

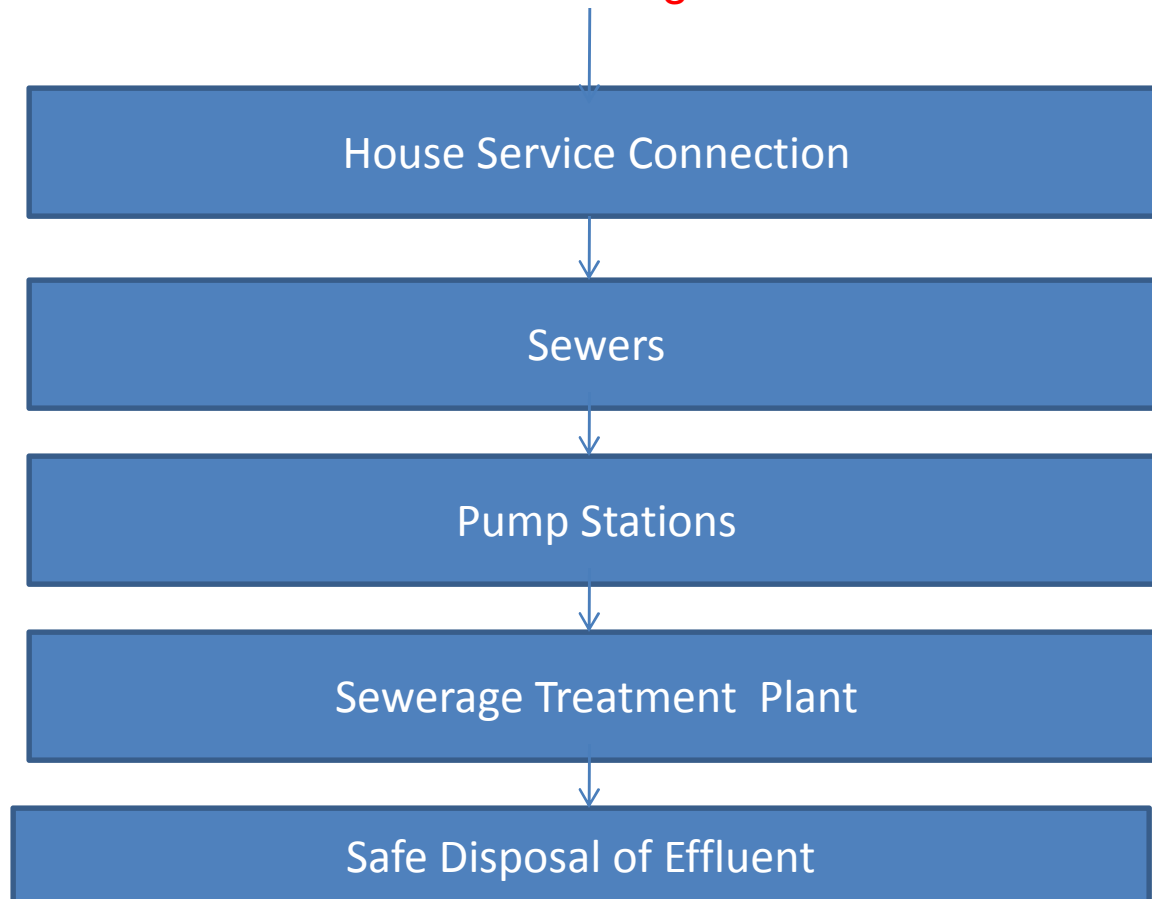
SEWERAGE & SEWAGE TREATMENT PLANT

PUBLIC HEALTH ENGINEERING
DEPARTMENT, HARYANA

By Lalit Arora
S.E Rewari

Sewerage System is the method of collection & transportation of sewage from household to Sewage Treatment Plant. Effective design and proper execution is the key for successful commissioning of Sewerage Projects.

Components of Sewerage System consist of following



Data Required for design of sewerage system

1. **Project Area**-Geographical description with reference to map, Topography, climate, culture, religion etc
2. **Population pattern** – Previous population data ,estimate future population data with different methods and most probable growth rate curve (demographic pattern to followed).
3. **Socio-economic Aspects**-Living standard of people ,density, present and future land uses as per development plan.
4. Natural gradient of the project area based on Survey of India sheets for identification of contour pattern.

Design parameters

Sr. No.	Description	Design periods in years	Clarification
1	Trunk Sewer/ Outfall Sewer	30 years	Laid for carrying discharge from branch sewers.
2	Pumping station	30 years	Civil work
3	Pumping machinery	15 years	The additional pumping machinery can be added later as per demand
4	Rising Main	30 Years	It can be laid in two parts 15 years and then parallel line can be draw laid
5	Sewage Treatment Plant	15 years	So that STP may not run underutilized. Capacity can be augmented later on as per requirement.

DENSITY OF POPULATION IF NOT SPECIFIED

Population	Density for Hectare
Upto 5000	75 to 150
5001 to 20000	150 to 250
20001 to 50000	250 to 300
50001 to 100000	300 to 350
Above 100001	350 to 1000

Per capita sewage flow is 70% to 80% of the water supply i.e. @ 135
LPCD

PEAK FACTOR

Contributing Population	Peak Factor
Upto 20000	3.00
20001 to 50000	2.50
50001 to 750000	2.25
Above 750001	2.00

DESIGN FLOW

Street Sewers	6 DWF
Trunk Sewers	3 DWF
Rising Main	Depending upon pumping hours 3 DWF – for 8 hours pumping 2 DWF – for 12 hours pumping 1.5 DWF – for 16 hours pumping And so on.....

SELF CLEANSING VELOCITY

The velocity at which suspended material in sewerage is not silted up is known as self cleansing velocity.

Sewers	Minimum Velocity at initial peak flow	0.6 m/s
	Minimum Velocity at ultimate peak flow	0.8 m/s
Open Drains	Peak flow	0.75-0.90 m/sec
Minimum velocity for force maximum (when lowest duty pump is working)		0.3 m/sec

MAXIMUM VELOCITY

S.W. Pipes	Velocity	1.4 m/sec
Brick Drain		2.1 M/sec
Concrete Drain		2.5 M/sec
Cemented Drain		3.0 M/sec
C.I Pipe		3.0 M/sec

PERMITTED DEPTH OF FLOW AND GRADIENT

Size of sewer	Depth of flow
Upto 400 mm	0.5 diameter
400 to 900 mm	0.67 diameter
Above 900 mm	0.75 diameter

GRADIENT TO MAINTAIN SELF CLEANSING VELOCITY

Dia	Slope	Capacity in LPM	Capacity in cusecs
150	1:155	410	0.24
200	1:280	670	0.39
250	1:375	1045	0.61
300	1:480	1505	0.88
350	1:570	2860	1.67
400	1:680	2510	1.47

MINIMUM GRADIENT OF SANITARY SEWERS

SEWER SIZE (mm)	GRADIENT – 1 IN
150	170
200	250
250	360
300	450
375	670
450	830
≥ 525	1000

GUIDELINES FOR EXECUTION

- Fix the permanent benchmark at one location and temporary bench mark along the alignment of sewer line and transfer the reduced level (R.L.)
- Study the L-Section drawing of the sewer to be laid especially with respect to
 - (i) Ground Level
 - (ii) Finished Excavation Level or Depth of excavation
 - (iii) Depth of water table below ground level
 - (iv) Size and slope of the sewer to be laid
- Get the depth of water table checked and record its level with respect to benchmark and get it signed from the contractual agency.
- Get the centre line of sewer alignment marked on the ground.
- Start laying trunk main sewer to ensure it is made functional with completion.
- Ensure permissions from B&R, NHAI, Railways, Forest Deptt.

GUIDELINES FOR LAYING OF SEWERS

- Material of Sewers mostly being used in Public Health Engineering Department.

(a) SW pipe upto 400 mm dia --- As per IS Code 651-1992

These shall be subject to test pressure of at least 1.5 m and is no case more than 2.45 m head of water.

(b) RCC NP-3 pipe manufactured with Sulphate Resistant Cement

From 450mm dia to 900 mm dia ---- As per IS Code 458-2003 & IS 783-2003

(c) RCC pipe NP-3 above 900 mm dia with 3 mm thick HDPE lining

- (i) No. of aggressive agents are observed in Sewage such as Hydrogen Sulphide. This causes immense damage in Concrete Sewage Pipes.
- (ii) The use of high density. Polyethylene lines inside the concrete pipe is recommended.
- What is NP-3

Non-Pressure, medium duty reinforced concrete pipes.

These can withstand a test pressure of 7 m head.

- What is Sulphate Resistant Cement (IS 12330-1988)

Use of this cement is particularly beneficial when the concrete is exposed to risk of deterioration due to sulphate attack BY acidic gases like H_2S etc.

- Rubber Ring ----- IS code 5382-----1985

GUIDELINES FOR EXECUTION

CONTINUED

- Study the Cross-Section of sewer for knowing the
 - (i) Width of excavation especially at bottom
 - (ii) Thickness and mix of lean concrete at bottom.
 - (iii) Type of sewer to be laid i.e. Type – A, B, C or D.
- The excavation should be carried out at least for one reach at a time i.e. from one man-hole to another man-hole.
- Proper safety arrangements to be observed i.e. either Shuttering of the trench
Or Proper side slope in case of open excavation.
- Ensure payment of width of excavation as per PWD specifications or as per cross section specified in the agreement.

MAXIMUM AND MINIMUM WIDTH OF TRENCHES

Maximum width of Trenches:-

- ✓ Trenches upto 2 meter depth – 500 mm + external diameter of pipe sewer
- ✓ Trenches exceeding 2 meter to 4.5 meter depth – 600 mm + external diameter of pipe sewer
- ✓ Trenches exceeding 4.5 meter depth – 680 mm + external diameter of pipe sewer

Minimum width of trenches down to the crowns of the barrels, for pipe sewers and drains:-

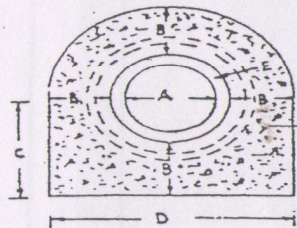
- ✓ Upto 18" (450 mm) in diameter shall be such as to give a clearance of 8" (200mm) on each side of the barrel of the pipe
- ✓ $\geq 18"$ (450 mm) in diameter – clearance of 9" (230mm) on each side of the barrel of the pipe

All such trenches shall have a clear width at the bottom equal to the width of the cradles of the sewers to be laid in them.

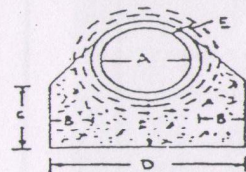
CROSS-SECTIONS OF SEWER

CROSS SECTION OF STANDARD S.W.P. SEWER.

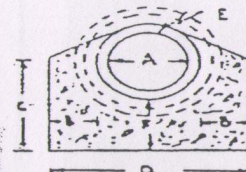
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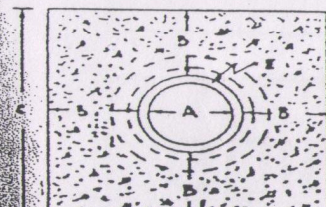
TYPE I



TYPE II



TYPE III



1/2 IN M.M.	100	150	200	250	300	350	400	450
A IN M.M.	100	150	200	250	300	350	400	450
B IN M.M.	100	115	125	125	150	150	150	150
C IN M.M.	162	206	242	270	325	355	385	413
D IN M.M.	324	412	484	540	650	710	770	820
E IN M.M.	12	16	17	20	25	30	35	38
LIME CONC. IN CU. M. MT.	0.0816	0.1255	0.1661	0.1943	0.2810	0.3180	0.3558	0.3918

1/2 IN M.M.	100	150	200	250	300	350	400	450
A IN M.M.	100	150	200	250	300	350	400	450
B IN M.M.	75	75	30	50	100	115	115	115
C IN M.M.	126	145	177	197	237	252	267	281
D IN M.M.	274	332	414	470	550	640	700	756
E IN M.M.	12	16	17	20	25	30	35	38
F IN M.M.	35	100	115	125	150	150	150	150
LIME CONC. IN CU. M. MT.	0.0370	0.0456	0.0741	0.0930	0.1283	0.1565	0.1755	0.1869

1/2 IN M.M.	100	150	200	250	300	350	400	450
A IN M.M.	100	150	200	250	300	350	400	450
B IN M.M.	50	90	100	115	115	115	115	125
C IN M.M.	162	206	257	295	325	355	385	413
D IN M.M.	304	362	434	520	580	640	700	776
E IN M.M.	12	16	17	20	25	30	35	38
F IN M.M.	100	115	140	150	150	150	150	150
LIME CONC. IN CU. M. MT.	0.0468	0.0668	0.0968	0.1311	0.1526	0.1726	0.1876	0.2313

1/2 IN M.M.	100	150	200	250	300	350	400	450
A IN M.M.	100	150	200	250	300	350	400	450
B IN M.M.	150	150	150	150	150	150	150	150
C IN M.M.	424	482	534	590	650	710	770	826
D IN M.M.	424	482	534	590	650	710	770	826
E IN M.M.	12	16	17	20	25	30	35	38
LIME CONC. IN CU. M. MT.	0.0816	0.1255	0.1661	0.1943	0.2810	0.3180	0.3558	0.3918

TYPE I

SEWER LAID IN OPEN TRENCHES WHERE COVER IS 0.91 M OR LESS IN FIELDS & 1.22 M OR LESS IN ROADS AND STREETS.

TYPE II

SEWER LAID IN OPEN TRENCHES WHERE COVER EXCEED 0.91 M IN FIELDS & 1.22 M IN ROADS AND STREETS BUT DOES NOT EXCEED 4.27 M.

TYPE III

SEWER LAID IN OPEN TRENCHES WHERE COVER EXCEEDS 4.27 M BUT DOES NOT EXCEED 6.10 M

TYPE IV

SEWER LAID IN ALL HEADINGS OR TUNNELS AND ALSO IN OPEN TRENCHES WHERE COVER EXCEEDS 6.10 M.

ALL LIME CONCRETE IN FOUNDATION HAUNCHES AND ENVELOPS OF PIPE SEWERS SHALL BE OF FINE CONCRETE.

NOTE:-

STD CROSS SECTION OF RCC PIPE SEWER CLASS NP3

(Under PWD. W/S & Sanitation Division No. 2. Sirsa)

Size of Pipe	BC NP3	C NP3	Thickness of Conc		
			a	b	T
500	650	850	125	165	290
600	770	970	150	195	345
700	870	1075	175	220	395
800	990	1225	200	250	450
900	1100	1375	225	275	500
1000	1230	1500	250	310	560
1100	1330	1665	275	335	610
1200	1440	1790	300	360	660
1400	1670	2090	350	420	770
1600	1880	2350	400	470	870
1800	2100	2625	450	525	975
2000	2340	2900	500	585	1085

Trench Width 'B' NP3

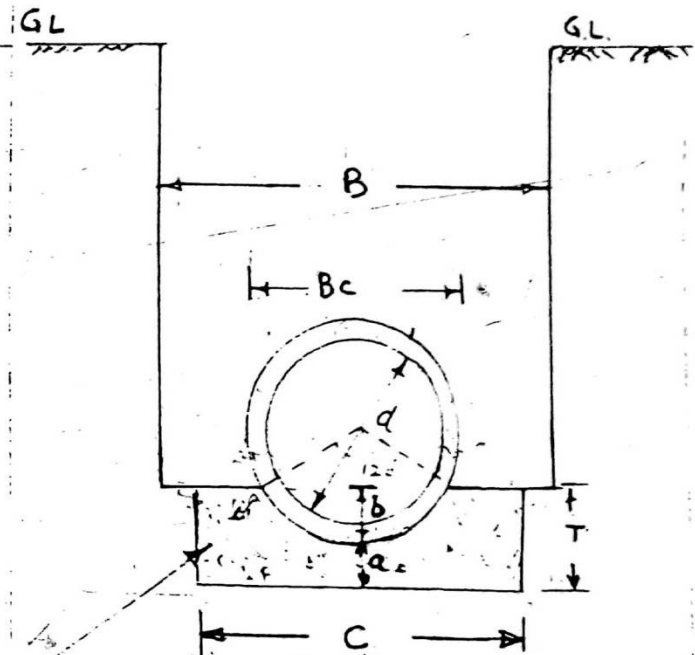
AS PER ITEM 29.2 PWD SPECIFICATION

i) FOR DEPTH UPTO 2.10M = 50CM + EXTERNAL DIA

ii) FOR DEPTH ABOVE 2.10M BUT UPTO 4.50M

= 60CM + EXTERNAL DIA

iii) FOR DEPTH ABOVE 4.50M = 68CM + EXTERNAL DIA



C C 1:4:8 IN NOMINAL CONDITION & C.CON 124 UNDER SUB SOIL WATER

NOTE: ALL DIMENSIONS ARE IN mm

(a) MIN 1/4 i/d OF RCC PIPE

(b) MIN Bc 4

AS PER IS: 783-1959

LAYING OF CONC. PIPES

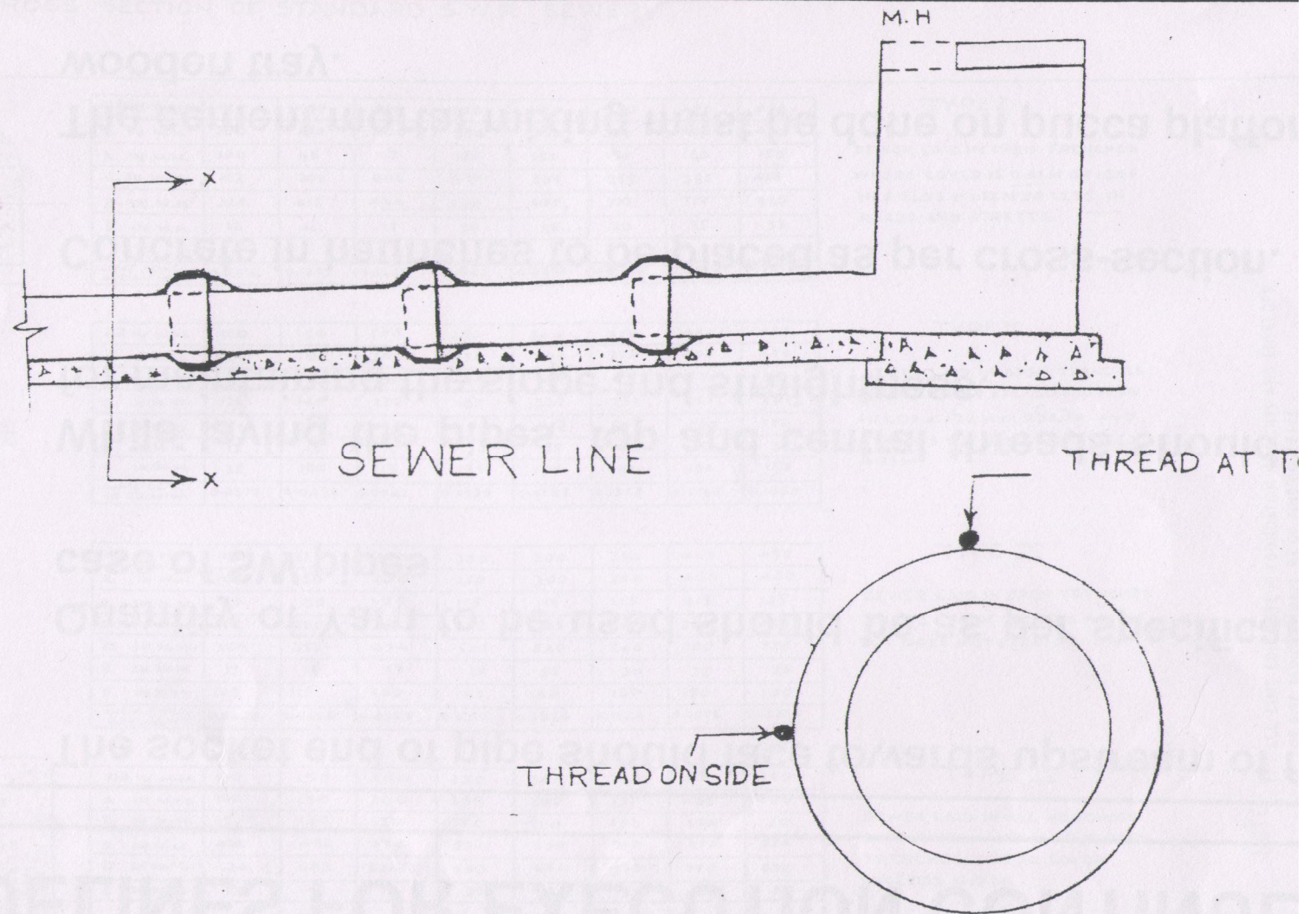
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GUIDELINES FOR EXECUTION CONTINUED...

- The socket end of pipe should face towards upstream of flow.
- Quantity of Yarn to be used should be as per specifications in case of SW pipes.
- While laying the pipes, top and central threads should be tied for maintaining the slope and straightness.
- Concrete in haunches to be placed as per cross-section.
- The cement mortar mixing must be done on pucca platform or a wooden tray.
- Curing of joints for minimum of 3 days before earth filling.

LAYING OF SW PIPE SEWER



SPUN YARN CONSUMPTION IN LAYING OF S.W. PIPES

Internal Dia of SW pipes (mm)	Quantity of Yarn in Kg. per 100 joints
100	4.54
150	9.10
200	12.30
250	16.80
300	19.00
350	22.20
400	25.00
450	28.00

MAN-HOLES

- The larger side (length) of man-hole should be in direction of flow.
- Lean concrete should extend minimum 15 cm extra on all side from outer face of walls of man-hole.
- Preferably RCC bed as per structural design with steel on both faces be placed in man-holes with depth more than 2.5 – 3 mtrs. Especially in areas of high water table.
- Man-hole walls be got plastered from outside also with CP 1:3.
- In case of sub soil water, RCC man-holes shall be constructed.
- Man-hole cover and frame be fixed in corner on upstream side.
- Fix man-hole cover as per site requirement i.e. MD, HD, EHD IS-4111-2003 to be followed.

MAN-HOLES CONTINUED...

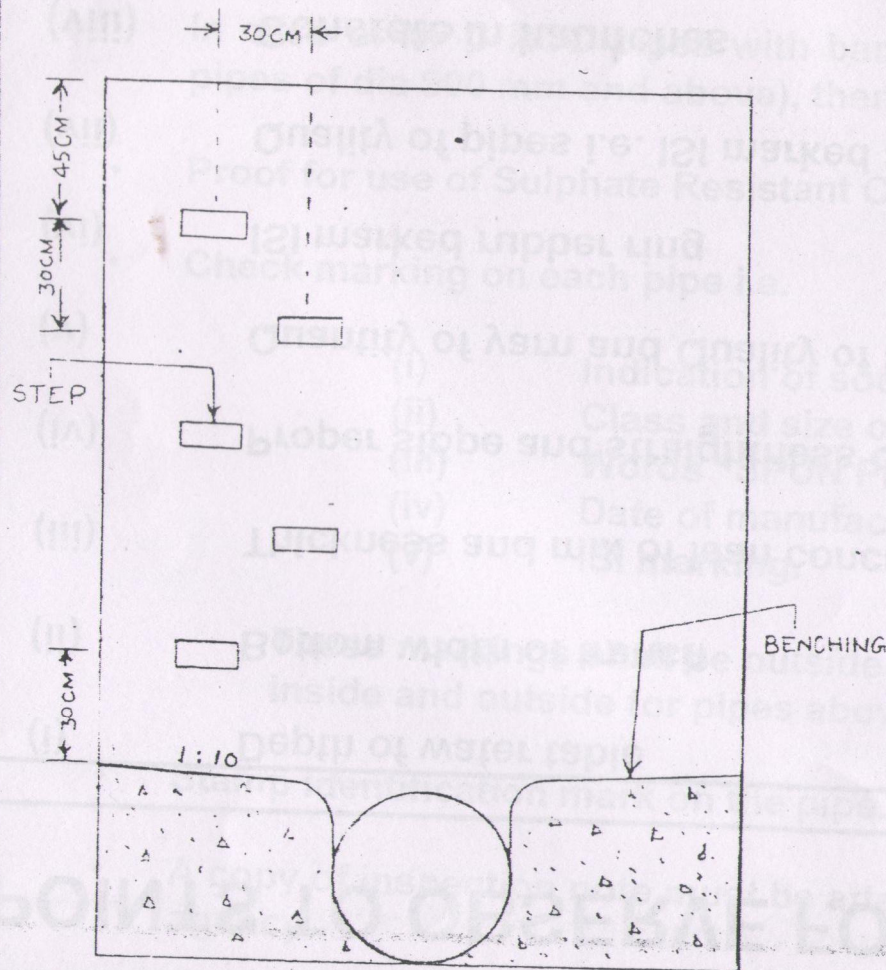
- Flow in man-hole should be carried in U-shaped channel constructed integrally with concrete bed. The side of channel should be equal to diameter of sewer pipe. The benching should have a slope of 1 in 10.
- The top level of man-hole slab should be such that man-hole cover/ frame flushes with the road level.
- Rungs/ PVC steps staggered in two rows 30 cm. apart vertically as well horizontally. Top rung 45 cm below man-hole cover and lowest rung not more than 30 cm above benching.
- Check that sewer pipe joint has been filled properly on underneath side.
- Check the weight of PVC step.

PVC FOOT REST

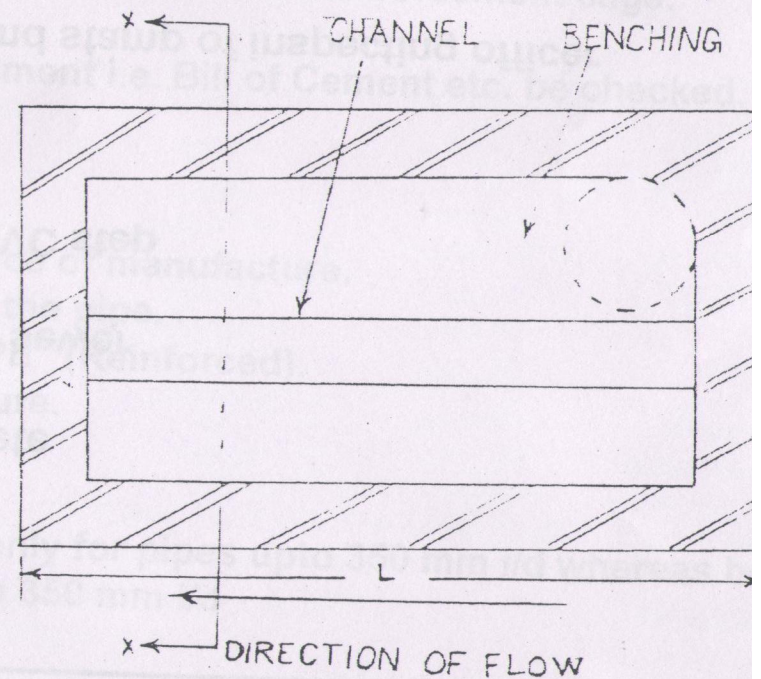
Specifications:

- Polypropylene – 8 mm thick copolymer polypropylene confirming to IS-10910
- Steel – 12 mm diameter steel bar conforming to IS-786
- Load Requirement – Easily exceeds 225 Kg as per IS-5455
- Surface finish – 2 mm treads – On top surface by ribbing or chequering.
- Overall minimum length as 263 mm and width as 165 mm
- Minimum cross section of 23 mm x 25 mm
- Minimum 112 mm space between protruded legs.

MAN HOLE



CROSS SECTION X - X



PLAN OF MAN-HOLE

POINTS TO BE OBSERVED DURING EXECUTION OF SEWERAGE WORK

- Depth of water table.
- Bottom width of trench.
- Thickness and mix of lean concrete.
- Proper slope and straightness of sewer.
- Quantity of yarn and Quality of PVC step.
- ISI marked rubber ring.
- Quality of pipes i.e. ISI marked and stamp of inspecting officer.
- Concrete in manholes.
- Curing
- Lean concrete in man-holes.
- Cleaning and plugging of man-holes.
- Rate for excavation i.e. without shuttering or with shuttering.

RCC PIPE INSPECTION

- Check the weight of steel cage.
- In case of NP-3 RCC pipes with barrel wall thickness as 100 mm and above (i.e. pipes of dia 900 mm and above), there shall be double reinforcement cage.
- Proof for use of Sulphate Resistant Cement i.e. Bill of Cement etc. be checked.
- Check marking on each pipe i.e.
 - (i) Indication of source of manufacture.
 - (ii) Class and size of the pipe.
 - (iii) Words “SPUN PIPE” (Reinforced).
 - (iv) Date of manufacture.
 - (v) ISI marking.
- These markings shall be outside only for pipes upto 350 mm i/d whereas both inside and outside for pipes above 350mm i/d.
- Stamp identification mark on the pipe.
- A copy of inspection note must be attached with office copy of voucher/ bill of the agency.

STEEL TABLE FOR RCC PIPE NP-3

- Design and Strength Test Requirements of Concrete Pipes of Class NP3 – Reinforced Concrete, Medium Duty, Non-pressure Pipes.
- (Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 9.3.2 and 8.1; and Table 20) IS 458:2003

Internal Diameter of pipes	Barrel Wall Thickness	Reinforcements			Strength Test Requirements for Three Edge Bearing Test		Weight of spirals (Hard drawn steel in sockets)
		Longitudinal, Mild Steel or Hard Drawn Steel		Spiral, Hard	Load to produce 0.25 mm Crack	Ultimate Load	
mm	mm	Minimum number	Kg/linear metre	Kg/linear metre	KN/ linear metre	KN/linear metre	Kg/Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
80	25	6	0.59	0.16	13.00	19.50	0.08
100	25	6	0.59	0.22	13.00	19.50	0.09
150	25	6	0.59	0.46	13.70	20.55	0.12
200	30	6	0.59	0.81	14.50	21.75	0.14
225	30	6	0.59	1.03	14.80	22.20	0.15
250	30	6	0.59	1.24	15.00	22.50	0.16
300	40	8	0.78	1.80	15.50	23.25	0.45
350	75	8	0.78	2.95	16.77	25.16	0.64
400	75	8	0.78	3.30	19.16	28.74	0.71
450	75	8	0.78	3.79	21.56	32.34	0.76
500	75	8	0.78	4.82	23.95	35.93	0.87
600	85	8 or 6+6	1.18	7.01	28.74	43.11	1.00
700	85	8 or 6+6	1.18	10.27	33.53	50JO	2.16
800	95	8 or 6+6	2.66	13.04	38.32	57.48	2.87
900	100	6+6	2.66	18.30	43.11	64.67	4.06

STEEL TABLE FOR RCC PIPE NP-3-CONTD.

- Design and Strength Test Requirements of Concrete Pipes of Class NP3 – Reinforced Concrete, Medium Duty, Non-pressure Pipes.
- (Clauses 6.1.1, 6.1.2.1, 6.1.3, 6.2.2, 9.3.2 and 8.1; and Table 20) IS 458:2003

Internal Diameter of pipes	Barrel Wall Thickness	Reinforcements			Strength Test Requirements for Three Edge Bearing Test		Weight of spirals (Hard drawn steel in sockets)
		Longitudinal, Mild Steel or Hard Drawn Steel		Spiral, Hard	Load to produce 0.25 mm Crack	Ultimate Load	
mm	mm	Minimum number	Kg/linear metre	Kg/linear metre	KN/ linear metre	KN/linear metre	Kg/Number
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1000	115	6+6	2.66	21.52	47.90	71.85	-----
1100	115	6+6	2.66	27.99	52.69	79.00	-----
1200	120	8+8	3.55	33.57	57.48	86.22	-----
1400	135	8+8	3.55	46.21	67.06	100.60	-----
1600	140	8+8	3.55	65.46	76.64	114.96	-----
1800	150	12+12	9.36	87.10	86.22	129.33	-----
2000	170	12+12	9.36	97.90	95.80	143.70	-----
2200	185	12+12	9.36	133.30	105.38	158.07	-----
2400	200	12+12	14.88	146.61	114.96	172.44	-----
2600	215	12+12	14.88	175.76	124.54	186.81	-----

NOTES

1. If mild steel is used for spiral reinforcement, the weight specified under col 5 shall be increased to 140/125.
2. The longitudinal reinforcement given in this table is valid for pipes upto 2.5 m effective length for internal diameter of pipe upto 250 mm and upto 3 m effective length for higher diameter pipes.
3. Total mass of longitudinal reinforcement shall be calculated by multiplying the values given in col 4 by the length of the pipe and the deducting for the cover length provided at the two ends.
4. Concrete pipes shall have a minimum compressive strength of 35 N/mm² at 28 days.
5. Longitudinal reinforcement in sockets shall be proportional to length of socket cage.