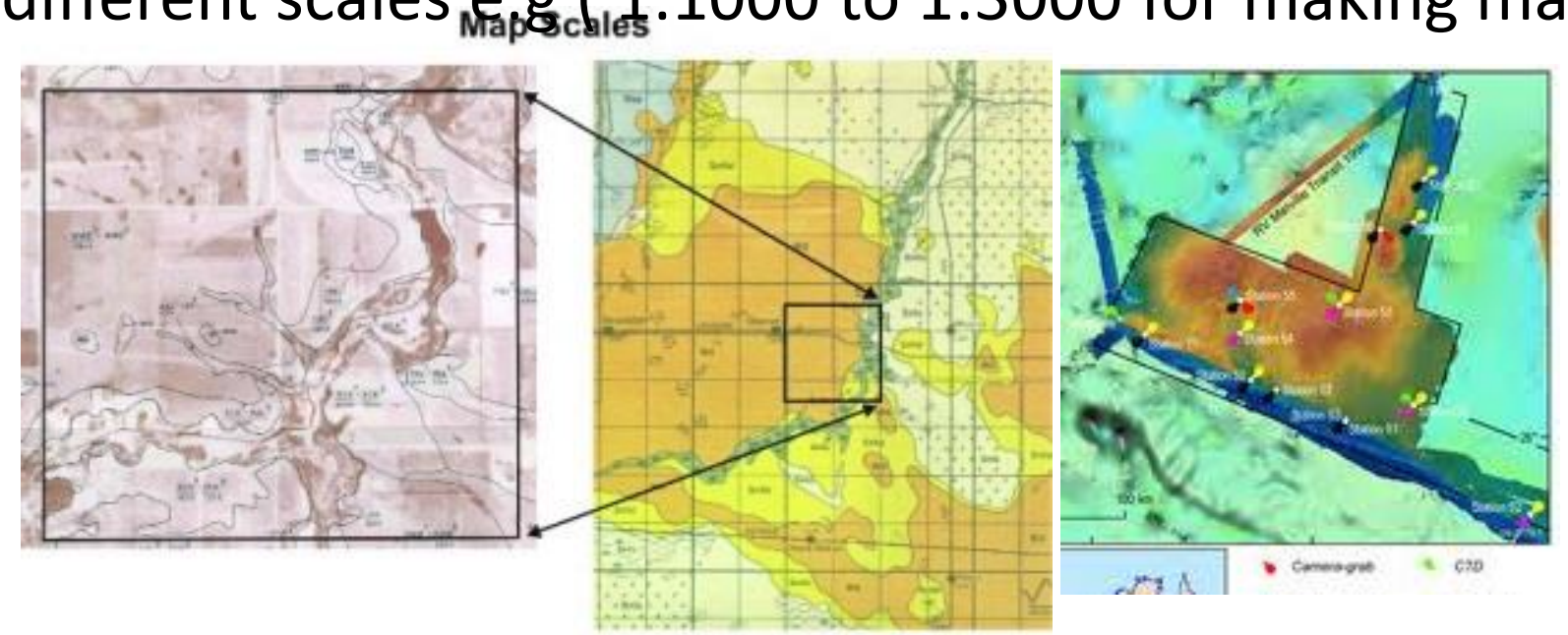
Population Density ,Water consumption, Soil characteristics, Natural slope, Disposal points, Groundwater table, Rocks, underground structure, Rainfall data, Location of Water & Gas pipes, Electric conduits.

- **Maps should also highlight the location of streets, parks , buildings etc.**

Note: Sewerage systems are operated under gravity where as water supply systems are operated under pressure

1.Preliminary Investigation

- If a map or needed information is not available conduct a detailed survey of the area to do the needful
- Establish Bench Marks throughout the area and make contours profiles and cross sections
- Mark surface elevations at street intersections.
- Make profile of the street through which sewer has to run.
- Use a different scales e.g (1:1000 to 1:3000 for making map)



1.Preliminary Investigation

- Soil conditions should be investigated for the type of stratum
- Location of water table
- Presence of any underground rock
- Collection of rainfall and runoff data.
- Study of natural slopes of the area and selection of a suitable disposal point.

2.Design Criteria Consideration

(1) Design Flow – Calculation of avg. sewage flow on the basis of water consumption and the population at the end of design period

(a) Sanitary Sewer

Q_{design} = Peak sewage flow + Infiltration

(b) Partially Combined Sewer

Q_{design} = Peak sewage flow +Storm flow+ Infiltration

WASA Criteria **(Peak sewage flow = Storm flow)**

Q_{design} = 2 x Peak sewage flow + Infiltration

2.Design Criteria Consideration

(2) Design Equation- Manning's formula is used for sewer flowing under gravity

$$V = \frac{1}{n} R^{\frac{2}{3}} S^{\frac{1}{2}}$$

V = velocity of flow m/sec

R = Hydraulics mean depth = Area/Perimeter

= D/4 (Circular Sewer)

S= Slope of sewer

n= coefficient of roughness for pipe (0.013-0.015)

(3)Minimum Self cleansing velocity

- Sewage should flow at all times with sufficient velocity to prevent settlement of solid matter in the sewer
- **Self cleansing velocity** is minimum velocity that ensures non-settlement of suspended matter in the sewer

- Sanitary sewer = 0.6m/s
- Storm sewer= 1m/s
- Partially combined = 0.7m/s

(4)Maximum Velocity

Should not be greater than **2.4m/s**

-To avoid excessive sewer abrasion

-To avoid steep slopes

(5)Minimum Sewer Size

-225mm for lateral WASA

-To avoid chocking of sewer with bigger size objects which enters through manholes**(bricks ,shrubs etc.)**

Commercial available diameters of sewer in mm

TABLE
Dimensions of reinforced concrete pipe*

Internal diameter, mm (in)	Wall thickness, mm (in)		
	Wall A	Wall B	Wall C
310 (12)	44 (1¾)	51 (2)	
380 (15)	47 (1⅞)	57 (2¼)	
460 (18)	51 (2)	63 (2½)	
530 (21)	57 (2¼)	70 (2¾)	
610 (24)	63 (2½)	76 (3)	95 (3¾)
690 (27)	66 (2⅝)	83 (3¼)	101 (4)
760 (30)	70 (2¾)	89 (3½)	108 (4¼)
840 (33)	73 (2⅞)	95 (3¾)	114 (4½)
910 (36)	76 (3)	101 (4)	120 (4¾)
1070 (42)	89 (3½)	114 (4½)	130 (5¼)
1220 (48)	101 (4)	127 (5)	146 (5¾)
1370 (54)	114 (4½)	140 (5½)	159 (6¼)
1520 (60)	127 (5)	152 (6)	171 (6¾)
1680 (66)	140 (5½)	165 (6½)	184 (7¼)
1830 (72)	152 (6)	178 (7)	197 (7¾)
1980 (78)	165 (6½)	190 (7½)	209 (8¼)
2130 (84)	178 (7)	203 (8)	222 (8¾)
2290 (90)	190 (7½)	216 (8½)	235 (9¼)
2440 (96)	203 (8)	229 (9)	248 (9¾)
2590 (102)	216 (8½)	241 (9½)	260 (10¼)
2740 (108)	229 (9)	254 (10)	273 (10¾)
2900 (114)	241 (9½)		
3050 (120)	254 (10)		
3200 (126)	267 (10½)		
3350 (132)	279 (11)		
3500 (138)	292 (11½)		
3650 (144)	305 (12)		
3800 (150)	318 (12½)		
3960 (156)	330 (13)		
4110 (162)	343 (13½)		
4270 (168)	356 (14)		
4420 (174)	368 (14½)		
4570 (180)	381 (15)		

* Not all sizes are available in all classes.

2.Design Criteria Consideration

(6) Minimum cover

- Minimum 1 m earth cover on sewer crown to avoid damage from live loads

(7)Manholes

-Purpose: **(1)Cleaning**

(2) Inspection

(3)House connection

-Provision at: **(1) Change in sewer**

(2)direction

(3) Diameter

(4) Slope

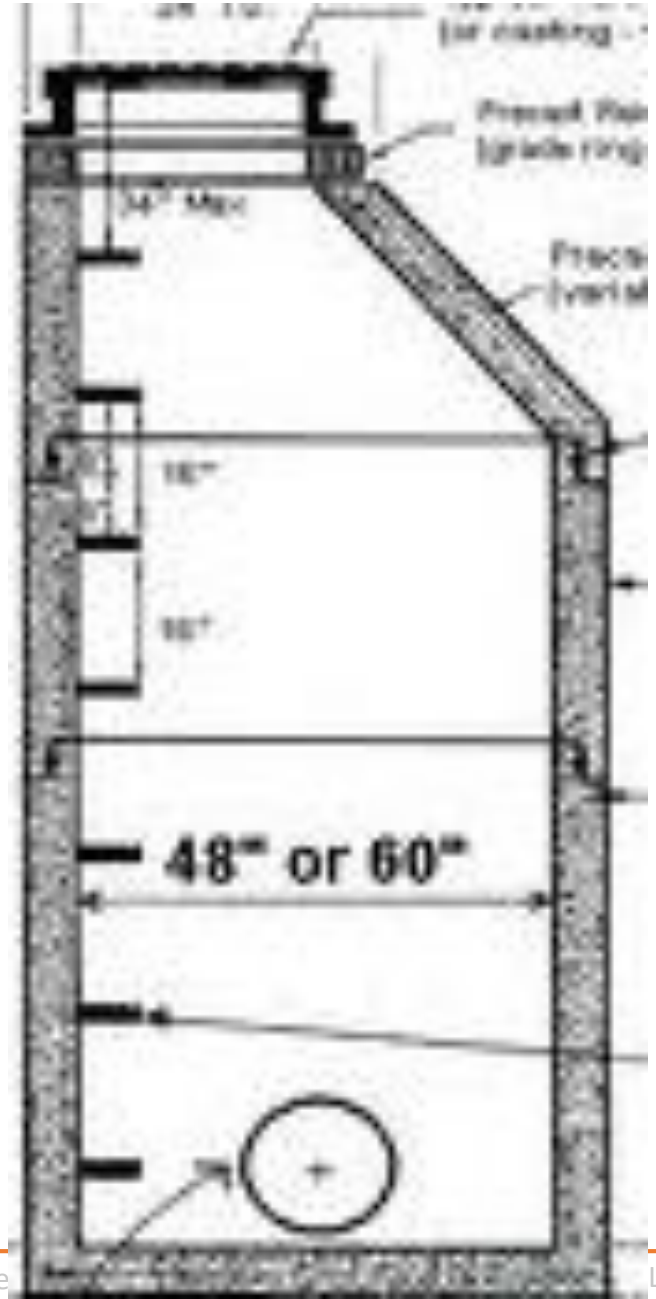
-One manhole for 2-4 plots

-Spacing not more than **-100m(225-380mm)**

-120m(460-910mm)

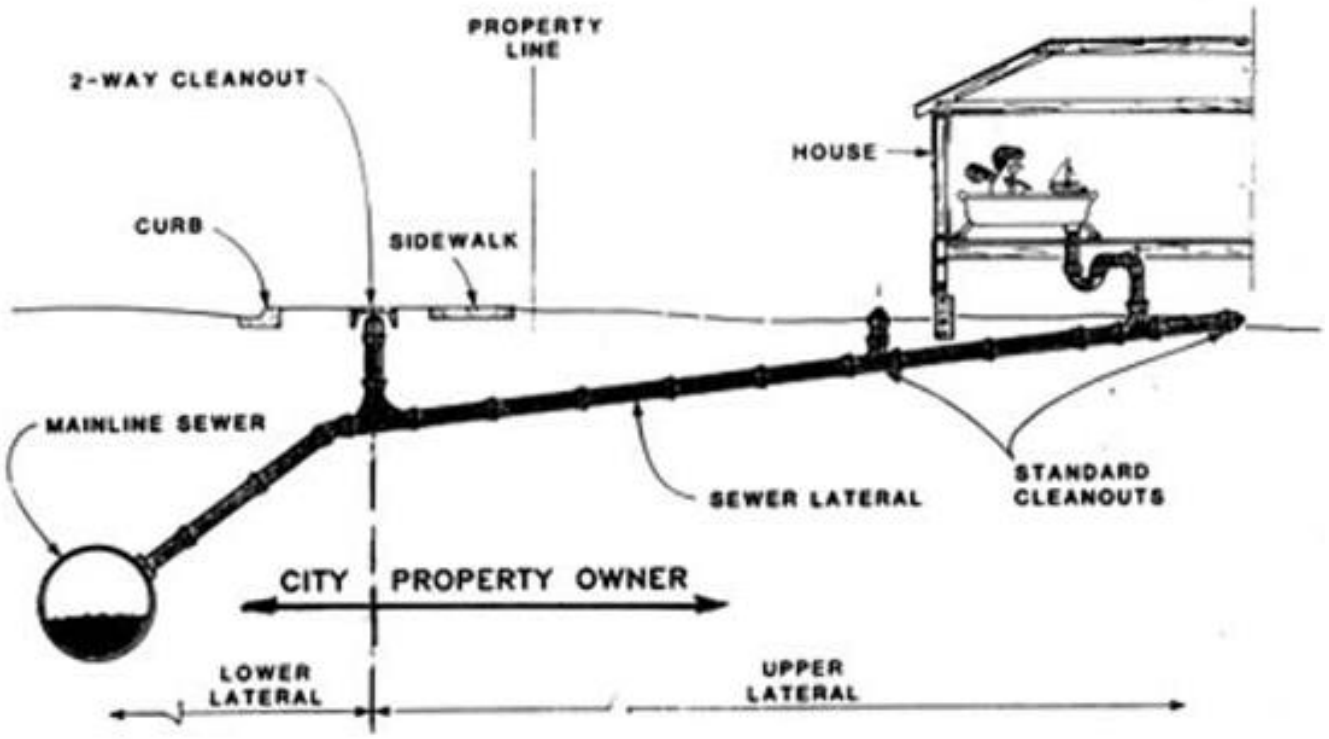
-150m(>910mm)

Manhole



(8) Direction of Sewer lines

-Sewers should follow as far as possible the natural slope



(9) Q_d/Q_f Ratio

- Q_d= Design Flow
- Q_f = Flow when sewer is flowing full

- In order to provide air space in the upper portion of sewers for ventilation purposes WASA recommends to maintain the following ratios **for sanitary sewer**

Sewer Size	
225-375 mm	Ratio 0.7
450-1200mm	Ratio 0.75
1350mm or larger	Ratio 0.8

3. Actual Design of Sewer

- **Size of sewer** : Using **Q=AV** *for the calculation of diameter*

- **Slope of sewer:** Using manning formula

$$V = 1/n\ R^{2/3}\ S^{1/2}$$

used for either calculation of slope or checking velocity

4. Preparation of drawings and BOQs

- **Typical drawing includes**

-Sewer joints (Type of joints used and sizing)

-Manholes (Dimensions and depth of manholes)

-Disposal stations (Locations)

-Sewer profile

BOQ's include all costs regarding all the components of sewer system

Sewer Profile

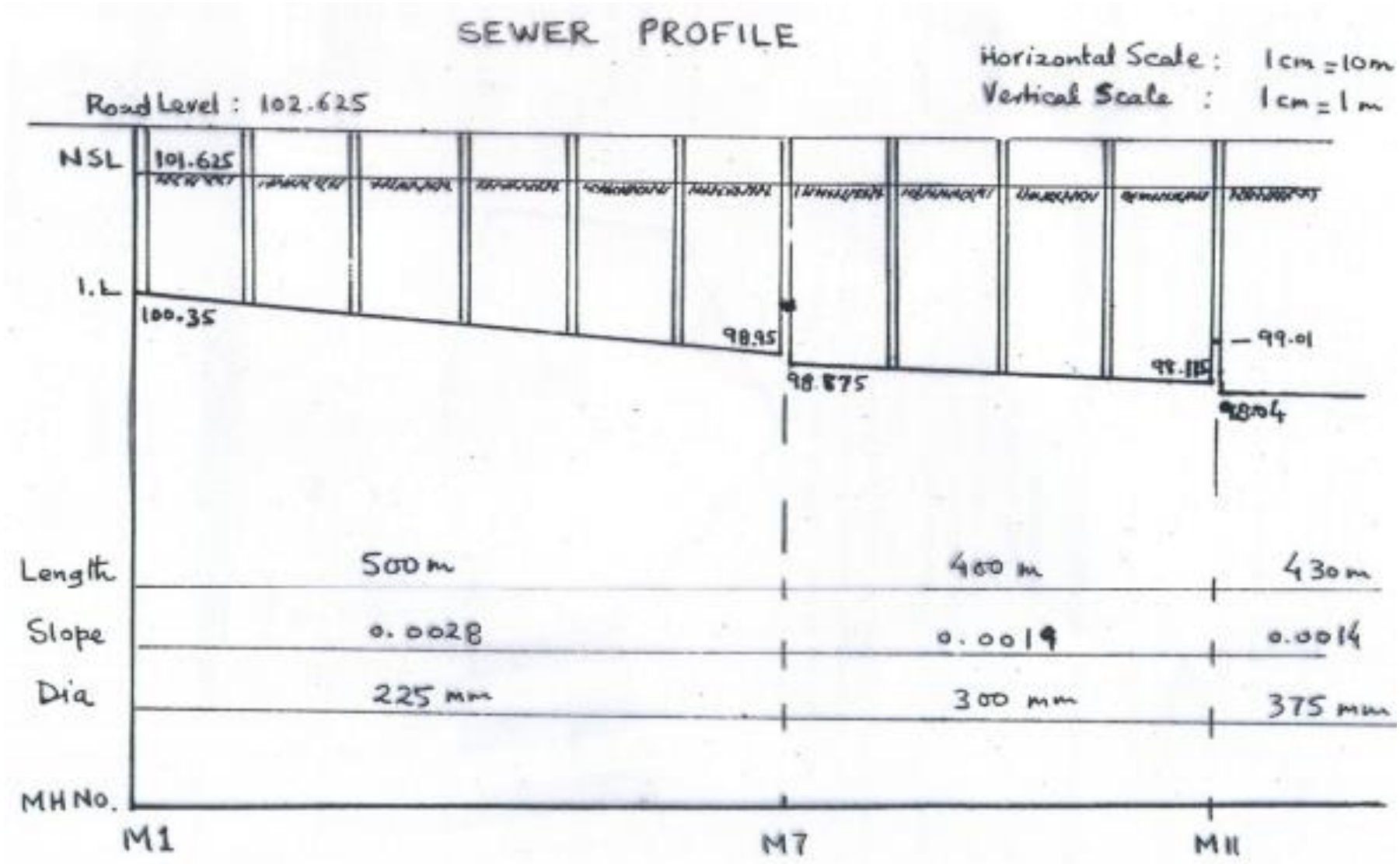
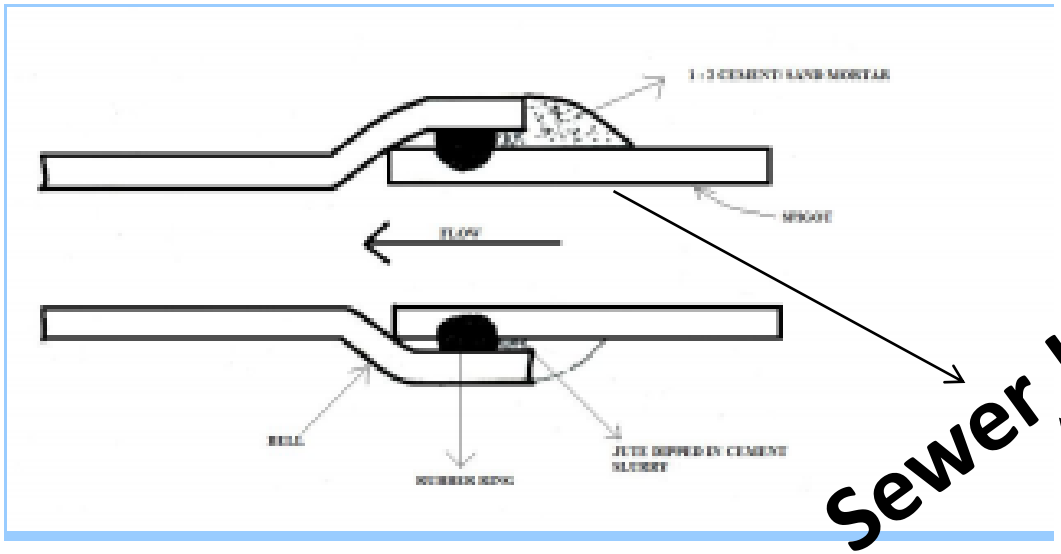
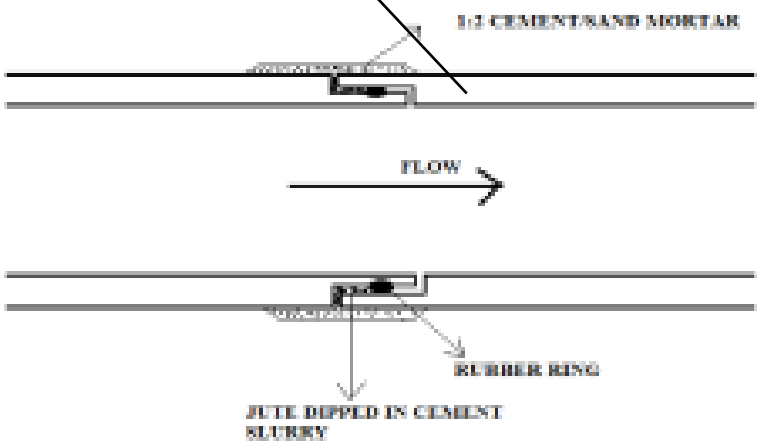


Fig: Sewer Profile

Sewer joint



Sewer Joint



Bill of Quantity

001A New Demo

1 Substructure

Ref	Description	Quantity	Units	Rate	Value
	GROUNDWORK				
	D20: EXCAVATING AND FILLING				
	Site preparation				
	Clear site of vegetation, undergrowth, bushes, hedges, trees or the like and remove from site:				
A	generally	585	m2	1.05	614.25
	Machine excavation				
	Oversite excavation to remove topsoil, average depth:				
B	150 mm	150	m2	0.30	45.00
	Trench excavation to receive foundations, pile caps and ground beams, depth not exceeding:				
C	1.00 m	38	m3	7.00	266.00
	IN SITU CONCRETE & LARGE PC CONCRETE				